



## Haynesville | Activity Overview

### December 2017

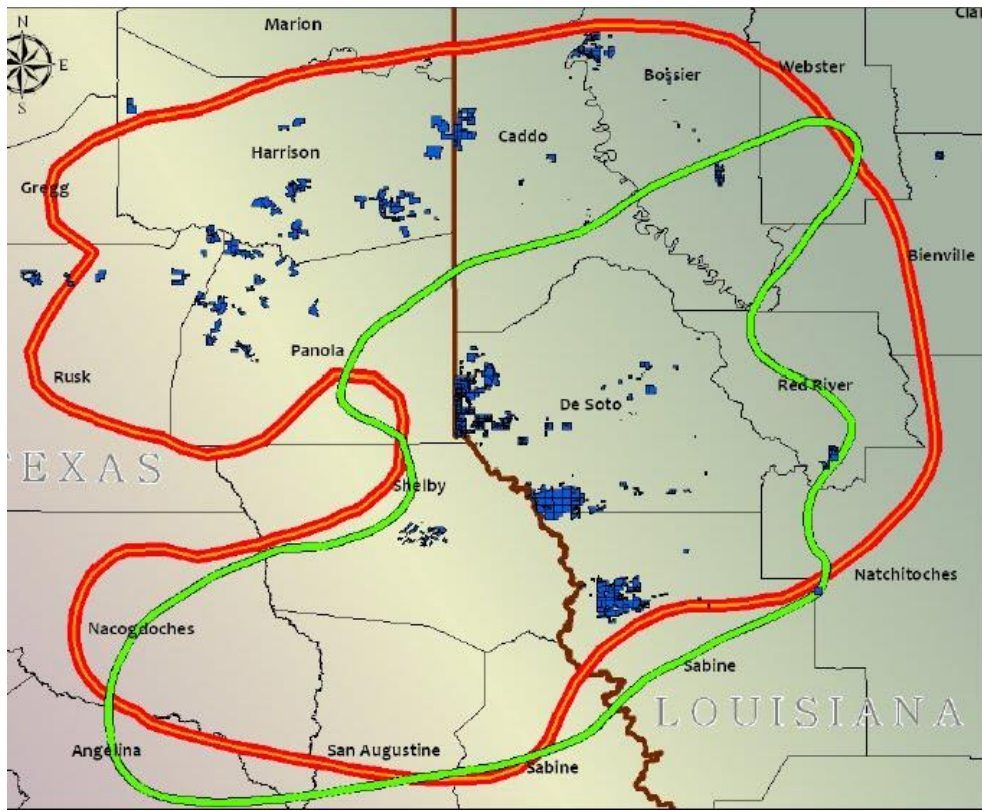
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Our technical competence comes from a wide variety of backgrounds with an emphasis on energy and industrials. Our experience covers upstream, midstream and downstream markets, including exploration, completions, well services, project management, engineering, pipeline and processes, refining, chemical processing, supply chain, operations, and financing in the oil, gas, renewables and industrial sectors.

Here, we present an update on the Haynesville Shale play and explore the reasons as to why the region represents an attractive destination for investment in both the short and long term.

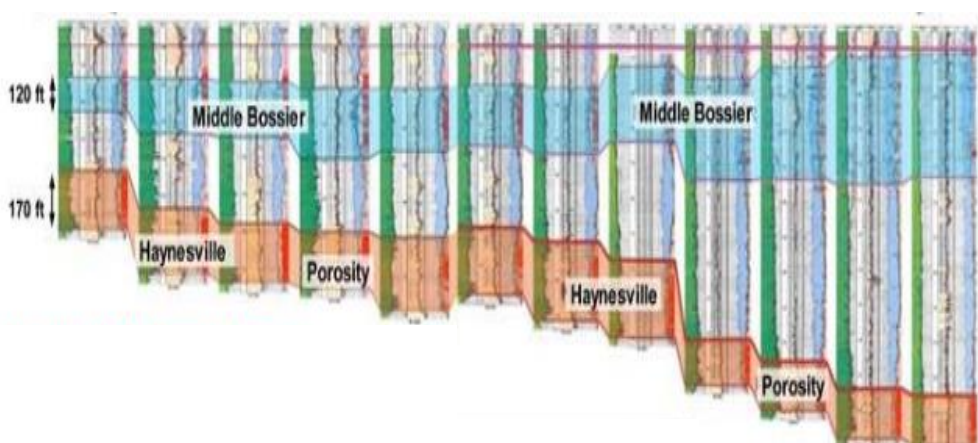
**Activity in the Haynesville was impacted more than other plays, as operators focused reduced budgets on liquid rich plays. However, as a dry gas play, well located and well connected to several LNG developments on the South Coast, the outlook for the Haynesville is more optimistic.**

#### Haynesville- Bossier Shale Play | [Haynesvilleplay.com](http://Haynesvilleplay.com)



The Haynesville Shale (outlined in red above) is primarily a dry natural gas formation that runs through Northwest Louisiana and East Texas at depths between 10,000 and 14,000ft. The Bossier Shale (outlined in green above) is also a productive formation, that lies above the Haynesville formation, although operators commonly refer to the Haynesville/Bossier shale as a collective. Parts of the Haynesville Shale are overlain by the Cotton Valley Clastic trends and/or underlain by the Lower Smackover Brown Dense. Chesapeake was the first operator to effectively produce the Haynesville in 2008. The Haynesville shale is typically 100 to 350 feet wide.

#### Haynesville- Bossier Shale Play Cross Section



One characteristic of the Haynesville play is that it is over pressured. This results in extremely high flows post completion that typically decay quickly over time. Formation depths and pressures are normally higher in the eastern (Louisiana) side of the play. Current Haynesville drilling and completion activity is centered in Northern Louisiana with less (though growing) activity in East Texas where target depths (and well costs) are typically greater.

During the downturn, operators have been choking back initial production rates to expand the productive life of a well and increase total recovery from horizontal wells.

In 2011, the Haynesville play surpassed the Barnett Shale to become the highest producing shale gas play in the US.

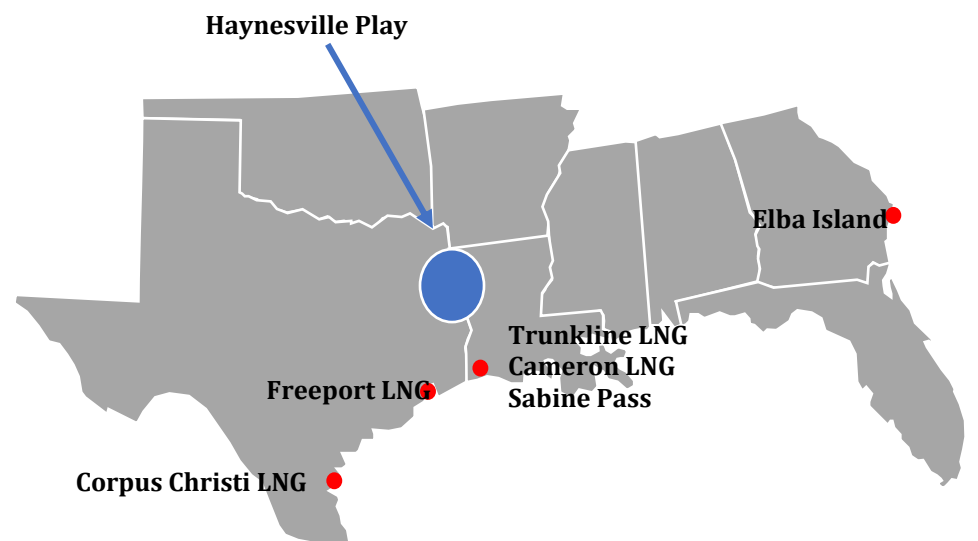
However, a combination of low gas prices, increased gas from oil production and oil price imposed budget cuts, saw activity in the play reduce significantly from its 2012 peak, and it has not returned at the same pace as the lower cost Marcellus shale in the North East.

Activity is returning however, and the rig count has increased monthly since the turn of the year.

Longer term dynamics appear favorable for the Haynesville because:

- 1) It is well connected to export channels (several major pipelines), and petrochemical plants resulting in no export bottlenecks similar to those that characterize production from the Marcellus for example. Price differentials are only ~10¢ to 15¢ vs. Henry Hub compared to ~\$1 transportation costs from the Marcellus.
- 2) It will be well located to serve the emerging LNG export hubs on the Gulf Coast, including the Sabine Pass and Cameron plants in Louisiana, the Freeport and Corpus Christi plants in Texas and Kinder Morgan's Elba Island trains in Georgia.
- 3) The IGS released estimates earlier this year that the Haynesville and Bossier formations collectively held more than four times the amount of gas thought to be in place in 2010
- 4) Improving extraction economics due to longer laterals, improved fracture designs, higher fluid volumes, and refracs of existing wells.
- 5) Reduced drilling and completions costs, although operators are now indicating that some costs (including frac crews) have begun to rise.
- 6) Favorable tax treatment in Louisiana due to the 24 months severance tax suspension on horizontal wells in Louisiana (estimate ~15¢ per MCF)

#### Haynesville – Access to LNG Export Hubs | Calash



**The Haynesville has seen a high level of M&A activity in recent months. Divestment has been driven by many operators disposing of what they perceive to be non-core, higher cost assets, as well as providing financial relief to service mounting debt. Investment has been driven by**



the availability of relatively cheap acreage and operators beginning to position themselves for the LNG driven resurgence. In addition to the larger transactions listed below Haynesville operators have been completing many smaller swaps and other A&D transactions to increase their operated acreage and their inventory of extended reach laterals.

### M&A Highlights

**Oct 18: Goodrich Petroleum** agreed to an acreage swap on its undeveloped Haynesville position in Northern Louisiana to enable drilling of longer laterals in the play. The company swapped about 900 net acres out of its Metcalf area of central Caddo Parish for a similar acreage position in the Bethany-Longstreet area of Southern Caddo Parish. Earlier in the year, Goodrich had conducted a separate swap on a portion of its undeveloped acreage in the Bethany-Longstreet field.

**Aug 17: Rockcliff Energy** acquired 60,000 net acres of Haynesville Shale rights, located in Harrison and Panola Counties, East Texas. This followed its \$525million acquisition to buy assets from **Samsom Resources** two weeks previously, and is part of Rockcliff's wider, two play strategy, which focuses on the Haynesville and Permian basin. Early investment in the strategy has been directed towards Haynesville, with the CEO citing the cost of deals in the Permian as a barrier.

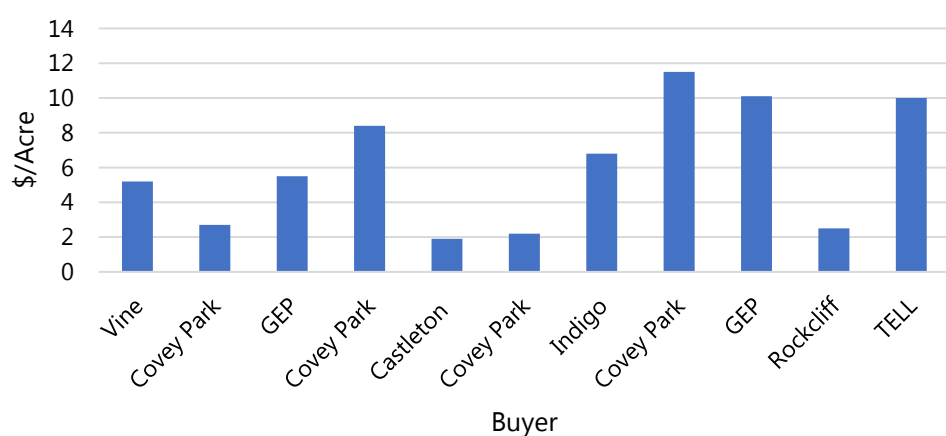
**Feb 17: Covey Park Energy LLC**, an independent oil and gas exploration and production company, acquired assets (41,500 net acres and 326 operates and non-operated wells) from **Chesapeake Exploration LLC** and associated companies for \$465million. It issued preferred equity to Magnetar, KKR and Triangle Peak to fund the acquisition and support growth initiatives. This followed the acquisition of additional assets in the Haynesville by Covey in Nov 2016 (90,000 net acres with average net production of 35MMcf/day.)

The Covey sale was the third significant Chesapeake divestment in recent months. In Dec 2016, it agreed the sale of \$450million (78,000 net acres including 250 wells producing c.30mcf of gas per day).

Covey Park submitted a proposal relating to a proposed IPO to the SEC in April 2017, with the offering expected to commence before the end of the year.

**Sept 17: Enable Midstream Partners** acquired **Align Midstream LLC** for \$300m. Align owns natural gas gathering and processing assets in both the Cotton Valley and Haynesville plays, as well as almost 200 miles of natural gas gathering pipelines and a cryogenic natural gas processing plant in Texas.

### Key M&A Transactions in the Haynesville from 2014, \$/Acre | RSEG

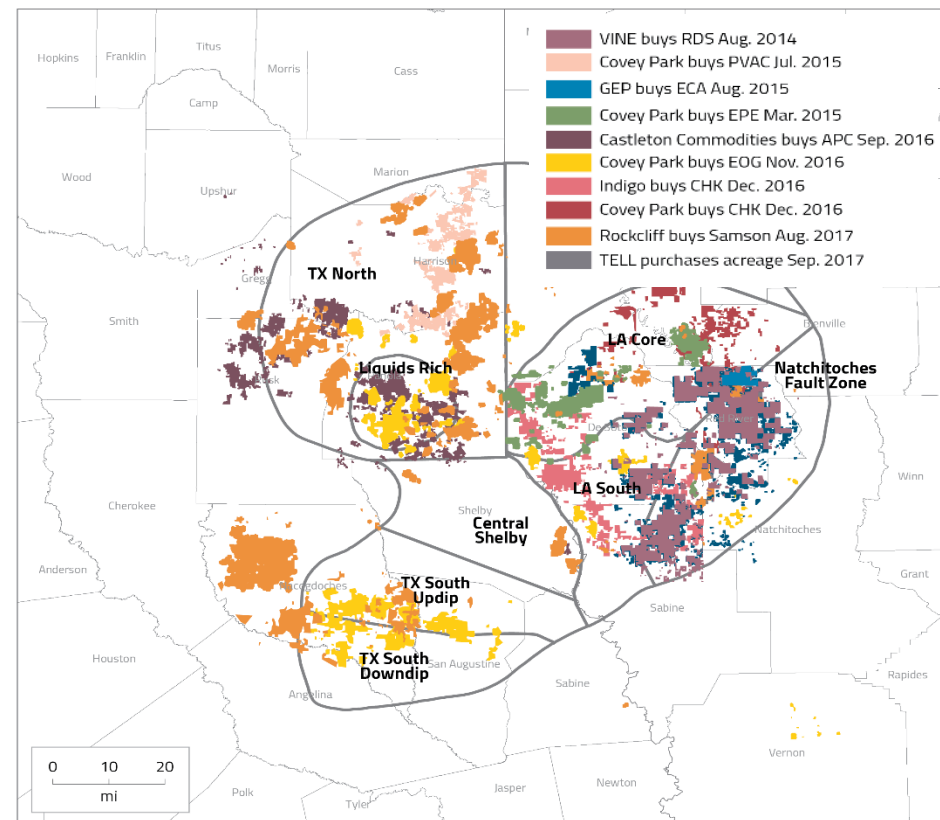


### Prevailing Trends

#### Divestment of Historical Key Players:

Chesapeake and Anadarko have both have divested significant assets, selling regional legacy assets to Private Equity backed independents, with divestments totaling nearly \$2billion.

### Key Acreage Acquisitions in the Haynesville | RSEG



### Access to LNG export Hubs and Petrochemicals:

LNG is likely to have been a consideration in the majority of recent deals, and the potential of access to LNG hubs has been, and will continue, to stimulate the play's recovery.

Perhaps the best example of the influence of LNG is seen in exporter **Tellurian** who announced in September 2017 it planned to buy 9200 net acres in the Haynesville for \$85million, in a bid to undercut Henry Hub Prices.

Tellurian also plans to export LNG from the proposed Driftwood terminal (Lake Charles, LA), and the acquisition of upstream acreage indicates a move to a small scale, integrated operator model.

The founder of Charif Souki recently highlighted that the cost of producing and exporting LNG from the Haynesville will be \$2.25 per mbtu, a significant discount relative to the daily LNG price for the Gulf of Mexico (\$7.66pmbtu).

Japan's biggest gas supplier (**Tokyo Gas Co**) acquired a 30% stake in a subsidiary of **Castleton Commodities**, which owns and operates over 160,000 net acres in the Cotton Valley and Haynesville Shale and has a net production of 238mcf per day (c.1.65mtpa of LNG)

The BG Group (now **Shell**), a primary global LNG player also has a presence in Haynesville, with a 50/50 production JV with **Exco Resources**, who announced in 2015 that it would shut down all Eagle Ford drilling to focus on Haynesville.

### Midstream Growth:

With renewed interest in the Haynesville play being in part driven by the attractiveness of access to LNG export hubs, investment in the midstream will continue to increase over the coming years in order to connect LNG export hubs to upstream production.

### Improving Extraction Economics:

In 2014, the Haynesville had some of the most expensive well breakeven costs in the US, due in part to the depth of the target horizon.

The re-emphasis on gas production during the oil price crash inspired a re-focus on developing technology to improve the well economics of the Haynesville play – the increased use of extended reach lateral wells for example.

**Well Design:** Lateral lengths are steadily increasing in the play improving well economics; typical lateral lengths range from 4,500 to 8,500 feet. However, Operators are now increasingly drilling at or near 10,000 foot laterals.

QEP stated recently that they intend to begin drilling some 10,000 foot lateral wells while Exco has said that 50% of their 2017 wells will be longer laterals up to 10,000 feet.

Chesapeake recently stated that their first 15,000 foot lateral Haynesville well should begin production in Q1 2018.

**Drilling:** Drilling speeds have significantly increased in the Haynesville play, with some wells approaching 20 days from spud to total depth. Average wells are typically 25-30 days.

**Fracture Design:** There has been continuing improvement in the execution of so called Generation 2 completion designs in the Haynesville with a significant transfer



of fracture design knowledge from other basins. Leading edge proppant intensities have increased from 2,500 to 3,000 pounds per foot in Generation 1 designs to around 4,000 pounds per foot in Generation 2 designs. While some operators have experimented with 5,000 pounds per foot proppant intensities, recent results show similar production levels can be achieved with lower proppant loadings. Chesapeake recently announced its Black 2 and 1-15-11 1H well, which has a lateral length of 9,764 feet, was completed with 5,140 pounds of sand per foot. Jason Piggot, Chesapeake's VP of Operations stated that, "This Chesapeake well is further evidence that more proppant, more stages and longer laterals is the right way to go". However, Chesapeake has also seen positive results with wells in the 2,600 to 2,700 pounds per foot range recently. Average proppant intensities in the play have now reached around 2,500 pounds per foot, however future wells will likely be completed with proppant intensities in the 2700 to 5000 pounds per foot range resulting in more pressure pumping per well on average. Stage spacing has decreased from around 250 feet between stages in Generation 1 designs to 150 feet in Generation 2 designs while cluster spacing has decreased from 50 feet to 30 feet. QEP has adopted dissolvable frac plugs for all its refractures.

**Frac Hits:** Tight spacing of wells in the Haynesville leads to a high potential of interference in existing wells from new well completions or refracturing of existing wells. In some cases, interference can lead to increased production in offset wells (~1million cubic feet per day according to Comstock Resources). Operators are however increasingly aware of potential frac hits and have reduced the impact of frac hits by shutting in offset wells to allow pressure build. Sources indicate the communication between offset operators is healthy which should help to minimize negative impacts of frac hits.

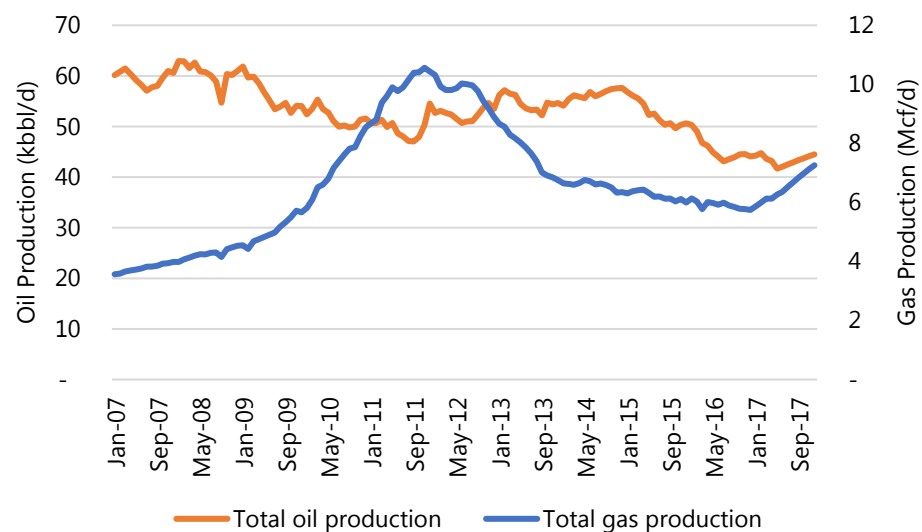
**Refracturing:** Refracturing of existing wells has added significant production in the Haynesville play. Refracturing is a cheaper alternative (~\$3-\$5.5million vs. ~\$8-\$12million) to drilling new wells, and allows operators to integrate updated fracturing techniques including stage and cluster spacing, proppant loading and fluid volumes in existing wells. QEP spent \$44 million per quarter on refracs in the play in Q2 and plans to increase its number of refracs by at least ten this year. Chesapeake has begun to refracture wells by running a new production liner including one which reached around 9 million cubic feet of gas per day from a lateral section of only 2,990 feet post refrac. The company indicated recently that they intended to increase their refrac activity, completing a further 29 refracs this year. Comstock has identified 115 potential refrac opportunities amongst its well inventory.

**Pressure Maintenance:** Operators are becoming increasingly conservative when selecting choke sizes to flatten production curves and minimize drawdown. This strategy should lead to increased estimated ultimate recoveries (EUR), but does have negative implications for a company's cash flow profiles. Reducing choke sizes can allow well fractures to heal and remain open before gradually opening the choke and therefore increase EUR. Haynesville operators are still experimenting and gathering data to ascertain optimal choke sizing.

**Costs:** Although reduced costs have played a major role in the resurgence of the basin, operators are indicating that service prices have begun to increase because of high demand. Exco indicated on their most recent conference call that price increases on completion related materials and services including coiled tubing and pumping were projected to lead to a 10 to 13% increase in well costs and that quotes for future services have continued to increase. Current indicative well cost data points include \$11.4 million for a 10,000 foot well (Chesapeake) and \$9 million for a 7,500 foot well (Goodrich).

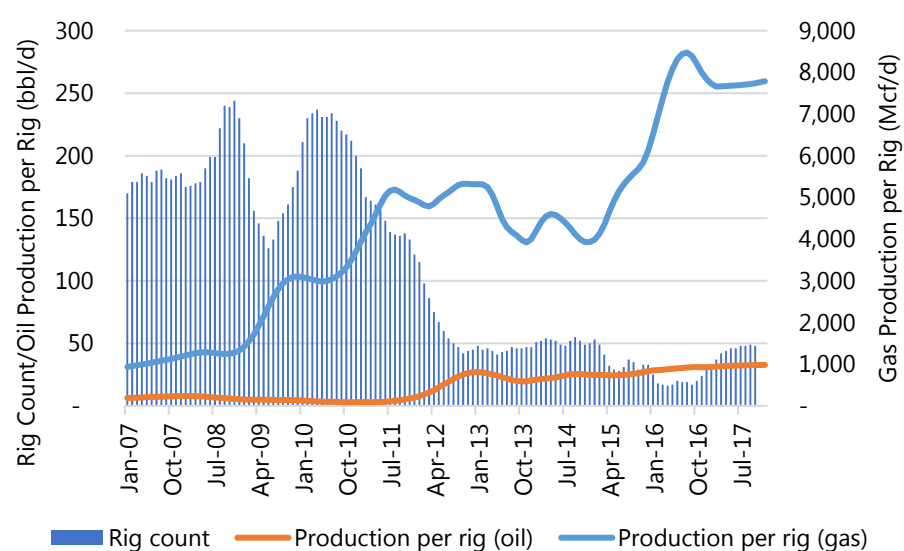
## Activity Overview

Haynesville Oil and Gas Production | EIA, 2017



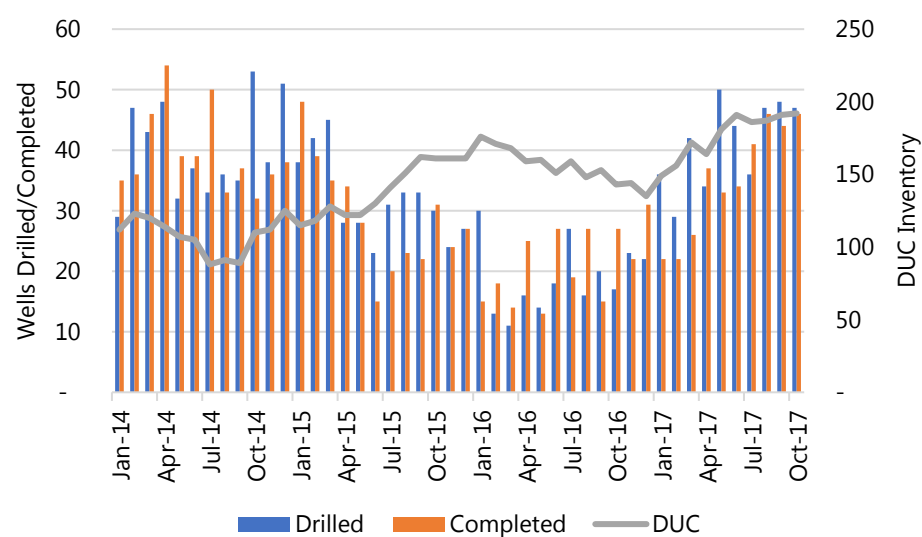
The recent uptick in Haynesville gas production highlights the returning positivity, reinforcing the belief that the Play is set to experience a new wave of investment, with activity focused in the Louisiana parish of Desoto, and parts of Caddo, and Bienville parishes.

Haynesville Rig Count and Efficiency | EIA, 2017



The uptick in rigs correlates with the uptick in gas production, and has been driven in part by the volume of acreage changing hands over the last 12 months. Gas production has risen more than 20% in 2017. The Haynesville rig count now stands at ~40 with multiple operators committed to adding rigs before the end of the year.

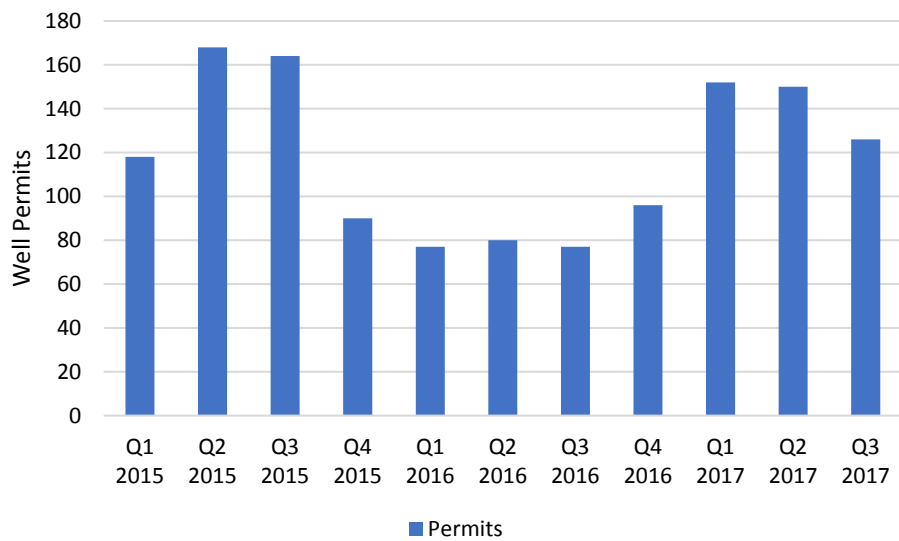
Completed Wells DUC Inventory | EIA, 2017



Haynesville wells have also seen a steady uptick in initial production (IP) in addition to a material upward shift of type. Typical IPs range from 15 million to 25 million cubic feet per day. Record or near record IPs have been set by operators including QEP (37 million cubic feet per day) and Chesapeake (38 million cubic feet per day). Chesapeake has noted that IP of 30 million cubic feet per day is the new normal for their wells, compared to an average of around 12 million cubic feet per day 3 years ago.

Based on the number of well permits, with average quarterly growth of 14.3% from Q1 16 to Q2 17, the uptick in drilling activity and rig count is a trend likely to persist based on the pickup of permit grants since the turn of the year.

## Haynesville Well Permits | Shale Experts, Q3 2017



### Key Regional Operators:

**Chesapeake Energy** discovered its Haynesville play in 2008 and remained during the downturn, striving to improve well economics and efficiencies, whilst some competitors left to pursue production in lower cost plays such as the Marcellus, Chesapeake has perhaps been the highest profile company to divest its Haynesville assets in recent months, driven in part to generate cash to pay down debt.

**Vine Oil and Gas** partnered with **Blackstone Energy Partners** to acquire Shell's Haynesville assets in 2015 for \$1.2 billion, leaving Vine with 107,000 net acres in the Haynesville. Drilling activity has increased year on year since acquisition.

**Indigo** is an independent operator focused on the Haynesville play with 97,350 net acres and a further 75,000 net acres targeting the Bossier. Indigo has also purchased Cotton Valley rights from other operators across the play.

**GEP Haynesville** bought Encana assets in the Haynesville in 2015 for \$850m and has recently acquired a further 5246 net acres from Sabine Oil and Gas (for \$45m in July 2017) as it continues to ramp up activity.

**Aethon Energy** is a private investment firm making direct investments in onshore assets in North America, acquired Haynesville acreage in 2014 when it took over the assets of Noble Energy Inc.

**Covey Park** is a private equity backed producer that has acquired significant acreage in the Haynesville of the last couple of years. It was formed in 2013 with \$300m backing from energy focused investor Denham Capital.

**Memorial Resources** had 220,000 net acres and in excess of 5Tcfe resource potential prior to its acquisition by **Range Resources** in May 2016 for \$4.4billion. At the time of acquisition, Memorial had natural gas production from 561 gas producing wells and an estimated 4000 horizontal well locations. Range Resources is focusing their efforts in Louisiana on the Terryville field (part of the Cotton Valley play).

**EXCO Resources** has 97,800 net acres in the Haynesville, targeting both the Haynesville and Bossier Shales. Its activity during the downturn has been limited, with activity levels falling since 2015 when production was 271Mmcfe. Exco has indicated that it may potentially enter Chapter 11 bankruptcy proceedings in the near future.

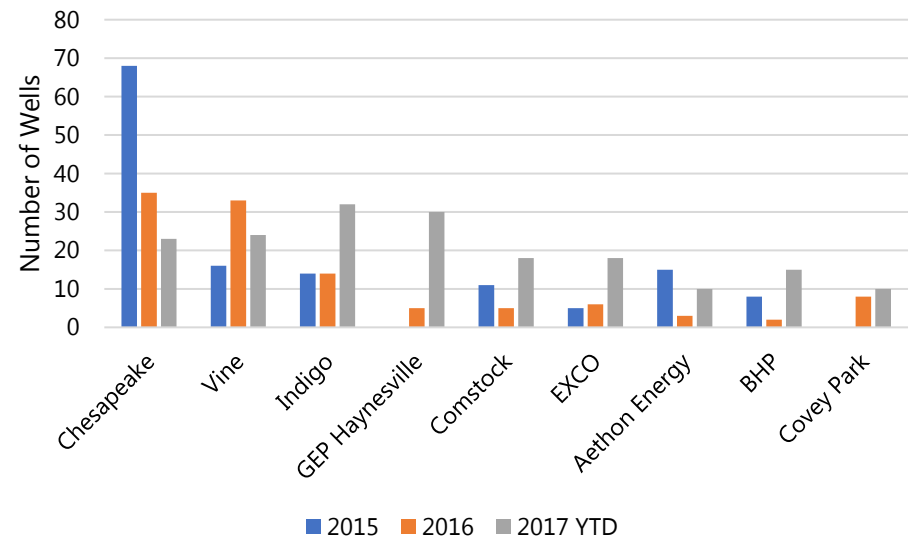
**BHP** has divested its footprint in US Shale significantly since 2011, and is actively marketing extensive leaseholds throughout the Permian, Haynesville, Eagle Ford and Fayetteville shales, with its unconventional onshore assets now considered 'non-core'. BHP has remained active in the Haynesville, relative to other locations, citing the production cost profile and remaining reserves as primary reasons for its commitment to the play – recently increasing the number of active rigs.

**Comstock** is a Haynesville focused independent with 859Bcfe of proved reserves and 700 future drilling locations on both the Haynesville and Bossier play. Its 2017 budget includes drilling 22 horizontal wells in 2017, and currently has three rigs active.

**Exxon**, through its subsidiary **XTO**, holds more than 661,000 net acres across Louisiana.

**QEP** has 144.3MMboe of proved reserves in the Haynesville and produced 2792.2Mboe in Q2 2017. It owns 48,000 net acres. QEP has not been actively drilling in 2017, but has indicated that it will shift capital back to its dry gas assets in the Haynesville when economics improves. QEP expect to re-frac 30 wells in the Haynesville throughout 2017.

### Horizontal Wells Drilled by Operator in the Haynesville | Rig Data, 2017

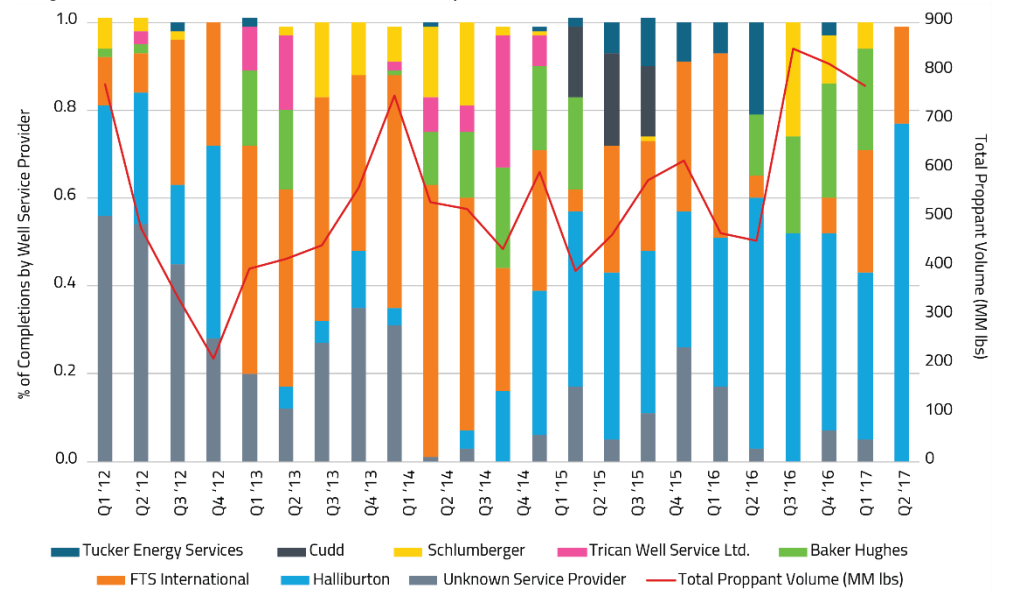


Haynesville operators currently active in East Texas include BP, Sabine, Rockclif and Sheridan.

**High levels of M&A activity and change in ownership of acreage present both risk and opportunity to businesses in the supply chain. Established working relationships will be severed as incumbents leave and opportunities to disrupt market share will be enhanced by new entrants. With large portions of the supply chain under resourced and cash constrained, opportunities for growth of existing, or new entrants will likely be higher, providing resources and financial support is in place.**

Smaller well service providers have moved out of the Haynesville, or ceased operations altogether during the downturn, leaving only privately owned FTS competing with Halliburton (who has grown its market share significantly since Q4 2014), Baker and Schlumberger.

### Haynesville Well Service Providers | RSEG



Due to the high pressures associated with the Haynesville shale, pressure pumping equipment operating in the play experiences higher than average wear rates. Increasing Haynesville activity is a positive indicator for pressure pumping repair, maintenance and new (replacement) order activity. The current uptick in Texas drilling activity where wells are typically deeper and higher pressure should translate to increased demand for pressure pumping HP in the play.

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