Managing the Curve

Lower capital costs and improved productivity make the Duvernay liquids and oil plays possible, but operating costs will drive profitability

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Overview of Study

This study reviews early stage development of the Duvernay shale play in Alberta, with a special focus on liquids development in the Kaybob and the East Duvernay shale. It looks at the geology of the play, activity in each play since its inception, and how capital efficiencies have improved through the evolution of drilling and completions technology. It then looks at operational challenges facing Duvernay producers and potential solutions to ensure profitability in the long term.

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The case for the Duvernay

The early-stage development Duvernay shale play became a significant area of focus for exploration and development companies seven years ago. Approximately 550 horizontal wells have been brought on-stream since 2011 and current production is around 80,000 barrels of oil equivalent per day.

The original focus for exploration was the southwest corner of the Duvernay in the Willesden Green area with deep natural gas being the initial target. Early drilling also focused in the Kaybob area to the north with higher condensate or oil production. The vast majority of Duvernay wells have been drilled at Kaybob but 2017 saw increased activity in what is called the East Duvernay shale basin, targeting oil in shallower zones. This report focuses on activity in the Kaybob and East Duvernay plays.

A number of companies, including multinationals Chevron and Shell, are moving into full-scale commercial development in the Kaybob area of the Duvernay, and production from the play is expected to begin climbing throughout 2018-2019 and beyond.

Activity is also heating up in the East Duvernay, led by private company Vesta Energy and a number of other junior and intermediate operators.

This report provides an update of the resource potential for the liquids rich and oil-rich areas of the Duvernay. It also reviews development from 2013 to 2017 through the window of productivity improvements driven by technological change.

It compares economic factors at work in the Duvernay that will influence future development trajectories. And it looks at potential operational challenges and solutions to these challenges that will ultimately determine the profitability of Duvernay liquids development going forward.

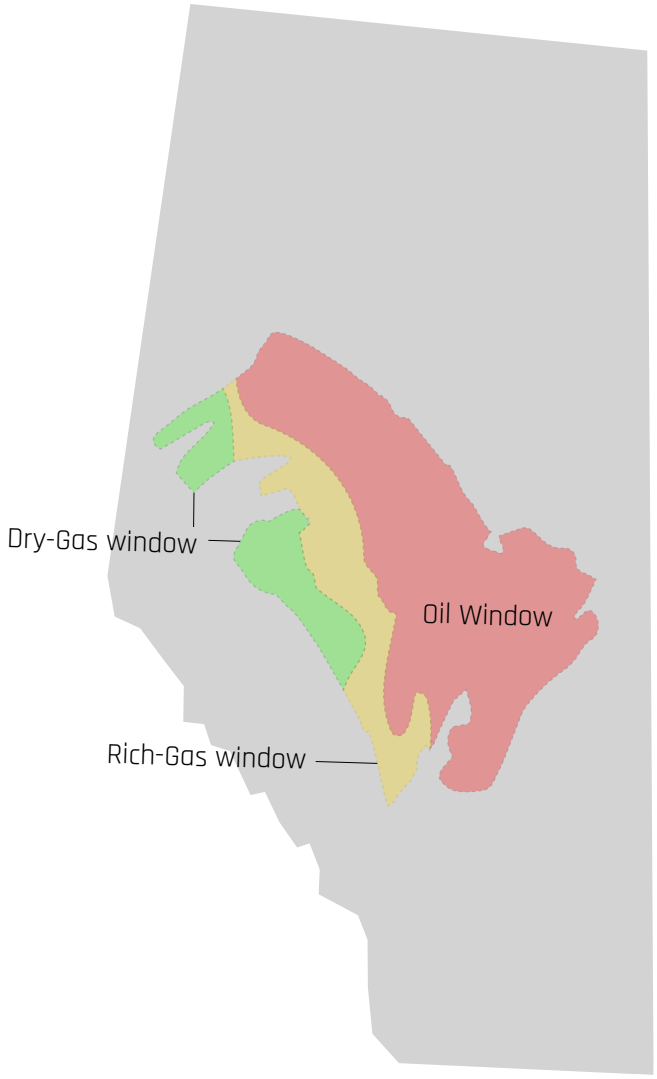
Duvernay Review

Duvernay Review

The Duvernay covers an estimated area of 38,600 square miles. It has deep, over-pressured zones on its western flank prospective for natural gas, a liquids-rich sweet spot mid-basin, before becoming shallower and oil prone as it moves eastward.

Duvernay Play Characteristics	
Estimated Area (sq. miles)	38,610
Depth (metres)	2,800-3,600
Net Thickness (metres)	25-60
Carbonate Content (%)	30-90
Mineralogy (% non-clay)	70-90
Total Organic Content (%)	1-7.5
Average Porosity (%)	6.0-7.5
Permeability (mD)	10-400

Source: Alberta Energy



Duvernay Review

A number of recent studies on the resource potential, technically recoverable resources and marketable resources in the Duvernay have been completed in the last few years. The studies show the Duvernay is a world-class resource with significant oil, gas and liquids resources.

West Shale Basin		
Natural Gas (TCF)	NGLs (billions barrels)	Oil (billions barrels)
703	73.9	102.4

East Shale Basin		
Natural Gas (TCF)	NGLs (billions barrels)	Oil (billions barrels)
118	21.7	106.1

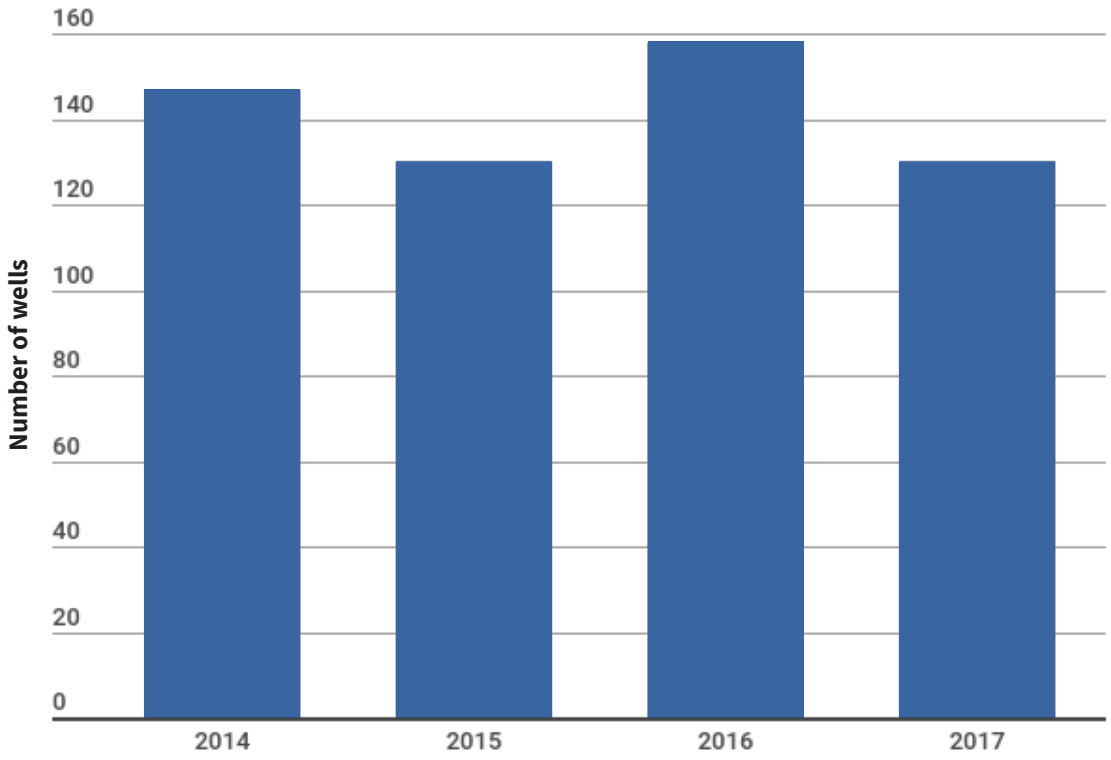
Duvernay Total		
Natural Gas (TCF)	NGLs (billions barrels)	Oil (billions barrels)
820	95.5	208.4

Source: AER/AGS midrange estimate

Duvernay Marketable Resources (TCF, billions of barrels)	
Gas	76.57
Oil	3.4
NGLs	6.26
Ethane	3.4
Propane	1.6
Butane	0.795
Petanes Plus	0.456

Source: NEB expected marketable recovery

Drilling ramp-up slow and steady

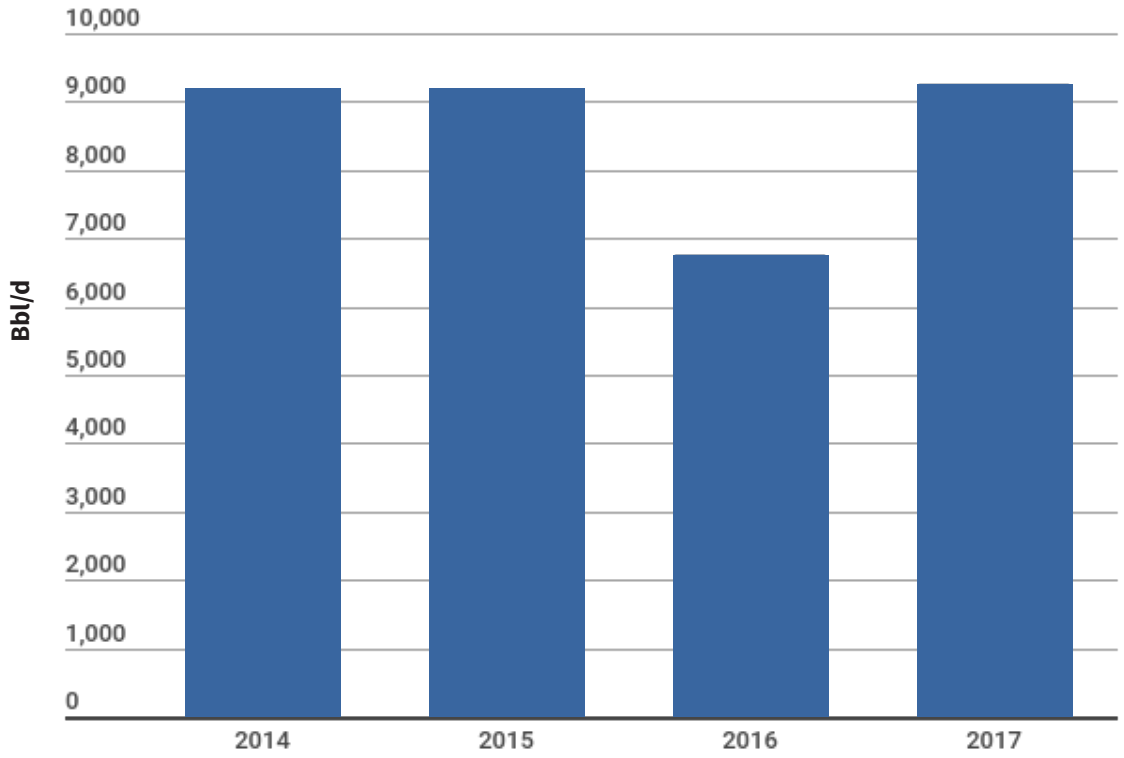


Source: CanOils

The number of wells drilled in the Duvernay climbed by 58 per cent, to 147 wells, between 2013 and 2014 before commodity prices collapsed.

Since then they have been relatively flat.

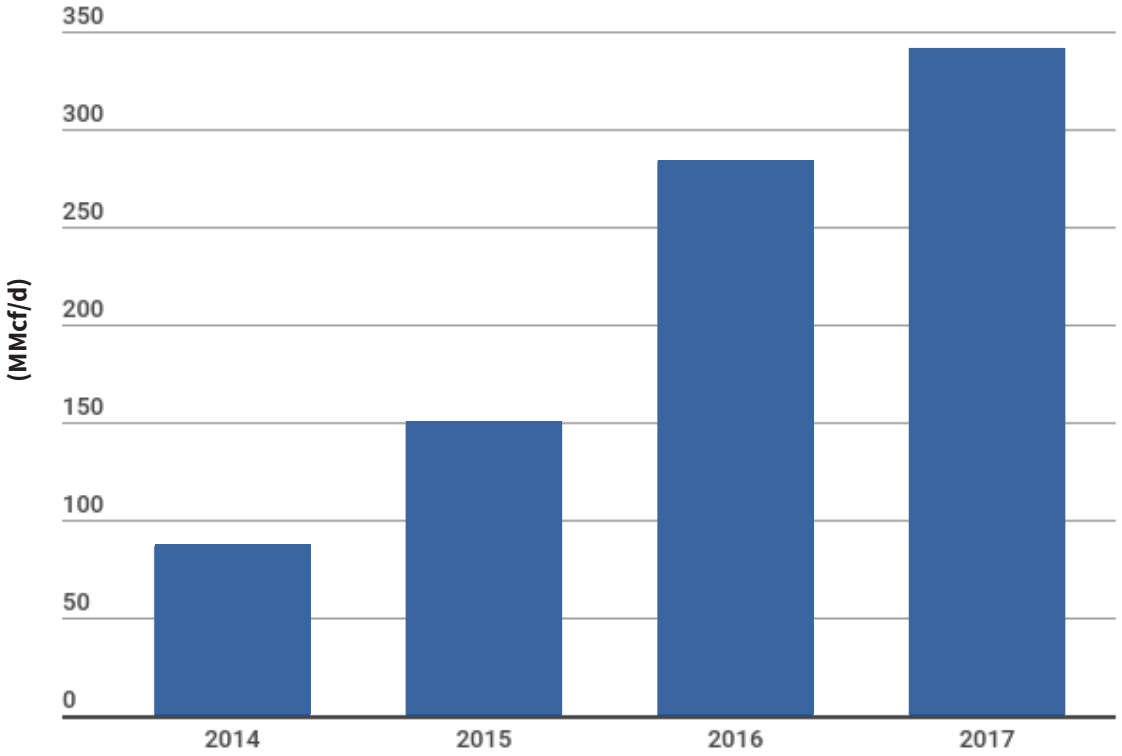
Oil production



Source: CanOils

While still in the early stages of development, oil production has climbed by 320 per cent from the first quarter of 2013 to the final quarter of 2017. This upward trend is expected to continue as more wells are drilled in the oil prone East Basin.

Natural Gas production on upward trajectory



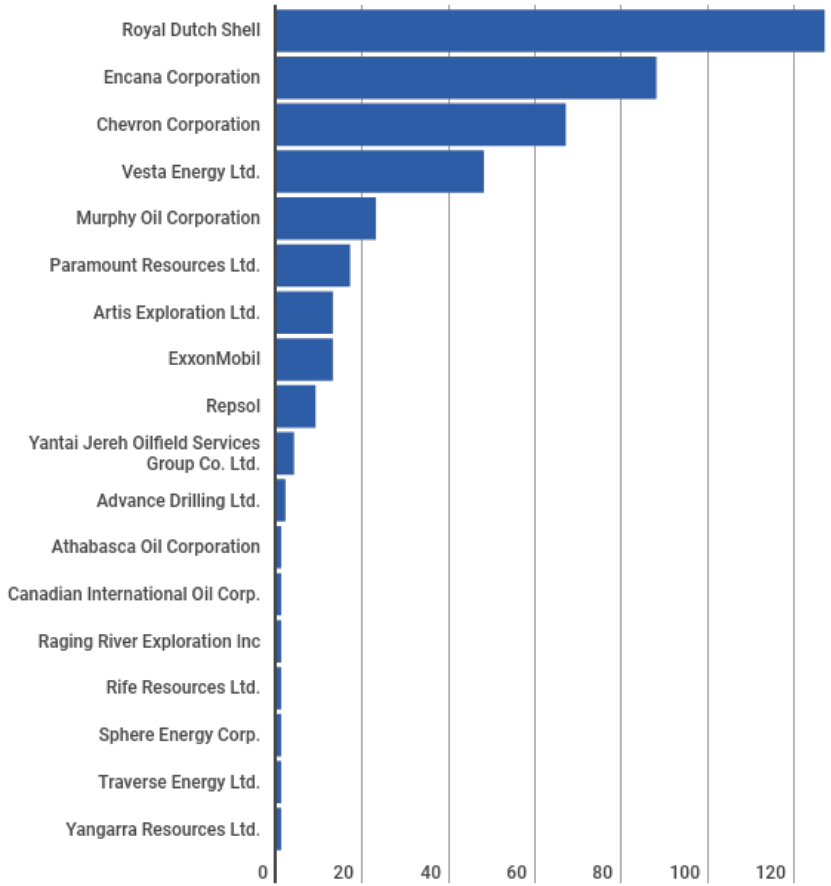
Source: CanOils

Duvernay natural gas production climbed by over 1,200 per cent from the first quarter of 2013 to the final quarter of 2017. Operators targeting condensate rich areas of the play that improve well economics have largely driven this increase.

There are no accurate figures for condensate production in the Duvernay.

Wells spud by operator

Number of wells spud between 2015-17 by current licensee (as of Dec 2017)



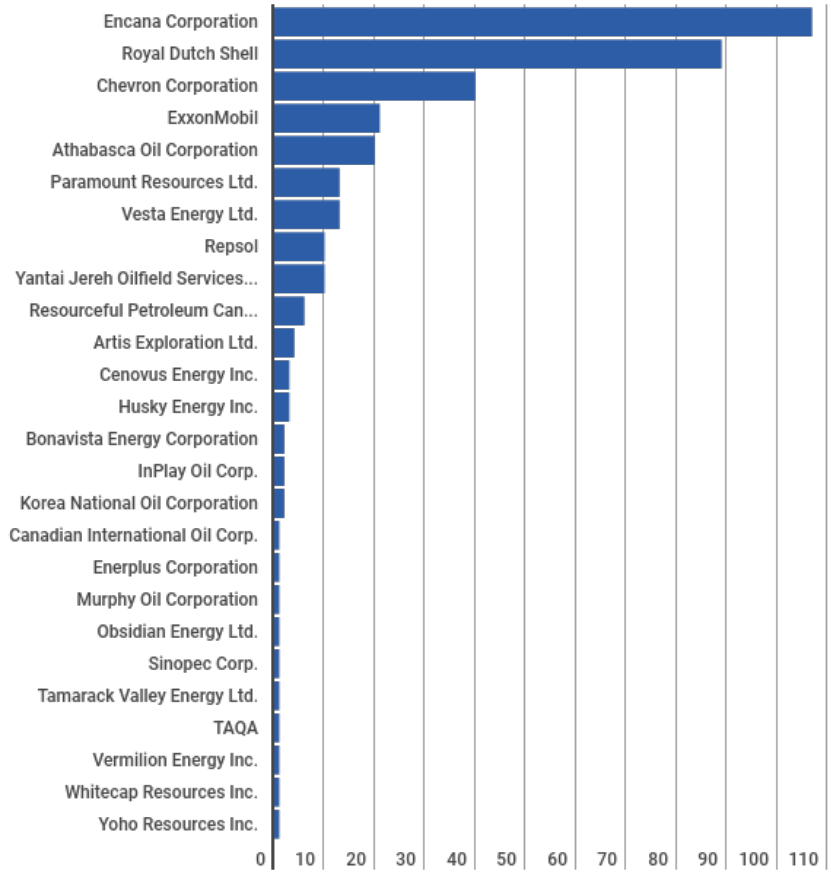
Source: CanOils

A small number of large operators are responsible for the majority of wells drilled into the Duvernay the last three years, with the top three accounting for more than half of wells drilled in the play.

In the East Duvernay, Vesta Energy and Artis Exploration have drilled almost all wells in the play.

Active wells by operator

Number of active wells as of Dec 2017 by current operator (only including wells spud since Jan. 1, 2013)



Source: CanOils

Again, large operators dominate the number of active wells producing in the Duvernay with EnCana the largest operator, followed by Shell and Chevron.

Technology drives down capital costs

Drilling technologies

High performance drilling rigs featuring AC drive systems, automated pipe-handling, walking systems, large pipe-racking capacities and the ability to drill with stands as long as 90 feet dominate activity in the Duvernay.

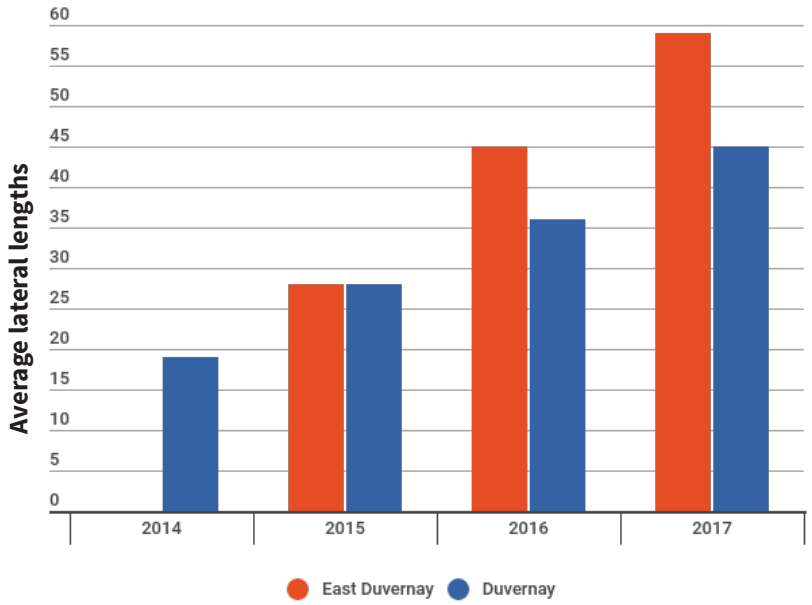
These top tier rigs, combined with the best crews due to the slowdown in activity the last three years, have driven drilling productivity upwards across North America and the Duvernay has benefitted.

Average lateral lengths increasing

Lateral lengths have been rapidly increasing in the Duvernay since 2014, rising by 42 per cent by year-end 2017, as operators worked to lower costs per boe of production.

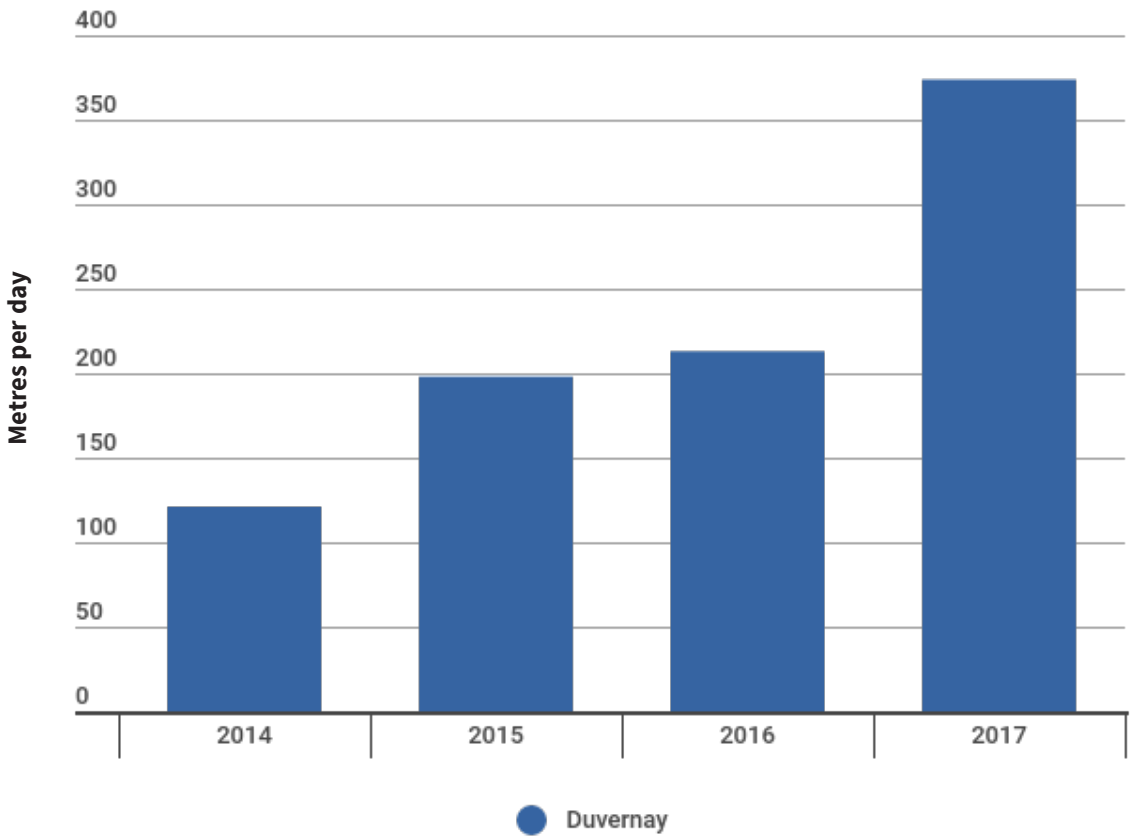
There was significant variation in lateral lengths, however, as different operators in different stages of development tested out well designs. In 2014, lateral lengths varied from 1,200-2,400 metres. In 2015, upper range lateral lengths climbed to 2,800 metres. By 2017, the largest cluster of laterals drilled in the play was in the 2,500-3,000 metre range. There have been some outliers, including a 7,770 metre lateral drilled by Shell Canada.

Operators in the East Duvernay were able to rapidly adopt longer laterals into their well designs, growing from 2,000 metres in 2016 to 3,000 metres in 2017.



Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

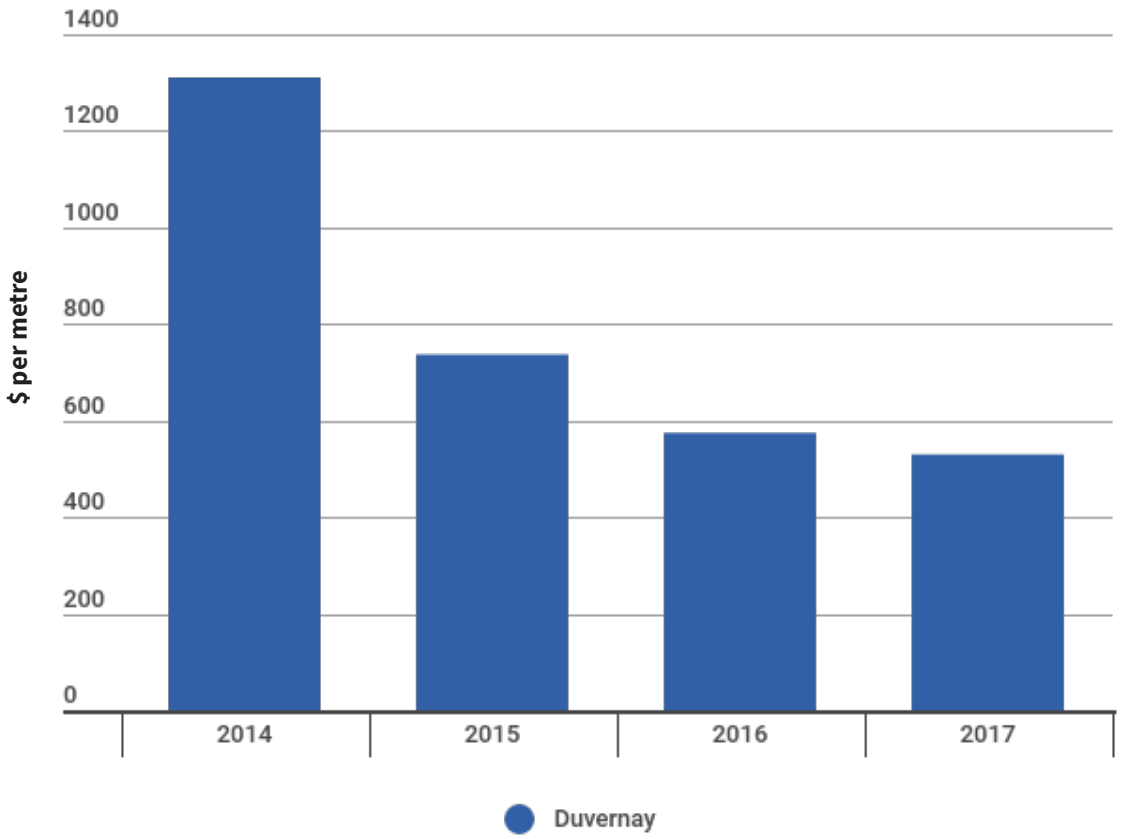
High performance rigs drive average drilling speeds



Duvernay drillers have more than tripled metres per day since 2014. Part of this has been an improvement in drilling technology but the move from exploratory drilling to pad development is likely the cause of much of this gain.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

Drilling costs decline

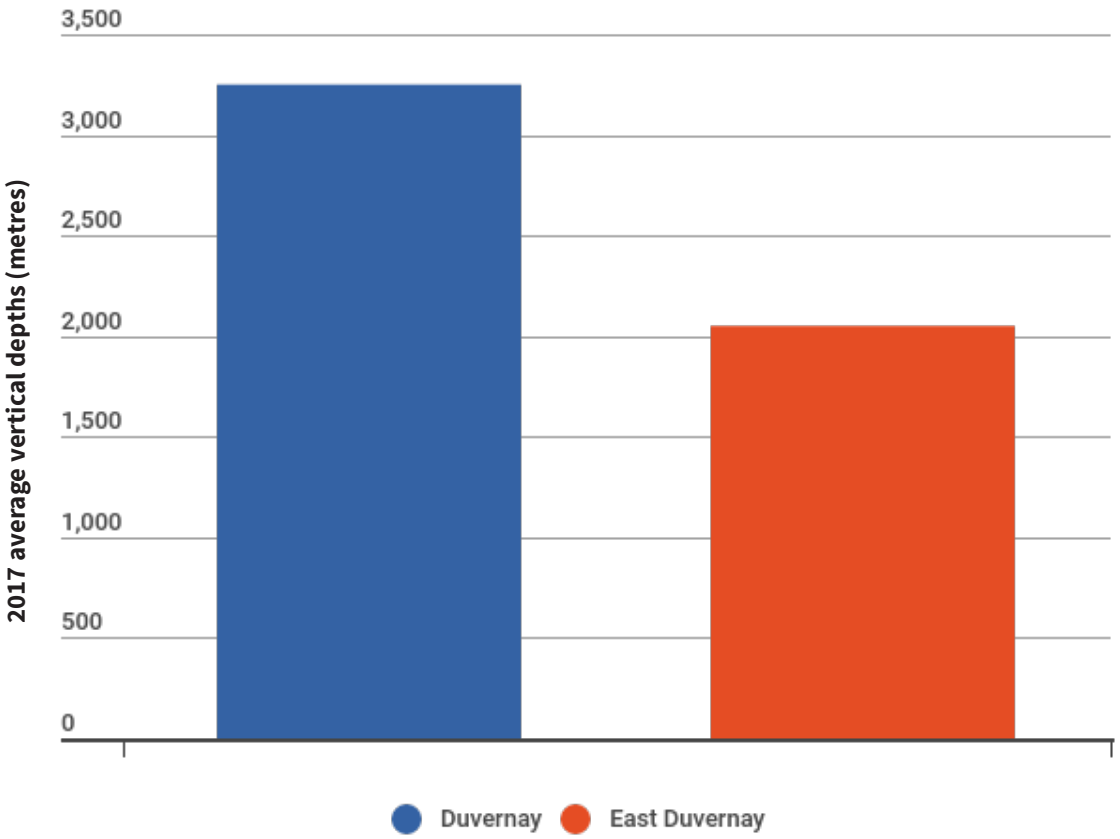


Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

The cost per metre drilled declined by 38 per cent in the Duvernay from 2014 to 2017, due to increased rig efficiency and lower day rates due to the decline in general activity.

Again, East Duvernay operators were able to quickly take advantage of increased drilling efficiency, cutting their cost per metre of lateral drilled from $710 per metre in 2016 to around $621 per metre by the first half of 2017, and around $560 per metre in more recent wells.

Less vertical depth makes East Duvernay lower cost



The large majority of wells drilled in the Duvernay have targeted condensate and volatile oil found in the Kaybob area at vertical depths of greater than 3,000 metres. East Duvernay vertical depths are between 2,000-2,200 metres. This difference in vertical depths adds around $600,000 to the cost of drilling wells at Kaybob.

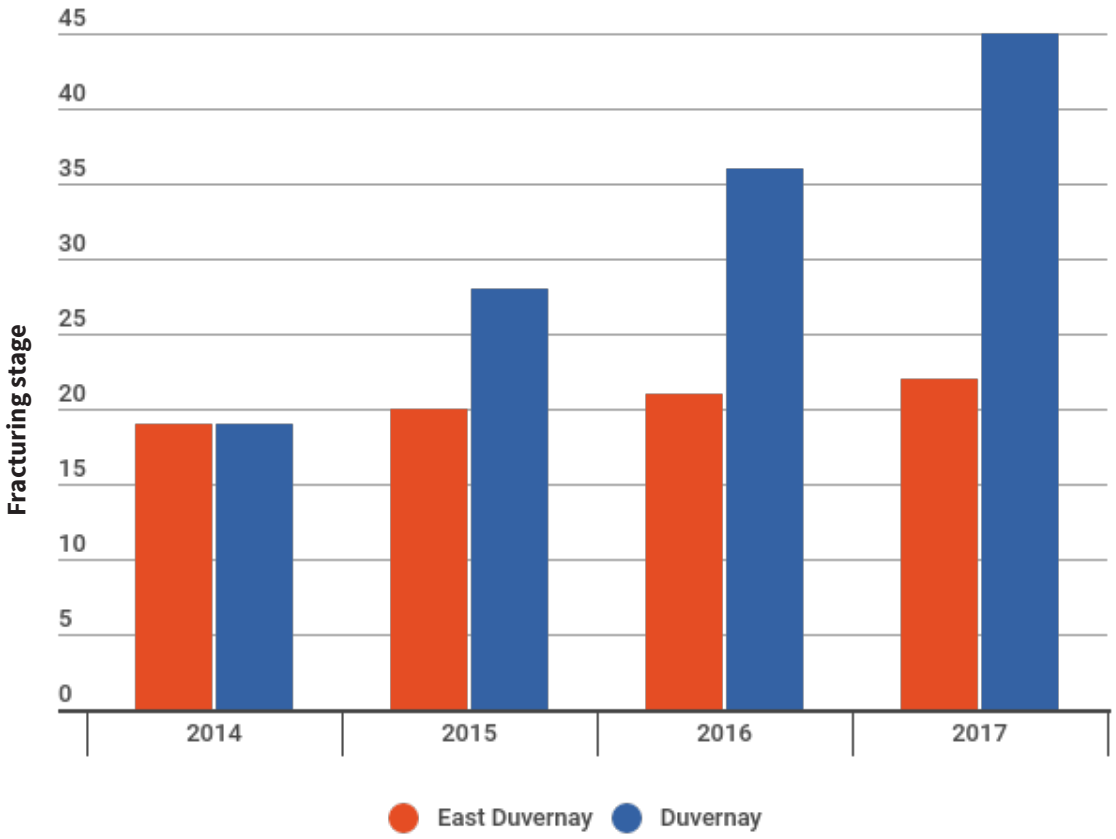
Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

Completions technologies

Operators in the Duvernay continue to optimize their completions technologies to cut costs and enhance resource recovery. Plug and perf technology has become dominant in the Duvernay, with sliding sleeve and ball drop technologies also being used. Slick water or hybrid slick water with gel fracs are common. There is also an effort under way to optimize the use of sand as proppant to cut costs.

But the biggest change in completions is in fracturing intensity. Longer laterals, more stages per lateral, more perforations per stage, and vastly increased proppant loads are driving productivity improvements.

Fracture stage counts up rapidly in the Duvernay

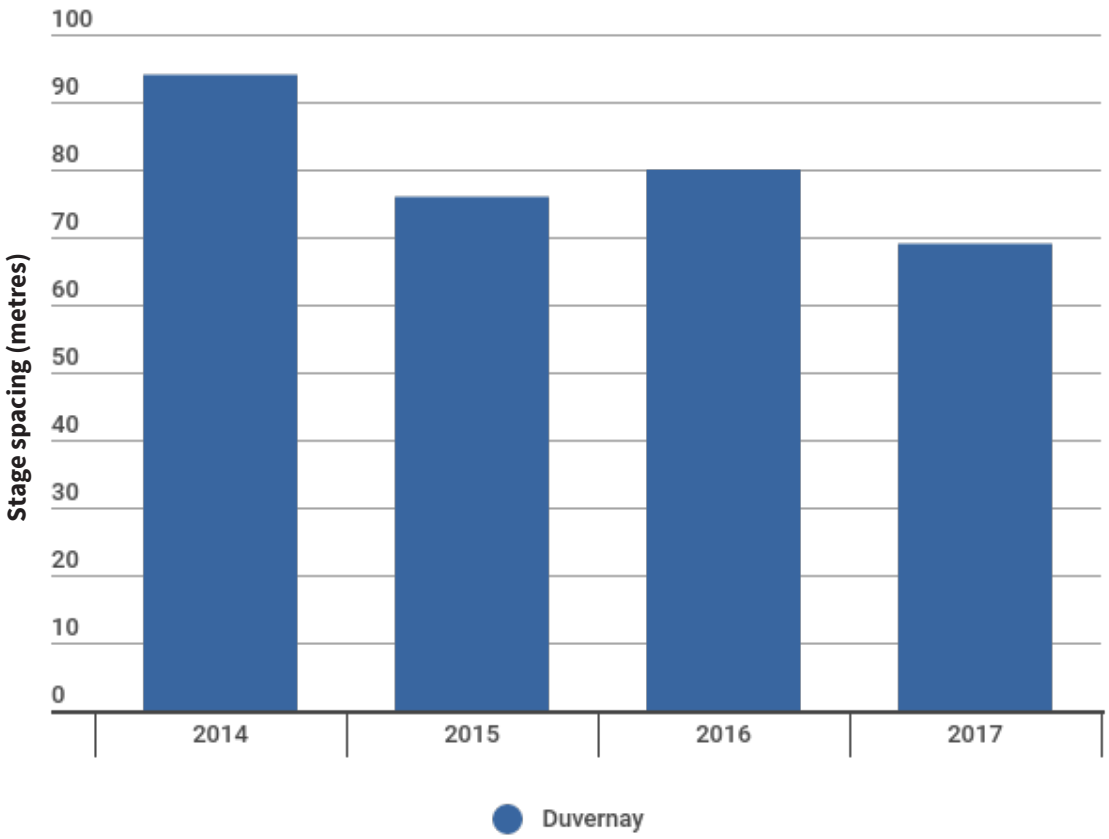


With the ability to drill longer laterals, Duvernay operators have been able to rapidly increase the number of fracturing stages per lateral. But there is substantial variation between wells. In 2015, the majority of Duvernay wells were stimulated with between 25 to 35 stages. That changed in late 2016 when there was a bump in wells with fracture stages ranging from 45-95 stages.

In the East Duvernay, Vesta Energy has rapidly increased stage counts in the play growing from around 28 stages pre-2016 to average 60 stages in 2017.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

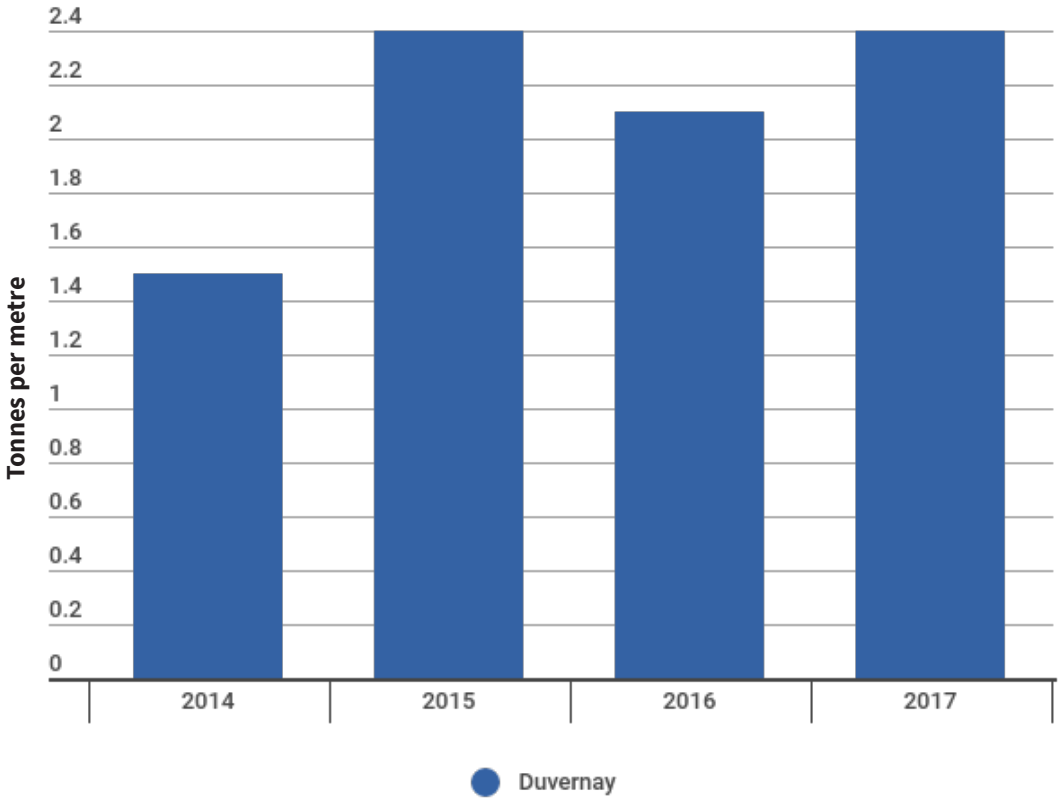
Tighter spacing driving stage count



Duvernay operators are also using tighter spacing to increase fracture treatments along laterals, cutting spacing by 28 per cent since 2014.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

Proppant loads rapidly climbing



Average proppant loads per metre of lateral length have been rapidly increasing in the Duvernay in an effort to increase production.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

East Duvernay costs per stage rapidly decline

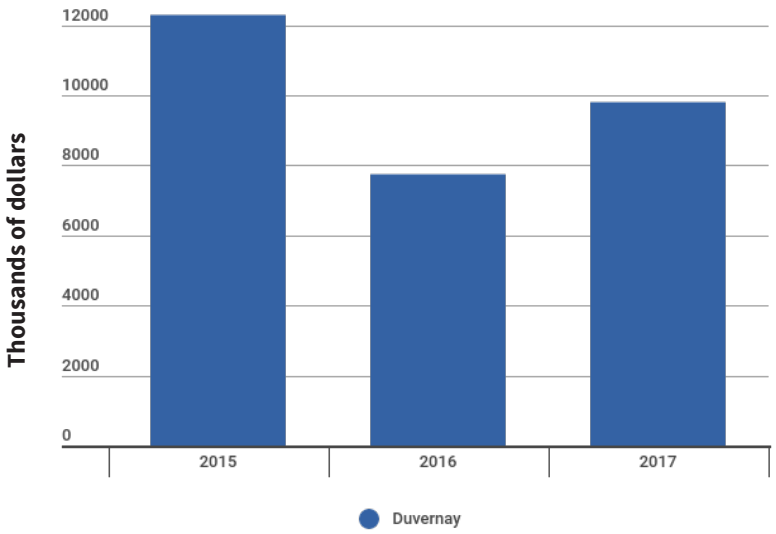
Cost per Stage	
2015	$128,000
2016	$65
2017	$63

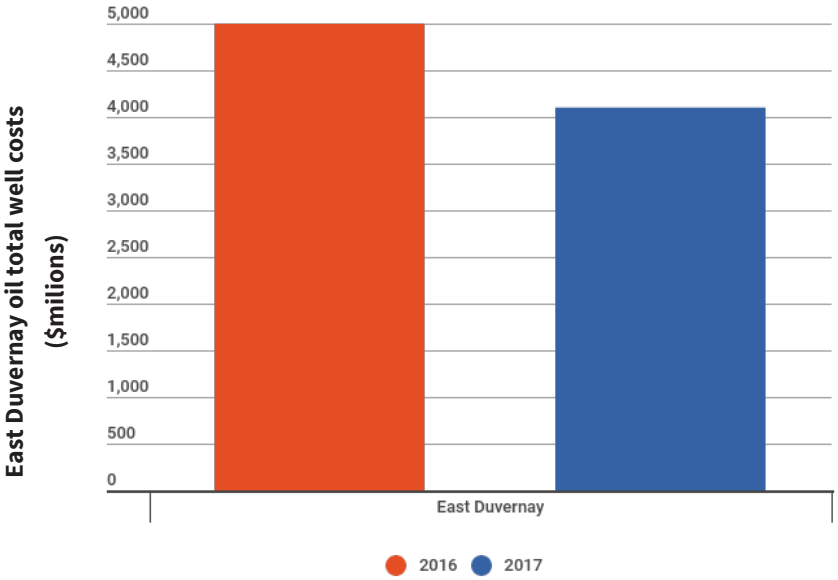
Completion costs per stage in the East Duvernay have declined by greater than 50 per cent in the last three years and Vesta sees further reductions due to design evolution and more multi-well pads.

Economic performance

Drilling and completion costs

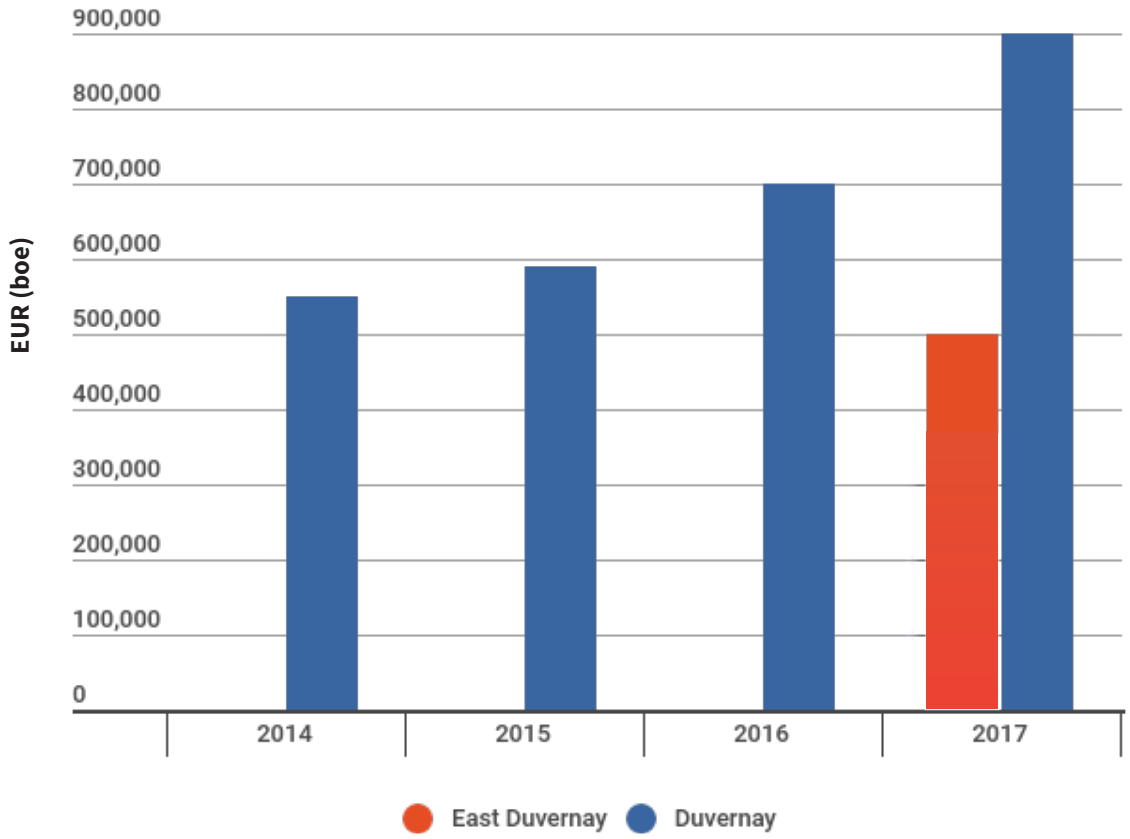
Kaybob Duvernay liquids operators have seen a 20 per cent drop in total drilling and completion costs since 2015, despite increasing lateral lengths and fracturing intensity. Expect average Duvernay costs to drop significantly as fewer single wells are drilled and more pad development drilling takes off. East Duvernay operators have also seen significant declines in drilling and completions costs despite increasing lateral lengths to 3,000 metres and increasing fracturing intensity.





Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

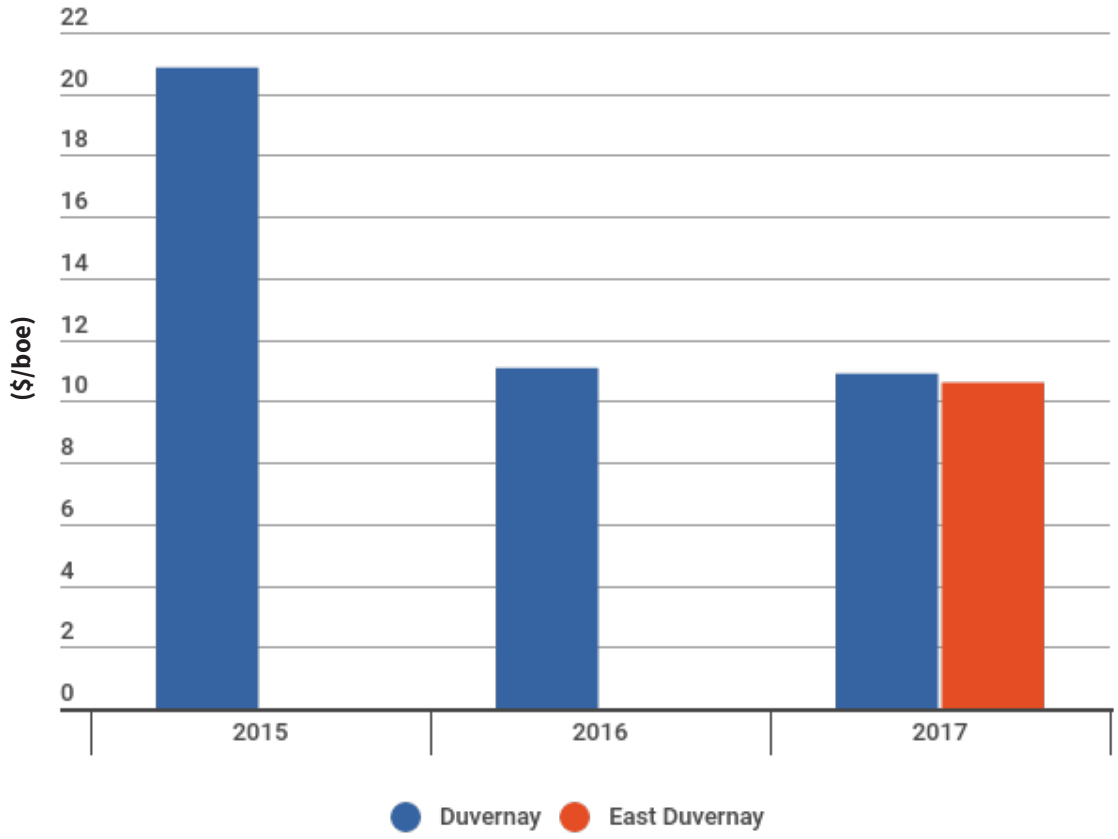
Rapidly climbing Estimated Ultimate Recovery (EURs) justify higher Duvernay costs



The combination of longer laterals and greater completions intensity is paying off in higher EURs in the Kaybob Duvernay. EURs have increased by 63 per cent as the play has moved from its exploration to early development phase. The East Duvernay is in very early development stages and EURs are likely to increase as more wells are drilled.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

Capital costs per boe of EUR down significantly



One measure of success of oil and gas explorers and producers is how effective they are at converting their capital into recoverable resources. Duvernay operators have seen capital costs per boe of EUR decline 46 per cent. Capital costs per boe of EUR averaged $10.89 in 2017, with East Duvernay costs coming in at a similar level.

Sources: McDaniel & Associates Consultants Ltd Duvernay update November 2017, CanOils, corporate presentations, EIA data

Operational efficiencies will drive profitability

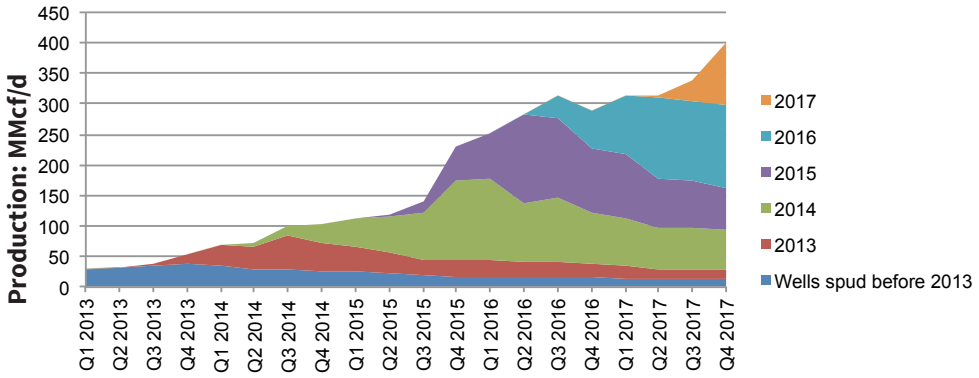
While cutting capital costs per boe recovered is a major step in commercialization of the liquids rich Kaybob and East Duvernay oil plays, ultimately managing production to keep wells operating as long as possible will determine their profitability.

This is a function of high early decline rates, meaning that despite strong initial production rates most of the expected ultimate recovery of resources will happen well after the first few years of production.

Long payout times for wells at current prices also mean wells won't begin to turn a profit until later in their production cycles, adding to the importance of maintaining production and avoiding unnecessary production costs.

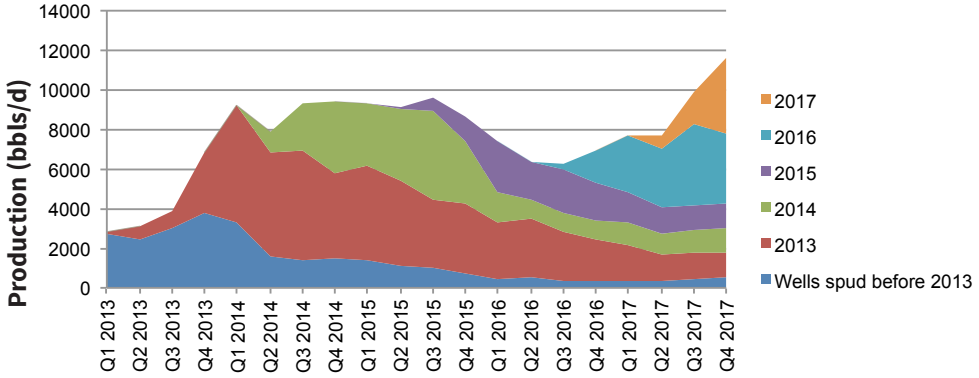
Decline rates

Gas Production by year wells drilled showing decline rates



Source: CanOils

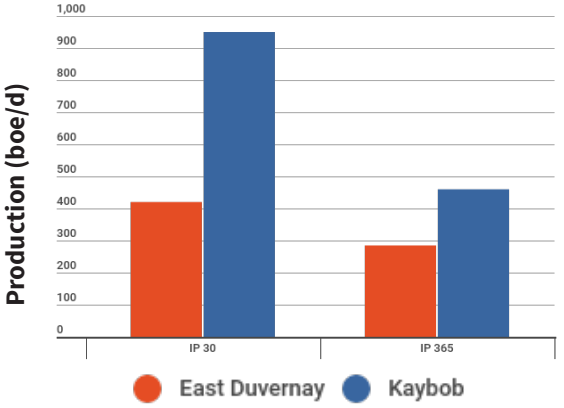
Oil Production by year wells drilled showing decline rates



Source: CanOils

Like all unconventional resource plays, the Duvernay enjoys high initial production rates that rapidly decline in the first year. In the East Duvernay, Vesta Energy reports IP90s of 420 boe/d but first year IPs decline to 285 boe/d. Only around 20 per cent of the expected ultimate recovery is captured during the first year of production. In the Kaybob area, Athabasca Oil Corp. is reporting IP90s of 750 boe/d before declining to 460 boe/d for the first full year of production. Around one-quarter of total expected recovery is captured in the first year.

Both the Kaybob and East Duvernay have rapid early declines



Source: CanOils

Payouts

How quickly developers can recapture their capital costs in drilling a well plays a key role in their profitability. While increases in productivity in the Duvernay are adding more barrels of production early on, at current oil prices payouts on wells remain extended compared to during the high price environment in 2014. In the East Duvernay, Vesta estimates it takes around 17 months to pay for a well in its central core area. Athabasca estimates it will take 26 months for payback on its West Kaybob wells. Keeping wells flowing at optimum rates after payout drives profitability.

Average payout at $55 per barrel oil (months)	
Kaybob	26
East Duvernay	17

Source: Vesta Energy, Athabasca Oil Corp.

Artificial Lift key to Duvernay oil profitability

With installation costs of around US$ 250,000 and replacement costs as high as US$150,000, maintaining and managing pumping systems ensures optimum production from Duvernay wells. Operators from other shale plays like the Eagle Ford have reported significant challenges in managing artificial lift

The most common production sequence in the Duvernay is:

1. Free flow where wells run without artificial lift
2. Electrical submersible pumps (ESPs) are used when volumes are high
3. Pump and rod systems are installed when production declines, and ESPs are no longer optimal. Some operators go straight to pump and rod systems

Managing paraffin wax build-up

East Duvernay operators aren't seeing paraffin issues until wells have been on stream six to nine months. Wax build-up begins when well pressures decline and the downhole temperature declines to the cloud-point of the oil.

There are a variety of ways to manage wax deposition, including:

1. Hot oil treatments, preferably with a dispersant added to the fluid, which is the traditional methods in western Canada
2. Paraffin inhibitors, which are added to fracking fluids during well stimulation, provide a proactive means to eliminate deposition before it starts.
3. There are also chemical treatments for use to remove wax deposition after the fact.
4. Various paraffin inhibitor or dispersants can be injected into well production to manage paraffin formation and build-up

SOLUTIONS

BAKER HUGHES a GE company

PAO108 Hot Oil Additive, PAW2351, PAW2315 Hot Water Additive
Parasorb
FORSA™ PAO2356, FORSA™ PAO2335F, FORSA™ PAO2326F, FORSA™ PAW2315, FORSA™ PAO2354 Paraffin Dispersants, PAO2715 Solvent, RE32369DMO – Paraffin Dispersant/Demulsifier

Scale deposition a challenge

Many operators are reporting scaling issues in Duvernay oil production. The problem is especially pronounced with ESP units. It is too early in development in the East Duvernay to see if scaling problems are impacting pump and rod systems. Scaling challenges can be dealt with proactively by adding chemical treatments into well stimulation treatments. There are also chemical treatments available to prevent scale from forming or to manage/remove once it becomes an issue.

SOLUTIONS

BAKER HUGHES a GE company

FORSA™ SCW4479, FORSA™ SCW8234C, FORSA™ SCW8225

Managing line pressures

Wax deposition can result in increased line pressures that can negatively impact production. East Duvernay wells are seeing wax build-ups in the upper 900 metres of the wellbore, and into flow-lines. Dispersants are commonly used to remove or move wax build-up. Demulsifiers can be utilized to increase oil-water separation, also helping to lower line pressures. There are, however, new generation products using a combination of dispersants and emulsifiers.

SOLUTIONS

BAKER HUGHES a GE company

TRETOLITE™DMO8698 , RE32369DMO Paraffin Dispersant/Demulsifier

Managing oil quality

East Duvernay operators can also increase profitability throughout the production phase through pretreating oil on location. During oil and water separation they can use a demulsifier. Demulsifiers can also be used in oil storage tanks before trucking or pipe transport to save treatment costs downstream.

SOLUTIONS

BAKER HUGHES a GE company

TRETOLITE™ DMO8658, TRETOLITE™DMO8698

Bacteria suppression and H2S production

East Duvernay operators are beginning to see bacteria in produced water. There are questions whether it is coming from water used for fracking or if it comes from the reservoir. Bacteria can produce H2S, leading to corrosion. If H2S is produced it can lead to oil production not meeting requirements for sweet pipelines. There are numerous biocides on the market to handle bacterial problems. H2S scavengers are available to mitigate souring issues.

SOLUTIONS

BAKER HUGHES a GE company

MAGNACIDE™ XC424, X-CIDE™ XC302

Summary

Advances in drilling and completions technologies have driven down capital costs in both the Kaybob liquids play and East Duvernay oil play in the last three years. However, because of high initial decline rates meaning most production comes later in the production cycle, and longer payouts due to lower oil prices, optimizing production will drive well profitability. Some factors that will drive operational efficiency include managing artificial lift, paraffin wax build-up, corrosion, sand incursions, bacteria, solids and line pressures to avoid costly well interventions or shutdowns.

For more information of the Duvernay Shale Play:
http://www.dailyoilbulletin.com/article/2018/4/4/crescent-point-reveals-east-shale-duvernay-land-po/
http://www.dailyoilbulletin.com/article/2018/3/12/improved-well-costs-equals-more-viable-duvernay-re/
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