

# U.S. Crude Exports

02 January 2016



**Makai Marine Advisors LLC**

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*Panamax THEO T leaves Corpus Christi with first US crude export cargo after export ban repeal*



# Repeal of US crude export ban resolves quality imbalances

Crude export debate pitted refiners vs. producers

- Refiners enjoyed cheap feedstock stranded by lack of export options
- Producers suffered from substantial price discounts to seaborne market

Infrastructure development reduced discounts partially

- Crude-by-rail allowed Bakken crude to reach both US coasts and USG
- Pipeline construction allowed crudes to reach seaborne markets in USG
- Crude price discounts in interior of US narrowed to international benchmarks

Still, refiners struggled with quality issues from crudes

- Rapid growth of super light crudes and condensate was overwhelming USG (PADD3) refiners' ability to process it in plants configured for heavy crude
- "Crude Wall" concerns of additional light crude intake causing run cuts

Export ban repeal resolves quality issues that remained

- Light crude & condensate exports remove unwanted feedstock for refiners
- PADD3 refiners can now optimise slate for refinery configuration
- New splitters also remove excess condensate, despite weaker economics

OPEC & crude price spreads limit near-term exports

- Rig count collapse in Eagle Ford & Permian Basin from OPEC pricing strategy will bring sharp drop in output during 2016, limiting supply for export
- Narrowing/reversal of Brent spreads to LLS & WTI removes export incentive

Ultimately, recovery in LTO output boosts exports

- Ultimate rebalancing of crude market should provide price signals that drive recovery in rig counts & LTO output, subject to capital availability
- Stable demand & return of quality issues should provide surplus for export

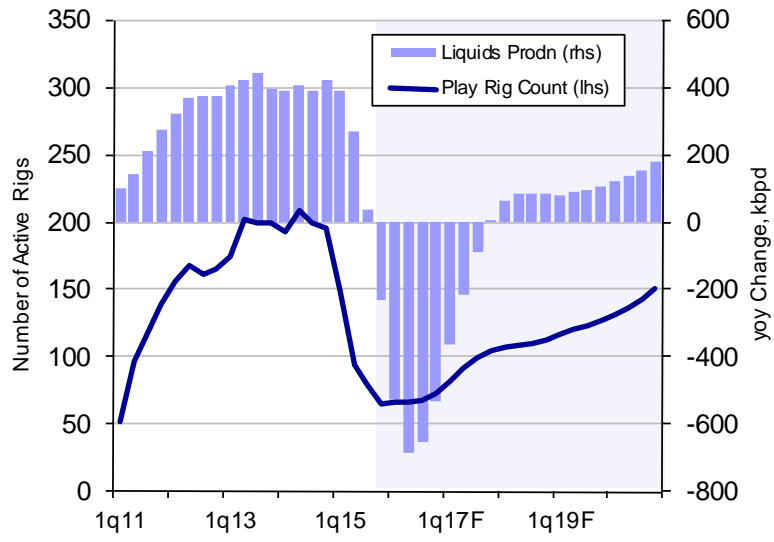


# U.S. Production



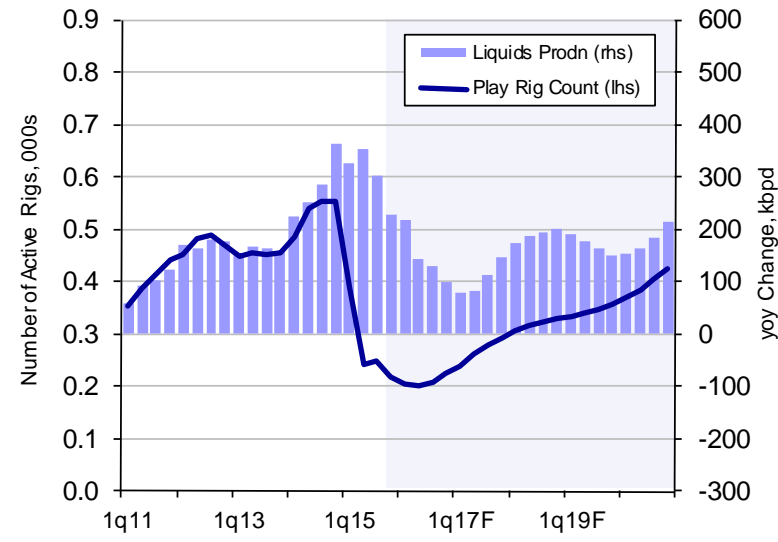
# Light Tight Oil (LTO) rig counts to remain flat in 2016, as global oversupply continues and as oil prices remain depressed

## Eagle Ford Rig Count & Production Change



Sources: EIA, Baker Hughes, Makai

## Permian Basin Rig Count & Production Change

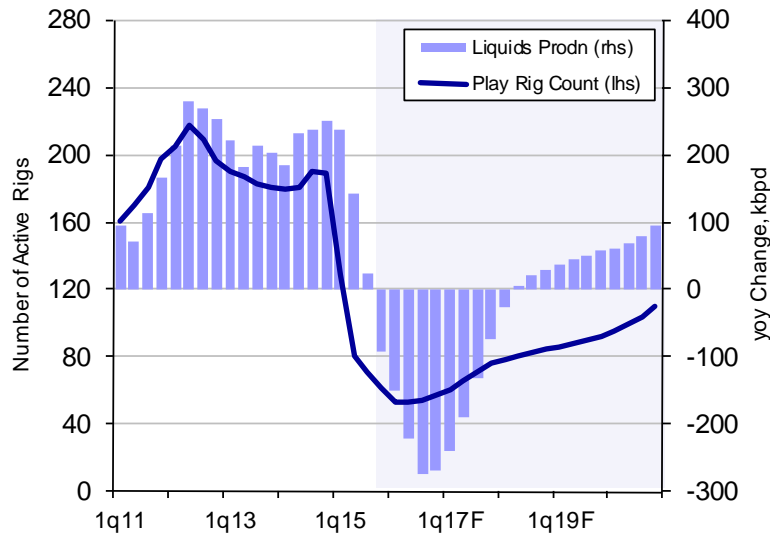


Sources: EIA, Baker Hughes, Makai

- No recovery in rig counts until 2017, when market starts to rebalance and prices finally move higher
- Sharper proportional drop in rig counts and rising decline rates are already leading to substantial drops in Eagle Ford crude and condensate production
- Permian Basin output benefiting from large jump in rig productivity during 2015, aided by “Stacked Play” opportunities, such as Spraberry and Wolfcamp formations in the Midland Basin
- Without large drop in rig productivity or rig counts, Permian gains should continue

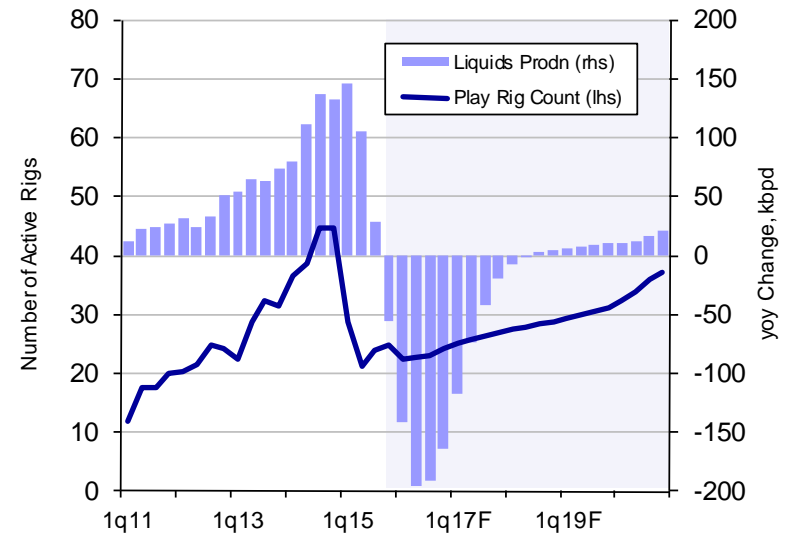
# Bakken & Niobrara rig counts follow similar pattern, with large yoy production declines bottoming in 2h16

## Bakken Rig Count & Production Change



Sources: EIA, Baker Hughes, Makai

## DJ Niobrara Count & Production Change

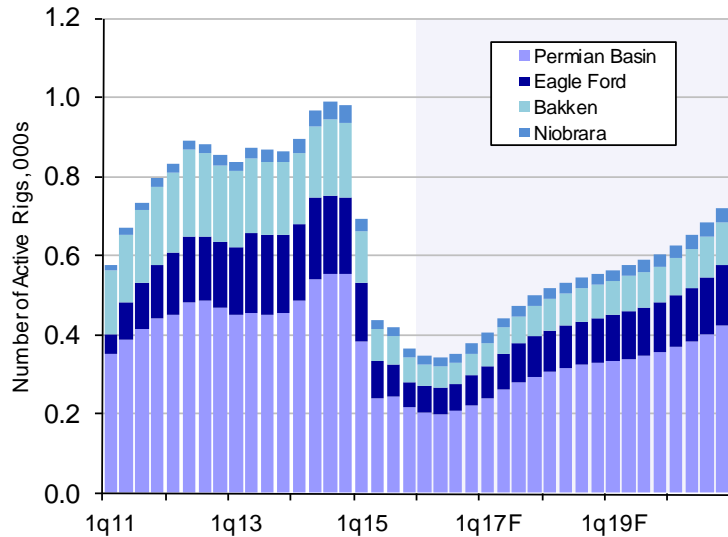


Sources: EIA, Baker Hughes, Makai

- Bakken production starting to show growing yoy decline in 1q16, accelerating into 2h16, on rising decline rates and some slippage in rig productivity
- Sharp jump in legacy well decline rates during 2h15 driving large proportional drop in Niobrara production in 2016, despite smaller rig counts than other LTO plays
- Unless Niobrara rig productivity rebounds 60-70%, back to 1h14 levels, this play's contribution to LTO output should remain limited

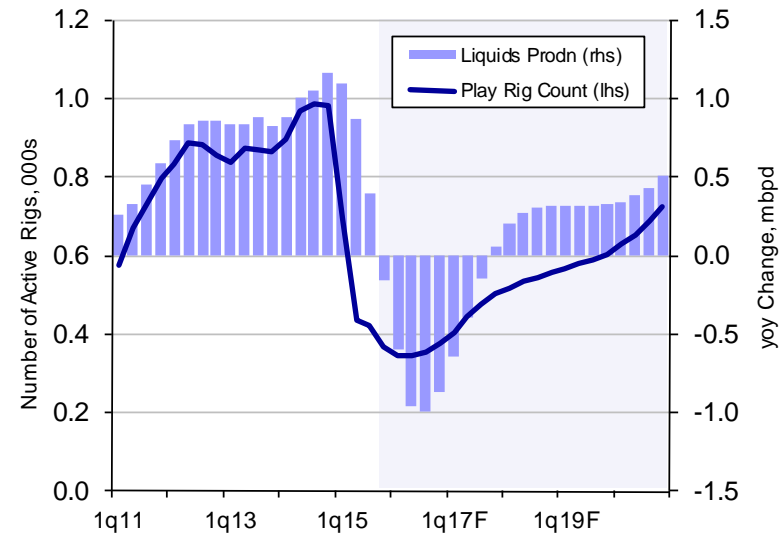
# Under Base Case, stabilising rig counts should provide 1 mbpd yoy declines in LTO output in mid-2016, enough to aid balance

## Major LTO Play Rig Count, by Basin



Sources: EIA, Baker Hughes, Makai

## Major Play Rig Count & Production Change



Sources: EIA, Baker Hughes, Makai

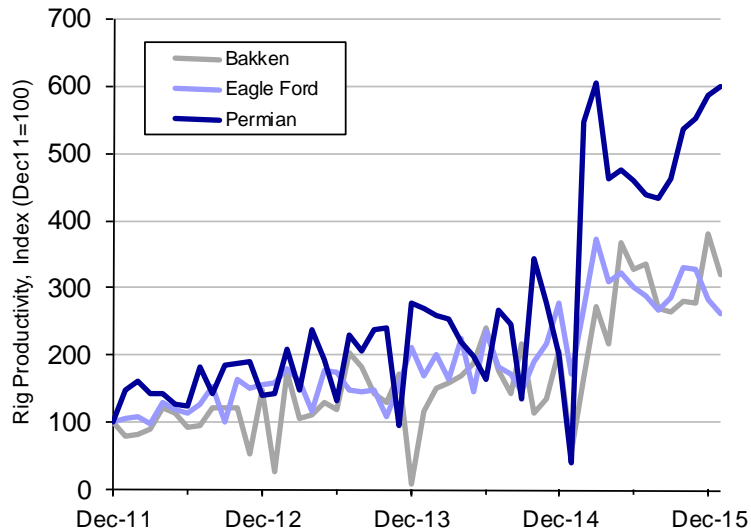
- LTO output has responded with 6-7 month lag to rig counts, so market not yet observing real impact of sharp reduction in rig count and other field production variables
- Keeping major LTO play rig counts at 341 in 1q16, seven units below Dec15 levels, should provide near 1 mbpd declines in play LTO production during mid-2016
- With Iran aggravating global oversupply in 2016, low crude prices should keep rig counts subdued until late-2016, when market begins to sniff an eventual rebalancing
- Given production lags, stable rig counts in 2016 should keep LTO production in check though 1h17

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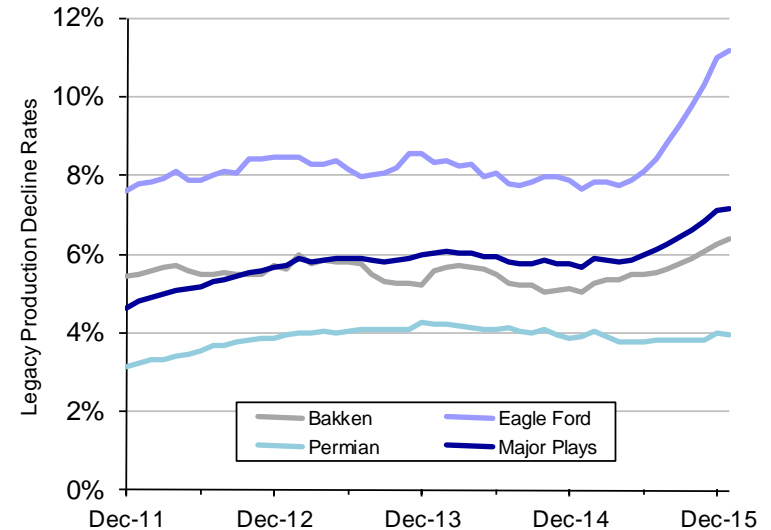
# Resilience of LTO output from remarkable rise in rig productivity, decline rates that remained stable until mid-2015

## Rig Productivity, by Basin, Indexed



Sources: EIA, Baker Hughes, Makai

## Legacy Production Decline Rates, Percent



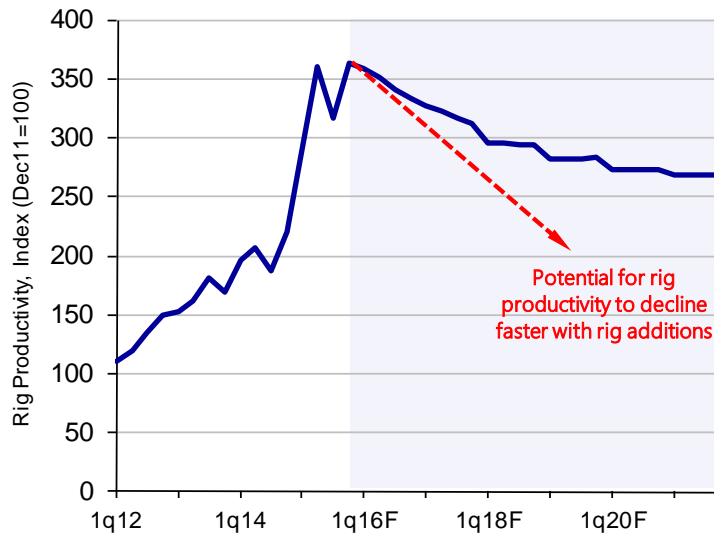
Sources: EIA, Makai

- In committing to its aggressive strategy, OPEC completely miscalculated the US production impact and time delay before supply and demand equilibrated, due to rig productivity
- EIA reports have shown that rig productivity (initial production per rig) has surged higher, as producers have focused on better acreage, used more efficient crews/techniques
- Both the decline in well drilling time per rig and the rise in initial production per well have contributed
- Offsetting this productivity, the decline rates for legacy wells have jumped in 2h15, most notably in the Eagle Ford, as total well counts decelerate



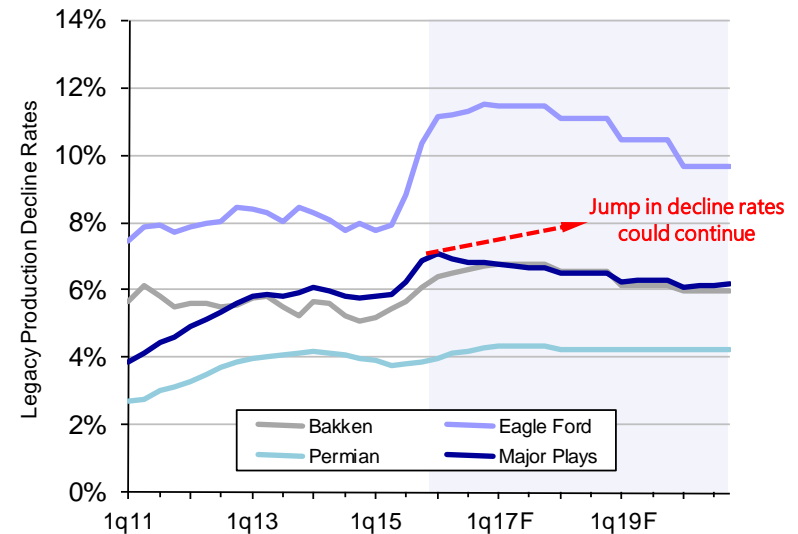
# Potential for slower production response, depending upon two highly-uncertain variables

## Major Play Rig Productivity, Indexed



Sources: EIA, Baker Hughes, Makai

## Legacy Production Decline Rates, Percent



Sources: EIA, Makai

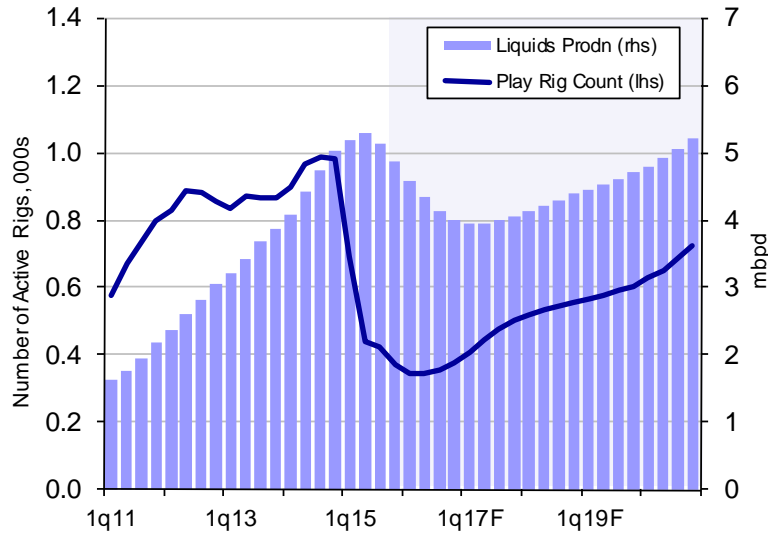
- Base Case production estimates for LTO plays includes a gradual decline in rig productivity, as rig count rises to 70% of 2014 peaks
- Actual productivity will depend on how less productive the marginal rig will be, on less-prolific acreage and with new/re-activated crews
- Decline rates should stabilise as legacy wells age and well numbers rise with rig count
- Variables are part of equilibrium process, as weaker productivity & faster decline rates would push output lower than forecast, quickening rebalance and price recovery -- and faster rig count rebound

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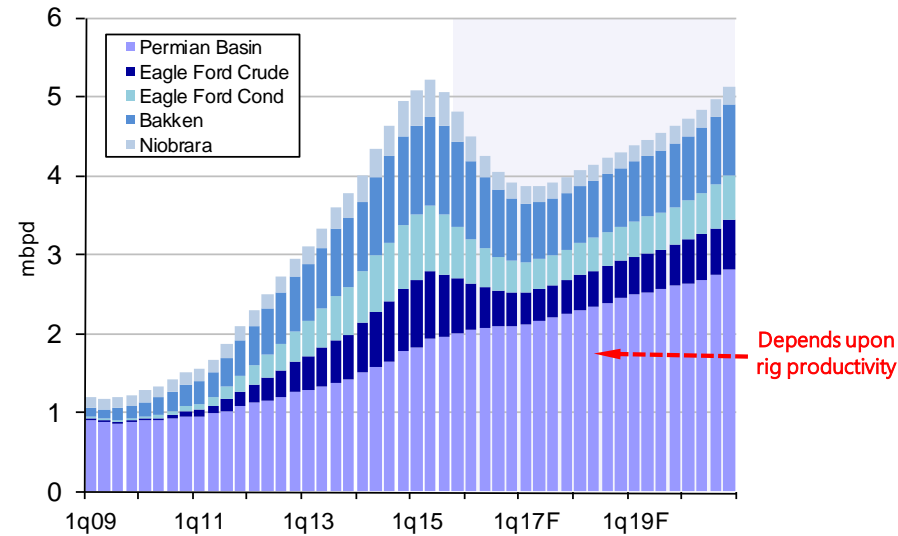
# LTO production returns to previous peak by 2020 in Base Case, as higher prices prompt acceleration in rig counts

## Major Play Rig Count vs. Production



Sources: EIA, Baker Hughes, Makai

## Major LTO Play Production, by Basin

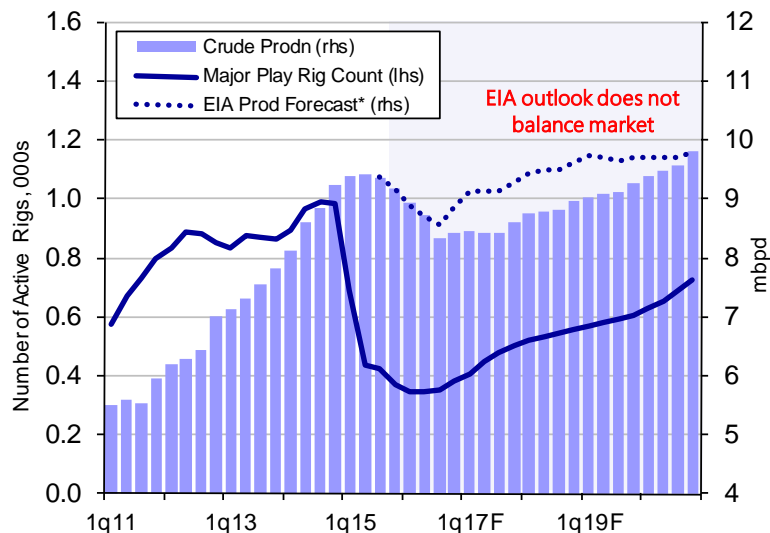


Sources: EIA, Makai

- Removing 1 mbpd of LTO production required for global rebalancing in late-2016/early-2017
- After potential inventory drama in 1h16, oil markets should sense emerging rebalance in 2h16, allowing for some price recovery and response in rig counts
- Rig count and LTO production rise remain measured until 2020, when oil under-investment in 2015-16 and lower OPEC spare capacity tighten oil markets significantly
- Again, LTO production recovery highly dependent upon rig productivity and decline rates

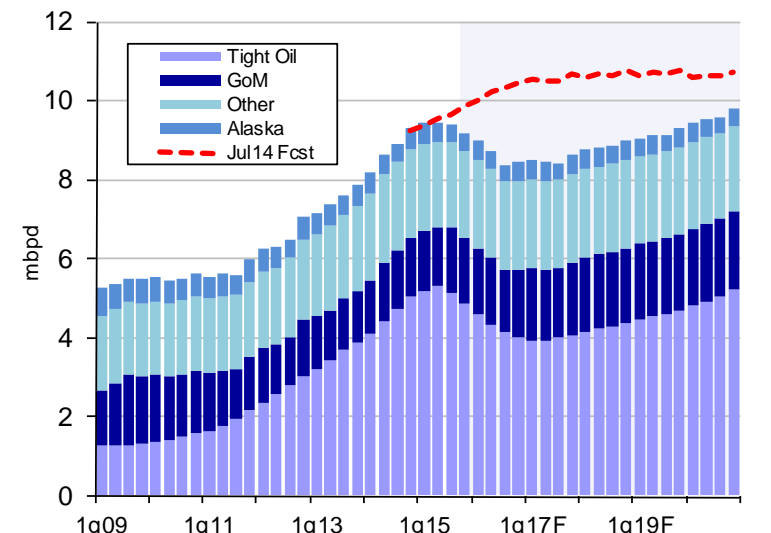
# Flat LTO rig counts in 2016 would maintain US crude production near 8.5 mbpd, allowing global rebalancing by year end

## US Crude Production vs LTO Rig Count



Sources: EIA, Baker Hughes, Makai

## US Crude Production, by Source



Sources: EIA, Makai

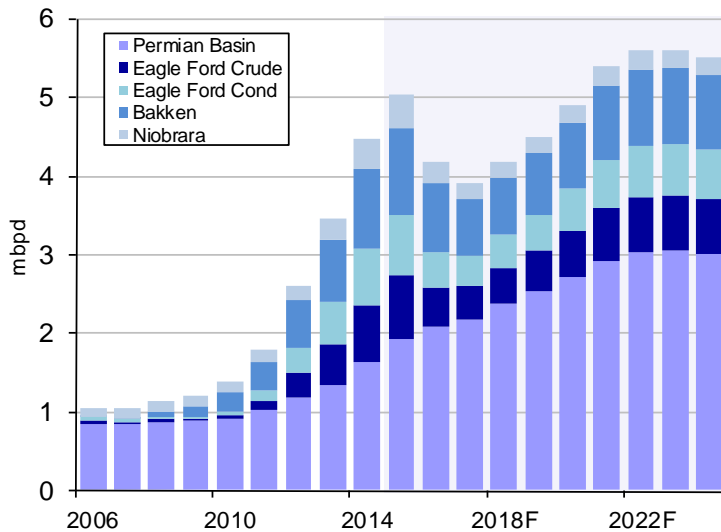
- Price signals and limited access to capital should keep rig activity muted, allowing US crude production to stabilise near 8.5 mbpd
- With 2 mbpd of oversupply and 1.2 mbpd of global demand growth, 1 mbpd decline in US production required to balance market
- Latest EIA Short-term Energy Outlook (STEO) does not balance market and is based upon a recovery in WTI price to \$54/bbl by 3q16 (Brent to \$59/bbl)
- OPEC strategy has removed 2 mbpd of US output from outlook prior to Nov14 announcement

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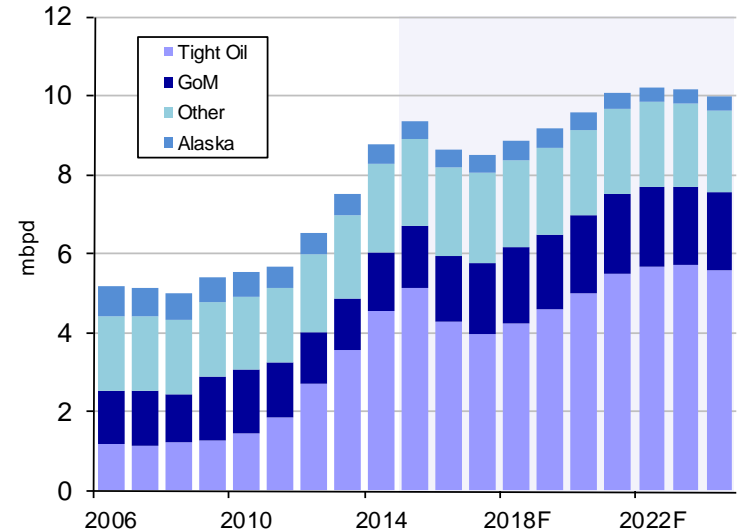
# Longer term, US crude production reaches plateau, as marginal returns of LTO plays diminish

Major LTO Play Production, by Basin



Sources: EIA, Makai

US Crude Production, by Source



Sources: EIA, Makai

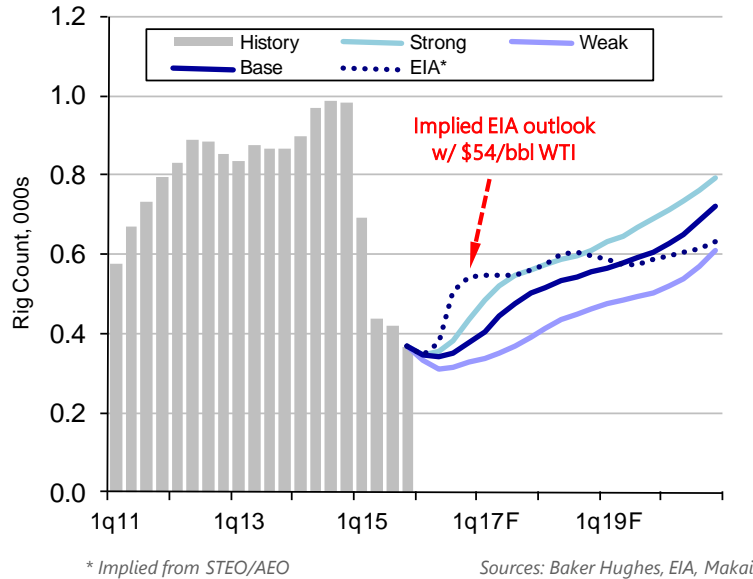
- In medium term, LTO output returns to levels just below those predicted prior to OPEC strategy shift
- With LTO peak arriving later than previous projections, overall US production peaks at 10.2 mbpd, lower than earlier forecasts
- One irony of OPEC strategy is that LTO phenomenon was never meant to last forever -- even the most optimistic outlooks had LTO output plateauing in the 2020s, as exploration moved to weaker acreage
- OPEC's action will now move peak LTO back five years, possibly later, if pricing gets out of hand in tighter market at the end of decade

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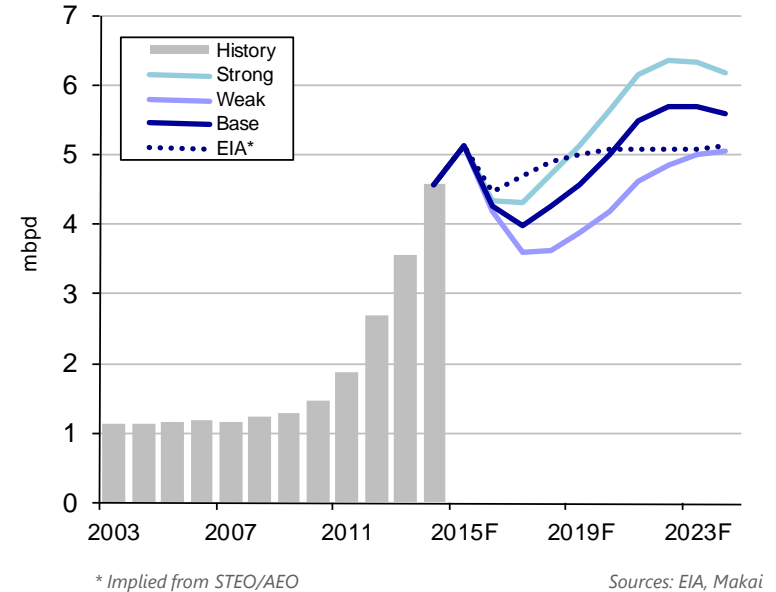


# All three scenarios see slower recovery in rig counts than implied by EIA outlook, but sharp rise after 2019 on high prices

## LTO Rig Count Scenarios



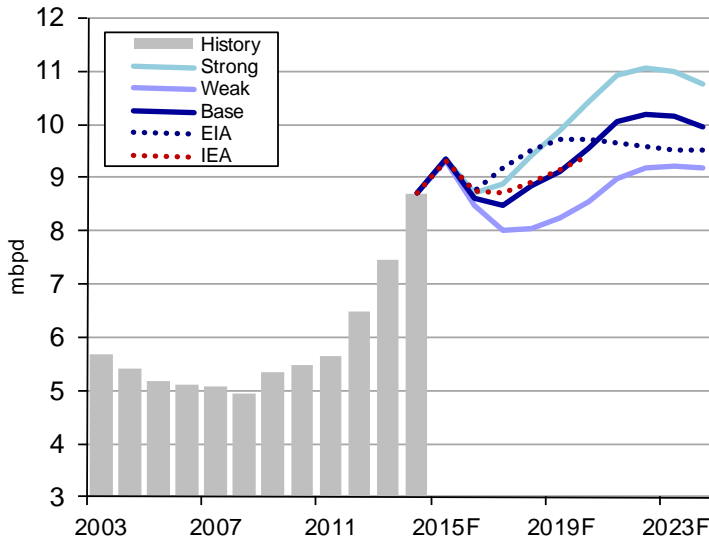
## Major Play Crude Production Scenarios



- EIA does not provide forecasts for rig counts or LTO production, only lower-48 states ex-GoM/Alaska, so estimates for EIA reflect other production trends and rig productivity & decline rate projections
- The only way that US production could rebound sharply in 2h16, as seen in latest EIA STEO, is for rig counts to recover dramatically in 2q16, consistent with agency \$54/bbl WTI forecast
- All three Makai forecasts are below the implied EIA outlook, given global imbalance and expected price patterns, until 2019, when price environment boosts exploration activity
- Base Case production forecast exceeds EIA plateau outlook from 2020

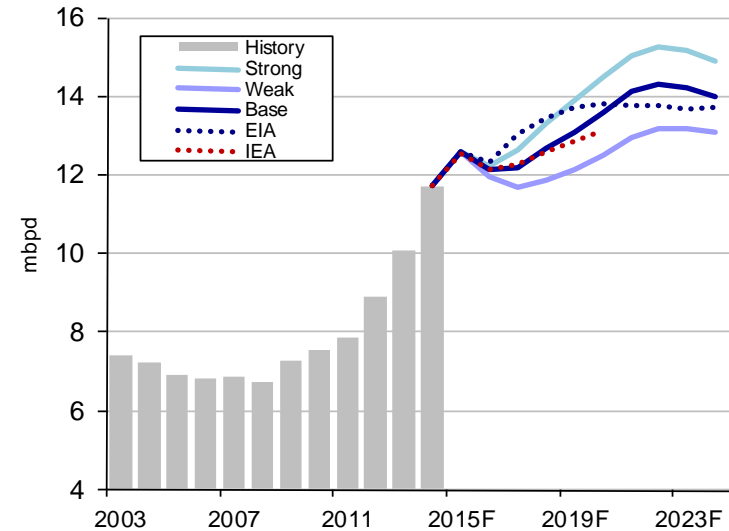
# Base Case scenario actually much closer to IEA outlook for 2016 and old IEA medium-term forecast from Feb15

## US Crude Production Scenarios



Sources: IEA, EIA, Makai

## US Liquids Production Scenarios



Sources: IEA, EIA, Makai

- Combined EIA STEO forecast and 2015 AEO outlook appear too optimistic, given global imbalances and price environment
- Recent revisions to IEA forecast 2016 US liquids production in its Oil Market Report (OMR) are looking more realistic
- EIA should make adjustments to 2016 forecast in next STEO, and for later years in 2016 AEO this spring
- IEA medium-term outlook is almost one year old -- next report may reflect potential for significantly-tighter market at end of decade, but more benign forecast is likely

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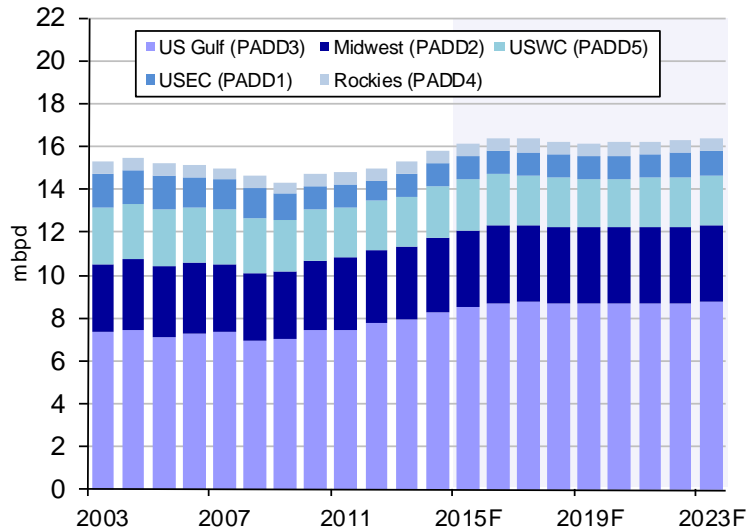


# U.S. Refining



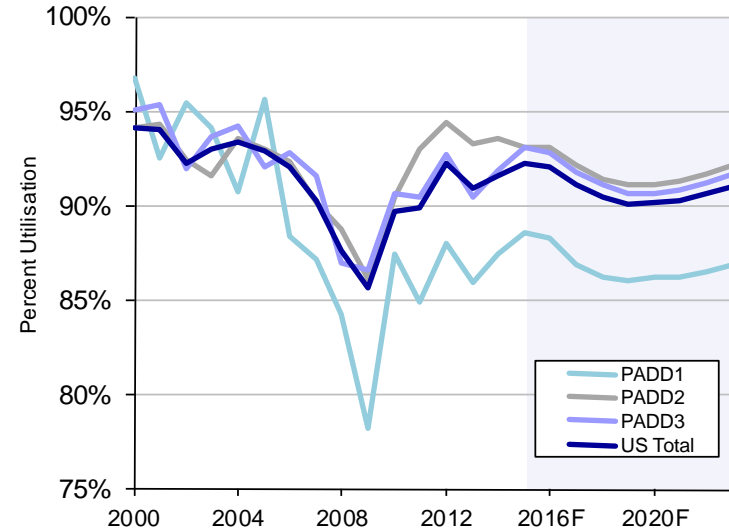
# Steady rise in US crude runs from higher utilisations on cheap LTO feedstock and from capacity additions

## US Refinery Crude Intake, by Region



Sources: EIA, Makai

## US Refinery Gross Utilisation\*, Percent



\* Gross Intake/Operating Capacity

Sources: EIA, Makai

- US crude intake jumped by 1.5 mbpd following the financial crisis, from 2009-14
- *Operable* capacity only rose by 0.2 mbpd during 2009-14, but *operating* capacity rose by 0.5 mbpd, as 0.3 mbpd of idle capacity came back on line
- A 6.0% jump in utilisation drove the majority of the rise in crude intake, as US refiners benefitted from cheap natural gas fuel and discounted LTO feedstock, suffering from stranded pricing
- Repeal of crude export ban and further midstream infrastructure development should pressure refining margins and utilisations, as stranded status of LTO continues to diminish

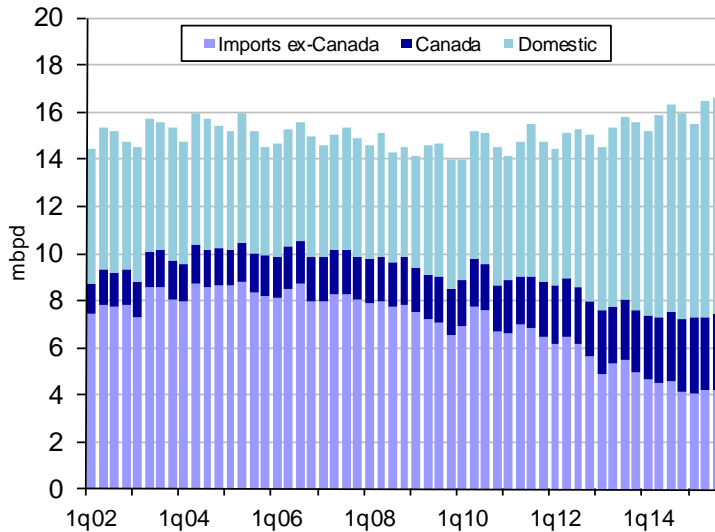
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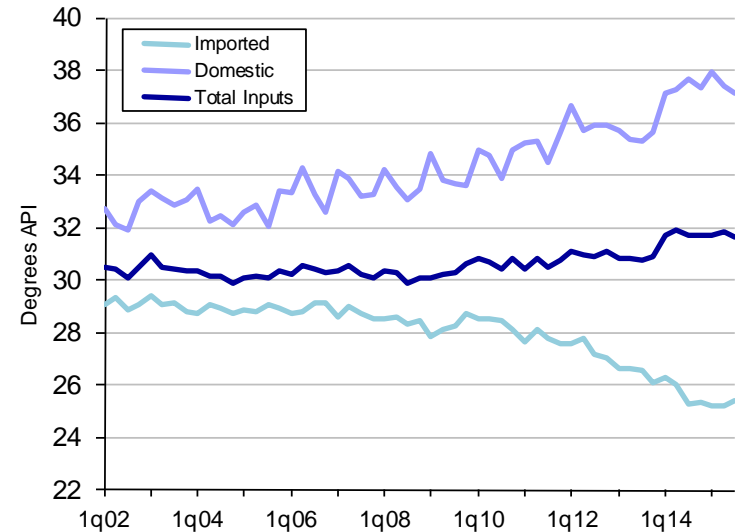
# Rising US crude production & Canadian imports have reduced other crude imports by half through 2015

## US Refinery Crude Intake, by Source



Sources: EIA, Makai

## US Crude Intake Gravity, by Source

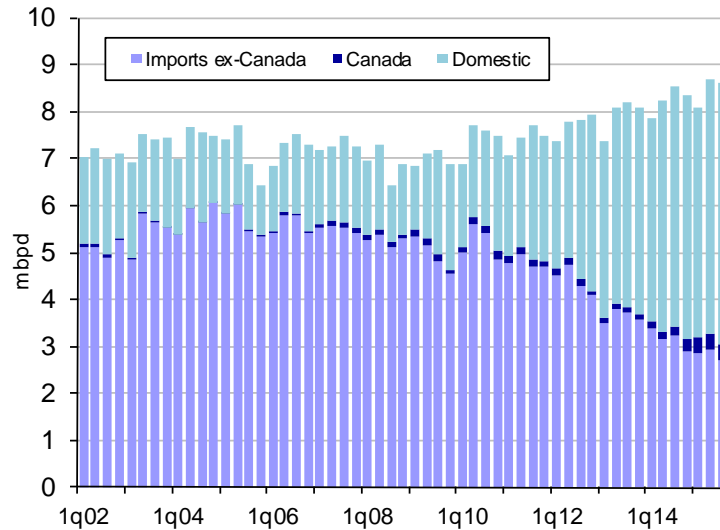


Sources: EIA, Makai

- Rapid growth in LTO output and limited export outlets have allowed domestic crude to displace imported grades from the US crude slate
- Rising Canadian production and exports to US have reduced the level of non-Canadian crude imports by half, despite rising US crude runs
- Intake of LTO with APIs above 40° has boosted average gravity of domestic feedstock and overall intake
- US refiners have imported increasingly-heavy crudes to keep rise in average APIs in check

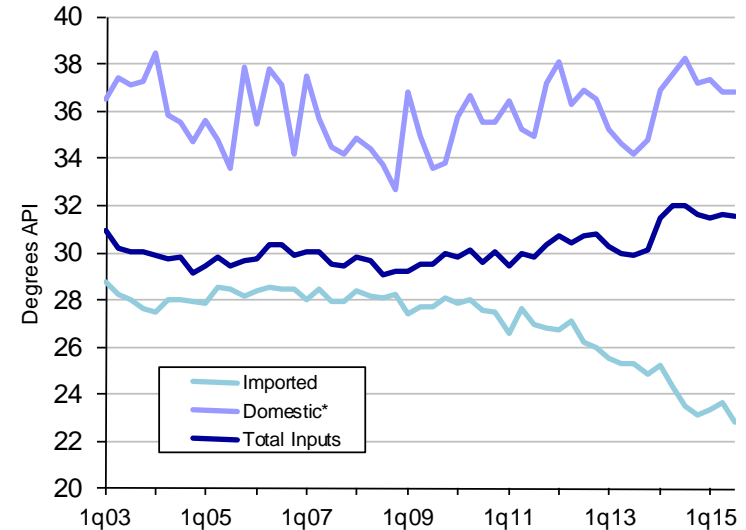
# US Gulf (PADD3) refining has been at epicentre of these feedstock shifts, struggling with lightness of crude slate

**PADD3 Crude Intake, by Source**



Sources: EIA, Makai

**PADD3 Crude Intake Gravities, by Source**



\* Imputed from Total & Imported

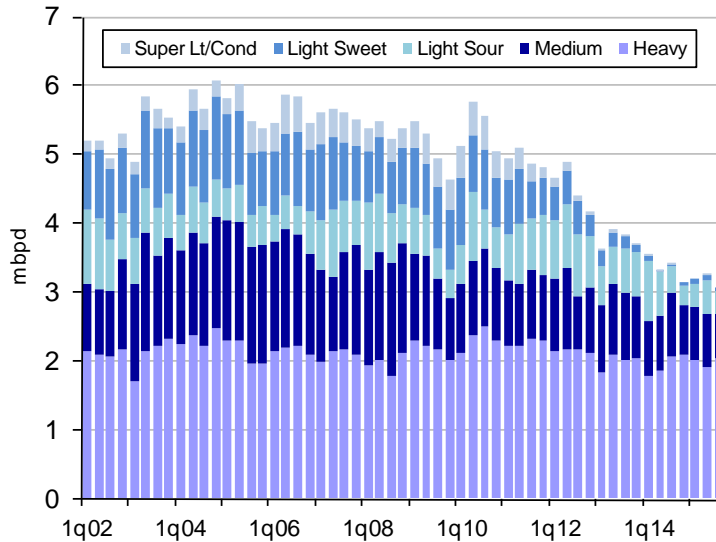
Sources: EIA, Makai

- Domestic crude share into PADD3 refineries has jumped from 22% in 2008 to estimated 63% in 2015
- Increasing share of regional LTO and condensates has boosted average gravity of crude intake for PADD3 refiners, hitting 32.0° API during 2014
- Configured for heavy crudes, PADD3 refiners have struggled with lighter crudes, giving rise to “crude wall” concerns -- when distillation columns cannot accept any more light crude without run cuts
- PADD3 refiners have accommodated a heavier import crude slate to offset, but resulting “barbell” of light/heavy not efficient either



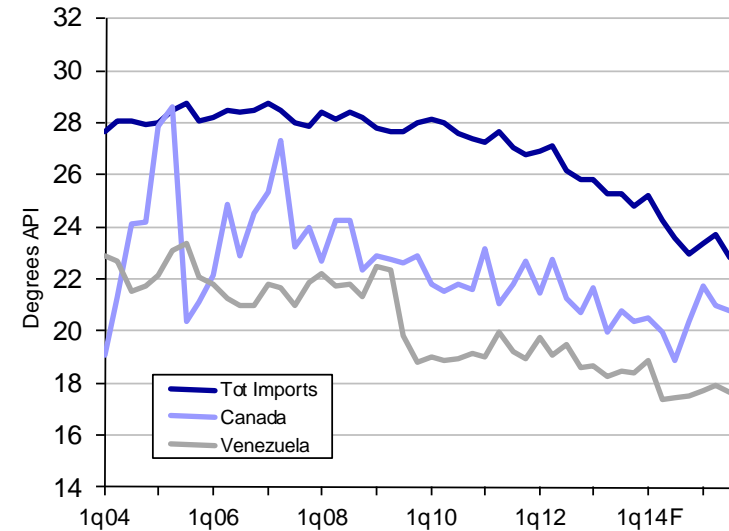
# Removal of light/sweet crudes made PADD3 import slate heavier, as did denser grades from traditional heavy crude sources

**PADD3 Crude Imports, by Quality**



Sources: EIA, Makai

**PADD3 Imports, API Gravity by Source**



Sources: EIA, Makai

- Removal of light/sweet African and North Sea grades was an immediate solution to surplus LTO
- Heavy crude imports have remained near 2 mbpd, but the heavy crude slate became heavier, actually boosting coker feed levels
- In addition to heavier Venezuelan grades, PADD3 refiners have also taken higher volumes of heavy Canadian "Railbit" bitumen in rising crude-by-rail volumes
- PADD3 imports of light/sour crude reaching structural minimum for Arab Light lube oil blending needs, but Iraqi and Kuwaiti grades also competing for share in light/medium sour imports

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# U.S. Crude Exports & Quality Balancing



# With exports allowed, PADD3 crude market finds quality balance

Under crude export ban, "crude wall" was looming

- Stranded condensate drove lightness of crude slate, and pushed distillation columns to hydraulic limits for handling light ends
- "Crude Wall" concerns of maximum light crude intake without run cuts

BIS rulings on "processed condensate" eased pressure

- BIS rulings in 2014 allowed exports of "lightly-processed" condensate from larger field separators, if parcels remained segregated
- Accommodated rise in these condensate exports to 120 kbpd by 2q15

Plans for condensate splitters also offered outlet

- Stranded pricing of condensate supported economics of splitters on USG
- Traders & midstream players planned 720 kbpd of splitter capacity
- With export ban repeal, only 350 kbpd of added capacity now likely

Export ban repeal now offers chance to balance feedstock

- Exports now act as balancing outlet to keep crude intake gravities in check
- Crude/condensate pricing should achieve equilibrium that balances value to PADD3 refiners and netback values for global demand

Exports would now allow refiners to optimise slate

- Crude/condensate exports would remove an unwanted feedstock
- Keeps Latin American and AG imports above structural minimum levels

Producers receive higher prices, subject to demand

- Removes deep discounts for stranded condensate, that started push for export law changes from producers
- Pricing still limited by global export demand for crude/condensate

# Only half of planned condensate splitter projects to take place

## PADD3 Distillation Capacity Additions 2014-19

Operator	Off-take Partner	Location	Start-up	Capacity kbpsd
<b>Condensate Splitters -- In Forecast</b>				
Buckeye	Trafigura	Corpus Christi, TX	3q15	50
Castleton Commodities	--	Corpus Christi, TX	2h16	100
Centurion Terminals	Unknown	Brownsville, TX	3q16	50
Kinder Morgan	BP	Galena Park, TX	1q15	50
Kinder Morgan	BP	Galena Park, TX	3q15	50
Magellan Midstream	Trafigura	Corpus Christi, TX	2h16	50
<b>Subtotal</b>				<b>350</b>
<b>Condensate Splitters -- Excluded</b>				
Cheniere Energy	--	Corpus Christi, TX	2018	100
Gravity Midstream	--	Corpus Christi, TX	2016	35
Kinder Morgan	BP	Galena Park, TX	2017	50
Magellan Midstream	Trafigura	Corpus Christi, TX	1h17	50
Martin Midstream	--	Corpus Christi, TX	2016	50
Phillips 66	--	Sweeny, TX	2017	50
Targa Resources	Noble	Channelview, TX	1h16	35
<b>Subtotal</b>				<b>370</b>
<b>Refinery Expansions</b>				
Alon		Big Sping, TX	2q14	3
Flint Hills Resources (Koch)		Corpus Christi, TX	2h17	16
Valero		McKee, TX (Sunray)	1h15	25
<b>Subtotal</b>				<b>44</b>
<b>Topping Units/Pre-flash Towers</b>				
Delek (Pre-flash expansion)		El Dorado, AK	1q14	10
Valero (Topping Unit)		Houston, TX	1q16	90
Valero (Topping Unit)		Corpus Christi, TX	1q16	70

- Stranded condensate pricing supported economics of splitters
- Traders & midstream players planned as much as 720 kbpsd of splitter capacity, as well as new stabilisers
- Lower condensate output & export ban repeal now placing economics in doubt
- Now, only splitters under construction or with committed off-take likely
- Limited refinery expansion projects in PADD3, but several for accommodating more light crude & condensate
- Valero building topping units at 205 kbpsd Corpus Christi and 90 kbpsd Houston refineries
- Units will not add to capacity, but will allow processing of 160 kbpsd additional Eagle Ford...
- ...replacing 55 kbpsd of LS atmos resid feed, for net 105 kbpsd increase in feed

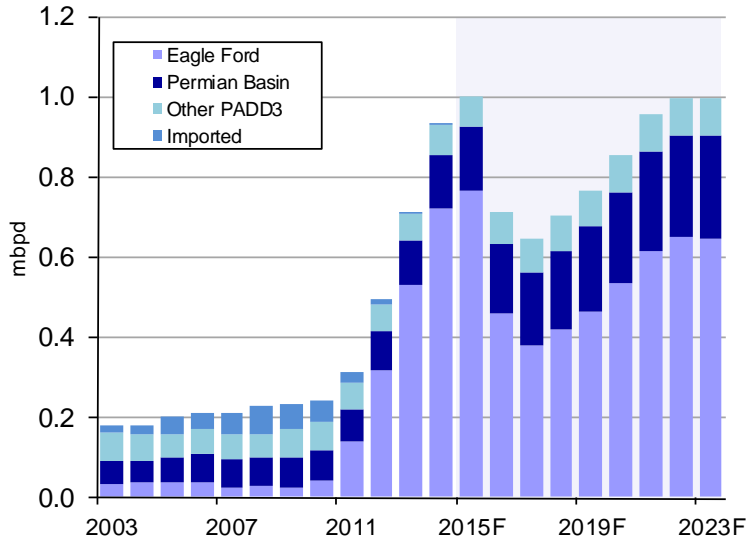
Sources: EIA, Company Reports, Makai

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# Sharp declines in Eagle Ford rig counts & output should cut into PADD3 condensate output, limiting export potential until 2018

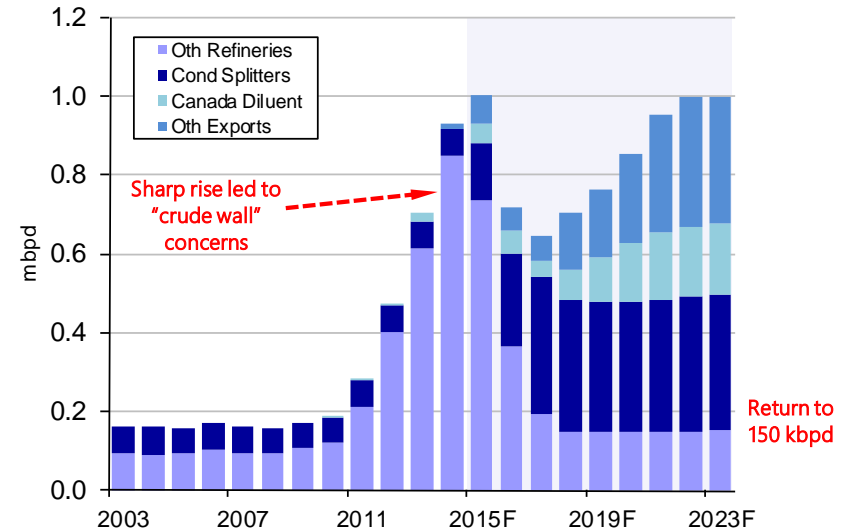
**PADD3 Condensate Supply, by Source**



Note: Estimates of PADD3 condensate production vary widely

Sources: EIA, TRRC, RBN Energy, Makai

**PADD3 Condensate Balance**

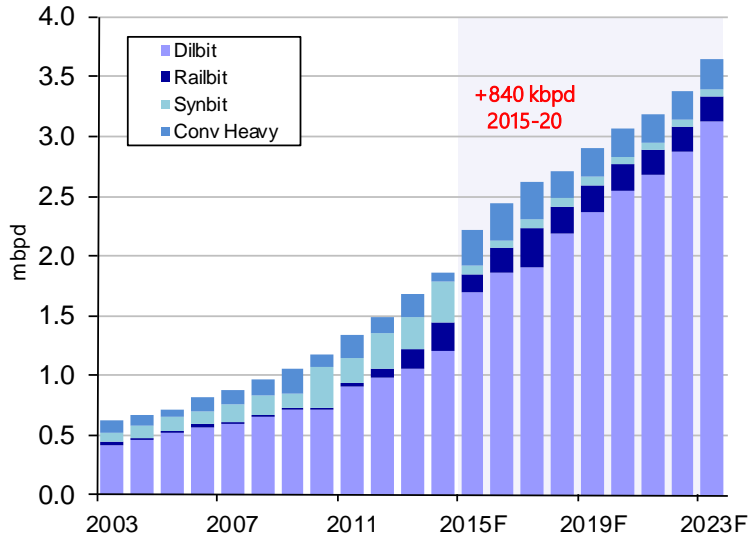


Sources: EIA, Statistics Canada, Makai

- Eagle Ford plays have provided majority of PADD3 condensate, but 70% cut in play rig count and greater emphasis on crude window should cut into PADD3 condensate production
- Lower condensate supply met by increase in demand from condensate splitters, and later, Canadian diluent demand
- With narrower/reversed Brent-LLS spreads and tighter condensate discounts to LLS, condensate export potential limited until 2018, when output rebounds
- Exports provide outlet to keep condensate feed near 150 kbpd previously-seen for normal refineries

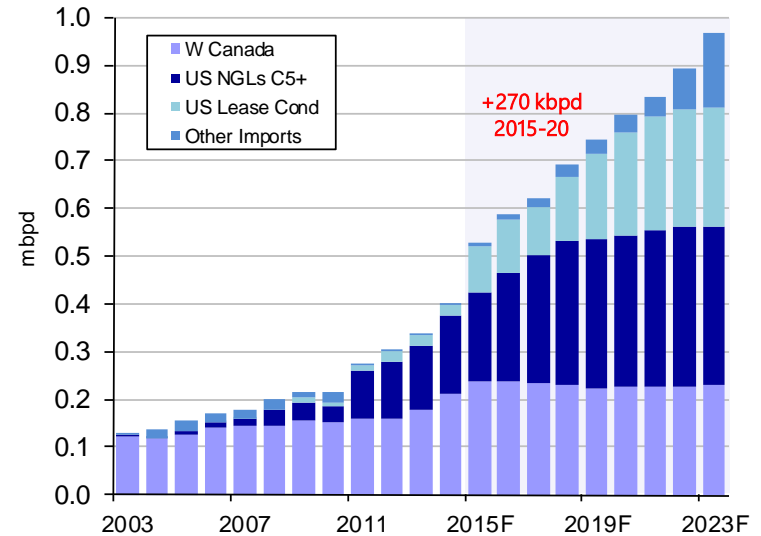
# Diluent for rising Canadian bitumen production would require additional US condensate, as other sources stabilise

## Canadian Oil Sands Heavy Composition



Sources: CAPP, Statistics Canada, Makai

## Western Canada Diluent Demand, by Source



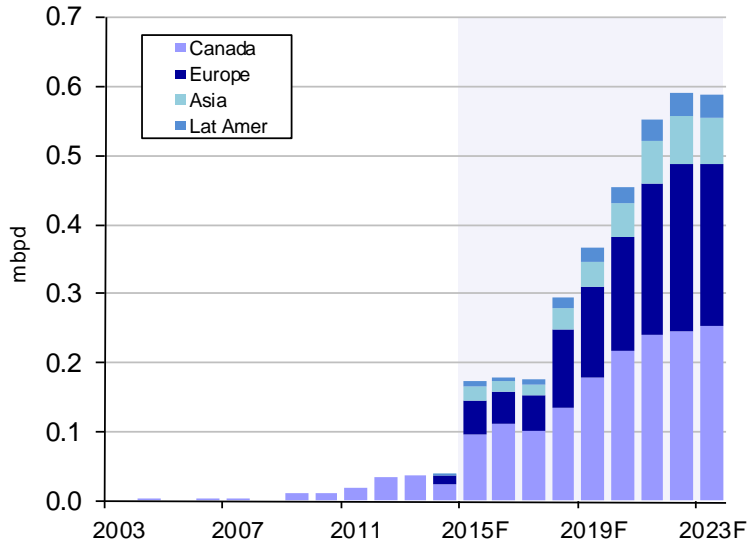
Sources: CAPP, Statistics Canada, EIA, Makai

- Western Canada bitumen production to rise 640 kbbpd over 2015-20 in Base Case, to 2.00 mbbpd
- “Oil Sands Heavy”, which includes other regional crude and diluent inputs, would increase by 840 kbbpd over same period, to 3.07 mbbpd
- Western Canadian condensate, pentane plus (C5+) and refinery naphtha have been traditional sources of diluent, but US supply of C5+ from NGL production surge has complemented
- US C5+ production should continue to rise, but demand is outpacing supply, leading to increasing use of US lease condensate



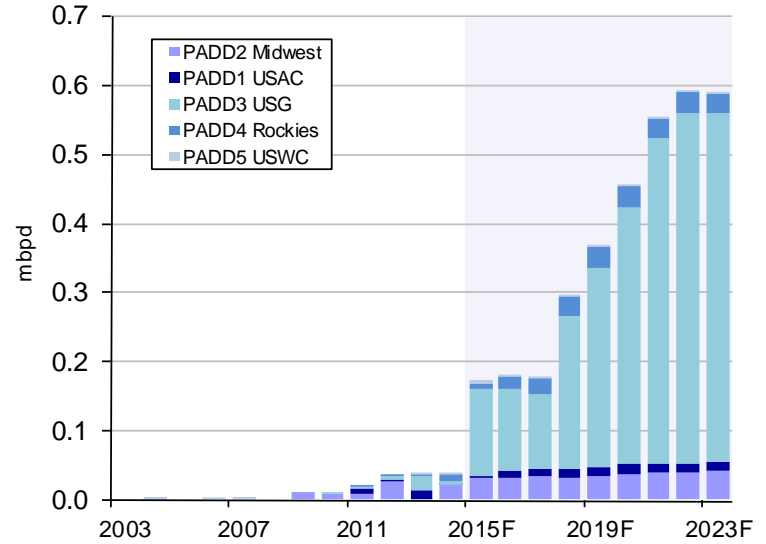
# Following start-up of USG & Midwest splitters, condensate exports set to accelerate on rebounding production

## US Condensate Exports, by Destination



Sources: EIA, Statistics Canada, Makai

## US Condensate Exports, by Source



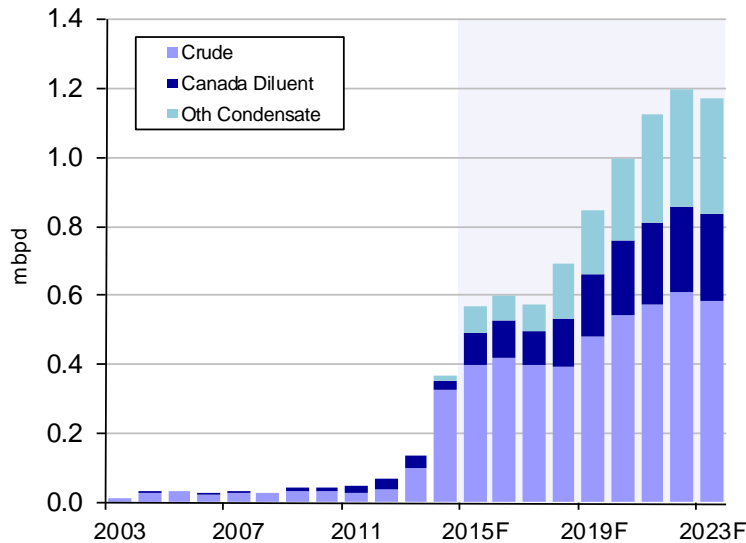
Sources: EIA, Makai

- Condensate exports to remain stable through 2017, as condensate splitters start and output declines
- Europe remains primary destination for seaborne exports, fitting with lightness of crude slate and replacing 300 kbpd of declining North Sea production during 2015-20 under the Base Case
- Asian response to PADD3 condensate has remain mixed, as petrochemical users have disliked quality inconsistencies, but Korean refiners are looking to diversify sourcing
- Eagle Ford and PADD3 remain dominant source of export condensate, but Perth Amboy, NJ becoming a PADD1 source of Utica & Marcellus condensate



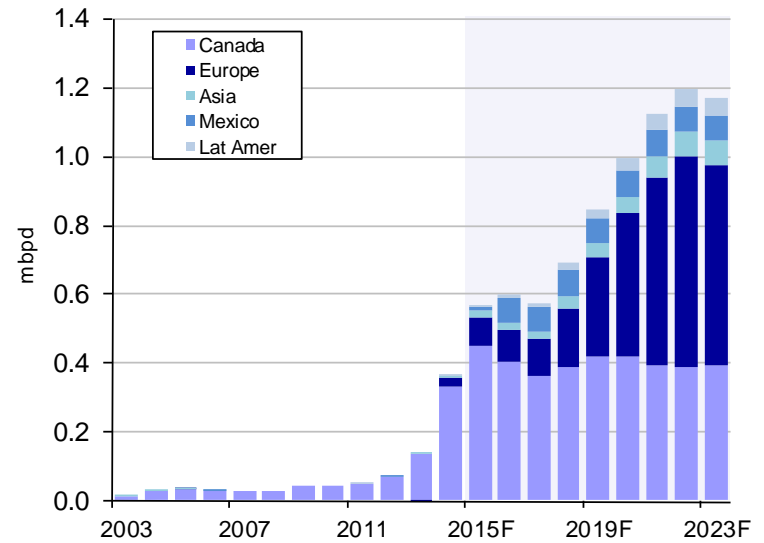
# Crude remains dominant export grade, with majority of crude & condensate exports destined for Europe

**US Crude & Condensate Exports**



Sources: EIA, Statistics Canada, Makai

**US Crude & Cond Exports, by Destination**



Sources: EIA, Statistics Canada, Makai

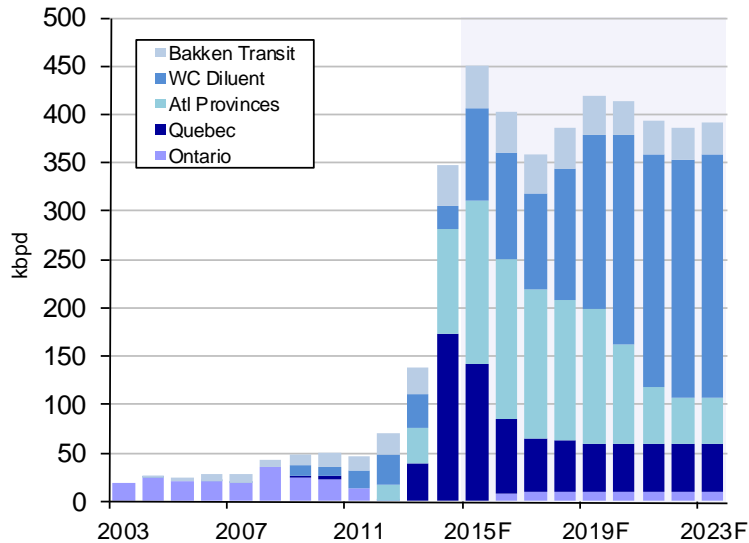
- Distinction between crude & condensate remains thin, with 45° API Eagle Ford crude and with condensate gravities above 50° API, but crude still holds significant -- but declining -- share of exports
- Crude exports rise after 2018, on recovering LTO production, but primarily to keep PADD3 refinery feed gravities in check
- With stable Canadian imports, Europe becomes primary destination for US seaborne exports, taking 440 kbpd of crude and 220 kbpd of condensate by 2023
- Base Case has Mexico continuing with 75 kbpd of crude imports, although refining needs could change

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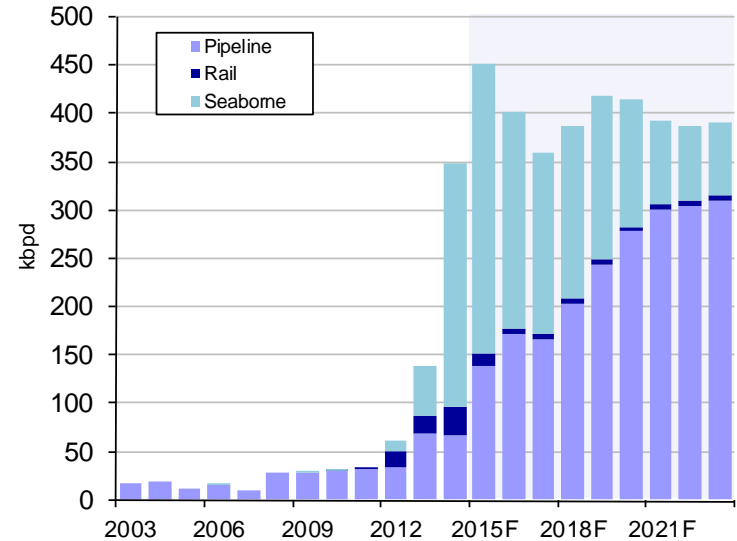
# Overall US exports to Canada to remain relatively flat, but composition and destinations to shift

## US Crude/Condensate Exports to Canada



Sources: EIA, Statistics Canada, Makai

## US Crude/Cond Exports to Canada, by Route



Sources: EIA, Statistics Canada, Makai

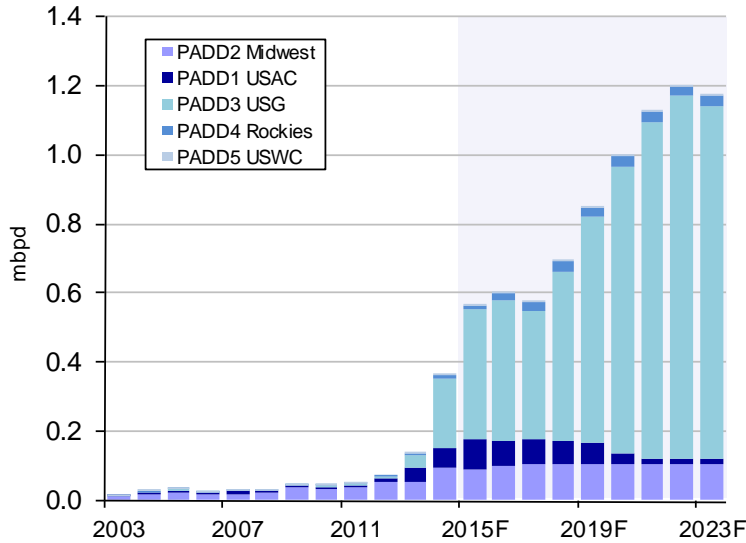
- US crude exports to Canada jumped by 317 kbpd in 2014-15, as Québécois and Atlantic Province refineries increased runs of Eagle Ford crude
- Canadian diluent demand for condensate rose in 2015, as US C5+ production growth slowed to 29 kbpd yoy and C5+ demand rose by 9 kbpd, on higher mogas blending needs
- Over 40 kbpd of official EIA export statistics reflect the transit of Bakken crude through Canada, either returning via Enbridge Mainline, or rail border crossings in Vermont or NY, towards Albany, NY
- Québécois imports should decline on Line 9B reversal; Atlantic Provinces on Energy East start-up

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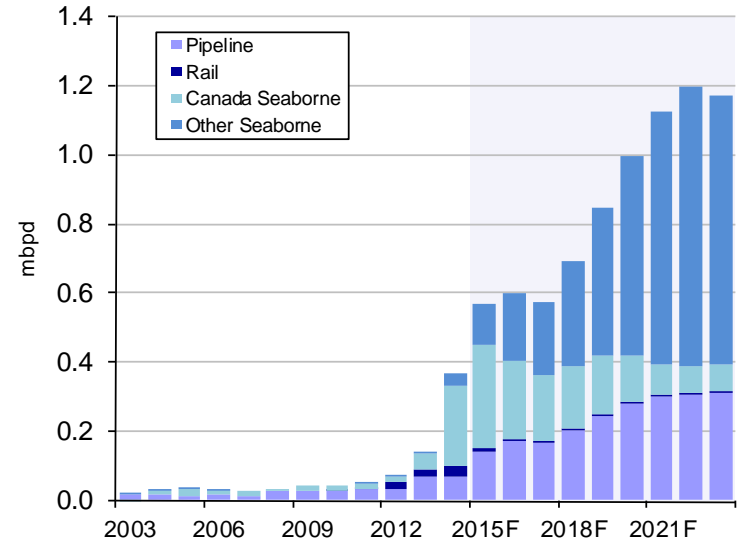
# PADD3 remains primary source of crude & condensate exports, with longer-haul seaborne volumes set to jump

## US Crude & Condensate Exports, by Source



Sources: EIA, Statistics Canada, Makai

## US Crude & Condensate Exports, by Route

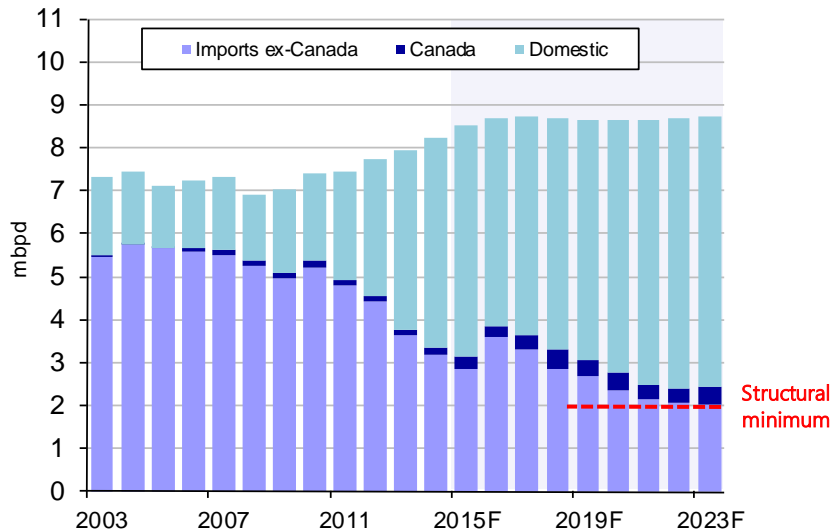


Sources: EIA, Statistics Canada, Makai

- PADD3 dominates US crude & condensate exports, with 88% share by 2023
- Current PADD1 exports of railed Bakken from Albany to Atlantic Provinces set to decline with Energy East start-up, and potential 220 kbpd TransCanada Upland pipeline connection from Bakken
- With stable Canadian imports, other seaborne volumes set to accelerate, from 120 kbpd in 2015, to 580 kbpd in 2020 and to 810 kbpd in 2022
- Total US crude & condensate exports would peak at 1.17 mbpd in 2022, before declining production reduces export availability

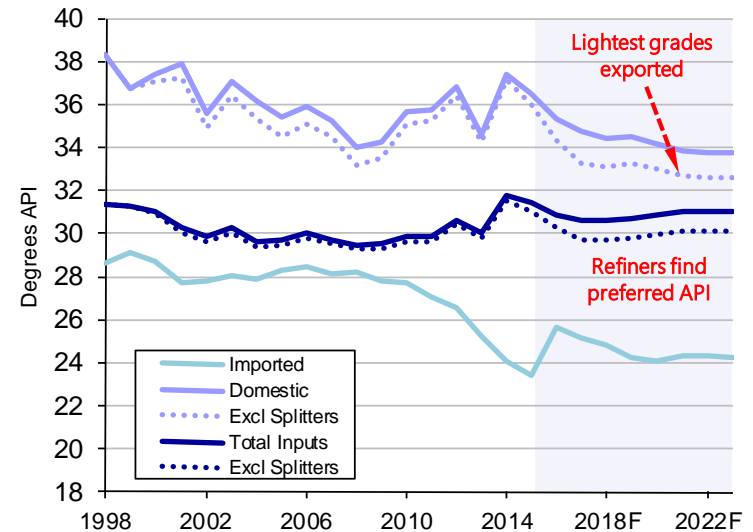
# Crude exports become key variable for controlling feedstock quality and maintaining structural minima for import volumes

**PADD3 Crude Intake, by Source**



Sources: EIA, Makai

**PADD3 Crude Intake Gravities, by Source**



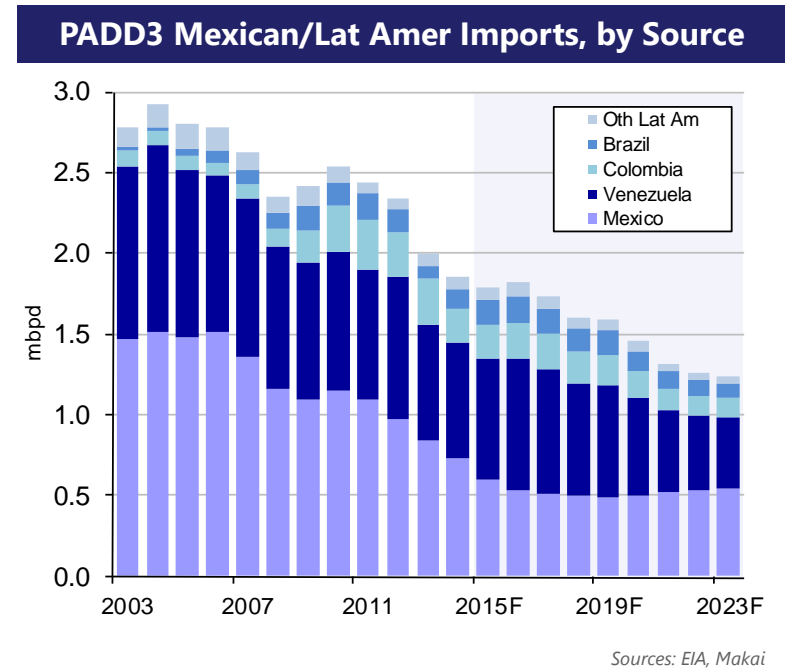
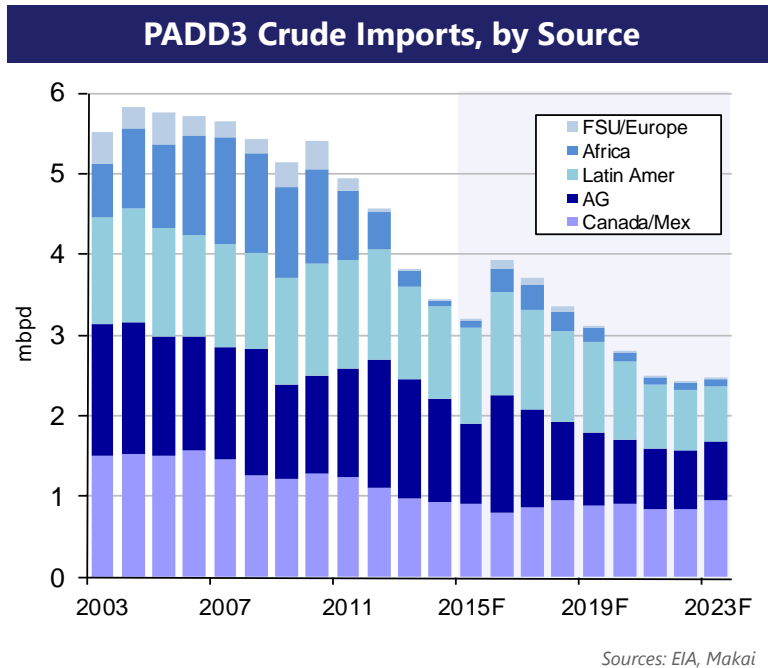
\* Imputed from Total & Imported

Sources: EIA, Makai

- Rising LTO production would send PADD3 imports below 1.5 mbpd, without rise in exports
- Given heavy coking configuration of PADD3 refineries, heavy & medium crude imports need to remain above 2.0 mbpd to keep cokers utilised
- PADD3 imports actually rise in 2016, as LTO production declines, then fade, as output recovers
- Exports of lighter grades and condensate splitters keeps gravities in check for normal refineries
- Required API gravity of imports rises with lost LTO production, then declines on production recovery



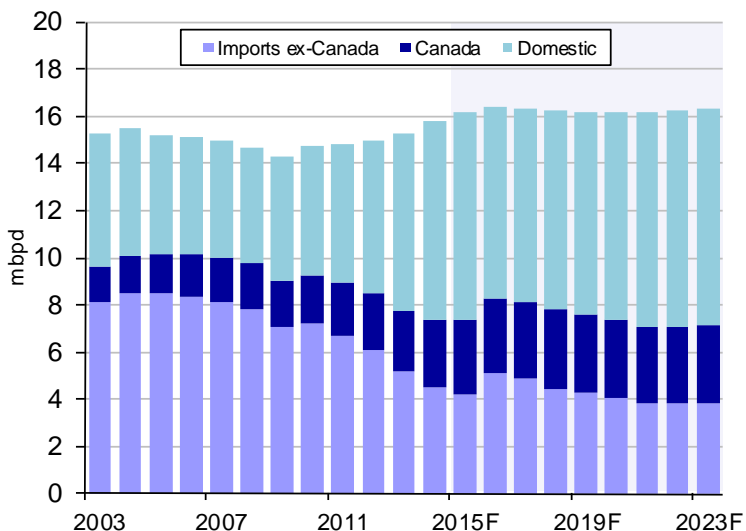
# Rebound in LTO production would send PADD3 crude imports below structural minimum levels without exports



- In addition to heavy crude requirements for PADD3 cokers, base import requirements include Saudi Aramco's 50% share of Motiva crude intake for its 1,076 kbpcd of refinery capacity
- Minimum Saudi crude requirements also include approximately 250 kbpd of Arab Light imports for lube oil manufacture, given the grade's superior lube base oil qualities
- Mexican and Latin American crude imports also need to remain above 1.1 mbpd for coker feed
- African imports bounce briefly, to replace lost LTO production, then return to minimal levels

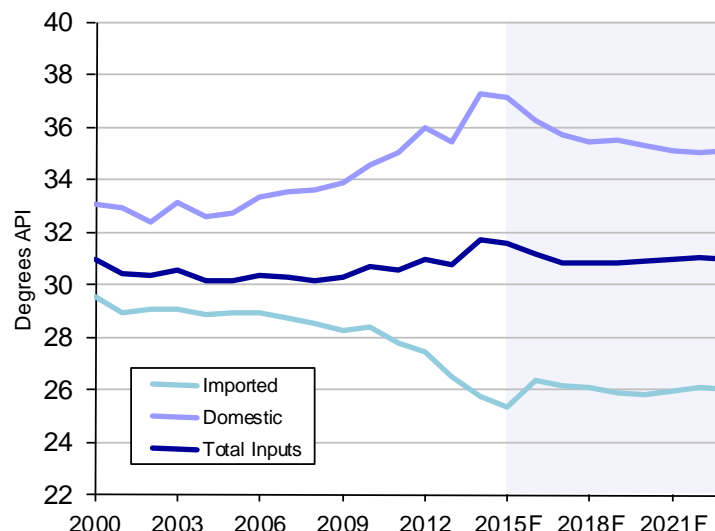
# US refinery intake balance and gravities follow the dominant PADD3 patterns

## US Refinery Crude Intake, by Source



Sources: EIA, Makai

## US Crude Intake Gravity, by Source



Sources: EIA, Makai

- Overall US refinery crude intake follows sourcing pattern for PADD3 refineries, with PADD1 also contributing to the rise in crude imports in 2016
- Under the Base Case, US crude imports would decline to 7.08 mbpd in 2022, from 7.32 mbpd in 2015, after a 0.90 mbpd bounce in 2016
- Non-Canadian imports would fall to 3.85 mbpd in 2021, from 4.17 mbpd in 2015
- API gravity of US crude intake would remain near 31.0° API



# Conclusions

- US Congress finished what BIS started -- new export regime should resolve crude quality issues for PADD3 refiners, while offering producers better pricing environment
- Muted near-term outlook for exports:
  - Collapse in rig counts leads to lower production and cargo availability
  - New condensate splitter capacity on USG also absorbs supply
  - Narrower/negative Brent-LLS and Brent-WTI spreads discourage exports
- Stable LTO rig counts in 1h16 should provide 1 mbpd yoy decline in production required to provide global rebalancing, given rig productivity & well decline rate trends
- Oil E&P under-investment in 2015-16 and lower OPEC spare capacity should tighten oil markets significantly by 2019, leading to higher LTO rig counts & output
- Rebounding LTO production and stable internal demand should increase export availability
- Exports act a key variable in optimizing PADD3 crude slate
- Europe should emerge as leading destination for US crude & condensate exports, given lightness of regional crude slate and declining North Sea production





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