



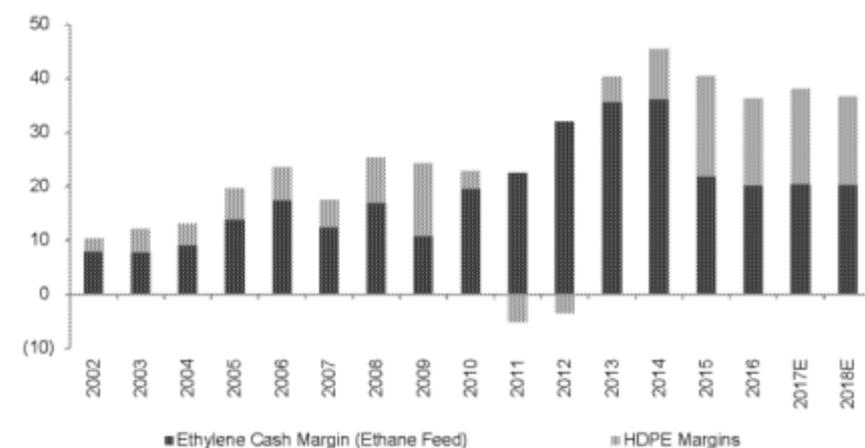
## Trend of Elevated Margins Expected to Continue

U.S. ethylene up-cycle to persist through 2020

Despite Brent oil prices rising 100% from their January 2016 lows of \$26/bbl, prices remain ~40% below their June 2014 highs of \$107/bbl. While lower oil prices have reduced U.S. ethylene profitability, we still expect U.S. ethylene margins to remain strong and U.S. ethylene producers to remain advantaged versus oil-based producers in Europe and Asia through the rest of the decade.

We forecast U.S. ethane-based ethylene cash margins to stay close to the current 13 c/lb level through 2018 as the majority of the 8 new greenfield U.S. ethylene crackers come on line. With the current 26 c/gal ethane price equating to 12-13 c/lb ethylene production cost, U.S. ethane-based ethylene cash margins are roughly 13 c/lb. While this is below the 44 c/lb margin achieved in September 2014 (the peak of the peak), the ethylene margins being realized today are still within the range of prior peaks of 10-15 c/lb. Starting in '18, we expect U.S. ethane prices to move higher on tightening supply/demand fundamentals (new ethylene capacity, increased exports, reduced drilling activity). Notwithstanding our view of rising ethane prices, we remain positive on the U.S. ethylene cycle through the rest of the decade (and likely longer) for 2 key reasons: a beneficial oil-to-gas ratio and limited global supply additions.

Figure 4: Integrated ethane-based US ethylene / HDPE margins, 2002-18E (c/lb)



Source: IHS Chemical, Deutsche Bank

U.S. ethylene producers have substantially increased their usage of less expensive NGLs

For U.S. chemical producers, the widening spread between oil and natural gas that took place over the past few years has signified a substantial cost advantage versus European and Asian producers, even with the decline in oil over the past three years. With NGLs less expensive than naphtha, flexible feed U.S. ethylene crackers have shifted as much as possible away from naphtha. In November 2017, 94% of U.S. ethylene was produced from NGLs versus ~70% in the early 2000s. Ethane is the primary U.S. ethylene feedstock responsible for 77% of production followed by propane at 12% and butane at 5%.