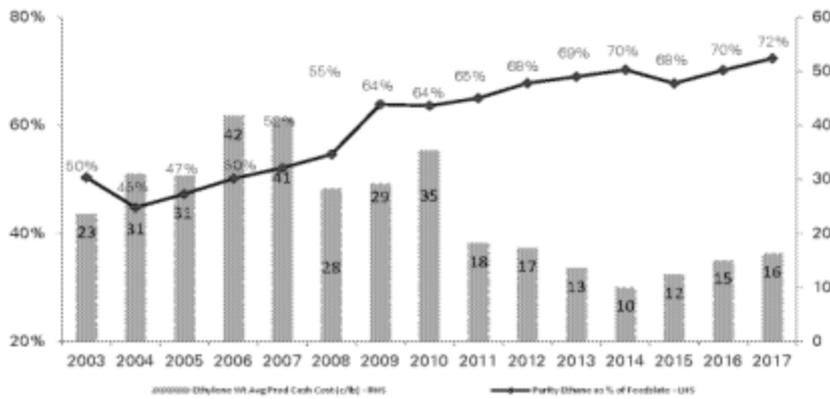




Figure 5: increased usage of cheap ethane feedstock has reduced average U.S. ethylene production costs



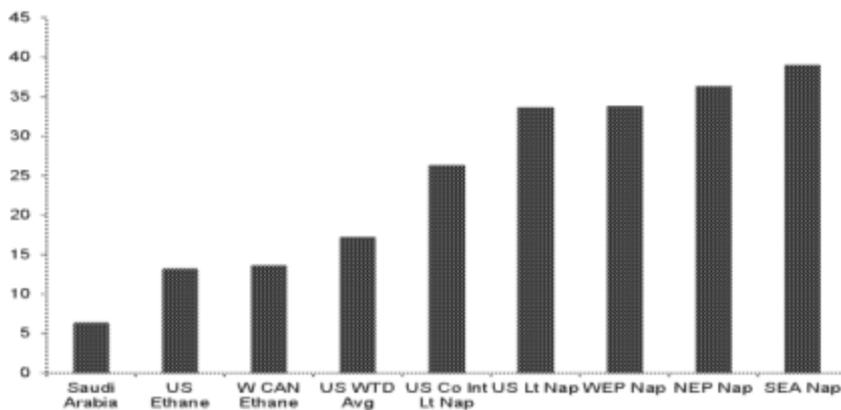
Source: IHS Chemical, Deutsche Bank

U.S. ethane-based ethylene producers maintain their cost advantage vs. naphtha-based ethylene producers in Europe and Asia

For U.S. NGL-based ethylene producers, the widening spread between oil and natural gas in '10-'14 signified a substantial cost advantage versus oil-based producers in Europe and Asia. Based on their respective fuel value, oil and gas are balanced at a ratio of roughly of 8x. After averaging 8x (Brent oil vs. U.S. natural gas) from 2000-'08, the oil-to-gas ratio widened to an average of 30x from 2011-'14 on higher oil prices and lower natural gas prices. With the ratio at 22x in November '17, U.S. NGL producers remain highly advantaged as an oil-to-gas ratio of 15x denotes a significant cost advantage. In November, U.S. ethane-based ethylene producers enjoyed a 26 c/lb cost advantage versus naphtha-based producers in Asia with U.S. costs of 13 c/lb vs 39 c/lb in Asia.

We expect this cost advantage for U.S. producers to continue through the rest of the decade. Deutsche Bank's Commodities team forecasts oil prices will average \$53.40/bbl (Brent) in 2017, \$54.50/bbl in 2018, \$56/bbl in 2019 while U.S. natural gas prices will average \$3.02/MMBtu in 2017, \$3.00/MMBtu in 2018 and \$3.10/MMBtu in 2019. These forecasts result in an oil-to-gas ratio of 17.7x in 2017, 18.1x in 2018 and 18.1x in 2019.

Figure 6: Global Ethylene Cost Curve 2017 (cents/lb)



Source: IHS Chemical, Deutsche Bank