RBN Energy LLC

2323 South Shepherd Drive, Suite 1010
Houston, Texas 77019
OFFICE 888-613-8874
FAX 713-391-8421

Drive My Car - The Thinking Behind A Planned Gulf Coast Ethylene-To-Alkylate Project

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Published by: Housley Carr

For a few years now, the Shale Revolution has been opening up development opportunities hardly anyone would have thought possible in the Pre-Shale Era. For example, new crude oil, natural gas and NGL pipelines from the Permian to the Gulf Coast, lots of new fractionators and steam crackers, as well as export terminals for crude, LNG, LPG, ethane and, most recently, ethylene. And here's another. Thanks to the combination of NGL production growth and new ethylene supply — plus increasing demand for alkylate, an octane-boosting gasoline blendstock — the developer of a novel ethylene-to-alkylate project along the Houston Ship Channel has reached a Final Investment Decision (FID). Today, we discuss how the FID is driven by both supply-side and demand-side trends in the NGL and fuels markets.

As Rusty Braziel said in "The Domino Effect," his book on the Shale Revolution, energy markets over the past few years have been characterized by an interconnected sequence of developments that have together propelled the U.S. crude oil, natural gas and NGL sectors into an extraordinary new era of abundance. Examples of the knock-on effects of the flourish caused by plentiful drill-bit hydrocarbons abound, but one that caught our eye in recent weeks is Next Wave Energy Partners' (NWEP) FID on its planned 28-Mb/d ethylene-to-alkylate plant in Pasadena, TX. We'll discuss the company's project, known as Project Traveler, in detail in a moment; first we'll look at "the row of falling dominoes" that led — almost inevitably, it now seems — to its fruition:

- **Rising NGL production.** Increased production of crude oil and natural gas in a number of major U.S. shale plays has resulted in higher and higher production of mixed NGLs — also known as y-grade. We have chronicled these gains in a number of RBN blogs, including Bring It On, where we noted that in 2019, produced volumes of NGLs (not counting ethane that is "rejected" into natural gas) approached 5 MMb/d — roughly double their level back in 2012 — and that by the mid-2020s, production is expected to increase by another 1 MMb/d.
- **More fractionators, more steam crackers, more exports.** The increasing supply of U.S.-sourced NGLs spurred the development of more fractionation capacity to separate y-grade into so-called "purity products" — ethane, propane, butane, isobutane and natural gasoline. Also, the growing supplies of NGL purity products led to the development of many new steam crackers (most of them designed to use ethane as their feedstock), and, with the U.S. now producing far more NGLs than it can consume, new marine terminal capacity is being added to handle growing volumes of LPG (propane and butane) and ethane exports. Most of this new fractionation, steam-cracker and export capacity is being added along the Gulf Coast.
- **Low and relatively stable ethane prices.** There can be a good bit of price volatility in the U.S. ethane market — back in September 2018, ethane prices at the Mont Belvieu ,TX, NGL storage and fractionation hub soared to north of 60 cents/gallon (c/gal) due in part to fractionation-capacity constraints. Generally speaking, though, ethane prices have been hovering within a few pennies of the 25-c/gal mark for most of the past two years, even as new steam crackers have come online and exports have risen. Our expectation is that while the next round of steam crackers will put upward pressure on prices, there is still plenty of ethane out there — much of it now being "rejected" into natural gas — and prices probably will not need to rise by more than a few c/gal to keep Gulf Coast steam crackers and export docks awash in the stuff. (Again, that doesn't mean there won't be at least some volatility.)

- **Low and relatively stable butane prices.** All of the increased y-grade production and addition of fractionation capacity can only mean one thing: more purity products. And, in the case of normal butane, this incremental supply must be exported because domestic demand is not growing. And that should mean that U.S. consumers can count on normal butane to be priced low enough to support exports.
- **Rising Gulf Coast ethylene supply, and low ethylene prices.** About 7.6 billion pounds per year of U.S. steam cracker capacity came online in 2018, followed by 11.2 billion pounds per year in new capacity last year; another 12.2 billion pounds per year is scheduled for start-up in the 2020-22 period. Given that ethane-consuming crackers in the Middle East and U.S. typically benefit from lower feedstock costs than their naphtha- and LPG-consuming brethren in Europe and Asia, the new U.S. plants are likely to run at high utilization rates, even if that contributes to a global ethylene-supply glut that keeps ethylene prices low. (Earlier this month, in a sign of things to come, the first cargo of ethylene was sent out of Enterprise Products Partners and Navigator Holdings' new, 2.2-billion-pound-per-year Morgan's Point export terminal along the Houston Ship Channel.)

Even if ethylene prices are in the cellar, steam crackers like the Corpus Christi-area one being developed jointly by ExxonMobil and SABIC that have adjoining polyethylene (PE) and monoethylene glycol (MEG) plants can benefit from that vertical integration so long as the margins between ethylene and PE and MEG hold up. Stand-alone steam crackers, though, are seeking to mitigate their exposure to ethylene commodity price risk, and one way to hedge is to explore other potential markets.

Which brings us to the alkylate side of all this. Unless you're a refining or blending geek, it's easy to forget when you're filling up the tank of your car, SUV or pickup that gasoline is a blend of many hydrocarbon components that in combination meet certain specifications. It's up to refineries and gasoline blenders to come up with their own gasoline recipes that satisfy the requirements of specs like Reid vapor pressure (RVP) and octane. Still further, as you're reminded with each visit to the pump, there are at least three grades of gasoline based on its octane level, the standard ones being 87 (regular), 91 (intermediate) and 93 (premium).

High octane, low RVP and low-sulfur content are three of the most desirable qualities that refineries and gasoline blenders seek in their blendstocks, and alkylate produced as part of the crude oil refining process has perhaps the best combo of the three of any major gasoline component: octane of 90 to 96, RVP of 4 to 5 pounds per square inch at atmospheric pressure (psia), and sulfur content of 5 to 15 parts per million (ppm) — see the yellow-outlined rectangle in Figure 1, which shows the octane number, RVP and sulfur content for the primary gasoline components produced at refineries, as well as the units within the refineries that produce them. The octane number indicates how much a fuel can be compressed before it self-ignites, which causes "knocking" — the closer to 100 the better — while the RVP measures how easily a fuel vaporizes — the lower the better under most weather conditions. (We should note that reformate — mainly a mix of toluene, xylene and benzene — at first glance may seem like an octane solution on par with alkylate, but it is 100% aromatic, and its use in gasoline is capped for environmental and health reasons.)

Octane, RVP and Sulfur Content of Refinery-Produced Blendstocks

Component	Process Unit Source	Octane	RVP psia	Sulfur ppm
Normal Butane	Distillation	90 to 92	70 to 74	2 to 6
Light Straight Run Naphtha	Crude Distillation	60 to 66	10 to 13	10 to 500+
Heavy Naphtha (non-hydrotreated)	Crude Distillation, Coker, Hydrocracker	58 to 64	1 to 1.5	40 to 500+
Reformate	Reformer	87 to 95	2 to 3	2 to 6
FCC Gasoline (non-hydrotreated)	FCC	82 to 87	1 to 2	10 to 500+
Alkylate	Alkylation Unit	90 to 96	4 to 5	5 to 15
Isomerate	Isomerization Unit	78 to 83	7.8 to 8.5	1 to 10

Blending Quality:
Highly Favorable
Favorable
Neutral
Unfavorable
Highly Unfavorable

Figure 1. Octane, RVP and Sulfur Content of Refinery-Produced Blendstocks. Source: EIA

There are three more pertinent things to mention before we get to the specifics of Next Wave's project. The first is that while overall demand for gasoline in the U.S. has remained close to flat over the past several years, mostly due to improved fuel efficiency, an increasing share of vehicles sold here require the use of 91- or 93-octane fuel and, as you'd expect, an increasing portion of the gasoline sold is premium: about 11% in 2018, according to the Energy Information Administration (EIA), compared with about 9% at the start of the 2010s. The main driver of this trend is the growing number of fuel-efficient, turbo-charged engines on the road today, which are required to meet the increasingly more stringent fuel efficiency standards. These engines need more octane to operate at their higher fuel compression ratios.

The second thing worth noting is that in the Shale Era U.S. refineries have been increasing their use of abundant domestically produced crude oils which, like West Texas Intermediate (WTI), tend to have a higher API gravity. (High-API barrels are referred to as light, versus low-API barrels, which are considered heavy.) When these lighter barrels are refined, they produce more naphtha than heavier crudes do. Because naphtha has a low octane number (see Figure 1), it needs to be "blended up" with the addition of more high-octane components like alkylate. Thirdly, if you're asking, why don't refineries just ramp up their output of alkylate, well, you've got to consider the bigger picture: a refinery is run to optimize consumption and profitability of the overall crude barrel, rather than to try to increase production from one internal unit and throw the whole refinery balance out of whack.

What Next Wave saw — in addition to the trends of growing butane and ethylene supply, coupled with increasing demand for alkylate — is that the technology exists to convert low-cost, NGL-based

products into an important gasoline blendstock. Project Traveler, a planned 28-Mb/d ethylene-to-alkylate plant scheduled to begin operation in mid-2022, will have two main elements (see Figure 2): a *dimerization unit* that reacts ethylene with itself to form butylene, and an *alkylation unit* that reacts butylene and isobutane to form a pure alkylate. We hear that Next Wave's alkylate will be 96 octane — 4 higher than the average 92-octane alkylate produced at refineries — with an RVP of only 3.5 psia and next to no sulfur content.

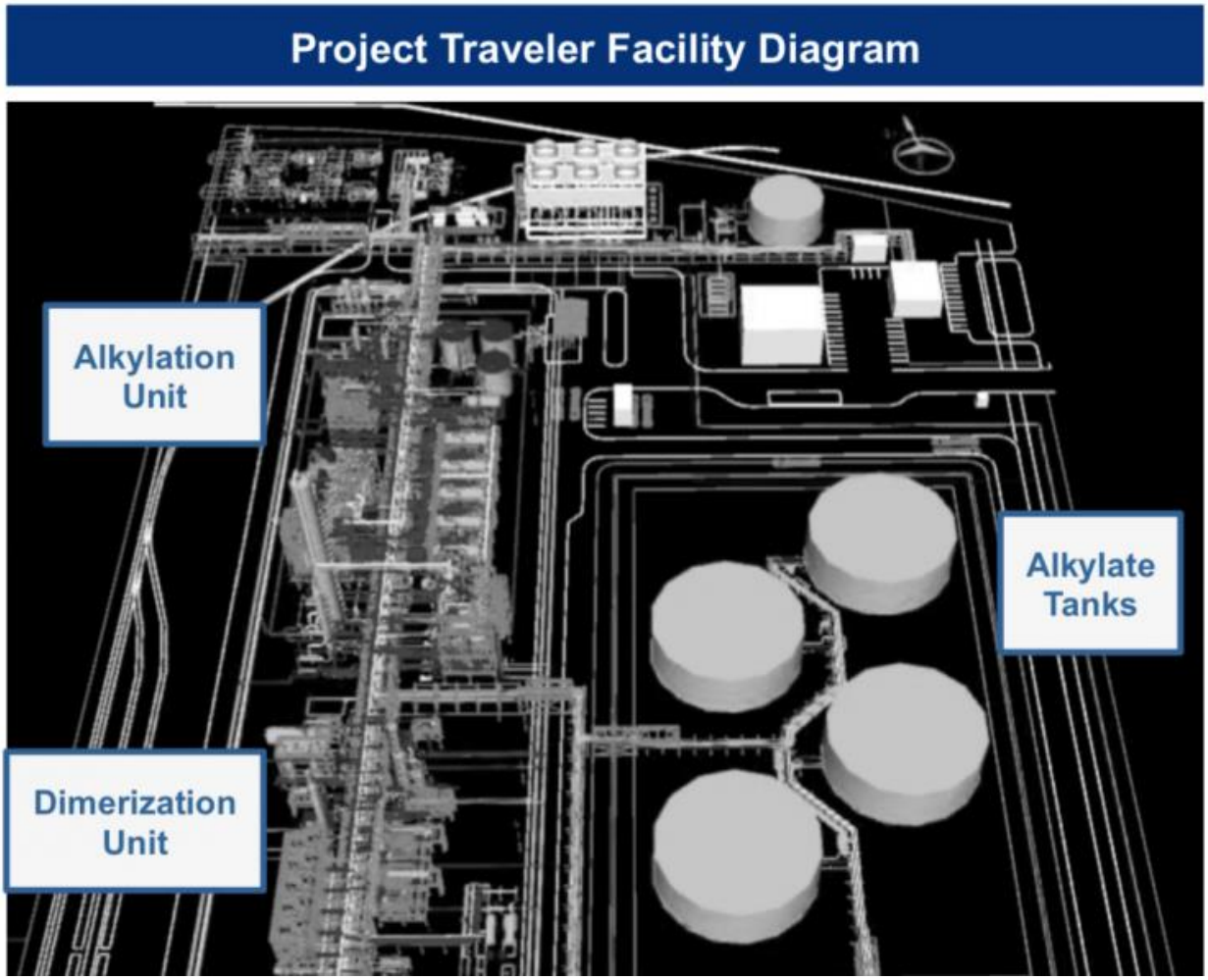

Figure 2. Project Traveler Facility Diagram. Source: Next Wave Energy Partners

Ethylene will be delivered to the Pasadena (TX) plant site (labeled "NWEP" in Figure 3) via the half-dozen or so ethylene pipelines that already run along the site's boundary; isobutane also will be delivered by pipe. As for the alkylate produced, Next Wave plans to pipe it to two large, close-by gasoline-blending and marine-terminal facilities in Pasadena, one owned by Kinder Morgan and the other by Intercontinental Terminals Co. (ITC). Kinder Morgan's facility is the largest gasoline blender by volume in the U.S.

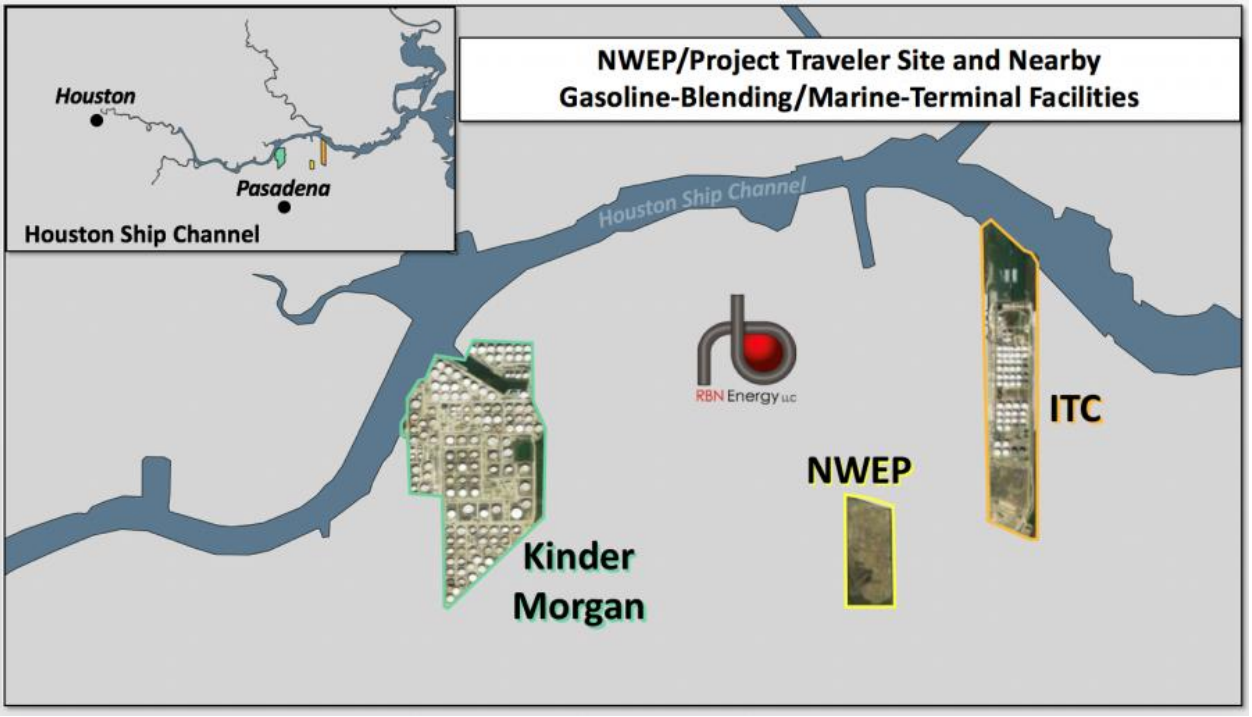

Figure 3. NWEP/Project Traveler Site and Nearby Gasoline-Blending/Marine-Terminal Facilities. Sources: Next Wave Energy Partners and RBN

Next Wave took a decidedly midstream approach to the commercial side of the project. Like the developer of a new pipeline, fractionator or export terminal, it sought to line up long-term customers for a substantial majority of its capacity and to minimize its exposure to the risks associated with commodity prices — in this case, ethylene and alkylate. Our understanding is that, prior to taking FID on Project Traveler, Next Wave entered into a number of agreements under which steam-cracker owners commit a small portion of their ethylene output and gasoline blenders commit to buying specified volumes of alkylate — locking in most of their spread. Through these deals, the majority of the commodity price risk is allocated to the ethylene suppliers and alkylate consumers looking to hedge their own long and short positions, respectively. This structure also provides the project with long-term commitments for ethylene supply and alkylate offtake that ensure the plant's capacity will be highly utilized.

Altogether, Project Traveler has a lot going for it. To put it simply, it's planning to use ethylene produced from an increasingly available NGL purity product — ethane — to make an increasingly important blendstock — alkylate. In doing so, the facility will provide its ethylene suppliers with a new, albeit small market, for their product; and give the project's alkylate buyers a new source for the blendstock, all the while mitigating their commodity risk.

Please note that, due to the Martin Luther King holiday, we will not publish a blog on Monday, January 20, 2020.

"Drive My Car" was written by Paul McCartney and John Lennon. The song was recorded at EMI Abbey Road Studios in London in October 1965, with George Martin producing. It has been suggested that the lyrics were inspired by an incident involving Beatles friend and Brian Epstein

protégée Cilla Black, and her then-boyfriend, Bobby Willis. The song was the first cut on the UK version of *Rubber Soul,* and on the American release of *Yesterday and Today.* It was the first Beatles song to feature a slide guitar solo, played by Paul McCartney. Personnel on the record were: Paul McCartney (lead vocal, bass, piano, slide guitar), John Lennon (lead vocal, tambourine), George Harrison (backing vocals, lead guitar) and Ringo Starr (drums, cowbell).

Yesterday and Today was The Beatles' 12th studio album and ninth album for Capitol Records in the U.S. It pulled together songs from the UK releases of *Rubber Soul*, *Help*, the not-yet-released *Revolver*, and the single of "Day Tripper"/"We Can Work It Out." The original album cover photo for the album by Robert Whitaker featured The Beatles wearing butcher smocks and draped with pieces of meat and body parts from plastic baby dolls. It has been presumed to be a reaction by The Beatles to Capitol Records in America pulling cuts culled from their UK releases, thus "butchering" the song selection and order. After a furor from U.S. retailers over the cover, Capitol pulled the album from stores and stickered over them with a new, non-offensive photo of the band. These re-stickered albums are referred to as the "butcher cover," and bring hefty prices in the collectors' market. In 2016, an ultra-rare sealed mint stereo copy of the original cover was sold at auction for $125,000. *Yesterday and Today* was released in June 1966, and went to #1 on the U.S. Billboard Top 200 Albums chart. It has been certified 2x Platinum by the Recording Industry Association of America.

The Beatles were a British rock band formed in Liverpool, England, in 1960. With the line-up of John Lennon, Paul McCartney, George Harrison and Ringo Starr, The Beatles went on to change the face of rock music and pop culture during their time together. They are the best-selling music artists in history, with estimated record and digital sales of over 800 million worldwide. The band released 23 studio albums, five live albums, 53 compilation albums, 21 EPs and 63 singles. The Beatles have won one Academy Award, one Billboard Music Award, four Brit Awards, 26 Grammy Awards, 15 Ivor Novello Awards, one MTV Video Music Award and three World Music Awards. They are members of the Rock and Roll Hall of Fame, the UK Music Hall of Fame and Vocal Group Hall of Fame, and are Members of the Order of the British Empire, as appointed by Queen Elizabeth II. John Lennon died in 1980 and George Harrison in 2001. Paul McCartney and Ringo Starr continue to record and tour as solo artists.