
Keeps Getting' Better, Part 2 - Project Eyes Using Ethanol To Make Bioethylene, Renewable Alkylate, SAF

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In these uncertain times, with the energy transition in flux and a recession looming, it takes moxie for a company to make a major capital investment in an energy-related project, especially one that could arguably be called the first of its kind. But that's what's happening at a site along the Houston Ship Channel (HSC) in Pasadena, TX, where Next Wave Energy Partners, which is now completing an ethylene-to-alkylate plant, is planning an adjoining ethanol-to-ethylene facility that will enable the company to produce bioethylene, renewable alkylate and/or sustainable aviation fuel (SAF), depending on market demand, production economics and other factors. In today's RBN blog, we discuss the ins and outs of Next Wave's Project Lightning.

In [Part 1](#), we took an in-depth look at the company's 28-Mb/d ethylene-to-alkylate plant — dubbed Project Traveler — which during the coming driving season will start producing pure alkylate, an octane-boosting gasoline blendstock, from NGL-based ethylene. More specifically, the plant's dimerization unit reacts ethylene to form butylene, and its alkylation unit reacts isobutane with butylene to form pure alkylate, with no material byproducts. The thinking behind the project is that a combination of NGL production growth and new Gulf Coast ethylene supply — plus increasing demand for alkylate — would be a win-win-win for ethylene producers, refiners and Next Wave itself. We noted that high octane, low Reid vapor pressure (RVP) and low sulfur content are three of the most desirable qualities for gasoline blendstock, and alkylate (typically produced as part of the crude oil refining process and representing about 15% of the total gasoline pool) has perhaps the best combo of the three.

Today, as promised, we'll dive into Project Lightning, which is designed to allow Next Wave and its customers to make a feedstock shift, over time, from conventional, NGL-based ethylene to chemically identical bioethylene derived from ethanol. As we previously noted in [Take a Look at Me Now](#), bioethylene can be used to produce plastics, fibers, antifreeze and many other products, or in the case of Project Traveler, renewable alkylate (an octane booster eligible for Renewable Identification Number environmental credits — more on this in a moment) or SAF (a low-carbon-intensity alternative to crude-oil-based jet kerosene).

Before we discuss the project details, we should explain the key drivers behind it. Most important, perhaps, is the big push by industries of all sorts to reduce the carbon intensity (CI) of their products in response to a company's own ESG-related goals, customer preference, regulatory mandates and/or government incentives — most notably California's Low Carbon Fuel Standard (LCFS; see [Come Clean, Part 2](#) for how CI and the LCFS work). For example, many companies that use plastic in their products or packaging want at least some of that plastic to come from non-petroleum sources; many airlines want to ramp up their use of SAF; and many gasoline blenders want to generate more revenue-producing RINs by increasing their use of ethanol (again, more on RINs in a sec).

As for Project Lightning — named, we’d guess, for “white lightning” (a.k.a. moonshine), which is distilled ethanol — it is a planned world-scale facility that, at full capacity, will use a dehydration unit (gray box within large green box in Figure 1) to convert denatured ethanol (the standard grade used in gasoline blending) to produce 900 million pounds per year (MMppy; equal to ~2.5 million lb/d or ~1,200 tons/d) of bioethylene, a polymer-grade ethylene. The ethanol can be delivered to the HSC area by unit train, barge or ship, then be piped to the plant via an existing ethanol pipeline that passes very near the site — one of the very few ethanol pipelines in the U.S., by the way (for reasons we discussed in [Come Clean, Part 3](#)).

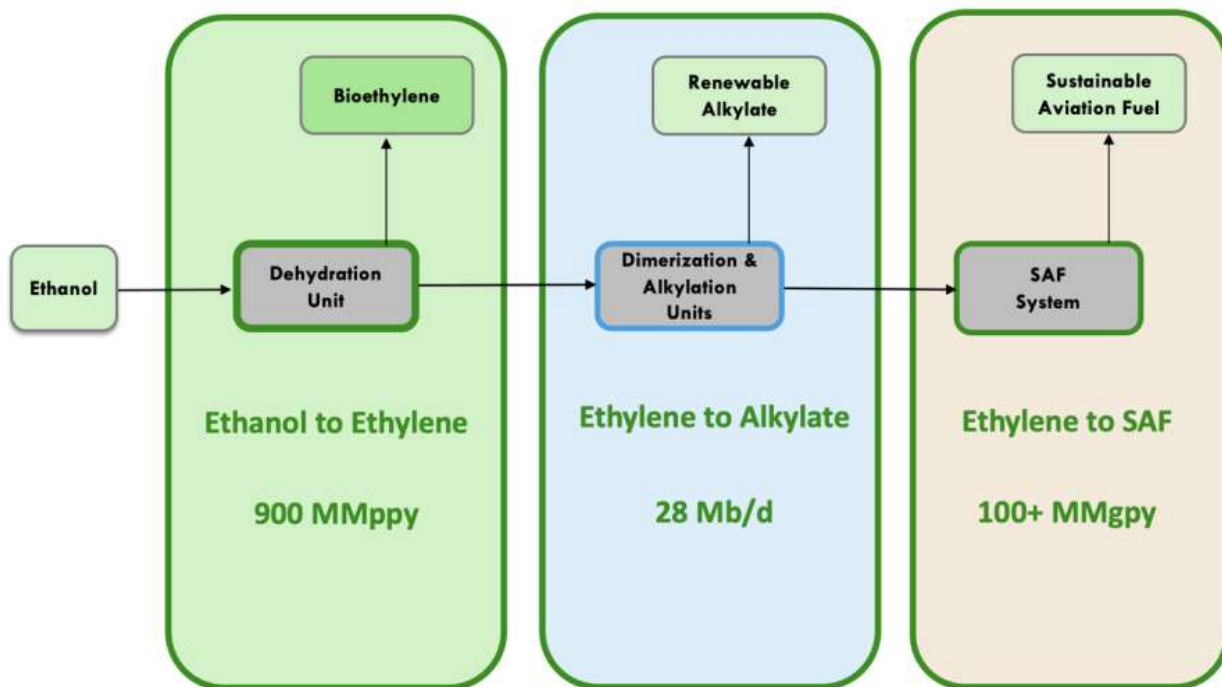


Figure 1. Production Flow Chart for Project Lightning. Source: Next Wave

There are three main steps to bioethylene production: reaction, recovery, and purification. In the first step, the ethanol is sent to catalytic reactors to begin the conversion into bioethylene, after which some unreacted ethanol remains. Water is also produced from the reaction. In the second step, nearly all the ethanol and water are removed, resulting in a decrease in the volume of ethanol. In the final step, polymer-grade bioethylene is obtained by removing the remaining impurities. We also should note that the differences between steam-cracking NGLs and producing bioethylene from ethanol go beyond production methods. One significant difference is yield. In the traditional production process, the ethylene yield from using ethane as the feedstock is about 70% (see our [Chart Toppers](#) model). Under the ethanol-dehydration method described above, the ethylene yield can be as high as 99%.

There are three ways that the bioethylene produced at Project Lightning can be used, again depending on demand, production economics and the like: (1) piped to Gulf Coast ethylene consumers (or export docks) for use in plastics and other ethylene derivatives (large green box in Figure 1), (2) to make “renewable alkylate” (large blue box), or (3) to make SAF (large tan box).

The first option is to simply route the produced bioethylene, via existing pipeline tie-ins, to one of the more than 70 derivative plants along the Gulf Coast that use ethylene to produce plastics and many other products — giving those customers a truly “drop-in” solution to assist in their CI challenges (notably, one which does not require them to make any capital or operational

changes). The bioethylene can also be piped to an ethylene export facility for shipment to ethylene-consuming customers overseas.

Renewable alkylate is produced by running bioethylene through the dimerization unit at the new Project Traveler plant, where it is reacted to form butylene, and then running the butylene through the plant's alkylation unit, where it reacts with isobutane to form pure alkylate. As we hinted at earlier, production of renewable alkylate from bioethylene has the potential to generate RINs that gasoline refiners and importers could use to meet their Renewable Volume Obligations (RVOs). This is significant in at least two ways. One is that, with U.S. gasoline consumption sagging as fuel economy continues to improve and more drivers shift to electric vehicles (EVs), the volumes of ethanol that can be blended into E10 gasoline (gasoline with 10% ethanol) are becoming more limited, and renewable alkylate creates a way to fit more ethanol into the gasoline pool. (Click [here](#) for more on the "ethanol blend wall.") Another is that renewable alkylate (which is chemically identical to conventional alkylate produced from crude oil or NGLs) can be blended with no maximum content restrictions, thereby opening the door for the gasoline we buy to have a considerably lower CI.

The equipment and processes at the Project Traveler plant can also be used to convert a portion of the bioethylene into SAF, a "drop-in" fuel that can be blended with (or replace) conventional jet fuel to power aircraft. Demand for SAF is growing tremendously as airlines and consumer-facing companies work to reduce carbon emissions from air travel, and SAF production has been further incentivized by the recently passed Inflation Reduction Act (see [Thunderstruck, Part 2](#)), which provides a credit of up to \$1.75/gallon of SAF produced. Next Wave plans to modify the facility to allow for production of up to 100 million gallons per year (MMgpy) of SAF initially, with the intent to increase volumes over time.

Next Wave's side-by-side projects in Pasadena hold out the promise of significant CI reductions. As shown in Figure 2, the NGL-based alkylate the company will start producing next year will provide a 4% CI reduction, while the bioethylene-based alkylate it intends to begin making in 2026 will provide CI reductions of 20% to 70%, and the SAF it will start producing in 2027 will provide a CI reduction of 50% or more.

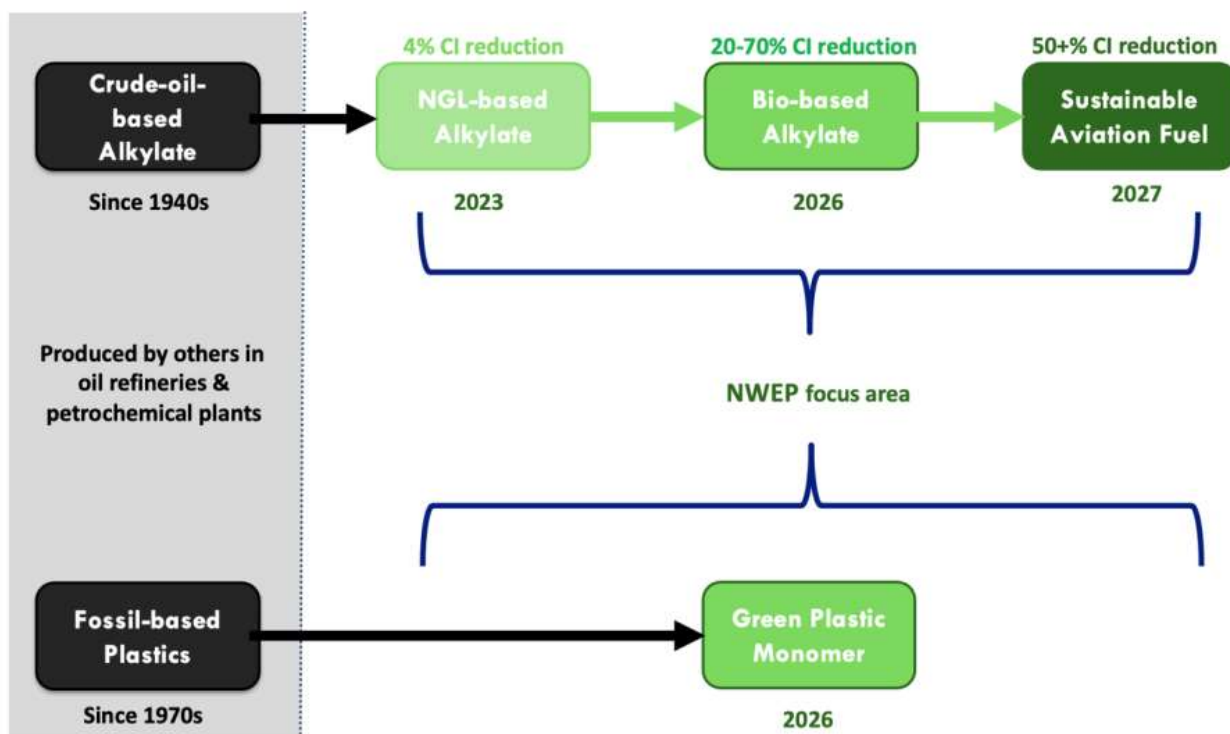


Figure 2. Carbon Intensity of Next Wave Alkylates and SAF. Source: Next Wave

The green box in Figure 2 marked “Green Plastic Monomer” refers to the routing of bioethylene into the conventional ethylene pool via pipeline for use in the production of plastics and other derivatives. Under what’s called the “mass balance approach,” if (for example) a company orders a plastic to be made entirely or partially from bioethylene, the bioethylene would be mixed with conventional, fossil-based ethylene and the plastics maker would allocate the sustainable material portion of that mix to that company’s plastic.

Next Wave’s aim is to provide its customers with a high degree of optionality, leading to what we understand to be strong interest in the project. Project Lightning customers will decide each month if they want bioethylene, renewable alkylate or SAF — or some combination of those products. Similarly, customers at the Project Traveler alkylate plant next door could decide if they want to produce their alkylate from conventional ethylene, bioethylene, or any combination of the two.

We hear that Next Wave is planning to make a final investment decision (FID) on Project Lightning in the second half of 2023, shortly after the startup of its Project Traveler facility. The company is clearly taking a different tack here. Rather than developing entirely new processes, it is putting together proven technologies in a new way. By signing up customers to long-term capacity commitments and providing those customers with the flexibility to respond to changing market conditions, it seems like the folks behind these projects have thought through all the angles. Our guess is that, while there may be no other projects exactly like Traveler and Lightning, many other companies will be thinking outside the box as they plan their energy-related projects during the ongoing energy transition.



“Keeps Gettin’ Better” was written by Christina Aguilera and Linda Perry and appears as the 12th song on Christina Aguilera’s first greatest hits album, *Keeps Gettin’ Better: A Decade of Hits*. Made specifically as a new song for the hits album, it was released as a single in September 2008. It went to #7 on both the Billboard Hot 100 and Dance Club Songs Singles charts. The electro-pop tune was produced by co-writer Linda Perry. Personnel on the record were: Christina Aguilera (vocals), Linda Perry (programming), and Marc Jameson (drum programming).

Keeps Gettin’ Better: A Decade of Hits features songs recorded between 1998 and 2008. Produced by Walter Afanasieff, Christina Aguilera, Glen Ballard, ChakDaddy, DJ Premier, E. Dawk, Missy Elliott, Ron Fair, Rob Lewis, Balewa Mahammad, Linda Perry, Charles Roane, Guy Roche, Rockwilder, Scott Storch, and Sol Survivor, the album was released in November 2008 and went to #9 on the Billboard 200 Albums chart. It has been certified Gold by the Recording Industry Association of America. “Keeps Gettin’ Better” was the only single released from the LP.

Christina Aguilera is an American singer, songwriter, actress, and television personality. She got her start as a professional entertainer as a member of *The Mickey Mouse Club* on the Disney Channel. She signed with RCA Records and released her debut studio album in 1999. Aguilera has released nine studio albums, six compilation albums, one soundtrack album, three EPs and 54 singles. She has sold more than 75 million records worldwide. Aguilera has appeared in nine motion pictures and 18 television shows and was a coach/judge on the television talent search program *The Voice* for six seasons. She has won four ASCAP Awards, five BMI Awards, three Golden Globe Awards, five Grammy Awards and one MTV Video Music Award, and has a star on the Hollywood Walk of Fame. She continues to record and tour.