

October 15, 2018

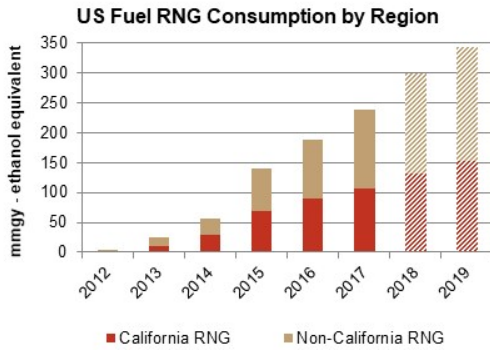
## RNG Growth On Pace with Cellulosic Biofuel Mandate in 2018

Stratas Advisors

Renewable natural gas (RNG), which is derived from biogas collected at various types of sources (e.g. landfills, livestock farms, wastewater treatment plants), has been increasingly used to meet US Renewable Fuel Standard (RFS) advanced biofuel targets. Like conventional natural gas, RNG can be incorporated into existing natural gas grids and used to generate electricity and heat or used as a transportation fuel in the form of compressed natural gas (CNG) or liquefied natural gas (LNG).

Since the EPA's decision to allow biogas use in US transportation fuel to qualify as a cellulosic biofuel for the RFS in July 2014, RNG production for transportation fuel has increased more than four-fold. Currently, RNG is leading the way in the delivery of cellulosic biofuel, making up about 98% of US cellulosic biofuel production and generation of D3 Renewable Identification Numbers (RINs) under the RFS program. In addition to qualifying for RIN credits, RNG also qualifies for Low Carbon Fuel Standard (LCFS) credits in California and Oregon. The LCFS program, in place since 2011, sets a target for the percentage reduction in the average carbon intensity (CI) of transport fuels. To stay below the regulatory emissions levels, fuel providers must meet reduction targets by incorporating more low-carbon fuels or purchasing credits from low-carbon fuel producers. With an average of 26 gCO<sub>2</sub>e/MJ carbon intensity (73% less than the CI of gasoline), RNG is recognized by CARB as one of the lowest-emission fuel pathways.

On September 27, CARB extended the LCFS to 2030 from 2022, and deepened the reduction requirement from 10% by 2022 to 20% by 2030. Also in September, California Governor Jerry Brown signed an RNG Coalition-sponsored bill to open a proceeding, by no later than July 1, 2019, to consider funding biomethane interconnection infrastructure. In addition to existing state and federal legislation, a number of programs at USDA, DOE, and EPA (e.g. AgSTAR, REAP, etc) are also providing technical and financial assistance to the agricultural producers and driving the development of biogas recovery systems.

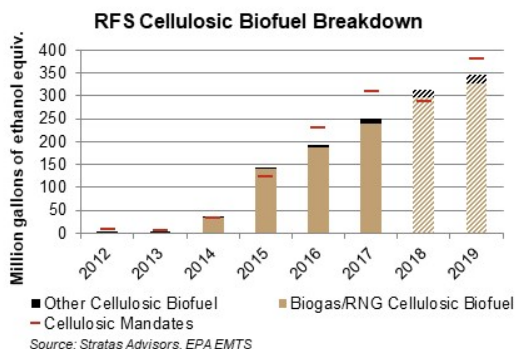


Source: Stratas Advisors, EPA, CARB

Combined consumption of liquefied RNG and compressed RNG grew by 27% in 2017, reaching nearly 240 million gallons of ethanol equivalent. Composition of US fuel RNG has been significantly tilted towards compressed RNG, which constituted around 65% of total demand in 2017. EPA data for January-August 2018 shows RNG demand growth of 24% YOY.

Stratas Advisors expects full-year 2018 RNG demand to reach nearly 300 million gallons of ethanol equivalent—amounting to about 25% growth over 2017, which would exceed the 288 million-gallon RFS mandate for 2018 cellulosic biofuel.

Compressed RNG is expected to grow by 43% in 2018, while liquefied RNG is on pace for an 8% decline in 2018. The proposed cellulosic biofuel standard for 2019 was set at 381 million gallons, increased by almost 100 million gallons over the 2018 standard. Stratas expects cellulosic biofuel growth to fall short of the 2019 proposed mandate given that YTD 2018 RNG growth (24%) is short of EPA’s estimated growth rate of 30.5%. The shortfall is expected to edge D3 RIN prices closer to cellulosic waiver credit-based replacement cost (CWC+D5 RIN), which is forecasted to be about \$2.30 in 2019.

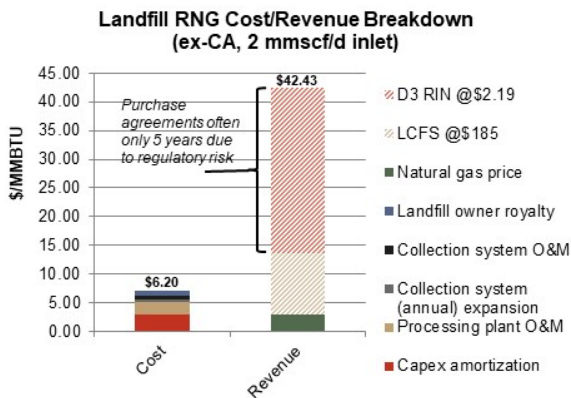


Source: Stratas Advisors, EPA EMTS

California’s LCFS credit price has recently surged to around \$190 per tonne of CO<sub>2</sub>e, which provides a critical additional incentive to RNG use in transportation fuel. Stratas expects high LCFS credit price levels will persist and potentially rise in the short term as LCFS targets remain aggressive and challenging to attain, requiring increasing volumes of RNG, renewable diesel, electricity, and other low-carbon alternative fuels.

According to the latest database from Coalition for Renewable Natural Gas, there are 78 RNG plants up and running in the US and 53 more under construction or in substantial development. California has by far the most RNG plants in place at

17, followed by Texas at 16 and Pennsylvania at 12. Landfill biogas is the supply source for 57% of the RNG projects in the US, followed by wastewater treatment plants and livestock farms. Costs of developing RNG projects vary by biogas sources and project sizes. Generally, landfill RNG cost is averagely around \$6-7/MMBTU. Despite the current relatively low natural gas prices (\$3/MMBTU), the production of RNG can be economically profitable, dependent on the revenue arrangement from RFS and LCFS credit value.



Source: Stratas Advisors

Despite RNG's large potential resource base and great environmental and economic benefits, currently, three-quarters of collected landfill gas (LFG) is used for electricity generation, 16% of LFG is used for heating, and only 7% of captured LFG is processed and upgraded for RNG for use as a transportation fuel. The market for CNG- and LNG-fueled vehicles has increased over time, but it still represents a small fraction (0.18% in 2017) of total natural gas consumption, given the need for vehicle infrastructure. A major barrier to wider development and integration of RNG resources is regulatory risk and associated RIN credit price volatility, which usually limits term length of purchase agreements and any RIN credit value guarantees. Another challenge is infrastructure cost involved in cleaning and testing biogas and transporting RNG from the producer to the natural gas distribution network (e.g. pipeline connection) which is typically capital intensive, requiring long-term project financing to be cost-effective. Restrictive maximum constituent specifications especially for siloxane have placed an extra hurdle to RNG developers in California.

Overall, RNG in transport is beginning to reach appreciable levels in the US, with 2017 demand equal to roughly 10 thousand bbl/d of gasoline equivalent. Continued growth remains dependent on regulatory mandates such as the federal RFS and California's LCFS, but the fuel's strong GHG reduction profile is likely to support it in the long term.