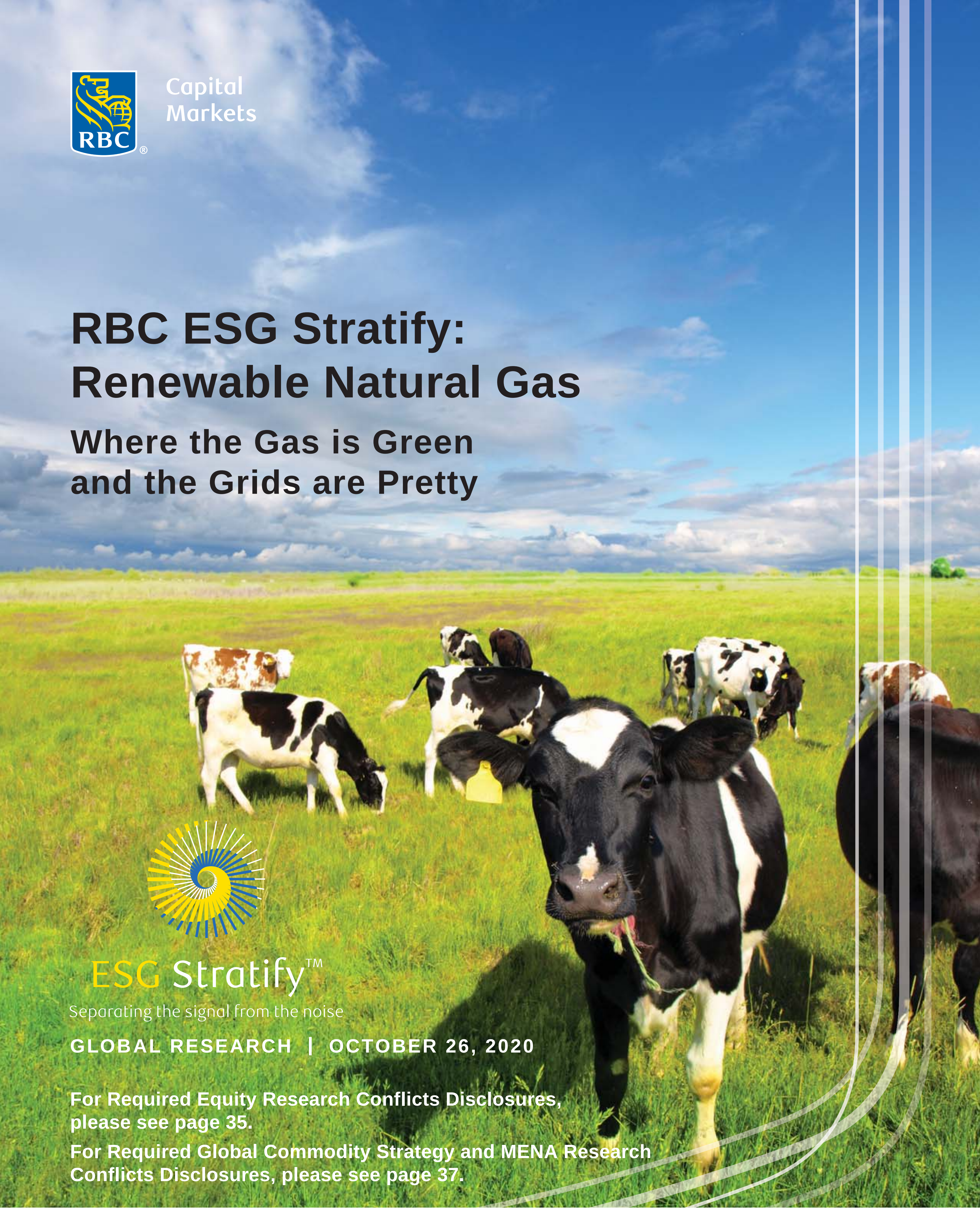

Capital Markets

RBC ESG Stratify: Renewable Natural Gas

Where the Gas is Green and the Grids are Pretty

ESG Stratify™

Separating the signal from the noise

GLOBAL RESEARCH | OCTOBER 26, 2020

For Required Equity Research Conflicts Disclosures, please see page 35.

For Required Global Commodity Strategy and MENA Research Conflicts Disclosures, please see page 37.

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RBC ESG Stratify: Renewable Natural Gas

For Required Equity Research Conflicts Disclosures, please see page 35.

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See Global Commodity Strategy commentary on page 16.

All values in USD unless otherwise noted.

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Where the Gas is Green and the Grids are Pretty

While renewable natural gas (or "RNG") production is currently a fraction (~0.1%) of the current US natural gas supply mix, we expect it to become more meaningful over time. The biggest hurdle is cost, with economics on RNG right now primarily supported by government incentives that place most RNG into the transport fuel market (natural gas vehicles). However, as broader ESG motivations and GHG emission reduction goals expand, we have seen increasing willingness from gas infrastructure companies, oil majors and gas utilities to support RNG production amid the higher costs (through voluntary programs to customers for a fee). This should support "greening the grid", but questions remain on how broad these voluntary programs can support RNG supply growth, how much costs can really come down with increased scale, and the extent to which public policy can evolve to support more development of RNG for end markets beyond the transport sector.

What is RNG?

- Also known as "biomethane", RNG is pipeline-quality gas produced from natural waste
- Current production is primarily via anaerobic digestion from landfills, dairy farms (manure), and wastewater treatment facilities
- RNG can also be made from renewable electricity (P2G), but we view this as earlier-stage

Incentive programs are supportive… and growing

- When used as a transport fuel, RNG qualifies for incentives under the federal Renewable Fuel Standard (RFS) and state-level Low Carbon Fuel Standard (LCFS) programs
- California's LCFS program is most relevant, but other states have followed (or might soon)
- We estimate project-level IRRs of ~20-40% depending on process and incentives

Supply = Small, but Maybe Mighty

- RBC's Global Commodity Strategy Team views RNG's potential growth story as a "demand pull" development
- Consumer demand and political will appear necessary to grow the needed credit and incentive structure that would make RNG more competitive with conventional natural gas
- RNG's plug and play nature make it ideal, and we believe RNG could grow to account for ~7-11% of natural gas supply by 2040, consistent with most industry analyses

What is demand?

- Addressable market is technically whatever total natural gas demand is; the market for RNG should be driven more by consumer tastes for cleaner fuels
- Supply of natural gas for transport could most easily be met by growing RNG supply
- RNG into the pipeline grid will help to reduce emissions where "electrify everything" is not well suited 100% of the time (i.e. gas-fired commercial bldg. boilers last 2+ decades)

Midstream and Utility Sector takeaways

- We believe that the likelihood of having a federal radical de-carbonization in the United States over the near-term is quite low. With that, we also view the possibility of midstream assets being permanently impaired over the next decade as equally very low. Regardless, natural gas pipeline infrastructure is the most obvious beneficiary, with incremental RNG helpful to counter arguments around terminal valuations to fossil-based infrastructure.
- From a utility perspective, states have more control over the energy mix that they want for their citizens. This creates a challenge for LDCs that are located in states with strong de-carbonization goals. The LDCs have a greater incentive to adapt faster and seek viable alternatives rather than just "adhering" to ESG principles.

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Key Questions

Our View

1. **What sectors should benefit from growing RNG production?**

RNG is injected to the current natural gas pipeline system for transportation to end markets. As RNG volumes grow, these systems should benefit by the additional volumes. Further, midstream and gas utility companies may both find opportunities to invest upstream into landfill, dairy farm, or wastewater RNG initiatives in order to secure the tie-ins and volumes. Both sectors can point to RNG as a vertical with potential growth, which can help alleviate some pressure on valuation discount to a lack of terminal value.

2. **What regulations support RNG and how safe are they?**

RNG is primarily used as a transport fuel, as economics are largely supported by (1) California's Low Carbon Fuel Standard (LCFS) and (2) the federal Renewable Fuel Standard (RFS). In addition to California, Oregon and Canada have also adopted LCFS. We see the programs as very safe, with the LCFS-type programs likely to expand further and the RFS seeing significant support from the agriculture lobby.

3. **RNG volumes are so small… can this really grow into something substantive?**

RNG is a small part of total US natural gas supply today (<0.1% of supply), but there are clearly exponential growth opportunities for RNG that should stem simply from more investments into landfill, wastewater center, and dairy farm projects to further supply into the transportation market. To reach longer-term views for RNG to reach ~10% of total natural gas supply (by 2040), we think RNG will need to continue getting traction with non-transportation focused end markets. We have started to see announcements from gas utilities offering voluntary programs for customers to receive RNG for a fee, and large public companies with corporate social responsibility plans could pay "green tariff" to take RNG as part of efforts to lower their carbon footprints, particularly given the increased focus on Scope 2 greenhouse gas emissions.

4. **What are the economics of renewable natural gas projects?**

The economics of renewable natural gas projects can differ significantly based on the type of project and the incentive structure. We estimate IRRs in the 20-40% range depending on project type, assuming that the RNG production benefits from the LCFS and/or RFS incentive structures.

5. **How easy is it to finance RNG production investments with or without the incentive structures?**

The growth in California's LCFS program was a game changer for the RNG development pace, with the program viewed as a much more bankable incentive structure as compared to volatile RIN pricing via the RFS. Beyond the incentives, we believe voluntary programs to support RNG production would require a "green tariff" of >$10/MMBtu to hit at least 10% IRRs for RNG producers. However, as gas utilities or pipeline companies invest into RNG production, we think the attraction of long-term contracts (and removing the uncertainty of incentive-based economics) would make RNG production growth even more bankable. Further, the potential for larger-scale investment has the potential to lower per-unit costs, though the degree of potential cost savings within RNG remains debatable given the amount of steel and concrete costs within the build structure.

Executive Summary

Renewable natural gas (RNG), also known as biomethane, is a pipeline-quality gas produced from natural waste. RNG is interchangeable with conventional natural gas. With no fracking or drilling involved, RNG minimizes the effects carbon emissions have on the planet, making it a safer and more environmentally friendly alternative to conventional fossil natural gas.

Why right now?

RNG technology has been around for decades, though the technology and processes have naturally improved with time. While renewable natural gas (or "RNG") production is currently a fraction (~0.1%) of the current US natural gas supply mix, we expect it to become more meaningful over time. The biggest hurdle is cost, with economics on RNG right now primarily supported by government incentives that place most RNG into the transport fuel market (natural gas vehicles). However, as broader ESG motivations and GHG emission reduction goals expand, we have seen increasing willingness from gas infrastructure companies, oil majors and gas utilities to support RNG production amid the higher costs (through voluntary programs to customers for a fee). This should support "greening the grid", but questions remain on how broad these voluntary programs can support RNG supply growth, how much costs can really come down with increased scale, and the extent to which public policy can evolve to support more development of RNG for end markets beyond the transport sector.

Supply & Demand

RBC's Global Commodity Strategy Team views RNG's potential growth story as a "demand pull" development. Consumer demand and political will appear necessary to grow the necessary credit and incentive structure that would make RNG more competitive with conventional natural gas. RNG's plug and play nature make it an ideal, and we believe RNG could grow to account for ~7-11% of natural gas supply by 2040, consistent with most industry analyses. The addressable market is technically whatever total natural gas demand is; the market for RNG should be driven more by consumer tastes for cleaner fuels. Supply of natural gas for transport could most easily be met by growing RNG supply, whereas RNG into the pipeline grid would help reduce emissions where "electrify everything" is not well-suited 100% of the time.

Sector Positioning

More recent investor focus on ESG and wider mandates on GHG emission reduction have spurred new downstream project announcements and JVs within RNG. The gas utility and pipeline companies strive to address environmental concerns that influence investor views on terminal values for their assets. We view the ability and desire of gas utilities to invest in and support RNG as critical to provide longer-term visibility on increased demand for RNG, which we think can potentially help RNG to compete without government incentives.

In this note, we walk through the basics of RNG. Admittedly, our view is generally US-centric, yet RNG is a global opportunity, with Europe ahead of the curve on RNG adoption and Canada offering similar incentives as in the US. We frame the conversation by touching on:

- RNG production process, primary feedstock and carbon intensities
- Regulations supporting RNG economics
- How RNG fits into the broader US natural gas supply/demand picture
- RNG project economics
- Midstream and utility company interplay with RNG
- Public Policy
- Primary risks to RNG

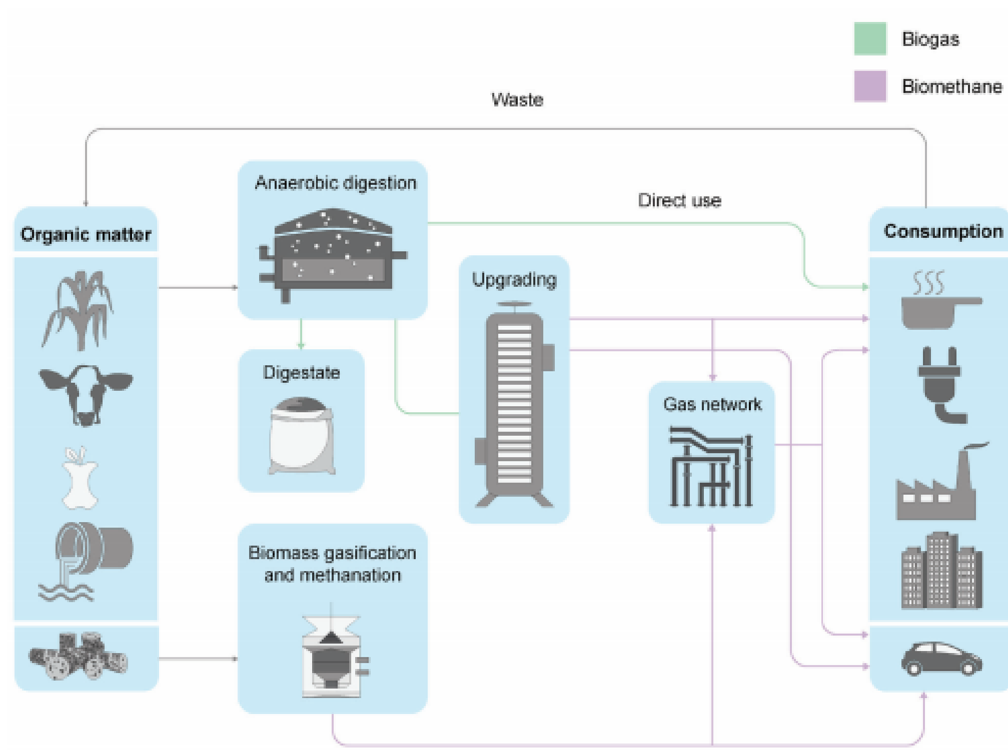
RNG Production Process

A 2019 study for the American Gas Foundation (AGF) by ICF provides that RNG is produced through collection of a feedstock, delivery to a processing facility for biomass-to-gas conversion, gas conditioning, compression, and interconnection and injection into the pipeline.

"Biogas" is created through an anaerobic digestion process, and carbon dioxide is removed to make the remaining RNG (methane) pipeline ready

We focus this report on ***anaerobic digestion***, which is by far the most common method to produce RNG today. In the anaerobic digestion process, RNG production starts with organic waste that is captured and stored into a controlled environment (most commonly referred to as a "digester" or a "reactor"). In the digester, an environment is created without oxygen, and organic material is broken down over a period of days to create biogas (a gaseous output yielding ~45-65% methane and ~35-55% carbon dioxide). The biogas is upgraded to pure methane (i.e. biomethane or RNG) and can be injected into common carrier pipelines or transported via tube trailer to the closest transport station.

Exhibit 1: RNG Production Process



Source: IEA

RNG from P2G has significant growth potential down the road, but we think the technology needs more work to drive costs lower

We acknowledge there are other processes to produce biomethane. RNG can be produced through a ***thermal gasification*** of biomass, which converts feedstock into a mixture of gases (syngas), including hydrogen, carbon monoxide, steam, carbon dioxide, methane, and trace amounts of other gases. Another process is ***power-to-gas (P2G)***, which may have significant growth potential down the road and we would expect to re-visit this production process opportunity in the future. P2G uses renewable electricity (as a feedstock) to generate hydrogen (see RBC's prior hydrogen publication) via electrolysis, which is methanated for subsequent injection into the pipeline.

RNG feedstock sources (via the anaerobic digestion process)

Landfill RNG currently dominates the market given lower per-unit costs, but positive LCFS incentives has spurred development at dairy farms and wastewater plants

Renewable natural gas is sourced from locations that produce/store/collect large amounts of natural waste. There are three key sources of RNG: (1) landfills (2) dairy farms, and (3) wastewater treatment centers. Further, swine farms, chicken farms, and many other agricultural operations can also produce large amounts of renewable natural gas.

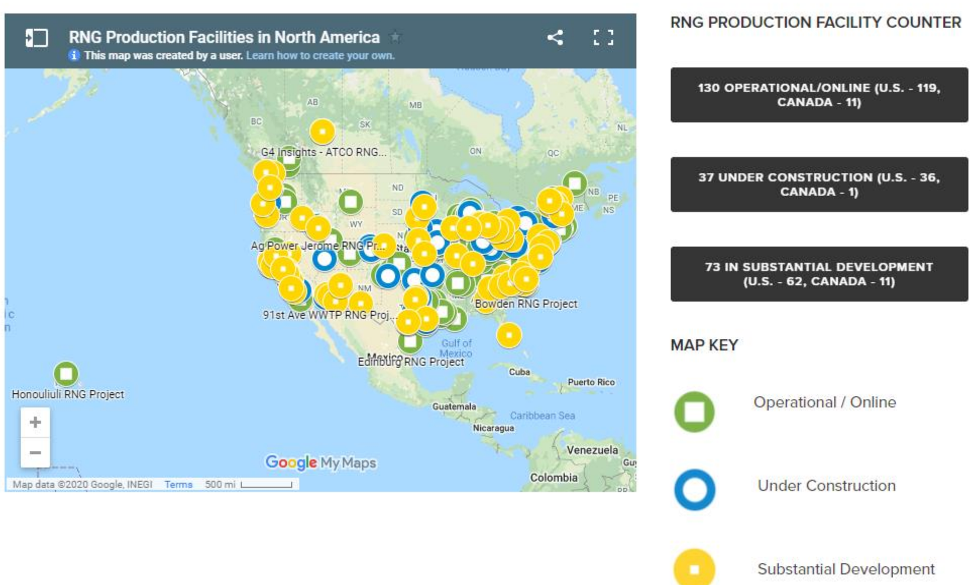
Exhibit 2: Fast Facts on Each Key RNG

	Landfills	Dairy Farms	WWTP	Total
Percent of Total RNG Volume	88%	8%	4%	100%
Projects in Service	67	39	13	119
Projects in Development	60	28	10	98
Potential Project Locations	2,600	8,000	16,000	26,600

Source: RBC Estimates, EPA, AGF, RNG Coalition

There is room for growth from all three sources. Landfills should continue to play a significant role in the RNG landscape as a typical landfill can often times produce 5-10x the amount of RNG of a dairy farm. We also think dairy farms will become a larger part of the mix due to the sheer quantity of farms and cows that produce high amounts of natural waste, coupled with extremely low carbon intensity (CI) scores from dairy farms (more on this later). Regardless, we would envision growth from all sources for RNG as it gains traction as a source of renewable energy in the United States.

Exhibit 3: Renewable Natural Gas Production Facilities in the US & Canada



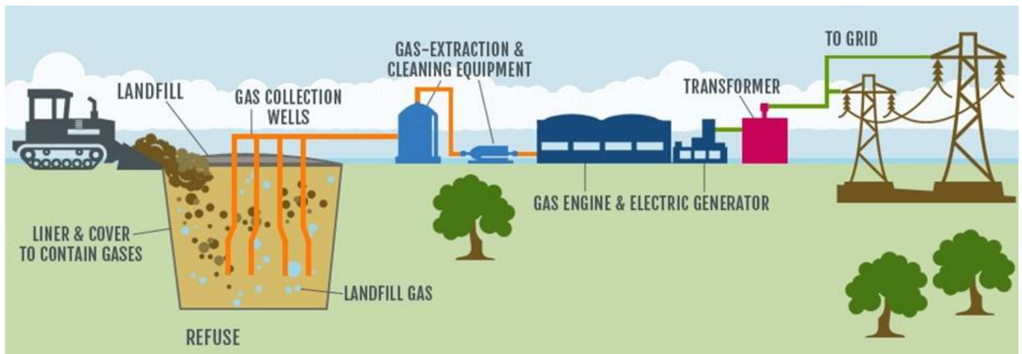
Source: RNG Coalition

Landfills are currently the largest source of RNG

The typical landfill produces 5-10x the amount of RNG of a typical dairy farm, which makes for lower per-unit costs

The EPA estimates that there are about 2,600 landfills in the United States that could be utilized for energy. Of those 2,600 landfills, only 67 are producing RNG for pipeline injection and local use. Waste management companies and municipalities run these landfills and are able to capture the biogas from decomposing organic matter. The organic matter goes through a process called aerobic digestion, which emits biogas. Biogas is only 45-65% methane. The biogas therefore needs to then be upgraded into pure methane so it can be ready for customer use. Based on data from the EPA, a typical landfill will produce approximately 700,000 MMBtu/yr, which is about 5-10x the RNG that a 2,000-cow dairy farm would produce making landfills a key source of RNG.

Exhibit 4: Landfill RNG Project Diagram



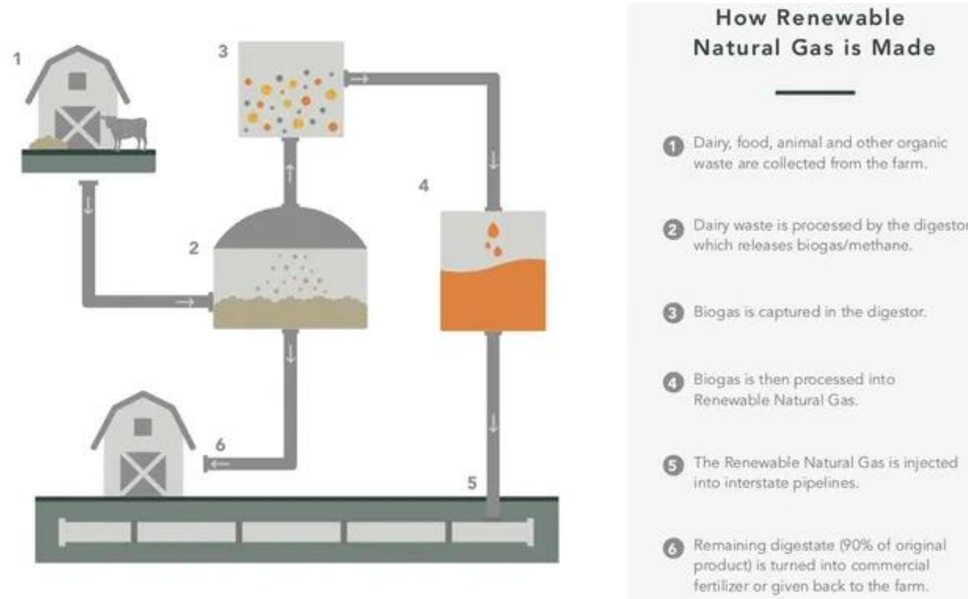
Source: www.advanceddisposal.com

Dairy farms could be an opportunity for growth

Dairy farms currently emit large amounts of methane into the atmosphere

With approximately 103 million cows in the United States, dairy farms are one of the largest producers of methane on the planet. Methane is 25-85x more potent in the atmosphere that CO2, which has created an opportunity for dairy farm owners to capture this methane and resell it for profits. According to the RNG Coalition, there are ~8,000 farms that could produce RNG to scale. With only 39 farm projects in service, we see dairy farms as a key source of future RNG growth. The dairy farm RNG production process is similar to the landfill process. The organic waste produced by cows and the farm will be collected under a digester where it will go through aerobic digestion emitting biogas. That biogas then needs to be upgraded before it is transported to the pipelines for customers. Based on data from the EPA, we estimate a typical dairy farm will produce ~50,000-150,000 MMBtu/yr.

Exhibit 5: Dairy RNG Project Diagram



Source: EPA

Wastewater treatment process… are you flushing away profits?

According to the EPA, there are more than 16,000 wastewater treatment centers in the United States, however only 13 employ anaerobic digestion to produce biogas. The wastewater treatment process is similar to that of the landfills and dairy farms. Wastewater mainly consists of liquids and solids from household water usage and commercial water usage. The contents of the wastewater will flow to a wastewater treatment center, where solids are separated and stored in a digester. In the digester, the waste goes through aerobic digestion, emitting biogas. The biogas is collected and upgraded into methane so it can be utilized for customer use. Based on data from the EPA, we estimate the typical wastewater treatment center can produce ~150,000 MMBtu/yr.

Regulations Supporting Renewable Natural Gas

RNG is supported by both federal and state incentive programs for use in the transportation markets

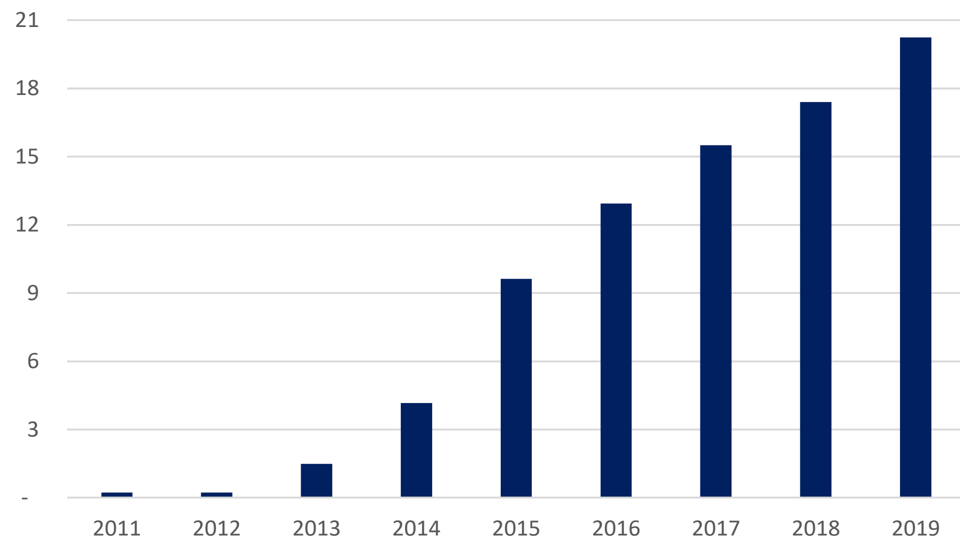
With RNG a similar beneficiary from regulations that support renewable diesel, we pull most of the background discussion on the Low-Carbon Fuel Standard (LCFS) and Renewable Fuel Standard (RFS) from RBC's prior publication on renewable diesel. The primary difference to renewable diesel is that RNG generates primarily D3 RINs (more on this below) under the RFS and has a different carbon intensity (CI) under California's LCFS.

Renewable Natural Gas Growth Profile

Renewable natural gas volumes have grown from near nothing 10 years ago to somewhat more meaningful levels today as a result of California's Low-Carbon Fuel Standard (began compliance in 2011 and then amended to provide a wider impact in 2016) and changes to the federal Renewable Fuel Standard (RFS) in 2014 that qualified RNG to generate D3 RINs.

RNG production increased after incentives improved from the RFS program in 2014 and then with CA's LCFS program in 2016+

Exhibit 6: California Biomethane Volumes (Bcf)



Source: California Air Resources Board

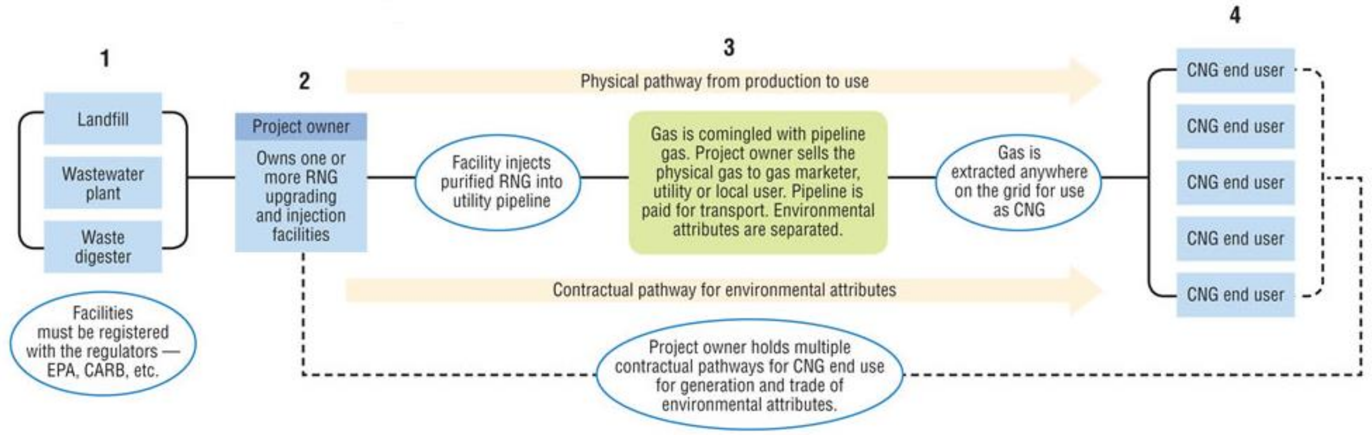
The Renewable Fuel Standard (RFS)

The Renewable Fuel Standard sets renewable fuel targets for the US. The RFS was originally passed by Congress in 2005, with a goal of increasing US energy security and moving energy to more renewable sources. The RFS includes annual targets (the Renewable Volume Obligation or RVO) for blending of renewable fuels like ethanol and biodiesel into the traditional fuel pool. Renewable identification numbers (RINs) are the credits through which the program is implemented. When renewable fuels are blended into the fuel pool, the blender receives a credit (the RIN). Refiners need to acquire these RINs and submit them to the EPA to show compliance with the program. Exhibit 7 demonstrates the process for RNG to generate RINs.

RNG began to qualify for D3 RINs in 2014

RNG producers entered the RFS fray in 2014. The RFS outlines four categories of renewable natural gas that can be traded as RINs: cellulosic biofuel (D3), biodiesel (D4), advanced biofuel (D5) and corn-based ethanol (D6). In the beginning stages of the RFS, it proved cost prohibitive to convert corn waste, grasses, and woody crops into liquid fuels. In 2014, the EPA made RNG eligible for the cellulosic category, which caused >6x jump in production from 2014 to 2016. RNG produced from cellulosic feedstocks can generate D3 RINs while non-cellulosic feedstocks (fats, oils, sugars, starches, and most food wastes) can generate D5 RINs. RNG production accounts for almost all compliance with D3 RFS policy.

Exhibit 7: RNG Pathway to Generate RINs



Source: https://www.biocycle.net/biogas-rng-projects/

RNG producers receive 11.727 RINs per MMBtu. The most attractive RINs to the biogas industry are D3 RINs due to the EPA-registered "pathway" available for biogas producers. RNG producers receive 11.727 D3 RINs for each MMBtu produced, with the 11.727x factor based on the amount of energy contained. At recent average prices of ~$1.50 per D3 RIN, RNG producers would receive around $17.60/MMBtu in RFS value.

D3 RIN prices have rebounded to $1.50 range. RIN prices can be volatile (likely making financing RNG projects solely dependent on the RFS a difficult task) and are largely determined by where the EPA sets the annual volume obligations. RIN prices declined in 2019 when the Trump administration handed a large amount of waivers to fuel blenders that allowed them to get out of requirements to buy some RINs (small refinery exemptions). However, prices have rebounded in 2020 as RVO levels have increased, carryover credits have been used and RNG demand picks up.

Exhibit 8: D3 RIN Price

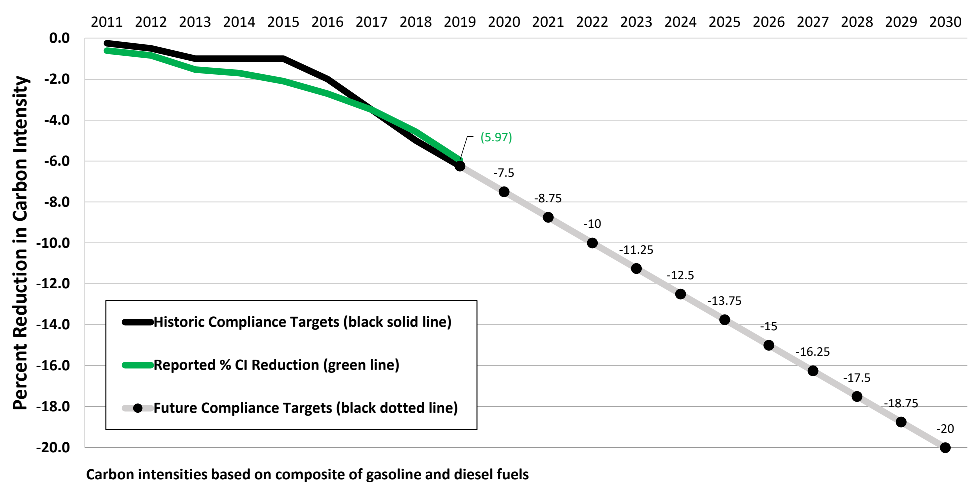
Source: EPA

Low-Carbon Fuel Standard (LCFS)

Originally designed to reduce the carbon intensity of transportation fuels in California. The California Air Resources Board (CARB) approved the LCFS program in 2009, which was designed to reduce the carbon intensity (CI) of California's transportation fuels by 10% by 2020. The LCFS has been amended and extended to a target of a 20% reduction in CI by 2030. The standard effectively puts a price on carbon in California, with low-carbon fuels generating credits for their carbon reduction, and higher-carbon fuels generating a deficit. A build-out of electrification and other low-carbon technologies also generates credits.

The LCFS is designed to reduce the carbon intensity of California's transportation fuel pool by 20% before 2030, with low carbon fuels generating credits and high-carbon fuels generating a deficit

Exhibit 9: LCFS benchmarking

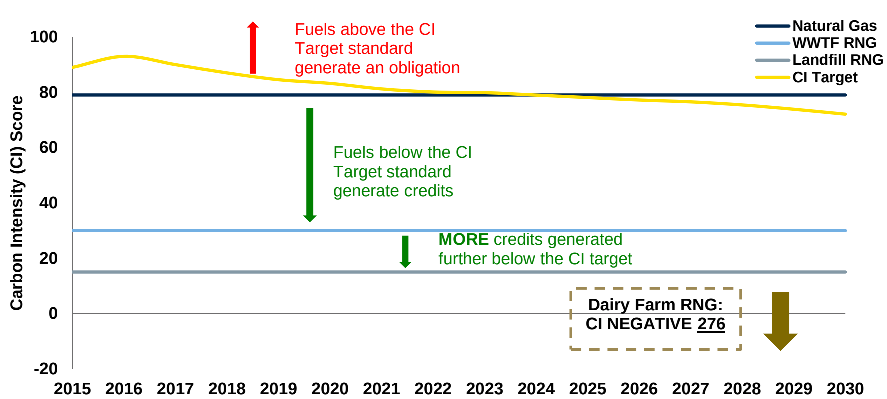


Source: California Air Resources Board

CI scores are key to the LCFS. The LCFS works by assigning CI scores to various fuels, which are compared against a declining CI target for the entire fuel pool each year. The sale of fuels below the benchmark (like RNG) generates credits, while the sale of fuels above (like petroleum gasoline and diesel) generate deficits. More carbon-efficient fuels generate more credits. Sellers and producers of petroleum products ultimately need to purchase LCFS credits from producers of renewable fuels in order to satisfy their regulatory obligations, which creates a market-based pricing system for carbon.

Fuels with carbon intensities below the annual target generate credits, with lower carbon intensity fuels generating more credits

Exhibit 10: LCFS benchmarking



Source: RBC Capital Estimates, HollyFrontier

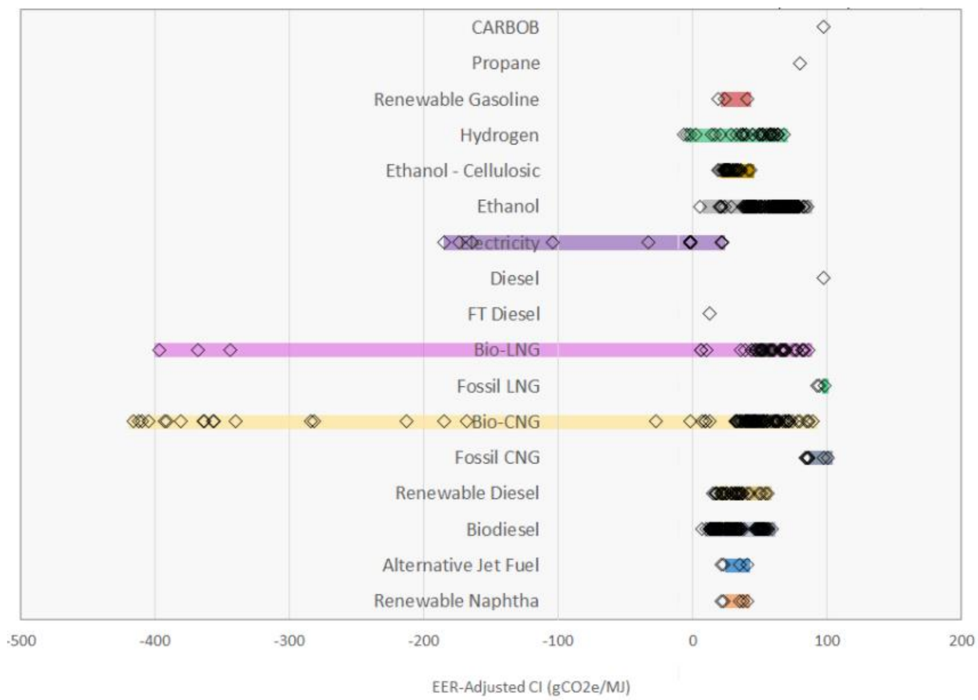
In this chart, each line represents a particular fuel type and each "marker" represents a specific project that is developing that fuel

"Bio-CNG" line in yellow equates to RNG, with the markers equating to various landfill, dairy, wastewater etc projects

Landfill gas typically has a CI score sub 50, which means its carbon intensity is >50% lower than diesel;

Fuel attractiveness boils down to production cost, supply and demand, and the credits generated for type of fuel. With credit generation determined by the carbon intensity score, lower CI fuels are more attractive.

Exhibit 11: Carbon Intensity by Fuel Type - 2020



Source: CARB

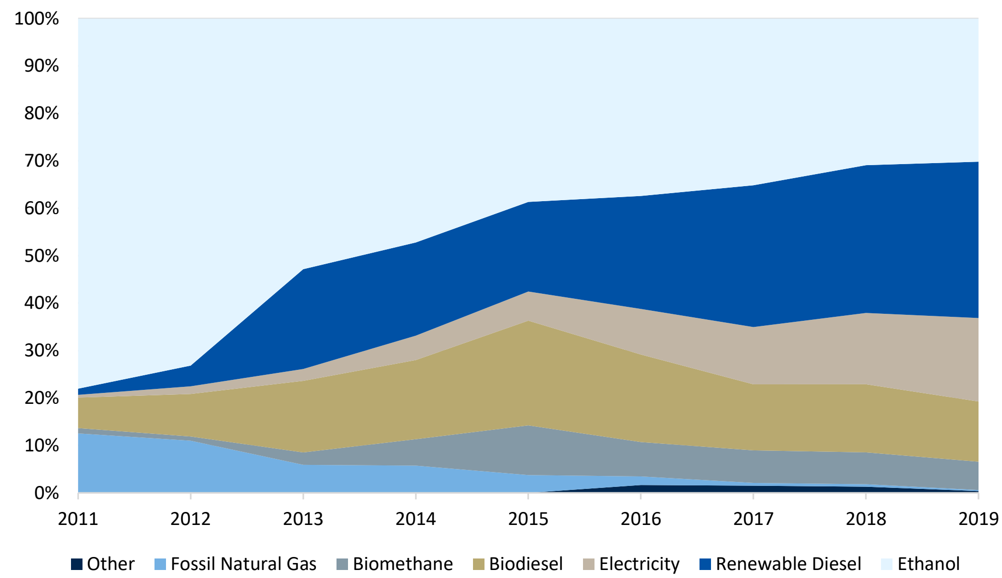
Dairy farms have a large negative CI score because the methane would otherwise escape into the atmosphere

Dairy-produced RNG has a large negative CI. The large negative CI values in Exhibit 11 are primarily the result of dairy cow manure methane capture. If cow manure methane is not captured, it would otherwise escape into the atmosphere (and is a large pollutant). With that, RNG projects at dairy digesters get the benefit of generating RNG, coupled with the ability to keep the methane from escaping into the air. There has been some discussion that regulations may begin in 2024 that would require dairy farms to have equipment in place to, at a minimum, capture and flare away the methane. This would set a new baseline for RNG projects at dairies and reduce the CI benefit of the RNG project. However, based on our conversations with industry experts, we think this faces significant pushback given the policy change would likely impact the desirability of investing in the dairy digester process. Regardless, we do note that existing projects should be grandfathered in for at least 10 years under the lower CI.

RNG is in the nascent stages in share of LCFS market share. RNG volumes and credits remain a relatively small part of the total pool, but we think RNG can grow in share as more projects are planned and utilities and pipelines get more involved. To date, LCFS credits have largely been attributed to ethanol, renewable diesel, biodiesel, and electricity.

We would expect RNG to capture an increasing share of LCFS credits as more projects are planned

Exhibit 12: LCFS Credits Generated By Fuel Type

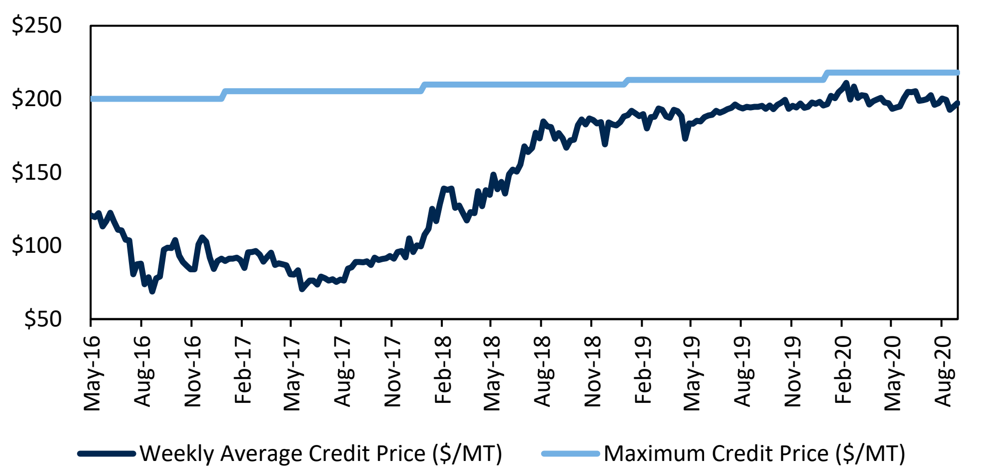


Source: CARB, RBC Capital Markets estimates

Determining LCFS credit value. The value of an LCFS credit is set in the marketplace. The price of one LCFS credit represents the value of 1 metric ton of CO2. The value of this can obviously vary over time depending on supply/demand dynamics. However, California's targets suggest a reduction in CO2 each year, suggesting that credits would increase in value annually without new renewable fuel sources. LCFS credits have recently traded at all-time highs, close to $200 per credit.

LCFS credit pricing is determined by supply and demand dynamics in the market, but prices are also subject to a cap

Exhibit 13: LCFS Credit Pricing and Cap



Source: CARB, RBC Capital Markets estimates

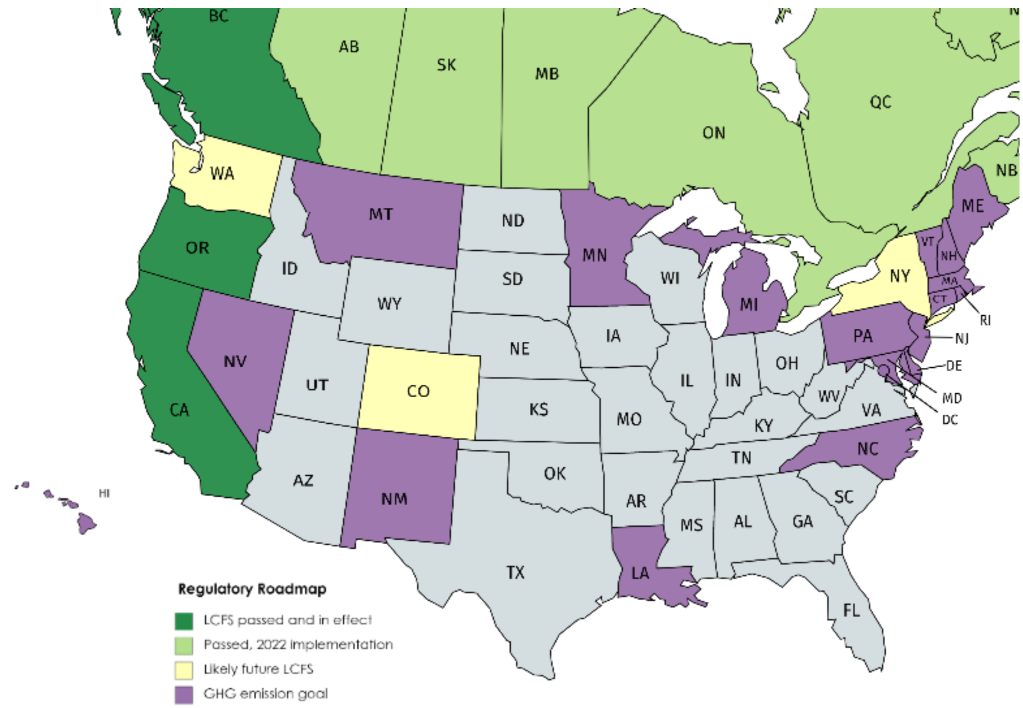
The LCFS credit price is capped. In order to prevent harm to consumers through an unexpectedly large increase in LCFS credit prices, the LCFS also includes a cap on the price of LCFS credits. This was set at $200 per ton in 2016, and the price is adjusted by the CPI deflator each year. For 2020, the maximum LCFS credit price is $217.97. Since mid-2018, LCFS credits have traded close to the cap, given the increasing difficulty of meeting the LCFS benchmark.

California is not the only LCFS market, just the biggest. In addition to California, Oregon and British Columbia also have LCFS programs that are currently in effect. These are structured very similarly to the California program. Canada has also passed an LCFS program, which will go into effect in 2022.

More adoption is likely to come over time. There are three states that have either proposed LCFS legislation or are in advanced planning: Colorado, New York and Washington. We expect that some of these states will adopt an LCFS like program in the coming years. In addition, there are 23 states in the US that have adopted a GHG reduction target, often aligning with the Paris Accord. We think some of these states are likely to look at LCFS type programs over time as well.

Two US states currently have an LCFS program, we think three more are likely to pass one soon, and there are another 18 states that have a GHG reduction target

Exhibit 14: Low Carbon Fuel Standard Map



Source: RBC Capital Markets

Higher LCFS prices incentivize the build-out of more than just RNG and other renewable fuels. LCFS credits are not only generated by producers of renewable fuels. The California standard has a number of alternative ways of generating credits. In 2019, 74% of the credits generated came from production of ethanol, biodiesel or renewable diesel. Of the remaining total, 18% came from various electrification programs. The largest of these is residential electric vehicle charging, which has a CI figure of around 81 (likely declining) and generates credits when below the standard. Part of the benefit of the LCFS from California's standpoint is that it incentivizes greater uptake of EVs.

Global Commodity Strategy and MENA Research commentary

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Supply and Demand Landscape: Small but Maybe Mighty

We view RNG's potential growth story as a "demand pull" development

Consumer demand and political will appear necessary to make RNG more competitive with conventional natural gas

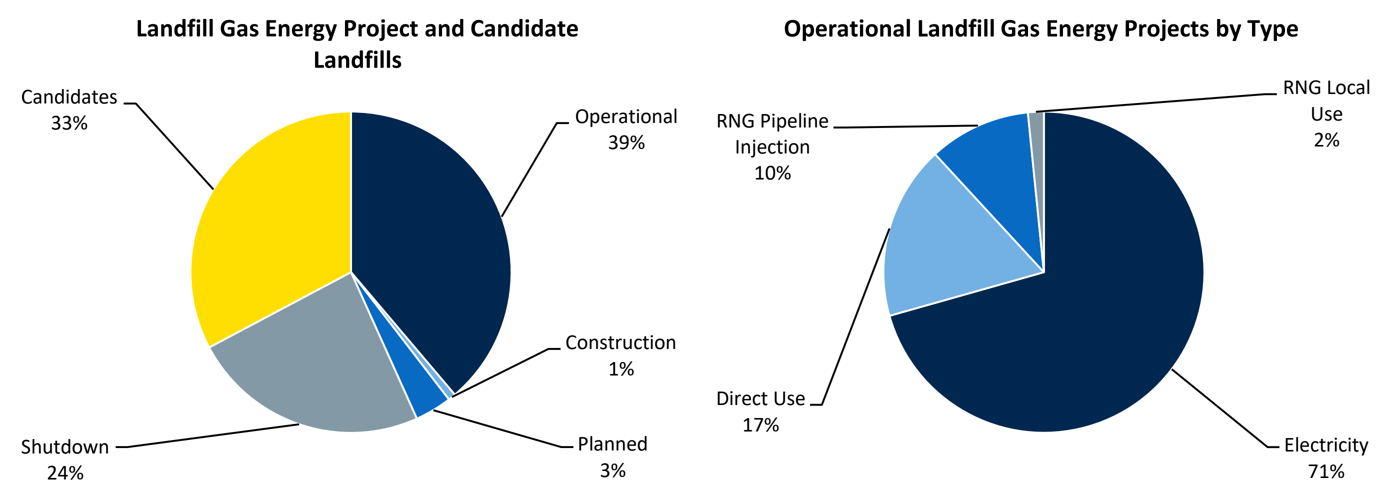
The renewable natural gas landscape is one filled with potential benefits, typified by largely untapped resources. At the outset, we should be clear that cost is a hurdle and the future of RNG, despite all of its environmental benefits over conventional geologic natural gas, is dependent on a supportive policy framework. Given the importance of such a framework for the growth of RNG supply over the longer term and the resultant GHG emissions reductions that could be achieved, we view RNG's potential growth story as a "demand pull" development. Consumer demand and political will appear necessary to grow the necessary credit and incentive structure that would make RNG more competitive with conventional natural gas production, as well as incentivize the investment dollars for efficient, scaled production capacity. This stands in contrast to what is arguably a "supply push" narrative for conventional natural gas seen over most of the last decade. This contrast leads us to believe that RNG displacing conventional geologic natural gas in the pipeline mix will only occur if we want it, and given the increasing focus on ESG investing and climate conscious consumers, we think this can occur over time. While RNG is not going to displace the entire natural supply profile, there is room for significant growth. RNG will not solve the climate crisis on its own, but through its GHG emission reduction potential it can play a crucial role in holistic package of solutions and help accelerate the necessary energy transition.

Where are we now?

There are 130 operational RNG production facilities in North America

According to the RNG Coalition, there are 130 operational RNG production facilities in North America (119 in America, 11 in Canada). Most are landfill gas operations that generate transportation fuel or electricity. Most biogas is produced and consumed on site for heat or such power generation, and far less is used to produce RNG and injected into pipelines. For example, the EPA's landfill gas energy project data shows that there are 565 operational landfill gas projects as of August, and just 67 of them produce RNG (for pipeline injection or local use), the vast majority produce electricity or for another direct use. Overall, almost 1 Bcf/d of landfill gas is flowing to these landfill projects, of which 234 MMcf/d is going to RNG.

Exhibit 15: EPA Landfill Methane Outreach Program Shows Extent of Landfill Potential



Source: EPA LMOP, RBC Capital Markets

Based on the Argonne National Laboratory[1] database of RNG projects in 2019 (which counted just 89 projects as confirmed as of early last year), RNG production amounted to approximately 121 MMcf/d, or about 0.1% of 2019's production, up from even smaller levels just a handful of years ago. With the list of planned projects, and more importantly technical resources available, there is the potential for a massive increase from such an incredibly small production base. At present, there are 37 projects under construction and 73 in substantial development according to the RNG coalition. As more states start to address fuel standards, we expect more projects to come online and produce additional RNG volumes.

Exhibit 16: Projects by Source and Production Capability as of Q1 2019

Confirmed Operational Projects by Production Capability (ANL, Q1 2019)		
Source	**Operational MMBtu/yr**	**Calculated MMcf/d**
Landfills	40,319,184	106.52
Farms	1,458,005	3.85
Food Waste	1,944,770	5.14
Wastewater Treatment	1,947,925	5.15
Total	**45,669,884**	**120.66**
	% of dry gas supply	*0.1%*

Source: Argonne National Laboratory (ANL.gov), RBC Capital Markets

Feedstocks and Supply Outlook

With some confidence, we can say that we believe RNG supplies in North America will grow materially over the coming years and decade, albeit from a small base

With some confidence, we can say that we believe RNG supplies in North America will grow materially over the coming years and decade, albeit from a small base and that the volume estimates we mention in this outlook could even prove conservative if supportive policy frameworks accelerate beyond expectations. Absent a doubling down on incentives, policy support and investment in the development of RNG production capacity though, cost remains a hurdle despite RNG's significant environmental benefits, and RNG's plug and play nature when purified and injected into the North American pipeline system.

We think RNG supply outlook is far more favorable in the near-term under a potential Biden Administration

Due to the policy-support-driven nature of production growth (from our perspective), we think elections do indeed matter. Given it is 2020 and the US presidential election is upon us, we would be remiss if we did not mention that the supply outlook is far more favorable in the near-term under a potential Biden Administration. As politics currently stand, we'd expect renewable policies generally to be accelerated (particularly given the Midwest, farm based potential for RNG and electoral tie-in), not the least of which is earlier attention towards biofuel mandates and criticism around the current administration's delaying of annual RFS targets and issuing waivers. While not necessarily a "make it or break it," given the small volumes currently, the more aggressive the clean energy goals and the more ambitious the target date to reach net-zero emissions, the better the outlook is for RNG.

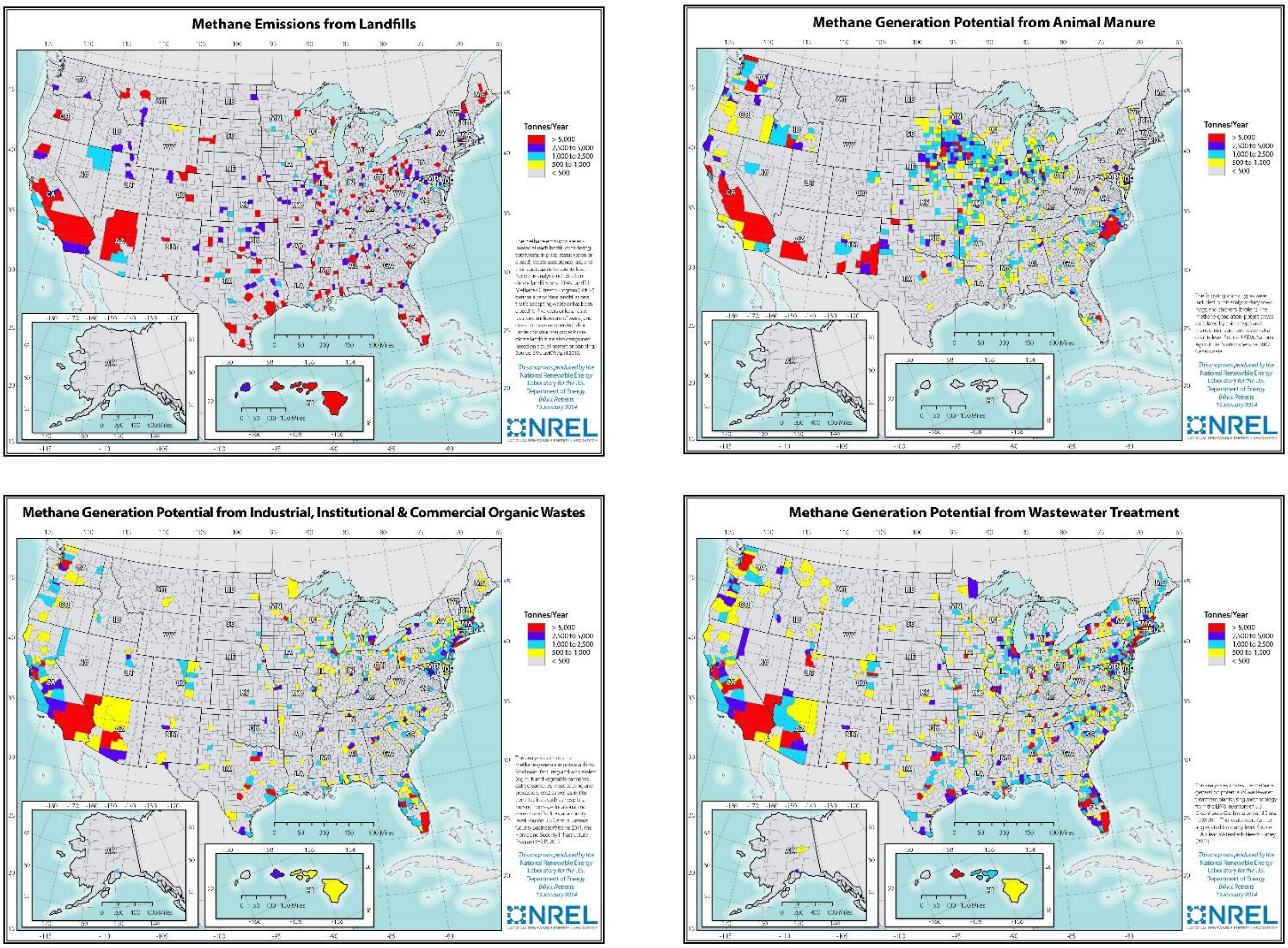
From a technical resource perspective, ample resources are present for material growth from the existing production base

From a technical resource perspective, ample resources are present for material growth from the existing production base. Feedstocks include landfill gas, animal manure, wastewater recovery facilities, food waste, agricultural residues, municipal solid waste, etc. In this piece, we have already focused on a handful of key sources, with clear untapped sources of feedstock available. In fact, according to the RNG Coalition, there are multiple untapped sources of feedstock available to create RNG. From a waste standpoint, there are 66.5mm tons of food waste produced each year that could be utilized for RNG production. From another standpoint there are over 16,000 capable wastewater facilities, 8,000 large farms and dairies, and 2,600 landfills that could also be utilized to help generate RNG (RNG Coalition). While in no scenario do we expect all of these resources to be utilized, we want to highlight that the total available feedstock of RNG leaves ample room for growth. A study from the National Renewable Energy

[1] Argonne National Laboratory, *Renewable Natural Gas Database,* Q1 2019.

Laboratory in 2014[2] estimated that there was 15,988 thousand tonnes per year of methane potential from anaerobic digestion, which is ~2,104 MMcf/d, or 1,644% higher than the 2019 numbers above, however this analysis even excluded RNG potential from some types of organic waste (i.e. fats, oils, grease, and lignocellulosic biomass).

Exhibit 17: Methane Generation Potential (NREL, 2014)



Source: National Renewable Energy Laboratory, RBC Capital Markets

Exhibit 18: NREL Estimates of Methane Potential by Source

US Methane Potential by Source (NREL)		
Source	**Methane Potential (total kt/yr)**	**Methane Potential (MMcf/d)**
Wastewater Treatment	2,339	308
Landfills	10,586	1,393
Animual Manure	1,905	251
IIC Waste	1,159	153
Total	15,988	2,104
Excludes some organic waste sources	*% of dry gas supply*	*2.3%*

Source: National Renewable Energy Laboratory (NREL.gov), RBC Capital Markets

[2] National Renewable Energy Laboratory, *Renewable Hydrogen Potential from Biogas in the United States*, G. Saur and a. Milbrant, National Renewable Energy Laboratory, July 2014.

We think the landfill based supply potential is somewhere in the 0.5-1.6 Bcf/d range

According to our analysis of the EPA's LMOP database, on top of the existing operating landfill gas (LFG) projects, an additional 200-300 MMcf/d of landfill gas could flow in planned and under construction landfill based RNG projects alone. All in all, based on the total data available, we think the landfill based supply potential is somewhere in the 0.5-1.6 Bcf/d range when considering the thousands of landfills in the US, available research and technology.

We think RNG production by 2040 could potentially grow into the 6.5-10 Bcf/d range

The RNG Coalition has counted 98 RNG projects under construction or in substantial development in the US and 12 in Canada. This could represent a near doubling in production capacity. Most estimates for North American RNG supply potential by 2040 are greater than 5 Bcf/d (which is greater than at least 5.5% of 2019's dry gas production level). For example, in the IEA's 2020 "Outlook for biogas and biomethane" it found that this meant biomethane would achieve a 5% blend in gas grids in North America in 2040, which would equate to about 5.8 Bcf/d in the US based on the EIA's Annual Energy Outlook estimate for 2040 dry natural gas production. By our conversions, the American Gas Foundation Study[3] found that by 2040, the US could produce 4.4-11.92 Bcf/d of renewable natural gas across their high and low resource potential scenarios. They also said that by 2040 costs could fall to between $7-20/MMBtu, versus even more than double that now. Again, RNG's selling point of its carbon potential, coupled with its plug and play nature, make it an ideal. It is that potential, which if coupled with supportive policies would result in levels around or above the AGF's aggressive estimate of 2.4 Tcf/year from their 2011 study, or potentially somewhere in the range of 6.5-10 Bcf/our in our view at the higher end – again very policy and demand dependent.

Demand Potential and Outlook

What is demand for RNG anyway? Given that RNG would theoretically replace conventional geologic natural gas production molecule for molecule by whatever volume it is produced, the addressable market is technically whatever total natural gas demand is. However, as we mentioned earlier, we view the development of the RNG space as a demand-pull type, one that is driven more by consumer tastes for cleaner fuels and propelled by a supportive policy apparatus than anything else, particularly given the current and likely future cost base.

Companies that will pay up for RNG under what they call a green tariff is the type of demand pull growth that we expect within RNG

Consumers matter immensely here and corporations with corporate social responsibility mandates and environmental goals represent the type of interest the RNG market needs. Companies looking to pay up for renewable energy sources, in addition to the natural gas utilities that are purchasing RNG under what they call a green tariff, represent the type of demand-pull scenario we are talking about. There is, and likely will be more of, this voluntary market development, alongside general consumers, which can incentivize the policy structure needed to increase supply, create competition for RNG, and result in longer-term agreements.

RNG can easily meet the demand form the natural gas vehicle market

To date, RNG has been utilized in transportation and power generation, largely locally, but the bigger opportunity set is being injected into pipelines and gas distribution networks for delivery to the entire natural gas demand stack regardless of sector. Going sector by sector, let's start with transportation use. Volumetrically and environmentally, RNG makes a lot of sense in transportation. Volumetrically, because natural gas use for transport is incredibly small (less than 1% of domestic demand in the US), it could most easily be met by growing RNG supply. Environmentally, the reduction in GHG emissions would be immense if it backs out other transportation fuels, such as diesel. In commercial and industrial vehicles, this may be easier from an infrastructure standpoint given the tendency towards hub and/spoke models. The credits that benefit RNG today largely focus on transportation fuels (RFS and LCFS in California) and in some cases credits for RNG based electricity generation, but the incentives for broad pipeline injection and distribution to end users such as residential and commercial usage at scale would be beneficial to development of the sector and would help get volumes

[3] American Gas Foundation, "Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment," December 2019.

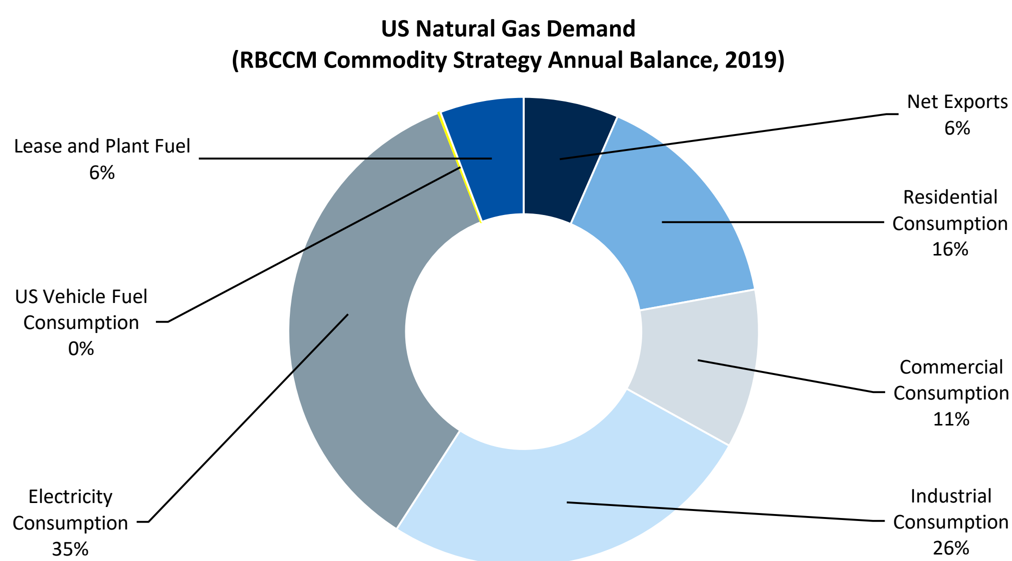
Incentives for broad pipeline injection and distribution to end users such as residential and commercial usage at scale would be beneficial to development of the sector

to the higher estimates. LCFS demand for renewable natural gas should grow from existing programs. The LCFS programs will likely lead to more demand for renewable natural gas to be utilized for vehicular use. Other US states could pass additional LCFS programs and add to demand later in the 2020s. Several states have either proposed LCFS legislation or are conducting studies. We think Colorado, New York and Washington are all relatively likely to pass LCFS programs over the next few years. Other states like Minnesota, Iowa and South Dakota have discussed the potential for LCFS programs, but are not as far along in the process. We think that the rulemaking process and preparation for implementation would take 1-2 years, so none of these states are likely to contribute to demand in the near term. Beyond transportation, getting RNG into the pipeline grid will help to reduce emissions immensely, particularly in situations where "electrify everything" it not feasible or well suited 100% of the time. In residential and commercial buildings for example, many have boilers that can last two decades or more, so the reality is that natural gas fired commercial building infrastructure will likely be around for some time, and reducing the life cycle emissions using RNG would be immensely beneficial. RNG has the potential to back out not only conventional geologic natural gas supplies, but depending on the demand sector, other fuels. Our view is that RNG does not preclude more electrification generally, but that it does present a viable and necessary alternative for applications where electrification is not possible or always beneficial. Cost will likely remain issue and thus a supportive policy framework is needed.

Many commercial buildings have boilers that can last two decades or more, so the reality is that natural gas fired commercial building infrastructure will likely be around for some time

Overall, RNG has two main things going for it on the demand side currently. The first is the potential GHG emission reductions (especially when compared to other fossil fuels and conventional natural gas, with some sources of RNG having a negative carbon intensity), and the second is that it can be consumed, one-for-one, like conventional natural gas without changes to existing consumption or distribution systems. RNG could easily reach volumes equivalent to all current natural gas powered vehicle use with little growth, but getting beyond 5 Bcf/d (which for context is around 2019 LNG export volumes of 5.5 Bcf/d) and achieving volumes seen in the commercial sector today (i.e. 9.6 Bcf/d in 2019), would require significant policy support to incentivize production capacity and then deliver that capacity through injection into the existing North American natural gas pipeline network.

Exhibit 19: How Much Demand could RNG meet?



Source: EIA. DOE, Bloomberg, Thomson Reuters, NOAA, RBC Capital Markets

RNG Project Economics

For Required Equity Research Conflicts Disclosures, please see page 35.

We do not hold ourselves to be experts on RNG production process economics. To compile our analysis on RNG project economics, we have relied on public disclosures for projects where available, conversations with various industry participants and third-party industry analyses of project economics. Notably, we highlight a July 2019 analysis on RNG Project Economics by MJ Bradley & Associates (energy consultants) and a December 2019 report for the American Gas Foundation by ICF (industry consultants). Our output is consistent with conversations and research that implies (i) the economics are largely supported by the incentive framework and (ii) payback periods are a few years or less when considering the current incentive framework. We also note that we view the economic analysis based on an average of outputs from various projects – not unexpectedly, larger projects offer more scale and better per-unit economics (though we note higher financing hurdles are likely for those projects, particularly when relying more on incentive-based paybacks).

Projects are economic under the current incentive framework and payback periods are typically 3-4 years or better

Our base case is that RNG initiatives are economic under the current standards. For RNG to become a larger mix of total natural gas demand, projects need to be economic for dairy farms, landfills, and wastewater treatment centers. As of today, the economics are largely supported by federal and state incentives for projects targeting the transport fuel (from RINs and LCFS credits). Without these incentives, it would be difficult for many of the farms, landfills, and wastewater treatment centers to take on these projects. To put it into perspective, conventional natural gas is sold at ~$2.50/MMBtu, which is about one-eighth the cost it takes most RNG initiatives to produce an MMBtu of RNG.

Economics should improve. While many jurisdictions do not have carbon pricing, for those that do (or will), the avoided cost of paying for credits (or paying carbon penalties) would further help relative RNG project economics in our view. We also do expect operating expenses to come down as technologies improve and economies of scale kick in, though the degree of cost saving potential is debatable within the industry, (much of the cost lies within steel and concrete). While we believe that operating costs can potentially come down, incentive benefits can be volatile. We also note that projects will have better economics if they are done closer to pipeline infrastructure; the further away, the more costly it becomes to transport the RNG. In order to improve RNG economics, investments into pipelines will need to be made, and this could be an opportunity for the midstream space.

Project Economics Assumptions

Largest build costs are for digesters and pipeline interconnects

Costs can vary widely depending on the project type. We estimate a typical landfill RNG initiative will produce 700,000 MMBtu/yr and cost somewhere between $15mm to $30mm. A typical dairy farm RNG initiative will produce 50,000-150,000 MMBtu/yr and cost somewhere between $5mm to $10mm. A typical wastewater treatment center will produce 300,000 MMBtu/yr and cost about $10-15mm. The highest capital costs are allocated to the digester (~$1mm-$3mm) and interconnection (~$1mm-$2mm). Across all projects, we estimate the most significant operational expenses are allocated to upgrading the biogas (~$4-$6/MMBtu) and ongoing transport costs (depending on proximity to long haul pipes). Although the costs are high compared to conventional natural gas prices of ~$2.50/MMBtu, with incentives from both the LCFS and the RFS, RNG production can be an attractive investment.

Landfills

Landfills are the most capital intensive, but produce RNG at the lowest $/MMBtu. We expect a typical landfill project to cost somewhere between $15-30mm. The average landfill in the United States produces 700,000 MMBtu/yr, which is about 5x more RNG than what a dairy farm or wastewater RNG project will produce. We estimate the capital costs to start a landfill RNG project are ~$40/MMBtu. We assume total incentives and revenues are ~$30-35/MMBtu and total operating expenses are about ~$10/MMBtu. This makes a landfill an attractive high margin investment with a low cost hurdle to incentivize RNG production. **From our analysis, a landfill offers an IRR of ~40% based on incentives.**

Exhibit 20: Landfill Base Case

($/MMBtu)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Build Capex	($20.00)	($20.00)	-	-	-	-	-	-	-	-	-	-
Opex	-	-	($10.00)	($9.90)	($9.80)	($9.70)	($9.61)	($9.51)	($9.41)	($9.32)	($9.23)	($9.14)
RNG Price	-	-	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50
RINs	-	-	$17.59	$17.59	$17.59	$17.24	$16.89	$16.56	$16.22	$15.90	$15.58	$15.27
LCFS	-	-	$15.00	$14.85	$14.70	$14.55	$14.41	$14.26	$14.12	$13.98	$13.84	$13.70
Total	**($20.00)**	**($20.00)**	**$25.09**	**$25.04**	**$24.99**	**$24.59**	**$24.20**	**$23.81**	**$23.43**	**$23.06**	**$22.70**	**$22.34**
Total After Tax	**($20.00)**	**($20.00)**	**$19.82**	**$19.78**	**$19.74**	**$19.43**	**$19.12**	**$18.81**	**$18.51**	**$18.22**	**$17.93**	**$17.65**

IRR	**39%**

Source: RBC Estimates

Dairy Farms

Dairy farm RNG projects are most costly per MMBtu, but receive the highest amount of incentives making them economic. We estimate **a** typical dairy farm project for a farm with ~2,000 cows would cost about $5-10mm in upfront capital costs and produce ~50,000-150,000 MMBtu/yr of natural gas. We estimate that it will cost $125/MMBtu in build costs. The operating costs to produce an MMBtu of RNG at a dairy farm are higher than those at a landfill. We estimate it costs ~$25/MMBtu in operating expenses as waste hauling, labor costs, and digester costs are higher. Dairy farms receive the highest amount of incentives since the RNG that they produce comes from cow manure. Cow manure produces harmful methane naturally. Since these RNG digesters are able to capture methane that would otherwise naturally be released into the atmosphere, the incentives from the LCFS program are highest given the large negative carbon intensity score. These incentives can range from $80-$120/MMBtu. We also believe that these projects need ~2,000 cows at a minimum to be viable but as you add more cows, the costs scale and further improve economics. **From our analysis, a typical dairy farm RNG project will have an IRR of 35-40%.**

Exhibit 21: Dairy Farm Base Case

($/MMBtu)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Build Capex	($62.50)	($62.50)	-	-	-	-	-	-	-	-	-	-
Opex	-	-	($25.00)	($24.75)	($24.50)	($24.26)	($24.01)	($23.77)	($23.54)	($23.30)	($23.07)	($22.84)
RNG Price	-	-	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50
RINs	-	-	$17.59	$17.59	$17.59	$17.24	$16.89	$16.56	$16.22	$15.90	$15.58	$15.27
LCFS	-	-	$80.00	$79.20	$78.41	$77.62	$76.85	$76.08	$75.32	$74.57	$73.82	$73.08
Total	**($62.50)**	**($62.50)**	**$75.09**	**$74.54**	**$74.00**	**$73.11**	**$72.23**	**$71.36**	**$70.51**	**$69.66**	**$68.83**	**$68.01**
Total After Tax	**($62.50)**	**($62.50)**	**$59.32**	**$58.89**	**$58.46**	**$57.75**	**$57.06**	**$56.37**	**$55.70**	**$55.03**	**$54.38**	**$53.73**

IRR	**38%**

Source: RBC Capital Market Estimates

Wastewater Treatment Centers

Wastewater treatment centers screen at slightly lower average IRRs. There are about 16,000 wastewater treatment centers in the United States, yet only 13 of those utilize a digester to create RNG. We estimate a typical wastewater treatment center will likely cost $10-15mm in capital expenditures producing around 300,000 MMBtu/yr. This gives us an upfront cost of ~$50/MMBtu. We estimate total operating costs ~$15/MMBtu and about ~$30-35/MMBtu in incentives and revenues. **We estimate that wastewater treatment centers can offer IRRs of around 20%.**

Exhibit 22: Wastewater Treatment Center Base Case

($/MMBtu)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Build Capex	($25.00)	($25.00)	-	-	-	-	-	-	-	-	-	-
Opex	-	-	($15.00)	($14.85)	($14.70)	($14.55)	($14.41)	($14.26)	($14.12)	($13.98)	($13.84)	($13.70)
RNG Price	-	-	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50
RINs	-	-	$17.59	$17.59	$17.59	$17.24	$16.89	$16.56	$16.22	$15.90	$15.58	$15.27
LCFS	-	-	$12.00	$11.88	$11.76	$11.64	$11.53	$11.41	$11.30	$11.18	$11.07	$10.96
Total	**($25.00)**	**($25.00)**	**$17.09**	**$17.12**	**$17.15**	**$16.83**	**$16.51**	**$16.20**	**$15.90**	**$15.60**	**$15.31**	**$15.03**
Total After Tax	**($25.00)**	**($25.00)**	**$13.50**	**$13.53**	**$13.55**	**$13.29**	**$13.04**	**$12.80**	**$12.56**	**$12.33**	**$12.10**	**$11.87**

IRR	**20%**

Source: RBC Estimates

Voluntary Programs

While voluntary programs may lack incentives, the ability to tie these programs to long-term contracts should be a more attractive financing option longer term for RNG producers

Growing RNG demand outside the incentives is a focus. RNG sold to gas utilities for things such as building heating or residential use does not receive those same incentives; therefore, the gas utility company would need to pay up for the RNG and then pass on the extra costs to its customers to earn a profit. This is already happening, and early indications are encouraging that the support from gas utilities can continue. Further, several larger public companies have announced intentions to pay this “green tariff”.

We expect landfills to source most of the initial voluntary RNG. As RNG sourced from landfills provides the lowest cost per MMBtu, we expect landfill projects to make the most sense to supply to utilities with customers willing to pay a premium for this sustainable product or for sustainable-focused companies looking to reduce their carbon footprint. Utilities can provide RNG instead of conventional natural gas for residential and commercial property use, and many sustainability-focused companies are open to pay this ‘green tariff’. *We highlight beauty product maker L’Oreal USA, who in 2018 agreed to purchase landfill RNG through a long-term commitment that will allow it to achieve carbon neutrality across all 21 of its facilities in 12 states. That commitment was a key underwriting component to finance the RNG project.*

In our analysis for the voluntary program, we look for the estimated premium that would need to be paid in order for the RNG producer to capture at least a 10% IRR. While the IRR is lower than incentive-based economics, we believe the ability to capture long-term contracts from utility customers will be desirable (and allow the RNG producer to scale). With that, our analysis on the voluntary program also assumes a quicker reduction in per-unit opex as the projects may be able to scale quicker with more certain financing options. **We assume the premium to be ~$15/MMBtu and decline slightly over time.**

Exhibit 23: Landfill Voluntary Base Case

($/MMBtu)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Build Capex	($20.00)	($20.00)	-	-	-	-	-	-	-	-	-	-
Opex	-	-	($10.00)	($9.60)	($9.22)	($8.85)	($8.49)	($8.15)	($7.83)	($7.51)	($7.21)	($6.93)
RNG Price	-	-	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50
Premium Paid			$15.00	$14.93	$14.85	$14.78	$14.70	$14.63	$14.56	$14.48	$14.41	$14.34
RINs	-	-	-	-	-	-	-	-	-	-	-	-
LCFS	-	-	-	-	-	-	-	-	-	-	-	-
Total	**($20.00)**	**($20.00)**	**$7.50**	**$7.83**	**$8.13**	**$8.43**	**$8.71**	**$8.98**	**$9.23**	**$9.47**	**$9.70**	**$9.91**
Total After Tax	**($20.00)**	**($20.00)**	**$5.93**	**$6.18**	**$6.43**	**$6.66**	**$6.88**	**$7.09**	**$7.29**	**$7.48**	**$7.66**	**$7.83**

IRR	**10%**

Source: RBC Estimates

We think policymakers could spur more RNG development if they considered targets for RNG production that would allow rate recovery to the utilities

Policy impacts to voluntary programs

While support from pipeline companies investing upstream, gas utilities offering voluntary programs, and large public companies paying the "green tariff" are all beneficial to RNG production development, it may take more public policy changes to move the needle further.

- If policymakers considered targets or incentives for RNG production that would allow direct rate recovery for the utilities (akin to renewable portfolio standards for electricity), we think this could further help support RNG development. For example, a 10% RNG standard should pave the way for utilities, at a minimum, to establish procurement processes to purchase RNG on behalf of all of their customers.
- We believe that governments and regulators could further facilitate the production and adoption of RNG by allowing regulated utilities to invest capital into RNG production initiatives and place those assets into regulated rate base, with costs recovered from customers at the regulated utility's prescribed cost of capital parameters (i.e., roughly 45-60% debt financing and 8.5-10.5% ROE depending on the state or province).
- Even if regulated utilities are not involved in investing capital, the RNG projects tied to these initiatives would have longer line of sight on demand (and a more stable source of cash flow vis-à-vis cash flow from the incentive structure), and we think RNG projects would be easier to finance (even if projected IRRs are more modest).

We highlight takeaways from RBC's recent CFO Roundtable with California utilities. There, Sempra Energy reiterated the importance to RNG of a state construct similar to a Renewable Portfolio Standard. Further, SRE also noted that RNG rate base opportunities could arise with projects related to generation assets. These are not far along in practice, but the company is exploring potential applications.

How Do Economics Go Wrong?

If an RNG project does not qualify for the LCFS or RFS incentive programs, the costs are going to be too high for RNG to be competitive with conventional natural gas. RIN values also trade on the open market and therefore fluctuate in value. If RINs values fall drastically like they did in 2019, economics will look different. This volatility in RIN prices made financing RNG projects difficult, but the growth of the LCFS program improved the ability for RNG producers to secure financing. LCFS programs are only in California and Oregon right now, so there is limitation to the amount of incentives that can be received for these RNG initiatives, but we expect these types of programs to expand.

Midstream and Utilities ESG Benefits

Renewable natural gas should lead to improvement in key ESG metrics. The Sustainability Accounting Standards Board (SASB) has identified three key environmental issues that midstream should focus on. These are greenhouse gas emissions, air quality, and ecological impacts. We think the incorporation of renewable natural gas projects to a midstream company's portfolio should improve the standing of midstream in each SASB environmental category.

Exhibit 24: SASB Focus Areas for Midstream

TOPIC	ACCOUNTING METRIC	CATEGORY	UNIT OF MEASURE
Greenhouse Gas Emissions	Gross global Scope 1 emissions, percentage methane, percentage covered under emissions-limiting regulations	Quantitative	Metric tons (t) CO_2-e, Percentage (%)
	Discussion of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets	Discussion and Analysis	n/a
Air Quality	Air emissions of the following pollutants: (1) NO_x (excluding N_2O), (2) SO_x, (3) volatile organic compounds (VOCs), and (4) particulate matter (PM_{10})	Quantitative	Metric tons (t)
Ecological Impacts	Description of environmental management policies and practices for active operations	Discussion and Analysis	n/a
	Percentage of land owned, leased, and/or operated within areas of protected conservation status or endangered species habitat	Quantitative	Percentage (%) by acreage
	Terrestrial acreage disturbed, percentage of impacted area restored	Quantitative	Acres (ac), Percentage (%)
	Number and aggregate volume of hydrocarbon spills, volume in Arctic, volume in Unusually Sensitive Areas (USAs), and volume recovered	Quantitative	Number, Barrels (bbls)

Source: SASB

More sustainable and defensive business model. We see potential runway for renewable natural gas, which should benefit the midstream businesses with more natural gas exposure. With more RNG projects taking place, there will be a need for infrastructure to transport natural gas from farms and landfills to end users. Investments into these projects should help generate business longer term and make midstream businesses more resistant to the many risks of oil and gas.

Investments in renewable natural gas can lead to inclusion in ESG indices. ESG indices tend to weight their components based on relative performance in key categories within each sector. As a result, we would expect midstream companies with larger renewable natural gas exposures to see higher weightings.

Terminal Value

We think RNG should help curb some of the terminal value risk embedded in the midstream energy space. With midstream valuations largely discounting zero terminal value, we believe that investments into RNG-type projects can provide potential to offset longer-term viability risk. It's early days here, but as the space grows, we believe those midstream entities that are best positioned to benefit from growing RNG can benefit in valuation most likely through some value ascribed to terminal calculations.

Additional Revenue Streams

RNG could add a new source of revenue for the midstream companies. More production of natural gas whether it is conventional or renewable will be a net positive for midstream energy companies who have the proper infrastructure. RNG production would likely increase volumes and lead to higher utilization rates.

Public Policy

The states have more control over the energy mix that they want for their citizens. This creates a challenge for LDCs that are located in states with strong de-carbonization goals

States could lead the way for more RNG

While local gas distribution companies (LDCs) share many of the ESG consideration of its midstream brethren, they also need to contend with a more immediate existential question. We believe that the likelihood of having a federal radical de-carbonization in the United States over the near-term is quite low. So the possibility of midstream assets being permanently impaired over the next decade is equally very low. The states, on the other hand, have more control over the energy mix that they want for their citizens. This creates a challenge for LDCs that are located in states with strong de-carbonization goals. The LDCs have a greater incentive to adapt faster and seek viable alternatives rather than just “adhering” to ESG principles.

Unsurprisingly, this de-carbonization stems from the West Coast. While California has taken the lead in carbon reduction on the Continental U.S., Oregon is a little ahead of the curve with LDCs and RNG. In 2019, Governor Kate Brown passed SB 98 into law. It was the first law in the United States that established RNG targets and incentives for LDCs to carry. The principal LDC, Northwest Natural Gas, a subsidiary of Northwest Natural Holdings, has a directive to add as much as 30% RNG on its system over time, within reasonable cost parameters. Meanwhile, California is not sitting idle, as the California Public Utilities Commission (CPUC) has been looking at the challenges of de-carbonization and the impact it may have on the California LDC. Other states, like New York, are banning fracking and refusing to permit new pipelines into the state. LDCs are increasingly adopting strategies that incorporate RNG and, over time, hydrogen.

Environmental Factors

According to the OECD, the United States produced ~6.7GT of GHG emissions in 2018, making it the second highest GHG emitter behind China. These high emissions have led the United States state and federal government to implement GHG emission reduction targets. In order to hit those targets the public and private sector have been focused on phasing in renewable energy sources, including RNG.

RNG sourced from landfills can provide a 125 percent reduction in greenhouse gas emissions, and RNG sourced from dairy manure can result in a 400 percent reduction in greenhouse gas.

RNG helps lower both GHG and Methane emissions. RNG is one of several key sources of renewable energy that will help minimize the harmful effects on the environment. According to the California Air Resources Board (CARB), RNG sourced from landfills can provide a 125 percent reduction in greenhouse gas emissions, and RNG sourced from dairy manure can result in a 400 percent reduction in greenhouse gas. Methane is also a problem for the environment as methane is 25-85x more potent in the atmosphere than carbon dioxide. Some methane emissions are difficult to manage as they come from living animals and food waste. By investing in RNG initiatives, digesters are able to capture methane that would otherwise be emitted into the atmosphere. RNG initiatives are key to helping the environment, which is why companies and organizations focused on ESG are making investments into these kinds of initiatives. We believe that midstream and the rest of the energy sector should continue to look at these projects to help them with the ESG and political risk they face.

GHG Reduction Targets and Policies in Place

Over the past few years, there have been 22 states to announce lower GHG emission targets. Most states are first targeting to have a ~50% reduction rate in 25 years and then targeting to be GHG neutral around 2045-2050. In order to hit these emissions targets we expect significant adoption of RNG and other renewable initiatives. There is already a large coalition of utility companies focused GHG emission reduction. The Downstream Natural Gas Initiative (DSI), has proclaimed they will be utilizing RNG to help reach long-term GHG emission environmental goals.

Exhibit 25: GHG Emission Targets by State

State	GHG Emissions Targets
California	California has a target of reaching net zero carbon dioxide emissions by 2045, which was set in 2018. The state also set a target in 2005 to reduce GHG emissions 80% below 1990 levels by 2050. In 2006, the state enacted a statutory target to reduce GHG emissions to 1990 levels by 2020 and in 2016; it set a statutory target to reduce GHG emissions 40% below 1990 levels by 2030.
Colorado	Colorado has statutory targets to reduce GHG emissions 26% by 2025, 50% by 2030, and 90% by 2050, all compared to 2005 levels, which were set in 2019.
Connecticut	Connecticut has an interim statutory target to reduce GHG emissions 45% below 2001 levels by 2030, which was enacted in 2018. Additionally, the state has statutory targets to reduce GHG emissions at least 10% below 1990 levels by 2020 and 80% below 2001 levels by 2050, which were enacted in 2008.
Delaware	Delaware has a target to reduce GHG emissions 30% below 2008 levels by 2030, which was enacted in 2014.
Louisiana	Louisiana has targets to reduce net GHG emissions 26-28% by 2025 and 40-50% by 2030, compared to 2005 levels, which were set in 2020. The targets also aim for net-zero GHG emissions by 2050.
Maine	Maine has a target of achieving net-zero GHG emissions by 2050, and statutory targets to reduce GHG emissions 45% below 1990 levels by 2030 and 80% below 1990 levels by 2050. All three targets were enacted in 2019.
Maryland	Maryland has a statutory target to reduce GHG emissions 40% below 2006 levels by 2030, which was enacted in 2016.
Massachusetts	Massachusetts has a target to reduce GHG emissions 85% below 1990 levels and reach net-zero GHG emissions by 2050, which was set in 2020. The state also has statutory targets to reduce GHG emissions 25% below 1990 levels by 2020 and 80% below 1990 levels by 2050, which were enacted in 2008.
Michigan	Michigan has a target to achieve economy-wide carbon neutrality by no later than 2050 and to maintain net negative GHG emissions thereafter, which was set in 2020. In 2019, the state also set a target of reducing GHG emissions 26-28% below 2005 levels by 2025.
Minnesota	Minnesota has statutory targets to reduce GHG emissions 30% below 2005 levels by 2025 and 80% below 2005 levels by 2050, which were enacted in 2007.
Montana	Montana set a target in 2019 to achieve economy-wide GHG neutrality at a date to be determined. In 2020, the state announced its target to reach economy-wide GHG neutrality between 2045-2050.
Nevada	Nevada enacted statutory targets in 2019 to reduce GHG emissions 28% by 2025 and 45% by 2030 compared to 2005 levels, and reach zero or near-zero by 2050.
New Hampshire	New Hampshire has targets to reduce GHG emissions 20% below 1990 levels by 2025 and 80% below 1990 levels by 2050, which were enacted in 2009.
New Jersey	New Jersey has targets to reduce GHG emissions to 1990 levels by 2020 and 80% below 2006 levels by 2050, which were enacted in 2007.
New Mexico	New Mexico has a target to reduce GHG emissions 45% below 2005 levels by 2030, which was enacted in 2019.
New York	New York has statutory targets to reduce GHG emissions 40% below 1990 levels by 2030 and no less than 85% below 1990 levels by 2050, which were enacted in 2019. The targets also aim for net-zero GHG emissions by 2050.
North Carolina	North Carolina has a target to reduce GHG emissions 40% below 2005 levels by 2025, which was enacted in 2018.
Oregon	Oregon has targets of reducing GHG emissions 45% below 1990 levels by 2035 and 80% below 1990 levels by 2050, which were set in 2020. Additionally, the state has statutory targets of reducing emissions 10% below 1990 levels by 2020 and 75% below 1990 levels by 2050, which were enacted in 2007.
Pennsylvania	Pennsylvania has targets to reduce GHG emissions 26% below 2005 levels by 2025 and 80% below 2005 levels by 2050, which were enacted in 2019.
Rhode Island	Rhode Island has statutory targets to reduce GHG emissions 10% by 2020, 45% by 2035, and 80% by 2050, all compared to 1990 levels, which were enacted in 2014.
Vermont	Vermont has statutory targets of reducing GHG emissions 25% below 1990 levels by 2012 and 50% below 1990 levels by 2028, which were enacted in 2005. The state also has a target to reduce GHG emissions 75% below 1990 levels by 2050 "if practicable using reasonable efforts".
Washington	Washington has statutory targets to reduce GHG emissions 45% by 2030, 70% by 2040, and 95% by 2050, all compared to 1990 levels, which were enacted in 2020. The targets also aim for net-zero GHG emissions by 2050.

Source: Center for Climate and Energy Solutions

Key Market Players

While RNG is too small right now to really move the needle on forecasted cash flow projections, we have started to see increased commentary from management teams on pursuing new RNG projects, and we expect the cash flow impact from these projects to increasingly capture investor attention. We think the most likely early beneficiaries are those midstream providers with existing natural gas pipeline networks that stand to benefit as new RNG volumes are interconnected and begin to flow. In our view, the most pressing near-term question will be the extent that midstream, oil companies or utilities are interested in investing upstream into RNG projects to capture additional volumes. It is possible that that midstream could play a part (in partnership with utility customers) to support RNG project economics to secure volumes as the space gains scale. Time will tell.

The Williams Companies (WMB)

Williams is collaborating with a dairy farm in Washington that is turning methane from cow manure into renewable natural gas. Williams built the necessary infrastructure in 2019 to connect the biogas to their Northwest Pipeline. This project is expected to convert dairy waste from up to 7,000 cows at the dairy farm into 160,000 MMBtu of renewable natural gas each year. Williams also is partnering with energy companies in Washington, Ohio and Texas to transport landfill-produced methane.

> *"…we have existing RNG projects coming into the system. We have a pretty good line of site… to add additional dairy farm [and] landfill projects to our system where not only we can invest in that upstream opportunity, but we can build the infrastructure to bring that renewable gas into our mainline systems."*
>
> *WMB 2Q Earnings Call*

TC Energy (TRP)

TC Energy owns a gas interconnect which transports 1.2–1.4 MMscf/d of renewable natural gas from Threemile Canyon Farms in Oregon to California. This project is part of TC Energy's commitment to help remove emissions from the gas value chain. TC Energy is also receiving gas captured from cow manure at Town Hall Road in Wisconsin, a landfill at Dane County in Wisconsin and from hog manure at Ruckman Farm in Missouri, each of which delivers around 1 MMscf/d.

> *"We're always looking for ways to optimize our asset base and from our perspective, we've got a very strong asset base to economically and safely connect growing sources of renewable natural gas or hydrogen or any other types of products, when they do become economic."*
>
> *TRP 2Q Earnings Call*

Energy Transfer (ET)

Energy Transfer owns and operates PEI Power, a gas-fired electric generating facility in Pennsylvania that is powered by landfill gas.

Kinder Morgan (KMI)

In Kinder Morgan's sustainability presentation, it indicates that it is connecting RNG from landfills, livestock, wastewater & more. On KMI's 3Q20 earnings call, it commented that it was looking at RNG but concerned on the relative size of the opportunity and higher costs.

> *"Renewable natural gas is relatively small market… and the potential issues are typically the supply forces which are landfills, dairy farms, wastewater treatment plants, those types of things that have – you can only get a small supply from those sources, and then it's also very expensive. So the cost estimates I've seen on it are $15 to $30 per dekatherm. So those are the issues that would have to be overcome but it is certainly something that we're looking at and that can be shipped on our pipelines"*
>
> *KMI3Q Earnings Call*

Enbridge (ENB)

In September 2020, the Ontario Energy Board approved Enbridge Gas' application to offer a Voluntary Renewable Natural Gas Program on a test basis. Residential and small business customers who participate in the program will pay an extra $2/month to cover the higher cost of RNG. On the production of RNG, Enbridge has collaborated with the City of Toronto, which will install biogas upgrading equipment at one of its solid waste management facilities.

SoCal Gas, Subsidiary of Sempra Energy (SRE)

SoCalGas has committed to replace 20 percent of its traditional natural gas supply with renewable natural gas (RNG) by 2030. In its original goals for the RNG path, SoCalGas announced plans to pursue regulatory authority to implement a broad renewable natural gas procurement program with a goal of replacing 5% of its natural gas supply with RNG by 2022. SoCalGas also filed in 2019 a request with the CPUC to allow customers to purchase renewable natural gas for their homes.

Dominion Energy (D)

Dominion Energy and Smithfield Foods, Inc. are investing $500 million in renewable natural gas projects across the US through 2028. This investment will expand their Align Renewable Natural Gas joint venture beyond its initial projects in North Carolina, Virginia, and Utah, to pursue new projects across the country, including in Arizona and California.

CenterPoint Energy (CNP)

In April of 2020, CenterPoint Energy submitted an interconnection proposal to the Minnesota Public Utilities Commission. CenterPoint Minnesota is pushing for the production of made-in-Minnesota renewable natural gas to supply the increasing demand for this resource. CenterPoint Energy is also seeking to open its Minnesota pipeline system to natural gas created from organic materials such as agricultural manure, landfill waste, wastewater and commercial food waste.

NW Natural Gas (NWN)

Oregon NW Natural is adding RNG to their system through a partnership with the City of Portland. Greenhouse gas emissions produced by wastewater will be converted into RNG at the City's wastewater treatment plant.

Chesapeake Utilities (CPK)

Chesapeake Utilities announced in June 2020 a partnership with Bioenergy DevCo, a developer of anaerobic digestion facilities. The joint venture have targeted poultry farms in the state of Delaware; Candidate Biden recently highlighted the undertaking as an example of finding creative ways to respond to the GHG issue. In July, CPK announced another partnership, this time with CleanBay Renewables, following the same concept of delivering RNG produced from poultry farms.

Fortis (FTS)

FortisBC Energy developed an RNG program in 2011 in response to their customers in British Columbia who were seeking a carbon neutral fuel option, giving customers an option to designate all or a portion of their consumption as RNG with the current premium paid by customers being C$5.70/GJ (roughly US$4.60/MMBtu). Selecting RNG also provides customers with a credit against the provincial carbon tax. The company has a goal of 15% of its natural gas supply being RNG by 2030.

Vermont Gas

In October of 2019, Vermont Gas (VGS) and NG Advantage (NGA) announced an initiative to deliver renewable natural gas to business and institutional customers – including hospitals – through VGS' pipeline and NGA's virtual pipeline infrastructure.

National Grid (NGG)

National Grid New England is working with the RNG and the utility industry to develop the nation's first interconnection guidelines for injecting RNG into the gas network. The company connected the country's first RNG facility, a landfill on Staten Island, New York, in the 1980s that continues to operate today.

Canadian Utilities (CU-TSX)

Together with its partners, G4 Insights and the Natural Gas Innovation Fund in Alberta, Canadian Utilities reached a key milestone in 2019 relating to its RNG demonstration project in Edmonton. This project used wood processing waste to produce a 98% pure methane stream that was injected directly into the provincial natural gas grid for the first time in Alberta.

BP p.l.c. (BP)

BP and Clean Energy have collaborated to expand U.S. renewable natural gas transportation fueling capabilities. BP acquired Clean Energy's biomethane production facilities business in May of 2017. nation's first interconnection guidelines for injecting RNG into the gas network.

Royal Dutch Shell (RDSA-L)

Shell operates Shell New Energies Junction City, a biomethane facility in Junction City, Oregon, which will produce approximately 736,000 MMBtu/yr of RNG. Shell also has invested in Denmark's' Nature Energy which produces RNG

Chevron (CVX)

In 2018, Chevron and Waste Management (WM) signed an agreement for Chevron to purchase RNG produced by WM landfills. Chevron is evaluating options for biomass processing for their transportation fuels businesses, particularly in California. Chevron is collaborating with CalBio and California dairy farmers to produce and market dairy biomethane as RNG. Chevron is working with Clean Energy Fuels Corp. on Adopt-a-Port, an initiative that provides truck operators serving the ports of Los Angeles and Long Beach with RNGs. Brightmark LLC and Chevron U.S.A. Inc. recently announced the formation of a joint venture, Brightmark RNG Holdings LLC, to own projects across the United States to produce and market dairy biomethane.

Pushbacks to the RNG Growth Story

Costs Are Too High

The cost to produce and supply RNG is very expensive, putting economic pressure on RNG producers. As shown in the economics section, the cost to produce RNG is more expensive than the price of Henry Hub conventional natural gas. With such high costs, either producers have to convince customers to spend more on RNG, or producers will lose money and have to rely on the government for incentives. This puts a lot of pressure on RNG producers and puts them in a position where they are relying on the government, which is not a sustainable business model.

RNG will never be cheaper than conventional natural gas. From our research and speaking with experts in the industry, we believe that RNG will never be cheaper than conventional natural gas. While costs will come down, the underlying economics for RNG will never look better than those of conventional natural gas. However, we believe that factors including potential GHG emissions taxes or penalties in certain jurisdictions have the ability to narrow the gap by factoring in the avoided cost of paying such taxes/penalties when evaluating the economics of installing equipment to produce RNG (versus emitting the GHGs and paying the penalty), as well as factoring in the incremental cost related to the emissions tax/penalty of consuming conventional natural gas. While we see the gap in costs as a risk, but do think that the value proposition of RNG will be easy to communicate to potential customers in this environmental climate.

Political and Incentive Risks

Incentive programs could change. Many RNG initiatives rely on incentives from its state and federal governments. If there were to be a shift in politics or the incentive programs, the RNG producer economics could change materially. Further, incentive structures can prove volatile, and this has an impact in the ability to finance new RNG production. Notably, we believe RNG projects had difficulty finding material financing options when solely relying on the RFS program (given the volatility in RIN pricing). While the LCFS incentive structure has had more success in supporting project financing, we do note there are still potential changes to the LCFS CI structure that could have an impact on development. For example, the CI measurement baseline for dairy farmers could potential change in 2024. While most industry experts expect this to be a long shot, it is nonetheless a potential risk to the economics for this particular pathway that bears watching.

All of This for 10%?

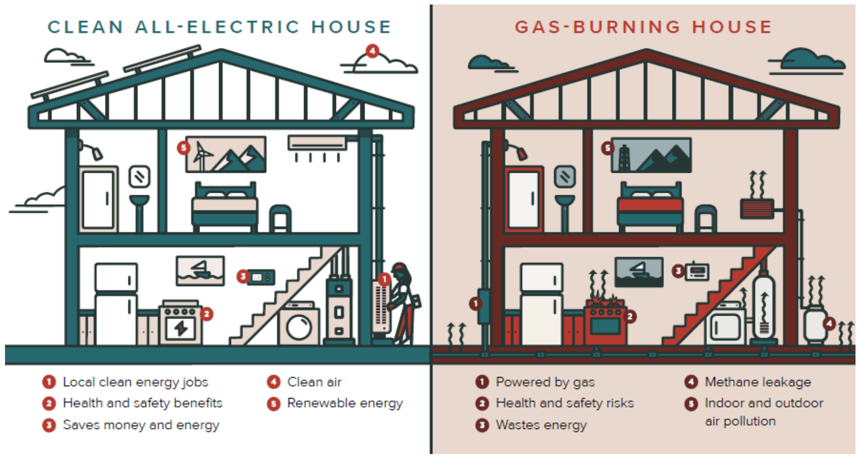
The potential size of the RNG market is expected to be ~10% of total US natural gas demand. As this is a relatively small amount of total energy, we do not know if RNG will have as much staying power as other renewables. There is risk that hydrogen or other renewables could replace RNG if RNG can only supply 10% of total natural gas demand. The other renewables have larger TAMs, which begs the question if RNG is just a transition fuel between natural gas and other renewables.

Feedstock risk of less organic material going into landfills. There could be some risk to the level of organic material going into landfills, with some locales requiring organic waste to be separated from non-organic waste (organic waste such as kitchen scraps and yard trimmings in one bin for collection and non-organic waste in another bin). While this is a risk for projects at existing landfill sites, it could also be an opportunity for new facilities where the organic materials go for composting that would likely generate more intense methane emissions.

Is RNG Greenwashing by the Energy Sector?

There is pushback by environmentalist groups such as the Sierra Club who claim that RNG is not environmentally friendly. While renewable natural gas has lower emissions than oil, RNG is not net-zero like electricity. There is criticism that gas utilities are pushing for RNG projects to help them survive the secular change away from natural gas and into electrification. The argument contends that if the market really wants to fully decarbonize buildings, the energy will have to be fully electric.

Exhibit 26: Pushback: Gas vs. Electric Home Example



Source: Sierra Club/Earthjustice

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