



Legislative Council Staff

Nonpartisan Services for Colorado's Legislature

Greenhouse Gas Emissions Report

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|-------------------------|--|-----------------|--|
| Drafting Number: | LLS 20-0999 | Date: | March 13, 2020 |
| Prime Sponsors: | Sen. Hansen; Coram Rep. Arndt; Catlin | Analyst: | Christina Van Winkle 303-866-6289 Christina.VanWinkle@state.co.us |

BILL TOPIC: **ADOPT RENEWABLE NATURAL GAS STANDARD**

| | | |
|--------------------------|--|--|
| Sectors Impacted: | <input checked="" type="checkbox"/> Electric Power | <input type="checkbox"/> Natural Gas and Oil Systems |
| | <input checked="" type="checkbox"/> Transportation | <input checked="" type="checkbox"/> Residential / Commercial / Industrial Fuel Use |
| | <input type="checkbox"/> Industrial Processes | <input checked="" type="checkbox"/> Coal Mining and Abandoned Mines |
| | <input checked="" type="checkbox"/> Waste Management | <input type="checkbox"/> Land Use / Land Use Change / Forestry |
| | <input checked="" type="checkbox"/> Agriculture | <input type="checkbox"/> Other |
| | | |

Net Change: Increase Decrease Indeterminate Minimal

Report Status: This report reflects the reengrossed bill.

Emissions Impact Summary

By requiring the use of renewable natural gas (RNG) by natural gas utilities, this bill will potentially reduce greenhouse gas emissions by both directly reducing greenhouse gas emissions from sources such as landfills, wastewater treatment plants, coalbed methane, and agriculture, and by displacing the use of fossil fuels. Under the bill's scheduled portfolio targets for large natural gas utilities, greenhouse gas emissions reductions from displaced geologic natural gas amounts to up to 0.4 million metric tons of carbon dioxide equivalent in 2025. These amounts may double by 2030 and triple by 2035, assuming reductions grow in line with the increased portfolio targets. Greenhouse gas emissions savings from producing RNG depends on a number of factors including the source and existing operating conditions under which the gas is captured and used.

Key Provisions Impacting Greenhouse Gas Emissions

This bill establishes the following portfolio targets for the percentage of RNG delivered by large natural gas utilities to retail natural gas customers in Colorado:

- at least 5 percent RNG by January 1, 2025;
- at least 10 percent RNG by January 1, 2030;
- at least 15 percent RNG by January 1, 2035.

RNG is defined in the bill as biogas, methane gas, and hydrogen gas derived from renewable energy sources that is processed to meet pipeline quality standards, transportation fuel-grade requirements, or are delivered by alternative energy carriers.

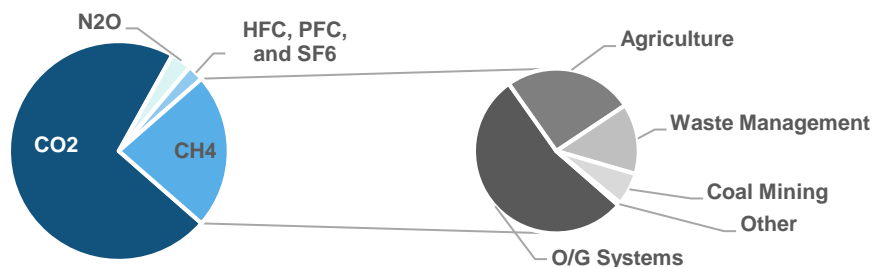
Background

Methane. Methane is a potent greenhouse gas, and also a valuable source of energy. Natural gas, which is methane derived from underground fossil resources, is an important energy source for heating homes, generating electricity, and fueling vehicles. The extraction, processing, and transportation of natural gas, however, releases methane that contributes to climate change. The combustion of natural gas also results in carbon dioxide, methane, and nitrous oxide emissions.

Biogas. Other human activities also contribute to the release of methane, such as landfilling waste, treating wastewater, and raising livestock for food. When organic materials such as food waste, biosolids, and livestock manure break down in the absence of oxygen, biogas is produced. This biogas contains approximately 50-70 percent methane, 30-40 percent carbon dioxide, and trace amounts of other gases. This biogas can be burned directly (e.g., to produce on-site heat and electricity), or processed into RNG that can be used alongside conventional natural gas.

Colorado’s greenhouse gas emissions profile. In 2015, Colorado emitted an estimated 127 million metric tons of carbon dioxide equivalent (MMT CO₂e).¹ Methane (CH₄) accounts for nearly one-quarter of greenhouse gas emissions. Oil and natural gas development is the largest contributor of methane emissions in Colorado, resulting from leaks and venting of natural gas throughout the production, transmission, processing, and distribution of oil and natural gas. Other major sources of methane emissions come from the agricultural (e.g., enteric fermentation and manure management), waste (e.g., wastewater treatment and landfills), and coal mining sectors. Figure 1 below shows greenhouse gas emissions by gas, and the specific sectors contributing to methane emissions. Emissions sources that could serve as potential RNG sources are highlighted in the accompanying table. Roughly 7.1 million metric tons of carbon dioxide equivalent (283,200 tons of methane) are emitted from these sources annually.

**Figure 1
 Colorado's 2015 Greenhouse Gas Emissions by Gas and Source**



| Sector | Source | 2015 Methane Emissions (MMT CO ₂ e) |
|---------------------|------------------------------|--|
| Agriculture | Enteric Fermentation* | 6.19 |
| | Manure Management | 1.20 |
| | Agricultural Residue Burning | 0.00 |
| Waste Management | Landfills | 3.52 |
| | Wastewater Treatment Plants | 0.51 |
| Coal Mining | Coal Mining | 1.85 |
| Oil and Gas Systems | Oil and Gas Systems | 15.62 |

Source: Colorado Department of Public Health and Environment

* Enteric fermentation is the microbial fermentation process during digestion in ruminant animals (e.g., cattle) that produces methane as a byproduct. This methane is either exhaled or belched by the animal.

¹ Greenhouse gases have different global warming potentials (i.e., their ability to absorb and retain heat). To account for these different physical properties, greenhouse gases are typically benchmarked to carbon dioxide (CO₂ = 1). For example, methane's ability to trap and retain heat is 25-28 times more powerful than carbon dioxide over a 100-year time horizon. Thus, the global warming potential of methane is 25-28.

Sources of renewable natural gas (RNG). RNG can be produced from a number of different biogas, methane gas, and hydrogen gas sources. RNG from biogas sources such as landfills, agriculture, and wastewater can be processed to meet pipeline quality standards and used alongside conventional natural gas for natural gas delivery, electricity generation, or used as a transportation fuel (e.g., in the form of compressed natural gas). In addition to avoiding methane emissions, the combustion of RNG from these sources is considered greenhouse gas neutral as the carbon emitted during combustion is offset by the carbon previously sequestered during organic feedstock growth.

RNG can also be produced from non-organic methane sources such as coalmine methane. Coalmine methane is methane from active and abandoned surface and underground coal mines that is released into the atmosphere during or following coal mining activities. This methane can be captured, processed, and used alongside conventional natural gas. Although these sources offer the potential to avoid methane emissions, the combustion of RNG from these sources is not considered greenhouse gas neutral.

Finally, RNG can be produced from other sources and processes such as municipal solid waste and tire pyrolysis, hydrogen gas production, and waste carbon dioxide. Pyrolysis, the thermal decomposition of material at elevated temperatures in the absence of oxygen, is still in the development stage with limited units in operation. Hydrogen gas produced using renewable energy sources can result in virtually zero greenhouse gas emissions.

The table below identifies the potential greenhouse gas emissions savings for each source of RNG.

**Table 1
 Greenhouse Gas Emissions Savings from Sources of Renewable Natural Gas**

| Source of RNG | Displaces GHG Emissions from Geologic Natural Gas | Avoids Methane Emissions | Assumptions/Notes |
|--|--|---------------------------------|--|
| Biogas – Landfills | Yes | Yes | Assumes biogas is not flared. |
| Biogas – Wastewater treatment plant | Yes | Yes | Assumes biogas is not flared. |
| Biogas – Manure management | Yes | Yes | Assumes biogas is not flared. |
| Biogas - Food waste | Yes | Yes | Assumes biogas is not flared. |
| Coalmine methane | No | Yes | Assumes CMM gas is not flared. |
| Naturally occurring coalbed deposits | No | Yes | Assumes methane was previously emitted. |
| Methane gas from municipal solid waste pyrolysis | Yes | Yes | Assumes MSW would have otherwise been landfilled. |
| Methane gas from waste tire pyrolysis | Yes | No | Waste tires generally do not degrade significantly in landfills. |
| Hydrogen gas from renewable energy | Yes | No | |
| Methane gas derived from hydrogen gas | Yes | No | |
| Waste carbon dioxide | Yes | No | |

Source: Legislative Council Staff

Emissions Assessment

The RNG standards under SB20-150 will reduce greenhouse gas emissions both by displacing geologic natural gas and/or reducing methane emissions from existing sources. Displacing 5 percent of geologic natural gas with RNG will reduce greenhouse gas emissions by up to 0.4 million metric tons of carbon dioxide equivalent in 2025. These emissions savings will double under the 10 percent portfolio target in 2030 and triple under the 15 percent portfolio target in 2035. These emissions savings, summarized in Table 2, are calculated based solely on the impact of the RNG portfolio targets for large utilities, assuming the portfolio targets are achieved. Actual emissions savings may be less, depending on the sources of RNG used to meet the portfolio standard and ability to achieve the portfolio targets within the investment restrictions in the bill.²

In addition, methane emissions may also be reduced. However, methane reductions will vary considerably depending on the source of RNG and baseline operating conditions. While this report cannot estimate the precise amount of methane emissions that are potentially avoided, Table 2 includes an estimate of the maximum potential reduction in avoided methane emissions if all RNG were to come from methane sources that otherwise would have been released into the atmosphere.

Additional emissions savings will also occur from RNG used by small natural gas utilities, but will depend on the targets and rate cap set by the Public Utilities Commission (PUC), rather than in this bill. For informational purposes, the potential scope of RNG use by small utilities are shown in Table 3, assuming the same targets as large utilities.

**Table 2
 Potential GHG Emissions Savings under SB20-150**

| Portfolio Targets under SB20-150 | Quantity of Natural Gas displaced by RNG Million cubic feet | Potential GHG Savings from Displaced Geologic Natural Gas Metric tons of CO ₂ e | Potential GHG Savings from Avoided Methane Emissions Metric tons of CO ₂ e |
|---|---|--|---|
| 5% | 6,727 | 0.4 million | up to 3.4 million |
| 10% | 13,453 | 0.7 million | up to 6.8 million |
| 15% | 20,180 | 1.1 million | up to 10.2 million |

Note: Reflects portfolio targets for large natural gas utilities as defined in SB20-150. Emissions savings from displaced geologic natural gas will be reduced if RNG is sourced from coalbed methane or naturally occurring coalbed deposits. Emissions savings from avoided methane emissions will depend on source of RNG.

Displaced geologic natural gas from large utilities. Currently, only one natural gas utility meets the criteria for a large natural gas utility: Public Service Company of Colorado dba Xcel Energy. According to filings with the Federal Energy Regulatory Commission, Xcel Energy delivered approximately 134,500 million cubic feet of natural gas to retail customers in 2018. If natural gas deliveries remain constant, Xcel Energy will be required to procure and deliver 6,700 million cubic feet of RNG under the 5 percent portfolio target beginning January 1, 2025. This will result in avoided greenhouse gas emissions of roughly 0.4 million metric tons of carbon dioxide equivalent per year from 2025 to 2030.³ These annual greenhouse gas emissions savings would double in 2030 and triple in 2035.

² SB20-150 limits qualified investments in RNG to 2 percent of the large natural gas utility's revenue requirements for a particular year. If qualified investments exceed this rate cap prior to meeting the portfolio targets, large natural gas utilities may not make further qualified investments without approval from the Commission. The emissions assessment provided here thus represents an upper bound of the potential greenhouse gas emissions savings under the large RNG program established under SB20-150, based on current qualifications.

³ U.S. EPA (2014). Emissions Factors for Greenhouse Gas Inventories. Available at: https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf.

Reduced methane emissions from large utilities. Capturing methane from existing sources such as wastewater treatment plants, livestock operations, landfills, and coal mines will reduce methane emissions. A 5 percent RNG target achieved through methane recovery would require 6,700 million cubic feet of methane, equivalent to 0.14 million metric tons of methane⁴, or 3.4 million metric tons of carbon dioxide equivalent. These emissions savings would double under a 10 percent target and triple under a 15 percent target. These emissions savings assume that the source was previously releasing methane into the atmosphere. If RNG is sourced from facilities that are currently mitigating methane emissions (e.g. via flaring), the emissions savings from RNG will be reduced.

Displaced geologic natural gas from small utilities. Portfolio targets for small natural gas utilities are not established in SB20-150, and municipally owned natural gas utilities may voluntarily implement an RNG program. An RNG program for small utilities will be established in rule by the PUC, and the exact greenhouse gas emissions will depend on the targets set and other provisions of the program. For informational purposes, the potential amount of natural gas displaced for large and small natural gas utilities are provided below, based on 2018 sales and the portfolio targets for large natural gas utilities.

**Table 3
 Potential Displacement of Natural Gas by
 Renewable Natural Gas for Large and Small Utilities**

| Natural Gas Utility | Number of Meters | 2018 Natural Gas Sales Million cubic feet | Quantity of Natural Gas Displaced by RNG under Large Utility Targets Million cubic feet | | |
|------------------------------|------------------|--|--|--------|--------|
| | | | 5% | 10% | 15% |
| PSCo (Xcel Energy) | 1,329,848 | 134,534 | 6,727 | 13,453 | 20,180 |
| Black Hills Colorado Gas | 84,586 | 9,180 | 459 | 918 | 1,377 |
| Black Hills Gas Distribution | 99,764 | 1,732 | 87 | 173 | 260 |
| Colorado Natural Gas | 21,831 | 1,790 | 90 | 179 | 269 |
| Atmos Energy | 114,866 | 4,086 | 204 | 409 | 613 |

Source: Public Utilities Commission.

Note: Atmos Energy retail sales based on 2020 gas cost recovery filings.

Limitations

The greenhouse gas emission reduction estimates provided above are not based on life cycle analyses, which would account for the energy inputs to recover, process, and transport the RNG, as comparable life cycle analyses were not found. California, however, has certified fuel pathways for specific RNG sources under their Low Carbon Fuel Standard using life cycle analyses, which can provide some context here. Certified fuel pathways measure the associated carbon intensity of various fuel feedstocks (e.g., landfill gas, dairy manure), and show that RNG, on a life cycle basis, represents a reduction between 50 and 300 percent in greenhouse gas emissions compared to conventional petroleum fuels used for transportation.

⁴ Methane at standard temperature and pressure is 0.717 kg/m³, or 20.3 g/ft³. Source: https://www.engineeringtoolbox.com/gas-density-d_158.html.

Data Sources and Agencies Contacted

Colorado Department of Public Health and Environment
Colorado Energy Office
Colorado Department of Regulatory Affairs, Public Utilities Commission
U.S. Department of Energy
U.S. Environmental Protection Agency
California Air Resources Board

Annex 1 Emissions Sectors and Description

| Emissions Sector | Description |
|--|---|
| Electric Power | The electric power sector generates, transmits, and distributes electricity to residential, commercial, and industrial end users. |
| Transportation | The transportation sector includes combustion emissions from all motorized vehicles for on-highway and off-highway (e.g. boats, aircraft) use of transporting people and/or goods. |
| Residential, Commercial, and Industrial Fuel Use | Fuel use includes the combustion of fuels in residential, commercial, and industrial sectors for heating and various commercial purposes. Industrial fuel use also includes fossil fuels used for non-combustion purposes, such as in the production of lubricants, solvents, and as feedstocks for asphalt and road oil. |
| Natural Gas and Oil Systems | The natural gas and oil systems sector includes the extraction, processing, transportation, and distribution of natural gas and oil. |
| Coal Mining and Abandoned Mines | The mining sector includes active and abandoned surface and underground coal mines, as well as the processing, transportation, and storage of coal. |
| Agriculture | The agriculture sector includes emissions from livestock and crop production activities. Including enteric fermentation, manure management, agricultural soil management, and agricultural residue burning. |
| Industrial Processes | Industrial processes include the manufacturing of products such as steel, cement, aluminum, lime, soda ash, and nitric acid. Greenhouse gases are emitted as byproducts of non-energy related industrial activities, or due to their use in manufacturing processes or by end-consumers. |
| Land Use, Land Use Change, and Forestry | This sector accounts for the greenhouse gas fluxes (e.g., net emissions or sequestration of carbon) from land use and land use change within and between all land-use types including forest land, cropland, grassland, wetlands, and settlements. |
| Waste Management | Waste management includes municipal solid waste and industrial waste that is landfilled, as well as the industrial treatment of wastewater. |

Source: Compiled by Legislative Council Staff from EPA's State Inventory Tool and CDPHE's Greenhouse Gas Inventory Report.

Additional information. For a full glossary of terms commonly used in greenhouse gas emissions reports, please refer to the Greenhouse Gas Emissions Report Overview memo, available at <https://leg.colorado.gov/agencies/legislative-council-staff/greenhouse-gas-emissions-reports>.