CCST REPORT
Biomethane in California Common Carrier Pipelines

Report Published **JUNE 2018**

One Pager

DOWNLOAD FULL REPORT

See the Full Report for more details.

STRONGER WITH SCIENCE FOR 30 YEARS

CCST
CALIFORNIA COUNCIL ON SCIENCE & TECHNOLOGY

WHAT IS BIOMETHANE?

- **Definition:** Biomethane is a type of gaseous fuel – which, like natural gas, is composed predominately of methane. Unlike natural gas, which is a fossil fuel that is extracted via wells drilled into geologic formations deep underground, biomethane is refined from "biogas" – a byproduct of the natural decomposition of organic waste, such as manure, agricultural and food waste, and sewage treatment waste.
- **Capture and Generation:** Biogas can be captured at facilities specially designed to "digest" organic waste and generate biogas, such as those treating dairy waste; or at facilities and generation sources such as landfills. This biogas must then be further refined ("upgraded") into biomethane.
- **Usage:** Once upgraded, biomethane can be used interchangeably in place of natural gas, for generating electricity, home heating, vehicle fuel, and other applications.
- **Environmental Impact:** Using biomethane in place of natural gas reduces carbon dioxide emissions. Capturing biogas from dairies, landfills, and other facilities diverts methane – a more impactful greenhouse gas than carbon dioxide – that would otherwise be emitted into the atmosphere.

TRANSPORTING BIOMETHANE IN COMMON-CARRIER PIPELINES

- **Preconditions for Blending and Transport:** Biomethane can be injected into "common-carrier pipelines" built for transporting and distributing natural gas – thereby blending biomethane with natural gas already being moved. To qualify for injection, however, the biomethane must pass three key tests: siloxane concentration must not be too high, the heating value and Wobbe Number must not be too low.
- **Siloxane Standards:** Unlike biogas processed from agricultural and forestry sources, biogas processed from landfill or wastewater and sewage sources is likely to contain volatile organic silicon compounds ("siloxanes"), due to residues from human products such as cosmetics. The combustion of biomethane containing siloxanes generates "amorphous silica nanoparticulates" – smaller than the size of a flu virus – which can form deposits on and may cause damage to combustion surfaces such as gas burners or engines. The human health impact of silica inhalation is unclear, and international standards are currently being developed for measuring these compounds. However, the California Public Utilities Commission has set maximum siloxane levels in biomethane since 2014 of no more than 0.1 mg Si/m^3.
- **Higher Heating Value (HV):** This technical term refers to the amount of heat that can be generated from combusting a gas, written in terms of energy-per-unit volume (British Thermal Units/standard cubic foot; BTU/scf). The HV of a gas depends on its chemical composition. Injecting a low-HV gas into a pipeline with high-HV gas will result in a lowered HV for the blended gas. Maintaining the HV in a gas supply is important, both for product quality and consumer expectation (e.g. time it takes to cook food on a gas stove), and for safe transport and combustion. Currently, biomethane must have a HV of 990 BTU/scf prior to pipeline injection.
- **Wobbe Number:** Also referred to as the Wobbe Index, this number serves as one indicator of whether two types of gaseous fuels can be interchangeable when combusted for use. The number represents the energy-to-density characteristic of a gaseous fuel. If two fuels – natural gas versus biomethane, for example – are determined to have similar Wobbe Numbers, then one can substitute for the other without loss in combustion performance.

FACTORS DICTATING BIOMETHANE TRANSPORT AND USE

- **Performance and Safety:** For common carrier pipelines, suppliers must ensure that their mechanisms for blending and injecting biomethane results in gas that meet quality standards.
- **Intended Use:** Alternatively, biomethane could be compressed on-site for use as vehicle fuel; or combusted on-site to generate electricity for distribution or dedicated for vehicle charging.
- **Economic Incentives:** Federal and State subsidies distort markets for qualifying biomethane supplies, favoring transportation uses over use for electricity generation.

SELECT EXPERTS

The following researchers can advise and share insights on biomethane conveyance in California.

AMBER J. MACE, PhD
Deputy Director
CCST
ambermace@ccst.us

Dr. Mace can speak on the overall findings of the 2018 CCST report on biomethane and the report process.

ADAM BRANDT, PhD
Assistant Professor
Energy Resources Engineering
Stanford University
abrandt@stanford.edu

Professor Brandt can speak on heating values and siloxanes research, as well as modeling scenarios of biomethane injection and blending into common carrier pipelines.

DEEPAK RAJAGOPAL, PhD
Assistant Professor
UCLA Institute of the Environment and Sustainability
rdeepak@ioes.ucla.edu

Professor Rajagopal can speak on the economics of biogas upgrading.

JAMES SWEENEY, PhD
Professor and Director
Precourt Energy Efficiency Center
Stanford University
jim.sweeney@stanford.edu

Professor Sweeney can speak on the CCST report recommendations and on the market distortions associated with the California Low Carbon Fuel Standard and the Federal Renewable Fuel Standard.

2018 CCST REPORT ON BIOMETHANE IN CALIFORNIA COMMON CARRIER PIPELINES

Assembly Bill 1900 (2012, Gatto) required the **California Public Utilities Commission (CPUC)** to adopt standards for biomethane that specify the concentrations of constituents of concern that are reasonably necessary to protect public health and ensure pipeline integrity and safety, as well as requirements for monitoring, testing, reporting, and recordkeeping.

In 2016, Senate Bill 840 (Budget Act) directed the **California Council on Science and Technology (CCST)** to produce an independent technical assessment on biomethane specifications. The CPUC will use this assessment to reexamine whether two such standards could be updated with scientific evidence: **1) the biomethane minimum heating value (HV)** adopted in 2006 (Decision 06-09-039), and **2) the maximum biomethane siloxane concentration** adopted in 2014 (Decision 14-01-034).

From a statewide field of leading energy researchers, CCST selected Professor James Sweeney, Director of the Stanford University Precourt Energy Efficiency Center, to serve as chair of the seven-member **CCST Report Steering Committee** — which supervised four Report Authors from Stanford University and University of California, Los Angeles, with expertise on biomethane heating values and siloxanes research, energy systems modeling, economic and market pricing modeling, and energy infrastructure scenarios. Each report chapter was subject to a peer review process by independent experts, while another independent expert served as Report Monitor to oversee the process, ensuring that peer review comments were sufficiently addressed in the final report. An additional Oversight Committee reviewed the entire process, including conflict-of-interest declarations.

FINDINGS AND CONCLUSIONS

The report's findings and conclusions are based on a review of published literature and official and voluntary databases, which the Report Authors compiled and delivered to the CPUC in June 2018. The CCST report reviewed the best available science and data and provided recommendations for the following questions (See the Full Report for additional findings and details):

- **Minimum Heating Values for Pipeline Injection of Biomethane:** Evidence suggests keeping the current minimum Wobbe Number requirement for biomethane— while relaxing the heating value specification to a level as low as 970 BTU/scf — will unlikely impact safety or equipment reliability. The study team recommends that the CPUC keep the Wobbe Number minimum requirements as they are now, and that the CPUC initiate a regulatory proceeding to examine the option of allowing biomethane injection with a heating value as low as 970 BTU/scf, provided the biomethane being injected satisfies current Wobbe Number limits and all other requirements.
- **Maximum Siloxane Concentrations for Biomethane:** Insufficient evidence is currently available to determine whether the CPUC maximum siloxane limit of 0.1 mg Si/m^3 is too stringent, or not stringent enough, to meet safety requirements. The study team recommends that the CPUC support a comprehensive research program to understand the operational, health, and safety consequences of various concentrations of siloxanes, and that it track ongoing efforts to adopt international standard testing methods for siloxanes. At the same time, because some biomethane generation sources are very unlikely to harbor siloxanes — e.g. dairy waste, agricultural waste, or forestry residues — the CPUC could subject biomethane from these sources to simpler monitoring requirements.

The report also summarizes options for blending biomethane to meet California standards; suggests uses for biomethane alternative to pipeline injection; and compares the economics of biomethane pipeline injection investments under State and Federal subsidy scenarios:

- **Uses for Biomethane or Biomethane Other Than Injection Into Common Carrier Pipelines:** Although this report has focused on regulations for upgrading biogas to biomethane and moving it on common-carrier pipelines, other uses of partially-upgraded biogas may be economically superior. In many cases, upgraded biogas can be combusted for heat or electricity generation either on-site or delivered off-site by dedicated pipelines. These alternatives avoid some of the large upgrading costs. In such "medium BTU" projects, biogas would be consumed by an end-user on-site or after moving it a short distance by a direct private pipeline. Upgraded biogas or biomethane on-site can provide heating for buildings and agricultural processes, while gas turbines, reciprocating engines, or fuel cells can generate electricity for on-site use or for sale given the appropriate grid connection.
- **Subsidy Implications for Biomethane Upgrading and Injection Economics:** Current State and Federal regulations greatly subsidize biomethane for transportation and only for that purpose. Financial incentives through the California Low Carbon Fuel Standard (LCFS) and the Federal Renewable Fuel Standard (RFS) programs can be up to 18 times greater than the commodity value of the biomethane itself. Although minimally-processed biogas can be used for on-site heat or electricity generation, these uses do not receive similar subsidies. The report recommends that California State and Federal agencies examine whether the substantial differences in incentives for various uses of biogas/biomethane are consistent with State and Federal policy intentions.

REFERENCES

The following resources form the basis of this summary:

Biomethane in California Common Carrier Pipelines — Assessing Heating Value and Maximum Siloxane Specifications: An Independent Review of Scientific and Technical Information. California Council on Science and Technology, June 2018.
http://ccst.us/projects/biomethane/publications.php

A CCST Commissioned Report requested by the California State Legislature via the Budget Act of 2016 (SB 840) and delivered to the California Public Utilities Commission, pursuant to the requirements of AB 1900 (2012, Gatto).