A Presentation on

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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 & Technology

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Legislative and Regulatory Background

Assembly Bill 1900 (Gatto, 2012)

- Required CPUC to adopt standards for pipeline biomethane
- Required CPUC to adopt additional incentives and policies to promote instate production and use of biomethane and biogas

Senate Bill 840 (2016)

- Required CPUC to hire CCST to re-assess BTU and siloxanes standards and recommend changes
- CPUC must give due deference to CCST recommendations and adopt within 6 months of study's release

Legislative Background (continued)

Assembly Bill 2313 (Williams, 2016)

- Increases incentive offered to interconnect pipeline biomethane projects up to $3 million / 50% of interconnection costs
- Requires CPUC to consider rate-basing interconnection before current program funds are expended

Senate Bill 1383 (Lara, 2016)

- Requires CPUC and other agencies to adopt additional incentives and policies to increase instate production and use of biomethane and biogas
- Adopted numerous incentives for dairy biomethane, but not for biomethane from diverted organic waste

Heating Value

- Mandate - Ensure safe combustion and reliable heat delivery
- Current regulations - 990 BTU/scf
- Shifting to 970 BTU/scf would not affect safety or operations
- Shifting to 950 BTU/scf could affect safety
- Maintain Wobbe number (WN)
    - WN measures interchangeability of gas

Siloxane

- Silica results from combustion of siloxane
- Silica particles have unclear health impacts when inhaled.
- Silica deposits can damage equipment and cause carbon monoxide emissions
- No standardized measurement protocol exists for dependable measurement for the specification of 0.1 mg Si/m3
- Current siloxane specifications could be below reliable detection limits
- Difficult to acquire project financing due to risk of not being able to meet specification and inject
- Very little data and involves large extrapolation from that data.

Additional Recommendations on Siloxanes

- Simplified verification regime for certain sources
- ASTM International process to adopt and test a standard test method
- Revisit the siloxane maximum standards.

Cost and Value of Biomethane

- Biomethane is a useful product from organic waste recycling facilities
- Local conditions may determine different end-uses, thus, all options are needed to develop facilities
- Biomethane options: on-site usage, trucking, private/direct pipeline, common-carrier pipeline
- Current incentives favor fuel utilization
- Common carrier pipeline injection is specifically needed in order to be able to distribute biomethane to end users and/or fuel stations
- Blending can be an option without revising injection specifications
- Thus, increased incentives are needed to increase pipeline injection
- CCST recommends the State examine differences in incentives

Impacts to Local Jurisdictions by EPD Staff

Anaerobic digestion (AD) infrastructure development

- Lowering Heating Value may help development
- Maintaining siloxane specifications may discourage development
- Co-digesters would not be eligible for relaxed siloxane verification

End markets for recycled organic waste products

- Pipeline injection of biomethane needs to become an economically feasible option to create a marketable end product of recycled organic waste.

Public health and safety

- state to work with PUC and utilities to develop guidelines for blending biomethane with pipeline gas

Impacts to Local Jurisdictions (continued)

- State to subsidize testing and/or removal of siloxanes.
- Ensure biomethane producers are not charged for NG removed, mixed, and re-introduced into the pipeline for blending.
- Ensure regulatory bodies are not charged for regulating the blending process.
- State to work with local jurisdictions to identify locations where, and specifications for large portions of biomethane that do not meet current standards, to be safely injected for in-pipeline passive mixing.

<u>Economic barriers</u>

- The monetary incentive program for biomethane projects established by AB 2313 ought to be expanded beyond the $40 million limit and the per project cap needs to be increased from 50% of interconnection costs up to 100%.

Questions?

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Overview of Recommendations of CCST

Recommendation 1: Keep the Wobbe Number (WN) minimum requirements as they are now.

Recommendation 2: Reexamine regulations on HV minimum levels. Initiate a regulatory proceeding to examine the option of allowing biomethane satisfying current WN limits and all other requirements, but with a heating value as low as 970 BTU/scf.

Recommendation 3: Support a comprehensive research program to understand the operational, health, and safety consequences of various concentrations of siloxanes.

Recommendation 4: There is not enough evidence to recommend any changes to the maximum allowable siloxanes concentration at this time.

Recommendation 5: Consider the development of a reduced and simplified verification regime for sources that are very unlikely to have siloxanes, such as dairies or agricultural waste.

Recommendation 6: Monitor the ASTM International process to adopt and test a standard test method for siloxanes.

Recommendation 7: Use the learnings from the siloxane research and the ASTM International process to revisit the siloxane maximum standards once more complete information becomes available.

Recommendation 8: State and Federal agencies should examine whether the substantial differences in incentives for various uses of biogas/biomethane are consistent with the State and Federal policy intentions.

Cost Implications of 970 vs. 990 BTU/scf

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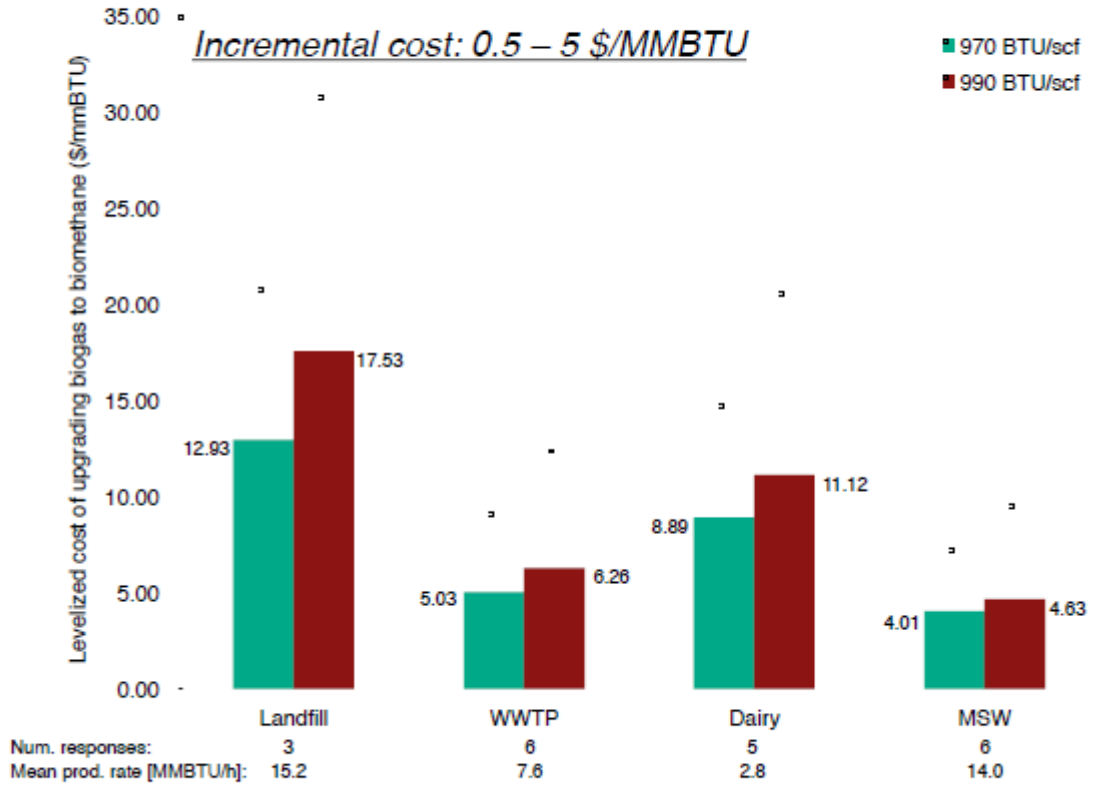
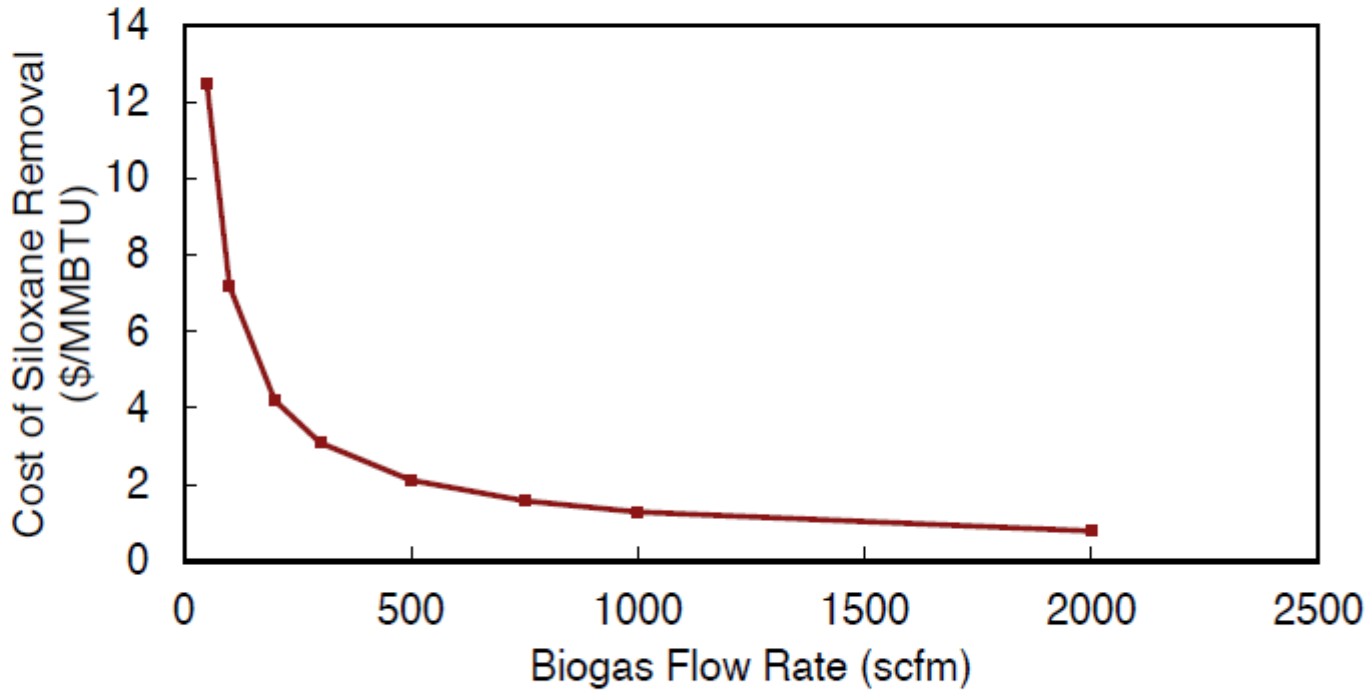
- No literature on cost of upgrading to 990 vs 970 BTU/scf
- We performed survey of biomethane upgrading equipment providers
- 28 companies contacted, 7 complete responses
- Constructed cost estimates for template projects

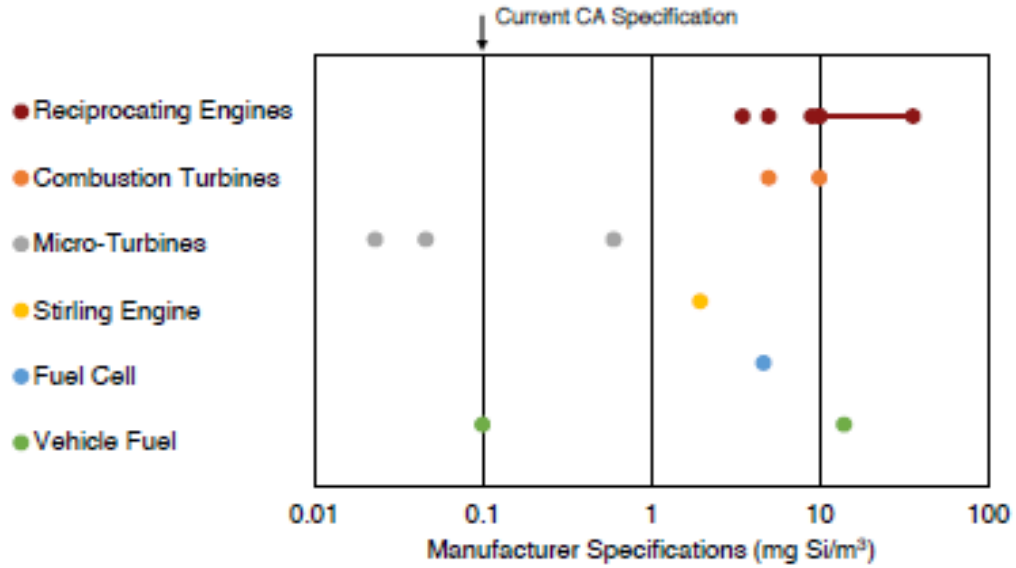


Cost Implications of Siloxane Removal

- GTI (2014) performed survey of siloxane removal costs
- At Point Loma WWTP scale: $2 per MMBTU



Manufacturer specifications



Key Points:

The CA siloxane specification is more stringent than most manufacturer imposed requirements

Not all equipment has specifications established yet

Alternatives to Pipeline Transportation of Biomethane: Regulatory Incentives

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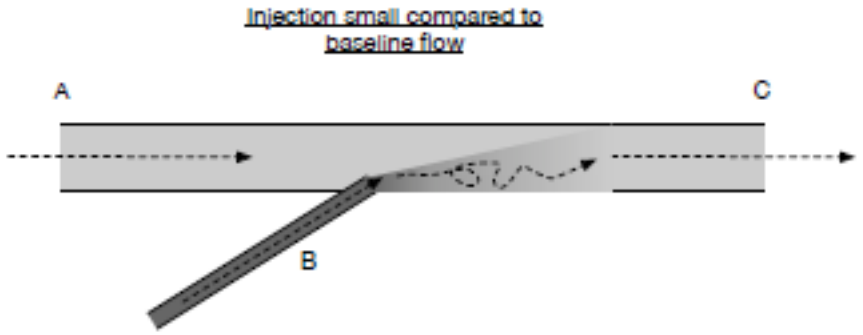
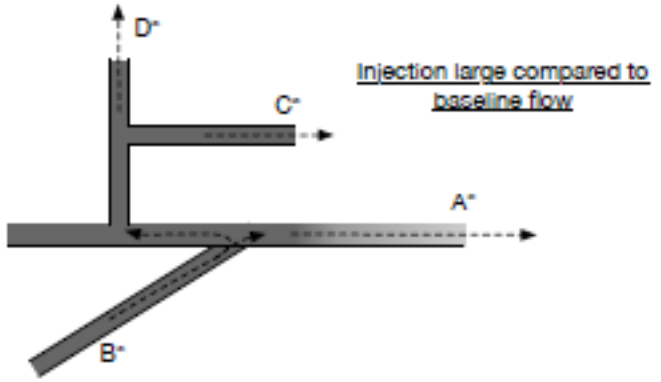
Biogas or Biomethane Use	Regulatory Incentive per MMBTU		
	State LCFS or Cap-and-Trade	Federal RFS	Total
Biogas upgraded to biomethane, transported in pipelines, used for transportation, certified pathway	$6 - $48	$29	$35 - $77
Biogas or biomethane used for residential, commercial, industrial or electricity generation	$1	$0	$1
Biomethane used to generate electricity, used for transportation: certified pathway	$6 - $48	$15	$21 - $63

Citygate Market Price of Natural Gas: About $3 per MMBTU

Options for dilution to meet specifications





- If injection is small compared to flow, dilution will result in gas quality similar to FNG
- If injection is large, displacement of gas over larger region will occur
- In-pipe dilution not a general solution or replacement for injection standards