Biomethane at Middlebury College:
Implications for Natural Gas Usage and Infrastructure Development

1. Introduction

The last seven years have seen Middlebury College make great strides toward its goal of achieving carbon neutrality by 2016. One of the major remaining hurdles is reducing the amount of carbon released to heat and cool the campus and generate hot water, all of which take place at the central heating plant. Although the 2009 upgrade to a biomass gasification plant reduced the College's use of fuel oil by 1,350,000 gallons, it still burns about 640,000 gallons of #6 fuel oil per year.

To further reduce the emissions of the central heating plant, a conversion is underway to burn biomethane, natural gas generated by the digestion of cow manure, delivered to Middlebury via a spur connected to Vermont Gas Systems' Addison Rutland natural gas pipeline. (The boiler conversion will also enable the combustion of natural gas, renewable diesel oil, and #2 fuel oil.) Construction of this pipeline, referred to as "Phase 1," was approved by the Vermont Public Service Board in 2013; construction will begin later this year. Construction of the spur will follow.

Although the biomethane project and the Addison Rutland natural gas project have different origins and environmental implications, their outcomes have been politically intertwined in the past year. The biomethane project provides the opportunity to burn locally sourced natural gas that would otherwise escape to the atmosphere during the natural course of manure decomposition. This would significantly reduce the carbon footprint of the College while providing an economic benefit to a local farm. Meanwhile, the main pipeline will deliver natural gas produced in western Canada by conventional extraction processes, including the controversial practice of hydro-fracturing (fracking). Because the biomethane project would be more difficult without the existence of the main pipeline--the College would otherwise have the biomethane trucked to campus--the impacts of both projects must be considered together.

The goal of this document is to inform members of the College and town communities about the biomethane project and Phase 1 of Addison Rutland natural gas project. The document does not support any particular viewpoint, but seeks to bring clarity to a discussion that is often muddied by complicated technical, scientific, and economic concepts. Because the members of the committee charged with writing this report were themselves confused or uninformed about many aspects of the pipeline, the document is structured around several questions.

2. Basic Facts

2.1 What are the Uses of and Alternatives to Natural Gas?

Across all sectors, but to varying degrees, natural gas is used for heating, cooling, cooking, electricity production and transportation. Industry--especially the pulp and paper, metal, chemical, petroleum refining, stone, clay and glass, plastic, and food processing industries--accounts for 43% of the natural gas consumed in the United States. Industrial uses include waste treatment and incineration; metals preheating; drying and dehumidification; glass melting; food

processing; fueling boilers; and as a base ingredient for products such as plastic, nitrogen fertilizers, anti-freeze, and fabrics.[1]

Because natural gas is typically burned to produce thermal energy, it is inefficient to replace it with electricity. As a result, alternative sources of electricity such as wind, solar, or hydro cannot be viewed as alternatives to natural gas. Geothermal heating and cooling is also not an alternative to natural gas because it relies on electricity. In essence, natural gas competes with other sources of fuel that can be burned, such as oil, coal, and biomass.

At Middlebury College, the administration considered meeting its need for thermal energy by building an additional biomass plant, either on its own, or one in a partnership with Porter Hospital or the Town of Middlebury. Upon further research, this approach appeared economically and logistically challenging. It would be difficult to manage a second system and coordinate it with the existing system especially since biomass systems are slow to come fully online and to take offline. The College also looked at other organic fuels made from waste products, algae, or willow trees. Once the pipeline was announced, however, biomethane made the most sense. Not only is it economically and logistically attractive for the College itself, but it also supports sustainable agriculture (see section 2.3).

2.2 What is the Addison Rutland Natural Gas Project (Phase 1)?

Vermont Gas Systems, Inc., a natural gas provider for more than 40,000 customers in the Vermont area, is constructing a pipeline to bring service to Vergennes and Middlebury.

The company was founded in 1965 and has expanded extensively over the past forty years. The natural gas that Vermont Gas provides comes from natural gas fields in Alberta, Canada. Natural gas is transported through the Trans Canada Pipeline and enters the company's main pipeline at Highgate, located on the Canadian border. An extensive network of more than 600 miles of pipeline then transports natural gas from this main pipe to customers throughout Vermont.

The map on page 3 shows the proposed route of the main pipeline as of February 2013. The pipeline will be about 41 miles long, running through the towns of Hinesburg and Monkton with a four-mile-long spur to serve the town of Vergennes. Multiple gate stations will connect the main pipeline to a network of lower pressure distribution lines serving communities and businesses. This pipeline will be 12 inches in diameter. It will be made of corrosion-resistant carbon steel, buried 5 feet below the ground and will maintain a minimum setback of 25 feet from any building. The typical lifetime of steel pipelines is 100 years, although exact lifetime depends on the soil acidity, temperature, and other local geological conditions.[2] When asked about the pipeline lifetime, VT Gas company said, "It should not need any repairs for many years. We do not predict a time for such a repair."[3] Although this answer is vague, it is in the company's best interest to have the most recent technology and avoid installing low-quality/temporary pipelines for public relations and liability issues.

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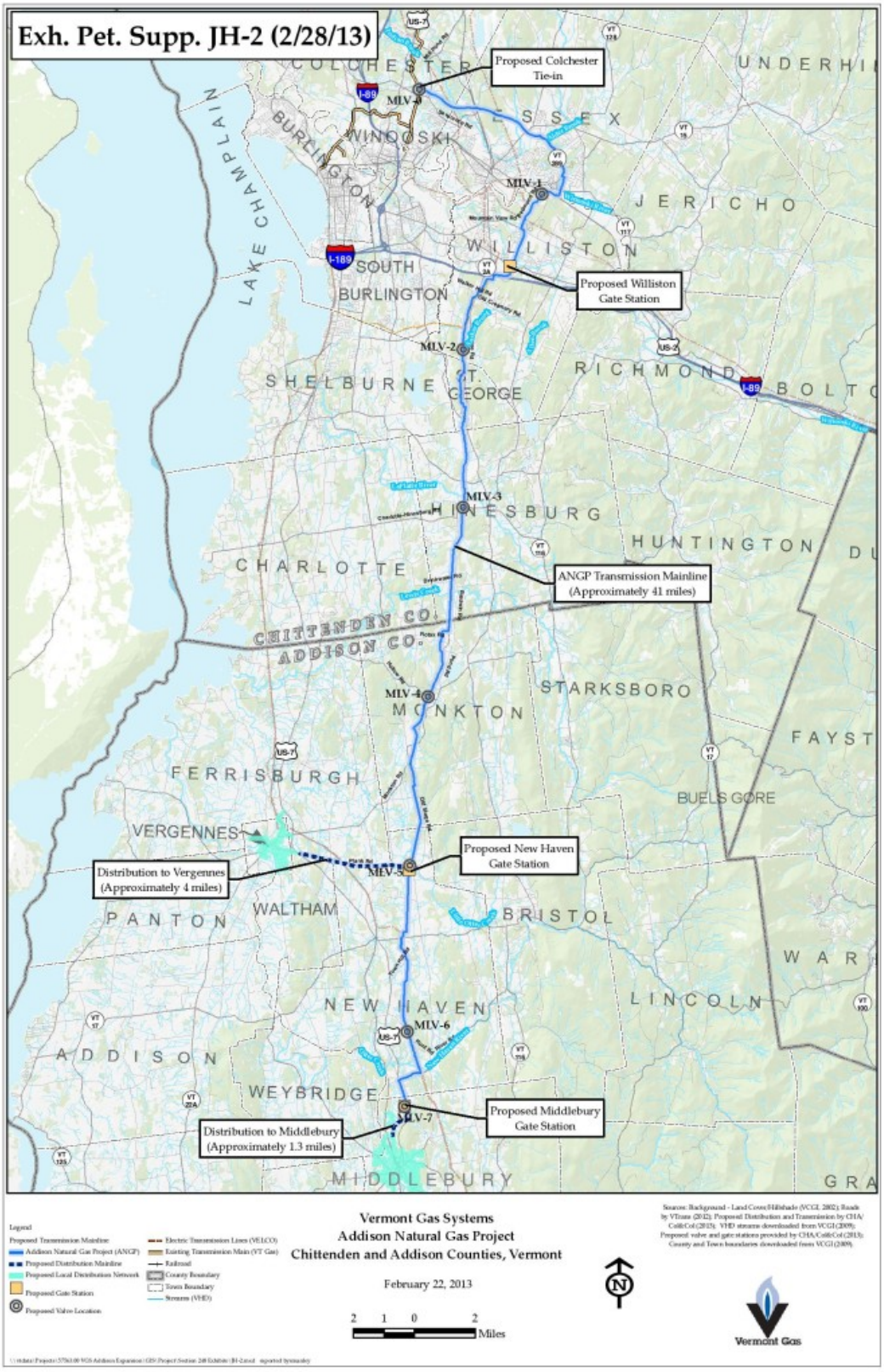
[1] NaturalGas.org. April 4, 2014. <http://naturalgas.org/overview/uses/>
[2] Vermont Gas. "Addison Rutland Natural Gas Project, Frequently Asked Questions." April 4, 2014. <http://addisonnaturalgas.com/frequently-asked-questions/>
[3] E-mail Communication with Addison@VTgas.com


Exh. Pet. Supp. JH-2 (2/28/13)
Proposed Colchester Tie-in
MLV-1
MLV-2
MLV-3
MLV-4
MLV-5
MLV-6
MLV-7
Proposed Williston Gate Station
ANGP Transmission Mainline (Approximately 41 miles)
Proposed New Haven Gate Station
Distribution to Vergennes (Approximately 4 miles)
Proposed Middlebury Gate Station
Distribution to Middlebury (Approximately 1.3 miles)
COLCHESTER
WINOOSKI
BURLINGTON
SOUTH BURLINGTON
WILLISTON
ESSEX
JERICHO
UNDERHILL
RICHMOND
BOLTON
SHELBURNE
ST. GEORGE
HINESBURG
HUNTINGTON
CHARLOTTE
CHITTENDEN CO.
ADDISON CO.
STARKSBORO
MONKTON
FERRISBURGH
VERGENNES
BUELS GORE
FAYSTON
PANTON
WALTHAM
BRISTOL
NEW HAVEN
LINCOLN
WARREN
ADDISON
WEYBRIDGE
MIDDLEBURY
LAKE CHAMPLAIN
Legend
Proposed Transmission Mainline
Addison Natural Gas Project (ANGP)
Proposed Distribution Mainline
Proposed Local Distribution Network
Proposed Gate Station
Proposed Valve Location
Electric Transmission Lines (VELCO)
Existing Transmission Main (VT Gas)
Railroad
County Boundary
Town Boundary
Streams (VHD)
Vermont Gas Systems
Addison Natural Gas Project
Chittenden and Addison Counties, Vermont
February 22, 2013
2 1 0 2
Miles
Vermont Gas

2.3 What is the Biomethane Project?

In spring 2010, Middlebury College announced plans to partner with Integrated Energy Solutions (IES) "to explore a bio-methane gas collection and delivery system that could help Middlebury further reduce its use of fossil fuels."[4] (Whenever the College's biomass gasification plant is not able to produce enough heat to meet demand, the boilers burn #6 fuel oil.) At that time, IES intended to process cow manure from Addison County farms and food waste from local businesses in a biodigester to make biomethane. The gas created through this process "would be scrubbed of impurities by a 'gas upgrade' plant connected to the digester, producing pipeline grade bio-methane, the chemical equivalent of natural gas."[5] The final product would be delivered by truck to campus for use in the central heating plant.

Since then, Middlebury and IES have refined their arrangement in light of Vermont Gas' plans to build a natural gas pipeline through Addison County. IES will build a biodigester for cow manure on the Goodrich Farm in Salisbury. The biomethane produced in Salisbury will be added to the Vermont Gas pipeline via a spur, which Vermont Gas will lease to IES. In turn, Middlebury College will draw from the main pipeline an amount of natural gas equivalent to what was produced at the farm.[6]

2.4 What are the Environmental, Economic, and Socio-Political Impacts of the Biomethane Project?

Middlebury College anticipates that the biomethane project will be online in early 2015. The College estimates that the project will reduce its use of fuel by approximately 640,000 gallons per year and its carbon emissions by 40% below its 2007 baseline year. Because the College has already reduced its emissions by 50%, this would bring total reduction to 90%.[7]

Unlike conventional natural gas, which is a fossil fuel, burning of gas produced by digestion of cow manure does not represent release of new carbon to the atmosphere. The process of digesting cow manure into gas and burning it for energy is carbon neutral on the timescale of hundreds of years. If the manure decomposed naturally, it would release all of its carbon into the atmosphere; converting it into biomethane and then burning it is very similar. In this cycle, the majority of the methane is released when the biomethane is burned. In this sense, the burning of biomethane is carbon neutral because the carbon released would have been released anyway.

In an announcement to the College community in spring 2013, President Ronald D. Liebowitz noted that the institution is "hopeful that the existence of the pipeline will encourage and support other biomethane projects in the area as a way to diversify and increase farm revenues."

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[4] Elizabeth Ridlington and John Rumpler, "Fracking by the Numbers: Key Impacts of Dirty Drilling at the State and National Level." October 2013. <http://www.environmentamerica.org/sites/environment/files/reports/EA_FrackingNumbers_scrn.pdf>

[5] Stephen Diehl, "Middlebury and farm energy company to explore use of bio-methane gas at the college." May 12, 2010. <http://www.middlebury.edu/newsroom/archive/2010/node/255394>

[6] Jack Byrne/Sarah McGowen, Correspondence, December 2, 2013.

[7] Jack Byrne/Sarah McGowen, Correspondence, December 2, 2013. Ronald Liebowitz/Middlebury College, Memo, May 6, 2013.

The Vermont Public Service Board's approval of Phase 1 indicates that this is a real possibility. In issuing its approval, the Service Board included a stipulation requiring VT Gas to support the future of biomethane production in Vermont by allowing other businesses to have access to the pipeline.[8] As of this writing, however, the price of biomethane is not competitive with the price of natural gas ($10/cubic sq. foot), and it does not seem likely that Vermont will subsidize biomethane.[9] As such, the long-term future and scalability of biomethane in Vermont remains murky.

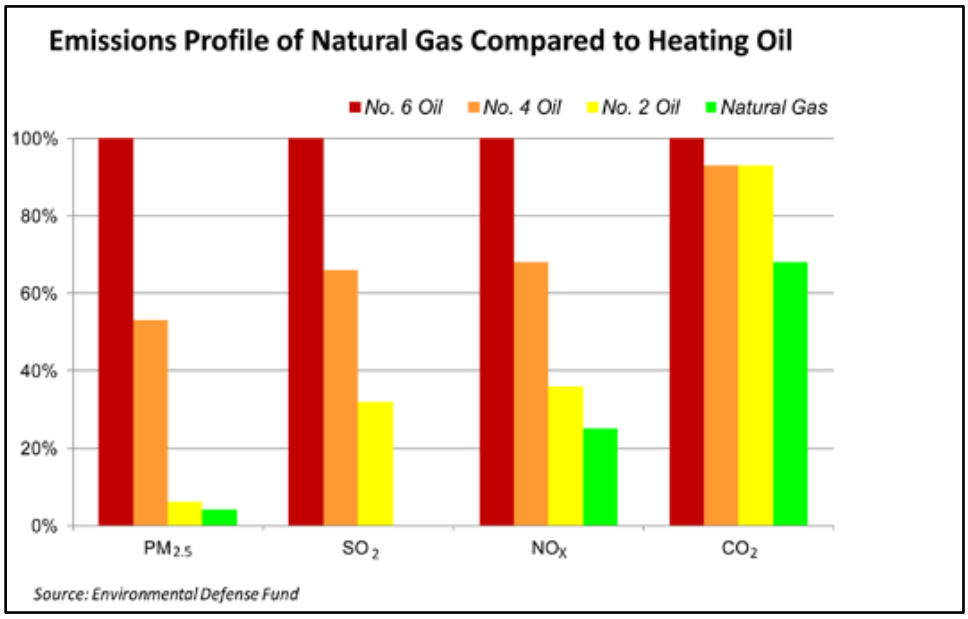
In the meantime, biomethane has many economic and environmental benefits for the Goodrich farm beyond selling biomethane to the College for cash. The digestion process will produce a liquid manure that can be injected directly into the soil, a practice that reduces runoff and increases soil fertility. The process will also create a dry material that can be used as livestock bedding and can be sold to other farmers. Because IES will hire someone to maintain the digester, the farm will not have to use their valuable time learning how to manage the infrastructure.[10]

3. Environmental Impacts of the Natural Gas Pipeline

3.1 What is the Pipeline's Effect on Greenhouse Gas Emissions?

Natural gas is considered to be the least-noxious fossil fuel for several reasons. Because it is a purified gas, it contains very little sulfur, nitrogen, or other impurities commonly found in coal and oil, and it releases no particulate matter. In addition, because it has a high density of hydrogen-carbon bonds, it has the highest ratio of energy output to CO2 output of any fossil fuel. Thus, when natural gas is burned instead of oil, CO2 emissions are reduced by about 25%.[11]

[8] State of Vermont Public Service Board, Petition of Vermont Gas Systems, Inc., for a certificate of public good, September 2013, http://psb.vermont.gov/sites/psb/files/orders/2013/2013-12/7970%20Final%20Order.pdf
[9] Environmental Council/Dan Smith, et al., Meeting, February 25, 2014.
[10] Environmental Council/Dan Smith, et al., Meeting, February 25, 2014.
[11] SOURCE NEEDED



The total amount of carbon emissions reduction achieved by Phase 1 of the pipeline project depends on changes in market demand and on the extent to which the infrastructure of the Vermont energy market changes with Phase 1. If it is assumed that demand stays constant and some homes and businesses switch from oil to natural gas, then the main pipeline will reduce Vermont's CO_2 emissions by 300,000 tons over 20 years. This includes reductions obtained through replacement of dirtier fuels & less trucking of these fuels around Vermont.[12]

3.2 What is Hydraulic Fracturing (Fracking)?

Fracking is a colloquial term for hydraulic fracturing, a technique used to extract natural gas from the shale-rich layers. Wells are drilled vertically and then horizontally above the shale area. Fluid made up of water, sand, and chemicals is injected into the wells at a high pressure to create cracks (fractures) that then release natural gas. After the fracking is completed, the wells are then encased with cement in order to ensure protection from leaking.[13] The process was first used commercially in the mid-1940s in order to extract natural gas from "unconventional sources," such as coal beds, shale, and tight sands. It has proven to greatly increase natural gas extraction production.[14] Frackng is also used in the extraction of crude oil and has played a significant role in pushing US crude production to it highest levels in a quarter century.[15]

Fracking is a hotly debated production technique due to its numerous advantages and disadvantages. On one hand, the process has proven to emit fewer greenhouse gases into the atmosphere than coal or oil extraction does. Many believe that it has or will drive down the price

[12] Andrew Stein, "Vermont Gas Systems Files Application for Natural Gas Pipeline." December 2012. <http://vtdigger.org/2012/12/21/vermont-gas-systems-files-application-for-natural-gas-pipeline>
[13] What is Fracking. April 4, 2014. <http://www.what-is-fracking.com>
[14] Heather Cooley and Kristina Donnelly, "Hydraulic Fracturing and Water Resources: Separating the Frack from Fiction." June 2012. <http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/full_report35.pdf>
[15] Christine Harvey and Asjylyn Loder, "Fracking Boom Pushes U.S. Oil Output to 25-Year High," December 11, 2013. <http://www.bloomberg.com/news/2013-12-11/fracking-boom-pushes-u-s-oil-output-to-25-year-high.html>

of energy because it has proven to be a cheaper production technique.[16] It also lowers our dependence on foreign oil and benefits the United States directly through increased jobs and economic profit (it is estimated that it resulted in roughly a total of $36 billion in revenue for companies in the United States in 2011).[17]

On the other hand, the fluid injected into gas wells contains toxic chemicals that significantly increase the risk of groundwater contamination. It has even been found that methane concentrations are 17 times higher in drinking water wells near the sites.[18] Moreover, the process requires significant amounts of water, with one estimation claiming that the process of fracking for natural gas in eight states has used roughly 250 billion gallons of water since 2005, converting much of it into toxic wastewater that then needs to be disposed of.[19] As an industrial operation, fracking also emits air pollutants such as methane.[20]

4. Safety and Landowner Concerns

4.1 Does the Pipeline Pose a Safety Hazard?

The Vermont Gas pipeline to be extended into the town of Middlebury does not pose any serious or alarming safety hazards. The installation process of the pipeline adheres to and goes beyond many of the standards required by law. For example, by law transmission lines are allowed to be within a few feet of residences, but Vermont Gas always tries to use a 25-foot minimum setback. Furthermore, buildings are not allowed to be located on top of natural gas pipelines. Others have questioned whether farmers will still be able to farm organically on land that has a transmission line going through it. The answer is "yes." Buried at a depth of 5 feet, there is no violation of organic standards to planting crops on land that has a transmission line below it.[21]

Before the installation process, all portions of the pipeline that are to be installed are tested at 150% of their allowed maximum operating pressure to insure that the pipes are strong and are not going to leak. Furthermore, once the pipeline has been installed the entire things is then x-rayed to ensure that there are no breaks in the pipes themselves or in the weldings. In cases of emergencies, there are shutoff valves located every eight miles along the pipeline that can be used in the case of a leak or of contaminated gas. To reduce this risk, the pipeline is monitored 24 hours a day, 7 days a week by Vermont Gas' Gas Control Department located in South Burlington, Vermont. Also, to ensure maximum safety, Vermont Gas provides natural gas emergency training to all emergency responders in case a problem arises. In addition, the gas that

[16] Kevin A. Hassett and Aparna Mathur, "Benefits of hydraulic fracking," April 4, 2013. <http://www.aei.org/article/economics/benefits-of-hydraulic-fracking/>
[17] Kevin A. Hassett and Aparna Mathur, "Benefits of hydraulic fracking," April 4, 2013. <http://www.aei.org/article/economics/benefits-of-hydraulic-fracking/>
[18] Dangers of Fracking, April 4, 2014. <http://www.dangersoffracking.com>
[19] Elizabeth Ridlington and John Rumpler, "Fracking by the Numbers: Key Impacts of Dirty Drilling at the State and National Level." October 2013.
[20] Elizabeth Ridlington and John Rumpler, "Fracking by the Numbers: Key Impacts of Dirty Drilling at the State and National Level." October 2013.
[21] Vermont Gas. "Addison Rutland Natural Gas Project, Frequently Asked Questions." April 4, 2014. <http://addisonnaturalgas.com/frequently-asked-questions/>

is transported through the pipeline is odorized (the smell of rotten eggs) to ensure that leaks can be easily detected.[22]

4.2 How Would the Pipeline Affect the Area Through Which It Runs?

A major concern about the pipeline is how it will affect the value of the land through which it passes. Because the pipeline will pass mostly along roads and through agricultural land, the impact on agriculture and, in particular, organic certification, is a key question. Because the pipeline is buried at a depth of 5-feet, it will not prevent farmers from plowing or harvesting their fields. As stated previously, there is no policy that says that organic agriculture cannot be produced on land above or near a natural gas pipeline. However, it is possible that an aging pipeline could leak natural gas. Because biomethane is a non-reactive gas, the gas in the soil would not cause any lasting contamination and would simply diffuse out of the soil.

5. How Many Homes and Businesses Will the Pipeline Reach? How Much Money Will They Save?

Currently, Vermont Gas operates 650 miles of underground transmission and distribution pipeline. This infrastructure primarily serves Chittenden and Franklin Counties. The 41-mile pipeline extension that would bring gas to Middlebury and Vergennes represents a 5.5% increase in pipeline infrastructure. With almost no limits to the Canadian supply of natural gas, every local community that demonstrates a demand for natural gas will have access to it. The expansion through Rutland (phase II) would streamline a proposal that originally had a 15-year timeline, driving the cost of the project, and consequently the cost of gas, down. Due to the demand for natural gas from businesses in Rutland and other parts of southern Addison county, Vermont Gas anticipates extending its services to more of Rutland county. They have also explained that during phase I, natural gas will be made available upon request in towns along the transmission pipeline route.[23]

As of April 2013, natural gas costs 43% less than fuel oil and 56% less than propane. This is a significant cost advantage to the homes and businesses that experience the direct economic benefit from the pipeline.[24] According to VT gas, and other natural gas researchers and suppliers, this is a much "cleaner" (read: less noxious) form of energy for this region of New England. In more tangible numbers, for the year 2014, the average electric and heating savings for each household are expected to be around $1,300/year compared to fuel oil. Homeowners that convert from propane to the natural gas serviced by this pipeline would have a net savings of approximately $1,400 per year.[25]

According to historic analyses of energy prices done by VT Gas, the proposed expansion of natural gas through Addison and Rutland counties will save homeowners and businesses an aggregate $200 million in energy and heating costs over the next 20 years. Although this

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[22] Vermont Gas. "Addison Rutland Natural Gas Project, Frequently Asked Questions." April 4, 2014. <http://addisonnaturalgas.com/frequently-asked-questions/>

[23] Vermont Gas. "Addison Rutland Natural Gas Project, Frequently Asked Questions." April 4, 2014. <http://addisonnaturalgas.com/frequently-asked-questions/>

[24] Kevin A. Hassett and Aparna Mathur, "Benefits of hydraulic fracking," April 4, 2013. <http://www.aei.org/article/economics/benefits-of-hydraulic-fracking/>

[25] 34% of Vermont's greenhouse gas emissions come from residential, commercial and industrial heating.

estimate comes from VT Gas, savings near the projected $10 million a year would add to economic prosperity in the region. For example, New Haven had a $660,000 general fund budget for the 2012-2013 fiscal year. Multiply that by (23[addison] + 29[rutland]) towns, and that is roughly a $35 million annual budget generated predominantly by town taxes. Town budgets aside, VT Gas and Rutland Herald and Addison County Independent have each claimed independently that natural gas service is 'highly desirable for business and economic development' and will serve to help the area create and retain jobs. The Addison Rutland Natural Gas transmission line would also add between 1.5 and 2 million dollars to each Town's Grand List. VT Gas would be responsible for paying local taxes on a town-by-town basis.[26]

From a purely economic perspective, we can conclude that there will be significant reductions in space heating and electric costs for residential and commercial buildings. This would also reduce the amount of large truck traffic on the roads around and between Vergennes and Middlebury.

[26] Vermont Gas. "Addison Rutland Natural Gas Project, Frequently Asked Questions." April 4, 2014. <http://addisonnaturalgas.com/frequently-asked-questions/>