Effects of Proposed Natural Gas Pipeline Construction in Massachusetts: An Analysis of Knowledge and Opinions in Dedham, West Roxbury, & Newton

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INTRODUCTION

In 2015, Americans consumed a total of 27.5 trillion cubic feet of natural gas. Overall, 33% of America's electricity came from natural gas while providing other energy-requiring services such as heat and industrial processes (U.S. EIA, 2016). According to the most recent data available, Massachusetts, the focus of our study, consumed 418 billion cubic feet of natural gas in 2014 (U.S. EIA, 2016).

Natural gas is a "mixture of hydrocarbon gases… formed primarily of methane [but] it can also include ethane, propane, butane, and pentane" (Speight, 2007). This combination forms a combustible gas with a high energy output and relatively "lower levels of potentially harmful by-products into the air" in comparison to other fossil fuels such as oil and coal (Speight, 2007). While this feature of natural gas has labeled it as a "transition fuel" between fossil fuels and renewable energy sources, this characterization does not account for the fossil fuels utilized in the complex extraction process known as hydraulic fracturing or "fracking." In addition, other externalities associated with natural gas extraction, refining, transport, and consumption must be considered: these include release of the extremely potent greenhouse gas methane into the atmosphere, groundwater pollution, earthquakes, and explosions. These add to the risks of natural gas pipelines explored in this paper.

Nevertheless, the consumption of natural gas remains popular, in part due to advances in fracking technology and a push for domestic energy sources, to warrant expansion of existing infrastructure in order to increase delivery to regions in North America for either domestic

consumption or international export. When looking at Boston College's energy portfolio, 91% of the university's energy is currently derived from natural gas in an effort to shift away from coal and oil (Willman & King, 2015). In order to meet the growing demand, Spectra Energy, a Houston-based North American pipeline and midstream company with "more than 21,000 miles of natural gas, natural gas liquids, and crude oil pipelines" (Spectra Energy), has proposed and begun construction on the Algonquin Gas Transmission Pipeline. The aim of this pipeline is to "offer abundant and reliable natural gas at a competitive rate" to the greater New England area and beyond (Spectra Energy). However, due to the negative side effects of such pipeline expansions observed in scientific literature and the media, research mentors at the Sierra Club Massachusetts Chapter recruited our research skillset in order to determine the awareness and attitudes of communities in the greater Boston area. From this information, our scientific and economic research would then be used to address any misconceptions or lack of knowledge that would potentially lead individuals to either passively or actively support the Algonquin Pipeline. Of these communities, Dedham/West Roxbury represented the community currently experiencing pipeline construction while Newton represented a town that did not have any planned major natural gas pipeline construction whether within the Algonquin project or otherwise. **Our project's aim was to find the public opinion and level of awareness on natural gas pipeline impacts on society and the environment. We sought to gain knowledge of the populace's opinion on pipeline expansion in Massachusetts, whether they support their elected officials stepping in, and what they expect the effects of these pipelines to be upon completion of the projects, in conjunction with demographics. We researched impacts**

of pipelines in other regions to determine the potential economic and environmental impacts in Massachusetts.

LITERATURE REVIEW

The consequences of high-pressure natural gas pipelines (HPNGP) in both the residential, commercial, and rural areas that the Spectra Algonquin Pipeline will run through can be categorized into two main sections: immediate effects and long-term effects. Within our literature review, we focused on the areas of health and environmental effects as well as economic effects.

Long-term environmental

Methane (CH4), the gas transported through natural gas pipelines, is classified as a potent greenhouse gas with a significant role in the global warming phenomenon. It has a lifespan of about 12 years in the atmosphere, but is around 25 times more potent at trapping the Earth's reflected infrared rays than the most abundant greenhouse gas, carbon dioxide (CO2) over a period of 100 years (EPA, 2016). According to the U.S. Environmental Protection Agency (EPA), In 2014, methane comprised 10.6% of all US greenhouse gas emissions (EPA, 2016). Of these emissions, the largest portion (33%) came from emissions associated Natural Gas and Petroleum Systems (EPA, 2016). This would include methane lost in the extraction and refining process as well as through pipeline leaks during the transmission process, a common occurrence within the industry (Subramanian *et al.,* 2015). High pressure natural gas pipelines, moving more gas at higher pressures and volumes (specifically 342,000 dekatherms/day in the Algonquin pipeline), would increase the amount of gas leaked through these naturally occurring compressor

and transmission stations (Spectra Energy). Already, the greater Boston area as well as a large portion of the United States is rife with methane leaks of varying degree due to aging infrastructure (Fig. 1) (EDF & CSU, 2016). The implications of CO2 and other pollutant emissions from the extraction and refining processes of natural gas add to the cradle-to-grave carbon footprint of natural gas. Therefore, though it might "burn cleaner" than other fossil fuels, the processes involved in natural gas consumption contribute significantly to greenhouse gas emissions. An increase in extraction and transport via this proposed HPNGP would increase methane emissions, which have a high atmospheric impact on retention of heat, therefore exacerbating the greenhouse gas effect and worsening the global problem of climate change (EDF, 2016).

Short-term environmental

Establishing a functional high-pressure natural gas pipeline requires a cleared space for "construction, monitoring, and maintenance" proportional to its width and carrying capacity (Johnson *et al.,* 2011). This can contribute to environmental and habitat degradation by raising the risk of habitat fragmentation, soil erosion, and sedimentation, as studied in Bradford County, Pennsylvania (Johnson *et al.,* 2011). In urban environments, road construction associated with pipeline installation produces significant levels of noise along with air pollutants such as particulate matter, nitrous oxides, sulfur oxides, hydrocarbons, and other toxic compounds (Anair, 2006). These pollutants can adversely affect the surrounding community during the construction process, with the potential to cause respiratory distress, cardiovascular issues, and restricted activity (Anair, 2006).

In addition, a specific environmental concern of the Spectra Algonquin pipeline is the potential for pipeline explosion. At the Spectra construction site surveyed by student researchers, the presence of a nearby rock quarry poses a disturbance threat to the structural integrity of pipeline (fig. 2) (Google Maps, 2016). During the field trip, local activists from the West Roxbury neighborhood noted that their homes shook from quarry blasts from as far as half a mile away. While Spectra maintains that their proposed pipeline standards would account for "ground vibrations, air vibrations, hydrogeologic disturbance, and projectiles (e.g., fly rock)" with a safety factor of 10, past repeated violations of the Federal Pipeline and Hazardous Materials Regulations as well as a recent natural gas pipeline explosion event in Salem Township, Philadelphia have called these assurances into question (Spectra Energy Partners, 2014) (U.S. DOT, 2011). The explosion on April 29th, 2016, under Spectra's subsidiary Texas Eastern, involved a 30-inch pipeline in a sparsely populated area geographically similar to that of Massachusetts (Hardway, 2016). This occurred while Spectra was under an ongoing investigation by the Pipeline and Hazardous Materials Safety Administration.

Overall, these pipeline implications on the environment and public health show that the concerns of residents of Massachusetts have a reasonable basis for opposing the pipeline's construction.

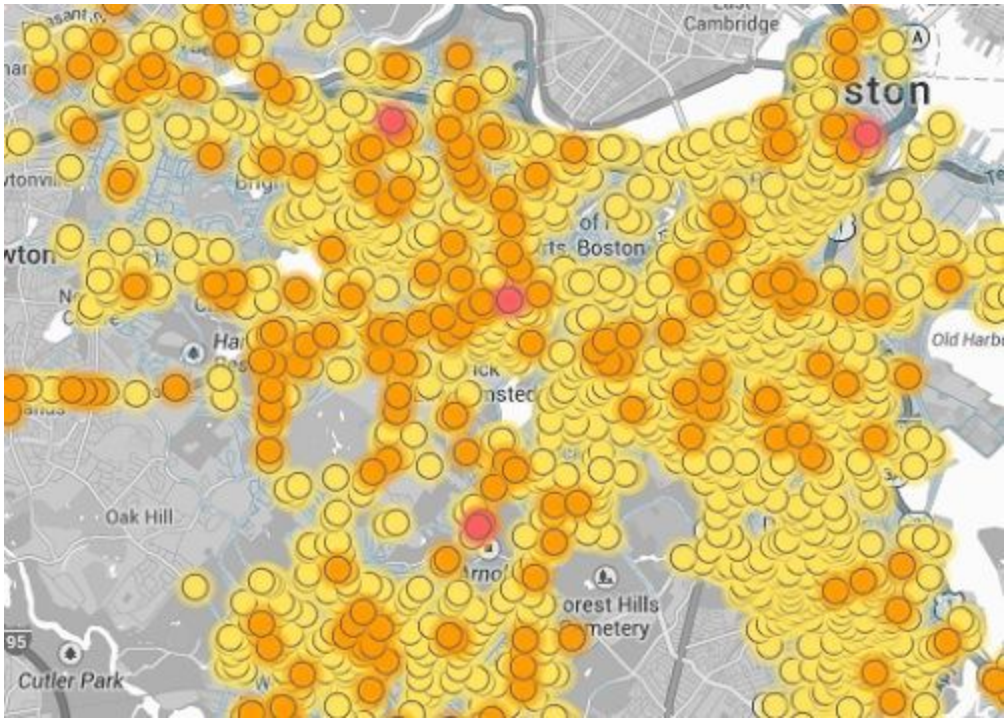


Fig. 1: Methane leaks from natural gas pipelines in Boston

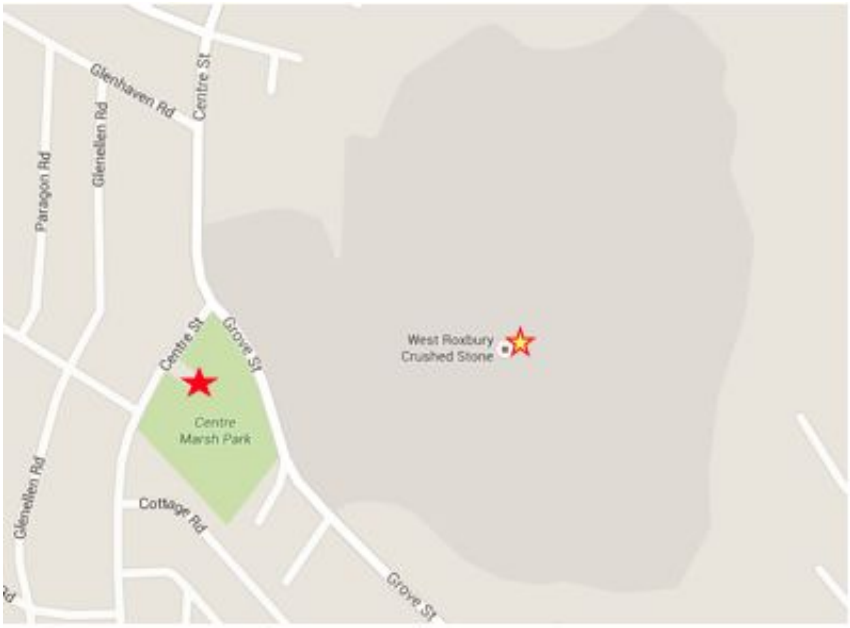


Fig. 2: Map showing current site of Spectra pipeline expansion (red star) in close proximity of the West Roxbury Crushed Stone quarry (yellow star)

Economic

The construction of a new natural gas pipeline not only has environmental effects, but also economic effects. One way these pipelines can have an economic effect on citizens living along the pipeline is through the impact on residential property values. If citizens become aware of the environmental effects of pipelines described previously, it would be reasonable to assume that less people would want to buy homes in an area that has a pipeline. For example, in an interview with Dedham Selectman Mike Butler, he described a permanent warning sign placed at the end of the driveway of a home along the new Spectra pipeline construction (personal communication, April 2016). Although not much formal research has been done to determine whether the presence of natural gas pipelines conclusively affects property values, a study was done in the southwestern United States for a pipeline expansion project. This study by Diskin et al titled, "The Effect of Natural Gas Pipelines on Residential Values" uses a paired-sales technique to analyze sales price information for properties encumbered by a natural gas pipeline easement, parcels adjacent to pipeline easements and properties neither encumbered by nor adjacent to a natural gas transmission pipeline. As a result of this analysis, the researchers were not able to come to a conclusion as to whether property values decrease with proximity to a pipeline, hypothesizing that more research in other areas must be conducted. Additionally, they state that it may be too soon to measure the long-term economic impact on proximity to a pipeline as this study was published only one year after the pipeline explosions in San Bruno, California (Diskin et al, 2011).

Another study was done by Boxall et al titled "The impact of oil and natural gas facilities on rural residential property values: a spatial hedonic analysis," which examined the impact of

oil and natural gas facilities on rural residential property values using data from Central Alberta, Canada using variables characterizing hazard effects and amenity effects. The type of natural gas in this study differs from the natural gas being transported through proposed pipelines in Massachusetts in that is is "sour," however they find that the presence of oil and gas facilities can have significant negative impacts on the values of neighboring rural residential properties by both measures of hazard and (dis)amenity attributes. While these results must be considered with some caution both in regards to our project as well as in regard to the fact that this is one of the first studies of its kind, the results are broadly consistent with other industries having potentially detrimental influences on the use and enjoyment of property (Boxall et al, 2005).

A report released in July of 2015 by the Massachusetts Office of the Attorney General outlines more potential economic effects to ratepayers in the proposed pipeline area. This study aims to evaluate all options to address electricity reliability needs in New England through 2030. The need for this study became apparent through contradicting comments of various parties with stake in the pipeline in regards to risks, solutions, reliability, environmental costs/benefits, ratepayer cost/benefits, market failure, and necessity. For example, in terms of the cost/benefit of new pipelines to ratepayer, the Environmental Defense Fund commented,

> Considering the high fixed cost of additional pipeline capacity, it is difficult, if not impossible, to envision a scenario in which electricity generated over the relatively small number of days during which new capacity would provide economic benefit would result in cost savings to ratepayers in excess of the all-in cost of new pipeline (including extensive stretches when the capacity is unneeded and lacks meaningful value).

Eversource Energy on the other hand argued that cost savings would be significant (Healey, 2015). In an aim to resolve these conflicting comments, The Analysis Group undertook the study, "Power System Reliability in New England: Meeting Electric Resource Needs in an Era of Growing Dependence on Natural Gas," which found that investment in energy efficiency and demand response (EE/DR) will result in the greatest customer savings and substantial greenhouse gas emissions. Additionally, building new gas pipelines to meet the deficiency is more expensive than the EE/DR solution. These results show that the new pipeline construction could actually cause some economic harm to ratepayers that could be alleviated through other options (Hibbard and Aubuchon, 2015). Despite the fact that the U.S. Natural Gas Alliance states that natural gas will create new jobs and generate economic growth, they fail to consider the negative impacts described above (America's Natural Gas Alliance, 2016).

METHODS

In order to answer our research question as to whether natural gas pipeline construction in a community would have an effect on the knowledge and opinions of residents of natural gas as an energy source, we distributed surveys to communities located where pipeline construction has already occurred (Dedham, MA and West Roxbury, MA) and to a community which is not directly affected by pipeline construction (Newton, MA). In order to target the main stakeholders in the community, we only recruited adult homeowners. Surveys were distributed with the help of local, unbiased community groups and leaders to potential participants via email. In this email they were able to follow a link to a Google survey.

The survey was composed of thirteen questions, which were a combination of demographic information and opinions on climate change and natural gas as an energy source. The purpose of the demographic questions was to be able to analyze trends in the certain groups of people's opinions. In total, we received 110 responses to our survey from all three communities after distributing it via different community listservs. We assigned ordinal and interval scales to our questions in order to quantify the population's opinion, awareness, and support. Using the numerical and qualitative data, we performed statistical analysis and made comparisons among the three populations identified above. In addition, we were prepared to run T-tests to determine whether any specific groups (ex. Newton vs. Dedham community, Male vs. female) have different average values in the study. However, given the number of respondents, we decided against it. Our results allowed us to gain more insight on what factors affect the population's opinion, awareness, and support of these pipelines. We then analyzed these responses and related the results to the actual environmental, health, and economic implications we found in our background research.

RESULTS

The survey distributed to residents of Dedham, West Roxbury, and Newton, Massachusetts was the most integral part of our results, allowing us to analyze how residents of different communities view natural gas pipelines. We collected 110 responses from the three communities, 39 of which were from people in communities where pipeline construction is occurring. The respondents' ages ranged from 21 to 84 and the overwhelming majority selected white/non-hispanic as their race. Of the 39 people that lived in Dedham and West Roxbury, 15.4% were not aware or not sure whether a pipeline was being built in their community. In

Newton on the other hand, a community in which there is no proposed pipeline, 67.2% of respondents were not sure whether or not there was a pipeline being built in their community. This comparison can be seen in Figures 3 and 4.

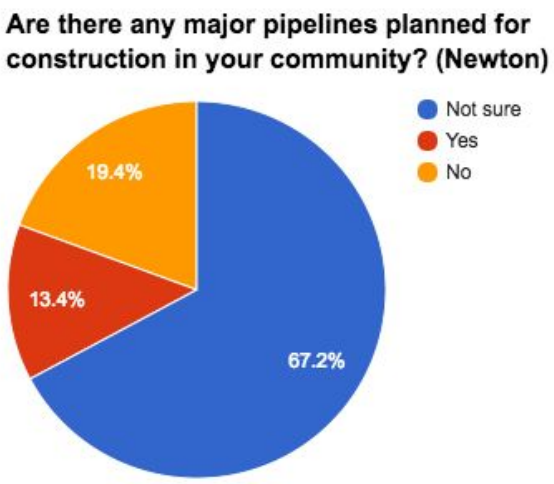


Figure 3. Percentage of Newton residents who responded "Yes," "No," or "Not sure" to knowing about pipeline construction in their community

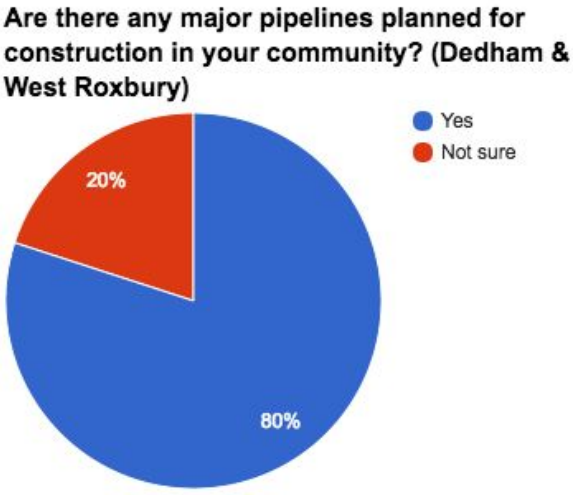


Figure 4. Percentage of Dedham/West Roxbury residents who responded "Yes," or "Not sure" to knowing about pipeline construction in their community

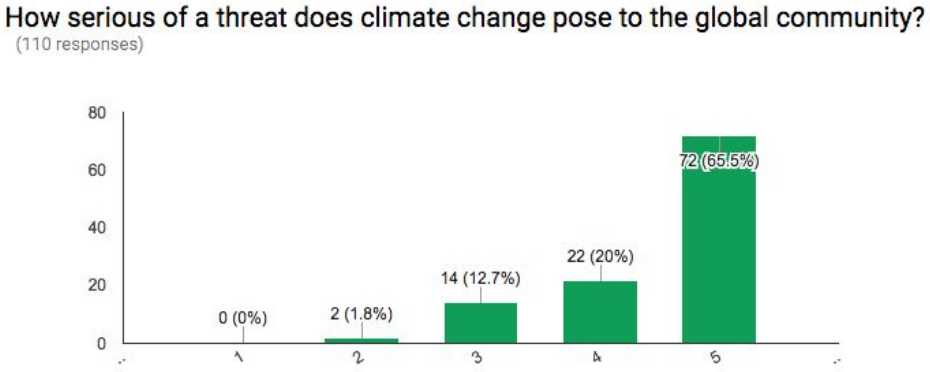
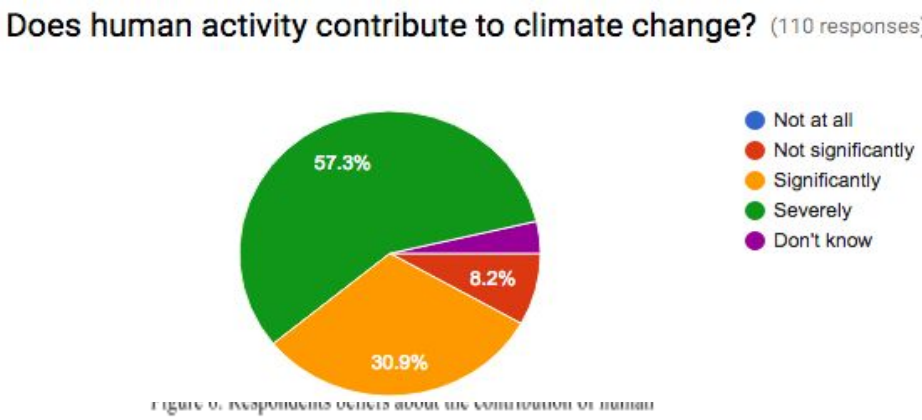


Figure 5. Respondent's beliefs about the threat of climate change to global community

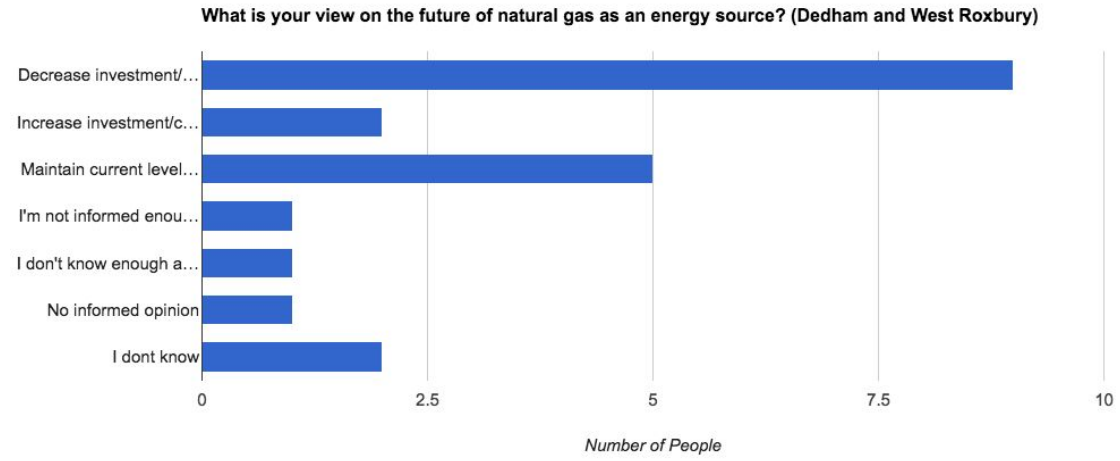
Across all three communities we found that the majority of respondents believe that human activity severely contributes to climate change, as can be seen in Figure 5. Figure 6 shows that the

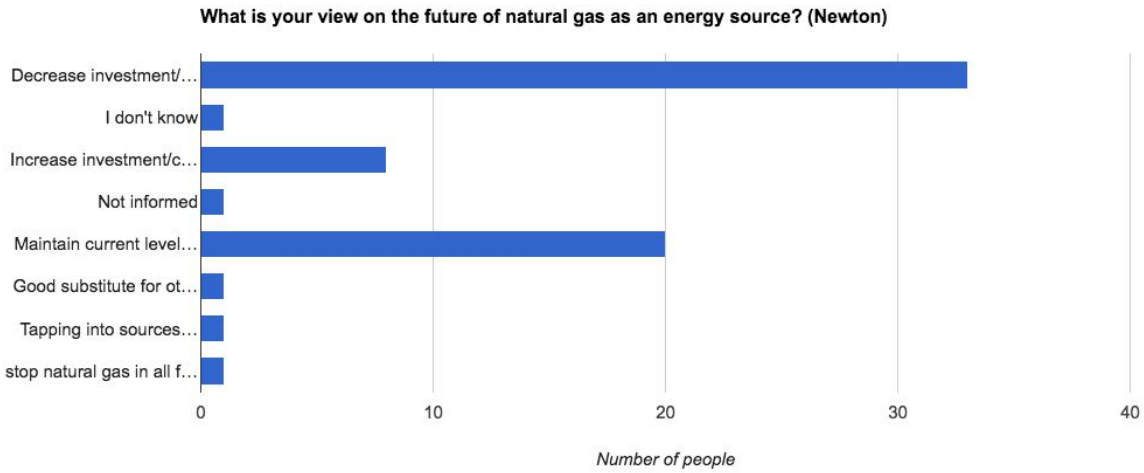


activity to climate change, measured as a percentage

majority also believes that climate change poses a serious threat to the global community. However, only half (49.5%) of people believed that we should decrease investment/ consumption of natural gas, while 40.3% of the respondents either thought that we should maintain or increase current level of investment in and consumption of natural gas. The number of people who think we should decrease investment in natural gas was even lower (43.6%) when we looked at the communities with pipeline construction on their own.

Figure 7 (Top). Respondent's view on investment of natural gas as an energy source (Dedham/West Roxbury)
Figure 8 (Bottom). Respondent's view on investment of natural gas as an energy source (Newton)





The comparison between feelings of natural gas as an energy source in communities with pipeline construction (Dedham and West Roxbury) compared to a community without construction (Newton) can be seen in Figures 7 and 8. This finding was somewhat inconsistent with the fact that 84.6% of people in Dedham and West Roxbury would like their elected officials to fight against pipeline construction. Differences also emerged between Dedham/West Roxbury and Newton when residents were asked about their current feelings toward natural gas as an energy source. Over 70% of Dedham and West Roxbury residents felt very negative or somewhat negative, while only just over 53% felt that way in Newton, which can be seen in Figures 9 and 10.

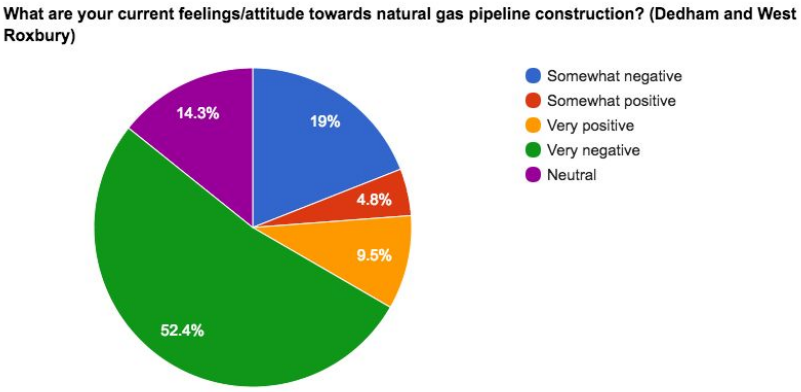


Figure 9. Dedham/West Roxbury respondent's current feelings toward natural gas pipeline construction, measured as a percentage

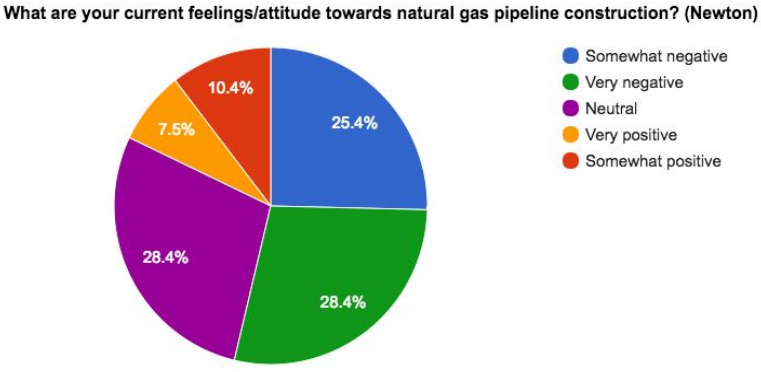


Figure 10. Newton respondent's current feelings toward natural gas pipeline construction, measured as a percentage

When we asked respondents to give a reason why they supported or opposed natural gas pipeline expansions several themes emerged, 65 people out of 84 people who responded to this section gave reasons why they were opposed to the pipeline. The different reasons why they were against the pipeline can be seen in Table 1. Most people did not want pipeline expansion because of reasons revolving around safety.

Reasons for pipeline opposition	**Percent of opposition stating reason**
Safety	43.1%
Negative long-term environmental impacts	23.1%
Better alternatives	21.5%
Too close to home	7.7%
Gas will be used for export	4.6%

Table 1: Respondent's reasons for pipeline opposition

ANALYSIS

We hypothesized that the residents of Dedham/West Roxbury would have greater awareness on issues related to pipelines and their negative environmental and economic consequences due to the construction of the Spectra Algonquin Pipeline in their community. Alternatively, we hypothesized that the residents of Newton would have less awareness and therefore a more favorable opinion on high-pressure natural gas pipelines.

Interestingly, residents in the area of pipeline construction were not overwhelmingly opposed to maintaining/increasing natural gas investments. However, the residents of the same community answered with almost an 85% majority that they wanted to see their elected officials

fight against the construction of the pipeline. These two juxtaposed facts, along with the primary concern of "Safety" mentioned in Table 1, indicate that while climate change is a concern of these communities, the primary reason for opposition within the Dedham/West Roxbury communities is the short-term environmental health impacts. This fits in with our hypothesis because these communities feel directly and tangibly threatened, with a prevailing sentiment of "Not in My Backyard" fueling their ongoing protests. While communities would like to see their officials opposing the pipeline, Marla, a community activist interviewed for this project, noted that the Federal Energy Regulatory Commission (FERC) has the main jurisdiction over these HPNGP projects, further adding to the frustration and feelings of powerlessness of the community. However, in Newton, residents are less likely to have formed opinion on HPNGP construction, and in fact are more likely to be in favor of natural gas, because it does not pose a direct threat or disruption to the health, environment, or economics of their community. Overall, awareness and knowledge in both communities exceeded our expectations, showing the strengths and dynamics of already existing awareness campaigns as well as growing networks of knowledge of the harmful effects of natural gas transmission.

CONCLUSION

In the process of conducting this study, student researchers gained valuable experiences connecting with various community leaders in different communities in order to reach the general population. From these efforts, researchers were able to distribute the research survey and interview leaders alongside gathering background literature on the complex issue of High-Pressure Natural Gas Pipelines.

Because the sample size was relatively small for the populations we wished to survey, statistics and data extrapolated from collected survey responses are not necessarily statistically relevant in regards to the entire population. Future directions for this research project would attempt to address this issue, potentially using in-person rather than online listserv survey methods, in order to obtain as many survey responses as possible for statistically relevant data able to be used by Boston and Massachusetts leaders during their decision-making processes. Given the recent shutdown of the Kinder-Morgan natural gas pipeline, an endeavor similar to that of the Spectra Algonquin, future research would be potentially geared towards analyzing movements, policies, and investment decisions that result in the death of these projects.

The researchers have found that new natural gas pipelines are unwanted by the local population, carry with them a great deal of risk, and may not even be necessary for the energy needs in Massachusetts. Based on these findings we recommend that the wishes and safety of the people, along with the recommendations of local officials should be put into more consideration than the profits of the natural gas companies. It is clear that the communities in which pipeline construction is occurring have more knowledge and more negative opinions of natural gas pipelines and natural gas as an energy source than those who are not experiencing construction. It is important going forward to raise awareness and knowledge in a greater portion of the population to promote widespread support for safer and cleaner sources of energy. The only way to help citizens in communities such as Dedham and West Roxbury who are being directly affected by pipeline construction is to get more people behind the movement away from natural gas and make federal officials and energy companies rethink their support.

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APPENDIX

Survey: A copy of the questions distributed through a Google survey (110 responses)

1. What community are you a part of?
    a. Dedham
    b. West Roxbury
    c. Newton
    d. Other

2. What is your age? _____

3. Gender? M F Other

4. Race/Ethnicity
    a. White/Non-Hispanic
    b. African American
    c. Hispanic
    d. Asian/ Pacific Islander
    e. Native American
    f. Other

5. What is your political identity
    a. Very Conservative
    b. Somewhat Conservative
    c. Moderate
    d. Somewhat Liberal
    e. Very Liberal
    f. Other

6. How serious of a threat does climate change pose to the global community?

    1----------2----------3----------4----------5
    Not at all serious Very serious

7. Does human activity contribute to climate change?
    a. Not at all
    b. Not significantly
    c. Significantly
    d. Severely
    e. Don't Know

8. What is your view on the future of natural gas as an energy source?
    a. Increase investment/consumption in natural gas
    b. Maintain current level of investment/consumption in natural gas
    c. Decrease investment/consumption in natural gas
    d. Other

9. Are there any major pipelines planned for construction in your community?
    a. Yes
    b. No
    c. Not sure

10. What are your current feelings/attitude towards natural gas pipeline construction?
    a. Very negative
    b. Somewhat negative
    c. Neutral
    d. Somewhat positive
    e. Very Positive

11. What is your primary reason or rationale for either supporting/opposing natural gas pipeline expansions?

_____

12. In regard to your elected officials, would you like them to encourage pipelines, fight against them, or not play any significant role?
    A. Fight for pipeline construction
    B. Fight against pipeline expansion
    C. Not play a significant role in pipeline expansion

13. Any other comments regarding Massachusetts's natural gas pipeline construction and impacts.

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