Modeling the Implications of Fugitive Gas Emissions on Building Heat Upgrade Decisions

(Technical Paper)

Reducing Net Carbon Emissions: Role of the United States in the 2015 Paris Agreement

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

If there is no change to the current trajectory of carbon emissions, the world will experience widespread devastation and extreme weather within the next two decades due to climate change (Harvey, 2021). Emissions of gasses such as carbon dioxide, methane, nitrous oxide, and fluoride gasses are the causes of this great concern. The proportion of economic sectors that contribute to climate change are 25% electricity and heat production, 21% industry, 24% agriculture and other land use, 14% transportation, 6% buildings, and 10% miscellaneous causes (*Embodied Carbon Call to Action Report*). Climate change is detrimental due to loss of crops and food security, rise in sea level, and increase of extreme climates-- droughts, floods, natural disasters. In order to curb permanent damage to the environment and avoid devastation, 190 countries gathered to make the 2015 Paris Agreement which aimed to limit global warming to 1.5°C. Climate change is an issue at an international level. It is insurmountable by a single country; it necessitates the cooperation and active participation by all world powers. As a citizen of the United States, it is imperative to hold policy makers accountable and stay informed.

Part of the proposed STS study is to look at what the United States has done and plans to do to abide by the Paris Agreement and help less fortunate countries. The rate of change to avoid permanent damage from climate change is demanding and currently, it is not happening fast enough. The government has attempted to reduce the carbon footprint via legislation but due to logistical hurdles, there has been too little change over a long period of time. It falls onto smaller entities to pick up the slack. Innovators, engineers, political activists, and smaller entities must find and implement their own solutions; this includes individual universities. As students at the University of Virginia, it is beneficial to know how we can make more mindful decisions when using University owned buildings and laboratories. In an effort to combat this at the University level, UVA has tasked every school to come up with a plan to be net-zero— negate greenhouse

gasses emitted— within ten years. This capstone project looks specifically at the School of Engineering and strives to find building designs and improved HVAC systems among other solutions to reduce UVA's carbon footprint and gas emissions.

Technical Topic

This research looks at the electricity and heat production and building portions of the economic sector which is responsible for 31% of all gas emissions collectively (*Environmental Protection Agency*). A report from the World Green Building Council announced that every building on Earth must be net zero by 2025 in order to maintain global warming below 2 degrees Celsius. An abundance of research on the topic is imperative if the UN hopes to meet their Paris Agreement target of 1.5 degrees Celsius. Big building complexes in urban areas, such as those at the University of Virginia, are the center of attention towards a transition to a net-zero building industry.

In an effort to narrow the perspective, this study looks at the building emissions through an embodied and operational scope. Embodied emissions are the greenhouse gases that are emitted during the manufacturing, installation, maintenance, and disposal and transportation of materials during the building process. This type of emission is less applicable in the study of University of Virginia because the school is not constructing new academic buildings, but is focusing on reducing operational emissions of preexisting buildings. These emissions pertain to the day-to-day upkeep and use. Using tools to model both types of emissions, the capstone group will strive to identify sectors that contribute to the most gas emissions and find solutions to reduce it.

Another portion of gas emissions that will be viewed pertains to the heating aspect of buildings. A pre-existing issue is methane leaks. According to the Environmental Defense Fund, the U.S. oil and gas system leaks an average of 2.3% of all gas produced. Although the switch

from coal to gas hypothetically drives down carbon emissions, the leakages within the system negate the positive aspects of methane. Leaks occur in the gas wells, gas processing plant, commercial users, and residential users of the transportation process. This research will look at enabling a more systems-oriented efficiency approach with increased connectivity between users and the electric power grid.

Working with the UVA Delta Force and Green Labs team, this capstone group will use their data to look at the carbon intensity of materials in the use and operation of buildings. Some aspects to focus on include energy efficiency within buildings, billing and restrictions on usage, and management of different inputs and outputs to a building-- air circulation, division of tenants within a building, and materials used in a building. By looking at the full life cycle consumption for a building, this research will work with a green building engineering company, Integral Corporation, to find solutions to reduce carbon emissions in the everyday use of UVA buildings.

The aim of this group is to create two models that will reflect the effect of changes made in methane usage and systems. The first model relates to the financial benefit of changes in methane consumption. By analyzing the ROI (return on investment) and GHG (greenhouse gas) output, the model will help the financial portion of the consumer's decision making for different methane systems. The second model considers environmental impact by examining GHG policy and operations, therefore affecting the eco-friendly aspect of the consumer's decision making.

STS Topic

Environmental issues are growing to be major topics of international debate. Global warming, deforestation, desertification, acid precipitation, and air pollution are among some of the concerns that are worsening at alarming rates. While individual principalities may attempt to tackle environmental problems themselves, many of the climate concerns regard common pool resources that are not owned by one single nation. Global warming is not an issue that affects a

single country; it transcends borders and demands international collaboration (*International Environmental Problems and Global Search for Solutions*). In an effort to combat this, almost 190 nations gathered in Paris to sign the first universal, legally binding global climate change agreement. The Paris Agreement aims for climate-neutrality by the end of the century. More specifically, the signatories will collaborate to limit global warming to 1.5°C and richer, more powerful countries will aid other countries with their resources and technology (*Paris Agreement*).

Although the United States is at fault for emitting the most cumulative carbon dioxide into the atmosphere, the Trump administration ceased participation in the 2015 Paris Agreement. In response, U.S. states, cities, businesses, and universities committed to the reducing carbon footprint with "America's Pledge." The main goals are to collect data on non-national climate action, communicate research and data findings, and catalyze further action. The most recent data analysis showed a positive increase in changes regarding electricity. The bottom-up leaders invested in renewable energy and storage and grid modernization. Transportation has greatly improved as funding for public transit and electric vehicles went up. Methane and HFCs improved as well with advanced clean-up for idle or abandoned infrastructure and consumer efficiency incentives. The only category that has not seen any change are buildings (*Delivering on America's Pledge*). Under President Biden, the United States rejoins the agreement via an executive order (Mai, H). Although this plan still needs to be approved by Congress, the Biden administration aims be in accordance with the Paris agreement by decarbonizing the power sector by implementing a Clean Energy Standard and investing $65 billion to modernize the power grid. To improve the transport sector, the goal is to make half of all new vehicles sold to be zero-emissions vehicles. There will be stricter fuel efficiency and emissions standards (*Policies & Action*).

Technological fix is applicable in the study of America's role as global leader and its effect on zero-net emissions since the 2015 Paris Agreement. Technological fix is technology that exists to solve certain problems caused by a larger root problem but does not directly address it. The STS framework is limited in its effectiveness because it is unable to stop the same issues from occurring in the future. Unfortunately, this research embodies this framework by thinking of solutions to limit the effects of gas emissions, but not completely solve the issue of climate change. There is no way to eliminate all emissions or to avoid creating any. Instead, this project works towards finding solutions and tools to minimize methane waste and to increase energy efficiency. The issues range from operational and embodied emissions to emissions from methane leaks. These solutions "fix" the issue of carbon emissions for the short term but do not completely halt emissions. Therefore, a technological fix will need to be monitored once implemented in order to maintain control over the main issue and avoid it.

An example would be energy production. 35% of all global emissions are attributed to energy production (Yaniz, 2017). America cannot completely cut global emissions and reverse all the effects of climate change, however, governments and smaller entities are finding new ways to tackle emissions and reduce the effects of energy production. Small wind, solar, geothermal, and oceanic energies are technological fixes that try to mitigate the problem. It is not the solution to climate change because it does not absorb preexisting emissions.

Conclusion

The implications and potential future risks of climate change is an international issue that demands immediate action. Policymakers in the 2015 Paris Agreement attempted to tackle this problem head-on by setting an ambitious goal of limiting climate change to less than 2 degrees Celsius. This paper looks specifically at the role of the United States in the global effort to halt the effects of Climate change caused by gas emissions. This research is further narrowed to look

at what happens at an even smaller scale. The UVA School of Engineering is in need of a 10 year plan that will cut building emissions to zero. Using modeling tools, this team will attempt to identify problem points within existing buildings and find solutions to address them. This new perspective will then be brought to the UVA team responsible for bringing the Net-Zero Plan to fruition.

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