

Thesis Project Portfolio

Modeling the Implications of Fugitive Gas Emissions on Building Heat Upgrade Decisions
(Technical Report)

Reducing Net Carbon Emissions: Role of the United States in the 2015 Paris Agreement
(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The purpose for both the technical report and the thesis paper was to research what strategies are being taken to mitigate greenhouse gas emissions that contribute to climate change. The long-term shifts of climate change in temperature and weather are becoming increasingly concerning and can be detrimental to the environment unless drastic measures are taken. The thesis paper outlines the Paris Agreement of 2015 and specifically studies the initiatives America is taking and the technology that exists to meet the goals set by the international treaty. The technical report introduces an example of the use of technology in decreasing greenhouse gas emissions: a gas emissions calculator. This tool incorporates different factors that affect the gas emissions from heating systems in building upgrades, helping building owners make environmentally informed decisions.

The University of Virginia Life Cycle Cost Calculator that evaluated the emissions and finances throughout the life cycle of heating systems was used as the building block for the Capstone project. The preexisting tool analyzed buildings with the preimposed notion that it used natural gas. However, the extreme potency of the greenhouse gasses that are a product from using natural gas have instigated research into finding an alternative. The introduction of all-electric heating alternatives or 'certified' or 'renewable' gas alternatives complicated the emissions and economic profiles of building upgrades. These factors were incorporated into the new model made by the Capstone group so that stakeholders had an accurate, holistic scope of the lifetime of heating systems and can find the alternative that suited their economic and environmental needs. The tool currently being used by UVA also disregarded the fugitive emissions that result from leaky infrastructure. Fugitive emissions differ depending on the pipe

material, age of pipe, etc of the natural gas distribution lines. The data used in the Capstone tool came from all the major metropolitan areas in the United States and can be adjusted to a specific city. Taking fugitive emissions into consideration will give decision makers more accurate estimates of the emissions over the lifetime of a heating unit. Users can input various heating systems into the tool to find the impact each has on economic factors (return on investment, estimated lifetime cost, etc.) and environmental factors (carbon dioxide-equivalents avoided per year, lifecycle greenhouse gas emissions, etc). Ultimately, this new tool assesses capital expenditures with location-specific fugitive emissions and cost estimates as well as full cost-accounting of both the economic and greenhouse gas emissions associated with different heating options.

Before 2015, there were multiple efforts from national governments to cooperate in a movement to become more carbon neutral but all were in vain until the Paris Agreement. The legally binding treaty produced in the aforementioned convention was unprecedented in that the goals and expectations set were unilaterally agreed upon by 190 countries. This climate change treaty covers climate change mitigation, adaptation, and finance. The most notable goal of the treaty is that it promises to limit global warming changes to under 2 degrees Celsius and become carbon neutral by midcentury. The thesis paper studies climate change in the lenses of the main sectors in the United States that contribute the most emissions annually: electricity and heat production, industry, agriculture and other land use, transportation, buildings. The current research and existing technologies that may be a solution to mitigating greenhouse gas emissions that pertain to each sector are enumerated in the paper. These engineering solutions are studied using the technological fix STS framework. Climate change is an issue that cannot be undone.

There is no way to extract the gasses that have already been emitted into the atmosphere, therefore, technological fix is the best strategy to tackle these negative environmental effects. It will not completely 'cure' climate change, but it will curb the effects and avoid worsening the problem.

Although government intervention and regulations are the most standard routes to achieve carbon neutrality and reduction in greenhouse gas emissions, smaller entities hold great potential for change. The research done in the technical and thesis paper highlights the development of new tools that are more environmentally friendly. It is up to smaller entities to adopt and implement these changes. Smaller entities can take initiative by finding existing or inventing technological alternatives that work more efficiently and emit less greenhouse gasses into the atmosphere. With all the main sectors switching to eco-friendly alternatives, the accumulation of these changes can make a significant impact on cutting emissions and help America meet the goals set out by the Paris Agreement of 2015.