Sustainable Carbon Reduction Policy

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I. Executive Summary

This policy paper discusses the environmental consequences for increased carbon emissions, and how the State College Borough can implement a plan that will help reduce the town's CO2 output. This document was made in support of the United Nations Sustainable Goals eleven and twelve, which are "Sustainable Cities and Communities" and "Responsible Consumption and Production" respectively.

This document explores the effects of carbon dioxide emissions in the atmosphere and how it is a major cause for global warming. Last year the amount of carbon dioxide in the atmosphere reached an all time high, and scientists believe that communities need to come together to formulate a plan on how to reduce our carbon footprint.

In order to understand how to a create a policy that is not only feasible but also effective, research was conducted on past policies that aimed to reduce carbon emissions.

After review of these policies, it was determined that the effective strategy to measure carbon emissions is to focus on fossil fuels. Because fossil fuels are the primary source of carbon emissions that America struggles with, this policy paper measures fossil fuel sources in three areas. These areas include electricity production, natural gas usage, and transportation fuel usage.

The policy holds businesses accountable by making them responsible for reporting their electricity, natural gas, and transportation fuels consumption. Following this, the businesses would be assessed through various methods to determine their individual level of sustainability. The amount of CO2 a business produces effects how the carbon reduction policy would affect them.

Even though the State College Borough would benefit from our policy, we understand that implementing a tax on the state, county, and borough level is complex. Since carbon

emissions are accelerating at such an alarming rate, it is imperative for State College to take initiative.

II. Introduction and Background

The drastic increase of carbon dioxide emissions into the atmosphere is the major cause for global warming today. Carbon dioxide is one of the greenhouse gases that is emitted into the atmosphere by burning fossil fuels for heat, electricity, and transportation ("Overview"). Greenhouse gases warm the the Earth by absorbing energy and slowing the rate at which energy escapes to space; they essentially act like a blanket that insulates the Earth by keeping temperatures above average ("Greenhouse"). Even though carbon dioxide is a natural component of the atmosphere, it has increased by approximately 30% since the Industrial Revolution making it exceed its natural amount at an unfathomable rate ("Effects"). In 2016, the amount of carbon dioxide in the atmosphere broke a record of 400 parts per million making it the hottest year since records started in 1880 (Yale). According to environmental scientists, this record breaking number has served as a clear red line into a dangerous area of climate change that we should all be seriously concerned about.

Annemarie Eldering, The Deputy Project Scientist for NASA's Orbiting Carbon Observatory-2 Satellite Mission at the Jet Propulsion Laboratory said that, "Passing this mark should motivate us to advocate for focused efforts to reduce emissions across the globe (Jones)"

This is a significant problem that is going to have detrimental effects for every region of the world, and we need to take action now. Climate scientists say that with the current rate of growth in carbon dioxide levels we are on track to hit 500 parts per million within the next 50 years. Reaching 500 parts per million of carbon dioxide in the atmosphere will cause us to see temperature increases of more than 5.4 degrees Fahrenheit. Having 500 parts per million of carbon dioxide in the atmosphere would cause such extreme weather conditions and sea level rise that would endanger global food supplies, and possibly destroy the Amazon rainforest due to

droughts and fires (Jones). This amount of carbon dioxide would be catastrophic to many living organisms on planet Earth.

Dr. Erika Podest, a Carbon and Water Cycle research scientist explained how vital it is for us to be proactive about decreasing carbon emissions when she stated, “This milestone is a wake up call that our actions in response to climate change need to match the persistent rise in CO2. Climate change is threat to life on Earth and we can no longer afford to be spectators (“Climate Change)”

Emissions of carbon dioxide into the atmosphere started to significantly increase during the 1950’s with 5 billion tons of carbon dioxide emitted every year (Jones). Today we are emitting 35 billion tons of carbon dioxide into the atmosphere per year. This is a 700 percent increase in less than 70 years. One of the catalysts for a significant increase of carbon dioxide emissions was the Industrial Revolution. For approximately 10,000 years before the Industrial Revolution ice cores show that CO2 stayed between 180 and 290 ppm. Now we are at 400 ppm and on our way to 500ppm (Jones). CO2 emissions are rapidly accelerating and if we don’t take action now, we will reach a place of no return. Having such a high percentage of carbon dioxide in the atmosphere has already caused desertification, stronger storms, and extreme weather events (“Effects”). We are already experiencing the consequences of increased carbon emissions and remaining complacent on the issue will only exacerbate the issue.

Because the largest contributor for greenhouse gas emissions is carbon dioxide we believe that implementing a carbon tax in the State College Borough will reduce these emissions, and therefore force businesses, restaurants, hotels, and Penn State buildings to reduce their carbon footprint. Because State College is such a prominent area due to it harboring a

world-renowned university, we believe that implementing a carbon tax will also encourage not just other universities, but cities and towns from across the country to start thinking about their carbon footprint. Refusing to take action to reduce carbon dioxide emissions will result in a significant increase in taxes to pay for infrastructure damage due to extreme weather events, as well as threaten human life as we know it.

III. Literature Review

3.1 PAST POLICIES

The recommendations that will be provided herein after draw on the powers and governances at the different levels of government that exist within the Commonwealth of Pennsylvania, specifically, focusing on State, Centre County, and the State College borough. On a county level, the largest taxes that are authorized by the state are related to property. This is handled by the Centre County Assessment Office. Properties are valued using the method of appraisals in which it is assigned a market value based on several metrics, including location, land amount, structure age, etc. Additionally, appraisals are made to be uniform so that taxation on constituents within the county is fair. On this subject, the county has previously passed and has continued to enforce particular acts that alter how an appraisal is conducted. In particular, recall the Act 319/156 Clean and Green preferential assessment program. This program is designed to encourage the continued use of land devoted to agricultural use, agricultural reserve use, and forest reserve use by giving preferential assessment on these properties. This preferential assessment results in the property being assessed for its use rather than the fair market value which is a net reduction in the property tax. While this is the only policy of its kind at the moment, this could be expanded to incorporate objectives of the government.

3.2 MODELS

To implement this policy, several models of other universities and cities that have done similar projects have been looked at. These models have built foundations of a successful carbon tax policy and two of such models are Yale University's policy and British Columbia's policy.

Yale's Policy includes an implemented internal charge on the emissions of carbon dioxide. It has defined a baseline of carbon use by comparing the energy data of its buildings throughout its history. The metric that Yale University uses is based on the emissions of its campus as a whole and is backed up by years of carbon dioxide emission tracking. If a building increases its emissions at a rate that is the equal to the emission rate of the university as a whole, it is not affected by the carbon tax. Next, if a third building produces more emissions than Yale, then it must pay into the tax pool. This discourages buildings from using as much energy as well as funding the last group of buildings. Finally, if another building does not increase its emissions as much as Yale as a whole, it receives money back from the tax pool. These additional revenues can be spent as needed and are often used to make the building more sustainable (Jones). Yale's Policy serves as a model because it has been done on a comparable scale to that which we are trying to produce. It is also a simple concept to understand and implement. The hindrances of this policy is the lack of historic data per building at the University Park campus. Installing measurement devices and recording accurate data would need to occur before a baseline could be implemented on campus alone, this does not include the struggles of organizing and enforcing the same policy within the rest of the borough.

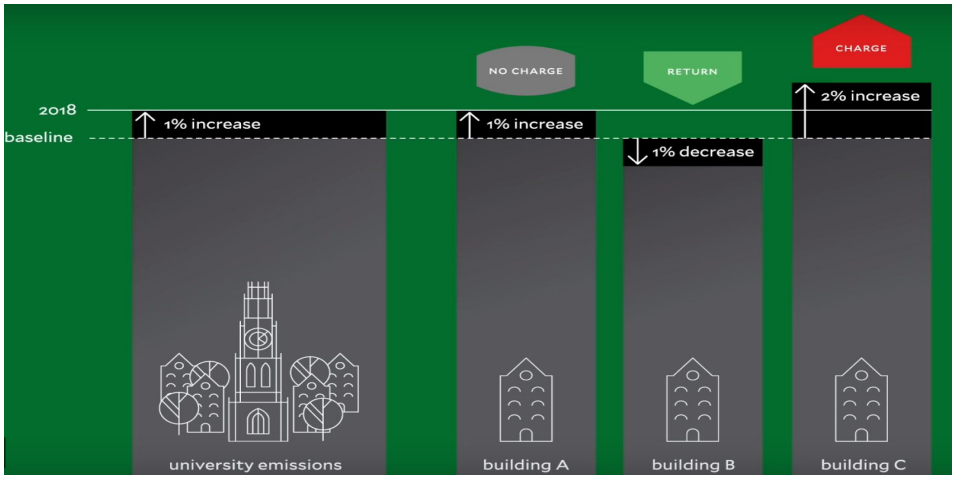

Figure 1. Yale's depiction of its carbon policy model on the buildings of its campus (Shelton, "Yale Lunches..").

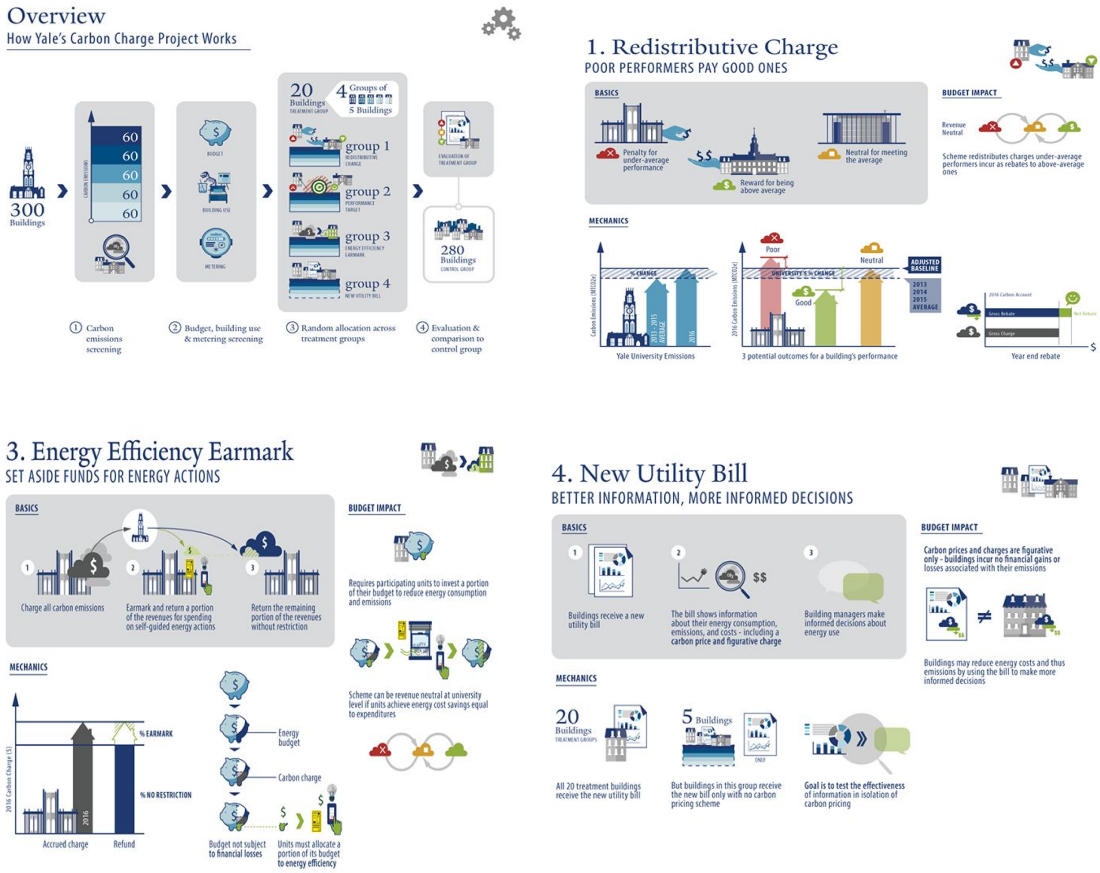

Figure 2. The overview of the processes and how Yale's carbon policy works regarding its the redistribution changes, energy efficiency enmarks, and its new utility bill (Shelton, "Yale Introduces…").

In addition to Yale, British Columbia's policy was also taken into consideration to create this carbon reduction policy. British Columbia introduced a revenue-neutral carbon tax in 2008, which covers about 70% of its total greenhouse gas emissions. In 2008 the tax rate started at $10 per tonne of carbon dioxide equivalent emissions and as each year passed on the rate had been set to increase by $5 per tonne until it reached the rate of $30 per tonne in 2012. This tax targets the following fuel sources: Gasoline at 6.67¢/litre, diesel at 7.67¢/litre, and Natural Gas at 5.70 ¢/cubic meter (Environment). Likewise, in part of the the next section, calculations has been done regarding Pennsylvania's fuel usage.

IV. Methodology

4.1 MEASUREMENT

1 - Electricity

Property usage of electricity can be appropriately measured through the metered connection to the grid. The responsibility of managing these rates of usage is done through the local utility. These rates, which are reported on monthly statements and can easily be assessed, can be converted to the estimated quantity of carbon dioxide produced. To do this conversion, data from the Energy Information Administration Table A.3. can be used, which can be viewed in Appendix B-1.

Pennsylvania has the following breakdown of electricity generation sources, with those denoted as fossil fuel based bolded:

- **Petroleum-Fired: 75,000 MWh**
- **Natural Gas-Fired: 4,621,000 MWh**
- **Coal-Fired: 5,476,000 MWh**
- Nuclear: 7,619,000 MWh
- Hydroelectric: 197,000 MWh
- Non Hydroelectric Renewables: 512,000 MWh

This data was taken from the Pennsylvania Net Electricity Generation by Source, Dec. 2017 chart, provided by the EIA, which can be viewed in Appendix B-2.

With this data, calculations can be made on the amount of CO2 that is produced from fossil fuel sources for electricity generation. Calculations were performed to determine the appropriate conversions for the previous sources to determine the effective Carbon Dioxide

outputs. These conversions can be viewed in Appendix B-3. It was determined from the data that for every 1 kWh consumed in Pennsylvania from the traditional electricity supply, approximately 0.14 kg or 140 grams of CO2 are produced.

2 - Natural Gas

Data was taken from the EIA, for natural gas conversion to CO2. The conversion information can be found in Appendix B-4. Through these calculations, it was determined that for every 1 CCF of Natural Gas used, it produces 26.748 kg of CO2.

3 - Transportation Fuel

Conversion of transportation fuel was done by relation of gallons to British thermal units (Btu). This was then paired with data from the EIA to determine the appropriate amount of CO2 produced. This conversion process can be viewed in Appendix B-5. The calculations revealed that every 1 Gallon of Diesel produces 48.88 kg CO2 and every 1 Gallon of Gasoline produces 41.75 kg CO2.

Summarization of Measurement

The following is a chart created from the conversions and calculations of the above section. This chart is important as it allows for the easy conversion from electricity, gas, and fuel, to kg of carbon dioxide emissions.

EQUIVALENT CO2 CONVERSION CHART FOR PENNSYLVANIA (data from EIA)		
Source	**Unit**	**Equivalent CO2**
Electricity (non-renewable)	1 kWh	0.14 kg CO2
Natural Gas	1 CCF	26.748 kg CO2
Diesel	1 Gallon	48.88 kg CO2
Gasoline	1 Gallon	41.75 kg CO2

Table 1. Equivalency chart for various CO2-emitting sources with common units to allow for easy conversion.

4.2 ENFORCEMENT: COLLECTION OF DATA FROM BUSINESSES

The selection of the units for the equivalent CO2 conversion chart generated were purposeful, as they match what common utility/ municipalities use for their own measurements. Businesses would be asked to self-report their usage of the listed sources, and would also submit necessary supporting material if needed to verify. The three metrics can undergo verification through the following methods.

Verification of Electricity consumption:

Electricity consumption can be monitored through submission of electricity usage statements, which are given out every billing period by the electricity utility. These statements would list the amount of electricity consumption for the time period, usually done in kWh, which would be converted to the equivalent CO2 quantity as shown in the chart. A request to turn in electricity

usage statements along with the business self reporting their electricity usage would serve as means to confirm that the entity is being truthful with what is being reported.

Verification of natural gas consumption:

Similar to electricity consumption, natural gas usage can be verified through account statements as well, measured usually in CCF.

Verification of transportation fuels consumption:

Verification of transportation fuels can be accomplished by requesting vehicle records, of both current vehicle mileage and make/model of the vehicle(s). A simple fuel mileage calculation that can be done between reported vehicle records can be compared to the self-reported fuel amounts to determine if they are in an approximate close range to each other. If these two reports do not line up, further action can be taken against the offending business.

In all three of the verification methods, if the self-report is not aligning with the provided materials, the businesses can be investigated for fraud and tax/compliance evading.

V. Results

Past policies have shown the state has some level of influence on the development of member counties and in particular Center County. The most important taxes have to be authorized by the state and the ones currently in place are related to properties. Property appraisals provide room to modify the assessment criteria so to include sustainability requirements as this would help influence the development in the State College Borough to be more sustainable.

Several models have been looked at that serve as a reference point for a policy such as a carbon tax. The two models which were assessed were Yale university's carbon charge policy and British Columbia's revenue neutral carbon tax. Yale's policy provided both incentives and taxes to buildings in it's campus depending on the amount of CO2 emissions the buildings produce. Building which receive revenue due to low carbon dioxide emissions typically reinvest the money to employ more sustainable practices. British Columbia focused more on reducing taxes on desirables like income tax and increasing taxes on non desirables like fossil fuels.

Once these models had been assessed there was a need for a model that the State College Borough could use to determine how much CO2 is being emitted and from there determine how much of a tax is needed. Several data was acquired from the Environmental Impact Assessment and was used to calculate the amount of CO2 emitted from three main categories, electricity production, natural gas usage and transportation fuel usage. In December 2017 alone 2,598,777,530 kg of CO2 were produced from power plants in Pennsylvania that use fossil fuels as a means of energy. Further calculations revealed that 1 CCF of natural gas produces 26.748 kg of CO2, 1 gallon of diesel produces 48.88 kg of CO2, and 1 gallon of gasoline produces 41.75 kg of CO2.

All these measurements serve as baseline to determine the level of emissions in the State College Borough. The next step is to have Businesses self report their emissions and several strategies will be used to verify the reported data. Some of these strategies include comparing the reported data to already existing data to see if there is a correlation between the data which would help verify if the data is genuine

or not. Businesses that provide false data would have to face penalties that pertain to falsifying data or even tax evasion.

VI. Policy Options and Recommendations

This section focuses on possibilities and recommendations for lowering carbon emissions and maintaining a sustainable community. The recommendations have a range based upon implementing power and legality and therefore have been divided into three major subsections: borough, county, and state. Each of the subsections contains unique ideas and plans that may be used at a future time with the proper team of legal experts. The goal is ultimately to tax carbon usage for businesses and various buildings in the State College area and other areas across Pennsylvania so sustainable lifestyle choices are favorable for everyone.

To begin, it is important to include the first idea and the reason this current policy exists. Originally, it was proposed to implement a carbon tax on all of State College, including the downtown borough and its businesses. After some research and meetings with leaders like Mayor Hahn (Mayor of State College) and Dr. Sylvia Neely (member of Citizens' Climate Lobby) it was decided that, realistically, a policy to implement a tax would need to be state-level. Instead, the idea was broken into three levels of recommendations for future policies that may be executed by the borough and those who have the power to make change happen.

6.1 STATE LEVELS

According to Mayor Hahn, the borough of State College does not possess the power to impose any tax on residences and businesses downtown without state legislation approval. With this in mind, the borough does have the power to strongly recommend a tax to the state legislation and provide evidence to support why the tax would be a good idea. The group felt that having the borough recommend a carbon tax would be much more likely to pass on the state

level than having this policy pass on the state level. Therefore, this policy is dedicated to giving high quality recommendations and ideas for future implementation in the borough's policy for the state.

Current Problems

As stated in the introduction and exemplified through tables, charts, and figures, carbon emissions are harming the environment and State College is playing a role. The borough is currently operating under an "Environmental Stewardship" which states the borough's goal of "educating its employees and residents on sustainable practices." Many of the outlined goals include "strongly encouraging" a group to abide by many outstanding recommended ways of living to be more sustainable. Until now, this was the best way to hope for a sustainable community. Educating the residence and employees can be very helpful in reducing emissions, but the group has an idea that is not optional for anyone; a carbon tax.

Benefits and Solutions

A carbon tax would not only put all businesses downtown on fair terms of taxation based on building/business type, but it would also allow greener/more sustainable businesses the opportunity to be competitive in the market. The tax would be selective toward green businesses and encourage those with non-sustainable practices to reevaluate ways to be more cautious with their carbon usage. This tax would not just span over the borough of State College but also include Penn State University and its businesses and buildings on campus. The group feels this

idea will be successful based on the ideology that including a financial burden as a consequence for bad sustainable practices will make individuals more accountable for their actions.

Large buildings and properties tend to emit more carbon because of energy needs such as electricity, natural gas, and transportation fuel. Highlighted in the "Methodology" section are conversions for every different type of building, business, property, etc. that tell how much carbon is directly being emitted from electricity, natural gas, and transportation fuel. Having these conversions can help to calculate the levels of carbon emission coming from each different type of building, downtown and on campus, which will ultimately help to create an appropriate carbon tax to lower the calculated emissions. As mentioned in "Models", establishing a baseline is an important component for any of the following recommendations. This would require at least a years worth of data on CO2 emissions to be collected in the borough before the baseline could be chosen and the tax/ other policy to go into effect.

Another benefit to consider would be publicity. The United States has very few active carbon taxes however, the places that do include this tax are positively known for their sustainable living practices. Branding Penn State and State College with such a large change in the positive direction for the environment would benefit the University and the surrounding community. Families, either with potential students or who are considering moving into the area, would see the area's efforts at creating a greener and environmentally friendly campus and immediately have a positive connection to these locations.

Other Models

The idea of a carbon tax is very new in the United States and few places have successfully passed the tax through their state legislation. There are many states with big plans for the future of carbon taxation that would like to follow in the footsteps of other countries around the world with acting taxes on carbon emissions. California in particular has an active tax that the group wanted to research in order to find goals, proper steps in government, barriers, etc. Many articles suggest universities can stand as an excellent model for implementing a carbon tax on larger, state scales. Universities also provide a similar set up to city conditions by having many different buildings spanning a large range of ages and carbon usage ("Environmental Stewardship").

Yale University has been a main source of inspiration and information for having its own, functional carbon tax system on the buildings within the University. They charge their buildings when carbon emissions are calculated to be worse than previous historical records indicate for the building. More information was mentioned in section 3.2 of this policy paper. They have created a unique "carbon charge system" that works for the parameters of their campus only ("Environmental Stewardship"). State College could follow a similar structure and create its own unique carbon charge system.

6.2 COUNTY LEVEL

If the carbon tax recommendation were to be rejected, another route to lower emissions would be taken on the county level. The group decided a more feasible direction would be to find an

existing tax on businesses and buildings and add a sustainability component to the clause of the tax. This way, creating an entirely new tax and hoping it will be accepted by the Pennsylvania Legislation is no longer a concern. After research and discussion, the group decided adding a sustainability component to a property tax would be the most beneficial and easiest to integrate smoothly.

Property Tax and Appraisal Modification

An appraisal for property taxes is used to evaluate how much a property should be taxed based on its value. Value can be defined by many different aspects such as how modern the property's architecture is, where the property is located in town, how large the property spans in a given area, etc. Given this, another value that should be included in this appraisal assessment is a component on sustainability. A property with higher rates of sustainability, as measured using the defined metric, and lower carbon emissions should be taxed less than a property with the opposite. This would be accomplished by modifying the appraisal evaluation process in the tax policy, making sustainable properties more favorable to consumers. This would need to be conducted by the Centre County Assessment Office and would require assessors to have a training to learn the new assessment measures but the cost would be minimal. The main costs would be effective against those who do not work sustainably as they would feed the tax pool to make up for the lost revenue of those who receive the preferential assessment.

The process of evaluating carbon usage for each property would be the same as mentioned in the state level recommendation. Outlined in the "Methodology" section of the policy are conversions for specific individual buildings and properties that can be used to find

carbon emissions based on electricity usage, natural gas usage, and transportation fuel usage accordingly.

Clean and Green Act

The Clean and Green Act is "a preferential tax assessment program, that bases property taxes on use values rather than fair market values" which is primarily used to give land owners tax savings for owning valuable farmland. This is just one example of a modified tax assessment for property taxes that has been approved and used for years. A very similar ideology can be transferred to property taxes on all properties, not just those with farmland or forest reserves. There would be an effort to make all properties more sustainable with use of tax savings as the benefit for doing so. This would require working with the lobbying groups that represent farmers as they would be the main proponents against this preferential assessment being expanded, for it would benefit them less. To this point, increasing there benefits under the act could satisfy them and encourage them to support expansion of the policy.

6.3 BOROUGH LEVEL

Due to the large restrictions of local government by the state, Pennsylvania is very uniform on the borough level, severely limiting the policy that is able to be implemented. However, even here there is potential to implement similar policy to what we have proposed. By using the measurement metric above to assign a baseline and a gradient scale, the borough can offer incentives for businesses in respect to zoning. As much of the new construction in the area

is in commercial residential properties, this incentives could include higher density, such as an extra floor of height, and relaxed amount of mandatory parking. Additionally, many commercial residential properties are approaching a point in time where major retrofitting needs to be done for them to remain competitive, and thus similar incentives could be provided given they perform sustainable retrofitting that allows the property to operate above the baseline expectations. This would build onto policy written for the Commercial Incentive District Section 1855 for the borough of State College. This would fall under the borough planning and zoning department and would require working closely with them to drive support for this policy. This recommendation does not require a revenue source and thus has no major impact on taxes, lifting any burden off of the surrounding populace.

Another department that could be worked with is the borough tax administration. Under the New Home Construction Local Tax Abatement Act, the borough is able to give abatement of taxes on certain property improvements, in which the proposed metric could be an added function of this act. Other than this, tax policy in the Commonwealth of Pennsylvania limits the ability to offer a tax deduction directly for our proposal. However, to navigate this the borough could implement a rebate program that would directly supply a check based on the sustainability level of the business. This method is effective in how business owners receive a tangible reward for their work to be more sustainable and this positive feedback would drive even more sustainable practices, both on their part and on the part of businesses who are able to see these benefits but do not yet take advantage of them.

Next Steps

Given all of these recommendations the borough council must choose to move forward with one or to make a decision on how to apply the recommendations. The council must balance the feasibility of implementation with the benefit that each would provide. It is understandable that Pennsylvania State policy is difficult to influence due to the small number of representatives from this area and the knowledge that Pennsylvania is known for production of coal and natural gas, however it would have the greatest benefit because the entirety of the state would be able to become more sustainable. Influence and benefit decrease as we decrease in the level of government, however it is more specified toward the actual goal of improving the sustainability of the local community. Given this, a more feasible policy is strongly recommended over advocating on a state level.

VII. Conclusions

Forming a more sustainable community is quintessential for the continued prosperity of State College's growing population. However, striving to become an environmentally-conscious community requires legislative intervention, as it is not in the immediate best interest for businesses to be concerned about their respective emissions. The implementation of one of the three suggested policy plans will help to provide incentive for green development by placing sustainable businesses and practices on a competitive level with their damaging counterparts. This allows the market to adjust prices, and eventually favor those who are making smarter decisions for our community.

By choosing to focus carbon dioxide monitoring around easily measurable commodities such as electricity, natural gas, and transportation fuel, the policy becomes much more attainable. This approach allows for direct, tangible results and data collection to show actual quantifiable improvements in carbon emissions. By converting each metric into their equivalent carbon dioxide amount, businesses can be measured on a fair basis, no matter which commodity is being utilized at higher rates.

The examples of other governmental agencies as well as institutions such as universities successfully implementing carbon control policies indicates that a sustainable carbon reduction policy for the State College area is feasible. This also allows the Borough Council to review these various models and formulate a plan that works best for the residents of the community. Regardless of the direction in which the Borough Council chooses to head, the results would help ensure a more sustainable future and environment for State College.

It is with all of the supporting evidence and claims listed within this document that a recommendation for the Borough Council to recognize the need to reduce emissions and promote

sustainable development is suggested. Instituting a carbon reduction plan as specified will safeguard the Borough's commitment to making State College a leading entity in the areas of environmental concern and resident wellbeing.

VIII. Acknowledgements

We would like to thank Dr. Sylvia Neely who advocates for climate change through her work with the Citizens' Climate Lobby. Her recommendations regarding possible models to use for our project, such as British Colombia, was very helpful. We are also grateful since she was the first person who warned us about the legality of implementing a carbon tax.

We also would like to thank Mayor Donald Hahn for his feedback on our project. He informed that that Pennsylvania state is very rigid regarding its tax authorizations, and gave us some direction regarding the general idea of our project. This led us to brainstorm in order to come up with a more tangible plan of action. Mayor Hahn was als the person who introduced us to Dr. Sylvia Neely.

In Addition we would like to thank Mr. Tom Fontaine, the Borough manager. advised us about the specific pathways we can take for the project on the borough level. Since Pennsylvania gives restricted power to the boroughs to implement policy, he informed us how we can go about our project certain already placed taxes and Acts in order to create a tangible plan. He also introduced us to Ed LeClear.

We would like to thank Mr. Ed LeClear, the Planning & Community Development Director at the Borough. He informed us about the State College zoning ordinances and also the changes that can occur in its plans in the future. He also informed us about how we can implement a sustainability goal and clean energy use to zoning plans for new and possibly even older apartments as they would need to keep up with the newer ones in the future.

Lastly we would like to thank Kevin Kassab, Supervisor of Inspections and Health Officer of the borough. He, alongside Mayor Hahn, gave us suggestions regarding how the

revenues of a carbon tax can be used to benefit the businesses and the borough community. He also guided us a bit about how to implement a tax that would focus on the on the businesses.

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X. Appendices

APPENDIX A- RESOURCES ON LAND ASSESSMENT

Below is a list of websites that provide more information on the Clean and Green Act as well as how the State College Borough provides incentives for new building development.

Preferential assessment of farmland and forest land under the Clean and Green Act

- https://www.pacode.com/secure/data/007/chapter137b/chap137btoc.html

State College Borough Zoning Specifications

- https://www.statecollegepa.us/DocumentCenter/View/17471

APPENDIX B- METHODOLOGY

B-1

https://www.eia.gov/electricity/annual/html/epa_a_03.html

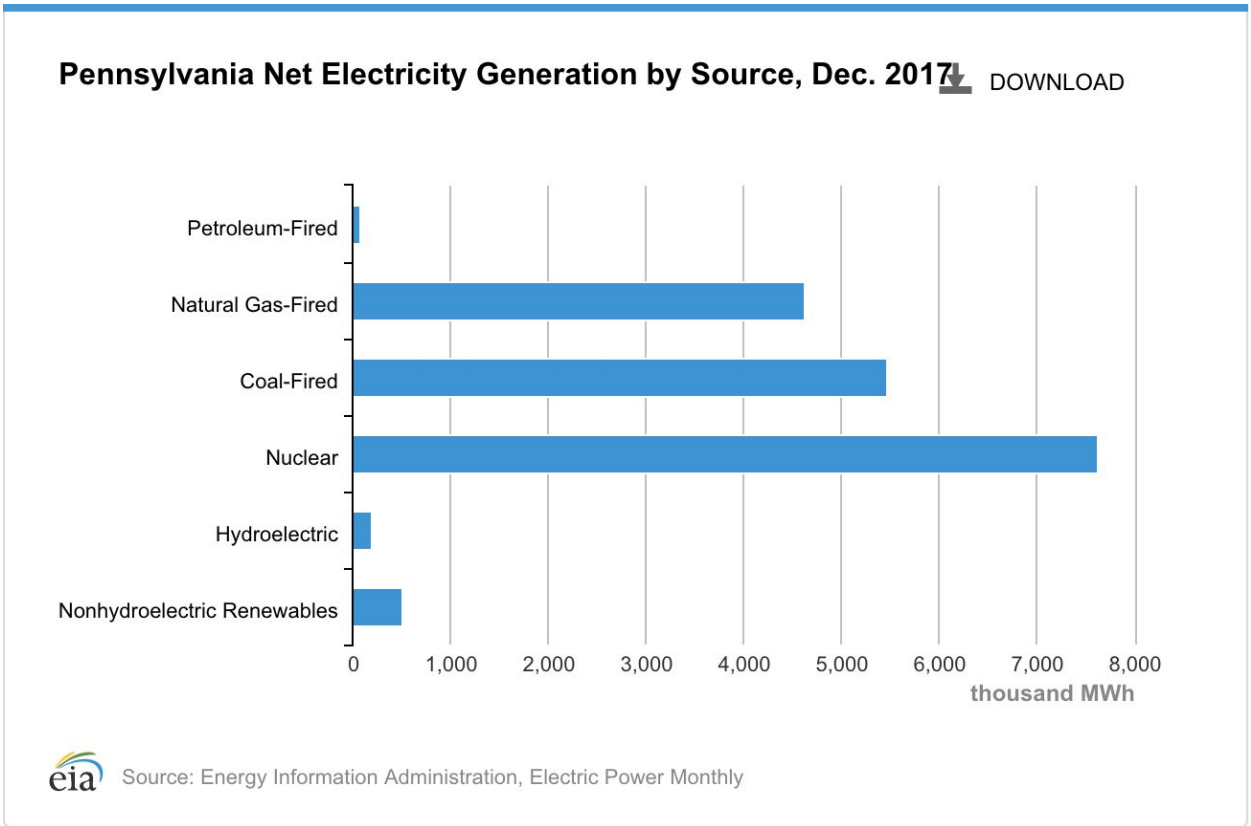
Table A.3. Carbon Dioxide Uncontrolled Emission Factors

Fuel	EIA Fuel Code	Factor (Kilograms of CO2 Per Million Btu)**	Notes
Bituminous Coal	BIT	93.3	
Distillate Fuel Oil	DFO	73.16	
Geothermal	GEO	7.71	
Jet Fuel	JF	70.9	
Kerosene	KER	72.3	
Lignite Coal	LIG	97.7	
Municipal Solid Waste	MSW	41.69	
Natural Gas	NG	53.07	
Petroleum Coke	PC	102.1	
Propane Gas	PG	63.07	
Refined Coal	RC	93.3	Assumed to have emissions similar to Bituminous Coal.
Residual Fuel Oil	RFO	78.79	
Synthesis Gas Derived from Coal	SGC	*	Factor is based on the fuel source used to produce the synthesis gas
Synthesis Gas Derived from Petroleum Coke	SGP	*	Factor is based on the fuel source used to produce the synthesis gas
Subbituminous Coal	SUB	97.2	
Tire-Derived Fuel	TDF	85.97	
Waste Coal	WC	93.3	Assumed to have emissions similar to Bituminous Coal.
Waste Oil	WO	95.25	

Notes:
* Factors for synthesis gas derived from coal and synthesis gas derived from petroleum coke are based on the fuel source used to produce the synthesis gas.
** CO2 factors do not vary by combustion system type or boiler firing configuration.

Source: Energy Information Administration estimates:
http://www.eia.gov/environment/emissions/co2_vol_mass.cfm

B-2



B-3

- Distillate Fuel Oil: 73.16 kg CO2 per Million Btu (1 Million Btu = 0.29307107 MWh)
    - (Assuming this as feedstock for Petroleum-Fired plants)
    - Conversion: **249.63 kg CO2 per MWh (.24963 kg CO2 per kWh)**
- Natural Gas: 53.07 Kg CO2 per Million Btu
    - Conversion: **181.08 kg CO2 per MWh (.18108 kg CO2 per kWh)**
- Bituminous Coal: 93.3 kg CO2 per Million Btu
    - (Assuming Bituminous Coal as feedstock for Coal-Fired plants)
    - Conversion: **318.35 kg CO2 per MWh (.31835 kg CO2 per kWh)**

TOTAL MONTHLY CO2 OUTPUT FROM FOSSIL FUEL FIRED PLANTS IN PENNSYLVANIA (DATA PRESENTED IN KG AND TAKEN FROM DECEMBER 2017)

*75,000 MWh * 249.63 kg CO2/MWh + 4,621,000 MWh * 181.08 kg CO2/MWh + 5,476,000 MWh * 318.35 kg CO2 / MWh =* ***2,598,777,530 kg CO2 per month (specifically looking at December)***

PERCENT OF ELECTRICITY FOSSIL FUEL-BASED PLANTS PRODUCE

*[(75,000 + 4,621,000 + 5,476,000) / (75,000 + 4,621,000 + 5,476,000 + 7,619,000 + 197,000 + 512,000)]*100 =* ***54.98% Fossil-Fuel Sourced Electricity***

0.4% from Petroleum-Fired

24.98% Natural Gas-Fired

29.6% Coal-Fired

DERIVATION FOR CO2 EQUIVALENT TO 1 kWh (FOR MEASUREMENT AT METER)

*(.24963 kg CO2 / kWh) * 0.004 kWh + (.18108 kg CO2 / kWh) * 0.2498 kWh + (.31835 kg CO2 / kWh) * 0.296 kWh = 0.1405 kg CO2 / kWh*

"Therefore, for every 1 kWh consumed in Pennsylvania from the traditional electricity supply, approximately 0.14 kg or 140 grams of CO2 is produced"

B-4

Pounds of CO2 emitted per million British thermal units (Btu) of energy for various fuels:

Coal (anthracite)	228.6
Coal (bituminous)	205.7
Coal (lignite)	215.4
Coal (subbituminous)	214.3
Diesel fuel and heating oil	161.3
Gasoline (without ethanol)	157.2
Propane	139.0
Natural gas	117.0

https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

117 Pounds of CO2 per 1 million BTU of NG

NG measured in CCF (100 cubic feet)

https://www.energy.gov/energysaver/how-read-residential-electric-and-natural-gas-meters

100 cubic feet (Ccf) of natural gas equals 103,700 Btu or 1.037 therms. One

https://www.eia.gov/tools/faqs/faq.php?id=45&t=8

1,000,000 Btu * (1 CCF / 103,700 BTU) = 9.6432015429 CCF

117 Pounds of CO2 / 9.6432015429 CCF

12.1329 Pounds of CO2 / CCF

12.1329 lb * (1 lb / 0.453592 kg) = 26.748 kg

“1 CCF of Natural Gas produces 26.748 kg of CO2”

B-5

Sample Btu conversion factors

Energy source/fuel	Physical units and Btu (averages,[1] 2015)
Electricity	1 kilowatthour = 3,412 Btu
Natural gas	1 cubic foot = 1,037 Btu 1 therm = 100,000 Btu
Motor gasoline	1 gallon = 120,476 Btu[2]
Diesel fuel	1 gallon = 137,452 Btu
Heating oil	1 gallon = 138,500 Btu
Propane	1 gallon = 91,333 Btu
Wood	1 cord = 20,000,000 Btu[3]

[1] Weighted averages for energy sources/fuels as consumed by end-use sectors.
[2] Gasoline sold at retail in the United States, with about 10% ethanol content by volume.

https://www.eia.gov/energyexplained/index.cfm?page=about_btu

Otherwise being defined as diesel and gas

161.3 Pounds of CO2 per 1 million Btu of diesel

1 gallon of diesel = 137,452 Btu

1,000,000 Btu / (137,452 Btu / gallon of diesel) = 7.275267 gallons of diesel

161.3 Pounds of CO2 * (1 lb / 0.453592 kg) = 355.6059 kg CO2

355.6059 kg CO2 / 7.275267 gallons of diesel

“1 Gallon of Diesel produces 48.88 kg CO2”

157.2 lbs of CO2 per 1 million Btu of Gasoline

1 gallon of gasoline = 120,476 Btu

1,000,000 Btu / (120,476 Btu / gallon of gasoline) = 8.30040838 gallons of gasoline

157.2 lbs of CO2 * (1 lb / 0.453592 kg) = 346.566959 kg CO2

346.566959 kg CO2 / 8.30040838 gallons of gasoline

“1 Gallon of Gasoline produces 41.75 kg CO2”

APPENDIX C- MODELS

Below is more information on the models that other universities have used in-order to lower their carbon footprint.

Yale's Carbon Charge

- https://news.yale.edu/2017/09/11/yale-launches-carbon-charge-campus-buildings-and-department