TAMPA'S EMISSION EXPEDITION:

A Review of GHG Emissions in Hillsborough County

THE UNIVERSITY OF SOUTH FLORIDA (USF) TEAM-

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SECTION 1: WHY HILLSBOROUGH COUNTY?

Global warming is a phenomenon that affects every facet of mankind. A rise in the earth's temperature above 1.5°C higher than pre-industrial levels will lead to the destabilization of many of the earth's natural systems that have been thriving for hundreds of years. This disruption to the systems mankind has grown into will uproot many behaviors and luxuries we are accustomed to. Tampa sees a lot of natural beauty and recreational activity at its water fronts including the Tampa Bay and Hillsborough River. Common activities for locals include fishing, boating, hiking, swimming, kayaking, and other outdoor activities. Coastal communities like Tampa and a large part of Hillsborough County will suffer greatly from the effects of climate change such as rising sea levels, stronger hurricanes, and increased rainfall. Due to the abundance of water in Hillsborough, this region remains vulnerable to the most immediate effects of climate change, making the matter of GHG emission reduction of vital importance and improve infrastructure for the changes led by global warming a priority. In Tampa, energy production remains the largest source of greenhouse gases at 47% of total emissions[1] and emitting approximately 6 million tons of CO_2 in 2021.[2]

Unfortunately, in the state of Florida, legislation from 2021 limits counties or cities from restricting or prohibiting the types of fuel sources or energy production used/supplied. This obstacle makes it more challenging for local governments to reduce the harmful emissions coming from their communities. One way the city of Tampa is trying to reduce the impact of its energy sector is by investing in renewable energy sources, such as solar, to power municipal buildings they own. In Tampa, for every 641 MWh, approximately 109 MWh is used by government buildings and 532 MWh used by the city. By replacing all its energy needs with renewable energy, 109 MWh worth of GHG emissions can be eliminated.[3]

While that is great news, the main source of emissions remains and must be improved upon. In the Hillsborough area there are 4 providers of energy, the main ones being the steam electric plants owned by TECO (Bayside and Big Bend) while the other two facilities are Waste-to-Energy locations (McKay Bay Refuse-to-Energy and Hillsborough City Resource Recovery Facility). Understanding and improving these operations to reduce as much GHG emissions as possible will have the greatest impact in improving the overall emissions of Tampa city and Hillsborough County.

[1] (*City of Tampa Climate Action and Equity Plan*, 2023,23)
[2] (US EPA, n.d.)
[3] (*City of Tampa Climate Action and Equity Plan*, 2023,34)

SECTION 2: AN OVERVIEW OF OUR PLANTS

In this report we analyzed the four main emission points in Tampa, Florida. Bayside Power Station as one of them is the main source of Green House Gas (GHG) emissions. It is a natural gas-fueled electric plant, and overlooks the East Bay Channel. The power plant has two units, Bayside Unit One and Two, with seven combustion turbines, and seven heat recovery steam generators. The plant is able to reliably deliver 1,800 megawatts of power to the people, and it is able to support the grid in case of a catastrophic weather disaster. It works by burning natural gas to power two gas turbines generators that will create electricity; the hot gas released is then cooled in the heat recovery steam generators to create more electricity, and the final product is condensed into water and recycled[4].

The second major source of emissions in Tampa Bay is Big Bend Power Station, which is a major coal-fired plant located by Apollo Beach. After the most recent modernization in 2022 the plant has a generating capacity of 2,000 megawatts of power. The plant is formed by five different units installed throughout the years since its foundation, and most of them are or were powered by burning coal or natural gases. The first unit built was modernized recently and it eliminated coal as its fuel, the second and third units were retired, one of them early this year being almost 18 years early.[5] The fourth unit is still operational and burns coal and natural gas to produce power. The most recent unit has been built in 2009 and it is a natural gas and fuel-oil-fired peaking unit. The process followed by this power plant is very similar to that of the Bayside Power Station, with the only difference in the kind of fuel burnt, even though Big Bend is also diving into natural gas as a fuel.

The last kind of power plant researched is Refuse-to-Energy Facilities. The Mckay Bay Refuse-to-Energy Facility sits on the Mckay Bay on the estuary of the Palm River. The plant produces around 22 megawatts of power while also processing 2 million pounds of household and commercial refuse. The plant was remodeled in a retrofit project where it introduced modified mass-burns, a furnace system, and water walled boilers. The retrofit project enhanced the equipment already at Mckay a well as improving the air pollution equipment by putting a spray drier absorber, a nitrogen control system, a baghouse, and a single shell multiflued stack.[6] The second power plant in Tampa that uses Waste-to-Energy is the Hillsborough Resource Recovery Facility, located in Brandon and produces 47 megawatts of electricity. The facility

[4] (*Bayside Power Station*, n.d.),(*H L Culbreath Bayside Power Station - Tampa, FL (Address and Phone)*, n.d.), (*Power Plant Profile: HL Culbreath Bayside Power Station, US*, 2023), (*Power Generation*, n.d.)

[5] (*Florida Conservation and Technology Center - Big Bend Power Station*, n.d.), (*Tampa Electric Knew the Procedure Was Dangerous. It Sent Workers in Anyway.*, 2017)

[6] (Rosania, 1996, 1-10),(*McKay Bay Waste Transfer Station*, n.d.),(*Solid Waste - External*, n.d.),(*OBB FY 2022 Solid Waste & Environmental Program Management*, n.d.),(Schwartz & White, 2002, 1),(*Covanta Hillsborough*, n.d.)

processes a million pounds of waste to create the steam used to power the electric generators for energy production.[7]

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SECTION 3: IDENTIFIED EMISSION POINTS

[7] (*Resource Recovery Facility*, 2023), (*Burning Question: Where Does All Your Trash Go?*, 2017)

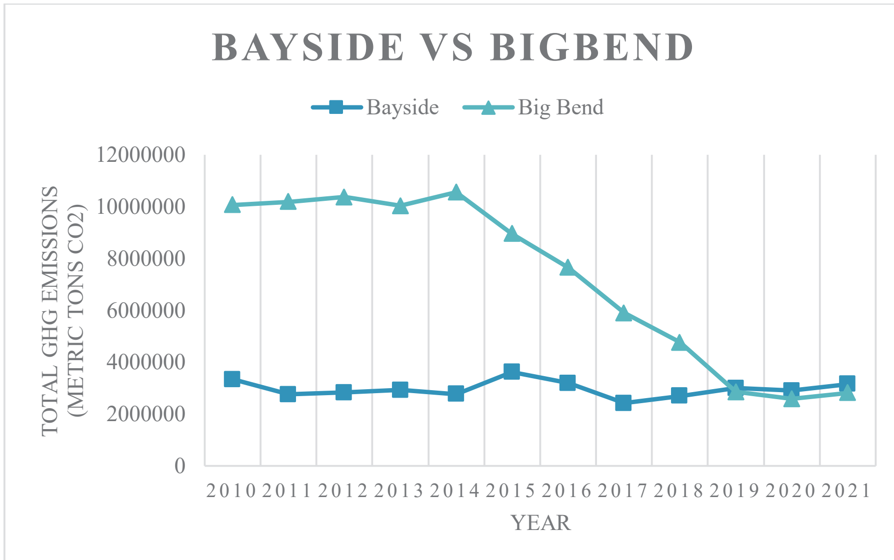

FIGURE 1 TOTAL GHG EMISSIONS FOR BAYSIDE AND BIG BEND POWER PLANTS

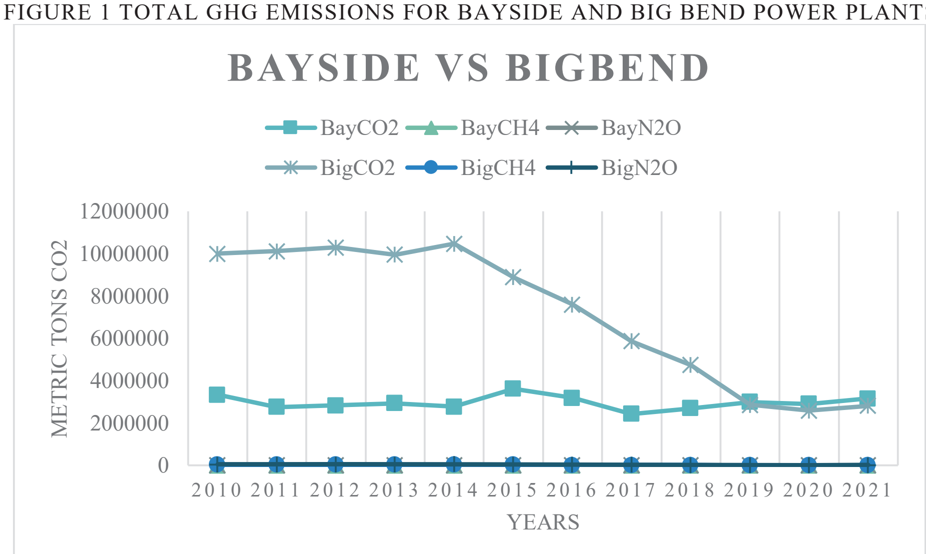

FIGURE 2 TOTAL GHG EMISSIONS FOR BAYSIDE AND BIG BEND POWER PLANTS WITH CARBON DIOXIDE EMISSIONS

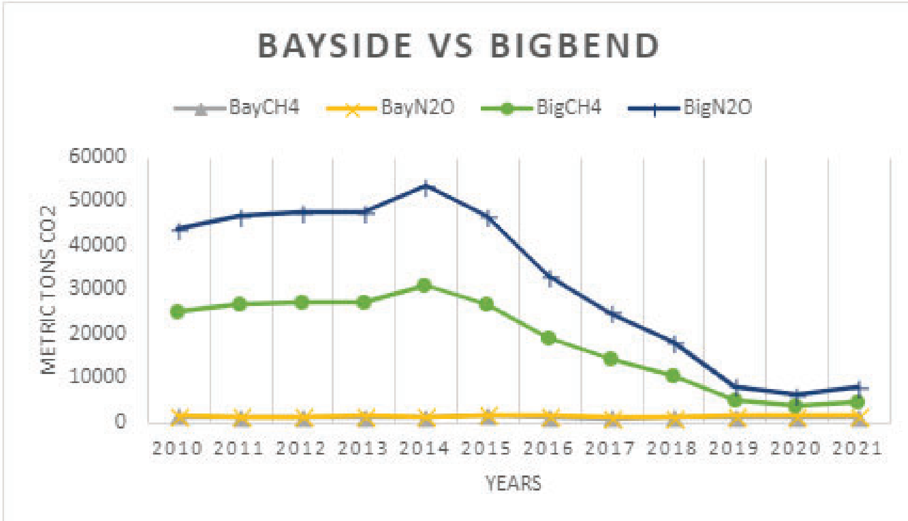

FIGURE 3 TOTAL GHG EMISSIONS FOR BAYSIDE AND BIG BEND POWER PLANTS WITHOUT CARBON DIOXIDE EMISSIONS

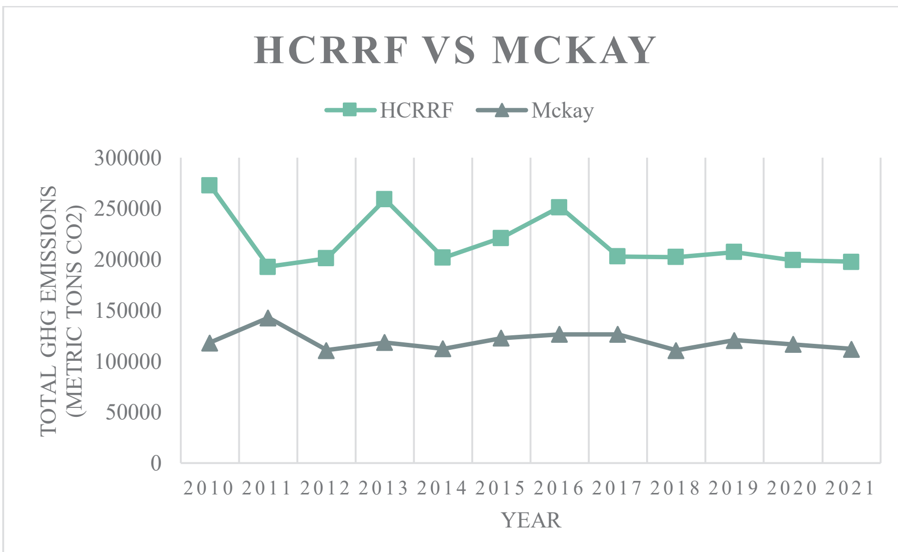

FIGURE 4 TOTAL GHG EMISSIONS FOR WASTE TO ENERGY PLANTS

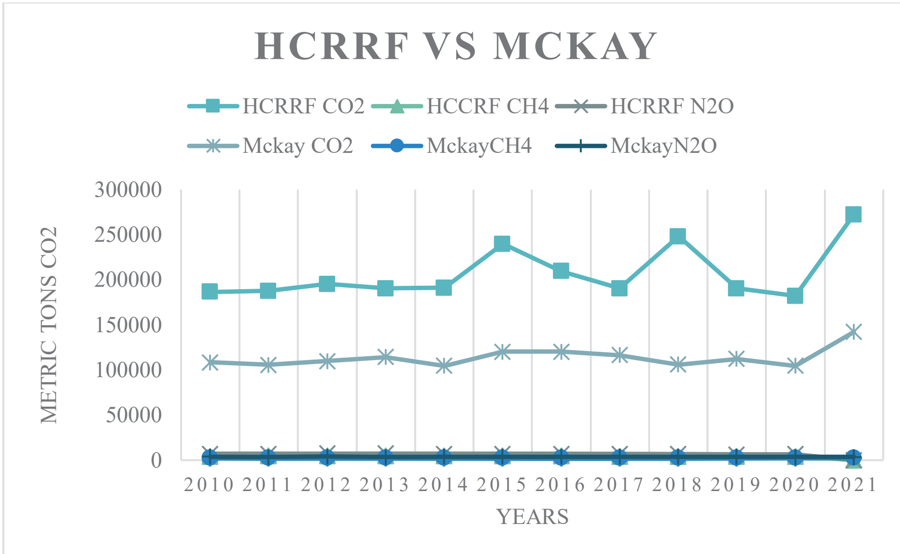

FIGURE 5 TOTAL GHG EMISSIONS FOR WASTE TO ENERGY PLANTS WITH CARBON DIOXIDE EMISSIONS

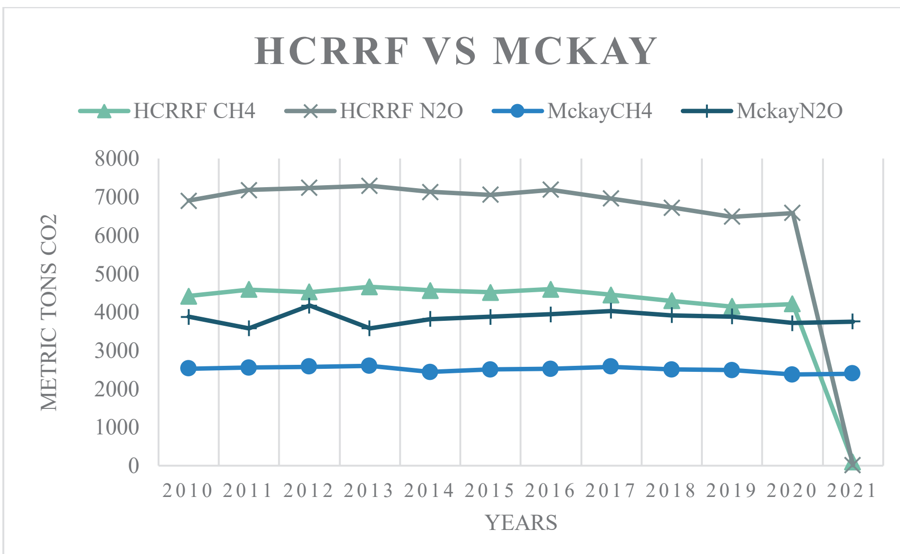

FIGURE 6 TOTAL GHG EMISSIONS FOR WASTE TO ENERGY PLANTS WITHOUT CARBON DIOXIDE EMISSIONS

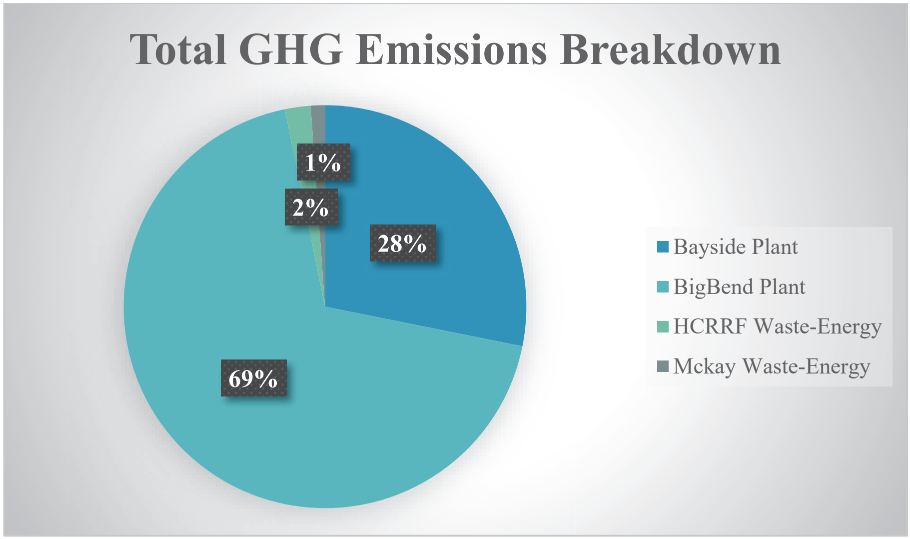

FIGURE 7 TOTAL GHG EMISSIONS BREAKDOWN

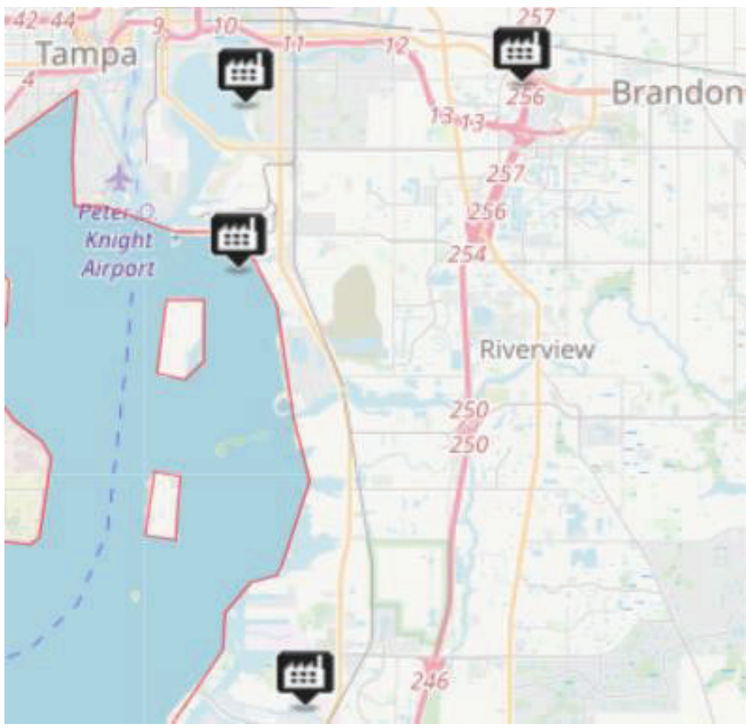

FIGURE 8 PLANT LOCATIONS ON MAP

Rank	Facility	Facility Type	Total Emissions (2010-2021)
1	Big Bend	Steam-Electric Plant	86,793,049
2	Bayside Power Station	Steam-Electric Plant	35,595,350
3	HILLSBOROUGH COUNTY RESOURCE RECOVERY FACILITY	Waste-to-Energy	2,610,261.38
4	Mckay Bay Facility	Waste-to-Energy	1,435,851

FIGURE 9 TABLE DISPLAYING THE TOTAL EMISSIONS FOR EACH PLANT FROM 2010 TO 2021

NOTE: All GHG emission data was sourced from US EPA FLIGHT data[8].

[8] (US EPA, n.d.)

SECTION 4: EMISSION REDUCTION OPTIONS ANALYSIS

The research conducted exposed four different power-generation facilities in Hillsborough County. While we were not able to find the processes causing the most emissions, an analysis of the general processes these plants undergo to generate energy gave insight into general points in the process that could be evaluated. Of the four power plants, two are steam-powered power plants, and the other two are municipal waste incineration power plants.

Steam power plants work by burning fuel which heats water, causing it to change state from liquid to gas. After this phase change, it rises and turns large turbines. When these turbines are turned, energy is produced. This energy is what is used to power generators, and from the generators the power is distributed. For the plants in Hillsborough County, the fuel burned is natural gas- a relatively 'clean burning' gas. However, natural gas when burned still releases pollutants into the atmosphere-greenhouse gases. Natural gas mainly produces methane when burned, and methane is a greenhouse gas. Waste-to-energy plants work in the same way, but instead of using natural gas as fuel they use waste. Some technological solutions which can be implemented in these plants, if not done so already, include:

- Spray Dryer Absorption (SPA)
- Particulate Control
  - Electrostatic Precipitators
  - Cyclone Separation
  - Fabric Filters
- Gas Control
  - Scrubbers
  - Incineration
  - Carbon Capture

These emission control techniques can be beneficial to the reduction of GHG emissions. For example, SDA facilitates the removal of pollutants, heavy metals, and dust from flue-and-off gases. By installing a spray dryer before the flue gas reaches the stack where it is released into the atmosphere, harmful substances can be removed from the gas, thus reducing GHG emissions from a plant. This is beneficial as it would help keep harmful pollutants out of the atmosphere. Additionally, according to the study *Removal of Carbon Dioxide by a Spray Dryer,* "Experimental results show that the best removal efficiency of CO_2 by a spray dryer is 48% as the absorbent is 10%NaOH + 5%Ca(OH)2 and the operating temperature is 150 °C. Comparing this result with previous study shows that the performance of spray dryer is better than traditional NaOH wet scrubber."[9] This study highlights SDA being a more efficient means of removing CO_2 in flue gas compared to another emission mitigation technique, gas scrubbing, which will be discussed later. The costs of implementing SDA in facilities and the carbon benefit in reduction in emissions is as follows[10]:

Process	Levelized Cost ($/ton SO2 removed)	Reduction in Emissions (%)
SDA	633	97
WFGD	543	97

Secondly, particulate control techniques-which are mechanical means of separating harmful substances from gases-are another technological solution which can help lower the emission amounts. Three types of particulate control systems include electrostatic precipitators, cyclone separation devices, and fabric filters. Electrostatic precipitators function by using the differences in electrical charge/static electricity in particles to separate them[11]. Usually, electrostatic precipitators can only remove particulate matter of a certain size range, and anything bigger or smaller is removed by either a cyclone (for larger particles), or another gas cleaning technique (for smaller particles). Due to electrostatic precipitators not being able to remove all pollutants from flue gas, they are used with other particulate control devices such as cyclones and fabric filters. Cyclones are devices that use inertia to remove particulate matter from flue gas. Unlike electrostatic precipitators, cyclones do not use electricity to remove particulate matter, and they also can remove larger particles from flue gasses. The third type of particulate control device is fabric filters, which use fabric with small holes in it to prevent dust from exiting smokestacks with gas. An example of these filters are bag houses which are an extremely common form of mitigation technique. Bag houses are highly effective in removing dust and debris from flue gas, but not as effective at removing specific pollutants from flue gases, which makes sense as they are not a chemical means of separation.[12]

Cost Analysis and carbon benefit[13]:

Process	Levelized Cost ($/ton SO2 removed)	Reduction in Emissions (%)
Baghouse (for municipal incineration)	200	99.9

[9] (Chen et al., 2005, 99-105)
[10] (Air Economics Group-Health and Environmental Impacts Division, 2023)
[11] (EPA, n.d.)
[12] (*Baghouse Dust Collector FAQ*, 2020)
[13] (AICHE ELA132: An Introduction to Large-Scale Energy Production)

Thirdly, scrubbers, incineration, and carbon capture are all forms of chemical gas control systems/processes. Scrubbers work by using chemical reactions to either neutralize acidic compounds in the gas (most commonly gas desulfurization to remove Sulphur oxides) or create other chemical compounds using pollutants, thus reducing their emissions. There are two types of scrubbers, wet and dry. Wet scrubbing removes harmful components of flue gases by spraying a liquid through the gas. The main chemical used in this process is Calcium carbonate ($CaCO_3$). Dry scrubbing removed harmful compounds from flue gases by introducing a solid to the gas. Scrubbing is highly effective, removing almost 98% of Sulphur from flue gases. According to the United States Environmental Protection Agency, "A wet scrubber's particulate collection efficiency is directly related to the amount of energy expended in contacting the gas stream with the scrubber liquid. Most wet scrubbing systems operate with particulate collection efficiencies over 95 percent."[14]

Cost Analysis and carbon benefit[15]:

Process:	**Levelized Cost ($/ton SO2 removed)**	**Reduction in Emissions (%)**
Flue Gas Desulfurization	600	90

Lastly, incineration is used to convert volatile organic compound emissions into CO_2 and water via combustion, and it generally takes place in a specialized device called an afterburner- a machine that facilitates complete combustion. Incinerated gas must also be mixed to ensure complete combustion. Paired with a carbon capture process, emissions can be greatly reduced. There are two types of carbon capture: pre-combustion capture and post-combustion capture. Both types are effective at removing carbon dioxide from flue gases, but plants can only be retrofitted for post-combustion capture if they are older. The benefits of carbon capture include that it is effective at removing carbon dioxide from power plants, and older plants can be repurposed to include this type of emission mitigation technique. Despite the benefits, however, there are still some things that need to be considered, such as the fact that the process is expensive, and that all the captured CO_2 needs to be transported and stored, which in turn uses energy and the cycle continues.[16]

[14] (*Monitoring by Control Technique - Wet Scrubber For Particulate Matter | US EPA*, 2022)
[15] (AICHE ELA132: An Introduction to Large-Scale Energy Production)
[16] (Greenwald, n.d.)

Cost Analysis and carbon benefit[17]:

Process	Levelized Cost ($/ton CO2 captured)	Reduction in Emissions (%)
Carbon Capture	50-100	<= 90

Most energy production facilities already use scrubbers in their systems to help reduce emissions, showing that scrubbers are a popular choice for energy production facilities. While all these technological means of mitigation discussed, it is also beneficial that non-technological ideas be presented. Some non-technological emission mitigation techniques include A non-technological emission mitigation technique includes policy.

Beneficial Policies:

Inflation Reduction Act -→·

Methane Emissions Reduction Program

With the Inflation Reduction Act, the Methane Emissions Reduction Program was created to disperse $1.55 billion dollars' worth of funds in grants, rebates, and other contracts to eligible recipients including states, counties, cities, businesses and more… Funding for this program can be used to improve or deploy equipment that reduces emissions or improve monitoring emissions. Funding for this program lasts until September 2028. [18]

Infrastructure Investment and Jobs Act

Carbon Management Funding → Carbon Dioxide Transportation Infrastructure Finance and Innovation Program: $2.1 billion

Under the Infrastructure Investment and Jobs Act, approximately $12 billion dollars total will be allocated towards carbon capture, transport and storage equipment and processes under specific programs. Specifically, $2.1 billion will be part of the Carbon Dioxide Transportation Infrastructure Finance and Innovation Program. This program offers capital for large, common carrier carbon dioxide transport projects such as new pipelines, shipping, rail systems and more. This program will run for the fiscal years 2022-2026 and offer loans, loan guarantees, or grants until all money in the fund is expended. [19]

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[17] (AICHE ELA132: An Introduction to Large-Scale Energy Production)
[18] (*BUILDING A CLEAN ENERGY ECONOMY:*, 2022,72)
[19] (*THE INFRASTRUCTURE INVESTMENT AND JOBS ACT: Opportunities to Accelerate Deployment in Fossil Energy and Carbon Management Activities*, 2022,2)

All these policies are beneficial as they are incentives for plants to make moves towards lowering GHG emissions.

SECTION 5: EMISSIONS REDUCTION PLANS

Objective five details the cost and carbon benefit evaluation of proposed emission reduction plans. We were tasked with assessing the carbon benefits and total system costs for each of our proposed emissions plans, which will be expounded upon in this section. Additionally, we had to compare the carbon benefits achieved with the overall costs incurred. The emissions plans we propose are as follows: Plant Improvement, Carbon Capture and Sequestration/Storage, Research Implementation, and AI Use.

The first emission reduction plan proposed by our group is that the steam power plants and municipal incineration plants researched improve their existing processes. We propose that they do this by replacing existing equipment in their processes with new machines which are more updated as this can improve efficiency. New technologies have been developed such that the same devices have been made more efficient at doing their job, and implementation of these new devices can make current processes better at limiting pollutant emissions. An exact process of each of the plants was not able to be found, but, using a general steam-electric power plant and municipal incineration power plant process as a template, an estimate of what these processes would look like was achieved.

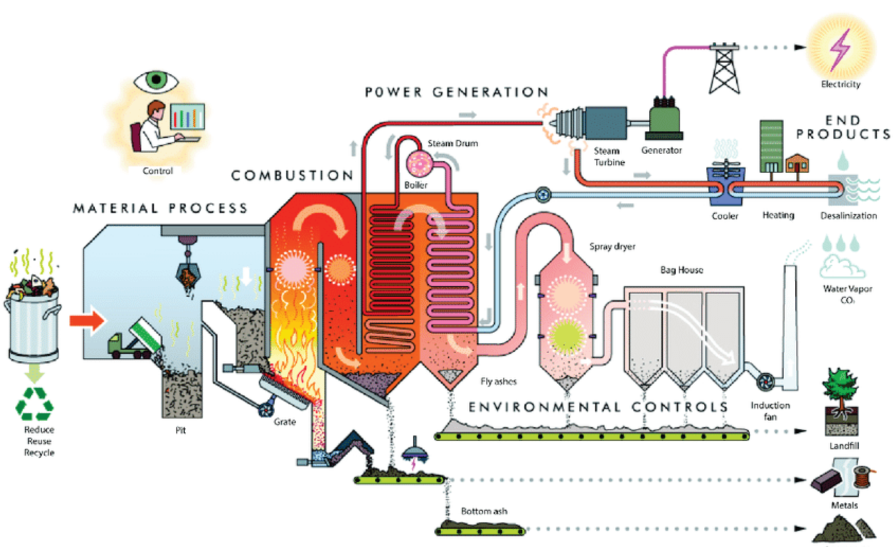


FIGURE 10 GENERAL WASTE-TO-ENERGY POWER PLANT SCHEMATIC

Note: Sources for photos are provided on the references page.

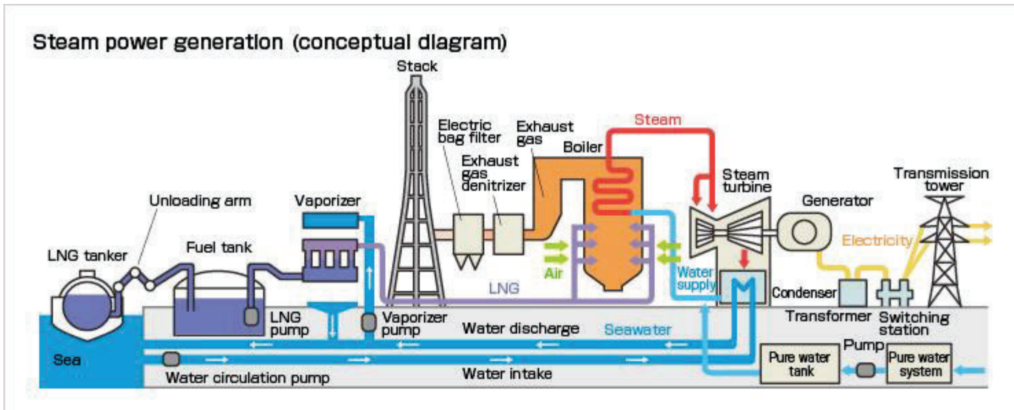


FIGURE 11 GENERAL STEAM POWER PLANT SCHEMATIC [20]

In the figures above, a general process for steam-powered electric plants and municipal incineration power plants can be seen. In these schematics, gas cleaning devices such as bag houses, scrubbers, and spray dryers are a part of the process. These are all popular gas cleaning techniques used in most power plants, along with catalytic reduction and heavy metals removal through chemical reactions. The idea of this emission reduction plan is to replace these devices with newer ones, boosting process efficiency and reducing GHG emissions. Furthermore, in processes which do not include some of these devices, more GHG emissions can be removed if more gas cleaning techniques are implemented.

The second emission reduction plan relates directly to carbon sequestration, which is the process of, "capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change," according to the United States Geological Survey[21]. There are two types of carbon sequestration, geologic and biologic. For this reduction plan, we will be focusing on geologic carbon sequestration-injecting carbon dioxide into aquifers deep underground. While carbon sequestration reduces a large amount of carbon dioxide from flue gas entering the atmosphere-it does require chemical separation of carbon dioxide from the flue gas. The AICHE academy course *ELA132: An Introduction to Large-Scale Energy Production*, "Amine scrubbing is the most developed carbon capture technique, most complicated, and turns your power station into a chemical plant. Oxy-combustion has been proven at full-scale, and has a high parasitic load." The other two forms of potential carbon capture have not been proven at large scale or are still undergoing further research. Therefore, it is obvious that carbon capture and sequestration, while highly efficient, is a tedious and costly process. Not only does the plant have to be

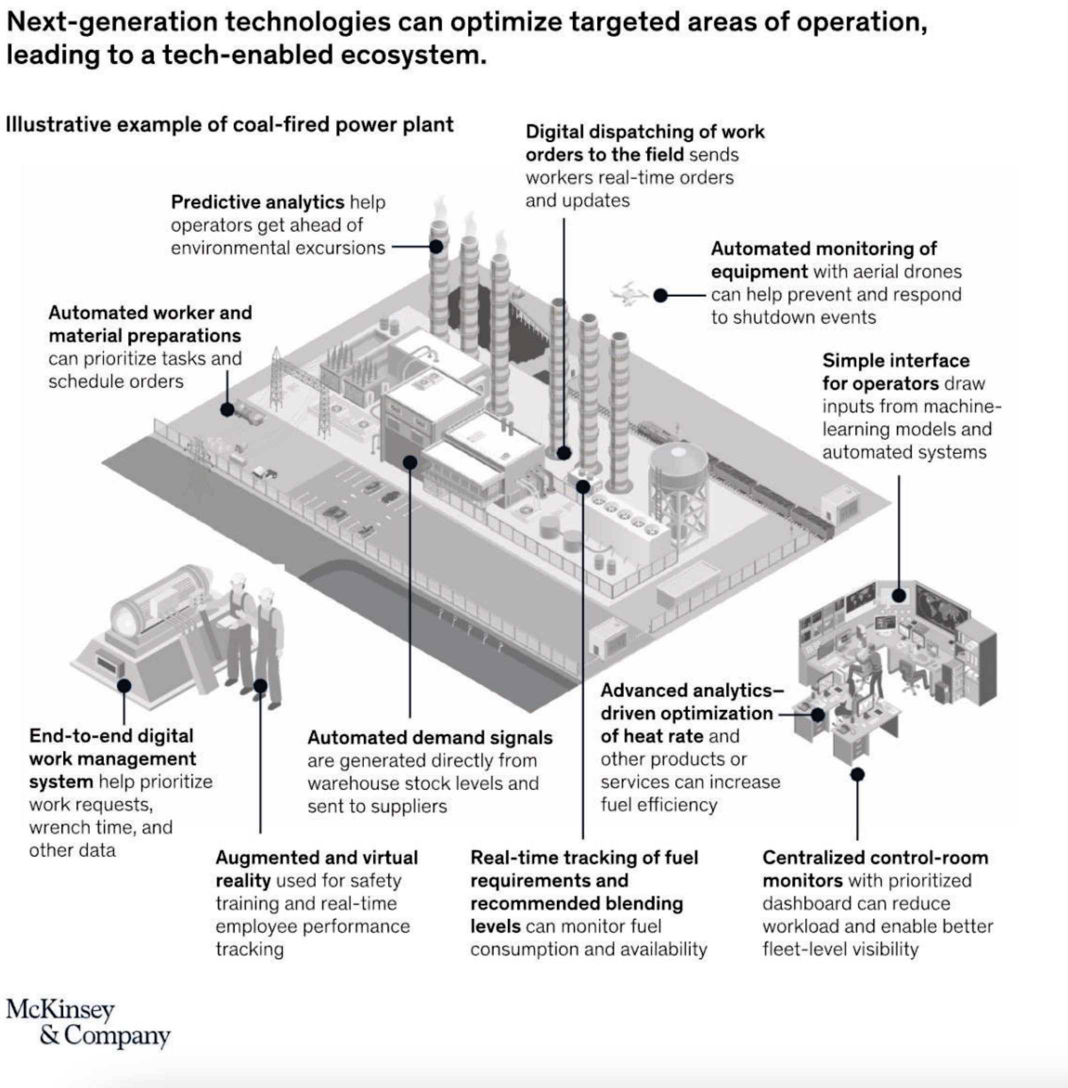
[21] (Merrill et al., n.d.)

retrofitted with the machinery to conduct the chemical separation, put personnel must be hired to manage this process (engineers, technicians, etc.) and the carbon sequestration process requires resources as well-transportation, carbon dioxide storage, and the process of injecting the carbon dioxide underground.

Our third proposed emission plan focuses on a less technological approach- that is, instead of investing into tangible aspects of the power plants (machinery), plants can invest in research instead to tailor technologies to fit their available resources and processes. This way researchers can identify points of interest in the existing plants which could use improvement or be replaced with an entirely new process. These power plants can fund a research team that focuses on greenhouse gas emission technologies which can be applied to their specific plant, boost efficiency, and even help reduce running costs.

The final emission reduction plan is one that takes a 21st century approach. Artificial Intelligence has proven immensely useful in automating repetitive processes and conducting data analysis in the STEM world. In fact, over the years AI has become an indispensable tool researchers use. AI use in power plants is something that is currently being researched and implemented worldwide, and it has proven to be a game-changer for power plants across the globe, improving plant intelligence and efficiency, as well as being a valuable tool for modelling processes globally in the energy sector such as trends and policies. Additionally, AI use in power plants can help significantly GHG emissions and better equip plants with the data needed to know exactly where in their processes improvements can be made. McKinsey & Company claim in their September 2020 article titled *Power Pant 4.0: Embracing next-generation technologies for power plant digitization,* "Many power companies began their digital transformations with technological solutions such as data models, which help optimize set points, enable better dispatch decisions, and support maintenance strategies and operating-mode selection. Forward-thinking companies, however, have recently started using visualization tools to manage real-time generation performance and digital control software to relay predictive data to control rooms." [22]

[22] (Embracing 4.0 Technology for Power-Plant Digitization | McKinsey, 2020)



As seen in the figure above, digital systems can be of great use in power plants, opening up a world of possibilities, such as advanced data analysis programs being run which can identify points of inefficiency in a process, places where mechanical failure might be imminent, and general improvements which can be made.

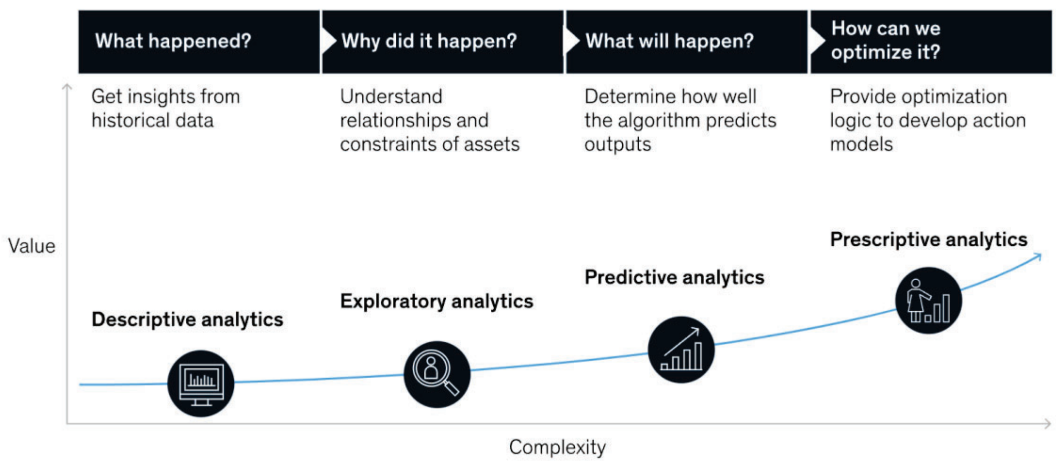
The article by McKinsey & Company also explains how power plants already collect vast amounts of data, of which only a fraction is actually used for data analysis. This "black box," as they call it, can be a reservoir of useful information for future technologies that can have an immense impact on how power plants are run- and an immense impact on GHG emissions as well.[23] While these technologies are not available for use currently, in the future

[23](Embracing 4.0 Technology for Power-Plant Digitization | McKinsey, 2020)

AI can become one of the leaders in reducing GHG emissions in the energy sector, moving the world towards a greener, more sustainable future. "Even the most efficient power plants can benefit from advanced-analytics models to improve heat rates (Exhibit 4). An increasing number of power companies at the outset of their digital journeys are already seeing promising results. Irrespective of fuel type (coal or gas), machine learning and advanced analytics can create heat-rate improvement of up to 3 percent. Generating higher profits and lower carbon emissions can be accomplished by following a four-step program,"[24]

Exhibit 4

Prescriptive analytics, which use machine learning to recommend optimal real-time actions, can create significant value.



McKinsey & Company

Another example of AI being the future for power plants is given in the article *Artificial Intelligence Modeling-Based Optimization of an Industrial-Scale Steam Turbine for Moving toward Net-Zero in the Energy Sector*, which claims that, "The AI-based modeling and optimization analysis is conducted to enhance the operation excellence of the industrial-scale steam turbine that promotes higher-energy efficiency and contributes to the net-zero target from the energy sector."[25] As clearly stated by the article, AI can be used to optimize the processes of power plants, helping reduce GHG emissions and thus having a positive carbon benefit.

[24] (Embracing 4.0 Technology for Power-Plant Digitization | McKinsey, 2020)
[25] (Ashraf et al., 2023, 21709-21725)

The emissions reduction plants proposed are options that will all be beneficial in removing GHG emissions from electricity generation processes, all with varying degrees of applicability and cost.

SECTION 6: CATEGORIZATION OF PLANS

There are three categories that the proposed emissions plans fall under. These consist of low value, marginal value, and high value. Low value projects have a notably bad benefit to cost ratio. Marginal value projects are projects where the benefits outweigh the costs to implement, but only ever so slightly. The final category these projects can fall under is high value. High value projects are projects that the benefit outweighs the cost by a large margin.

The plant improvement plan's value is not immediately attainable as the state of the equipment of each plant is not known. Though improvements to reduce specific gas emissions that a plant has a high amount in are possible. This would be done by implementing processes that a plant does not have for reducing emissions. Taking this into account, the value of this plan would be marginal as these power plants and waste-to-energy facilities have processes in place to reduce emissions making the amount they can further reduce by adding another process marginal.

Carbon Capture and Sequestration/Storage was the second emission plan proposed. This plan would reduce the most abundant emission, carbon dioxide. Although every power plant and waste-to-energy facility covered has large CO2 emissions, the cost to implement a chemical carbon reduction plan in these emissions is just as big. According to AIChE academy, to reduce carbon dioxide emissions by 90% through a carbon capture system, it would approximately cost between $50-$100 per ton of carbon dioxide captured. Considering the carbon dioxide emissions of the BigBend power plant for 2021, 3,159,319 metric tons of CO2 were emitted by the operation alone. Implementation of carbon capture would've cost between $157,965,950-$315,931,900 while also reducing emissions by 2,843,387 metric tons.[26] Even with governmental aid the cost of carbon capture is an unrealistic option for most power plants or waste-to-energy facilities. Overall, carbon capture has major benefits for reducing GHG emissions but also has major drawbacks due to cost making this plan have a marginal value.

Research Implementation was the third proposed emission reduction plan. The plan proposed depends upon the success of the researchers. This makes estimating the value of this plan more difficult. The value of researching areas that need improvement specific to the plant or waste-to-energy facility cannot be understated, but the uncertainty of the results lowers the value of the plan. With all this in mind the plan falls into marginal value.

[26] (AICHE ELA132: An Introduction to Large-Scale Energy Production)

The final proposed emission reduction plan was artificial intelligence (AI) implementation to the facilities. This would automize monitoring systems which alone would provide great value for a plant or waste-to-energy facility. Other benefits of this implementation that improve the value of this plan consist of potential efficiency increases, information flow increase, and operation improvements. The wide array of benefits makes this a high value plan.

SECTION 7: POLICY & TAX ANALYSIS

Green House Gas emissions (GHGs) will bring climate change, which will consequently bring to damages to natural ecosystems and to human well-being. The UN, a worldwide nonprofit organization that gathers nations across the globe to discuss common issues, is very concerned with the temperature increasing by 1.5°C. The IPCC (Intergovernmental Panel on Climate Change) in specific is a branch of the UN concerned about climate change, and they research data gathering scientific papers to summarize the knowledge for the year. The Fifth Assessment Report (AR5) by the IPCC expressed the dangers of overshooting the temperature goal, as there would be catastrophic consequences for ecosystems and possible life on earth. An increase in precipitations and climate disasters have already been observed all around the world, and the increase in temperature would bring the world to its tipping point. Which would bring destruction to ecosystems, limit food and water supply, and could possibly endanger life on earth.

This section is concerned about what the goal of the UN is, as well as what they are doing to achieve that goal. The UN meets in a different country every year to discuss climate change, check how every nation has been doing, how close they are to their set goals, and ways that they can be helped. During the last meeting about climate change held in Egypt, the UN created partnerships between third world countries and more developed countries to hopefully help them reach their climate goals more easily by supporting them. They also recalibrated ways that the energy industry can be monitored as they constitute a major fraction of emissions into the atmosphere and have fallen back with their timeline. In addition, the UN is planning on developing a virtual platform for every country to overcome barriers and accelerate processes by the 2028 Conference. After the UN conference the US put in place new goals and timelines to conform with the GHG reduction plans.

With the Biden Administration in office the US plans to reduce GHG emissions by 50% from those of 2005, as well as having a net zero emissions by 2050, and energy production with no pollution by 2035. The question therefore lies: what has actually been done by the US to reduce GHG emissions?

The Inflation Reduction Act (2022) includes two main tax benefits for renewable energy industries and credits for residential steps taken towards clean energy. The Investment Tax Credit (ITC) which gives a one-time grant of 30% of construction costs once the equipment is put into service for energy companies. Branched from the ITC there is a tax credit for companies that sell the clean energy equipment, which awards $10 Billion competitively to investments in clean or recycled clean energy components. Out of the national budget, $27 billion have also been allocated to reducing GHG emissions by giving it to private projects prioritizing disadvantageous communities, and $40 billion are reserved for innovative clean energy projects. The second main tax credit is the Production Tax Credit (PTC), which is only applicable after the start of operations and is valid for 10 years and give 2.6 cents per kilowatt hour of energy produced. As for benefitting the individual the federal government implemented the Residential Renewable Energy Tax Credit, which has no cap and will cover the equipment, assembly and wiring of the system.

The Clean Air Act (CAA), first signed into law in 1970 started taking ground in the 1990s regulating air emissions as section 112 was being added to the legislation requiring technology-based sources for dangerous pollutants. The act presents various ways that Environmental Protection Agency (EPA) is taking steps towards a cleaner future with less emissions. Coal fired power plants release the most GHG by generator, and they hold a section of the CAA.

Coal fired plants have accumulated a fair number of civil lawsuits because of dangerous releases in the atmosphere, and of them happened in Tampa. The Tampa Electric Company was sued for modifying the plant without putting pollution controls in place. The suit settled with the company having to pay millions of dollars to reduce their emissions by installing new equipment and the releases of the region by investing money in environmental beneficial projects. The CAA includes a few compliance monitoring programs, like the Acid Rain Monitoring (ARP) which was the first national cap on emissions of sulfur and nitrogen, as well as introducing trading emissions reduction methods with other companies. The Mobile Source Compliance provides a certificate of compliance for any engine used in the US and its fuel, as well as continuous checkups and a need for the company to keep research facilities for quality assessments and testing reports.

In addition, the New Source Performance Standards (NSPS) are a module by which a process will go through an initial testing, while also having continuous monitoring. As part of the constant monitoring there is the National Stack Testing Guidance, which makes sure that the levels of GHG released in the atmosphere are within the limits of the CAA. State Implementation Plans (SIPs) are plans submitted by each individual state for implementation, attainment, maintenance, and enforcement of National Air Quality Standards. The National Ambient Air Quality Standards (NAAQS) are limits put in place for public protection and as time goes on they can be reviewed, they set a national cap for GHG emissions.

SECTION 8: CONCLUSION

The effects that industrialization has had on the environment are extreme and undoubtedly real. We are feeling these effects more than ever as the temperature of our planet continues to rise-hotter summers and colder winters, more severe storms and increased drought are some of the repercussions of our damage to our planet. Therefore, it is imperative that we take a firm stance and approach to undo everything we have done to harm our planet in the last two-hundred fifty (250) years. There is no time better than now for more sustainability practices to be implemented across nations worldwide. We must preserve our planet not only for future generations, but for the millions of other species that call Earth home as well.

The goal of this report was to collect data on the top emitters for a chosen region and determine solutions for lowering GHG emissions to move the selected region towards a more sustainable future. For this to be achieved, many objectives were specified by AICHE, such as what region to select, which industry heavily affects the selected region's GHG emissions, what processes this industry employs to reduce emissions and ideas on how these processes can either be improved or replaced, the cost of these ideas, and a tax analysis. It can be concluded that these objectives have been met by our team.

However, there were some experimental limitations which hindered research. These limitations include a lack of knowledge about the specific processes the plants used to remove pollutants from their flue gas, and knowledge about the cost of these processes. Information about the specific gas cleaning processes the plants use was not available online, nor did the plants respond to our emails regarding tours, therefore a 100% accurate cost analysis and emission reduction plans were not able to be made. An estimation of the processes by using a general steam-electric plant and waste-to-energy plant was conducted instead. With an exact schematic of the power plants' processes, a more specified approach to GHG emission reduction options would have been able to be made.

Despite these limitations, the project was still able to be completed successfully as demonstrated in this report. Furthermore, we hope that this report can be beneficial in aiding GHG emissions reduction in Tampa Bay and the world at large.

REFERENCES

(n.d.). Outline of Thermal Power Generation [KEPCO]. Retrieved November 14, 2023, from https://www.kepco.co.jp/english/energy/fuel/thermal_power/shikumi/index.html

(2023, June 16). Untitled. Retrieved November 14, 2023, from https://npr.brightspotcdn.com/2e/af/84775471478b81dcdd7393ecd308/tampa-climate-action-and-equity-plan-low-res.pdf

Air Economics Group-Health and Environmental Impacts Division. (2023, January). *Air Pollution Control Cost Estimation Spreadsheet*. US Environmental Protection Agency.

Air pollution control devices. (n.d.). Energy Education. Retrieved November 1, 2023, from https://energyeducation.ca/encyclopedia/Air_pollution_control_devices

Alam, Q. (n.d.). *Figure 2.1: Schematic of Waste-to-Energy plant showing the incineration...* ResearchGate. Retrieved November 14, 2023, from https://www.researchgate.net/figure/Schematic-of-Waste-to-Energy-plant-showing-the-incineration-of-municipal-solid-waste_fig6_337077791

Ashraf, W. M., Uddin, G. M., Tariq, R., Ahmed, A., Farhan, M., Nazeer, M. A., Hassan, R. U., Naeem, A., Jamil, H., Krzywanski, J., Sosnowski, M., & Dua, V. (2023, June 20). Artificial Intelligence Modeling-Based Optimization of an Industrial Scale Steam Turbine for Moving toward Net-Zero in the Energy Sector. *ACS Omega*, *8*(24), 21709-21725. 10.1021/acsomega.3c01227

Baghouse Dust Collector FAQ. (2020, October 19). U.S. Air Filtration. Retrieved November 1, 2023, from https://www.usairfiltration.com/baghouse-dust-collector-faq/

Bayside Power Station. (n.d.). Tampa Electric. Retrieved November 15, 2023, from https://www.tampaelectric.com/company/ourpowersystem/powergeneration/bayside/

Bouckaert, S., Pales, A. F., McGlade, C., Remme, U., Wanner, B., & Varro, L. (2021). *Net Zero by 2050-A Roadmap for the Global Energy Sector*. International Energy Agency. Retrieved Nov

1, 2023, from https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

BUILDING A CLEAN ENERGY ECONOMY:. (2022, December 15). The White House. Retrieved November 14, 2023, from https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf

Burning Question: Where Does All Your Trash Go? (2017, August 21). Hillsborough County. Retrieved November 15, 2023, from https://www.hillsboroughcounty.org/en/newsroom/2017/08/21/burning-question-where-does-all-your-trash-go

Carbon Benefits | UNREDD Programme. (n.d.). UN-REDD Programme. Retrieved November 1, 2023, from https://www.un-redd.org/glossary/carbon-benefits

Carbon capture and storage. (n.d.). Energy Education. Retrieved November 1, 2023, from https://energyeducation.ca/encyclopedia/Carbon_capture_and_storage

Carter, K. (n.d.). *What is carbon sequestration? | U.S. Geological Survey*. USGS.gov. Retrieved November 14, 2023, from https://www.usgs.gov/faqs/what-carbon-sequestration

Chen, J.-C., Fang, G.-C., Tang, J.-T., & Liu, L.-P. (2005). Removal of carbon dioxide by a spray dryer. *Chemosphere*, *59*(1), 99-105. Retrieved Oct 31, 2023, from https://www.sciencedirect.com/science/article/pii/S0045653504008732

City of Tampa Climate Action and Equity Plan. (2023). https://npr.brightspotcdn.com/2e/af/84775471478b81dcdd7393ecd308/tampa-climate-action-and-equity-plan-low-res.pdf

Climate Ambition Summit – Chair's Summary 20 September 2023 The Climate Ambition Summit was convened to: • showcase "fir. (2023, September 20). the United Nations. Retrieved November 6, 2023, from https://www.un.org/sites/un2.un.org/files/climate_ambition_summit_-_20_september_2023_-_chairs_summary.pdf

Coal-Fired Power Plant Enforcement | US EPA. (2023, April 5). EPA. Retrieved November 7, 2023, from https://www.epa.gov/enforcement/coal-fired-power-plant-enforcement

Covanta Hillsborough. (n.d.). Covanta. Retrieved November 15, 2023, from https://www.covanta.com/where-we-are/our-facilities/hillsborough

Embracing 4.0 technology for power-plant digitization | McKinsey. (2020, September 17). McKinsey & Company. Retrieved November 1, 2023, from https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/power-plant-4-point-0-embracing-next-generation-technologies-for-power-plant-digitization

EPA. (n.d.). *Monitoring by Control Technique - Electrostatic Precipitators*. United States Environmental Protection Agency. Retrieved November 1, 2023, from https://www.epa.gov/air-emissions-monitoring-knowledge-base/monitoring-control-technique-electrostatic-precipitators

Florida Conservation and Technology Center - Big Bend Power Station. (n.d.). Tampa Electric. Retrieved November 15, 2023, from https://www.tampaelectric.com/company/ourpowersystem/powergeneration/bigbend/

Greenwald, J. (n.d.). *Carbon Capture - Center for Climate and Energy SolutionsCenter for Climate and Energy Solutions*. C2ES. Retrieved November 1, 2023, from https://www.c2es.org/content/carbon-capture/

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018: Impacts of 1.5oC Global Warming on Natural and Human Systems. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global* *greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 175-312. https://doi.org/10.1017/9781009157940.005.

H L Culbreath Bayside Power Station - Tampa, FL (Address and Phone). (n.d.). CountyOffice.org. Retrieved November 15, 2023, from https://www.countyoffice.org/h-l-culbreath-bayside-power-station-tampa-fl-e25/

Industrial Environmental Control Systems. (n.d.). EC&S. Retrieved November 1, 2023, from https://www.ecands.com/bag-house/

THE INFRASTRUCTURE INVESTMENT AND JOBS ACT: Opportunities to Accelerate Deployment in Fossil Energy and Carbon Management Activities. (2022, September). Department of Energy. Retrieved November 14, 2023, from https://www.energy.gov/sites/default/files/2022-09/FECM%20Infrastructure%20Factsheet-revised%209-27-22.pdf

Krull, F. (n.d.). *Unleashing AI in power plants*. Siemens Energy. Retrieved November 14, 2023, from https://www.siemens-energy.com/global/en/home/stories/unleashing-ai-in-power-plants.html

McKay Bay Waste Transfer Station. (n.d.). Menard USA. Retrieved November 15, 2023, from https://www.menardusa.com/soil-expert-portfolio/mckay-bay-waste-transfer-station/

Merrill, M. D., Anderson, S. T., & DeVera, C. A. (n.d.). *What's the difference between geologic and biologic carbon sequestration? | U.S. Geological Survey*. USGS.gov. Retrieved November 15, 2023, from https://www.usgs.gov/faqs/whats-difference-between-geologic-and-biologic-carbon-sequestration

Monitoring by Control Technique - Wet Scrubber For Particulate Matter | US EPA. (2022, December 14). Environmental Protection Agency. Retrieved November 1, 2023, from https://www.epa.gov/air-emissions-monitoring-knowledge-base/monitoring-control-technique-wet-scrubber-particulate-0

NAAQS Table | US EPA. (2023, March 15). Environmental Protection Agency. Retrieved November 8, 2023, from https://www.epa.gov/criteria-air-pollutants/naaqs-table

OBB FY 2022 Solid Waste & Environmental Program Management. (n.d.). OpenGov. Retrieved November 15, 2023, from https://stories.opengov.com/tampa/published/WVzg7bmVh

Power Generation. (n.d.). Tampa Electric. Retrieved November 15, 2023, from https://www.tampaelectric.com/company/ourpowersystem/powergeneration/

Power plant profile: HL Culbreath Bayside Power Station, US. (2023, November 14). Power Technology. Retrieved November 15, 2023, from https://www.power-technology.com/data-insights/power-plant-profile-hl-culbreath-bayside-power-station-us/

Resource Recovery Facility. (2023, June 16). Hillsborough County Florida. Retrieved November 15, 2023, from https://www.hillsboroughcounty.org/locations/resource-recovery-facility

Rosania, S. M. (1996, November 11). TAMPA FLORIDA MCKAY BAY REFUSE TO ENERGY FACILITY RETROFIT PROJECT: OPEN PROCUREMENT PROCESS POTENTIALLY SAVES MILLIONS AND ESTABLISHES EMISSION GUARANTEES ABOVE AIR PERMIT THRESHOLDS. https://wtert.org/wp-content/uploads/2020/10/nawtec07-04.pdf

Schwartz, M. P., & White, T. M. (2002). Retrofit of the McKay Bay Waste-To-Energy Facility.

Scrubber. (n.d.). Energy Education. Retrieved November 1, 2023, from https://energyeducation.ca/encyclopedia/Scrubber

sect1 chap1. (2002, July 15). EPA. Retrieved November 1, 2023, from https://www.epa.gov/sites/default/files/2020-11/documents/cs6ch2.pdf

Self-Tuning Artificial Intelligence Improves Plant Efficiency and Flexibility. (2021, April 13). POWER Magazine. Retrieved November 14, 2023, from https://www.powermag.com/self-tuning-artificial-intelligence-improves-plant-efficiency-and-flexibility/

Solid Waste - External. (n.d.). OpenGov. Retrieved November 15, 2023, from https://stories.opengov.com/tampa/published/N4d2ePg94

Spray dryer absorber (SDA). (n.d.). GEA. Retrieved November 1, 2023, from https://www.gea.com/en/products/emission-control/sorption/spray-dryer-absorber.jsp

Tampa Electric knew the procedure was dangerous. It sent workers in anyway. (2017, August 17). Investigations. Retrieved November 15, 2023, from https://projects.tampabay.com/projects/2017/investigations/tampa-electric/big-bend-hellfire-from-above/

This Simple Material Could Scrub Carbon Dioxide From Power Plant Smokestacks. (2022, November 2). National Institute of Standards and Technology. Retrieved November 1, 2023, from https://www.nist.gov/news-events/news/2022/11/simple-material-could-scrub-carbon-dioxide-power-plant-smokestacks

US EPA. (n.d.). *Air Pollution Control Technology Fact Sheet*. United States Environmental Protection Agency. Retrieved Nov 1, 2023, from https://www3.epa.gov/ttncatc1/dir1/fwespwpi.pdf

US EPA. (n.d.). *US EPA Flight*. Welcome To The Green House Gases Mobile Website. Retrieved November 13, 2023, from https://ghgdata.epa.gov/ghgp/main.do#/trend/?q=Find%20a%20Facility%20or%20Location&st=FL&bs=&et=&fid=&sf=11001100&lowE=-20000&highE=23000000&g1=1&g2=1&g3=1&g4=1&g5=1&g6=0&g7=1&g8=1&g9=1&g10=1&g11=1&g12=1&s1=1&s2=1&s3=1&s4=1&s5=1&s6=1&s7=1&s8=1&s9=1&s10=1&s

WINDExchange: Production Tax Credit and Investment Tax Credit for Wind Energy. (n.d.). WINDExchange. Retrieved November 7, 2023, from https://windexchange.energy.gov/projects/tax-credits

WIRED Brand Lab | AI gives power plants a power-up. (n.d.). WIRED. Retrieved November 14, 2023, from https://www.wired.com/sponsored/story/ai-gives-power-plants-a-power-up/

Sources:
[EPA Facility Level GHG Emissions Data]
[emissions2021.xlsx (live.com)]
[McKay Bay Trash Incinerator (energyjustice.net)]

Identified Emission Points:
Steam Electric Plant
Natural Gas compression/distribution
Municipal Incineration

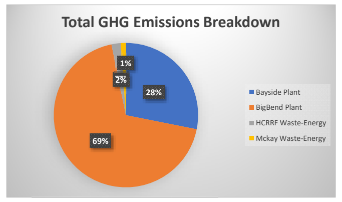
Online Emissions Data
Total emissions from energy producers in hillsborough county: 6085853

EPA DATA **Emission Sources in Hillsborough County from Energy Producers**

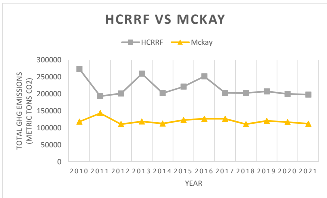
Facilities	City	Postal Code	Year for data	Facility Type	Total Emissions (metric tons)	Emissions by CO2 (metric tons)	Emissions by CH4 (metric tons)	Emissions by N2O (metric tons)	Emissions by SO2 (metric tons)	Emissions by NOx (metric tons)	Electricity Generation	Emissions by Biogenic CO2 (metric tons)
Bayside Power Station	Tampa	33619	2010	Steam Electric Plant	3331345	3327963	1543	1839			3331344	
Bayside Power Station	Tampa	33619	2011	Steam Electric Plant	2754508	2751711	1276	1521			2754508	
Bayside Power Station	Tampa	33619	2012	Steam Electric Plant	2823999	2821130	1309	1560			2823998	
Bayside Power Station	Tampa	33619	2013	Steam Electric Plant	2927394	2924422	1356	1616			2927395	
Bayside Power Station	Tampa	33619	2014	Steam Electric Plant	2773897	2771084	1284	1529			2773897	
Bayside Power Station	Tampa	33619	2015	Steam Electric Plant	3618031	3614358	1676	1997			3618031	
Bayside Power Station	Tampa	33619	2016	Steam Electric Plant	3185638	3182404	1476	1758			3185638	
Bayside Power Station	Tampa	33619	2017	Steam Electric Plant	2424040	2421579	1123	1338			2424040	
Bayside Power Station	Tampa	33619	2018	Steam Electric Plant	2694636	2691901	1248	1487			2694636	
Bayside Power Station	Tampa	33619	2019	Steam Electric Plant	2999621	2996574	1390	1657			2999621	
Bayside Power Station	Tampa	33619	2020	Steam Electric Plant	2902922	2899974	1345	1603				
Bayside Power Station	Tampa	33619	2021	Steam Electric Plant	3159319	3155762	1464	1744	17	332		
Big Bend	Apollo Beach	33572	2010	Steam Electric Plant	10064542	9995622	25206	43714			10064541	
Big Bend	Apollo Beach	33572	2011	Steam Electric Plant	10192968	10119201	26982	46785			10192967	
Big Bend	Apollo Beach	33572	2012	Steam Electric Plant	10375170	10300110	27452	47608			10375170	
Big Bend	Apollo Beach	33572	2013	Steam Electric Plant	10032731	9957643	27455	47633			10032730	
Big Bend	Apollo Beach	33572	2014	Steam Electric Plant	10555962	10471358	30943	53661			10555962	
Big Bend	Apollo Beach	33572	2015	Steam Electric Plant	8959076	8885351	26927	46798			8959077	
Big Bend	Apollo Beach	33572	2016	Steam Electric Plant	7650480	7597974	19252	33254			7650480	
Big Bend	Apollo Beach	33572	2017	Steam Electric Plant	5898781	5859397	14450	24934			5898780	
Big Bend	Apollo Beach	33572	2018	Steam Electric Plant	4763815	4734464	10854	18497			4763815	
Big Bend	Apollo Beach	33572	2019	Steam Electric Plant	2872448	2859042	5074	8332			2872448	
Big Bend	Apollo Beach	33572	2020	Steam Electric Plant	2597983	2587868	3843	6272			2597982	
Big Bend	Apollo Beach	33572	2021	Steam Electric Plant	2829093	2816280	4816	7997	1405	1445		
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2010	MUNICIPAL INCINERATION OR RRF	197825	186509	4413	6903				315120
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2011	MUNICIPAL INCINERATION OR RRF	199359	187594	4588	7177				299518
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2012	MUNICIPAL INCINERATION OR RRF	207229	195468	4526	7235				301291
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2013	MUNICIPAL INCINERATION OR RRF	202297	190347	4660	7290				304905
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2014	MUNICIPAL INCINERATION OR RRF	202875	191180	4561	7134				299355
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2015	MUNICIPAL INCINERATION OR RRF	251324	239754	4512	7058				283155
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2016	MUNICIPAL INCINERATION OR RRF	221269	209483	4596	7190				293555
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2017	MUNICIPAL INCINERATION OR RRF	201877	190475	4446	6956				302016
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2018	MUNICIPAL INCINERATION OR RRF	259117	248103	4295	6719				248254
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2019	MUNICIPAL INCINERATION OR RRF	201101	190472	4145	6484				286372
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	TAMPA	33619	2020	MUNICIPAL INCINERATION OR RRF	192982	182191	4208	6583				275384
HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	Tampa	33619	2021	MUNICIPAL INCINERATION OR RRF	273006.38	272396	96.69	12.69	80	421		162470
Mckay bay refuse-to-energy	Tampa	33605	2010	MUNICIPAL INCINERATION OR RRF	114991	108592	2525	3874				183784
Mckay bay refuse-to-energy	Tampa	33605	2011	MUNICIPAL INCINERATION OR RRF	111980	105854	2550	3576				182062
Mckay bay refuse-to-energy	Tampa	33605	2012	MUNICIPAL INCINERATION OR RRF	116688	109941	2575	4172				182978
Mckay bay refuse-to-energy	Tampa	33605	2013	MUNICIPAL INCINERATION OR RRF	120607	114431	2600	3576				177643
Mckay bay refuse-to-energy	Tampa	33605	2014	MUNICIPAL INCINERATION OR RRF	110751	104492	2441	3818				172216
Mckay bay refuse-to-energy	Tampa	33605	2015	MUNICIPAL INCINERATION OR RRF	126686	120312	2500	3874				164050
Mckay bay refuse-to-energy	Tampa	33605	2016	MUNICIPAL INCINERATION OR RRF	126593	120131	2520	3942				165886
Mckay bay refuse-to-energy	Tampa	33605	2017	MUNICIPAL INCINERATION OR RRF	122967	116356	2578	4033				176281
Mckay bay refuse-to-energy	Tampa	33605	2018	MUNICIPAL INCINERATION OR RRF	112409	105982	2506	3921				178489
Mckay bay refuse-to-energy	Tampa	33605	2019	MUNICIPAL INCINERATION OR RRF	118568	112198	2484	3886				169867
Mckay bay refuse-to-energy	Tampa	33605	2020	MUNICIPAL INCINERATION OR RRF	110790	104700	2375	3715				164941
Mckay bay refuse-to-energy	Tampa	33605	2021	MUNICIPAL INCINERATION OR RRF	142821	142245			220	356		
Mckay bay refuse-to-energy	Tampa	33605	2022	MUNICIPAL INCINERATION OR RRF	118228	112029	2417	3782				162470
					0							

	Total CO2 Emissions	Total CH4	Total N20	Total SO2	total
	125995604	1291940.69	528208.69	1502	127817255.4
Percents	98.57480011	1.010771735	0.413253037	0.001175115	

Facility Name	Total Emissions (2010-2021)
Bayside Plant	35595350
BigBend Plant	86793049
HCRRF Waste-Energy	2610261.38
Mckay Waste-Energy	1435851



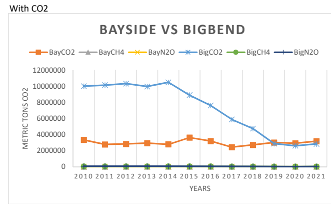
Year	HILLSBOROUGH CTY. RESOURCE RECOVERY FAC.	Mckay bay refuse-to-energy
2010	273006.38	118228
2011	192982	142821
2012	201101	110790
2013	259117	118568
2014	201877	112409
2015	221269	122967
2016	251324	126593
2017	202875	126686
2018	202297	110751
2019	207229	120607
2020	199359	116688
2021	197825	111980



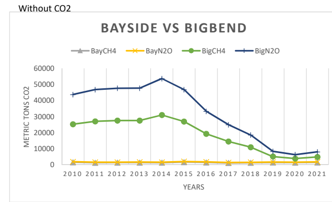
GAS Breakdown of plants

Year	Bayside Emissions by CO2 (metric tons)	Bayside Emissions by CH4 (metric tons)	Bayside Emissions by N2O (metric tons)	BigBend Emissions by CO2 (metric tons)	BigBend Emissions by CH4 (metric tons)	BigBend Emissions by N2O (metric tons)
2010	3327963	1543	1839	9995622	25206	43714
2011	2751711	1276	1521	10119201	26982	46785
2012	2821130	1309	1560	10300110	27452	47608
2013	2924422	1356	1616	9957643	27455	47633
2014	2771084	1284	1529	10471358	30943	53661
2015	3614358	1676	1997	8885351	26927	46798
2016	3182404	1476	1758	7597974	19252	33254
2017	2421579	1123	1338	5859397	14450	24934
2018	2691901	1248	1487	4734464	10854	18497
2019	2996574	1390	1657	2859042	5074	8332
2020	2899974	1345	1603	2587868	3843	6272
2021	3159319	1464	1744	2816280	4816	7997

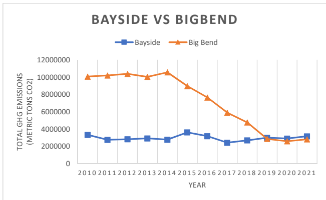
With CO2



Without CO2



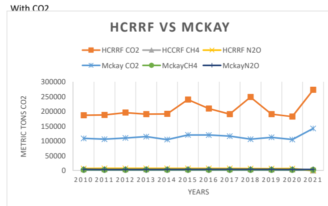
Year	Bayside Power Station	Big Bend
2010	3331345	10064542
2011	2754508	10192968
2012	2823999	10375170
2013	2927394	10032731
2014	2773897	10555962
2015	3618031	8959076
2016	3185638	7650480
2017	2424040	5898781
2018	2694636	4763815
2019	2999621	2859042
2020	2902922	2587868
2021	3159319	2816280



GAS Breakdown of trash

Year	HCRRF Emissions by CO2 (metric tons)	HCRRF Emissions by CH4 (metric tons)	HCRRF Emissions by N2O (metric tons)	Mckay Emissions by CO2 (metric tons)	Mckay Emissions by CH4 (metric tons)	Mckay Emissions by N2O (metric tons)
2010	186509	4413	6903	108592	2525	3874
2011	187594	4588	7177	105854	2550	3576
2012	195468	4526	7235	109941	2575	4172
2013	190347	4660	7290	114431	2600	3576
2014	191180	4561	7134	104492	2441	3818
2015	239754	4512	7058	120312	2500	3874
2016	209483	4596	7190	120131	2520	3942
2017	190475	4446	6956	116356	2578	4033
2018	248103	4295	6719	105982	2506	3921
2019	190472	4145	6484	112198	2484	3886
2020	182191	4208	6583	104700	2375	3715
2021	272396	96.69	12.69	142245	2399	3753
				112029	2417	3782

With CO2



Without CO2