**Problem Statement**

Glass factory float lines generate significant amounts of wasted heat, which represents an opportunity for heat reclamation. The problem lies in converting the heat to useful electricity with an economically viable waste heat recovery system. Glass factories currently source electricity from the grid at competitive rates for industrial consumption. For our solution to be cost-competitive with electricity generated from fossil fuel plants, it must supply electricity at a lower comparative price.

We intend to explore two primary methods by which we can supply electricity at a lower comparative price to fossil fuel plants. The first method is based on the price that we can generate electricity with our thermophotovoltaic (TPV) waste heat recovery system. Some estimates show electricity rates for TPVs at around $0.06/kwh - which is already half the price of fossil fuel-generated electricity (quoted at an average of $0.12/kwh). However, TPVs are expensive to make and the price of the system would factor into the price of electricity produced by the system. We intend to explore the cost-competitiveness of our system using datasets on state-level electrical prices compared to our best-case-scenario for TPV electricity rates ($0.06/kwh).

The second method is based on generating carbon credits from emission savings brought about by our waste heat recovery system. Our waste heat recovery system operates with net zero emissions and we estimate it can mitigate carbon emissions from each glass factory with efficiencies ranging from 20% and up. Essentially, we would mitigate carbon emissions by 20% at each plant where we implement our waste heat recovery system. The emission savings are quantified as tons of carbon dioxide saved, with each ton saved equal to one carbon credit. This represents a revenue stream for our company in the form of carbon credits valued at state-level prices per credit.

We intend to use data analytics methods taught in this class applied to generating different profit scenarios. We aim to generate a set of profit scenarios from low-end profits to high-end profits based on our assumptions of energy cost, carbon emissions mitigation, and conversion to carbon credits as a source of revenue. We will use our TPV efficiencies, carbon mitigation efficiencies, and waste heat recovery system manufacturing/deployment costs as dependent variables to construct a data set from which we can base predictions. We will use trends present in these data sets to predict future revenue from carbon credit prices and electricity prices. We will conduct comparative analyses between our electrical rates and fossil fuel plant electrical rates, factoring in added revenue to the glass plants from selling them carbon credits - if it brings these plants in compliance with government emission regulations and decreases their taxes correspondingly.

**What questions we would like to explore**

* How much carbon emissions does the glass industry contribute?
* How much electricity do glass plants use?
* What are the electrical costs for glass plants?
* How much can TPV technology save on electrical costs and CO2 emissions?
* How does this translate to carbon credits?
* What are the future trends for carbon credit prices?
* What are the future trends for fossil fuel plant electrical rates?
* What are the future trends for government emission regulations?
* What is the competitive landscape for waste heat recovery now and how can we position ourselves in low, medium, and high-end profit scenarios to be competitively priced for our electrical rates and our carbon mitigation?

**Why these are the right questions to consider**

These questions take into account the amount of carbon dioxide emissions the glass industry produces during their manufacturing processes as well as the electricity used in the manufacturing processes. Knowing how much the renewable system technology can save on electricity will translate to the amount of carbon emissions that can be reduced.

**Previous attempts at these questions and how our approach differs**

We have accumulated several reports aggregating data on electricity rates for retail, commercial, and industrial end-uses. There are numerous reports on the location of float glass factories and their number of float lines. There is significant literature on the pricing of carbon credits. However, none of these reports are motivated by the type of questions we are considering - namely, how these trends fit into waste heat recovery with renewable energy systems.

**Dataset**

Float Glass Factory Dataset:

*Source*

<https://members.glass.org/cvweb/cgi-bin/msascartdll.dll/ProductInfo?productcd=WOGFLOAT>

*Location*

<https://docs.google.com/spreadsheets/d/184kJd3PJ4hn2CUh795bUs3U1rP0pWbG-/edit?rtpof=true#gid=1366517478>

Electrical Costs Dataset:

*Source*

<https://www.eia.gov/electricity/monthly/xls/table_5_06_a.xlsx>

*Location*

<https://drive.google.com/file/d/1LlzoEiJHyTIZF-enDpgKA0eiupHm2TRK/view>

Carbon Pricing Dataset:

*Source*

<https://carbonpricingdashboard.worldbank.org/>

*Location*

<https://drive.google.com/file/d/1LlzoEiJHyTIZF-enDpgKA0eiupHm2TRK/view>

**Data Cleaning**

With the proposed datasets, list some of the steps you might need to carry out to get it

to a form that will be more amenable to analysis.

Please be as specific as possible to your dataset and less generic.

Float Glass Factory Dataset:

* US located plants
* Establish WCSS (Global coordinates) for each plant location
  + For mapping the location of the plants onto a US layer
* Largest plants (tons glass/size)

Electrical Cost Dataset

* Pure electrical costs $/kWh
* WCSS for mapping cost of electricity to each state
* WCSS locations for power plant locations
  + Petroleum
  + Natural gas
  + Coal

Carbon Pricing Dataset:

* Filter data in terms of US, EU, and Canada
* Organize data in terms of where carbon prices are the highest and the lowest

Generate a new data set based on our WCSS power plant and glass plant coordinates to find the distance between the two

**Visualizations**

What plots would you graph as you explore your dataset?

Here I want you to think about the plots that would be most useful for yourself to make sense of

your dataset as it relates to your problem state.

Distance and energy cost

Price Saving vs amount of CO2 emissions reduced

* US Maps
  + Glass plant locations
  + Power plant locations
  + Regions of interest that show electrical prices by state
  + Shows carbon emissions in each plant
    - Dependent on number float lines
    - Each location will be weighted on 3 scenarios that are:
      * 500 tons of glass / float line
      * 700 tons of glass / float line
      * 1000 tons of glass / float line
* Carbon credit prices in the future
* Electricity prices in the future
* Government emission regulation trends

**Ethical Considerations**

What ethical concerns, if any, may arise as you consider your problem statement? Who might

be affected? Why? How can that be mitigated?

It’s great practice to start considering these questions and would make a much stronger final

project report. Refer to week 1 lecture notes if you need to.

Ethical concerns that arise are CO2 emissions in regards to Global Warming. This affects the entire world to sustain the planet. Utilizing advanced technology like TPVs, we can mitigate the effects of global warming.