In Situ Carbon Sequestration Potential For New York City Power Sources

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Overview

- Background
  - Carbon capture and storage
  - In situ mineralization
  - Field application
  - Thesis
- Identifying potential power plants and sequestration sites
- Data collection
  - Analyzing physical and economic feasibility
  - Conventional CCS vs. CarbFix (cost)
- Results
- Conclusions

Background on Carbon Capture and Storage

- Generally achieved through saline tanks or underground CO_2 storage reservoirs
  - Covered by impermeable rock
- Leakage of CO_2 can still occur
  - Carbon is highly buoyant at injection
  - Potential contamination of groundwater surfaces
- “Trapping methods” is a recent technology offering more secure and permanent storage of CO_2
  - Physical trapping
  - Residual saturation trapping
  - Solubility trapping
  - **Mineral trapping**

In Situ Carbon Mineralization and CarbFix

- Pure/dissolved CO_2 injected into porous rock
  - Weak carbonic acid reacts with carbonate/silicate minerals
  - Bicarbonate ions
  - Minerals within the rock react with the bicarbonate ions
    - Calcium, magnesium, iron
    - Specific rock types: basalt and peridotite
- Successful field implementation
  - Hellisheiði Geothermal Power Station in Iceland
    - Began in 2006
    - Over 95% of the injected CO_2 was mineralized within a year
  - Wallula project in Washington State
    - No CO_2 leakage, unknown how much was actually mineralized
  - Staten Island serpentine study
    - Field tests, no actual implementation

Thesis: *The construction of a CO2 sequestration system, as part of a coal or oil plant located in the New York tri state area, will prove to be economically, socially, and physically feasible in tandem with the technology used in the Carbfix project in Iceland.*

Step 1: Identify Potential Power Plants

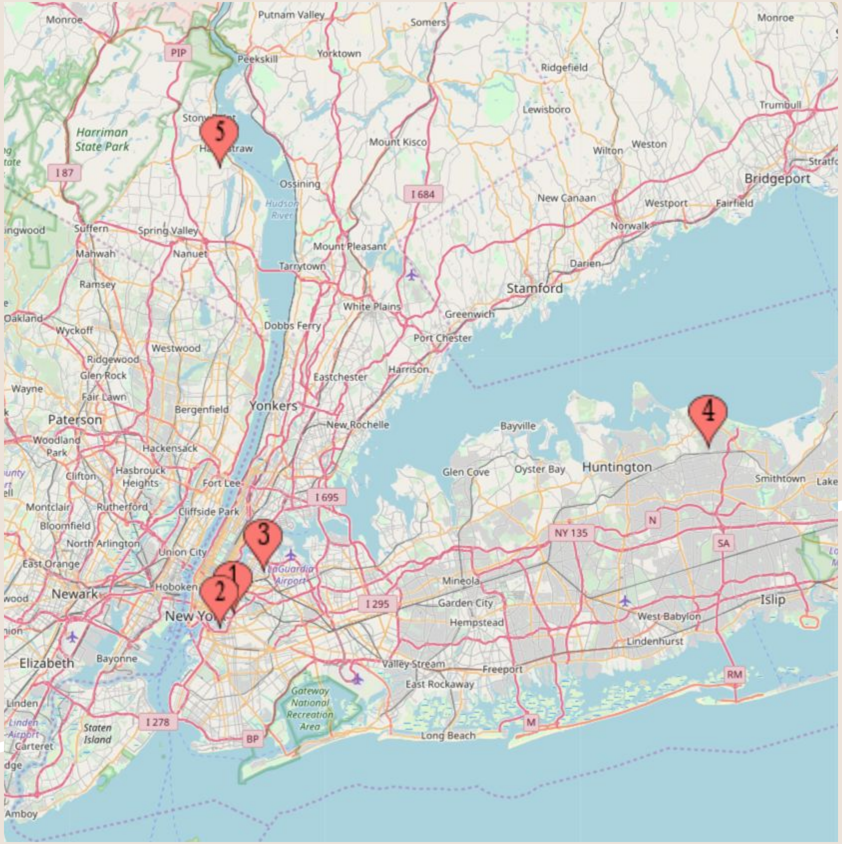
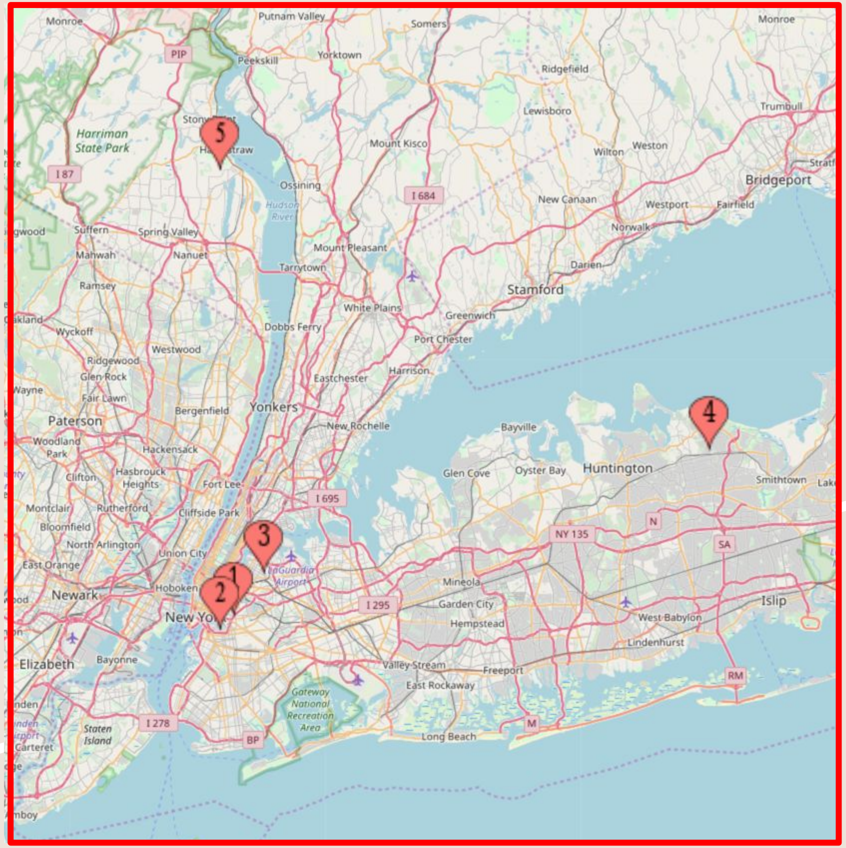


Table 1: Measurements for Choosing Power Plants to Assess

Power Plant	Annual CO2 emissions	Transportation feasibility
1. East River	1,375,180.33	Distance to Newark site: 22 km Sandy Hook: 38 km NY Bight: 27 m Sum of distances: 87 **Average distance: 29**
2. Astoria	3,189,821.02	Newark: 51 km Sandy Hook: 111 km NY Bight: 27 km Sum of distances: 189 **Average distance: 63**
3. Ravenswood	3,458,795.84	Newark: 53 km Sandy Hook: 97 km NY Bight: 32 km Sum of distances: 182 **Average distance: 61**
4. Northport	5,023,285.66	Newark:: 107 km Sandy Hook: 167 km NY Bight: 62 km Sum of distances: 336 **Average distance: 112**
5. Bowline Point	1,028,981.30	Newark: 61 km Sandy Hook: 96 km NY Bight: 83 km Sum of distances: 240 **Average distance: 80**

Original figures; Data sources: Johanna Nelson; Commission for Environmental Cooperation; Google Maps

Step 2: Identify Potential Sequestration Sites



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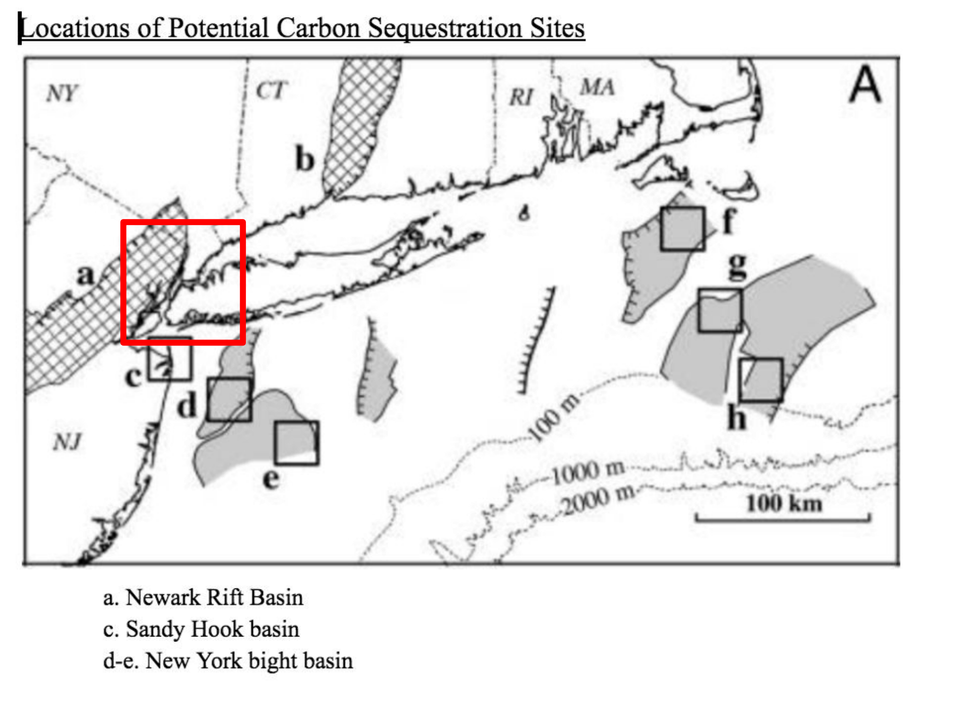
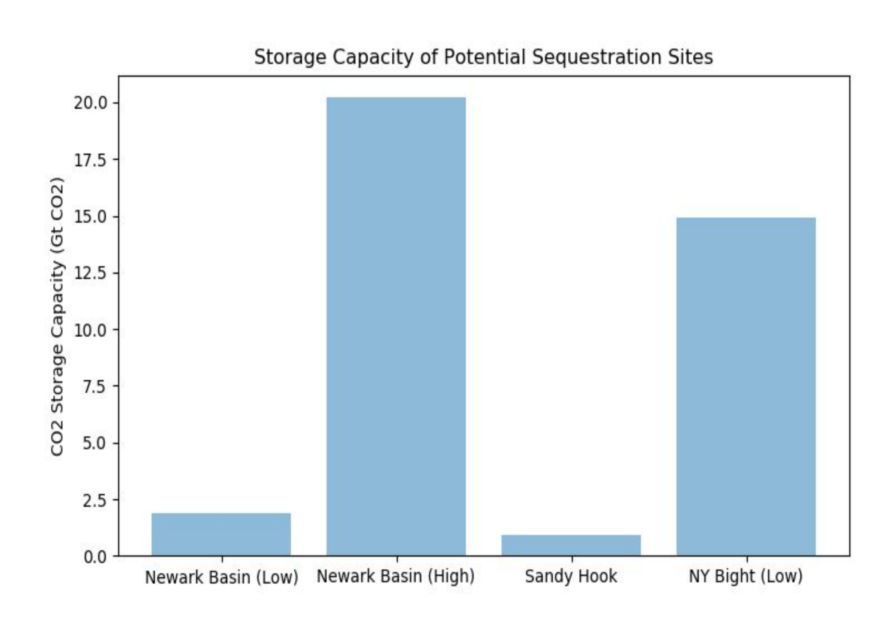


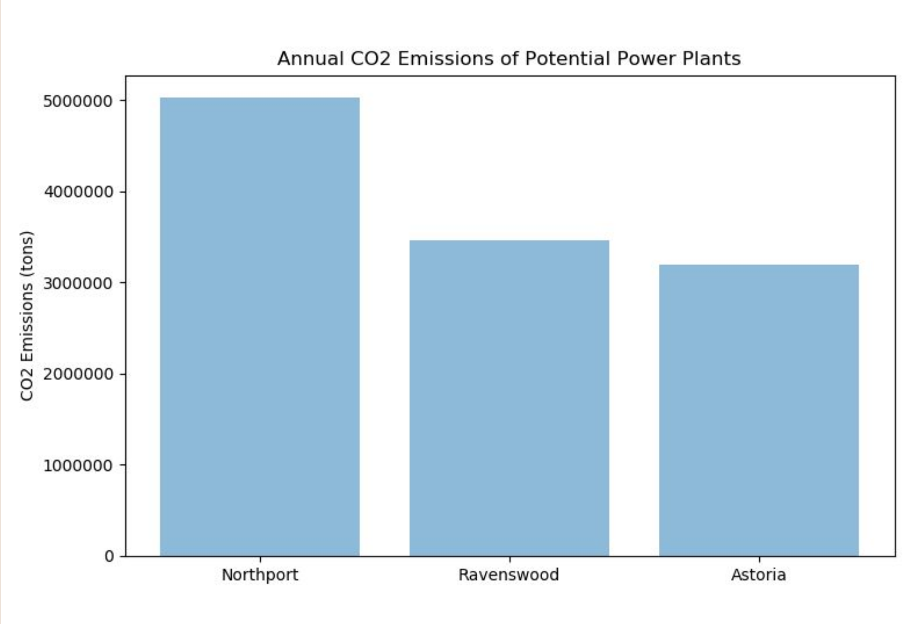
Source: David Goldberg et. al. (2010)

Data Collection

1. Years of Potential Storage from Sequestration Sites for Each Power Plant
2. Annual Social Cost of Power Plants
3. Social Savings of Using Full Potential of Each Sequestration Site
4. Cost of Implementing Conventional CCS vs. CarbFix

Initial Calculations: Measuring the Potential of Sequestration Sites and Current State of Power Plants

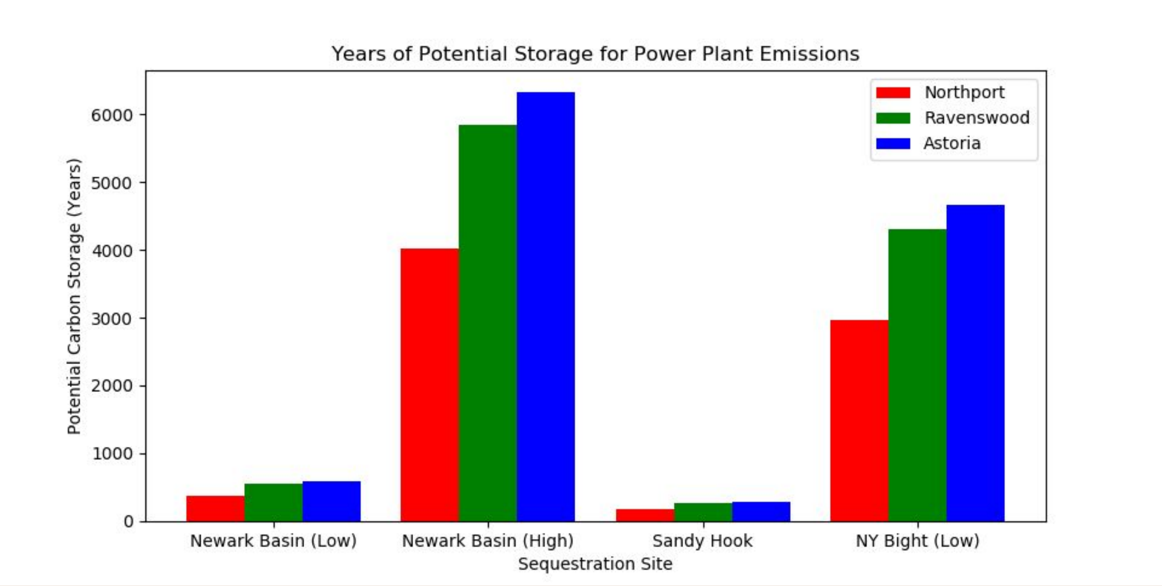


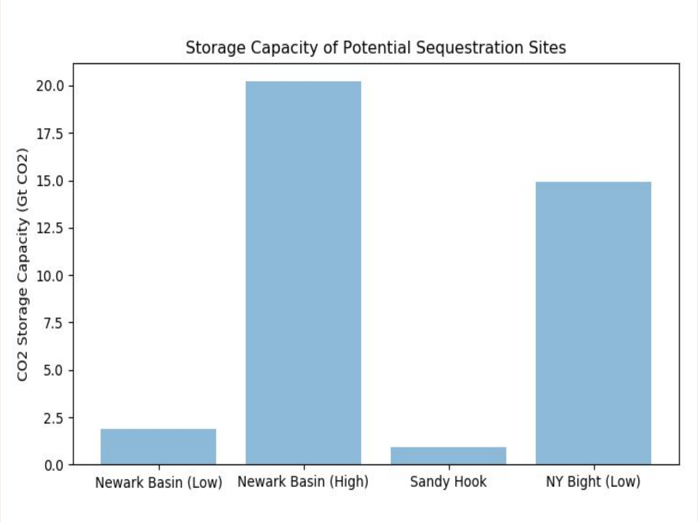


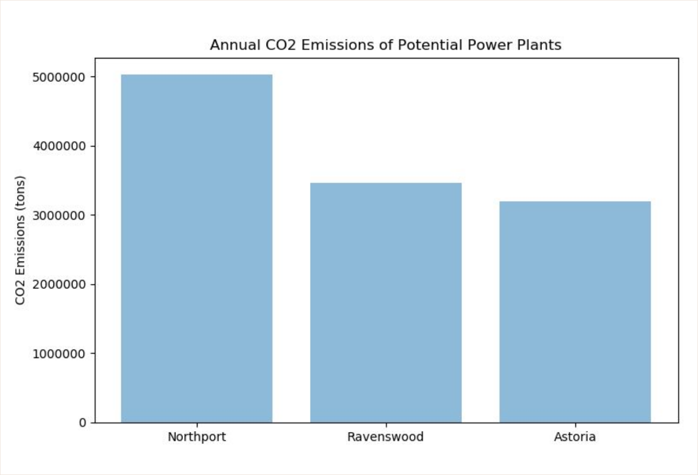
Storage Capacity = [Surface Area] x [Depth of feasible CCS] x [Conversion to Gt CO2]

1. Years of Potential Storage from Sequestration Sites for Each Power Plant

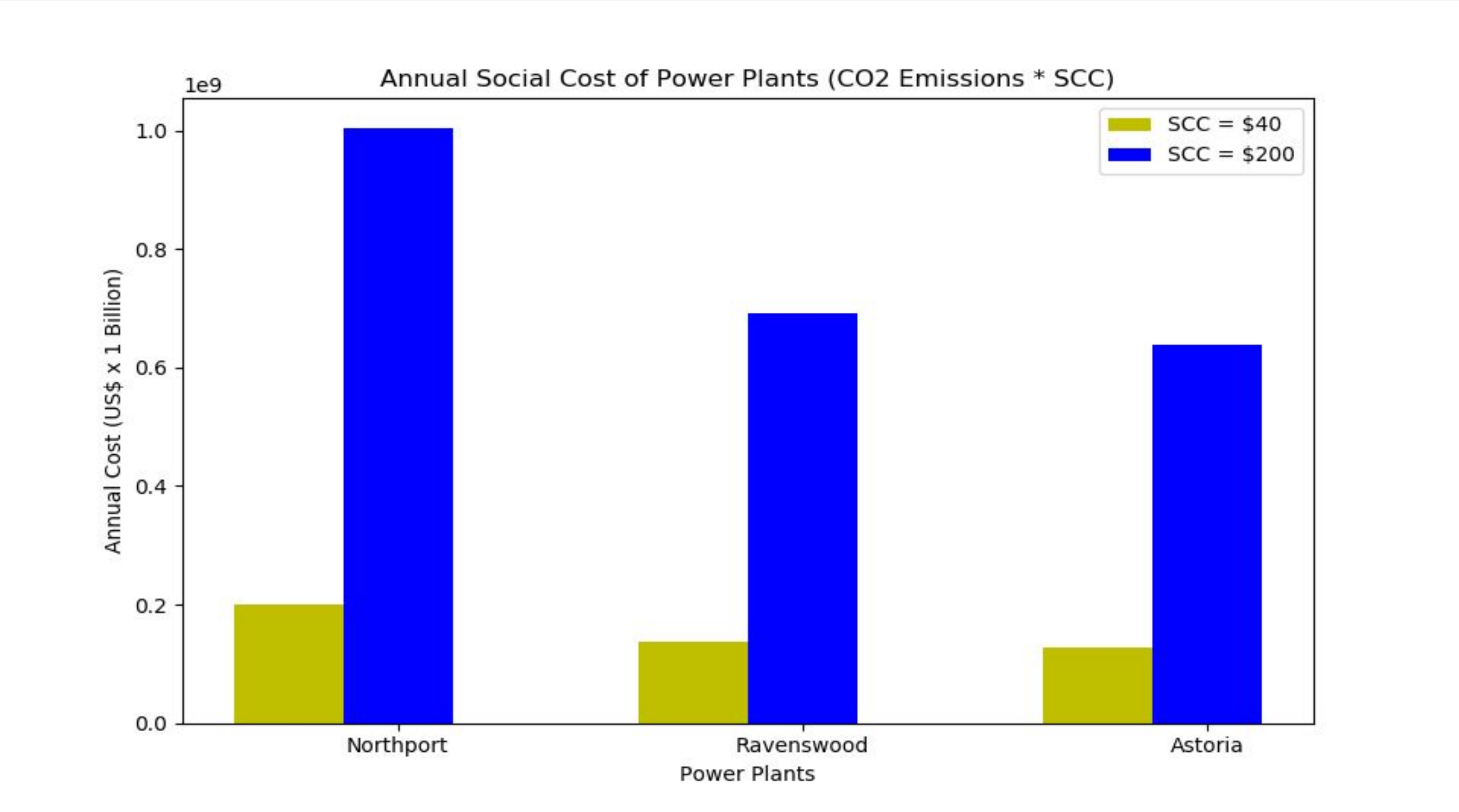
Years of Potential Storage = [Storage Capacity] / [CO2 Emissions]







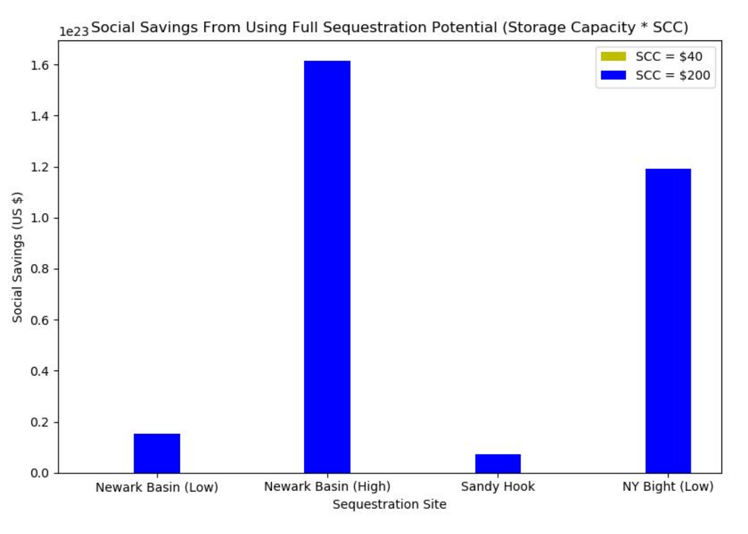
2. Annual Social Cost of Power Plants



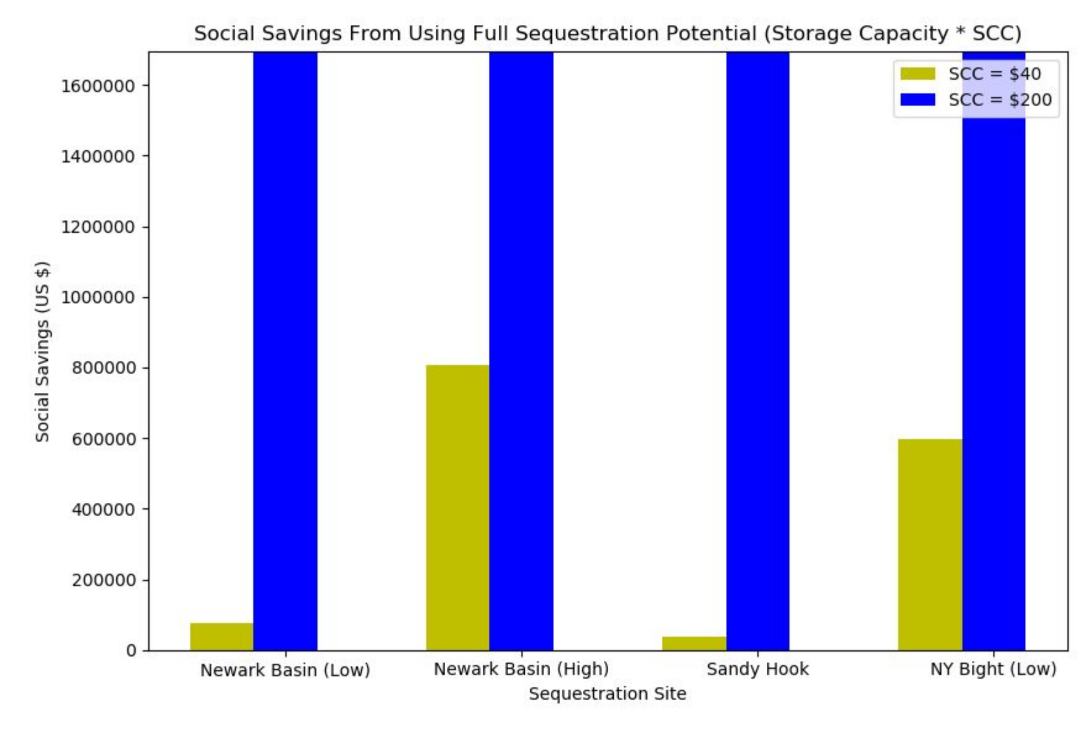
[Power Plant CO2 Emissions/yr] x [SCC] = Negative Social Cost from Emissions/yr

3. Social Savings of Using Full Potential of Each Sequestration Site

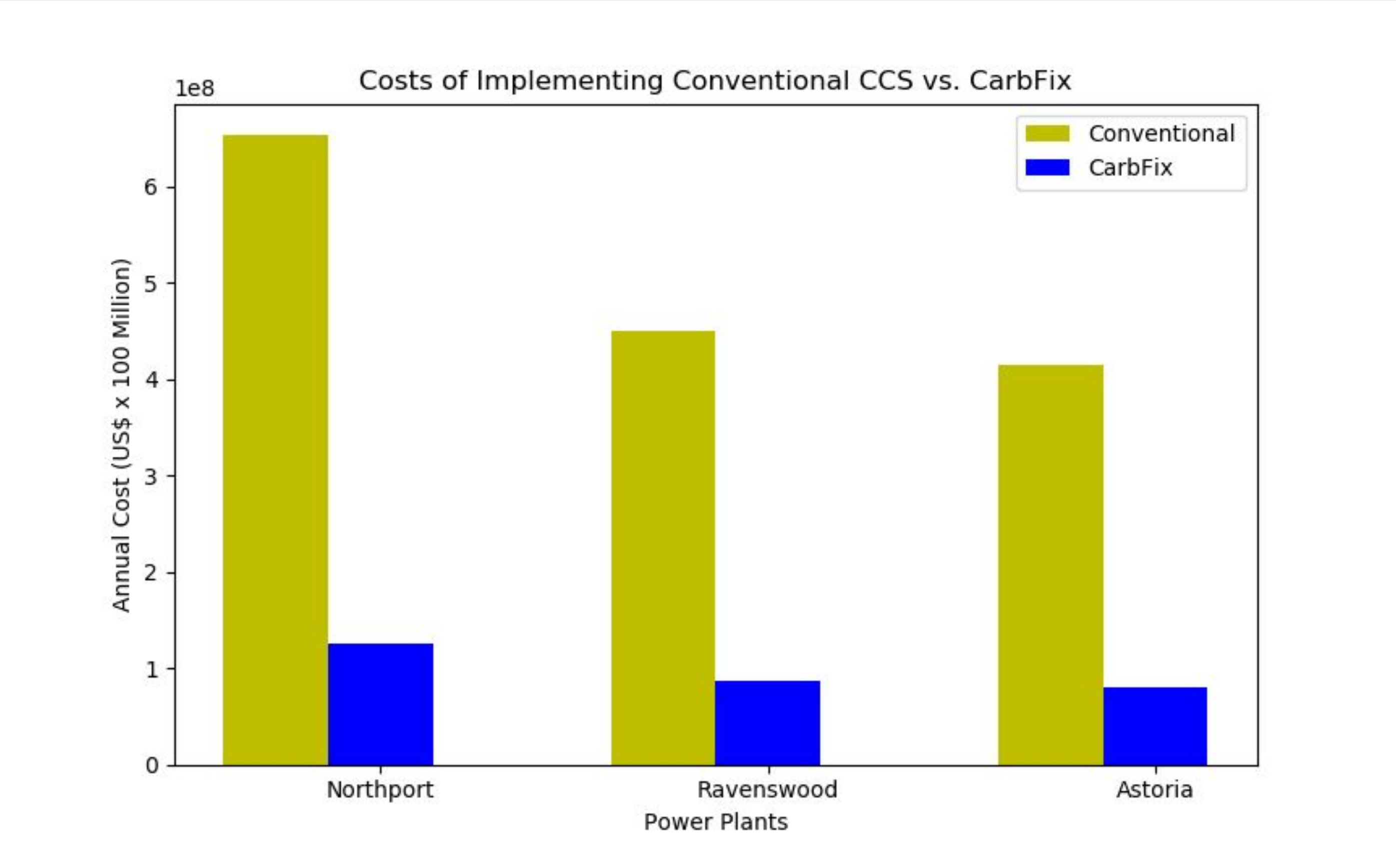
[Potential CO2 Storage of Sequestration Site] x [SCC] = Positive Social Cost from Emissions/yr



Zoomed in:



4. Cost of Implementing Conventional CCS vs. CarbFix



[Cost/ton of storage] x [Power Plant Emissions] = Total Implementation Cost

Determining the Optimal Power Plant + Sequestration Site Pairings

Rank	**Sequestration Site Parameters**	Surface area	Positive Social Cost	Offshore/ Onshore	**Power Plant Parameters**	Distance	Emissions	Negative Social Cost
1 (highest)		Newark	Newark	NY Bight (offshore)		Ravenswood	Northport	Astoria
2		NY Bight	NY Bight	Newark Sandy Hook (onshore)		Astoria	Ravenswood	Ravenswood
3 (lowest)		Sandy Hook	Sandy Hook			Northport	Astoria	Northport

Results

Optimal sites based on...

- **Potential years of storage and lowest negative social cost:** Astoria Generating Station
- **Largest storage capacity:** Newark Rift Basin
- **Offshore sequestration advantage:** New York Bight basin
- **Best transportation feasibility:** Ravenswood Generating Station
- **Most emissions saved:** Northport Power Station

Conclusions

- In terms of geology and location, constructing the in situ capture and storage site IS POSSIBLE!
- No clear-cut optimal pairing
    - Energy companies looking to invest and do pilot tests can do so, knowing what advantages different pairings have
- Future research is needed for cost benefit analysis between specific power plants and sequestration sites

Works Cited

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