Environmental Prospects of Carbon Dioxide Sequestration and Utilization in Pennsylvania's Industrial and Agricultural Sectors

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Introduction:

Objective: Reduce greenhouse gas (GHG) emissions in Pennsylvania (PA).

- The power sector contributes approximately 40% of total global annual GHG emissions.
- With 218.6 million metric tons, PA was the 4th highest Carbon Dioxide (CO_2) emitter in 2016 U.S. rankings.
- In anaerobic digesters (ADs) microorganisms break down organic matter into a gas composed of CO_2 and methane (CH_4) (see Fig. 1).
- CH_4 is the energy producing component in biogas.

Solution : Use CO_2 recirculation in existing agricultural ADs in PA to increase CH_4 and decrease CO_2 in biogas products. It is also possible to capture CO_2 from fossil energy and bioenergy systems and inject it into geologic formations to reduce GHGs. (see Fig. 2).

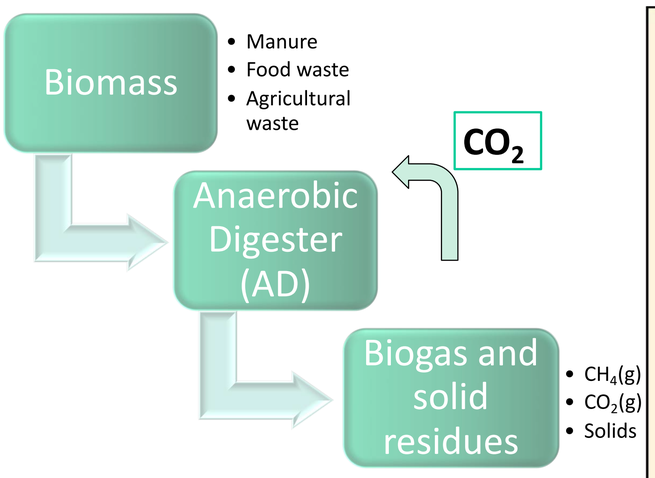


Figure 1. CO_2 enhancement in ADs

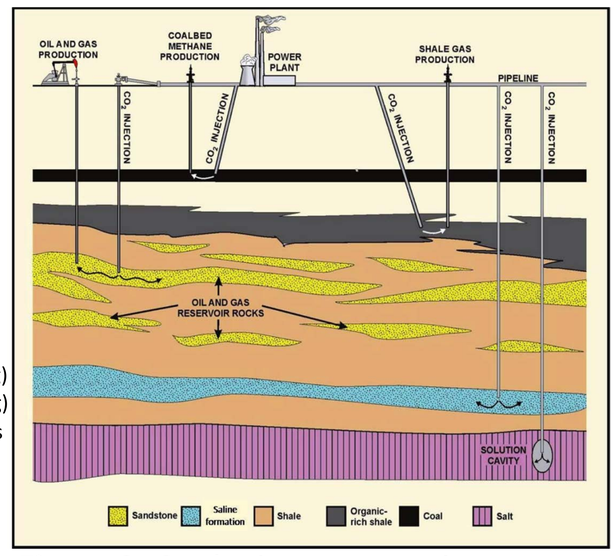


Figure 2. Geologic sequestration targets

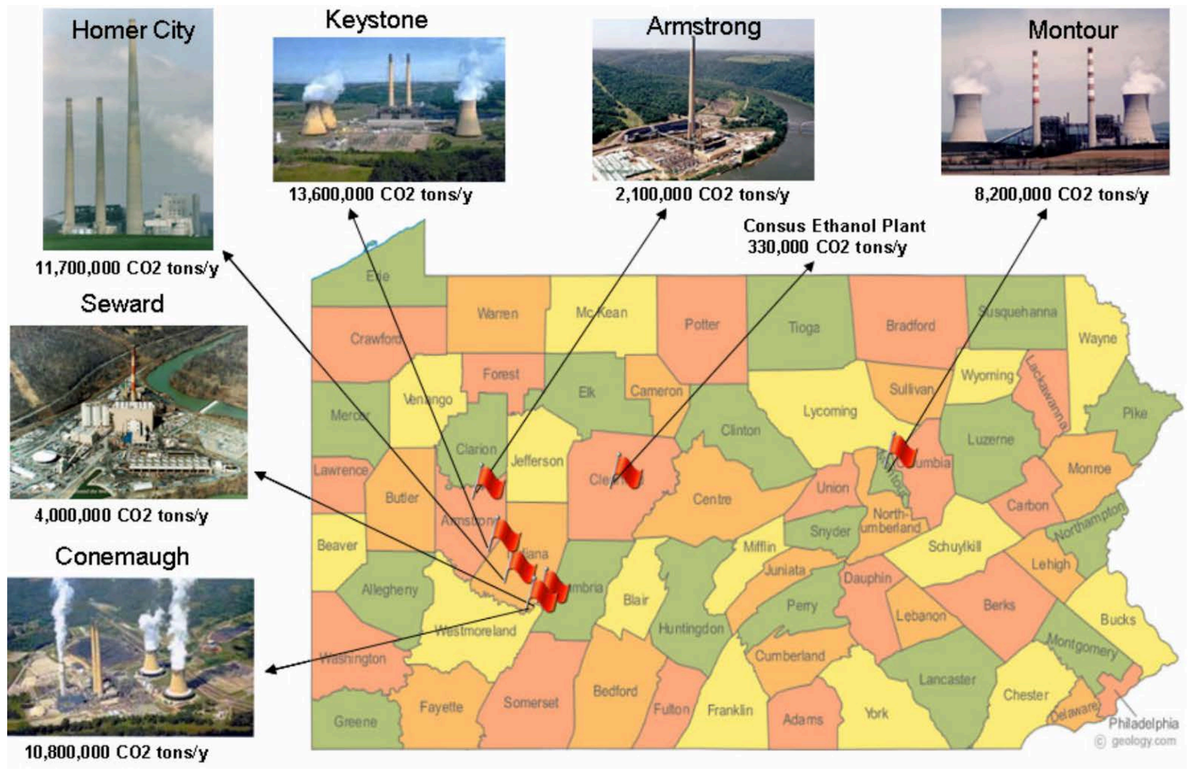


Figure 3. Coal-fired power generating stations and their CO_2 footprint

Major CO_2 capture opportunities in PA

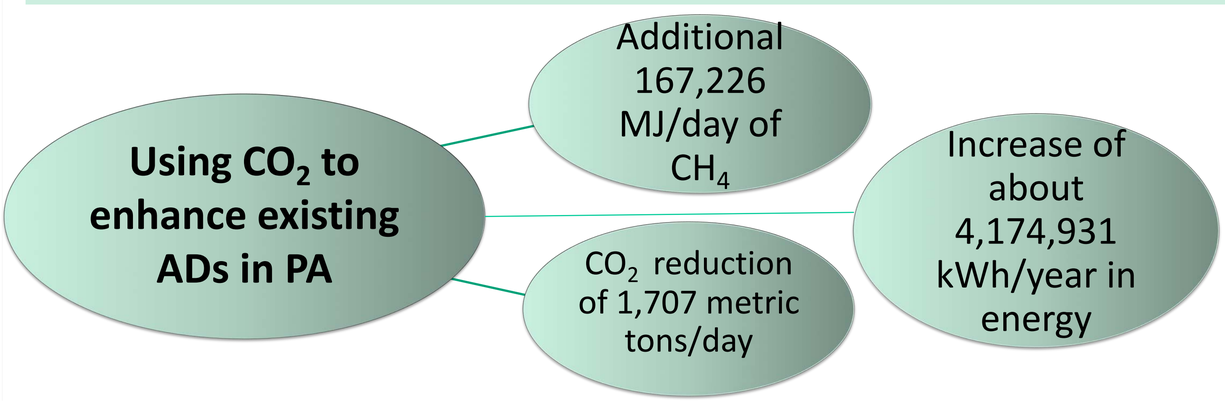
- Six facilities release over 15% of PA's total emissions (see Fig 3).
- Some required infrastructure for CO_2 transportation and storage is already in place because of the industrialization of sites.
- This network could capture 18-27 million metric tons of CO_2 per year
- In the future, if 90 million metric tons of CO_2 could be collected and sequestered from stationary power plants, that would eliminate 70% of the state's emissions per year from electricity generation.

Results:

PA has the potential to geologically store hundreds of years of CO_2 emissions at current emission rates.

CO_2 sequestration capacity in PA	**88.5 billion metric tons**
PA's storable years of CO_2 emissions	**300 years**
PA's main storage capacity distribution includes:	• **85% saline formations** • **14% carbonaceous shales**

Benefits of reuse: CO_2 recirculation can increase CH_4, increase renewable electricity and reduce CO_2 emissions from current ADs in PA.



Methods:

- Storage efficiency determined using Monte Carlo sampling.
- Only physical constraints were accounted for when determining the areas that can store CO_2.
- No consideration was given to the sequestration potential of saline formations shallower than 2,500 feet.
- For AD improvements, two studies were analyzed. The most conservative percentages were used to make numerical estimates.
- 28 out of 29 working ADs in PA had data that allow for estimations of potential CH_4 increases if CO_2 recirculation was applied.
- Linear regression used to extrapolate missing information.

Future Research:

Geologic storage and AD enhancing are only two of the many uses of CO_2. Investigating the other uses and benefits of CO_2 in the production of plastics, fuels, food, beverages, fire extinguishers, refrigerants, and more would be beneficial.

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References:

1.Bajón Fernández, Y., Soares, A., Villa, R., Vale, P., & Cartmell, E. (2014, February 12). Carbon capture and biogas enhancement by carbon dioxide enrichment of anaerobic digesters treating sewage sludge or food waste. Retrieved July 17, 2019, from https://www.sciencedirect.com/science/article/pii/S0960852414001813#b0120

2. Department of Conservation and Natural Resources. (2009, August 14). Geologic Carbon Sequestration Opportunities in Pennsylvania. Retrieved July 17, 2019, from https://pecpa.org/wp-content/uploads/Geologic-Carbon-Sequestration-Opportunities-in-PA-2009-1.pdf

3. See additional document for a full list of references.