

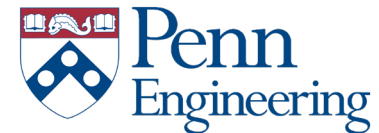


CCS and CDR Opportunities in Industrial Decarbonization

Jen Wilcox

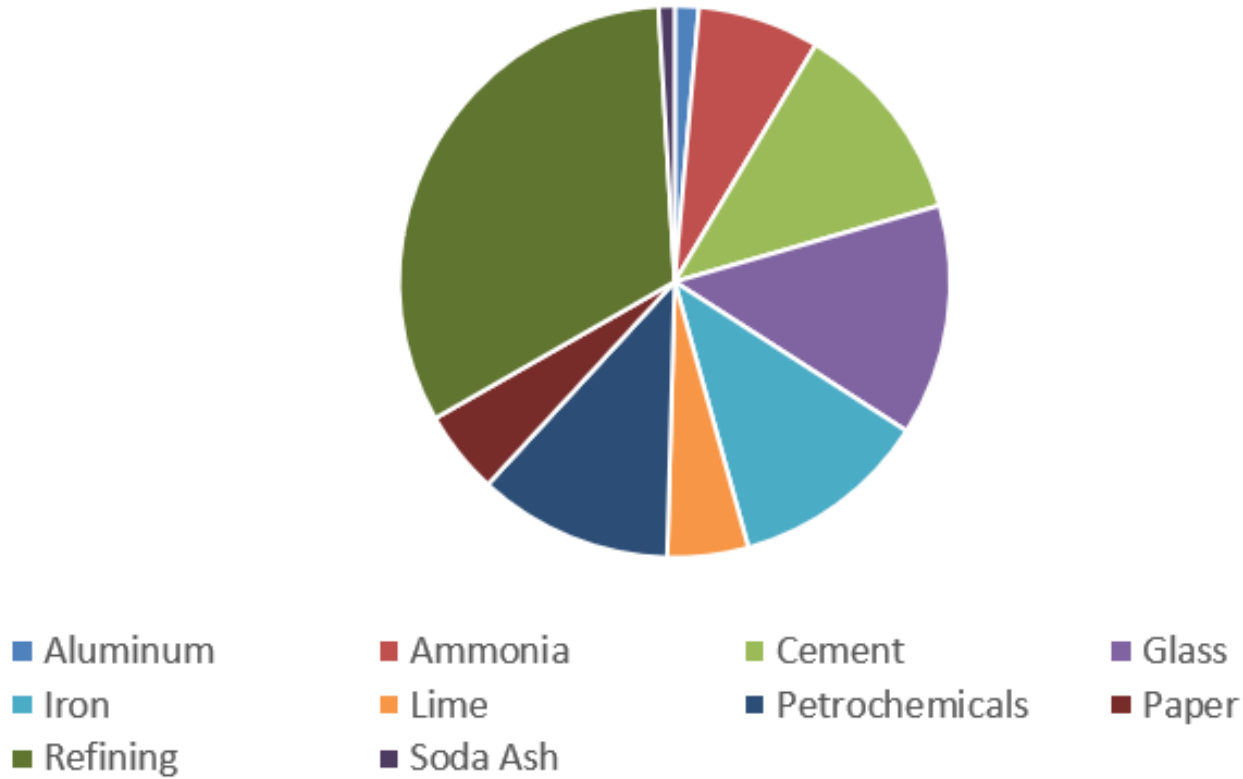
2024 FECM/NETL Carbon Management Research Project Review Meeting

August 4th, 2024



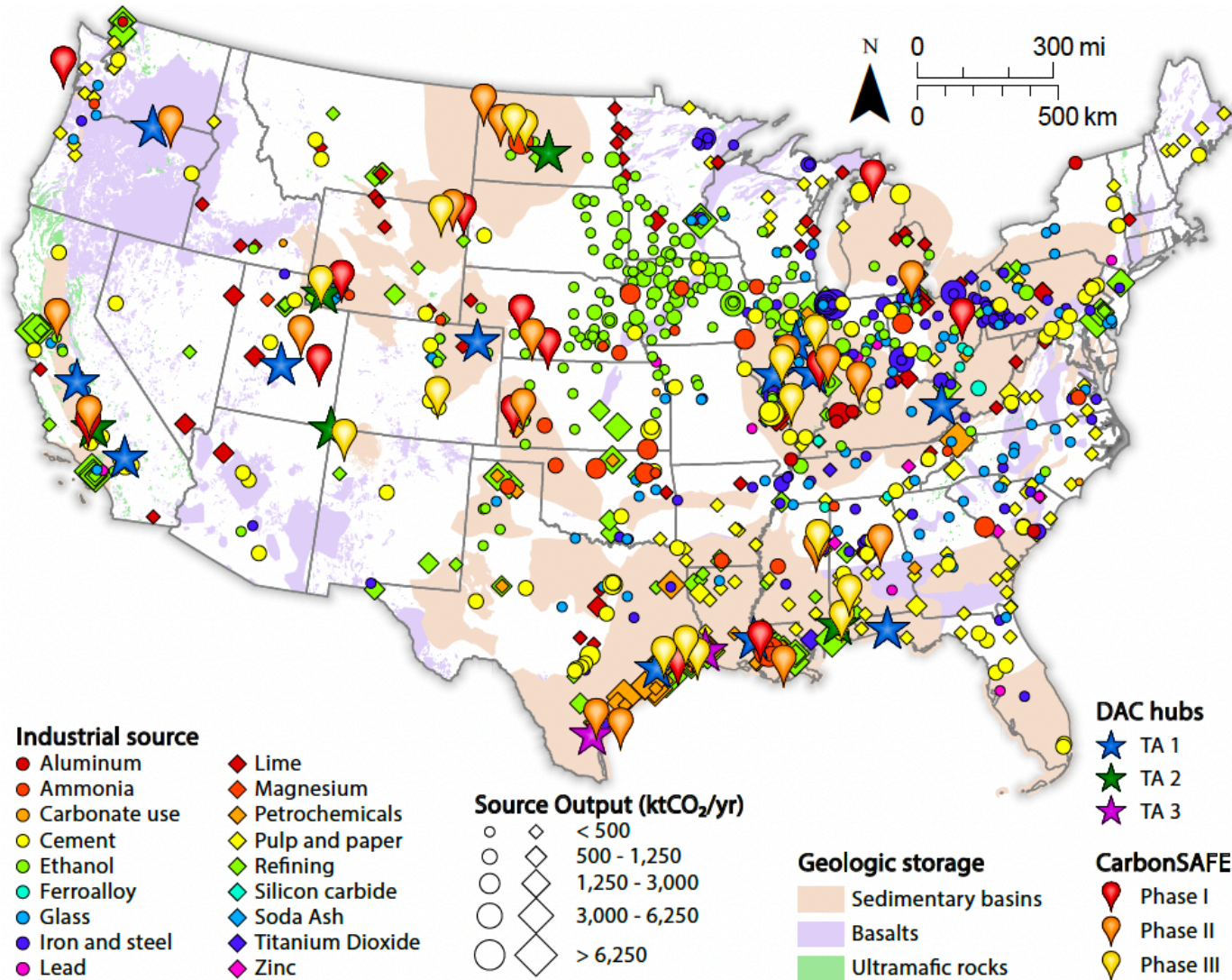
US Industry Emissions

Distribution of Industrial Emissions for Sectors Not Yet Demonstrated
(575 MT CO₂/yr)



Source: Recent EPA Flight Data

Carbon Hubs Emerging – Importance of Thoughtful Siting



Focus on Several Sectors

US Emissions (Global Emissions) in MtCO₂/yr

1. Cement 69 (2420)
2. Iron-Steel 66 (2620)
3. Lime 27 (495)
4. Paper 25 (150)
5. Glass 8 (95)

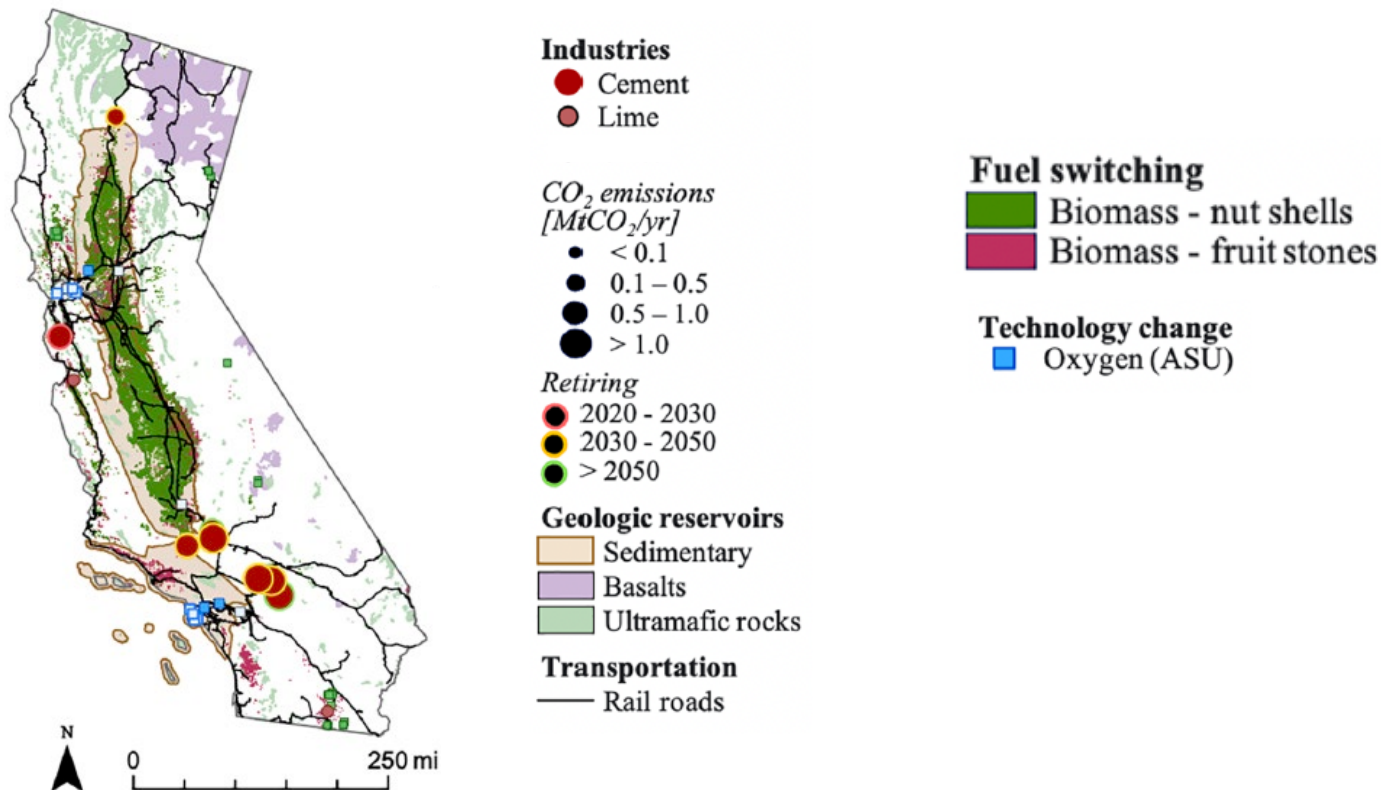
- CCS retrofits have the potential to significantly reduce the emissions in many of these sectors – with stacking decarbonization approaches with CDR
- Reducing these emissions supply chains means reduction of others' Scope 3 emissions

References: Pisciotta et al., Current state of industrial heating and opportunities for decarbonization, Progress in Energy and Combustion Science, 2022; Renforth, et al., Carbon dioxide removal could result in the use of lower-grade iron ore in a decarbonized net-negative emission steel industry, Journal of Cleaner Production, 2024.

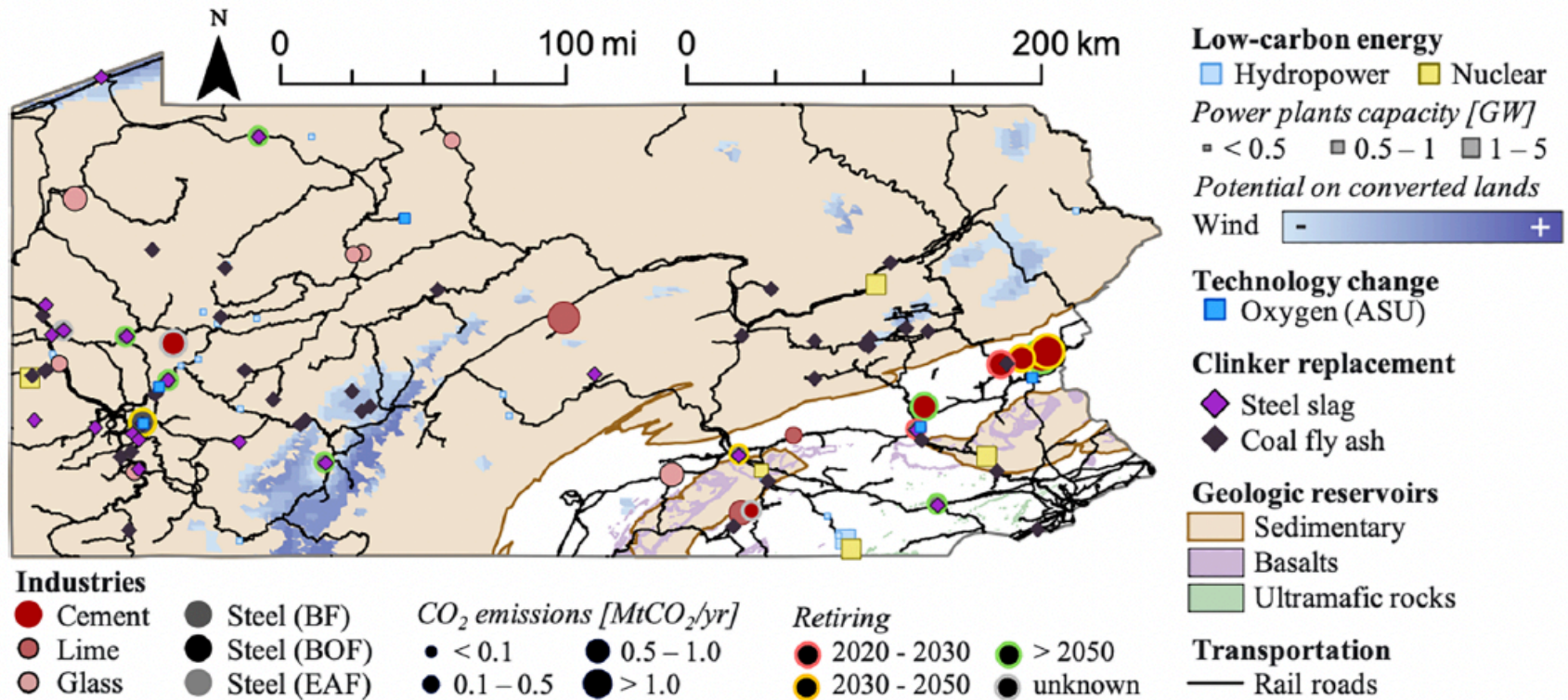
Looking at Cement Decarb in California

US Emissions (Global Emissions) in MtCO₂/yr
Cement 69 (2420)

Options for decarbonization include fuel switching with high-quality sustainably sourced biomass and CCS + kiln age may lead to new approaches, e.g., oxy-fired which is already taking place in the glass industry to reduce NO_x by 80%



Cement and Steel Decarb Opportunities in PA



- Cement production is often co-located with concrete production
- Cement decarbonization efforts (CCS, fuel switching, using fly ash) + synthetic aggregates for concrete can lead to deeper reductions
- Steel slag + DAC could also lead to reductions in steel

References: Pisciotta et al., Current state of industrial heating and opportunities for decarbonization, Progress in Energy and Combustion Science, 2022; Renforth, et al., Carbon dioxide removal could result in the use of lower-grade iron ore in a decarbonized net-negative emission steel industry, Journal of Cleaner Production, 2024.

When Considering Siting

Co-locating projects with geologic storage opportunities and, but what about community benefits in terms of reduced air pollution?

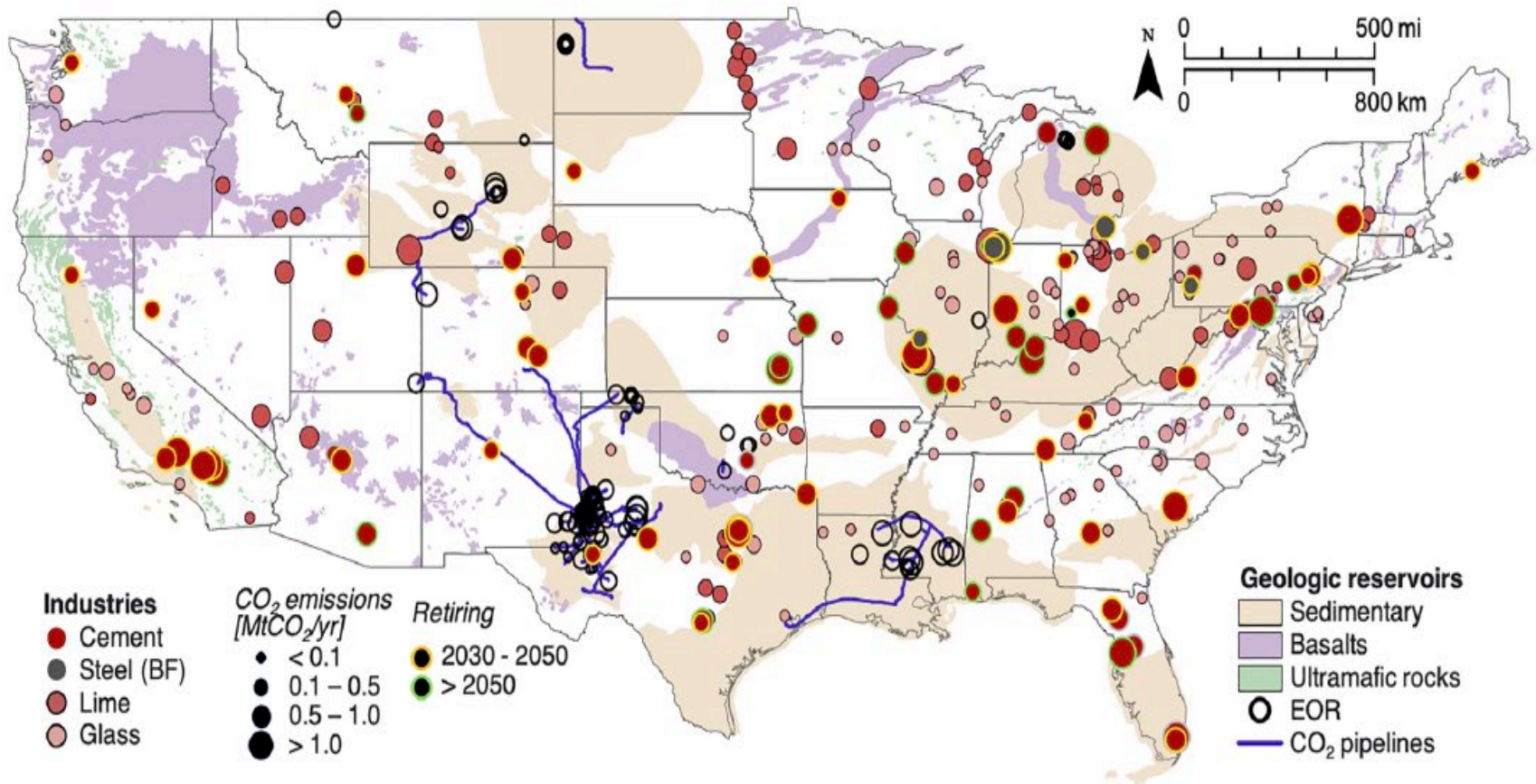
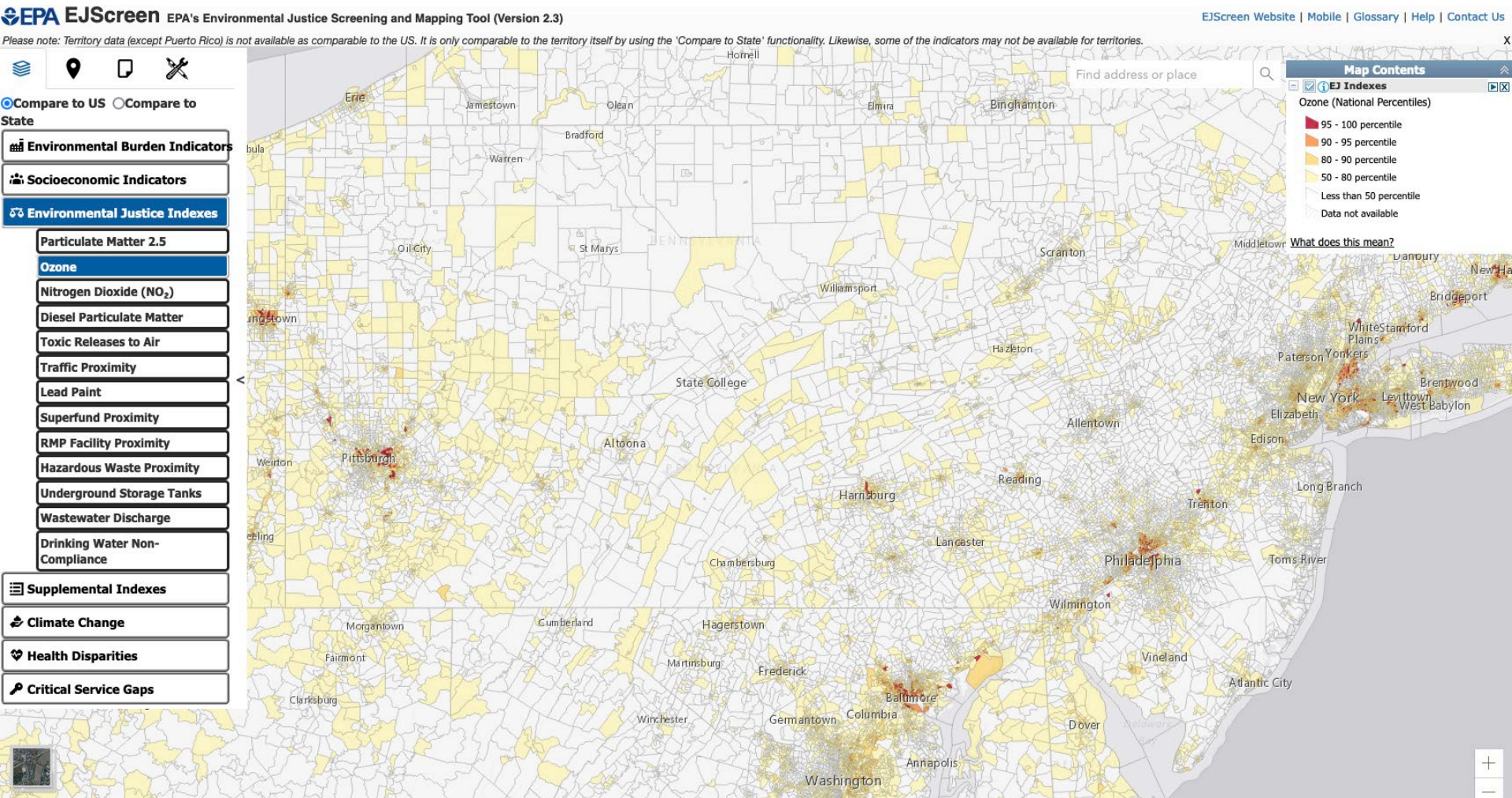


Fig. 8. Carbon capture in the cement, lime, glass, and steel industries, transportation, and storage opportunities in the U.S. for facilities retiring in more than 10 years [18,22,33-38,106-112]. Note that no retirement year estimate is given for lime and glass.

Community Benefits – beyond jobs



<https://ejscreen.epa.gov/mapper/>

Be Thoughtful when Siting

- Are there opportunities to integrate low-carbon supply chains with removals that may lead to “net-zero” supply chains
- When thinking about DAC technologies – are there approaches on could add for reducing other air pollutants (e.g., acid gases SO_x and NO_x, PM, and ozone)
- When thinking about CCS – can co-pollutants (acid gases, PM) be reduced?
- Take advantage of mapping tools for siting consideration
 - <https://ejscreen.epa.gov/mapper/>
 - <https://edxspatial.arcgis.netl.doe.gov/webmaps/carbon-management-connect-toolkit-index.html>