Preliminary Assessment of Coal and Ash Resources in the Gulf Coast Basin

DOE Project No.: DE-FE0032053

Bridget Scanlon^{1,} Robert Reedy¹, Tristan Childress¹, Jim Hower², Peter Warwick³, Sandy Ebersole⁴, Dennis James⁵, Charles Nye⁶, Nolan Theaker⁷, Rich Kyle¹, and Kristine Uhlman¹

¹University of Texas at Austin, Bureau of Economic Geology; ²James Hower, Univ. of Kentucky, Lexington, KY; ³US Geological Survey, Reston, VA; ⁴Geological Survey of Alabama, Tuscaloosa, AL; ⁵Dennis James Consulting LLC, Allen, TX;⁶Center for Economic Geology, Univ. of Wyoming; ⁷Univ. of North Dakota, North Dakota

Project Team:

University of Texas at Austin



Bridget Scanlon (PI)



Tristan Childress



Bob Reedy



JP Nicot



Rich Kyle



Kristine Uhlman

US Geological Survey



Peter Warwick



Lesli Ruppert

Univ. KY

Jim Hower

Univ. WYKY



Charles Nye

Univ. N Dakota



Nolan Theaker

Univ. Texas



Sheldon Landsberger



Outline

- Background (project background, produced water
- Objectives
- Methods
- Results
 - Coal resources
 - REE levels in representative coal samples
 - Ash resources
 - REE levels in ash from Powder River Basin
- Next steps

Project Background

- Funding: DOE, 1,497,378.00; Cost share: \$381,813.00
- Project Performance Dates: 9/15/2021 9/14/2023

Task No.	Deliverable Title	Due Date		
1.0	Project Management Plan (PMP)	< 30 d after award		
	Site Access agreement (for each site accessed in Phase 1)			
2.0	Basinal Assessment of CORE-CM Resources	Dec - 23		
3.0	Basinal Strategies for Reuse of Waste Streams	Oct - 23		
4.0	Connection with Infrastructure, Industries, and Business	Dec 23		
5.0	Data Gaps for Technology Assessment, Development and Field Testing	Mar 23		
6.0	Technology Innovation Center Plans	Dec 23		
7.0	Stakeholder Outreach and Education	Mar 23		



Environmental Science & Technology

Maximize reuse of PW for HF

Will Water Issues Constrain Oil and Gas Production in

the U.S.?

Bridget R. Scanlon*, Svetlana Ikonnikova, Qian Yang, and Robert C. Reedy

Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin, Austin, Texas

- Oil plays in semiarid W U.S.; gas plays in humid east
- PW from oil reservoirs >> than that from gas reservoirs
- Permian PW = 50× Marcellus PW
- Partially mitigate water sourcing and disposal issues by reusing PW for HF
- Projected PW volumes = ~ 4× HF water demand in the Delaware



Scanlon, B. R., Ikonnikova, S., Yang, Q. & Reedy, R. C., Will water issues constrain oil and gas production in the U.S.? *Env. Sci. & Technol.* <u>https://pubs.acs.org/doi/10.1021/acs.est.9b06390</u>

Produced Water Quality: Total Dissolved Solids



USGS: Produced Waters Database

Scanlon et al., STOTEN, 2020





Science of The Total Environment Available online 3 February 2020, 137085 In Press, Journal Pre-proof (?)



Can we beneficially reuse produced water from oil and gas extraction in the U.S.?

- Highlights
- Irrigation demand exceeds produced water (PW) volumes from UOG by 5× in the U.S.
- PW volumes would not substantially alleviate overall water scarcity
- PW quality is variable with salinity up to 7 that seawater
- Intensive treatment is required for PW use outside of energy
- Economics, knowledge gaps in PW quality, and regulatory limitations are major barriers to reuse of PW outside of energy



Scanlon, B. R. *et al.* Can we beneficially reuse produced water from oil and gas extraction in the U.S.? *Science of the Total Environment*

https://www.sciencedirect.com/science/article/ pii/S0048969720305957

Prices of Rare Earth Elements as Oxides



USGS Minerals Yearbook

Objectives

- Map coal resources within the Gulf Coast Basin region
- Quantify concentrations of **REEs** in representative **coal deposits**
- Quantify coal ash resources in power plants in Gulf Coast Basin
- Estimate REE levels based on existing data from coal ash reports in the Powder River Basin

Key Parts of CORE-CM Program



NCRDS: USGS National Coal Resources Data System; CORD: Carbon Ore Resources Database; NETL EDX; Energy Data Exchange

Methods

Coal Resources and REE levels

- Coal thickness mapped (TX, LA, Ark, MS, and AL) totaling~28,000 boreholes
- Developed regional maps of total coal thickness across the basin in top 300 ft
- Analyzed 50 representative USGS archived coal samples from across the basin for critical minerals and REE levels
- Compared lignite data with information on REE levels in lignites in North Dakota

Ash Resources

- Compile data on coal source, tonnage, and nominal ash contents at individual power plants (EIA)
- Ash disposition data from EIA
- Subtracted ash used for beneficial purposes from gross ash production
- Distinguished fly ash and bottom ash.
- Use REE data Gulf Coast coals and from Powder River Basin ash to estimate REE potential for ash deposits.

Coal Mines in the Gulf Coast



Surface mines extracting coal in upper 300 ft with cumulative thickness > 2 ft.

Regional Coal Thickness Distribution (28,100 boreholes)



Regional Coal Thickness Distribution

Coal Bearing Units

Coal Resources

Ctoto	Million Short Tons (≥2 ft thick, ≤X-ft depth)							
State	300-ft	250-ft	200-ft	150-ft	100-ft	75-ft	50-ft	
Texas	16,512	14,682	11,617	8,242	4,156	2,118	451	
Mississippi	8,659	7,425	5,725	3,748	1,983	1,052	206	
Louisiana	4,473	3,536	2,481	1,339	451	150	11	
Alabama	960	812	537	379	145	45	0	
Arkansas	739	704	644	547	314	135	11	
Georgia	5	4	3	2	2	1	-	
Tennessee	3	3	1	1	1	1	-	
Total	31,351	27,168	21,009	14,257	7,053	3,502		
% of Total	100%	87%	67%	45%	22%	11%	2%	

Coal volume (thickness × area) Convert to mass by × by density (1.29 g/cm³ lignite)

Considering cumulative coal thickness exceeding 2 ft

Coal Resources

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Coal Sample Locations for This Study

Total REE Levels in Representative Coal Samples (mean ash content: 33%)

Total REE, ash basis (ppm)

REE Elements, ash basis

Levels of REEs in Upper Continental Crust

Ratio of REE/Upper Continental Crust

Ratio of REE/Upper Continental Crust

Glbbons Creek Samples

Ratio of REE/Upper Continental Crust

North Dakota Lignite REE (617 Samples)

N Dakota Geological Survey

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Electricity Generation by Fuel Source in US 1990 2020

EIA data

Power Plants in Gulf Coast

Power Plants and Related Mines in Gulf Coast

Gulf Coast Basin

33 power plants in study area
1.5 B tons coal burned
 (2008 – 2020)
15% of US coal used in
 power plants
60% of coal from Wyoming

175 M tons of ash
~17% of US ash inventory,
1 B tons
~100 M tons in landfills

Electricity Generation by Fuel Source in Gulf Coast Annual Generation (Twh)

Power Plant Coal and Ash Resources (2008 – 2020)

Grade	Source State/ Province/ Country	Total Delivered (tons)	Average Ash %	Grade Total (tons)	% of Total Coal	Ash Total (tons)	Ash %
Bituminous	Alabama	3,093,871	11.9	85,331,255	5.4	7,233,409	5.0
	Columbia	31,571,900	7.5				
	Colorado	10,281,608	8.5				
	Illinois	15,473,272	8.5				
	Indiana	4,429,532	6.5				
	Kentucky	2,285,507	10.0				
	Ontario	715,331	7.3				
	Utah	465,148	9.1				
	Virginia	3,213,735	10.6				
	West Virginia	13,801,351	9.7				
Sub- bituminous	Idaho	2,677	5.1	979,099,466	61.5	50,179,620	35
	Montana	27,700	9.1				
	Wyoming	979,069,089	5.1				
Lignite	Louisiana	35,222,231	14.8	528,774,790	33.2	87,495,859	60
	Mississippi	38,628,399	14.2				
	Texas	454,924,160	16.9				
			Total	1,593,205,511	100.0	144,908,889	

Ash Byproducts from Power Plants

Total REE Levels in Powder River Basin Ash

REEs in ash more readily extractable than from other coals

Bagdonas et al., 2022

Stakeholder Engagement

- Advisory Board (Industry, Government, Academia)
- Webinars on critical topics, recorded, posted on website
- Outreach via universities, community colleges, and public speaking
- Geological Society of America Topical Session, Denver, Colorado: Assessing Critical Mineral and Rare Earth Element Potential from Unconventional Resources in the United States
- Web site: https://www.beg.utexas.edu/minerals/rare-earth
- Fact Sheet on topic.

Integrating Environmental Justice, ESG, and standards development

Environmental Justice (Social Vulnerability Index (SoVI) and parameters (poverty, race etc) mapping relative to mines, power plants, and landfills etc). EPA EJSCREEN: 11 environmental indicators, 6 demographic indicators, 11 EJ indices

White House EJ Advisory Council Rept. WHEJAC

Leveraging ES&G efforts related to Oil and Gas and Carbon Capture & Storage

Working with campus group to develop new approaches to ESG and

environmental standards

CDC Social Vulnerability Index, 2018

Vision for Technology Innovation Center

- Proposed Technology Innovation Center(s) will leverage strengths of existing centers (e.g., Carbon Capture and Storage, Industrial Associates programs)
- Identify opportunities for new centers across CORE-CM value chain
- Consider virtual Centers

BUREAU OF ECONOMIC Base on Public/Private partnership

Next Steps

- Geologic characterization, extrapolate outside of mined areas based on depositional settings
- More detailed evaluation of REE levels in areas with high concentrations (Gibbons Creek, San Miguel)
- Understanding of location of REEs (with organics like North Dakota or with clays)
- Sampling of ash resources in power plants in Gulf Coast
- More detailed evaluation of REE resources from ash deposits
- Environmental justice mapping
- Stakeholder engagement

Summary

- Large coal resource in Gulf Coast region, 31 billion short tons, ~50% in Texas, ~30% in Mississippi, and ~15% in Louisiana
- REE levels variable
- Need to determine where REEs are in coal in the Gulf Coast, ? in organics? Affects extractability
- Coal burned in Gulf Coast Basin represents ~ 15% of coal burned in power plants in the US
- 175 M tons of ash, 17% of US inventory (1 billion tons)
 - ~60% of coal ash is potentially accessible, mostly in landfills
- Wyoming Powder River Basin represents 60% of the coal burned in the Gulf Coast and 30% of ash resources