

GAIN Update Coal to Nuclear Transitions

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NS&T SAC Meeting

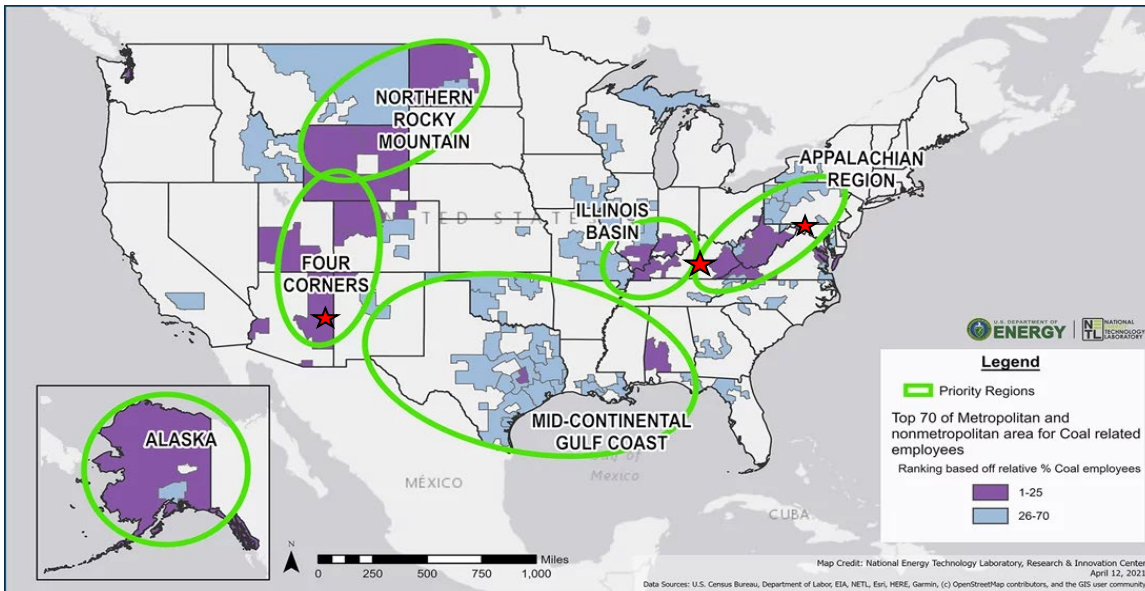


COAL TO NUCLEAR ENERGY COMMUNITY TRANSITIONS



Case Study Pilot (in partnership with DOE-FECM)

GAIN is in the process of scoping several case studies of specific coal sites/plants to understand the parameters that will have the most influence on moving forward with transitioning a coal site to nuclear. Scope several this year – complete 1 or 2 in the calendar year and initiate others in the future.



Coal to Nuclear Research Group

Each group is leading important projects associated with potential repurposing coal sites with nuclear technology. Use group discussions to align our individual efforts to make the most of this opportunity for the broader industry. In addition, get constructive feedback on GAIN case study pilot project.

Coronado Generating Station

**Primary Objective: Assess the feasibility of transitioning from coal to nuclear;
Learnings will help 6 other coal units within commuting distance**

- Siting Evaluation (leveraging EPRI's Siting Guide)
 - Assess suitability of the CGS site for a nuclear power plant.
 - Identify strengths and weaknesses associated with the site.
 - Support selection of preferred nuclear technologies (based on evaluation results).
- Economic Impact Assessment
 - Evaluate economic outcomes we may expect from:
 - (a) coal plant retirement
 - (b) introduction of a nuclear power plant, focusing on impacts to the community.
- Nuclear Technology Assessment (leveraging EPRI's Nuclear Technology Assessment Guide)
 - Identify and document candidate nuclear technologies that could be leveraged at CGS, building off siting evaluation results.



Coronado Generating Station
Owned/Operated by
Salt River Project
Located in
Saint Johns, AZ

Partnered with Salt River Project and St Johns Mayor's Office
Plant is in same county as Navajo Nation

Warrior Run Generating Station

Primary Objective: Assess the feasibility of transitioning from coal to nuclear to determine the value of site to an owner interested in nuclear

- Repowering Assessment
 - Siting Evaluation
 - Confirm the suitability of the site for a nuclear power plant.
 - Identify potential investment opportunities to reduce noted risk(s).
 - Evaluate value of existing infrastructure (e.g., substation, transmission lines, office buildings, etc.)
 - Licensing/Permitting Evaluation
 - Support development of a permitting and licensing strategy.
 - Identify opportunities for potential reuse of existing permits and rights and permitting risk/gaps.
 - Community and Workforce Engagement
 - Develop/identify education material that can be leveraged by AES.
- Value Assessment
 - Develop value case (based on results from previous phases) to support AES decision regarding path forward.



Warrior Run Generating Station
Owned/Operated by AES
Located in Cumberland, MD

AES retiring fossil by 2025, Plant has PPA through 2030

Ghent Generating Station

Primary Objective: Assess the feasibility of transitioning from coal to nuclear to support nearby industrial customers

- Repowering Assessment – Assess feasibility and understand value of physical and human assets
 - Siting Evaluation
 - Confirm the suitability of the site for a nuclear power plant.
 - Workforce Planning
 - Identify support needed for a nuclear plant.
 - Identify opportunities to retrain existing coal plant staff.
- Nuclear Benefits Beyond Electricity – Identify and evaluate opportunities to support industrial customers in region
- Community Engagement – Share study results with the community, address questions and concerns, engage community in next steps



Ghent Generating Station
Owned/Operated by Louisville Gas and Electric
Company and Kentucky Utilities Company
Located in Carroll County, KY

Station retirement is planned in 2040s.

Investigating Benefits and Challenges of Converting Coal Power Plants to Nuclear Power Plants

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ENERGY

INL/MIS-22-68369

Study Team



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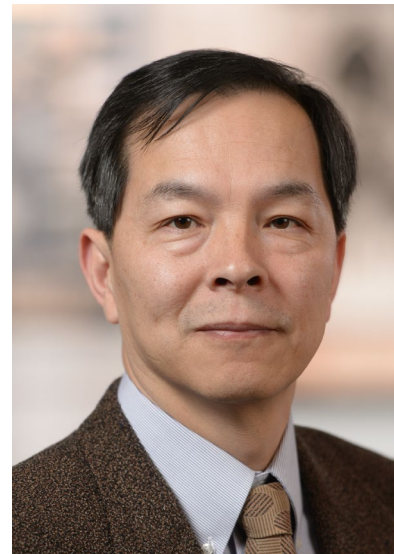
Will Jenson



Anna Wrobel



Femi Omitaomu



TK Kim



Katie Biegel

Outline

1. Introduction and Overview

- Research Team
- External Reviewers

2. Components of the Study

- Siting Evaluation
- Techno-Economic Analysis
- Regional Economic and Environmental Impact Analysis

3. Summary and Conclusions

Research Questions

- Are there reactor siting opportunities at retired and operating coal plant sites?
- What are the main decision drivers making C2N projects attractive?
- What are the socioeconomic impacts from a C2N transition?

SA&I Analysis on C2N in Context

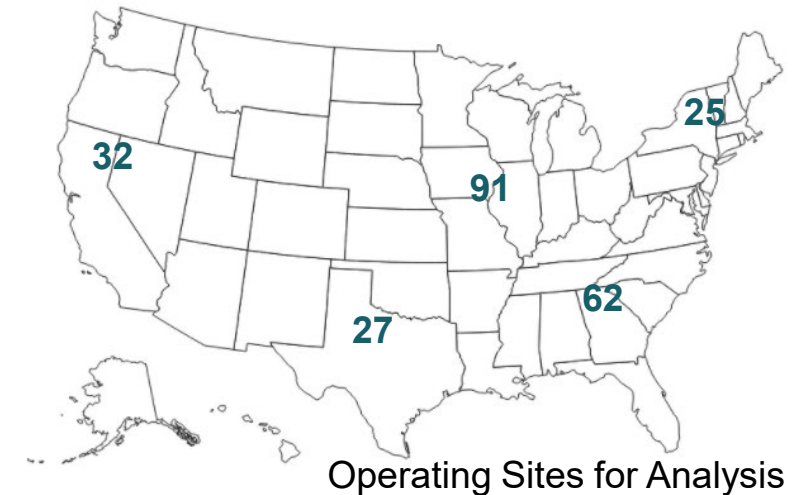
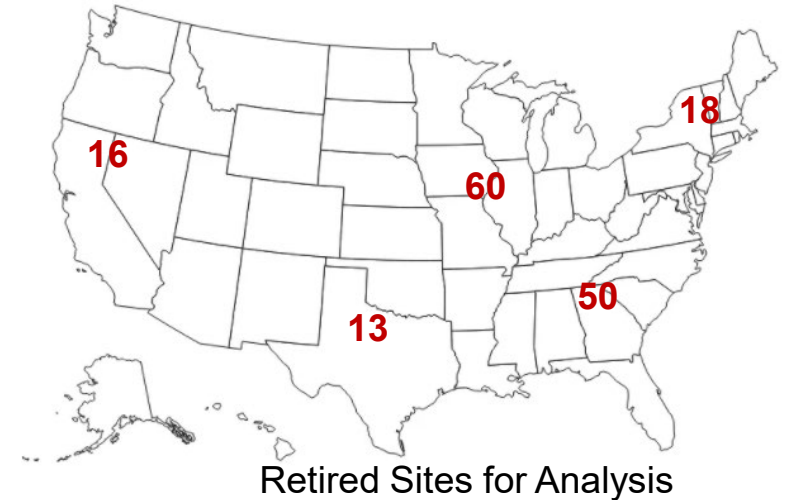


Siting Evaluation

1. Are there reactor siting opportunities at retired coal plant sites?
2. Select a candidate site for economic analyses.
3. Stretch Goal: What are the siting opportunities at operating coal plant sites?

2 – Approach: Parameters Evaluated

- **Population Density**
 - Within 4 miles of population centers for ARs
 - Within 20 miles of population centers for large LWRs
- **Safe Shutdown Earthquake**
- **Faults**
- **Protected Land**
- **Slope**
- **Landslide**
- **Wetlands and Open Water**
- **Floodplain**
- **Hazardous Facilities**
- **Availability of Make-up Cooling Water**
 - Large LWRs only



Techno-Economic Analysis

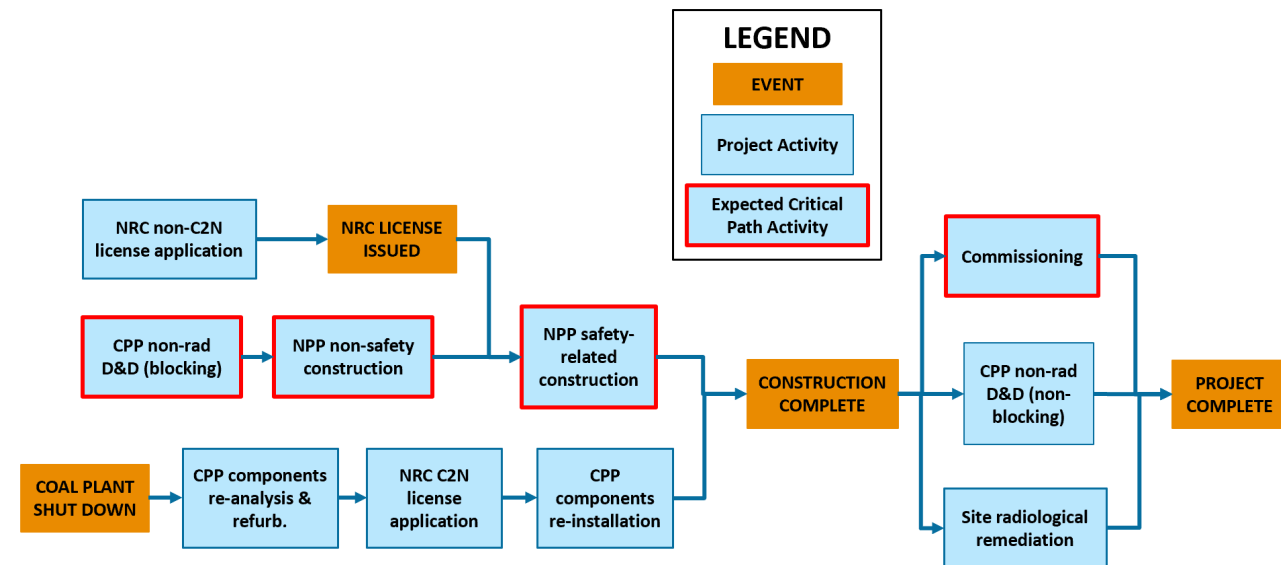
What are the main decision drivers making C2N projects attractive?

3 – Technical Results: Project Model

- For different C2N projects, which components can be re-used and what are the associated project costs and timeline?
 - Assessed project timeline and other cost estimates based on literature and subject matter expertise
 - Developed simplified “project plan” for each C2N project, with associated timeline
 - Estimated project duration with spending and revenue distribution
 - Some projects types (C2N#0 and #3) display more attractive revenue distribution

Project type	Example Reactor Type	Total OCC	Required revenue gap
		\$/kW	years
Greenfield	PWR	\$4,572	0
C2N#0	PWR	\$4,799	0
C2N#1	PWR	\$3,598	6.75
C2N#2	HTGR	\$3,951	6.5
C2N#3	SFR	\$3,398	2.75

Project plan example for C2N#3



4 – Summary

- **This analysis provides preliminary confirmation that C2N projects could offer tangible economic value to utility firms.**
- **C2N projects can be categorized by the extent of site infrastructure and equipment to be reused. Different NPPs are most compatible with each of the three project types.**
- **Each category of C2N project is associated with different levels of benefits and drawbacks, which were quantified in this study.**
 - C2N#1 to #3 projects had estimated savings between 15-35% in OCC when compared with greenfield projects.
 - Different C2N projects show more beneficial revenue profiles with reduced/eliminated revenue gap between closure of CPP and startup of NPP.
- **Preliminary assessment of decision drivers was completed using novel agent-based capacity expansion approach. This showed preference of agents for C2N projects over greenfield (due to benefits highlighted above).**

Economic and Environmental Impacts

What are the socioeconomic impacts from a C2N transition?

1-Overview

- **Annual economic impact on composite, analysis region, net change from “All-Coal” to “All-Nuclear” scenario**
 - New economic activity: Up to \$275 million
 - New Jobs: 650
 - New income: \$102 million
- **Tax impact from CPP closure**
 - In representative county CPP accounts for almost 1/3 of tax revenue
- **Environmental Impacts (IMPLAN / EPA)**
 - PP greenhouse gases reduced by 99%
 - Coal mining and long-term waste storage not included in this study
- **Statewide workforce transition from C2N**
 - 797 net jobs retained or created by PP, supply chain, and community
- **3-Part approach: Economic Impacts, Environmental Impacts, Workforce Transition**

2-Approach: Impact Scenarios

Pre-Closure

- 150 Coal plant jobs
- 1,200 MW

Half Closure

- Single generating Unit 2 Retired
- 75 jobs
- 600 MW

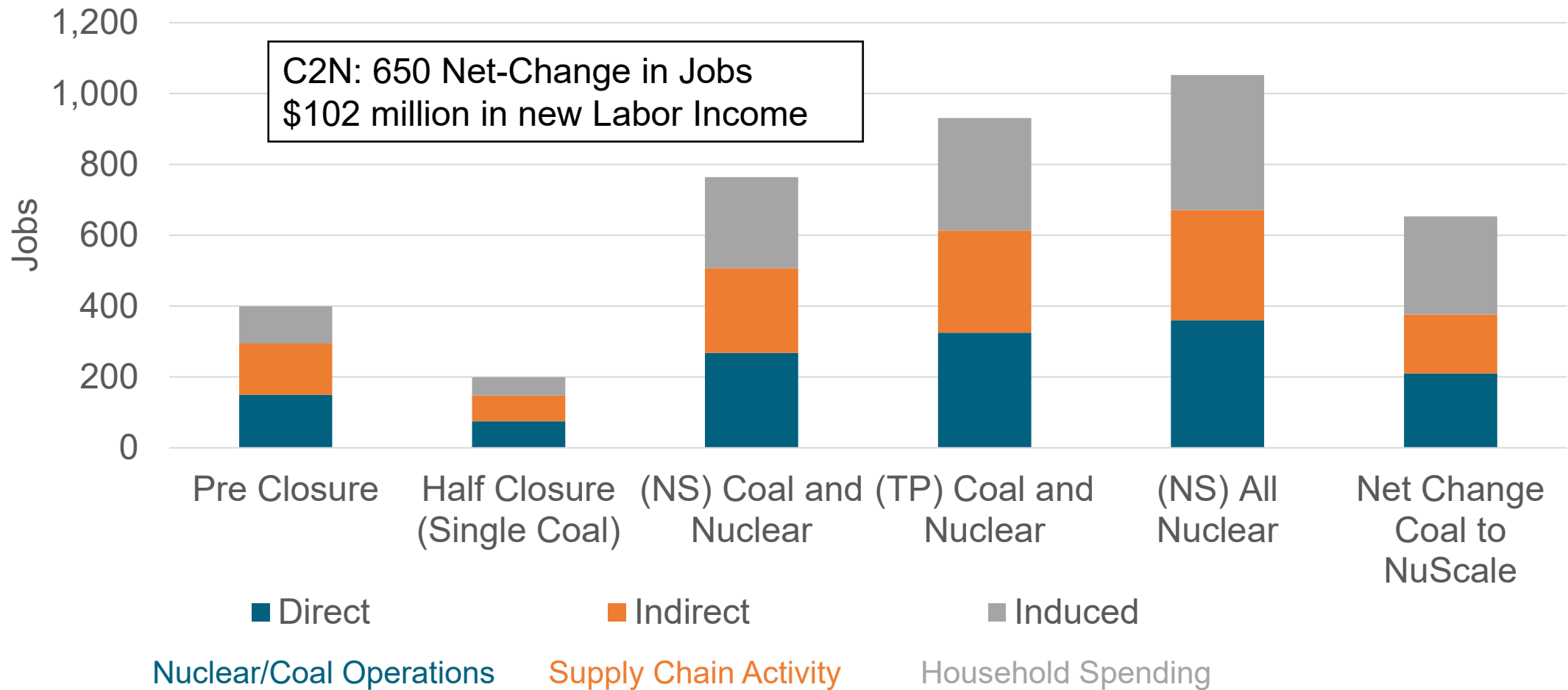
Coal and Nuclear

- Single coal Unit 2 Retired
 - 75 Jobs
- Small Modular (NuScale or TerraPower) design
 - 193-250 Jobs
 - 345-462 MW

All Nuclear

- Dual unit coal Unit 2 Retired and Unit 1 Retirement
- 12-Module NuScale reactor design
- 360 Jobs
- 924 MW

3-Results: Employment Impact, jobs created or sustained



Summary and Conclusions

Summary of Study Results

- The drive to a net-zero GHG emissions economy by 2050 has resulted in a reassessment of the needed energy mix with a focus on “clean firm” sources of energy that are available on demand. The main source of clean firm energy is nuclear and the ~95 GW of existing nuclear capacity in the United States currently produces roughly half of all U.S. emissions-free electricity.
- This study estimates a substantial amount of coal capacity in the U.S. is amendable to converting to nuclear power plants – over 250 GW.
- Results show that re-using coal infrastructure at nuclear power plants can save on nuclear construction costs – estimates range from 15% to 35%.
- The study estimates that repurposing coal power plants to nuclear power plants can make communities better off economically while at the same time improving environmental conditions – an especially important finding for disadvantaged communities.
 - Compared to coal plants, nuclear plants spend less on fuel but more on labor, so local economic activity increases, wages go up, and new, permanent jobs are added to the community. Modeling results show for a large plant conversion (1,200 MW), the impact is over 650 new jobs in the community, over \$100 million more in wages, and up to \$275 million more in annual total economic activity.
 - At the same time that economics improve for communities, so do environmental indicators. Again, comparing all coal to all nuclear, GHG emissions in the region fall by 86%.