Industry Sectors Regions Resources Series Webcasts Events Engage Enlit SUBSCRIBE

Coal Fired | Industry Insights | Strategic Development | World Regions

How to repower 2TW of coal by 2050

Guest Contributor March 18, 2022

Photorealistic image showing an existing coal plant re-fitted with an advanced heat source. Source: TerraPraxis

The world has more than 2TWe of coal-fired power plants, adding roughly 12 gigatonnes of CO_2 emissions per year, representing almost one-third of global total net emissions of 38.8 gigatonnes a year.

But shutting coal plants down worldwide is not a solution when the majority are less than 14 years old, and energy demand is soaring, writes Eric Ingersoll and Kirsty Gogan of Terrapraxis, a non-profit organisation focused on accelerating the energy transition through innovation.

The challenge

Even closing old coal plants in the US, Canada, and Europe is difficult and controversial because the loss of jobs and revenues can be devastating for communities, and utilities continue to value the reliable electricity generated.

Existing coal-fired power plants potentially offer enormous value by virtue of their established power markets, grid connections, cooling water access, real estate holdings, and experienced site personnel. In Wyoming, USA, Bill Gates's advanced reactor company, TerraPower, recently announced plans to build its Natrium reactor near a retiring coal plant in Kemmerer, Wyoming. The US Department of Energy plans to invest nearly $2 billion to support the licensing, construction, and demonstration of this first-of-a-kind reactor by 2028.

While this project in Wyoming is a welcome step, we need a strategy that will enable the rapid repowering of all coal plants. To work, that strategy must be fast, cheap, and minimize construction risk.

The opportunity

Repowering existing coal plant infrastructure is the largest single carbon abatement opportunity on the planet and could greatly accelerate the clean energy transition. It would also sustain jobs and community tax revenues associated with existing coal plants, and protect the larger social, economic, and environmental benefits associated with continued reliable and flexible electricity generation and continued use of existing transmission lines—without emissions.

Have you read?
Kicking out coal and greening gas on the road to net zero

By replacing coal-fired boilers at existing coal plants with carbon-free small modular reactors (SMRs), also known as advanced heat sources, these power plants can generate carbon-free electricity, rather than carbon-intensive electricity.

This would quickly transform coal-fired power plants from polluting liabilities facing an uncertain future, into jewels of the new clean energy system transition—an important part of the massive and pressing infrastructure build-out needed to address climate change.

Repowering coal fleets, therefore, offers a fast, low-risk, large-scale and equitable contribution to decarbonizing the world's power generation.

Converting 5,000-7,000 coal plant units globally between 2030 and 2050 (250–350 per year) will require a practical streamlined strategy that can meet this rate of deployment. To be successful, the deployment model has to de-risk the construction process – the riskiest part of a new build project. Providing coal plant owners with a high level of certainty about schedule and budget is necessary to facilitate the rapid and confident assessment, initiation, and completion of repowering projects.

To achieve this vision, we, at TerraPraxis, have assembled a consortium of partners including Bryden Wood, Microsoft, KPMG, MIT, University of Buffalo, US Department of Energy, along with a consortium of global utilities—to launch the Repowering Coal initiative.

Also of interest
Europe: Record prices and increased dependence on fossil fuels

'Repowering Coal' aims to deliver a substantial portion of the clean electricity required to achieve Net Zero by 2050 by replacing coal-fired boilers at existing power plants with advanced heat sources, which will be ready for deployment by 2028. TerraPraxis has engaged Bryden Wood, to create a new design and construction solution that will make this possible at the necessary scale and speed, a key part of which is a new digital platform hosted by Microsoft.

Standardised building system design

Our building system is being designed to be applicable to as many plants as possible, rather than a bespoke plant-by-plant approach, and therefore applies principles of standardization to address a wide variety of requirements relating to:

- Different energy and heat requirements at a wide range of coal plants (design of the heat transfer and storage system is being led by MIT).
- Different advanced heat source technologies that will be supplied as high-value components into building systems designed to accommodate the range of heat sources (imagine a kitchen designed with slots for the microwave oven).
- Different site layouts and local requirements.

The building system standardization and connection to an existing coal plant is enabled by a series of key design innovations. A standardized but customizable heat transfer and storage system allows the new modular nuclear systems to 'plug in' to existing coal plant infrastructure. This will deliver a capital cost saving of 28-35%, compared to a new nuclear plant, and enables continued use of existing transmission lines.

The standardized building system design being developed by Bryden Wood will address the differing requirements for a wide variety of advanced heat sources, site layouts, and energy and heat demand. The component-based design enables the plant to be reconfigured and expanded to accommodate different numbers of advanced heat sources while adhering to regulatory requirements.

Seismic variation usually drives site-specific redesign of nuclear plants, representing a major cost driver, and making standardization impossible. Professor Andrew Whittaker at the University of Buffalo is a global expert on seismic isolation for nuclear plants and is leading the design of the seismic isolation system to enable genuine standardization. Whittaker's work will enable the plant to be designed for a range of seismic conditions and licensed once, allowing a rapid roll out across a wide range of sites.

A new digital platform

In addition to innovative building system design strategies, the Repowering Coal consortium is creating new digital tools and data exchange infrastructure for the building system to standardize and optimize the following key elements:

- Procurement, investment, and regulatory approval
- Building and engineering systems
- Design, manufacture, assembly, and operation
- Interactions between different supply chain organizations to enable greater collaboration

Microsoft and TerraPraxis have been working together creating Azure tools to enable automated analysis of the U.S. (and ultimately global) coal fleet for retrofit. Microsoft will build the Repowering Coal analytics tools with TerraPraxis and help undertake strategic partnerships with Repowering Coal consortium stakeholders.

The goal of the analytics tools is to quickly assess repowering design options for many coal power plants. For each of many plants, the tools integrate: plant thermal assessment, steam unit configuration, site assessment, and heat source options; while reusing the existing balance of plant, such as turbines, switchyards, transmission infrastructure, buildings, and roads.

Have you read?
Renewables, nuclear and energy efficiency in IEA plan to break EU reliance on Russian gas

A further goal is for the tools to capture and communicate developing design knowledge, allowing all parties to communicate results and status in real time across all projects.

Algorithmic design tools are being created by Bryden Wood to:

- Assess coal plant viability for boiler replacement
- Create initial concepts using a design configurator in just days
- Produce detailed design outputs for manufacturing
- The structural components can then be mass produced by existing and new manufacturers and assembled on-site by non-nuclear specialists.

The design process incorporates an ongoing process for establishing and enhancing a catalogue of vetted, mass-produced standard components, which could even be assembled on-site by non-nuclear specialists.

Together, the tools will create a completely open digital platform to which all stakeholders may be granted access and will be able to contribute. Role-based access control will allow for sophisticated configuration and control of data security. For the first time in the nuclear energy sector, there will be a seat at the design table for everyone from plant owners to regulators, suppliers, AMR vendors, customers, investors and assemblers.

Similar automated site assessment and design tools have been designed and tested by Bryden Wood in other highly complex, highly regulated sectors, such as pharmaceuticals, highways, and data centers. These will be greatly enabled by Microsoft's software engineering and tools development, as well as the financial model, being developed by KPMG, that will enable coal plant owners to evaluate the benefits and value creation opportunities from repowering.

Instead of needing to spend hundreds of millions of dollars and potentially years evaluating the prospects for a single site (making it unlikely to happen at all), the evaluation of a site for repowering will be extremely fast, low-cost, and repeatable. The goal is to have hundreds of sites being assessed by the end of 2022.

The end-product will enable coal plant owners to begin pre-development analysis for their fleets using these tools to evaluate the financial, social, and environmental benefits of repowering with a high level of certainty with respect to requirements for budgeting, scheduling, licensing, and site development. This, in turn, could make existing coal plants into attractive assets, making it easier for owners and investors to build, maintain, and operate them as new clean energy plants across a broad range of markets.

ABOUT THE AUTHORS

Kirsty Gogan, co-founder and managing partner of TerraPraxis, has more than 15 years experience as a senior advisor to Government on climate and energy policy, including 10 Downing St, and the Office of the Deputy Prime Minister.

Eric Ingersoll, TerraPraxis co-founder and managing partner, is a strategic advisor and entrepreneur with deep experience in the commercialisation of new energy technologies. He has extensive project and policy experience in renewables, energy storage, oil & gas, and nuclear, with a special emphasis on advanced nuclear technologies.

Previous article
Ed's note: Can Russia's energy industry survive sanctions?

Next article
Measuring progress of renewable technology innovation

Guest Contributor

RELATED ARTICLES MORE FROM AUTHOR

Measuring progress of renewable technology innovation

Renewables, nuclear and energy efficiency in IEA plan to break EU reliance on Russian gas

Ukraine: DTEK provides hospitals, military and bakeries with free power