DECARBONIZATION PATHWAYS

Coal Conversion and **Biomass:**

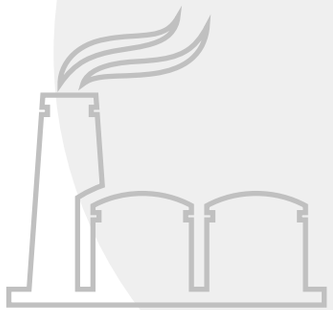
Planning, Committing and Retaining a Sustainable Pathway

BLACK & VEATCH

More goes into infrastructure than most might think, but you can't miss the difference it makes in the world. Black & Veatch makes the **Invisible, Invaluable**. Our Decarbonizaton Pathways eBooks help our clients stay ahead of the curve so they can progress relevant and effective decarbonization strategies and help the world transition to net-zero.

About this eBook

Asset owners with significant long-term capital invested in coal-fired generation can go farther, faster and avoid their assets becoming stranded. This eBook explores the role of and case for biomass in enabling that transition.



The **lifespan** of **most coal facilities** is approximately **30 years** while the average age of coal plants in **Asia is only 12 years.**

Transitioning from Coal

More coal was burnt in 2021 than in any other year previous, with demand for the fuel pushing prices to record-highs. These records were set in spite of fanfare from governments and corporations around COP26 as well as the countless decarbonization and net-zero commitments that have been made in recent years.

We have to discuss the issues openly and authentically if we are to create real change. Coal, for many years, has been relied upon to provide reliable and affordable baseload power. With billions of dollars already tied up in existing assets, how do we sustainably transition from coal?

Coal power remains the dominant form of energy production across much of Asia. As of 2018, coal generates almost 60% of electricity across the region. Further, the lifespan of most coal facilities is approximately 30 years while the average age of coal plants in Asia is only 12 years old, according to the Asian Development Bank. Taken together, the transition from coal is a colossal undertaking and, market-to-market, will require a range of different clean and lower carbon solutions to bring nations down the decarbonization ladder, and ensure the energy transition we engineer is just and fair, as well as environmentally sound.

Alongside mounting pressures from governments, lenders and the public to adopt sustainable means of power generation and conserve resources, coal-fired plant owners in Asia will be required to comply with tightening emissions and effluent norms imposed by governments, all impacting profitability. In addition, they face real competition from new renewable sources of generation which are closing in on price parity and steadily displacing coal from the grid.

Setting aside the clear and urgent global need to reduce our carbon emissions, asset owners need to act with financial prudence and consider the true long-term economic viability of their assets.

Broadly speaking, three options exist for coal asset owners:

- Full or partial fuel conversion to fuel sources like natural gas, hydrogen or, this guide's topic, biomass
- Retrofitting emissions control equipment or adopting carbon capture, use and storage solutions
- Decommissioning aged coal assets for re-purposing or repowering

Working to reduce carbon emissions and operational lifecycle

Black & Veatch, along with major international equipment manufacturers, financing entities and other stakeholders, announced their exit from coal generation. Since 2020, efforts have begun to focus on repurposing assets. Working with clients on a case-by-case basis, Black & Veatch can assist those committed to decarbonizing their facilities and help them achieve a clean energy transition.

Read Black & Veatch's Sustainability Report here.

Is there a future for fossil fuel generation (utility-scale coal and gas generation) in your region(s) of operation beyond 2035? *(Select the scenario that best applies)*

Source: Black & Veatch

	2020	2021
Yes, both coal and gas will remain important components of the grid beyond 2035	18.2%	15.4%
Yes, investment in gas will remain long term, however, coal will be gradually phased out with little new development	**48.5%**	30.8%
We will see limited investment in coal and gas investment will focus mostly on upgrading existing facilities only	12.1%	**25.0%**
No, we will see limited investment in both gas and coal	9.1%	3.8%
No, we will see limited investment in gas and we will also start seeing increased decommissioning of coal facilities	12.1%	**23.1%**
No, we will see increased decommissioning of both gas and coal facilities	0.0%	1.9%

According to ***Black & Veatch's 2022 Asia Electric Report,*** only **15 percent** of respondents **see a future for coal generation asset investment beyond 2035**; in addition, **85 percent believe there will be less investment in coal over the next five years.**

Co-Firing Biomass: Not a Straightforward Sustainable Option

Biomass fuels are typically a waste or byproduct of agricultural, industrial, or commercial processes, and can be relatively low in cost. Compared to coal, biomass is often lower in sulfur, nitrogen, mercury, and other pollutants. Additionally, it can be considered a carbon-neutral or renewable fuel throughout much of the world; however, to be considered as such, biomass generation must be coupled with sustainable harvesting or management practices, or carbon capture, utilization and storage.

The United Nations' Intergovernmental Panel on Climate Change (IPCC) has noted that "bioenergy has a significant greenhouse gas (GHG) mitigation potential, provided that the resources are developed sustainably and that efficient bioenergy systems are used." While the IPCC recognizes that certain current systems and key future options including perennial cropping systems, use of biomass residues and wastes and advanced conversion systems are able to deliver 80 to 90 percent emission reductions compared to the fossil energy baseline, it cautions that land use conversion and forest management that lead to a loss of carbon stocks (direct) in addition to indirect land use change effects can lessen or more than neutralize, the net positive GHG mitigation impacts.

Hence, biomass conversions will require a clear demonstration that sustainable sourcing exists to validate decarbonization claims.

Biomass in Asia

Considering co-firing biomass?

Here are activites to consider as you start out:

1. **Decarbonization roadmaps**
2. **Feasibility studies**
3. **Feedstock and resource assessments**
4. **Procurement planning**
5. **Environmental and health and safe permitting and planning**

There are emerging examples of economies in Asia considering biomass-based power generation in their decarbonization commitments.

Regulations in India are due to begin from October 2022 which require all coal-fired power plants to co-fire at least five percent blends of biomass pellets on an annual basis, although exemptions are being explored as at time of writing by a number of developers based on specified criterion. This is in line with communication stating that the policy for co-firing of biomass will be reviewed regularly as India learns more about how best to implement this initiative.

Indonesia has also announced its intention to make biomass co-firing in coal plants mandatory, in its efforts to reduce carbon emissions from coal power generation.

When considering the introduction and co-firing of biomass at a existing coal fired facilities, a number of key first steps are required to enable an effective and economically successful transition.

Black & Veatch's past experience working at facilities with both new and legacy coal technologies has found that co-firing alternative fuels, especially biomass in boilers designed for coal firing only, is complex when total heat content of biomass fuels exceeds more than 10 percent of overall heat input required by the boilers.

Other factors that will need to be carefully assessed are:

- Biomass feedstock sourcing, cost and quality; the type of biomass (raw, white pellets or black pellets) can impact many factors in the design process and the entire viability of the project;
- Dispersed, low energy density of bio-based feedstocks requiring additional densification processes like torrefication or pelletization for getting comparable heat value to coal;
- Combustion challenges and efficiency impacts, especially high unburnts, flame instability, coal mills issues, slagging and fouling;
- High variability in fuel characteristics, especially moisture, alkali, chlorides, etc;
- Material handling and coal feeding system modifications;
- Understanding the health and safety implications of blending biomass, given its great combustability compared to coal as well as its environmetnal emissions impact;
- Technological challenges with respect to burning different biomass feedstocks in conventional boilers.

It is essential to understand that the dispersed nature of biomass feedstocks usually limits the capacity of power generation facilities to about 10 to 100 megawatt electric (MWe). The implications of that

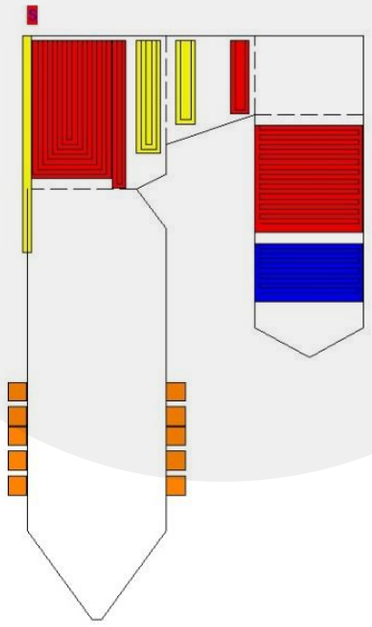
limitation include lower plant energy efficiency, higher specific capital expenditures (CAPEX), higher specific operating expenses (OPEX), and higher maintenance expenses compared to large-scale conventional generation units.

Additionally, in the early stages of project development, it is important to conduct a resource assessment to clarify the fuel properties and quantify the amount of available fuel within a reasonable distance from the plant. In addition to the resource assessment, a fuel procurement plan is required to demonstrate the long-term economic viability of the project to support financing.

Making Major Investments in Co-Firing and Repowering

Committing to major investments that co-fire biomass with coal or completely repower a coal-burning station needs to be assessed using a set of key technical and commercial parameters. These parameters include steam cycle performance impacts, fuel characteristics and handling and storage requirements, and plant condition and expected remaining life. Other assessment parameters include plant conversion CAPEX/OPEX, air emissions and permitting challenges, and government mandates.

One option is to co-fire biomass directly. That involves the direct combustion of biomass fuels with coal in existing boiler systems. In these cases, fuels can be blended before they are fed to the boiler or they can be separately injected into the boiler. Another option is indirect co-firing of biomass which involves the processing of biomass in a separate combustor; after which, the products are utilized by the existing thermal systems; this approach however can incur significant additional capital investment.



Performance modelling using software tools... is critical when considering biomass conversion or blending due to the high variability and differing nature of biomass feedstocks compared to fossil fuels.

Digitally Modelling a Full Biomass Conversion

For coal plant owners that have an interest in fully repowering the facility on biomass fuels, the impacts to boiler performance must be determined through preliminary engineering design and performance modeling using software tools such as the **Electric Power Research Institute's (EPRI) Vista** application. This is critical when considering biomass conversion or blending due to the high variability and differing nature of biomass feedstocks compared to fossil fuels.

EPRI Vista predicts how changes in fuel quality or sources at a combustion power plant will impact performance, maximum generating capability, emissions, reliability, maintenance and availability, and economics. The software supports modeling of alternative fuel use in a co-fired mode or individually, and is often employed in natural gas, biomass, and, increasingly, hydrogen studies globally.

Modeling the different possibilities for fuel quality is vital as repowered units often experience de-rating and other limitations because of the lower volumetric fuel energy density of biomass relative to coal.

In some cases, capacity limitations may be mitigated through the modification or installation of new plant equipment; however, such improvements need to be considered in terms of the available space within the plant, additional CAPEX, and potential improvement in net power generation.

Conclusion: Biomass Co-Firing and Conversion

If you are starting down the pathway to decarbonize your coal asset through a planned blending and ultimately a conversion to biomass fuel, it is critical to analyze the unique challenges and benefits associated with biomass fuels for co-firing applications in utility boilers. Scattered resource availability, variable fuel quality, complex fuel burning characteristics, and unique aspects of fuel handling and storage subsystems all require meticulous attention to ensure technical and economic viability of the fuel conversion program.

What's more, feedstock properties will ultimately dictate the selection of the most appropriate primary conversion technology and associated system design, and will play a considerable factor in the final investment decision.

This is where Black & Veatch can support your journey and help you assess and implement a co-firing and repowering plan that aligns with your decarbonization commitments, available financial incentives, your CAPEX and OPEX budgets, and the need for a controlled approach to engineering, test burns, and permitting needs.

Let's Talk

Our engineering, procurement and construction solutions help clients move farther, faster.

Let's find ways to help you, too.