

## Will this coal bet pay off?

Coal gasification fits into the current narrative of fuel diversification, but there are challenges

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India's \$5 billion bet on coal gasification — an expensive and polluting technology deployed since the 1920s to extract fuels and chemicals from coal — may seem anachronistic at a time when carbon caps and climate change capture the world's zeitgeist. But tapping the country's vast domestic coal reserves may seem a better bet than waiting endlessly for the next ship carrying urea or gas, a senior industry official said.

Minister of Mines Kishan Reddy has allocated 100 million tonnes of coal — one-tenth of India's coal output — for gasification, setting a new direction for a feedstock primarily used to generate electricity. Reddy expects to ride on ₹46,000 crore in incentives to reduce import dependence while attracting investments of ₹4 trillion.

But as Umang Shah, partner and managing director at management consultant BCG India, pointed out, "The capex subsidy being provided is 20 per cent because the objective is to provide it across large-quantum projects — 20 per cent is not a very high number in the larger scheme of things compared to subsidies provided in other sectors. From an energy security perspective, it is not relatively as big an investment to make."

The government has also relaxed rules to allow the use of Chinese technology — granting waivers from registration on a case-by-case basis — and created a new coal gasification sub-sector under the coal linkage auction policy to ensure steady supplies.

"We are entering an era of multi-energy hedging, driven by growing geopolitical and technological uncertainties," said Leslie Palti Guzman, a global gas expert affiliated with Columbia University. "To prepare for an increasingly unpredictable world, governments will seek diversification across fuels, technologies, suppliers, pricing mechanisms, and transportation routes. The goal is to build resilience across multiple scenarios."

### Indian challenges

Indian companies have dabbled with coal gasification since the early 1970-80s when state-run Fertiliser Corporation of India Ltd set up coal gas units at Ramagundam, Sindri and Talcher. But the unique characteristics of Indian coal — such as high ash content (30-45 per cent), variable gross calorific value, and complex mineral matter — have posed technical hurdles.

"Coal gasification depends on the type of feedstock, kind of technology, what works, what doesn't work, what you should do to make it work — and I think that's where the real challenge is," said Atanu Mukherjee, CEO,

### Trade balance and capital investment

Product / programme	Output target	Approx capital investment (in ₹trn)
Methanol blending	8.5-8.6 mtpa methanol for 20% petrol blending (approx)	0.68-0.85
DME-LPG blending	6.3 mtpa DME for 20% LPG blending (approx)	0.85-1.02
Coal-to-urea	20 mtpa urea	2.04-2.72
SNG	5 BCM/year SNG	1.02-1.36
Total platform	Methanol + DME + urea + SNG	4.6-6

mtpa: Million tonnes per annum; DME: Producing Dimethyl Ether; SNG: Synthetic Natural Gas

Note: Indicative national-scale estimates for India. Assumptions: ₹85/\$, domestic high-ash Indian coal at ₹30% ash, normal import-parity prices, and SNG counted as 5 BCM/year.



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"Different regions of the world have different kinds of coal. China's coal is very different from South African coal, compared to US coal, and Indian coal. Being able to synthesise the right kind of gasification technology in the ecosystem to drive the economical, affordable and scalable production of syngas (synthetic gas, the product of coal gasification) for production into downstream materials is the most important thing in terms of direction for a nation, for a firm," said Mukherjee, a Massachusetts Institute of Technology alumnus.

Matters are complicated by India's steep coal gasification target — virtually a 50-fold increase from around 2 million tonnes per annum (mtpa) now to 100 million tonnes (mt) of coal processing by 2030 — whereas the country's only functional coal gasification plant of scale, Jindal Steel's gasifiers at Angul in Odisha, is designed to process 2.4 mt of coal per year. Efforts by state-run companies have failed repeatedly. R R Sonde of Indian Institute of Technology Delhi said the Talcher and Ramagundam projects failed because of attempts to force-fit inappropriate imported technologies.

Now, Indian firms seem to be repeating these mistakes.

The ₹13,277 crore Talcher coal-based ammonia-urea gasification complex — promoted by Gail, Coal India Ltd, Rashtriya Chemicals & Fertilisers and FCIL is floundering — after the project proceeded with entrained gasifiers, against the advice of global experts on coal chemistry. A year later, China's Wuhuan Engineering was hired to supply entrained gasifiers. This project will have an output of 1.27 mtpa of Neem-coated urea, Talcher said.

BCGCL, or Bharat Coal Gasification and Chemicals Ltd, a coal-to-ammonium nitrate fertiliser project at Jharsuguda, Odisha,

led by BHEL and Coal India, has proposed using BHEL's gasifier technology, which is tailored to handle the high ash content and variability of Indian coal, a company official said. But the technology has never been scaled for commercial deployment.

The only Indian company to get it right is Jindal Steel: Rather than try and reinvent the wheel, it adapted Lurgi fixed bed gasifier technology (developed by Nazi Germany in the 1930s incidentally). "That's the only functional large-scale gasifier in India in high-ash coal," Mukherjee said.

The technology, which powers over 100 gasifiers across the world successfully in China and South Africa, was suitable for high-ash, low-rank coal, and the composition of the derived syngas was suitable for steel and fertilizer units, according to a company presentation. Furthermore, a carbon capture component in the design has limited emissions. Naveen Ahlawat, head of gasification projects at JSPL, advocated integrating carbon capture and storage to reduce the carbon footprint at a seminar last September.

"Coal gasification is the starting point, but you must complement that with carbon capture to make it sustainable at the levels that you want," Mukherjee said.

### The tech behind it

During World War II, Germany was producing 125,000 barrels a day of synthetic fuel under Hitler. After the war, a South African entrepreneur bought the rights to the technology, and in 1950 the racist Apartheid government produced gasoline from South Africa's vast coal deposits — useful when global sanctions were imposed against the country in the 1970s. However, Indian coal's ash content is not only high but also variable (30-45 per cent), complicating stable plant operation, suggested Martin Grabner at the Fraunhofer Institute for

Ceramic Technologies and Systems to NITI Aayog at an event in late 2025. Indian ash has high concentrations of silicon and alumina, coupled with low levels of iron and lime, which hinders its use in entrained-flow gasifiers, Mukherjee said.

There are three main gasifier technologies: Fixed-bed, fluidized-bed, and entrained. Fluidized bed gasifiers work best for Indian coal varieties because they tolerate varied particle sizes, operate at lower temperatures, and manage fluctuating feedstock quality, Grabner said. Fixed-bed is very energy-efficient but cannot handle powdered coal particles from crushed Indian coal. Entrained gasifiers liquefy coal into a slag, and suit lower-ash coal with a manageable composition from the US or China, Mukherjee said.

Talcher Fertilizers chose entrained gasifiers, primarily due to their scalability and relatively lower capital expenditure for coals with favourable characteristics. But Grabner thought entrained gasifiers to be the 'least suitable' for widespread application with raw, high-ash Indian coal.

Talcher coal has a mineral composition with high silicon and aluminium content leading to high ash fluid temperatures, which raises gasification costs. Talcher later made design modifications for blending coal with 25 per cent petcoke, a low-ash feedstock, tying up with Indian Oil for supplies. Also, mineral composition of the ash has to be adjusted by adding a fluxing agent for optimal flow of the liquified slag. But such adaptations come with significant operational compromises and costs, according to global coal gas expert Johan Van Dyk. Talcher still has no commissioning date in sight.

Indigenous technologies are in the pilot stages, including one to convert high-ash coal to methanol. V K Saraswat, member, NITI Aayog, has suggested India develop a technology that can handle various coal types.

For India's multibillion dollar bet to pay off quickly, the choice of gasifiers must be governed by practical considerations, Mukherjee said. And that, as Grabner said, requires a solid scientific understanding of India's coal characteristics as a starting point for technology selection.

A one-size-fits-all global approach is unlikely to succeed.