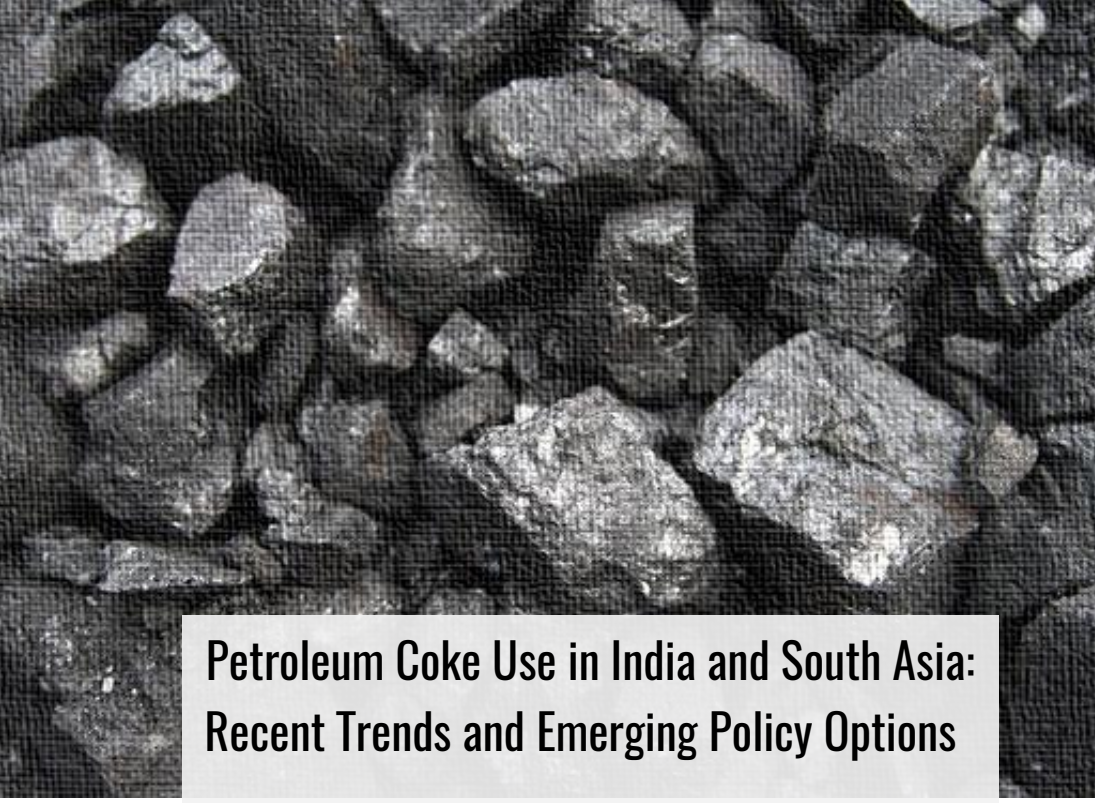

Petroleum Coke Use in India and South Asia: Recent Trends and Emerging Policy Options

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Abstract: *If there ever was a standard oil, it no longer exists. As conventional oil stores deplete, new oils are replacing them, including ultra-light oils produced by hydraulic fracturing and extra-heavy oils produced by mining and injecting steam. Different oils not only require different upstream production processes, they also use different refining techniques and result in a different slate of petroleum products. Current refining techniques for heavier oils produce a low-quality, solid residual fuel, and petroleum coke (petcoke). Oils high in sulfur and heavy metals generate a variety of petcoke that can be more polluting than coal. Since petcoke resembles coal, it can be difficult to closely monitor its trade and use. Still, broad indicators show that highly-degraded petcoke ends up in being burned to generate power in Asia. It is important to take stock of the global petcoke markets and flows around South Asia. Recent trends in the environmental management of petcoke in India can inform a more constructive petcoke policy approach for the broader South Asian region. Future actions include: establishing a framework for petcoke lifecycle emissions accounting, integrating petcoke into the U.S.-India Strategic and Commercial Dialogue, creating a South Asia Energy Data Center, and developing public-private partnerships to accelerate petcoke innovation.*

What is Petcoke and its Environmental Impacts?

Heavier oils are naturally higher in their carbon content, creating challenges in production, refining, transport, and marketing. In order to refine heavier oils, the 'coking' process was patented in 1913 in order to make more high-value transport fuels out of the 'bottom of the oil barrel.' Wringing out more liquids using coking, however, results in a solid residue called petroleum coke, or 'petcoke.'

The heavier the oil, the more petcoke produced. The higher an oil's sulfur and heavy metal content, the lower the petcoke's quality and value. While petcoke that is low in sulfur and heavy metals can be treated (calcined) and used to produce aluminum, steel, and as industrial feedstock, fuel grade or

"green" petcoke, which is high in sulfur and heavy metals, is burned in power plants to generate electricity.

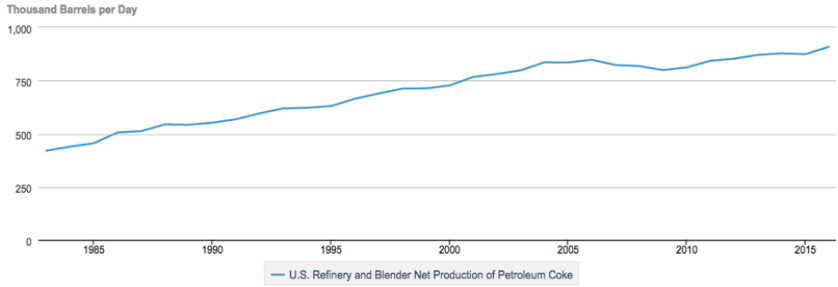
Fuel grade petcoke is generally too dirty to produce power in the United States. To prevent petcoke from piling up, the U.S. sells its stores of fuel grade petcoke, mostly to Asia where environmental regulations tend to be less stringent. With as much as 9% sulfur along with elevated levels of nickel and vanadium, burning petcoke emits particulates, sulfates, and other air contaminants that degrade the environment and threaten public health.

In recent years, China has improved its awareness of the environmental risks associated with petcoke use and tightened regulatory limits on petcoke's sulfur emissions (S&P Global Platts, 2015), (Zhou, 2016). However, this appears to have had the perverse effect of displacing petcoke flows to other emerging South Asian markets with growing power demands. South Asia represents such a node of growing petcoke demand. India, in particular, has become a major destination for U.S. petcoke exports while Saudi Arabia is shipping increasing volumes of petcoke throughout Asia.

Charting Global Petcoke Markets

In 2016, the U.S. was the world's largest petcoke producer at 60 million metric tons (MMT). And volumes are rising as America refines increasingly heavier oils from Canada, Mexico, and California (see figure 1 below). U.S. petcoke exports amounted to 38 MMT in 2016, representing the largest petroleum product volumes sold by American refiners after diesel and gasoline (with which petcoke is nearly tied).

Figure 1: U.S. Refinery and Blender Net Production of Petroleum Coke



Source: U.S. Energy Information Administration, (EIA, 2017)

Canada, another potential source of future petcoke exports, is currently stockpiling millions of tons of petcoke because export costs are higher than market prices. However, Canadian law safeguards the petcoke stockpiled as a strategic product that may be need to be sold at a future date.

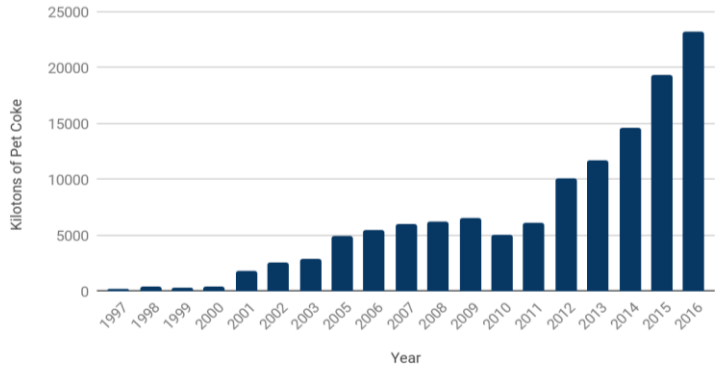
There is no readily-trackable and transparent spot market for petcoke. Since petcoke resembles coal, it can be difficult to monitor its trade and use. Relatively opaque sales data indicate that around 137 million tons of green petcoke are produced globally per annum, an amount that has grown steadily alongside the refining of heavier oils (CW Research, 2017). Although petcoke has long been at or near the bottom of the petroleum product value chain, oftentimes considered an undesired byproduct, enterprising refiners and traders have continued to find and motivate new markets for petcoke.

Sulfur content is a primary driver of price differentials in the petcoke market. In 2015, the premium observed in U.S. Gulf Coast petcoke exports of 4.5% sulfur petcoke compared to 6.5% sulfur petcoke ranged between $5 to just over $20 per ton. Although petcoke prices are quite volatile, at under $25 per ton, petcoke's low price makes it a bargain compared to coal that sells for twice as much (Argus, 2016). Worth over $11 billion in 2016, the global petcoke market is forecast by some analysts to more than double in value to $25 billion by 2024 (Global Market Insights, 2017).

The Indian Petcoke Market

Petcoke consumption in India has been rising along with economic growth, beginning in the 1990s (figure 2). Demand spikes over the past several years are due in part to increased petcoke consumption by the cement industry. And increased consumption of fuel grade petcoke has benefited from favorable logistics in certain areas where domestic coal supply has been constrained by rail network bottlenecks.

Figure 2: India Petcoke Consumption, 1997-2016



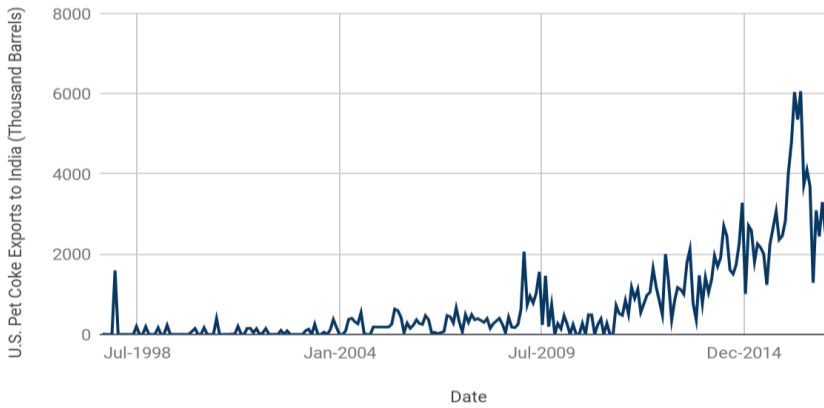
Source: Ministry of Petroleum and Natural Gas, Government of India

Alongside petcoke consumption, petcoke production in India has also been rising as Indian refineries have increased throughput of heavier, discounted crude streams. Indian petcoke production is currently estimated at 12.5 million tons, and may increase by 4 million tons if all planned capacity additions are realized (Roychoudhury, 2016).

Petcoke imports in India saw significant growth starting in late 2014, driven by a number of factors: (1) increasing U.S. petcoke exports that result from running Canadian oil sands through American refineries, (2) the start-up of two large-scale petcoke production facilities in Saudi Arabia with favorable shipping times to India, and (3) slowing petcoke import demand in China as growing awareness of associated environmental risks drove new regulations on imports and use (Tao, 2015). After staying at a stable, low level for more than a decade, there has been rapid growth in U.S. petcoke exports to India

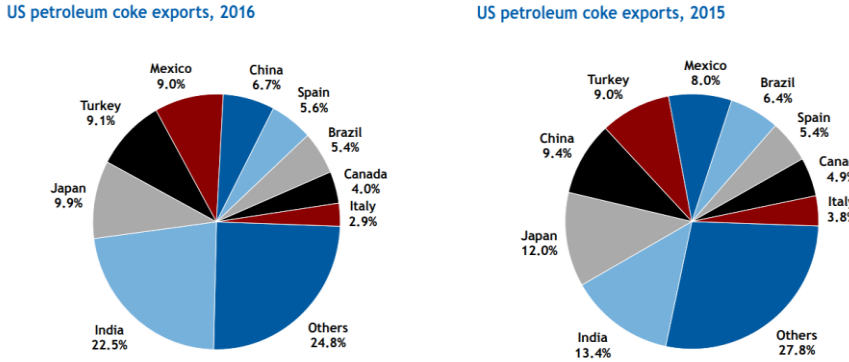
since the late 2000s, and India represented over 22% of U.S. petcoke exports in 2016, up from 13.4% in 2015 (figures 3 and 4).

Figure 3: U.S. Petcoke Exports to India, 1997-Present



Source: U.S. Energy Information Administration

Figure 4: U.S. Petcoke Exports by Destination, 2015 and 2016



Source: Argus

In 2016, India saw total petcoke imports increase substantially by 40% over the previous year, to 14 million tons. While this is still a small volume in comparison to India's coal imports (145 million tons over 2016-2017), petcoke's market immersion was spurred by its favorable price that may be

extending the life of coal (Pillay, 2017). As volatile petcoke prices rise, however, may challenge the economic logic of petcoke's substitution for coal in both industry and power generation.

Saudi Arabia, as noted, is also of growing importance in South Asian petcoke markets due to increasing capacity and a close proximity. Two new large-scale refineries in Jubail and Yanbu with a combined petcoke production capacity of 2.4 million tons per year began exporting in 2015. Moreover, Saudi Arabia enjoys logistical advantages over the U.S. when exporting to South Asia. From Jubail, shipping times to India are only 8–10 days, and from Yanbu 12–13 days (Argus, 2016).

Evolving Indian Petcoke Management Efforts

Despite the fact that petcoke, when burned for power, emits slightly more greenhouse gases than coal, and has nearly twice the emissions of natural gas (depending on assumed parameters regarding production, transport, and processing methods), petcoke has enjoyed preferential tax treatment in India. Since 2010, the Indian government has assessed a levy on every ton of coal, which has risen gradually to a current level of 400 rupees (~$6.27) per ton. Petcoke, by contrast, is not currently subject to the levy. This policy invites market distortion given that the sulfur content (as well as other pollutant levels) of petcoke can be far greater than coal. Environmental policy governing petcoke use could tip economies away from its use due to the historically close market price differential between petcoke and coal. A number of recent developments are pushing in this direction.

In December 2016, the Environmental Pollution Control and Prevention Authority (EPCPA) of India, a body appointed by the Supreme Court of India, asked the Court to consider restrictions on the use of petcoke in the Delhi/National Capital Region (NCR) in light of acute pollution concerns (Steel 360, 2017). EPCPA's study of air samples in the NCR revealed dangerously high levels of sulfur, and believed that much of this was attributed by the growing substitution of natural gas and other fuels for less expensive but dirtier petcoke.

The Ministry of Environment, Forests, and Climate Change has traditionally not endorsed an outright ban on petcoke utilization, instead advocating for continued use of the fuel in industries with emissions control mechanisms, or for a seven-month grace period for industries without such standards to transition to natural gas (Times of India, 2017). EPCPA, in turn, has maintained that even those industries with emissions control systems are adrift without emissions standards to adhere to.

In response to the EPCPA, in February 2017, the Supreme Court ordered various government bodies to develop a plan for controlling pollution levels in the NCR. In April, the EPCPA submitted a proposal to the Court involving a prohibition on the distribution, sale, and use of furnace oil and petcoke in the NCR. The state governments of Uttar Pradesh, Haryana and Rajasthan subsequently followed up with submissions indicating that they would not be opposed to such a ban.

In May 2017, the Court ordered the Central Government and the Central Pollution Control Board to promulgate sulfur dioxide (SO_2), sulfur oxide (SOx), and nitrogen oxide (NOx) emissions standards for 35 heretofore unregulated industries by 30 June 2017, with a compliance grace period until the end of 2017 (SS Rana & Co, 2017).

Concurrently in May, the country's National Green Tribunal (NGT) heard a case brought by an environmental group seeking a circumscription of petcoke handling and use in view of its deleterious health impacts. The NGT directed the Ministry of Environment, Forests, and Climate Change to determine within a period of two months whether petcoke should be treated as an "approved fuel" or instead as a "hazardous waste" that would trigger a series of restrictions on its use (Central Pollution Control Board, 2017).

Shortly thereafter, reports began appearing that the Ministry of Environment, Forests, and Climate Change was in the advanced stages of drafting a ban on petcoke usage in non-cement sectors within Delhi/NCR boundaries due to acute pollution concerns. This is in addition to the newly-developed industry emissions standards, prompting some to speculate whether the growing number of challenges to petcoke on environmental grounds could precipitate a nation-wide set of restrictions on petcoke use that mirror those to be implemented in Delhi/NCR (Steel 360, 2017).

Perhaps unsurprisingly, the evolving political economy of energy in India has also seen the coal industry become an advocate for more stringent environmental regulations on petcoke. The powerful Coal India Limited (CIL), currently the largest coal miner in the world and responsible for more than 80% of India's production, appears to have lobbied the government in 2016 to apply an environmental tax on petcoke on the basis of its sulfur content (Financial Express, 2016).

Next Steps for Petcoke in South Asia

The environmental externalities of petcoke must be regulated — and, ideally, priced — on a level playing field with other energy commodities. In a world beset by climate change, it makes little sense to economically promote global markets for 'one of the highest carbon fuels that exists.'

Establish a framework for lifecycle emissions accounting

First, the government of India should look to set an example for the rest of the South Asia by rationalizing its approach to energy taxation. Full lifecycle emissions accounting provides a neutral and objective approach to taxing polluting energy commodities not by their name, origin, or any other imperfect categorization, but instead in accordance with the commodity's actual environmental impact. Once a framework for full lifecycle emissions (impact) accounting is complete, individual governments can decide the degree to which they wish to weight certain pollutants (e.g. local air pollutants or climate change forcing agents) over others, in line with policy and societal priorities.

Integrate petcoke into the U.S.-India Strategic and Commercial Dialogue

The asymmetry between national-level policymaking and internationally-integrated markets can lead to unintended policy consequences that are difficult to predict and address. For example, as China works to rationalize and minimize its own petcoke imports and consumption, this in many cases can simply create a growing glut in the international market, making petcoke more

attractive to import and use in India and elsewhere throughout South Asia. In other example, South Asia may find efforts to increase regulation and oversight of petcoke at odds with efforts by U.S. industry and commercial diplomacy mechanisms to increase sales of petcoke to the region.

Policy coordination, both among and between major petcoke consumers and producers, is therefore desirable. A good starting point would be institutionalized exchange on petcoke issues between one of the world's largest consumers, India, and one of the largest producers, the United States. This could be integrated into the extant U.S.-India Strategic and Commercial Dialogue, and could start as a small, data-focused addition to the existing energy and climate agenda under the Dialogue. Over time, this could mature to include greater coordination beyond just data collection and analysis.

Create a South Asia Energy Data Center

Considering the significant capacity for intra-regional trade in South Asia and the region's significant energy demand growth in the decades ahead, well designed data-sharing initiatives can make for better policy design and a more intelligent build-out of new energy capacity to meet growing demands. Opaque petcoke markets need to be made far more transparent in order to monitor and track regional movements.

A South Asia energy data center, involving at least Bangladesh, Bhutan, India, Pakistan, Sri Lanka, and Nepal, should be considered, possibly within the context of the South Asian Association for Regional Cooperation (SAARC). A loose model for such an initiative is the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) in West Africa, which has grown with the support of the Global Environment Fund (GEF) and the U.N. Industrial Development Organization (UNIDO), among others. It is critical, however, that such an initiative in South Asia begin with a focus on data for all energy sources, in particular for fossil fuels, given the paucity of publicly available data for such a dominant group of energy sources. As long as coal, oil, petcoke, and other fossil fuels are growing in consumption and importation in South Asia, this is a prime area to start with a harmonized data collection and reporting effort.

Develop Public-Private Partnerships to Accelerate Innovation

The region should also consider embracing public-private partnerships as a means to assess petcoke innovation, especially where more carbon-efficient processes could yield economic benefits. For example, Reliance Industries is planning to install eight petcoke gasifiers at the Jamnagar refining and petrochemical complex, the world's largest. This could create a combined capacity of over 18.5 million cubic meters per day of synthetic gas ("syngas") production using "e-gas" technology licensed from Phillips 66 (Wang, 2016). The resulting syngas can be used either as a refinery process fuel or for chemicals production by utilizing syngas-to-methanol and methanol-to-olefins technologies. A similar state-of-the-art petcoke to methanol project in the U.S. received a conditional loan guarantee from the Department of Energy in December 2016 (Energy.Gov, 2016).

The U.S. project notably involves a planned carbon capture mechanism, which the Jamnagar gasifier project thus far lacks. Consequently, it is difficult to make sweeping statements as to the environmental benefit (or cost) of the petcoke gasification processes that would be employed. Once the full lifecycle emissions of different petcoke strategies is assessed, governments and international financial institutions can then prioritize technologies and pathways with the lowest environmental and greatest economic impact, and support these with a range of mechanisms including subsidies, loan guarantees, and procurement agreements.

These steps will not lead overnight to a reconciliation of the competing economic, security, and environmental priorities that have made petcoke such a challenging energy source to manage. However, while addressing concerns raised by this underappreciated and unintended consequence of the global oil market, countries in South Asia can take a step forward towards a stronger, more integrated platform for energy, environmental, and climate policy harmonization in the region.

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