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Why Coal Will Keep Burning

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Why Coal Will Keep Burning

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AT A GLANCE

Coal is likely to remain a significant source of power generation in the years ahead. This has major implications, including for climate change efforts.

Developing Countries Drive Demand

While OECD countries shift away from coal and demand in China flattens, coal demand is increasing in developing countries such as India and Indonesia.

Eliminating Coal Poses a Challenge

Eliminating coal-fired power in developing countries would be costly. Those countries are unlikely to move away from coal without economic assistance from developed countries.

Companies and Investors Must Adapt

Despite the continued demand for coal, companies with a stake in the market face mounting challenges, including the risk of stranded assets.

This article is the third in a series on the future of energy in an increasingly uncertain world.

If you listen to the rhetoric, the outlook for the coal market can be summed up in one word: bleak. In Europe, political and social opposition to coal is mounting as efforts intensify to limit CO_2 emissions. In the US, cheap and accessible shale gas is rapidly displacing coal. And in China, concerns about poor air quality and related health issues have caused demand for coal to fall three years in a row, from 2014 to 2016. So is coal demand about to decline globally? Is coal headed for the ash heap of history?

Such a development is unlikely. Without drastic changes in current consumption patterns, coal demand is likely to remain relatively stable in the years ahead, according to BCG's Global Energy Scenario Model. The main reason: the unquenchable thirst for energy in numerous Asian developing countries, such as India and Indonesia.

Certainly, several developments could trigger a slowdown in coal demand growth—or even a contraction. These include slower than projected global GDP growth and an exceptionally fast uptake in renewable power—even faster than the rapid pace currently projected—combined with disruptive advances in renewable energy storage. Comprehensive, coordinated global regulatory action to limit greenhouse gas emissions—difficult and complex, but not impossible—could also reverse the coal trajectory. Absent such events, coal is expected to continue to play a major role in the energy market for the foreseeable future.

The main reason coal demand will remain relatively stable: the unquenchable thirst for energy in developing countries in Asia.

Even amid stable global demand, however, risks will mount for those with a stake in coal. Heavy users in energy-intensive industries will need to regularly evaluate whether to shift to other power sources, given that new regulation can abruptly make coal less cost competitive. In addition, while a concerted global shift from coal is unlikely, coal-mining companies and coal-fired power plant owners face the potential of swift and unexpected regulatory changes in many markets, which could result in stranded assets. At the same time, the challenges facing coal will lead many investors to exit the sector—although those with a higher risk tolerance may look for distressed asset opportunities.

Perhaps even more significant, the continued demand for coal has global implications. Most notably, it substantially reduces the likelihood that efforts to limit the global temperature increase to less than 2°C will succeed. (See "Preparing for a Warmer World," BCG article, December 2017.)

Continued Demand—but Growing Uncertainty

Coal has enjoyed nearly 200 years of continuous volume growth, with 1.6% annual growth in the past 100 years alone despite the displacement of coal by oil in transportation. Today, coal accounts for roughly one-third of global energy production. The primary reason: it is affordable, accessible, and easily stored and transported, making it well suited to meeting the energy needs of industrializing economies. It's no surprise, then, that about 76% of global coal demand comes from China and other developing countries, which continue to add coal-fired power capacity. In 2016 alone, 70 gigawatts of new coal capacity was added globally—a net increase of 57 gigawatts, after accounting for plants taken out of use. That's nearly 40% of the total coal-fired power plant capacity in Europe today, or the equivalent of roughly 800 megawatts of new capacity every four days.

New Headwinds Emerge. Such statistics, of course, do not tell the full story. Multiple coal-fired power projects, with a total capacity of 440 gigawatts, have been cancelled, deferred, or delayed around the world over the past three years, including at least 250 gigawatts in China.

Within Asia, demand growth is shifting from China, where coal consumption will plateau in the 2020s, to other countries.

Such actions stem from two developments. First, the environmental costs of coal are becoming more apparent. Coal is roughly 40% more carbon intensive per energy unit than gasoline and about 80% more carbon intensive than natural gas. It is the leading source of global carbon emissions and the second most dominant source of air pollution, after oil. Second, costs are declining for renewable energy, including centralized wind and solar power and decentralized solar—prompting China, India, and other Asian countries to invest in renewable power generation.

Even taking cancellations into account, however, some 220 gigawatts of new coal-fired power generation is under construction, primarily in Asia. Within Asia, demand growth is shifting from China, where coal consumption will plateau in the 2020s, to other countries. In India, roughly 50 gigawatts of new coal-fired power generation capacity is under construction—which represents about 20% of the country's current coal-fired capacity. Meanwhile, Indonesia, Taiwan, Vietnam, Malaysia, and the Philippines are constructing coal-fired plants.

Potential Disruptions in the Coal Market. There are a number of wild cards when it comes to the outlook for coal demand. Expanded access to electricity, a rapid shift to electricity for heating, or a breakthrough in electric vehicle technology, particularly in developing markets, could stoke stronger than expected power demand and, therefore, coal consumption. Advances in cutting-edge clean coal technology that enables the capture and storage of CO_2 from coal power plants—an approach that is currently cost prohibitive—could also boost coal consumption.

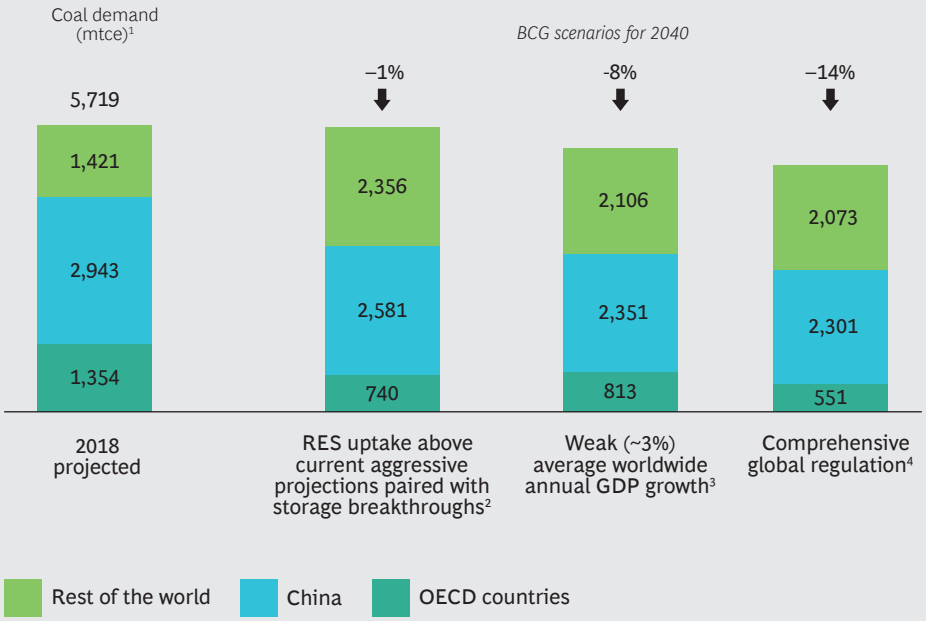
A couple of developments could dampen growth in the demand for coal. One is the faster than expected substitution of gas for coal in the power industry. However, even under a scenario in which shale gas reserves in China and Argentina are tapped, coal demand would still increase by roughly 0.3% annually between now and 2040. Another possible development is rapid gains in energy efficiency in buildings and appliances, which would limit coal demand growth to 0.2% annually through 2040, according to our model.

Under all these scenarios, coal demand either continues to grow modestly or remains stable. What would trigger a contraction? Our model indicates three developments that—either alone or in combination—could reduce the demand for coal. (See Exhibit 1.)

1. **Rapid Deployment of Renewables and Breakthroughs in Energy Storage.** There is no doubt that steadily declining costs will fuel the massive deployment of renewable power in the years ahead. The question is whether the uptake could exceed even current, aggressive projections. Another uncertainty is the outlook for storage technology. Solar and wind power are now competitive with coal when the sun is shining or the wind is blowing. However, the technology for storing that power is not cheap enough to make renewables competitive with coal 24 hours a day, 7 days a week. Breakthroughs such as the development of large-scale, inexpensive batteries or affordable power-to-gas or power-to-hydrogen technologies, combined with quicker than expected uptake of renewable energy globally, could change that calculation.

   We have modeled such a scenario, one that assumes society is able to harness roughly 40% of the potential decentralized solar capacity that is technically fea-

EXHIBIT 1 | Three Disruptions Could Decrease the Demand for Coal



Sources: BCG Global Energy Scenario Model; IEA.
[1]Primary energy demand for coal in million tons of coal equivalent.
[2]RES = renewable energy sources; assuming that 40% of technical potential in decentralized solar is realized, providing 19% of global power demand, and that centralized renewables provide 16% of global power demand.
[3]Baseline assumes 3.5% average GDP growth.
[4]Assuming that OECD countries and China stop building new coal power plants as of 2018, retire all plants older than 40 years as of 2020 and all plants older than 35 as of 2030, while the rest of the world stops building new plants as of 2025 and retires all plants older than 40 years as of 2030.

sible. (The calculation of potential capacity depends on factors including the amount of solar energy reaching the earth as well as the size and structure of the global building stock and solar panel efficiency.) Even in such a scenario, however, coal demand would decline by just 1% from 2018 through 2040.

2. **Weak GDP Growth.** GDP growth remains a strong driver of power demand, particularly in emerging countries. Our model indicates that a relatively low global GDP growth rate of about 3% per year between 2018 and 2040 would dampen overall energy demand; coal demand would fall by about 8% during that period.

A coordinated, global regulatory push to limit CO_2 emissions could derail coal.

3. **Comprehensive Global Regulation.** A coordinated, global regulatory push to limit CO_2 emissions could derail coal. Certainly, such an undertaking would be challenging and complex—but it is not impossible. To succeed, an international CO_2 emission reduction scheme would need to recognize the right of developing countries to continue advancing economically. And it would likely call on developed countries to provide some economic support to help developing countries shift to less carbon-intensive energy sources.

   To evaluate the impact of such an effort in our model, we assume that OECD countries and China stop building new coal power plants as of today (2018) and retire all plants older than 40 years by 2020 and all plants older than 35 by 2030. We also assume that the rest of the world stops building new plants by 2025 and retires all plants older than 40 by 2030. In this scenario, coal demand would decline 14% from 2018 to 2040.

None of these developments would lead to an outright collapse in coal demand—a fact that underscores just how entrenched coal remains in the global economy.

The Outlook for Coal by Region

As part of our analysis of the feasibility and impact of shifting away from coal, we have divided the world into three parts: OECD countries, China, and other non-OECD nations, which we refer to as "developing countries."

As coal consumption declines in most developed countries, including those in Europe and the US, the future of coal is increasingly dependent on developing countries. Without some sort of international emissions reduction plan, the total tab for those countries to move aggressively off coal in the near term would be prohibitively high.

Such calculations, however, do not factor in the long-term economic costs created by unchecked global warming. Ultimately, those costs, while difficult to project with precision, are likely to be massive and outweigh the bill for eliminating the use of coal-fired power globally.

OECD Countries Move Beyond Coal. Most European power generation players have ruled out the construction of new coal plants. And utilization at existing coal-fired plants in Europe is decreasing as renewable energy sources expand.

Government leaders in Germany, France, Italy, the UK, Austria, the Netherlands, Portugal, and Finland are all considering the elimination of coal-fired power generation between 2025 and 2030. A number of regulatory actions, including a hike in the price of CO_2 to about $15 per ton, would effectively drive coal out of the market. In fact, under planned changes to the EU emissions trading system, CO_2 prices could hit that level—or higher—in the 2020s.

Such a move would come with significant, but not prohibitive, costs. We estimate that the stranded costs—the write-offs associated with closing Europe's coal plants—would be about $100 billion. Add in the higher energy costs that would come from substituting coal-fired power with a mix of renewables and gas, and the total bill on a net-present-value basis would hit about $180 billion—roughly 0.07% of the region's cumulative GDP from 2018 through 2030.

Meanwhile, the shale revolution in the US has upended the coal market, leading to annual declines of about 4.7% in coal consumption for power generation over the past ten years. This trend is likely to continue—although the degree of substitution varies by region. States such as Pennsylvania and Ohio, which have established gas infrastructure, for example, have seen rapid substitution, while coal has lost little share in states such as Utah and Wyoming, which have limited existing gas infrastructure and proximity to substitutes. For the US to completely eliminate coal, the total net-present-value cost would be about $100 billion, or a relatively modest 0.04% of cumulative US GDP through 2030.

The remaining OECD countries, such as Japan and Australia, typically have a younger base of coal-fired power generation and a greater reliance on coal than Europe and the US. This is particularly true in Japan, where coal-based power generation got a boost after the Fukushima accident. We estimate the net-present-value cost for these countries to eliminate coal-fired power generation to be about $150 billion, or roughly 0.08% of cumulative GDP through 2030.

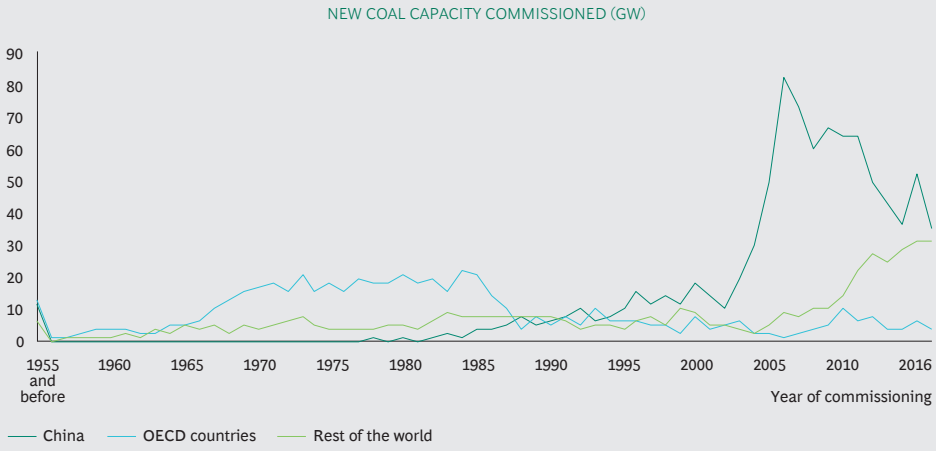
Slowing Demand Growth in China. China has been the primary driver of coal demand since the early 2000s, thanks to its ever-growing need for power. In 2016, 35 of the 70 gigawatts in new capacity was in China.

The decline in China's coal-fired power generation capacity, which today stands at about 920 gigawatts, is unlikely to be dramatic.

However, demand for coal in China has just about peaked and is likely to begin declining in the early 2020s. The government is promoting a shift from coal to less polluting sources, including renewables, in a bid to address the country's air quality challenges. This has included a push in urban centers to move away from coal-fired heat and a drive to shutter some of the country's older, high-polluting coal plants. At the same time, the government has curtailed coal production since 2015 as part of an effort to prop up domestic coal prices.

But these efforts merely mark a reset in China's reliance on coal—not a full-scale reduction. In fact, the decline in China's coal-fired power generation capacity, which today stands at about 920 gigawatts, is unlikely to be dramatic. For one thing, China added a significant amount of coal-fired capacity from 2000 to 2016. (See Exhibit 2.) As a result, the average age of a coal-fired power plant in China is just 11 years—and another 90 gigawatts is under construction. Given that the average coal-fired

EXHIBIT 2 | Recent Capacity Additions Give China a Relatively Young Base of Coal-Fired Plants



Sources: Platts, 2017; BCG analysis.

plant currently operates for about 60 years, those assets may be in use for decades to come.

In addition, coal mining and production account for a significant number of jobs in China—making the shutdown of such operations politically unpalatable. Finally, absent significant government intervention, gas will not be a viable substitute for coal in China. We estimate that Chinese domestic gas prices would need to hit $4.2 to $5.3 per million British thermal units (mmbtu) for natural gas to displace coal. Such prices would be possible only if China could tap into natural gas reserves at cost levels nearly as low as those in the US—a possibility that is not realistic in the near term.

In this environment, the steep cost of eliminating coal in China makes such a move difficult. The best option is to replace coal with a mix of renewables and gas. But such a mix is still more expensive than coal. As a result, we estimate the full net-present-value cost of substituting coal-fired power with renewables and gas in China to be $1.3 trillion—or 0.55% of China's cumulative GDP through 2030—including about $750 billion in stranded assets.

Growing Coal Demand in Developing Countries. Amid energy-intensive economic growth, coal remains a primary power source in most developing markets. Even after multiple project cancellations in countries such as India, roughly 100 gigawatts in coal-fired generation capacity is under construction. The bulk of the capacity is being constructed in India, Indonesia, Taiwan, Vietnam, Malaysia, the Philippines, Pakistan, Bangladesh, and South Africa. And even more is on the drawing board.

The growing appetite for coal is unlikely to diminish any time soon. For one thing, natural gas cannot displace coal in these markets. That's because these countries lack their own major cheap and accessible gas reserves and therefore would need

to import liquefied natural gas (LNG). But the costs associated with LNG, including liquefaction, transport, and the construction of infrastructure to move gas inland, make it noncompetitive with coal in most cases. In fact, assuming there is no global scheme for putting a price on CO_2 emissions, US gas prices would need to fall below $2 per mmbtu for LNG to be a viable option in most of these countries. That price level is about 25% below the average US Henry Hub spot price over the past five years.

In addition, while renewable energy sources are growing quickly in these markets, the increasing demand for power swamps that additional capacity. India, for example, has taken decisive steps to support renewable energy development, including eliminating both import duties on critical solar parts and interstate transmission charges on the export of solar power. The government's goal: to reach 175 gigawatts of renewable energy capacity by 2022, up from 60 gigawatts currently. But that will represent just one-third of the country's total power generation capacity—and coal is still projected to account for more than 50% of that capacity.

Renewable energy sources are growing quickly in developing countries, but the increasing demand for power swamps the additional capacity.

In this environment, the costs of shifting rapidly away from coal are steep. BCG estimates that substituting coal-fired power generation with higher-cost renewables in developing countries, including balancing intermittent renewable power generation with gas, would have a net-present-value cost of more than $700 billion. This amounts to nearly 0.25% of the cumulative GDP for these countries through 2030—although some countries bear a higher share of these costs than others. This estimate includes roughly $350 billion in stranded assets, many of which would be relatively young coal-fired power plants, but does not include the sizable economic hit to these countries from closing coal mines.

Even if such high costs could be addressed with a global emissions reduction plan, countries would confront major execution challenges in shifting away from coal. These would include rapidly building new low-carbon power generation and storage capacity and upgrading the power grid.

Adjusting to the New Realities

For decades, utilities and other energy-related businesses have been accustomed to predictable, steady demand growth, a stable technology landscape, and a relatively slow pace of regulatory change. But this stable environment is morphing into something more dynamic and less predictable. (See the sidebar "Preparing for an Uncertain Energy Future.")

This new reality is particularly challenging for companies linked to the coal sector. It has major implications for companies that consume large amounts of energy, mining companies, coal-fired power generators, and investors.

Industrial Coal Users. The risk posed by new, strict coal regulations is very real for companies that rely on coal-fired power. Tougher regulations will increase the cost of coal use. Meanwhile, the potential upside from declining coal demand—lower coal prices—is limited given the fuel's flat cost curve. That's one reason industrial coal users need to regularly evaluate the option to switch to gas or renewables.

PREPARING FOR AN UNCERTAIN ENERGY FUTURE

Participants across the energy industry are struggling to find their footing in a rapidly evolving landscape. The pace of change, and the disruption it brings, is set to accelerate before we reach a new equilibrium. And no one knows precisely what that will look like.

For decades, the industry had familiar contours: energy sources and markets operated in virtual silos, investment horizons were long, and technological development was steady but not disruptive. The uninterrupted growth of global demand for all sources—whether coal, oil, or natural gas—was taken as a given.

Now, all that is in flux. Rapid structural changes in energy markets—at times initiated by regulation but fundamentally driven by technological innovation—have intensified competition among both traditional and renewable sources. Disruptions that were unimaginable not long ago—such as the emergence of environmentally friendly electric vehicles and the substantial use of wind and solar energy in power generation—are now realities.

The myriad potential combinations of these disruptive factors and others would lead to very different outcomes for energy companies, regardless of sector, and for countries.

But whatever the outcome, industry players will need to adapt. Companies must minimize the risk of stranded assets, manage complex resource exposures, and stay on the right side of upcoming regulations. Governments must ensure that the transition to cleaner energy is not overly costly for citizens and industry, and promote long-term technologies without generating windfall profits for a few.

Industry players and governments also face a higher-order challenge: given an uncertain world, they must develop the capability to examine the assumptions behind differing scenarios and projections, assess the impact of various disruptions, individually and in combination, and prepare for the range of possible outcomes in the energy market.

Companies and national authorities need to navigate strategic energy decisions and engage in a dialogue with stakeholders about solutions. In this way, they can successfully navigate the changes in the energy landscape while also addressing environmental challenges.

Mining Companies. Mining operators have long-cycle investments, often putting sizable amounts of capital to work over many years to gain access to resources and develop production and export infrastructure. Faced with a less certain demand outlook, coal-mining companies will need to find ways to reduce the risk of stranded assets. This will require a review of their investment plans with a more conservative approach to new developments. This approach should include a focus on projects that will yield lower-cost and higher-quality (lower ash content) resources, are located close to or within existing operational sites, or have existing export agreements. At the same time, these operators should take a hard look at options for diversifying away from coal.

For vertically integrated utilities that retain coal-fired plants, the risk of stranded assets is high.

Vertically Integrated Utilities with Coal-Fired Power Plants. While mining companies can ship their product to regions where coal is still in demand, coal-fired plant operators do not have that luxury. In addition, profitability for coal-fired plants will continue to decline as increasingly competitive renewables drive overall market power prices lower and mounting regulatory constraints push coal-fired generation costs higher.

As a result, vertically integrated utilities with coal-fired plants have a decision to make. They must either improve the efficiency of their operations or sell their coal assets while a market remains for them. For those that retain coal assets, the risk of stranded assets is high. As a result, they should explore putting those coal assets into a separate entity.

Walling off the coal business in a separate unit will make it easier to pursue a strategy that is appropriate for those assets. That strategy has three primary components. First and foremost, companies must relentlessly reduce costs and improve flexibility—the ability to rapidly ramp energy production up and down. Second, coal-fired plant owners must find ways to limit their downside, such as by charging customers for energy capacity rather than actual consumption. Third, operators must make careful decisions about maintenance and investments, including limiting investments in new assets to those with a short payback period. In addition, investment decisions should always take into account a market price for CO_2, even in regions where carbon is not yet taxed.

Investors. Focused investors, including infrastructure funds and private equity firms, can find significant opportunities in distressed coal assets. To make this investment play work, however, they need to carefully manage the risks and focus on cost efficiency, flexibility, and maintenance and investment optimization, as described above.

Despite the fact that a global exit from coal is unlikely, the risk of a major negative regulatory event in any one market is real. As a result, investors should build a diversified portfolio of assets. In fact, the declining profitability of coal plants is already driving consolidation. Larger and more focused players in coal-fired and other conventional power plants can realize significant economies of scale, including through better pricing in procurement and the ability to spread overhead costs over a larger base. And as they acquire more assets, these consolidators can invest in plants with the best potential and shut down those with weaker prospects.

At the end of the day, investors need to be ready to make decisions swiftly. Market conditions and regulations are likely to change rapidly. It will be critical to assess those changes quickly and be agile in responding.

THE EVIDENCE IS clear that coal is likely to remain a significant component of the global power sector for the foreseeable future. Certainly, weak global economic growth or new renewable breakthroughs could limit coal demand growth. And a global regulatory backlash is always possible. However, global action to curtail or eliminate coal use would need to include a mechanism for compensating emerging economies, which simply cannot afford such action on their own. Such a development, while feasible, is not likely in the near term.

Still, even if coal demand holds steady, risks—particularly those related to stranded assets—are rising for participants in the market. While coal's 200-year run is far from over, the rules are changing.

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