Comment

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Germany intends to phase out coal-fired power stations like this one at Neurath.

To end coal, adapt to regional realities

Jan Steckel & Michael Jakob

Four broad categories capture countries' political and economic barriers to quit coal. Use these to tailor solutions.

To stall climate change, coal power plants must be phased out globally. But king coal is far from abdicating. And that's because global strategies are not adapted to national realities.

Coal power plants are the dirtiest form of electricity production, emitting up to twice as much carbon dioxide per kilowatt hour as do natural-gas facilities. In 2019, coal was responsible for more than one-third of global electricity generation and 26% of global greenhouse-gas emissions[1] — around the same amount as all emissions from agriculture and land use. Most analyses[2] conclude that global coal use needs to be cut by 30–70% by 2030 to achieve the targets of the 2015 Paris climate agreement.

Yet action has been slow. Although some industrial countries place weaning themselves off coal high on the political agenda, most low- and middle-income countries still regard it as essential for economic growth; environmental concerns rank much lower.

During the COVID-19 pandemic, energy demands initially declined, and power generation from coal dropped by 4% from 2019 to 2020. But in 2021, it jumped by 9%, to a record high. Recent events have, if anything, shifted power generation towards coal. The war between Russia and Ukraine puts natural-gas supplies in jeopardy (Russia typically supplies around 40% of European gas imports). Some countries, including Germany, are considering coal as a stopgap. Rising gas prices might also revive coal in Asia.

Today, 2,429 coal power plants are in operation globally, with a total capacity of more than 2,000 gigawatts (GW). The total power capacity from coal increased by 110 GW from 2017 to 2022. If all the plants in the pipeline are built and are run for 40 years alongside existing plants, they will soak up 60–75% of the emissions budget needed to be on track to keep global temperature increases below 1.5 °C.

Urgent, targeted action is needed to shift this trajectory. A global phase-down will not happen unless the global community targets support to suit political realities.

To identify the most useful policies, we created detailed case studies from 2018 to 2020 on 15 key countries, which together comprise 84% of the world's current coal power-plant capacity, and 83% of the global coal pipeline for new plants[3]. For each case study, researchers conducted detailed interviews with policymakers, analysts, academics and non-governmental organizations, following a harmonized framework so that cases could be compared fairly[4]. (Those conducting this work are listed as co-signatories; see go.nature.com/3yy5ghy for details)

This revealed four categories into which all economies that have, or are planning to build, coal-fired power plants can be grouped[5]: phase-out regions that are already drastically reducing their reliance on coal; established coal users; phase-in countries that do not yet rely on coal but are actively building new coal plants; and export-oriented regions (see 'How we categorized coal-using economies'). Each category has distinct political challenges.

It is sometimes assumed that slapping on a high carbon price or removing subsidies for coal will be effective. But it won't always. In economies with robust legal frameworks and good access to capital, renewables can indeed

outcompete coal under such conditions. But many other regions have entrenched vested interests in coal, a lack of financial and intellectual capital to sink into new energy systems, and other issues that undermine attempts to reform subsidies or introduce emission fees. Each of our categories has its own set of challenges, and thus needs specific policy priorities that would spur change in the most effective ways. The policies that work for one won't necessarily work in another.

Although China comprises about half of existing and planned coal capacities, other countries cannot be neglected. Indeed, if all the phase-in countries continue to embrace coal, their aggregate emissions could surpass those of China. The emissions from coal plants already planned or under way in these countries will exceed those of all coal plants that currently operate in India. Every group is important.

Phase-out economies

Economies phasing out coal include Chile, Germany, the United Kingdom and the United States (see 'Four categories of coal use'). Most of the economies that are actively phasing out coal are OECD countries with high per-capita incomes and the financial, technological and institutional capacities to invest in renewable energies and improved energy efficiency[5,6]. For now, their coal plants have a total capacity of 360 GW. By 2030, it should fall to one-quarter of that amount.

How did these regions get where they are? In the United Kingdom, a carbon levy was effectively applied in the power and industry sectors on top of the carbon price prevailing in the European Union Emission Trading Scheme[7]. In Germany, a high-level commission negotiated the coal exit, which included generous payments to coal regions and power companies of around €40 billion (US$42 billion) to phase out coal by 2038. In the United States, lower natural-gas prices due to the fracking boom, as well as rapidly declining costs of wind and solar power, reduced coal use by almost half from its peak in 2007, despite political support for the coal industry. Chile's 2019 announcement to phase out coal by 2040 can be traced to economic motives to take advantage of high solar potential and shield the market from the volatility of gas and coal imports.

Even if declines proceed as projected, the phase-out economies will still generate 90 GW from coal by 2030, causing emissions equivalent to those generated by 75 million cars. Accelerating these transitions would both cut emissions and spur innovation, and will require national support for research and diffusion of clean energy, such as price guarantees for clean-energy producers.

Coal subsidies — nearly $4 billion in tax breaks in the United States — should be phased out and channelled instead to low-carbon energy industries. Coal-dependent regions should be provided with alternative streams of income. Regions such as West Virginia could benefit from measures similar to those put in place in Germany.

International cooperation and multi-level governance can wean phase-out regions off coal even more quickly. Rising carbon prices in the EU, for example, are likely to drive coal out of the energy mix even in economies without dedicated plans to phase it out, such as Bulgaria. Firm international commitments, such as those made by the G7 or G20 countries, can further raise governments' accountability.

Established users

Established coal users, such as China, India and Turkey, are mainly middle-income countries that have experienced substantial economic growth and a fall in poverty. Surges in energy demand were first met with coal-fired facilities, which often needs little capital to get started. China and India are prime examples.

In these countries, the government controls energy prices and highly regulates energy and electricity markets, which makes them much less sensitive to declining costs of renewable energy. The entire coal value chain — including mining, transport, electricity generation and finance — is frequently dominated by state-owned enterprises. Vested interests generate misaligned incentives: for instance, regulators often protect coal-fired power plants by purchasing power under favourable agreements.

Coal can be a huge chunk of the economy in some of these regions: in India, up to 15 million jobs are directly or indirectly connected to coal. Energy from coal often powers energy-intensive industries such as iron, steel and cement production, all of which demand many workers.

Policies in these countries should focus on reforms that check vested interests and corruption, reduce state control over the energy sector and level the playing field for alternative energy systems. These countries also need to develop alternative economies, which includes investing in infrastructure and retraining the labour force to support, say, manufacturing or information services.

Agreements to decarbonize energy-intensive industries — including iron, steel and cement production — could enable emerging economies to access markets in industrialized countries that have mandates to purchase green materials. Also, if these countries decarbonize, then industrialized nations cannot stall their own decarbonization by claiming that less stringent climate policies give emerging economies an unfair competitive advantage. International bodies can help by enabling technology transfer and by providing financial and policy support.

Phase-in countries

Countries on track to ramp up coal-fired power generation, such as Pakistan and Vietnam, tend to have relatively low per-capita incomes and low, but rapidly increasing, energy demand. In Vietnam, for example, energy demand has been growing by more than 10% per year, and 56 coal plants are currently planned.

The affordability, security and reliability of electricity rank very high on the political agenda; state-controlled energy prices can force power companies into debt, leaving them no economic room to finance a shift to coal alternatives. Although phase-in countries generally lack the coal-specific vested interests characteristic of established countries, ruling elites closely connected to energy can still provide unfair advantages to coal, such as easier access to the electricity grid.

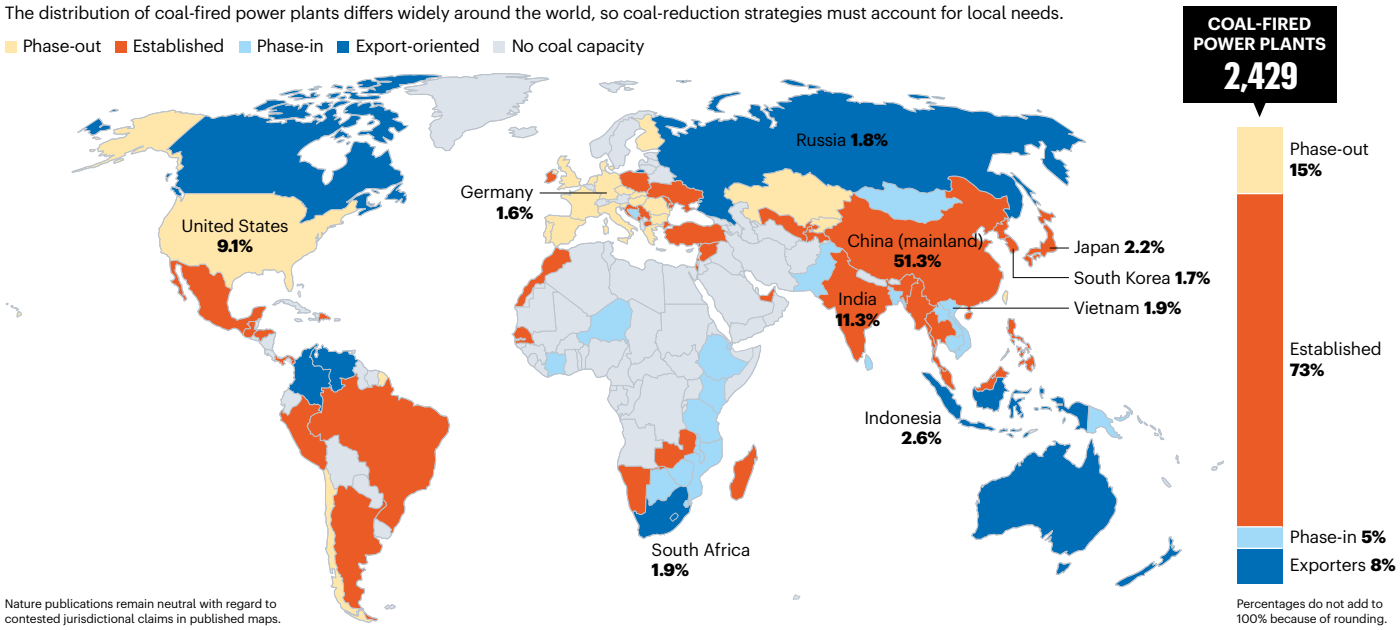
Phase-in nations are hindered by high capital costs for renewable power plants, and high investment risks, especially where underdeveloped electricity grids would struggle to accommodate intermittent renewables. Decision makers are often sceptical of renewable energy. Government ministries, such as in Vietnam, told us explicitly that they lacked capacity to manage an energy system that was based on intermittent solar and wind power. Nonetheless, Vietnam boosted its solar power from basically zero in 2018 (when our interviews were conducted) to become the leader in solar power in southeast Asia in 2019. Such positive examples in 'peer countries' can inspire other countries and soften deeply embedded reluctance. However, arrests of environmental activists in Vietnam, including the powerhouse of much of the improvement, Nguy Thi Khanh, show how powerful the resistance to

HOW WE CATEGORIZED COAL-USING ECONOMIES

Type	Definition	Examples
Phase-out	Less capacity under construction than is currently operating No planned power plants beyond what's currently under construction At least one plant retired since 2000	Chile, Germany, United Kingdom, United States
Established	New capacity planned or under construction Operating capacity at least equal to pipeline Retired capacity less than operating capacity	China, India, Turkey
Phase-in	Coal pipeline greater than operating capacity	Pakistan, Vietnam
Exporter	Average coal production 2010–20 at least 1.5 times higher than consumption	Australia, Colombia, Indonesia, South Africa

FOUR CATEGORIES OF COAL USE

The distribution of coal-fired power plants differs widely around the world, so coal-reduction strategies must account for local needs.



SOURCE: J. STECKEL & M. JAKOB/GLOBAL ENERGY MONITOR

these efforts can be, and how sophisticated intergovernmental forces must be in support.

International finance and proof-of-concept projects can lower barriers. In November, for example, the Asian Development Bank announced a plan to buy coal plants and mines in Asia, starting with a pilot project in the Philippines to wind them down before their projected end of life. Such purchases provide utilities with the capital to invest in alternatives, including grid capacity and storage. They could also provide successful examples of energy transitions.

Coal exporters

The socio-economic realities of exporters, which include Australia, Colombia, Indonesia and South Africa, are highly diverse. Some, such as Australia, have high per-capita incomes, whereas others, such as Indonesia, don't. South Africa consumes a substantial share of the coal it mines; Colombia produces coal mostly for export.

What they all share, however, are economies that are largely based on extractive industries, with coal revenues constituting a much higher proportion of gross domestic product than the global average. For example, coal exports account for about 5% of Indonesia's public budget. Regions that are highly dependent on coal royalties often have enough political influence to delay national measures against coal mining.

In these countries, phasing out coal will probably need to be part of a broader economic diversification towards other, preferably non-extractive, economic activities with comparably high-paid jobs. In Australia, a solar-powered hydrogen export economy is promising. In other nations, such as Indonesia, alternatives are less obvious, but could include labour-intensive manufacturing industries such as textiles or assembly of electronic equipment.

For many of these countries, economic reliance on coal means that carbon pricing and similar instruments have limited potential. Indonesia recently implemented a (very low) carbon price, for example, but political pressures made coal exempt. An emissions-trading scheme due to start in July is intended to cover coal, but has ample loopholes (see go.nature.com/3hgybv9). Attempts to reform fossil-fuel subsidies have led to sometimes-violent protests.

International efforts are essential. At the COP26 UN climate-change conference in Glasgow, UK, last year, the United Kingdom, the United States, the EU, France and Germany offered South Africa $8.5 billion to support socially just transition measures, power-sector decarbonization and clean-energy diversification. Indonesia is open to comparable support. Whether such schemes deliver on their high hopes remains to be seen.

Way forward

For every category, international cooperation is crucial. Many nations won't be able to do it alone.

Economies already phasing out coal can use international agreements to strengthen their commitments, and should support other regions with technologies, finance and capacity building. Phase-in countries need financial support for renewables, grid capacity and storage facilities. Established coal users might derive the largest benefits from agreements that support the decarbonization of energy-intensive industries, such as steel and concrete, and a preferential market for green materials. Export-oriented countries should be supported in transitioning to economies based on non-extractive activities.

All elements for the required international cooperation are already in place. Important emitters, such as the G7 and G20 countries, can complement and accelerate negotiations within the United Nations Framework Convention on Climate Change. Some of the already-pledged $100 billion per year[8] to support climate measures should be targeted at phase-out strategies.

A rapid, smooth and just power transition from king coal to a cleaner regime is possible, but only if the global community targets policies for local conditions.

The authors

Jan C. Steckel heads the working group on climate and development at the Mercator Research Institute on Global Commons and Climate Change, Berlin. **Michael Jakob** is a senior fellow at the Ecologic Institute in Berlin.
e-mails: steckel@mcc-berlin.net; jakob@mcc-berlin.net

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