

# Fossil fuel industry development in the 21<sup>st</sup> century: a case of coal

Wadim Strielkowski<sup>1,2,\*</sup>, Eugeny Lutsenko<sup>3</sup> and Dmitriy Pavlov<sup>3</sup>

<sup>1</sup>Department of Agricultural and Resource Economics, University of California, Berkeley, Giannini Hall, CA 94720 Berkeley, United States

<sup>2</sup>Centre for Energy Studies, Prague Business School, Werichova str. 1145/29, 15200 Prague, Czech Republic

<sup>3</sup>Federal State Budgetary Educational Institution of Higher Education “Kuban State Agrarian University named after I. T. Trubilin”, Kalinina str. 13, 350044 Krasnodar, Russian Federation

**Abstract.** Our article analyses the prospects of coal industry development in the 21<sup>st</sup> century. It is apparent that the share of coal in the world’s total energy mix is shrinking as it is replaced by natural gas, renewables, and other forms of energy production. In the same time, countries like China, Russia, but also Poland are dependent on coal as the major fuel for generating their electricity. Quite remarkably, China is using more coal to generate electricity for powering its growing fleet of electric vehicles and transport. This cycle needs to be broken in order to ensure the full transition to the renewable energy future and reducing the burden on the climate and global warming. We argue that the shift away from coal to the renewable energy is driven mainly by the growth of green energy policies and supporting actions induced by the political forces. However, it might still remain the major source of power generation in less-developed and developing economies.

## 1 Introduction

Coal has been an important source of power in the developing and developed economies for many decades. Electricity generation is the primary market for coal in the United States and accounts for about 93% of total consumption [1]. The EIA projects that the share of renewable energy in the electricity generation market will increase by 2.6% over the next five years, with renewables accounting for 28% of the market by the end of this forecast period [2]. The shift away from coal is driven mainly by the growth of renewable energy and the policies that support it, such as the Clean Power Plan (CPP). In the future, coal would probably account for less than 1% of total United States electricity generation, and would be replaced by natural gas, renewables, and other forms of energy production.

The economics of coal and natural gas could change if coal and natural gas prices rise in 2017, making coal operations more profitable, while gas price increases could make coal-fired power plants more competitive in some markets and regions. Coal production and consumption in the United States have fluctuated in recent decades, with the decline from

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\* Corresponding author: [strielkowski@berkeley.edu](mailto:strielkowski@berkeley.edu)

peaks in 1920 to 1945 later reversed. Dams, wind farms, and solar panels generate more electricity than coal, slightly dwarfing coal's share of total United States power generation in 2015. This is the last coal-fired power plant in the United States to be connected to the grid since the end of the Cold War and the start of World War II. The largest coal-fired power plant in the United States, was shut down in 2012 after it went bankrupt due to rising environmental costs and the collapse of the coal industry. While EIA expects a 5% decline in electricity generation due to falling demand from store closures and factory closures, coal's share of total power generation in the United States will decline. According to the United States Energy Information Administration (EIA), 38% of electricity is generated from coal and coal meets 27% of our primary energy needs. However, coal combustion releases more than 1.5 billion tonnes of carbon dioxide (CO<sub>2</sub>) into the atmosphere every year, of which about half is used to generate electricity [3].

China is also replacing obsolete coal-fired power plants with new, more efficient ones that burn less coal and provide critical base-load electricity to support the country's transition to more renewable energy. While the Zhengning plant itself is unlikely to threaten countries' carbon targets, China is adding wind, solar, and hydropower projects, and coal could still decline as a share of the energy mix [4]. The term "clean coal" uses supercritical coal-fired power plants (CCS) because CO<sub>2</sub> emissions are lower than older plants, but still much higher than those of nuclear and renewable energy. Chinese coal-fired power plant and its carbon dioxide emissions from the power plant's CO<sub>2</sub> capture and storage system.

Experts say these factors are already destroying coal-fired power plants in India and other parts of the world. In 2019, Indian states like Gujarat and Chhattisgarh, the latter of which is the country's largest coal producer and second largest coal exporter, have announced that they will not build new coal-fired power plants. India's chief energy minister, Ashok Gajapathi Raju, declared that by 2020, the nation's renewable-energy capacity would more than double, and that 29 coal-fired power plants scheduled to be shut down in the coming years would be fully replaced by renewables [5]. The Indian government is seeking bold renewable energy targets, and coal consumption is expected to rise as India's total energy needs rise. In India, for example, coal-fired power is more than three times more expensive than renewable energy. Indeed, this view was recently expressed by the country's chief energy minister, Ashok Gajapathi Raju, who declared that India would increase its coal-based thermal energy to 1,000 megawatts (MW) by 2020, up from 500 MW today. Meanwhile, India's share of coal-fired electricity has risen from 68% in 1992 to 75% in 2015 [6].

Looking ahead, coal will remain an important source of energy for developing countries in the coming decades, especially in Africa and Asia. The turn towards the renewable energy might change its domination but this is going to happen in the long run since there are no cheaper and more economic alternatives available.

## **2 Impacts of coal industry on the environment**

In general terms, coal industry and coal mining can lead to a number of negative impacts on the environment, such as air pollution, water pollution and climate change, as well as biodiversity loss. One of these challenges is that pollution is primarily caused by man-made sources such as coal mining and coal-fired power stations [7]. Coal mining, coal burning and the coal-fired power industry are major sources of pollutants and gases that cause significant health problems, contribute to the production of acid rain and have serious environmental and human health impacts. Radioactivity in coal contains high levels of radioactivity that can cause cancer, heart disease and other health problems. This has become a serious problem worldwide, especially in developed countries, and has led to serious health problems such as cancer, heart disease, lung cancer and respiratory diseases. Coal-fired power plants are an

important source of mercury in the atmosphere, which accumulates in the food chain and can damage the developing nervous system of human foetuses, causing a general disruption to the Earth's ecosystem. This has negative effects on human health and the environment and has led to a reduction in the concentrations of carbon dioxide, methane, nitrous oxide, carbon monoxide and other pollutants [8].

Coal mining and incineration projects require large investments, and the risks and costs of these investments are often passed on to taxpayers through infrastructure subsidies, loans, and guarantees [9]. The simple economic cost of coal stems from subsidies and tax breaks that are not reflected in the estimated \$4.6 billion in coal - the related subsidies under the 2009 stimulus package. In addition to pollution from coal-fired power stations and the disposal of toxic coal waste, the effects of coal have negative effects on fishermen who work downstream from coal mines and lose jobs, as well as on the environment.

Preventing coal burning would save more money than preventing diseases caused by deaths linked to emissions from coal-fired power plants - such as lung cancer, heart disease, and cancer. An analysis by the United States Department of Energy shows that 10,000 US power plants that run on natural gas instead of coal could be avoided by avoiding the use of fossil fuels such as coal, oil, and coal-to-gas plants [10]. The burning of natural gases is cleaner than burning other fossil fuels and produces negligible amounts of sulphur and mercury particles. During transport, the combustion of natural gas produces less nitrogen oxide (NOx), which is a precursor to smog, than gasoline and diesel used in motor vehicles. Air pollutants produced by coal burning contribute to cancer, heart disease, diabetes, asthma, cardiovascular disease and other health problems. The environmental health effects of the coal industry include high concentrations of carbon dioxide, mercury, arsenic, cadmium, lead, chromium and mercury. Other substances known to be harmful to human health cause cancer, heart attack and death, as well as respiratory diseases [11].

Moreover, coal is a major contributor to the increase in global greenhouse gas emissions caused by man. The list of historical disasters in coal mining is also long, although the number of coal deaths has declined in recent years as safety measures have been taken and underground mining has lost market share to surface mining. Coal mining also damages plants and soil, creating barren areas that are aesthetically unpleasant and contribute to biodiversity loss. To contain the slurry, dams are being built on the mountains where coal is extracted, and the land beneath the surface can be reclaimed and reshaped. There are documented cases of slurry dams failing, leading to deadly floods and subsequent environmental disasters. Acid mining dewatering, also known as acid mining, or acid mining dewatering, channels waterways, contaminates local water supplies and affects the pH balance of surrounding lakes and streams. Mining can bury streams under debris and cause water pollution. These waterways can also be contaminated by coal ash, also known as "coal ash" from coal-fired power plants. Coal-fired power plants reduce their coal's carbon footprint by using biomass as an additional fuel for existing coal-fired boilers. It also releases more energy - the methane emissions that go with it - than any other fossil-fuel industry. Solid distillery waste contaminates water supplies to individuals and communities, and fly ash - a by-product of coal mining - contaminates rivers, streams, lakes, rivers and streams [12]. Coal ash, waste water and solid waste – all the incineration waste contributes to the formation of toxic chemicals such as arsenic, lead, mercury, cadmium and lead in the atmosphere.

### **3 Coal mining and coal industry in Russia**

One of the countries with the developed coal industry is the Russian Federation. The industry exhibits many problems and issues and calls for modernization [13]. In March 2012, Bloomberg reported that four companies in the Siberian region are planning a state-backed

railway that would double the country's metallurgical coal exports to 40 million tons by 2020. Russia's coal industry comprises 240 coal mines, including 1,200 coal mines and 2,000 coal processing plants, which account for more than 80% of the country's total coal production [14]. Russia's power generation sector is being restructured, with plans to privatize fossil-fuel power plants, while nuclear and hydropower plants remain under state control. Coal is extracted in 85 municipalities in Russia, 58 of which are towns developed to extract the mines. The coal industry plays an enormous role in the country's energy balance [15]. Russia has increased its coal production capacity by more than 30% over the last decade, reaching a total capacity of 440 million tonnes and becoming the third largest coal producer in the world. Coal is also used for electricity generation, which accounts for more than 25% of total capacity [16, 17].

Due to the increasing demand for thermal coal, Russia is further expanding its production volume and infrastructure. It is worth pointing out that global coal consumption has risen again, including in countries of South-East Asia, India and Turkey, and that the coking coal trade exceeded 1.3 billion tonnes. A new window of opportunity appears, as consumption will increase by at least 100 million tonnes in the period 2025-2030 [18]. The market in Japan, Korea and Taiwan is primarily for thermal coal, in particular for the production of coal for power generation and industrial use. The current situation allows Russia to expand its presence in the global coal market, strengthen its position and increase its share. This means that today it must clearly understand where it wants to extract coal, how it will manage logistics and how it will develop its technical capacities. Coal production in Russia in 2012 amounted to 353 million mtoe, an increase of 3.1% compared to 2011, and the total volume of Russian coal supply rose 3-to-1 to 310 million tones, including export-marked deliveries, which rose 19% to 353 million mtoe. However, the Russian Ministry of Energy estimates that domestic coal production and exports will remain at this level. According to the ministry, total Russian coal exports, both domestically and in exports, amounted to 453 million tons [19]. According to the Ministry of Economic Development, the main obstacle to the development of the industry is currently the lack of access to natural resources, especially coal, in the country. In Russia, coal is extracted from 161 coal companies, which produce more than 2.5 million tonnes of coal a year. Part of this will be used to build transport and port infrastructure geared towards exports, as well as to develop new coal mines and coal terminals. The rest will go toward improving the country's energy supply and developing new coal-mining technologies. Russian coal production will reach 480 million tons annually by 2030, and this investment is expected to more than double to 1.5 million tons. Exports will be hit hard, which is a 257% increase from current levels. Due to the lack of environmental controls and scrubbers, suspended particles from coal-fired power plants in Russia are more than twice as high as from other power plants. In 2013, the total number of particulate matter emissions from the Russian coal industry more than doubled to 1.5 million tonnes per year, 1,000 times more than a decade ago [20]. That is about one-third of the country's total annual coal emissions.

## **4 Coal power industry and electric transport**

The world's largest markets for electric cars are the United States and China, although electric vehicles have a larger market share in European countries such as the Netherlands Germany, and Norway [21]. They are selling so well that several million electric vehicles will be on the road by the end of 2021. Electric cars can help limit climate change in most countries around the world, scientists say, especially in the United States, where drivers can recharge batteries without needing large - polluting - coal-fired power plants. The United States gets about one-third of its electricity from fossil fuels such as coal, nuclear power, and natural

gas, and about half of that comes from burning coal. California electric vehicles can be plugged into the grid, where coal generates 72% of the electricity.

In the United States, more than half of coal and nuclear power generation comes from coal fires. In China, coal-fired power generates about two-thirds of China's electricity [22]. Many studies have questioned the ecology of electric vehicles due to the high emissions associated with batteries, which account for only a small percentage of their total emissions. It makes sense to drive electric cars in key markets, including China, the United States and almost all of Europe [23]. There are no exceptions where electric vehicles require electricity from coal-fired power plants - except for charging where they need to be charged. The Bloomberg analysis shows that the biggest difference in vehicle efficiency is seen in the UK, where there is a large renewable energy industry, electric vehicles are more efficient in Europe and the United States, while China is more reliant on coal. The worldwide electric fleet consumes 58 TWh of electricity per year, of which China accounts for more than half. Germany is the second largest. While coal-fired electric vehicles are not as efficient as renewable-energy power, that does not mean that coal-fired power plants and charged electric vehicles are not as efficient as ICE vehicles.

Electricity sources for electric vehicles should be taken into account when determining the overall efficiency of vehicles. Electric vehicles are technically emission-free and thus more efficient than generally assumed. However, electric vehicles rely on the grid to generate energy, as they do not have their own solar panels and therefore do not regularly supply themselves with electricity. This is the main problem: while the electric vehicle itself is the main load for charging electric batteries, it indirectly contributes to increased CO<sub>2</sub> emissions [24]. As more coal-fired power plants are shut down and cleaner energy sources are brought to the grid, electric vehicles need to be recharged. Night-time charging times will increase the possibility of using wind power to further reduce emissions, but at the expense of higher costs. Another caveat to be borne in mind is that electric vehicles, if they provide the majority of electricity in a given area, emit more than twice as much CO<sub>2</sub> as their coal-fired counterparts. Learn more about the coming electricity sources, what states and municipalities plan to do in their renewable energy plans, and whether you have the opportunity to switch to clean energy. When the wind is not blowing, the windmills stop turning, solar energy stops working in the dark, and most of the electricity is consumed before it is produced. Green electricity is produced during the day, however, if solar power can be fed into the grid. Today's grid has almost no capacity to store solar or wind power - electricity generated to be used later. Storage of electricity grids is expanding slowly, but not enough to produce cheap electricity and consume most of the electricity after generation, according to the United States Energy Information Administration. Furthermore, an electricity unit cannot be labelled by the place and type of electricity it is produced, and no one checks whether the electricity it consumes comes from a sustainable source. In some United States regions, switching on at different times of day could even double or even double the emissions impact of an electric car. For example, charging for a few hours at a time each day could cause more emissions than the average petrol.

In selected regions that are less reliant on coal gas-powered cars are more popular. An electric car charged for 100 miles of driving could consume roughly the same amount of energy as the average United States home consumes in just one day. An electric vehicle charged in the evening would emit about twice as much carbon dioxide at the end of the day as the average petrol car, according to the study. The estimate for gas-fired electricity is about 90 g CO<sub>2</sub> per km, and for coal-fired electricity to burn around 60 g of electric vehicles powered by coal or gas still have the same emissions as petrol or diesel, which together with emissions for extraction, refinement and transport of the fuel amount to around 240 gCO<sub>2</sub> / km. Therefore, an interesting paradox emerges – currently the electrification of transport that is indented to reduce the environmental damage and mitigate the global warming and the

climate change it is causing is leading to the increase in the consumption of the electricity most of which is still produced by burning coal [25, 26]. This cycle needs to be broken in order to set the path towards decarbonization of the economy and solving the issue of the climate change before it can be too late.

## 5 Conclusions

It is clear that coal is a reliable, cheap and secure source of energy that continues to support energy security and industrialisation in both developing and developed countries. It is cheaper to produce than the renewable energy using solar panels or wind turbines, it will never explode like the atomic reactor at Chernobyl nuclear power station, and it has a long history of mining and burning with the technologies and processes already in place. The coal industry is particularly strong in the east - the Asian market where there are a large number of coal-fired power stations - to meet future demand. Neighbouring Southeast Asia is another key market where the share of the coal-fired power mix will increase as new power plants come on line.

However, coals power industry also represents a burden for the environment and leads to the intensifying global warming caused by the change of climate. Surely, the industry needs serious modifications and modernizations. In order to do this, economically viable and secure alternatives need to be found and presented. Until then, coal might just remain one of the widely-used sources of energy.

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