Dirty coal is desperately trying to clean up its image. Coal proponents are trying to buy their way into a clean energy future by promoting "high efficiency, low emissions" coal plants. The coal industry has even attempted to extract funding from climate finance mechanisms, such as the Clean Development Mechanism, for more efficient coal plants.

It is time to stop this deception.

Coal-fired power plants produce the dirtiest electricity on the planet. They poison our air and water and emit far more carbon pollution than any other electricity source. While pollution control equipment can reduce toxic air emissions, they do not eliminate all of the pollution. Instead, they transfer much of the toxic air pollutants to liquid and solid waste streams.

Often, companies and governments prioritise profits over public health and choose not to install the full suite of available pollution control equipment. In these cases, toxic pollution still goes into the air, leading to premature deaths and increased rates of disease.

Coal plants are responsible for 72% of electricity-related greenhouse gas emissions. Even the most efficient coal plants generate twice as much carbon pollution as gas-fired power plants and over 20-80 times more than renewable energy systems. Technology to capture and store carbon dioxide is expensive and largely unproven.

Moreover, if you consider the social and environmental costs of coal mining, preparation and transport, coal generation can never be considered "clean."

This factsheet describes the technologies used to control pollution and improve the efficiencies of coal plants.
For decades, the coal industry has used the term “clean coal” to promote its latest technology. Currently, “clean coal” refers to: 1) plants that burn coal more efficiently; 2) the use of pollution control technologies to capture particulate matter, sulfur dioxide, nitrous oxides and other pollutants; and/or 3) technologies to capture carbon dioxide emissions, known as carbon capture and storage (CCS).

1) IMPROVING EFFICIENCY

The coal industry is promoting the construction of “high efficiency” plants, which generate more electricity per kilogram of coal burned. Today, nearly 75% of operating coal plants are considered subcritical, with plant efficiencies between 33 and 37% (i.e. between 33% and 37% of the energy in the coal is converted into electricity).

• Supercritical plants, which produce steam at pressures above the critical pressure of water, can achieve efficiencies of 42-43%. This “new” technology was first introduced into commercial service in the 1970s. India and China have issued national directives to employ supercritical technology in all new coal plants to reduce fuel costs.

• Ultra-supercritical (USC) plants can achieve efficiencies of up to 45% through the use of higher temperature and pressure.

• Integrated gasification combined cycle (IGCC) plants can supposedly achieve efficiencies of up to 50%. In an IGCC plant, coal gas is used in a combined cycle gas turbine to reduce heat loss. Few IGCC plants have been constructed because of their higher capital and operating costs and more complex technical design.

• Circulating fluidised bed combustion (CFBC) power plants burn coal with air in a circulating bed of limestone. This reduces sulphur dioxide emissions but not emissions of other pollutants. CFBC is advantageous because it can burn a variety of fuels, but they are less efficient than other coal plants.

Supercritical plants reduce CO$_2$ emissions by only 15-20% compared to subcritical plants. As a result, they still emit far more CO$_2$ and hazardous pollutants than any other electricity generation source. In addition, their higher construction costs have deterred many poorer nations from adopting these technologies. In 2011, half of all new coal plants were built with subcritical technology.

2) AIR POLLUTION CONTROL TECHNOLOGIES

Air pollution control technologies can control the release of many hazardous pollutants into the atmosphere. However, after these pollutants are captured, they are often stored in unlined waste ponds or ash dumps. They can then leach into surface and ground water, contaminating water supplies on which people and wildlife depend. In addition, there are currently no pollution control technologies to eliminate ultra hazardous pollutants, such as dioxins and furans.

Air pollution controls are expensive, adding hundreds of millions of dollars to the cost of a coal plant. They can raise the cost of generation to around 9 US cents per kilowatt-hour. Pollution controls reduce the efficiency of coal plants, requiring more coal to be burned per unit of electricity generated. Project developers often do not install all available pollution controls to cut costs. Coal operators sometimes shut off existing pollution controls to reduce operating costs. In these cases, corporate profits come at the expense of public health and the environment.

The following section describes common air pollutants from coal-fired power plants and technologies used to control them.
Fine Particulates (PM2.5)
Exposure to fine particulates (less than 1/30th the width of a human hair) increases rates of heart attack, stroke and respiratory disease. Fabric filters, or baghouses, are often used to control the direct emission of particulates. Baghouses can capture 99.9% of total particulates and 99.0-99.8% of fine particulates. For a typical 600-MW coal plant, this system costs about $100 million. If one or two of the bags break, emissions of particulates can increase 20-fold.

Electrostatic precipitators (ESP) can also be used to capture particulates. An ESP can capture over 99% of total particulates and 80-95% of fine particulates. The best controls include both fabric filters and ESP to achieve even higher removal of particulates.

While these systems capture the direct emissions of fine particulates, they do not capture fine particulates which form in the atmosphere through the reaction of nitrogen oxides and sulphur dioxide. These fine particulates are of particular concern to public health.

Sulphur Dioxide
Sulphur dioxide emissions can cause acid rain and lead to the formation of fine particulates, which increase cancer and respiratory disease. Two methods to reduce sulphur emissions are switching to low-sulphur coal and capturing emissions after combustion. The primary method of controlling sulphur dioxide emissions is flue gas desulphurisation, also known as scrubbing or FGD. FGD may use wet, spray-dry or dry scrubbers.

In the wet scrubber process, exhaust gases are sprayed with vast amounts of water and lime. The International Energy Agency (IEA) estimates that wet scrubbers may use up to 50 tonnes of water per hour. This process generates a huge slurry of sulphur, mercury and other metals which must be stored in waste ponds indefinitely. If the dams that impound the slurry ponds break, millions of litres of waste can spill into rivers, causing large fish kills and contaminating drinking and irrigation supplies with heavy metals and other toxics. Modern scrubbers typically remove over 95% of SO$_2$ and can achieve capture rates of 98-99%.

Dry scrubber processes are used at some coal plants. In this process, lime and a smaller amount of water are used to absorb sulphur and other pollutants. This waste is then collected using baghouses or electrostatic precipitators. Modern systems can capture 90% or more of SO$_2$.

FGD is the single most expensive pollution control device and can cost $300-500 million for a 600-MW plant. This can amount to roughly 25% of the cost of a new coal plant. Many new plants do not install FGDs because of their cost.

Nitrogen Oxides
The emissions of nitrogen oxides can lead to the formation of fine particulates and ozone. These pollutants can increase rates of respiratory disease, including...
emphysema and bronchitis. Technologies such as low NOx burners, which use lower combustion temperatures, can be used to reduce the formation of NOx. After combustion, selective catalytic reduction (SCR) can be used to capture NOx pollution. Using a combination of NOx reduction techniques, emissions can be reduced by 90%. SCR technology costs about $300 million per unit. An alternative – selective non-catalytic reduction – is cheaper and can achieve 60-80% control efficiency.

**Mercury**

Coal burning is the single largest human-caused source of mercury emissions. Mercury is a neurotoxin, which can cause birth defects and irreversibly harm the development of children’s brains. In 2013, 140 nations ratified the UN Minamata Convention on Mercury and agreed to reduce their emissions of mercury to the environment.

Mercury emissions can be reduced somewhat by coal washing, however, this generates mercury-laden wastewater which can contaminate ground and surface water. Most mercury emissions can be captured in systems used to control other pollutants, such as baghouses, SCR and FGD systems.

A system known as activated carbon injection can also be used to capture mercury. Together with a baghouse or ESP, this system can capture up to 90% of mercury emissions and costs about $3 million for a 600-MW plant.⁴

### 3) CARBON CAPTURE AND STORAGE

Some coal advocates assert that carbon capture and storage (CCS) can reduce carbon dioxide emissions from coal-fired power plants. CCS involves capturing carbon dioxide emissions, compressing them into a liquid, transporting them to a site and injecting them into deep underground rock formations for permanent storage.

CCS is currently an extremely expensive, unproven technology, which has not been widely implemented on a commercial scale. The first barrier to CCS is its economic viability. Between 25-40% more coal is required to produce the same amount of energy using this technology. Consequently, more coal is mined, transported, processed and burned, increasing the amount of air pollution and hazardous waste generated by coal plants. The cost of construction of CCS facilities and the “energy penalty” more than doubles the costs of electricity generation from coal, making it economically unviable. The highly touted 600-MW Kemper plant in the US is mired in delays and cost overruns. Originally projected to cost $2.8 billion, the plant is now estimated to cost $6.1 billion and is three years behind schedule.

Furthermore, there are considerable questions about the technical viability of CCS. It is unclear whether CO₂ can be permanently sequestered underground and what seismic risks underground storage poses. There are also doubts about whether there are enough suitable underground storage sites situated close to coal plants to physically store the captured carbon dioxide.

### THE LIMITS OF CANADA’S BOUNDARY DAM PROJECT

The coal industry lauded the recent opening of the 110-MW Boundary Dam project in Saskatchewan, Canada as a milestone in commercial-scale CCS. However, the US$1.4 billion project would not have proceeded without $194 million in government subsidies. (The same amount of money could have built a 240 MW solar PV plant.)

SaskPower considered several options before eventually downsizing the project. Retrofitting CCS to an existing coal plant would have consumed 40% of the power generated by the plant. A proposal to build a new 300-MW coal plant with CCS would have cost $3.1 billion. In a telling sign, SaskPower admitted that the project was also downsized because it was not profitable to generate and capture more than one million tons of CO₂ per year. Typical 600-MW coal plants emit roughly 3.5 million tons of CO₂ per year.

Instead of pouring millions of dollars into troubled CCS pilot projects, governments should prioritize investments in renewable energy to sustainably meet our energy needs.

### ENDNOTES

1 “New unabated coal is not compatible with keeping global warming below 2°C”, Statement by leading climate and energy scientists, November 2013, p.3.