CAN COAL REALLY BE CLEAN?

'Clean coal' seems to be an oxymoron: coal is the filthiest of the fuels we use and has the highest carbon emissions. However, the global demand for coal as a fuel for energy generation will not go away any time soon. As a result, technologies that can reduce the emissions from coal are likely to be an important part of the future energy mix — whether we like it or not.

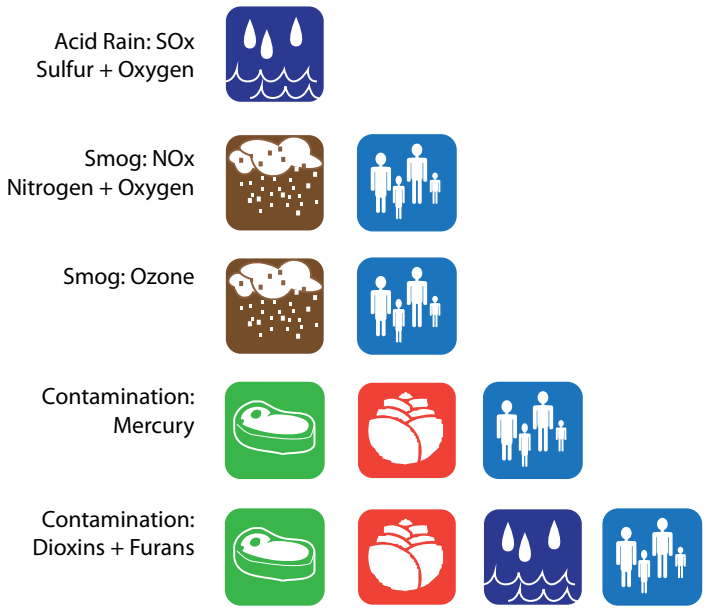
The two main contenders are CCS — Carbon Capture and Sequestration — and gasification. Sequestration involves extracting the CO2 from the stack at the utility, and then 'sequestering' it underground. Utilities sited near petroleum reserves have found some success when combined with oil extraction: their carbon emissions are used to force low reserves out of the ground. However, large scale adoption of CCS has not yet proved to be financially feasible, nor politically acceptable in the United States, in spite of media attention over the last few years.

That leaves gasification, a process that turns coal into a synthetic gas — syngas — that has many uses.

Not a new technology, coal was first commercially gasified in England in 1785 to power street lamps. In the 1930's, processes were developed to convert coal gas to gasoline, diesel and jet fuel.

Because these catalytic conversions require clean inputs, gas scrubbing developed into its own industry. Today exhaust scrubbers, mandated for many coal burning facilities, have been useful in controlling some of the pollution from coal.

Contaminants from Coal



More effective, however, is scrubbing out contaminants prior to combustion by gasifying the coal and cleaning the gas. Gasification in the 21st century is capable of economically producing clean gas and liquid fuels from any carbon source — coal, biomass and garbage — and producing pure commodities from the contaminants.

The impurities in coal are primarily sulfur, nitrogen, mercury and other metals, as well as particulate matter. When combusted, these pollutants escape into the environment and some react with oxygen to form dangerous compounds that foul our air quality and contribute to global warming. Sulfur and oxygen combine to

form sulfur dioxides, or SOx, the main component in acid rain. Nitrogen reacts with oxygen to form nitrogen oxides, or NOx, and ozone, the main components of smog. Particulates form soot and smoke. Mercury is absorbed into soil and water, becoming part of the food chain, which is detrimental to human health. Dioxins and furans, believed to cause cancer, form during combustion and can contaminate air, food, and water. Coal is the most carbon intensive fuel and releases more CO2 per unit of energy than any other source, contributing substantially to global warming.

Another important problem is that coal pollution disproportionately affects the poor who are often unable to move away from coal burning power plants. The NAACP released a report in 2012, detailing the emissions data of 378 large coal fired power plants in the United States and how they impact local communities. It is sad but not surprising to learn how the oldest and filthiest power plants are most often found near the poorest communities who suffer the highest mortality burden.

Coal mining and disposal of coal ash remain deeply troubling. Coal mining is a dangerous industry for workers even with improved safety measures in recent decades. Occupational hazards include black lung disease and accidents such as mine collapses and methane explosions. Mountaintop removal has become the mining technique of choice in certain regions, because it lowers costs compared to conventional mining. Blasts send rubble hurtling down the hillsides, destroying habitats and polluting watersheds. Coal ash, the waste that remains after burning, is one of the largest waste streams and can be heavily contaminated with metals such as arsenic, selenium, cadmium, lead and mercury. The coal industry has resisted proposals to treat coal ash as hazardous waste.

So what can be done? Coal provides around 40% of America's electricity supply and alternatives remain controversial. Nuclear power is caught in a status quo where the aging power plants are too expensive to upgrade, too critical to shut down and too unpopular to replicate. Wind and solar, though favored by environmentalists, have not gained enough traction to actually displace any existing coal power plants. Biomass can be burned in some coal power plants, helping to improve the emissions profile, but the practice has not proven practical or economic compared with other forms of biomass energy. The dramatic shift that has occurred in recent years is the revolution in natural gas due to new drilling techniques and hydrofracking.

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Natural gas, which is primarily methane, is driving coal power plants out of business. While hydrofracking remains a controversial subject with many environmental concerns, there is no argument that methane is the cleanest and most energy dense of all hydrocarbons. New horizontal drilling and hydrofracking techniques have unlocked massive reserves of natural gas that were not expected to be available just a few short years ago.

New gas supplies have caused the price of natural gas to drop substantially from over $12 per MMBtu in 2008 to under $4 today. Natural gas has huge environmental advantages over coal, because it does not contain all the contaminants of coal. Pure methane is CH4 (one carbon bonded to four hydrogen atoms) has no sulfur, nitrogen, mercury or particulate matter in the fuel and therefore none in the exhaust. Overall CO2 emissions' pure unit of energy are much lower with methane than with coal. Combusting natural gas can still see some production of NOx and dioxin emissions, but these can be mitigated through improved engineering of the combustion equipment.

Coal is being caught in a squeeze play, where public perceptions and environmental regulations are driving up costs, while natural gas is providing superior performance at a lower price. Industry sources predict that more than 200 coal-fired power plants will be shut down in the next five years because of increased environmental regulations and lower gas prices.

CASE STUDIES

DAKOTA GASIFICATION

Dakota Gas in North Dakota is one firm that has been producing synthetic natural gas from coal for over 25 years. Their Great Plains Synfuels plant is also one of the few successful carbon capture and sequestration systems in operation. Dakota Gas uses gasification and a series of processes to clean the gas and upgrade it to methane, while at the same time removing the CO2.

Dakota Gas pipelines their CO2 to oil fields in Canada, where it is injected into the ground to assist in oil drilling. The synthetic natural gas is pipelined and sold as a commodity. The plant began producing methane in 1984, but it was not until the late 1990's that there was a market for the CO2. This led to building a pipeline into Canada. It is not clear how scalable this solution is since CO2 markets are limited and we do not know what long term environmental issues may result from pumping large quantities of CO2 underground. However, the technology to capture CO2 does work.

GREAT POINT ENERGY

Great Point Energy is another company converting coal to natural gas. They won a large contract in China to create methane from coal in the western deserts and pipeline it to the large cities in the east. Their process is a proprietary gasification and catalytic conversion process that effectively transforms coal to methane.

RENTECH

Rentech manufactures ultra clean liquid fuels, using similar processes. Though Rentech focuses on biomass feedstocks, the same technologies are applicable to coal. They have developed ultra clean synthetic jet fuels and diesel that have been successfully tested with the military. Rentech fuels are clear and burn without soot or smoke, very different from conventional gasoline and diesel.

The answer may simply be to convert coal into natural gas and mix them together.

Gasification is the common process for converting any kind of carbon based feedstock into fuels and chemicals. Coal, biomass and garbage can be effectively converted into natural gas, liquid fuels, chemicals and plastics. Many companies are operating in this space, trying to develop the art as well as the engineering.

The two biggest sources of pollution remain coal-fired power plants and vehicular engines. Both of these can run on natural gas. Natural gas can be produced synthetically from a variety of carbon sources: coal, biomass, and garbage. Methane can be produced biologically using digesters or microbes. In addition, gas power plants are superior to coal plants because they run on a turbine, which is similar to a jet engine and very flexible to operate. The operational flexibility of gas power plants makes them complementary to wind and solar.

Methane is everywhere. It is in the oil fields, coal mines, landfills and farms, as well as locked up in methane hydrates on the sea floor. Methane has even been identified on other planets. Carbon and hydrogen are basic building blocks of the universe.

We are not going to stop consuming hydrocarbons, because there is no viable replacement. We might as well use them as cleanly as possible because pollution does matter. The lowest price at the pump does not justify ongoing, unmitigated pollution and endless wars for resources. We have cost-effective solutions available that will provide jobs and improve our standard of living.

Cheap natural gas is a huge competitive advantage for the United States, as it empowers manufacturing. Low gas prices in the USA will help bring manufacturing back as it offsets our high labor costs in international markets. Coal is likely to remain an important part of the natural gas story for years to come. Perhaps it is time to take a more holistic view of coal and the opportunities it represents.

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