FACT SHEET: 'Clean Coal' Power Plants

Coal-Fired Power Generation

More than half of the electric power generated in the U.S. comes from coal-fired power plants, which are also the largest single source of greenhouse gases. Coal-fired power plants emit:

- 66% of sulfur dioxides (SOx, or acid rain)
- 40% of carbon dioxide (CO_2)
- 33% of mercury
- 22% of nitrogen oxides (NOx).[1]

Coal is the most CO_2-intensive fossil fuel, emitting about 3 pounds of CO_2 for every pound of coal burned. The U.S. burns over 1 billion tons of coal every year. There are 492 coal-fired power plants in the U.S., with an average size of 667 megawatts (MW) and an average age of 40 years.[2] One 500 MW coal-fired power plant produces about 3 million tons/year of CO_2, adding a total of approximately 1.5 billion tons/year of CO_2 to the atmosphere. If 60% of the CO_2 from all these plants were captured and compressed to a liquid for geologic sequestration, its volume would equal the U.S. oil consumption of 20 million barrels/day.[3] A large coal-fired power plant emits the CO_2 equivalent from one million SUVs. Coal-fired electrical generation has been the largest single source of pollution in the U.S. (and the world) for over 30 years.

What is IGCC?

IGCC (Integrated Gasification Combined Cycle) is a type of power plant that gasifies coal into synthetic gas (syngas) to power a gas turbine. The heat from the gas turbine exhaust then generates steam to run a steam turbine. None of the basic technologies – coal gasification, gas turbines, and steam turbines – are new. It is the *integration o*f these into electric power plants that is new, and presents engineering challenges.

There are 160-250 proposed new coal-fired power plants in the U.S.; 32 proposed to be IGCC.[4] A September 2004 study commissioned by the U.S. Department of Energy (DOE) found that, despite a long history of gasification, only two gasified coal plants whose primary output is for electrical generation have been built.[5]

Although IGCC is promoted as being capture "ready," the key word is "ready" – no IGCC plants are actually capturing and storing CO_2 in commercial quantities.

Two Currently Operating IGCC Plants in U.S.

The two currently operating IGCC plants in the U.S. are the Polk plant in Tampa, Florida and Wabash River in Indiana. Although many petroleum and chemical plants employ gasification, the Polk and Wabash River plants use coal to generate electrical power with combined cycle turbines. Very little research has been done on using low-rank sub-bituminous coal, such as Powder River Basin (PRB) coal. Existing plants use bituminous coal.[6]

According to Xcel Energy, the 4th largest electrical utility in the U.S., it costs more to use western coals, such as Powder River Basin, as IGCC feedstock.[7] Western sub-bituminous coal decreases plant performance due to its higher moisture content and lower heat value compared to eastern bituminous coal.

IGCC plants burn either coal or "petroleum coke," an oil refinery residue. All contain high levels of toxins, and "pet coke" contains high levels of sulfur.

Generally, conventional pulverized coal (PC) plants operate at 32-38% efficiency, while IGCC plants operate at 36-39% efficiency.[8] However, capturing CO_2 increases costs significantly, and has only been demonstrated at a handful of sites, in amounts that are a small fraction of total CO_2 emissions.

IGCC Feasibility

Bush administration policies have ramped up the push for "clean" coal.[9] A number of studies have looked at "market barriers" to widespread IGCC implementation. IGCC "uncertainties" include lack of standard plant design; lack of a market; performance guarantees; and high capital costs.[10] These uncertainties question whether the technology is commercially viable.

IGCC veteran Stephen D. Jenkins testified in January 2007 that IGCC technology won't be ready for 6-8 years, has limited performance and emissions guarantees, and that commercial-scale CO_2 capture and storage has not been demonstrated.[11]

High Costs

Capital costs for IGCC plants are estimated to be 20-47% higher than traditional coal plants.[12,13] In 2004, Indeck Energy Services testified before the Illinois State EPA that IGCC's "capital costs are 30% higher."[14] On top of this, construction costs in general (including concrete, steel and labor) have risen from 100-300% in recent years, driving up the costs of all sorts of power plants.[15] The Department of Energy reports that IGCC is seen as too risky for private investors, and requires large subsidies from the federal, state and local governments.[16]

In 2006, the EPA estimated that capturing 90% of CO_2 emissions from IGCC plants would increase capital costs 47%; and the total cost of electricity 38%.[17] "Capture" does not include transportation of gas or storage. According to the DOE, IGCC is seen as too risky for private investors, and requires enormous subsidies from the federal, state and sometimes local government.[18] Extensive research is required before a commercial-scale IGCC plant could capture, transport and store its CO_2.[19]

The DOE initially estimated the total capital cost for the 600 Megawatt IGCC Mesaba plant in Minnesota at $800

million, but the **final cost is currently estimated at $2.155 billion or $3,593 per kW,** NOT including carbon capture, transportation or storage.[20] In April 2007, Minnesota's Office of Administrative Hearings rejected the Mesaba plant, finding that:

- neither the project nor the IGCC technology is likely to be a least-cost resource;
- emissions of nitrogen oxides (NOx) and mercury are not reduced significantly, and are not lower than currently available control technology for pulverized coal;
- the technology does not qualify as an "Innovative Energy Project;"
- there's no guarantee of carbon sequestration;
- **the plant would cost 9-11 cents/kWh; and capturing and transporting the carbon would add at least 5 cents/kWh.[21]**

In 2006, AEP, the largest electricity generator and coal user in the U.S., estimated capital costs in for a traditional pulverized coal plant at $1,700 per kW; IGCC without carbon capture at almost $2,000 per kW; and IGCC with carbon capture at $2,600 per kW.[22] These costs are far below DOE's estimated capital cost for Mesaba.

Gasification Creates Water Contamination

IGCC more closely resembles a chemical plant than a traditional pulverized coal power plant. Using water to clean the gas creates water contamination problems. Coal gasification wastewater has an average pH of 9.8. (Pure water has a pH of 7.0. Hand soap has a pH of 9.0 – 10.0, while household ammonia has a pH of 11.5.[23])

The principal contaminant of "process wastewater" is NO_3 (nitrate). The Great Plains Coal Gasification plant in Beulah, ND generated 4.83 million metric tons of wastewater in 1988. This plant also produced 245,000 metric tons of gasifier ash, which is removed from the bottom of the gasifier unit. In addition, cooling water is bled from the system to prevent the build-up of minerals that would cause scaling and operational problems. This "bleed" is called "cooling tower blowdown," and the Dakota plant generated 766,000 metric tons in 1988.[24]

DOE's IGCC pilot project in Wabash River, Indiana found that elevated levels of selenium, cyanide and arsenic in the wastewater caused a permit violation, and that selenium and cyanide limits were "routinely exceeded."[25]

Although IGCC theoretically uses less water than traditional coal plants, the added power demand and reduced output due to carbon capture may not result in overall less water use.

CO_2 Capture

IGCC is being promoted by the coal industry as having the potential to "capture" CO_2. However, studies show that capturing CO_2 reduces plant efficiency and increases water use. According to the Electric Power Research Institute, installation of CO_2 capture equipment has been found to decrease plant output by at least 25%;[26] while installation of CO_2 capture equipment increases water consumption by approximately 23%.[27]

Additional "capture" costs beyond the plant gate, plus transportation and storage costs, are not factored into the efficiency loss or cost increase.

A July 2006 EPA report estimated CO_2 capture costs at $24/ton, and says that "widespread introduction" of carbon capture and sequestration technology into the commercial market is "highly uncertain."[28]

CO_2 Transport

Pipeline costs must be added to total estimated CO_2 capture and storage costs.[29] If stored CO_2 leaks out, the concentrated CO_2 can cause suffocation because it is heavier than air.[30] In 1986, a large release of CO_2 from a volcanic crater, Lake Nyos in West Africa, suffocated and killed 1,700 people. A similar event happened at Lake Monoun in Cameroon. Researchers continue to work on degassing the lakes to prevent another tragedy.[31] Further research is needed on CO_2 migration and seismic shifts from storing large amounts of CO_2 underground.

Pipeline costs for the proposed Mesaba IGCC plant in Minnesota were estimated to cost between $25,000 and $60,000 per inch (diameter of the pipe) per mile[32] plus the cost of repressurization stations to keep the gas flowing. A natural gas pipeline costs about $2-4 million/mile, using a 30 inch pipeline.[33]

CO_2 Storage and Sequestration

CO_2 sequestration differs from "storage" in that it is a more permanent storing of the gas, and must be stored without leaking for thousands of years. We have been unable to safely store solid and liquid radioactive wastes for 50-60 years without leakage. It's unlikely that we'll be able to store a significant part of the world's 28 billion metric tons of CO_2 gas emitted every year without leakage problems. The Minnesota Department of Commerce estimated CO_2 sequestration costs for Mesaba at roughly $1.107 billion in 2011; and pipeline costs at $635.4 million.[34]

Carbon sequestration costs are highly uncertain. The National Energy Technology Laboratory states, "the economics of CO_2 recovery are poor in all scenarios…."[35]

A December 2006 DOE Environmental Impact Statement reported that geologic sequestration of CO_2 "is not a reasonable option because [the] technology is not sufficiently mature to be implemented at production scale during the demonstration period for the proposed facility;" and isn't expected to be "technically practicable" for large-scale commercial development within the next 15 years.[36]

A February 2006 presentation on IGCC by Xcel Energy stated that the "wild card" in the IGCC cost equation is CO_2 capture, but no currently operating plants include CO_2 capture.[37] Transport and storage costs must also be included in the total cost of electricity.

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An April 2007 MIT study, *The Future of Coal*, states that the U.S. should not increase investment in IGCC or any coal-fired generation that lacks CO_2 capture; and that plants built before CO_2 emissions are capped should not be "grandfathered."[38] The largest CO_2 sequestration project is in Sleipner, Norway, where, since 1996, Statoil has been pumping one million tons of CO_2/year into a reservoir beneath the North Sea for enhanced oil recovery, deploying one of the largest offshore platforms in the world. But it would take 10 of these projects to store the CO_2 emissions of a single large coal plant.[39]

Emissions Profile Not Good / More Mercury

Mercury emissions per megawatt-hour (MWh) from the proposed Mesaba IGCC plant are 15-27% higher than either Supercritical Pulverized Coal (SCPC) or Ultra-Supercritical Pulverized Coal (USCPC) plants. SCPC and USCPC are simply newer types of conventional (pulverized coal) plant technologies that burn hotter and include state of the art pollution control technology.[40]

However, mercury in any amount is one of the most toxic substances known. A 2006 study by the University Of Texas Health Science Center reported that for every 1,000 pounds of mercury emitted in Texas counties, there was a 43% increase in special education and a 61% increase in autism.[41]

Power plants emit more pollutants during start-up than in steady-state operation. Because gasification plants require about 60 start-up/shut-down events every year (as opposed to 2-3 for pulverized coal), and because it takes a few days for a plant's cold start, pollution emission rates are estimated to increase an average of 38%.[42] Start-up/shut-down emissions are far higher than steady-state emissions, and regulations limiting pollutants generally don't apply during start-up/shut-down.

Billions in Subsidies

The Bush administration's Energy Policy Act of 2005 included $1.8 billion for "clean coal," plus billions in federally guaranteed loans for IGCC. In June 2001, the Government Accountability Office found that of the 13 "clean" coal projects examined, 8 had serious delays or financial problems, 6 were behind schedule by 2-7 years, and 2 projects went bankrupt and were abandoned.[43]

Renewables: Lower Total Cost

Ironically, a 2004 IGCC feasibility study concludes that "[n]on-fossil's zero emissions and low operating costs (depending on the source) could pose a threat to IGCC market penetration in more restrictive environmental scenarios."[44] These "restrictive scenarios" include carbon "adders" – a penalty for each ton of CO_2 emitted.

When the currently unaccounted-for, "externalized" costs for coal plants, including CO_2 capture, pipeline and transportation costs, storage and sequestration costs, increased risk, liability for explosion or the release of large amounts of CO_2; plus the future cost of global warming, acidified lakes, mercury-poisoned fish, air pollution, asthma, heart attacks, fetal deformities, coal sludge and waste, and the destruction caused by coal mining in our communities, the "higher" costs of renewables aren't so high. We should take NASA scientist James Hansen to heart when he says we should not build one more coal plant, and figure out how to phase out existing ones.

Renewables are cheaper:

- Energy efficiency (EE), also called Demand Side Management (DMS) costs 1-3 cents/kWh;
- Wind costs 3-6 cents/kWh;
- Concentrating Solar Power facilities over 50 MW cost 10 cents/kWh (an average electrical generation plant is about 250 MW); and
- Solar photovoltaic power, which uses very little water, in addition to zero emissions, costs 14-25 cents/kWh.

IGCC is being promoted as "clean" coal, but there's nothing clean about coal, whether you burn it as a solid or if you gasify it, or liquefy it first.

When total lifecycle costs for coal-fired generation are considered, including coal mining and transportation, power plant construction, CO_2 capture, pipeline construction and transportation, CO_2 storage, coal waste product landfilling, the health effects of air pollution, environmental degradation, and global warming… coal is no bargain. It's just that the coal and utility industry have successfully offloaded these very real costs to citizens, which are "paid" eventually in dirty air, contaminated and acidified water, sick people and lost lives.

We should invest in clean, renewable energy, not doom our children to a 50-year investment in dirty energy.

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