# Should the U.S. Coal Option be Preserved?

By Tobey Winters*

New electric generation projects fueled by coal are being turned down on the basis that new coal projects produce unacceptable amounts of $CO_2$ emissions. There is no national policy on $CO_2$ emissions, so the States are taking a piecemeal approach to regulation. To a large extent the pattern is reminiscent of the last 40 years of battles over air pollution and coal. However, this time around the issue is not about a local fix to a local, interstate or regional air pollution problem, but the absence of a national policy to address a global problem.

The regulatory framework for U.S. environmental policy since the Clean Air Act of 1970 has divided the world into approximately two groups of polluters: 1) new energy projects that must pass through the eye of the needle of local acceptance, stringent regulations and "best available" and "lowest achievable" emission technology and 2) existing plants that are largely grandfathered from change, unless science can demonstrate direct health effects. This is a bit of an exaggeration, but existing plants are a protected class when it comes to environmental performance. As applied to $CO_2$ emissions, the bar to new plants is beginning to be raised to the level of an effective ban on new coal plant construction. A few recent examples are cited.

Any power project in California or Washington will now need to meet a $CO_2$ emissions limit of 1100 lbs (499 kg) per megawatt hour, which effectively bans a conventional coal based power plant using advanced technology. In the State of Washington, a coal gasification project to produce electricity (IGCC) was denied, because it did not have a sequestration plan. In Florida, 4,400 megawatts of coal fired plants including the Southern Company's IGCC clean coal project have been rejected since the new Governor has taken office and expressed concerns about global warming and using coal. The Kansas Department of Health and Environment turned down permits for two 700 MW coal fired units to be built by a local electric cooperative citing $CO_2$ emissions as the basis the decision. Although $CO_2$ is a greenhouse gas and not a pollutant with direct health effects, the Kansas regulator reasoned that because the Supreme Court ruled that EPA could regulate in this area, the permit could be rejected on the basis that $CO_2$ emissions contribute to climate change. In Maine, the Town of Wiscasset voted against taking the next step in the regulatory process for a gasification project by a vote of 55% to 45%. Public concerns about the generation of $CO_2$ played a large role in the debate over the project.

The $CO_2$ issue provides the environmental movement a very powerful tool to press opposition to new coal fired power plants. The environmental community has considerable leverage over new plant decisions, but in the arena where this leverage really counts – existing coal plants, environmental interests only prevailed in a modest way after decades of legal battles that often ended at the Supreme Court. Much of the painful history of environmental regulation might have been avoided if the emission standard when plants were originally approved expired after 30 to 40 years of operation. Instead, the useful life of a coal plant has often extended to 60 years based on low cost. With their legal rights secured, plant owners fought change and plant retirement in the name of the ratepayer.

But the question is, would a ban on new coal generation make U.S. $CO_2$ reduction goals easier or harder to achieve? And can the U.S. make headway on $CO_2$ reduction without addressing the emissions from the existing coal fleet?

**Basis for the Climate Change Crisis**

The International Panel on Climate Change (IPCC) lacks doubt about the science, consequences, and predictability of climate change. Critics of the science, its predictability, timing and consequences are dismissed by the weight of "scientific consensus". The call for quick and dramatic action is directed to political leaders around the world and the U.S most specifically. In the face of such certainty about the future backed by the scientific establishment, political leaders can be led into policy prescriptions with huge unintended consequences. One example would be a ban on new coal fired electric generation. It is a measure that can be conceived as a vote getter in the short term, and does not appear to the man in the street as an altogether unreasonable thing to do.

The generally agreed goal as defined by the IPCC is to stabilize $CO_2$ concentrations at the global level at 450 parts per million (ppm). The current level is 379 ppm. Based on climate modeling, this 450 ppm goal could confine the rise of global temperature to 2.1 degrees centigrade (within a projected range from 1.4° to 3.1°). If this goal is unattainable, a more achievable goal may be closer to

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550 ppm, which puts the projected temperature rise at 2.9 degrees rather than 2.1°[1]. However, this higher level raises the specter of "dangerous" climate change and "climate shocks" based on projections from models that estimate feedback effects from other models of climate effect interactions.

It is unclear how far down the chain of global warming reasoning this scientific consensus holds together, given the uncertainties and predictions about the future based on models. However, the principle that the negative impact of $CO_2$ emissions is due to its cumulative effect, means that any delay in $CO_2$ reduction today will require more reductions in the future in order to stabilize the concentration at a more future date. Because uncertainty is present, sooner action means less environmental risk. Small achievable actions that can be taken today may be as important as less certain, but potentially larger technological gains achievable in the future.

In the 2001 IPCC report, the authors concluded that in order to stabilize concentration at 450 ppm, global manmade emissions would have to drop below 1990 levels in a few decades. In order to stabilize concentration at 550 ppm, emissions need to drop below 1990 levels in about a century[2]. A recent UN Development Report states benchmarks that are much more difficult to meet than the 2001 conclusions. Based on the 2007 IPCC Report, the UN now states concentration at 450 ppm requires that global $CO_2$ emissions be reduced by 50% below 1990 levels by 2050. The UN Development Program reasons that developed countries like the U.S. (which has a carbon profile of 19.8 tons per capita) should be doing more to reduce emissions than developing countries like China (which has a carbon footprint of 3.8 tons per capita). The IPCC argues that the developed countries' objective should be 80% $CO_2$ emissions reduction by 2050 in order to achieve the overall goal[3]. These benchmarks were set out just before the Conference in Bali, Indonesia on what to do when the Kyoto accord expires in 2012. In a largely symbolic act on the first day of the Conference, the new Prime Minister of Australia announced that Australia would sign the Kyoto accord, leaving the U.S. as the only major developed nation that has not joined.

The political pressure mounts as U.S. presidential elections near. But the question is posed: Is an 80% reduction in $CO_2$ emissions achievable in the U.S. electric sector? Would a ban on new coal fired power plants help or hinder that objective? What is the role of existing coal plants?

**New Plant Electric Generation Options**

To meet a forecasted growth of electricity of 1.3% per year to 2030, EIA projects 228 gigawatts of new generation will be needed[4]. Renewable projects and nuclear plants could meet the demand with natural gas as a back-stop to match demand and supply. Only wind energy can deliver renewable energy at large scale. Wind projects have averaged about 3 gigawatts of new generation per year over the past 3 years. Assuming that wind generation could double its contribution to 6 gigawatts per year, an additional 138 gigawatts could come from wind. However, wind availability and electric transmission constraints limits actual generation. EIA generously computes wind turbine resource utilization at 33%. This rate is about half or less of what a new natural gas combined cycle units typically achieve based on the cost of generation. By contrast, a new coal or nuclear unit would aim at 80 to 90% utilization. Therefore, additional capacity would be needed beyond 228 Megawatts to fill in during times when wind resources are not available.

If the nuclear industry could have 3 suppliers each with a new commercial 1000 Megawatt unit placed in service by 2017, and each supplier could average a new unit a year from 2018 to 2030, the nuclear industry could add another 69 GW of power to the grid. After years of not building nuclear plants, both the industry base and regulatory process will take some time to develop the capacity to approve, build and operate these plants on time. The gap between demand and supply growth could be made up by fast start natural gas capacity to back-stop the undersupply of generation. Some variation of this illustration could stop the growth of $CO_2$ emissions in the electric sector to near zero, but it would not reduce total emissions. And it would not begin to get reductions near 80%.

**Path to Emission Reductions**

In order to reduce total emissions, the existing coal fleet needs to be replaced. The average age of a coal fired plant in the U.S. weighted by size is about 30 years old. This means that in the next 30 years, most of the fleet should be retired. Regardless of size, more coal units now in service were built in the 1950s than were built in any subsequent decade, which means that a number of units could be retired today, if a cost effective alternative were available. Over the next 40 years, the entire coal fleet could be replaced.

The least cost way to replace most of the existing coal fleet is with new coal technology. As noted in table 1 below, there is a huge gap between the $CO_2$ profile of new coal new technology and the existing fleet. New technologies significantly reduce $CO_2$ emissions even before the application of carbon capture and storage technologies. Co-firing of biomass with coal may also be environmentally and economically preferable to using biomass for ethanol production for the consumer and the biomass supplier[5]. Based on the logic that biomass is a net zero contributor to man-made emissions, co-firing with biomass reduces $CO_2$ beyond reductions noted in table 1.

Before the application of carbon capture and storage and without co-firing of biomass, new coal units can reduce coal fleet emissions by 24% to 57%. The benchmark established by California and adopted by the State of Washington implies a 51% reduction relative to existing coal units. A new natural gas combined cycle plant ideally achieves 61% reduction, but due to the frequent starts and stops and weather conditions when natural gas units are used, actual reduction is less in practice.

| **Stack Emissions of $CO_2$ (kilograms per megawatt hour)** | | | | | |
|---|---|---|---|---|---|
| **Existing Coal[1]** | **New USPC[2]** | **New IGCC[3]** | **Co-Pro[4]** | **Standard[5]** | **New CC[6]** |
| 1016.3 | 770.7 | 736.5 | 433.9 to 633.3 | 498.9 | 393.7 |
| 100% | -24.2% | -27.5% | -57.3 to -37.7% | -50.9% | -61.3% |
| [1]weighted avg. of all U.S. coal units (2004) over 100 MW | [2]Ultra super crtical pulverized coal | [3]Integrated gasification combined cycle coal | [4]Co-production of electricity and F-T diesel fuel using coal | [5]Standard adopted by California and Washington | [6]Natural gas combined cycle |
| "USPC "and "IGCC" based on Nexant analysis of environmental foot print : EPA Report 430/R-06/006. Co-production based on a project specific carbon balance. | | | | | |

USPC "and "IGCC" based on Nexant analysis of environmental foot print : EPA Report 430/R-06/006. Co-production based on a project specific carbon balance.

*Table 1 $CO_2$ Emission Profiles of Fossil Technologies*

The co-production technology (noted in table 1 column 4) shows two estimates of reduction. The lower number represents $CO_2$ emissions based on equivalent electric energy, where the useful energy in the liquid fuel production is added to the electric production to compute the overall emissions rate. By comparison, the higher number in column 4 simply scales the co-production plant to an IGCC project based on overall plant energy efficiency[6].

Co-production also has one other unique feature compared to IGCC and PC coal. In order to make the F-T diesel fuel, the $CO_2$ in the synthesis gas produced from coal must be captured. This fraction of the overall $CO_2$ emissions is about 25% of total stack emissions. With co-production, once the investment in the plant is made, the incremental cost of adding the carbon storage is lower than for the other coal options.

The U.S. could start down the path of emission reduction by re-investing in a new coal fleet and achieve reductions of 25-50% with new technology and biomass co-firing, with carbon storage options added later when commercially viable. If urgency of action is important, then it follows that it is foolish to stop new construction of coal technology now, on the theory that new coal is unacceptable until carbon sequestration is in place.

New coal fired generation is part of the solution to $CO_2$ stabilization. In addition, there are air pollution reduction benefits of modernizing the existing coal fleet, as shown in table 2.

The electric power industry is continuing to invest in NOx controls and $SO_2$ scrubbers to reduce emissions from old existing units to meet EPA and State regulations. These less efficient coal units are getting investment that would not occur if there were incentives to invest in new plants instead. By analogy, few consumers would invest 20% of the cost of new car to fix their 10 year old vehicle. The incentive to run old plants should be reversed to an incentive to build new plants, and retire the old plants. One side effect of air pollution controls on old plants is the reduction in overall plant efficiency, which increases (modestly to be sure) the $CO_2$ emissions per megawatt hour produced.

| | **Air Pollutant Comparisons - Coal Based** | | | |
|---|---|---|---|---|
| **Air Pollutant** | **Existing Coal[1]** | **New USPC[2]** | **New IGCC[3]** | **Co-Pro[4]** |
| NOx (kg per Mwhr) | 1.7 | 0.2 | 0.16 | 0.04 |
| SO2 (kg per Mwhr) | 4.7 | 0.29 | 0.15 | 0.06 |
| Mercury (grams per Gwhr) | 23.6 | 1.8 | 1.8 | 1.8 |
| | [1]weighted avg. of all U.S. coal units (2004) over 100 MW equivalent | [2]Ultra super critical pulverized coal | [3]Integrated gasification combined cycle coal | [4] Electricity and F-T diesel fuel |

USPC and IGCC based on Nexant analysis of environmental foot print : EPA Report 430/R-06/006. Mercury reductions based on average bituminous coal mercury content and a 66% removal rate. Co-production based on project specific heat and mass balance.

*Table 2: Pollutant Emissions of New vs. Existing Plants*

Fleet modernization provides three benefits: lower pollution, an additional path to $CO_2$ reduction and a less expensive option to new generation investment. If global warming requires urgent action to stabilize $CO_2$ concentration at 450 ppm, then the U.S. should be building, not rejecting new coal plants and providing incentives for the most efficient technologies. To insist that new coal investment should wait until carbon capture and storage is proven only delays action. Investors come in after new technologies demonstrate a period of successful operation at competitive prices. $CO_2$ reduction now does not preclude more reduction later.

If the 450 ppm goal is unattainable, and 550 ppm $CO_2$ concentration is the real objective, then we have a few decades to chase a silver bullet technology solution, like the hydrogen economy. If urgency is important and/or the silver bullet does not exist, then a ban on new coal works against early $CO_2$ stabilization. The anti-coal instinct based on once bitten, twice shy, while understandable, is counterproductive.

The premise of this argument is that any path to a low carbon future requires capital investment, raises energy prices and involves financial risk. Our preferences and biases for where that capital investment should be made (energy efficiency to reduce demand, renewable technologies, nuclear power or modernization of the coal fleet) should not preclude using all the means required to accomplish the objective. Greater urgency requires less prescription about how to obtain the $CO_2$ reduction goal.

New coal technology can modernize the existing coal fleet, and provide benefits that can also be justified on economic and air pollution grounds. So, there is also something here for global warming skeptics too.

**Footnotes**

[1] IPCC, Climate Change 2007, The Physical Science Basis, p. 791.

[2] 2001 IPCC Technical Summary of the Working Group 1 report, page 75.

[3] UN Human Development Report 2007/8, "Fighting Climate Change".

[4] From 1995 to 2006 electricity consumption increased 1.8% per year, so EIA projections imply some demand reduction or reduced energy intensiveness. Higher electricity prices could reduce growth further, thus making the new capacity targets more likely to be achieved.

[5] Eric D. Larson, Low GHG Liquid Fuels from Coal and Biomass, Presentation to Chewonki Carbon Capture and Storage Seminar, Wiscasset, ME, October 24, 2007. Eric D. Larson, A Review of Life-Cycle Analysis Studies on Liquid Biofuels Systems for the Transport Sector, Princeton Environmental Institute, Princeton University, Energy for Sustainable Development, Vol 10, No. 2, June 2006.

[6] With co-production the emissions from the stack are always the same, but the production of liquid fuels and electricity varies with demand and price. Using the cogenerator convention, the megawatt hour useful energy of the liquid fuel equivalent is calculated at 3413 Btus per kWhr. Because the stack emissions are constant regardless of the proportion of electricity to liquid fuels produced, this method computes a constant emissions rate. The counter argument is that the liquid fuels from co-production might otherwise come from a more efficient refinery using oil rather than coal as a feedstock. However, the argument ignores several realities: refineries make a whole slate of products and the efficiency of the overall plant depends on producing the complete slate of products – not just the premium product. Second, the marginal barrel of oil as a comparison point is unknown. The oil might be coming from oil sands, whose $CO_2$ emissions overall may be higher. Third, in this calculation the $CO_2$ emission rate varies through time depending on product mix; the latter method compares a known to a hypothetical.