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Redukcja emisji gazów cieplarnianych kwoty emisji czy obowiązkowo weryfikowane technologie

Emission Reduction of Greenhouse Gases: Emission Quotas or Mandated Control Technologies

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From a member of the editorial board

Streszczenie

Autor postuluje, że zamiast wprowadzanych limitów na emisję gazów cieplarnianych w celu redukcji ich emisji byłoby łatwiej wprowadzić przymus obligatoryjnego stosowania w oparciu o międzynarodowe konwencje najlepszych osiągalnych technologii kontroli emisji (Best Available Control Technology BACT) dla każdego z ważnych sektorów gospodarki. Dla elektrowni opalanych węglem taką technologią jest zintegrowany system gazyfikacji węgla łączący wiązanie węgla z sekwestracją. W przypadku transportu brak jest technologii która pozwoliłaby na zatrzymanie CO_2. W tym przypadku redukcja emisji CO_2,, powinna być prowadzona poprzez zmniejszenie zużycia paliwa na przejechanie danego odcinka drogi. Aby to osiągnąć autor postuluje wprowadzenie międzynarodowego porozumienia ograniczającego dopuszczalną masę samochodu osobowego do 1000 kg. Najlepsze technologie kontroli emisji (BACT) mogą być wprowadzone tylko dla nowych produktów. Dlatego też niezbędne jest „anty dziadkowa" zasada mówiąca, ze wszystkie konwencjonalne elektrownie opalane węglem powinny zostać wyłączone po 35 latach pracy a samochody po 10 latach.

Słowa kluczowe: emisja gazów cieplarnianych, technologia kontroli emisji, elektrownie opalane węglem, pojazdy samochodowe, sekwestracja węgla.

Abstract

It is argued that instead of imposing on each country internationally agreed quotas on Greenhouse Gas (GHG) emission reductions, it would be easier to implement, enforce and verify, if each country mandates the installation of Best Available Control Technology (BACT) for each significant industrial category. It is BACT that has to be agreed on by an international convention, such as the Intergovernmental Panel on Climate Change (IPCC). A possible BACT for coal-fueled power plants is the Integrated Coal Gasification Combined Cycle (IGCC) *cum* Carbon Capture and Sequestration. For transportation vehicles, there is no "add-on" technology that can capture CO_2 emissions. Here CO_2 emissions must be limited by increased fuel mileage. There should be an internationally agreed maximum vehicle weight for passenger cars, which the author suggests to be 1000 kg. Because BACT can be implemented only on new sources, there must be an anti-grandfathering rule, *e.g.* all existing coal-fired power plants must be retired after their 35^{th} year operating time; all personal vehicles must be scrapped after their 10^{th} year on the road.

Key words. greenhouse gas emissions, control technologies, coal fueled power plants, transportation vehicles, carbon capture and sequestration.

I am writing this letter upon the suggestion of Dr Lucjan Pawlowski, who read my Letter to the Editor of *Environmental Science and Technology*, and recommended that I provide a more detailed discussion for *Sustainable Development* (Golomb, 2007). In the *ES&T* letter I proposed that instead of meeting some internationally agreed quotas on Greenhouse Gas (GHG) emission reductions, alá

Kyoto, there should be an international agreement stipulating that each country's government impose performance standards on GHG emitting source categories. In other words, major emitting source categories must implement internationally prescribed control technologies that each source category has to employ in order to minimize GHG emissions. By implementing these performance standards, each country will achieve GHG emission reductions to the maximum achievable level by the currently best available control technology, called BACT. There is a precedent in the USA for implementing BACT. New coal fired power plants were mandated in 1977 to implement BACT in order to prevent significant air quality deterioration in Federal national parks (USA Clean Air Act and its Amendments, Section 111). In practice, what this meant is that new power plants that are likely to impact the air quality in national parks had to install the best available control technology for reducing emissions of sulfur oxides, nitrogen oxides and particulate matter. The selection of a particular BACT had to consider emission reduction efficacy as well as the cost of the technology. BACT can change from time to time as new technologies become available that are superior to the prevailing BACT. When enacted, BACT for SO_x emission reduction was flue gas desulfurization (the "scrubber"); for NO_x, the low-NO_x-burner; for particulate matter, the electrostatic precipitator.

Unfortunately, for emission reduction of CO_2, the principal anthropogenic GHG that causes global warming, there is no relatively simple add-on technology to new sources, let alone retrofit technology for existing sources, which can reduce the emissions of CO_2. Take the example of coal fired power plants. At present, there are only three technologies that are thought to reduce CO_2 emissions efficiently, but at a significant cost and energy penalty. They are as follows: (a) Integrated Coal Gasification Combined Cycle, called IGCC, *cum* Carbon Capture and Sequestration, called CCS. In such a power plant coal is gasified into CO and H_2; the CO is further processed in a water gas shift reaction to yield CO_2 and H_2. The CO_2 is separated, usually by physical absorption, and the H_2 is used for power generation either in a gas turbine or in a fuel cell. The separated CO_2 is liquefied under high pressure, and piped to a sequestration site such as a semi-depleted oil or gas reservoir, or a deep underground sedimentary saline formation. (b) Oxyfuel combustion. Here coal is combusted in almost pure oxygen (95+%) in a boiler. The flue gas consists almost entirely of CO_2 and H_2O; the water vapor is condensed, and the CO_2 is liquefied and disposed as in (a). This method requires an air separation unit that separates oxygen from nitrogen. Because of the enormous quantities of oxygen required (a 1000 MW power plant would need approximately 20 000 tons per day of oxygen), this method is deemed to be even more expensive and energy intensive than the IGCC *cum* CCS. (c) Chemical absorption. The flue gas of a conventional boiler passes through an absorption tower where a chemical absorbent, usually monoethanolamine (MEA) absorbs CO_2 but not the rest of the flue gas. The absorbed CO_2 is boiled off in a separate tower, liquefied and disposed as in (a).

The second largest source category for CO_2 emissions is transportation: automobiles, trucks, locomotives, ships and airplanes. For transportation vehicles, there is no technology that can capture CO_2 from the exhaust gases in any efficient and economic way. The only solution is to increase the fuel economy, that is, liters of fuel consumed per kilometer travel. There are several ways to achieve increased fuel mileage. For example, the internal combustion engine/electric motor hybrid, plug-in electric car, and foremostly, reduction in vehicle mass. Fuel consumption is directly proportional to vehicle mass. Propelling a vehicle from rest to cruising speed, and maintaining cruising speed is, primarily, dependent on the weight of the vehicle (Fay and Golomb, 2002). There are perfectly acceptable passenger vehicles that do not exceed 1000 kg in weight. They can achieve a fuel economy of 10-12 km/liter (62-74 mi/ga) with conventional engines, and even better with hybrid propulsion. Governments must simply mandate that no passenger vehicle be produced that weighs more than 1000 kg. Period. No fleet averaged gas mileage, so that some people can buy gas guzzlers, as long as there are others who buy gas sippers. No large SUVs, vans, pickup trucks, unless certified that they are for commercial use, not personal transportation.

The disadvantage of BACT is that it pertains only to new sources. Grandfathering of existing emitting sources must be strictly limited. Again, a government diktat is necessary. Existing sources must be phased out on an internationally agreed time scale. For example, if it is agreed that a reasonable life time of an existing coal fired power plant is 35 years, it must be scrapped on its 35^{th} birthday, and a new power plant built with carbon capture and sequestration. Or, a utility can decide it is cheaper to replace the retired coal-fired plant with a nuclear-fueled power plant, wind farm, solar thermal, solar photoelectric, tidal, geothermal, wave, or any other plant that does not emit CO_2. Old gas guzzling vehicles must be phased out over an agreed period (10 years?). Also, here a government intervention is necessary. Owners of the old vehicles receive a government financed voucher toward the purchase of a new gas saving vehicle.

Massive emission reduction of CO_2 (and other GHGs) presents a paradigm shift in our urban-industrial civilization. It will require enormous expenses, technology development, economic and social dislocations, life style and habit changes. Some economists believe that economic incentives,

such as cap-and-trade, fee-to-pollute, carbon tax, gasoline tax, etc, will minimize the monetary and social costs of GHG emission reduction. Since we are paying for emission reduction anyway as tax payers, rate payers, or commodity buyers, I doubt that as individuals we shall save if emission reduction is accomplished through government fiat or through economic incentives. However, it appears to me that internationally agreed upon technology standards promulgated by each country's government are easier to implement, and are more efficient and equitable than, for example, putting an arbitrary tax on a ton of carbon emitted. With implementation of technology standards, including automobile fuel standards, it is easier to achieve a certain leveling-off of GHG concentrations in the atmosphere than by imposing arbitrary emission reduction quotas on individual countries, which evidently not every country wants to accept. Uniform, world-wide technology standards are less likely to pit one country against the other, *e.g*. developed *vs*. under-developed. A new coal-fired power plant has to have carbon capture *cum* sequestration, no matter in what country it is built. A new personal automobile can not weigh more than 1000 kg, no matter where it is manufactured.

References

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