A SECOND "CLEAN" AIR FOR FOSSIL FUELS

Climate change is possibly the most critical problem faced by mankind. It is mostly produced by the burning of fossil fuels (FF), which currently provide ~80% of the energy spent in the world. There is the belief that the way to stop global warming necessarily implies abandoning the use of oil, coal and natural gas. The alternatives to FF include nuclear energy and renewable sources.

The fastest growing renewable source is "modern" biomass, obtained from vegetation produced in a sustainable manner. However, due to diverse impacts on the environment (*Interciencia*, 34: 106-112, 2009) this alternative is polemic, and perhaps the second generation will be more acceptable. "Traditional" biomass, not sustainable, represents ~8.5% of global energy but, as a safeguard to the ecosystems, a reduction of its incidence is sought. Hydroelectric potential is limited, initial costs are very high and, furthermore, the building of large dams is objected, be it in defense of communities, landscapes or biodiversity. The most acceptable technologies, solar and eolic, are significantly more expensive than FF and their implementation, even in rich countries, takes place very slowly. Together, these two options do not exceed 1% of the energy currently consumed. Other renewable sources include geothermal, tidal, and small hydroelectric plants.

Nuclear plants provide ~6% of global energy. This option has recently received new impulse. Thanks to decades of research and development, nuclear energy has gained efficiency and safety. Presently, third generation reactors are being installed. Those of fourth generation, "fast" reactors, could start operating in the 20's. They would use up practically all the fuel, and will be able to operate with existing refuse. Their own wastes have a half life of only decades. No doubt, the revival of the nuclear option will be rejected by several sectors that historically have been opposed to it.

To replace FF is a way to stop global warming, but the energetic alternatives have economic limitations, environmental problems and, even, social reject. Between 1990 and 2009, the amount of CO_2 emitted per unit of economic activity grew ~25%. On their side, the mitigations proposed for 2020 in the Copenhagen Agreement indicate that the global CO_2 emissions will continue to grow significantly at 1% per year. This reflects the limitations of alternative energies and the continued predominance of FF. The most realistic scenarios of the IPCC consider a high incidence of FF all along this century. That our future still requires a great amount of carbon is not a supposition.

Another way to de-carbonize energy is through the implementation of capture and storage of CO_2 (CCS) in thermoelectric plants operating with FF (www.ccsassociation.org.uk). Great efforts are being made in this respect, but there isn't yet any commercial scale thermoelectric plant that employs CCS. Only experimental pilot projects exist. With support from the powerful sector of FF and governmental subsidies, it is expected that economically viable CCS technologies will be in operation in the next decade. The technological essays are being made principally with coal and natural gas, but they should be extended to non-conventional oils (Canada's bituminous sands or Venezuela's extra-heavy oil), which are very abundant and will play an important energetic role in the mid-term. CCS technologies will also be applicable in high CO_2 emission industries, such as steel, aluminum and cement. The use of CCS in thermoelectric plants run on biomass would produce a net atmospheric CO_2 reduction.

In order to avoid a catastrophic global warming, greenhouse gas emissions in 2050 should be 50% below those in 1990 (*Interciencia 35*: 624-631, 2010). This will require of an unprecedented political will to boost and finance the needed technological innovations. Among other measures, a portfolio of low carbon emission energetic alternatives: solar, eolic, hydrologic, nuclear, bio-fuels, and FF-CCS, will be necessary. Undoubtedly, no individual technology or subgroup of technologies can generate changes of the needed breadth. De-carbonizing energy in the mid-term appears to be a titanic endeavor, perhaps Utopian. The participation and validity of FF will depend upon the development of CCS, which shall give it a second air, clean this time, to the discredited FF.

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