The Wedge from Efficient Baseload Coal Plants

BAU

Activity level(AL)

- electricity output from coal plants in 2054: 13,000 TWh

Assumptions

- lower-heating value efficiency: 40%
- Carbon intensity: 93gC/kWh

Emission factor(EF)

- EF=93/0.4=232 gC/kWh

Total emissions

- =AL*EF=3.0 Gt-C/year

Target

Same as in BAU, except for a 60% efficiency, which leads to an emission factor of 155 gC/kWh and total emissions of 2.0 Gt-C/year. Thus, we derive a wedge.

Comments

Emissions from power plants can be reduced both by changing the fuel and by converting the fuel to electricity more efficiently at the power plant. We treat more efficient conversion here. More efficient conversion results at the plant level, for example, from better turbines, from high-temperature fuel cells, and from combining fuel cells and turbines. At the system level, more efficient conversion results from load leveling, from cogeneration (the co-production of electricity and useful heat), and from polygeneration (the co-production of chemicals and electricity).

According to the World Energy Outlook (S24, p. 411), global electricity output from coal in 2000 was 6000 TWh, so the output in 2054 is slightly more than twice of the output in 2000.

All the carbon intensities considered here for coal plants in 2054 exceed the current average carbon efficiency. Year 2000 carbon in and electricity out for coal-based power plants were, respectively, 1712 MtC/y and 5989 TWh/y, resulting in a carbon intensity of 290 gC/kWh (S24, p. 411 and p. 413).

Electricity production is already more decarbonized than non-electric end uses of energy. Only about 20% of all primary energy comes from sources other than fossil fuels, but for electricity production the share from other than fossil fuels is 40%[1]. The difference in

[1] The share of primary energy from non-fossil sources varies across data sources, depending on whether traditional energy sources are included and on how hydropower is treated. According to the IPCC Mitigation Report, the share of electricity from non-fossil sources in 1995 was 38%, 5000 TWh out of 13,200 TWh (S25, Table 3.29, p. 238).

share is the result of non-carbon primary energy (dominated by hydropower and nuclear energy) being used almost exclusively in the electricity sector. This trend is likely to continue. Wind and other renewables will also have their primary impact, for the foreseeable future, as sources of electricity. To decarbonize the fuel supply system, in contrast to the electricity supply system, there are fewer options available, as discussed in Section 3 of the Supporting On-Line Material. This is why wedges available from improved efficiency of fuel use are especially important.

References

S24 International Energy Agency, 2002. *World Energy Outlook 2002*. Paris, France: OECD/IEA. By subscription**:** http://library.iea.org/dbtw-wpd/Textbase/nppdf/stud/02/weo2002_1.pdf**.**

S25 Acota Moreno, R., et. al., 1996. "Technologies, policies and measures for mitigating climate change." In *IPCC Technical Paper 1,* R.T. Watson et al., eds. Geneva: IPCC. Cited in: W.R. Moomaw and J.R. Moreira, "Technical and economic potential of greenhouse gas emissions reduction," *Climate Change 2001: Mitigation,* B. Metz, et al., eds., 2001. One of four volumes of *Climate Change 2001 IPCC Third Assessment Report*. Geneva, Switzerland: IPCC Secretariat (ipcc-sec@wmo.int). http://www.grida.no/climate/ipcc_tar/wg3/index.htm**.** Page references in the text are for W.R. Moomaw and J.R. Moreira, 2001.