Effectiveness of CCS with time-dependent CO_2 leakage (*Energy Procedia,* vol. 1, issue 1, pp. 4977-4984, Elsevier, 2009).

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Abstract. The effectiveness of CCS, i.e. its emission abatement potential in relation to the possibility of leakage of CO_2 from geological reservoirs once this greenhouse gas has been stored artificially underground, will be among the main determinants of whether CCS can significantly contribute to a deep cut in global CO_2 emissions. This paper presents an analysis of the economic and climatic implications of the large-scale use of CCS for reaching a stringent climate change control target, when geological CO_2 leakage is accounted for. The natural scientific uncertainties regarding the rates of possible leakage of CO_2 from geological reservoirs are likely to remain large for a long time to come. We present a concise analytical inspection, as well as an analysis with a more detailed integrated assessment model, proffering insight into the economics of geological CO_2 storage and leakage. CO_2 leakage lowers the value of CCS as climate mitigation option below the prevailing level of the CO_2 tax. We therefore employ a definition for the effectiveness of temporary carbon storage as the net present value of the total stream of avoided emissions. We calculate the effectiveness of CCS under two leakage models (an exponential model with a constant seepage rate and a two-layer model with a bell-shaped time-dependent seepage rate) and with different assumptions regarding (1) the carbon tax growth rate relative to the interest rate and (2) the average CO_2 storage life-time. We introduce the expression for the effectiveness of CCS in a top-down integrated assessment model that represents three main CO_2 emission reduction options: energy savings, a carbon to non-carbon (renewable) energy transition and the use of CCS. We find CCS to remain a valuable option even with CO_2 leakage of a few %/yr, well above the maximum seepage rates that we think are likely from a geo-scientific point of view.