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A simple, physically-based method for evaluating the economic costs of geo-engineering schemes

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The consumption of primary energy (e.g coal, oil, uranium) by the global economy is done in expectation of a return on investment. For geo-engineering schemes, however, the relationship between the primary energy consumption required and the economic return is, at first glance, quite different. The energy costs of a given scheme represent a removal of economically productive available energy to do work in the normal global economy. What are the economic implications of the energy consumption associated with geo-engineering techniques? I will present a simple thermodynamic argument that, in general, real (inflation-adjusted) economic value has a fixed relationship to the rate of global primary energy consumption. This hypothesis will be shown to be supported by 36 years of available energy statistics and a two millennia period of statistics for global economic production. What is found from this analysis is that the value in any given inflation-adjusted 1990 dollar is sustained by a constant 9.7 +/- 0.3 milliwatts of global primary energy consumption. Thus, insofar as geo-engineering is concerned, any scheme that requires some nominal fraction of continuous global primary energy output necessitates a corresponding inflationary loss of real global economic value. For example, if 1% of global energy output is required, at today's consumption rates of 15 TW this corresponds to an inflationary loss of 15 trillion 1990 dollars of real value. The loss will be less, however, if the geo-engineering scheme also enables a demonstrable enhancement to global economic production capacity through climate modification.