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PERSPECTIVE

40 yr phase-out for conventional coal? If only!

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Myhrvold and Caldeira worked out the climate consequences of various ways in which the world's current fleet of coal power plants could evolve into something different [1]. They imagined one-fortieth of the world's coal plants being closed down each year for 40 years. Two limiting cases are (1) nothing is built to take the place of this power, because efficiency gains have made them unnecessary, and (2) coal plants exactly like those now running take their place. Since coal power is the most carbon-intensive form of power, all other options fall between these limits. They looked at six single-technology alternatives: taking over from coal as we know it are coal with carbon dioxide capture and storage, natural gas, nuclear power and three forms of intermittent renewables (presented as baseload options). Moreover, whatever the alternative, it remains in place unchanged from year 40 through year 100.

Results are presented as 100 yr trajectories for the increment in the average global surface temperature due only to this power production. For the coal-for-coal scenario, the surface temperature increase is about 0.13 °C in 40 yr and 0.31 °C in 100 yr. For the efficiency-for-coal scenario, the rise is 0.07 °C in 40 yr and 0.06 °C in 100 yr. Clearly, temperature rise is approximately proportional to emissions and these are self-consistent answers. For example, after 40 yr efficiency-for-coal has brought approximately half the temperature rise of coal-for-coal, and there have been exactly half the emissions. The efficiency-for-coal trajectory falls ever so slightly between years 40 and 100, because once CO_2 enters the atmosphere it lingers.

As for the absolute magnitude of the coal-to-coal trajectory, today's global coal power production (8300 TWh in 2008) is almost exactly what would be produced from one thousand one-gigawatt coal plants running flat out (8760 TWh), which is the coal power production assumed by Myhrvold and Caldeira. From table S1 of their paper, each GW-year of coal power production is accompanied by 6.59 Mt of CO_2 emissions. Thus, a century of this coal will emit 659 billion tons of CO_2. A rule of thumb recently promoted associates each trillion tons of carbon emissions (each 3.7 trillion tons of CO_2 emissions) with a long-term temperature rise whose fifth and 95th per cent confidence intervals are 1.0 and 2.1 °C [2]. With this rule of thumb, the long-term temperature rise should fall between 0.18 and 0.38 °C, so the estimated rise of 0.31 °C agrees with the rule of thumb.

Much of the paper is about estimates of the emissions for the alternatives to coal and efficiency. Emissions are estimated for building the physical stock as well as running it. The authors cite a high and a low value for each alternative, and the lower limits, with one exception, are close to what most analysis assumes. (The exception is natural gas, whose lower limit is 60% of the value for coal, even though values of 50% or lower are widely claimed.) The high limits are unorthodox and are already creating consternation. The high limit for hydropower reflects large emissions of methane from the lakes that form behind dams. In the cases of nuclear power, solar electric power, solar thermal power and wind power, the high limits can be attributed to emissions during construction. One suspects that these high values are straw men, avoidable with care.

It is illuminating to compare the Myhrvold–Caldeira partial emissions scenarios with the two full blown scenarios of the International Energy Agency (IEA)—the Current Policy Scenario and the 450 Scenario, presented in World Energy Outlook 2010 [3]. Both IEA scenarios go only to 2035. In the Current Policies Scenario, coal emissions approximately double by 2035 (to 16 500 TWh); Myhrvold and Caldeira actually do not tell us that this is where global coal power is heading, in the absence of new policies and priorities.

As for the IEA's 450 Scenario, it provides insight into the 40 yr phase-out for global coal power chosen by Myhrvold and Caldeira as their base case. In the 450 Scenario, global coal power falls to 5600 TWh in 2035, down one third from its 2008 value. By contrast, the pace for coal phase-out explored in the Myhrvold and Caldeira paper is about twice as fast: if their 40 yr phase-out had started in 2008, by 2035—27 yr later—global coal production would have fallen by about two thirds. I think one can view the 450 Scenario as capturing the IEA's judgment about the fastest achievable decarbonization of the world energy system. It is sobering to realize that allowing 40 yr for the closing out of world coal power production, which might strike some readers as relaxed, is actually so intense as to stretch credibility.

The IEA 450 Scenario also sheds light on the small fraction of the potential change in the future of the global energy system that the Myhrvold–Caldeira paper captures. The 2700 TWh reduction in coal power production between 2008 and 2035 in the 450 Scenario is smaller in magnitude than the increases in wind power (3900 TWh), nuclear power (3700 TWh), and hydropower (2800 TWh) in the same interval. Myhrvold and Caldeira present a textbook exercise, not to be confused with an exploration of the full range of possible futures.

I would not recommend this paper for its insight into energy systems. Rather, I would recommend it, strongly, as one of the rare papers that adequately confronts both of the sources of inertia that characterize our world: the inertia of the climate system epitomized by the durability of atmospheric CO_2 and the inertia of the energy system epitomized by the durability of our capital stock. Confronting this inertia can lead us to despair that what we can change for the better each year matters so little. Or it can inspire us, because what we do each year that points in the wrong direction will take so long to undo.

References

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