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Reply on EC1

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Community comment on "Lotka's Wheel and the long arm of history: how does the distant past determine today's global rate of energy consumption?" by Timothy J. Garrett et al., Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2021-21-CC2>, 2021

Again, as I indicate in my other comment, the culprit that determines all the energy consumption trends is the type of technologies invested in each year over the past, which consumes somewhat varying amounts of energy from year to year, but which has a finite lifetime. Given the typical rate of global growth over the past decades, the typical energy consuming technology might only be 10-20 years into a 50 year lifetime, to use rough but illustrative numbers. This could be a piece of industrial equipment, a power plant, or a building heating system. Energy consuming vehicles tend to turn over at a faster rate, of course, than once every 50 years. That implies that typically if no new policies are introduced by governments to phase out existing energy consuming technologies, or if market forces do not lead to existing energy consuming technologies being abandoned prior to their normal lifetime, the well-known slow but steady 1-2 percent per year declining trend of total energy use in a given year per dollar of GDP will continue unabated. This is the rough trend that these authors show, however it is precisely expressed. Overall, macroeconomic production functions have little to do with these consumption trends for energy technologies. This argument applies to both fossil fuel consuming technologies as well as to renewable energy consuming technologies. The fairly steady ratio that the authors find between annual energy consumption and cumulative GDP is mostly a coincidence, and a simple product of these slow long term trends for the very slow turnover of energy consuming technologies. Obviously, in terms of cause and effect, only the fraction of any year's GDP that is directly invested in energy consuming technologies cause a fraction of future year's energy consumption until that piece of technology is retired. Thus, macroeconomic arguments alone can never explain these trends. Once either the governments of the world or market forces cause more efficient energy consuming technologies to be invested in more rapidly than typically happened in the past, then this fairly constant ratio can change. The author's analysis shows that this has not yet happened in the past. But if this article is to be published, it must be completely revised so that it focuses on the types and rates of investment in energy consuming technologies in each year in the past compared to total GDP in each year. This

will allow the authors to explain the trends they find by disaggregating the causes and effects of the trend in terms of technology and not abstract arguments.