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Interactive comment on "Revolutions in energy input and material cycling in Earth history and human history" *by* T. M. Lenton et al.

Anonymous Referee #3

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Reviewer comments on manuscript:

Revolutions in energy input and material cycling in Earth history and human history Timothy M. Lenton, Peter-Paul Pichler, and Helga Weisz

Overall this is a super-cool, excellent paper. I much enjoyed reading it twice, and have found it a rich source of detailed numbers, of the knowns and unknowns about the history of energy and material cycling over billions of years, and ideas about how we got to the current state of the planet and what might be needed for the future. I generally agree with their push for "scaling up new solar energy technologies and the development of much more efficient material recycling systems – thus creating a more autotrophic social metabolism" – a 7th revolution!

A few suggestions:

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Discussion paper

(1) Though “solar” is mentioned in the abstract, in the concluding section about renewables, they are apparently talking about wind, too, as a form of solar energy. They might want to be more clear about this.

(2) I found the dates in Table S1 to be confusing. The dates given for any item seem to be the final date for that “era” and the start of the next revolution. For example, the date of the Neolithic Revolution is given as 1850 AD (perhaps “CE” is more preferred here?) but really that is the start of the Industrial Revolution. I assume the dates refer to the time when their numbers apply, when the revolution is mature. I think this should be clarified. The same comments apply to the other revolutions, as dated in that table. (And the same comments apply to the year numbers in their Figure 1.)

(3) The authors might want to clarify their term “biosphere.” They seem to apply it to what some might call the “biota,” for example, the marine and terrestrial biota. Often the word biosphere is used to include all life, atmosphere, ocean, and soil, and thus the energy input to that would be the entire absorbed solar energy, which is not relevant to the authors’ points and calculations.

(4) More on terminology: In Figure 1 the authors use “land plants” for the revolution or era they call “eukaryotic photosynthesis” in Table S1. These should be consistent, and given the discussion and calculation, “land plants” seems to be the better choice for what they are covering.

(5) Good discussion of how to draw the system boundary for human society on page 11.

(6) The authors might want to give more context for they think they have done, possibly at the end of the paper. For example, on page 2, they say, “following pioneering work by Smil (1991), we propose an alternative approach to measure the human influence against a natural background.” It would be good to give some more credit to Smil: What was his pioneering approach? What have the authors taken from Smil, and what have they extended in their own work? This could be done with additional text on page 2, or,

again as I suggest, toward the end of the paper.

(6) All in all, wonderfully clear and interesting!

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