Concerning the comments of Carsten Herrmann-Pillath (CHP), I agree that adding a glossary for explaining the relationship of the economic terms used in the paper and their standard meanings in economics would be very helpful to clarify what has been done and to facilitate connecting to the literature in economics.

Appendix B already addresses the issue of comparing economic quantities in traditional contexts and the context presented here. The differences are sometimes rather subtle, too much so to lend itself readily to a simple table. However, I have word-smithed the appendix and references to it within the text to make it more clear that how the respective quantities are similar and different.

The first sentence of Section 3.1 is incomplete. Please check.

Fixed

Furthermore, expanding the discussion of unexplained technological innovation in the model noted by CHP would be very valuable to point the way to future developments in further exploring the explanatory power of physics-based (socio-metabolic) models of socio-economic systems. Closely related to this issue is the comment by Andrew Jarvis calling for a more in-depth discussion of the role of human perception of value in a model that claims to be thermodynamic. Along the lines of a corresponding comment by Jarvis, I would also like to stress the need for discussing more carefully the conditional nature of the results depending on both the data sets and statistical methodologies used. In the words of CHP: "It is not enough to refer back to earlier writings, as authors cannot expect readers to digest the entire oeuvre when they glance through a fresh paper."

Respectfully, I disagree with CHP that this paper does not provide a causal model for technological innovation. To be sure the explanation that is provided is derived more from physical forces than human creative impulses. I would argue that human innovation is facilitated when external physical forces are such that they facilitate faster growth. The text describes these forces. However, I have been engaged with a neuroscientist recently researching the physical basis of human learning and attention, and now include a little text that addresses the role of human perception in a physical system.

The challenge might be to comprehend how a psychological construct like money could be tied to a thermodynamic construct like power through a constant. Economic value only goes so far as human judgement. Even with no one home and all the utilities turned off, a~house still maintains some worth for as long as it can be perceived as being potentially useful by other active members of the global economy.

But the interpretation might be that our brains are themselves physical networks that are tied through flows of information to networks throughout the global economy. Our brains are extraordinarily dense networks of axons and dendrites that process a wealth of information relating to our environment and our interactions with others; patterns of oscillatory neuronal activity lead to the emergence of behavior and cognition; and powering the brain requires approximately 20% of the daily caloric input to the body as a whole (Varela et al., 2001; Lennie, 2003, Buzsaki et al., 2004}. Perhaps dissipative neuronal circulations reflect our collective perception of real global economic wealth, and they march to the broader economic circulations that are sustained by the global dissipation of oil, coal, and other primary energy supplies. So, while equations 1 to 3 may seem unorthodox by traditional economic standards, there may be some basis for interpreting λ as a type of psychological constant that links the physics of human perception to the thermodynamic flows that drive the global economy.

Also, to clarify the origins of the data, the text now reads:

Crucially, equation 1 is a hypothesis that can be tested using available data. As described 10 in greater detail in the Supporting Information of Part 1, GWP estimates from Maddison (2003) and the United Nations Nations (2010) are used for historical estimates of Y . Estimates of the global rate of primary energy consumption a are provided by the US Department of Energy (DOE, 2011). Expressing a in units of Watts, and Y in units of 2005 MER US dollars per second, then wealth has units of 2005 MER US dollars, and the constant λ has units of Watts per 2005 MER US dollar. What was shown in Table S2 of Garrett (2014), and in graphical form in Fig. 3 is that, for the period 1970 to 2010 for which global statistics for power consumption are available, both a and $\int_0^t Y(t')\,dt'$ have risen nearly in lockstep. The mean value of λ relating the two quantities is

7.1 milliwatts per 2005 US dollar. Even though the GWP more than tripled over this time period, from year to year, the SD in the ratio $\lambda = a/C$ was just one percent, implying an uncertainty in the mean at the 95 % confidence level of 0.1 milliwatts per 2005 US dollar.

Futher comments:

- Concerning Eq. 3, could you discuss the consequences of da/dt < 0 in the model framework? Is this even meaninful or might this case have to be excluded as a precondition?

The following text has been added:

Should diminishing returns, resource depletion, and decay combine to cause civilization growth to stall, then simulations described in Part 1 suggest that external forces may have the potential to push civilization into a~phase of accelerating decline. Civilization lacks the extra energy required to compensate for continued natural disasters, much less grow, and so it tips towards collapse.

Contraction of wealth implies a rate of return η that is negative (Eq. 4). From Eq. 5, this suggests a global economy with a positive nominal GWP but, in effect, a negative real GWP. Fortunately, recent history does not provide a guide for such a global economic disaster. Still, one might imagine a scenario where historically accumulated global wealth shrinks because at regional or sectoral levels, a smaller and smaller fraction of civilization remains involved in gross economic production. A nominal GWP remains to be tallied, but it is increasingly offset elsewhere by some combination of wars, a degrading environment, growing unemployment, inflation, death, and decay. Energy consumption is still required to support society – after all, at least we must always eat. But a diminishing portion of society is able to add net value calculated with monetary instruments that offer promises of future returns.

The first sentence of Section 3.1 is incomplete. Please check.

Fixed

- Caption of Fig. 4: use "GWP" instead of "GDP"

Fixed

- Tables 1-3: Please check carefully if the numbers given in Tables 1,2 and 3 match those mentioned in the text.

Checked. They were fine.