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Discussions

Interactive comment on "Can Limits to Growth in the Renewable Energy Sector be Inferred by Curve Fitting to Historical Data?" *by* Kristoffer Rypdal

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I appreciate this comment from J. P. Hansen and D. L. Aksnes (H&A). It helps pinpoint the essence of my critique.

Our disagreement on what one can conclude from the data boils down to whether or not an observed decrease in growth rate for the last few years in the record can be treated as an early warning signal for stagnating growth.

When considering the entire record in Fig.1b one will observe a slow oscillation with period of approximately 15 years around the fitted curves. This is what we would find if we make a polynomial interpolation curve through the data points. If I understand H&A correctly, they interpret the reduced slope for the years 2013-2016 as an early warning

of continuing reduced growth in the future. The logical implication of that interpretation is that if the same approach had been applied some years ago, when the oscillation was in a growing phase, the early warning would have been increased growth. An early warning signal that depends critically on the exact time you choose to detect it is of course useless.

This logical flaw is rooted in a lack of awareness of the importance of distinguishing between the modeled signal and the fluctuations. One of the main points in my paper is that when the signal grows more or less exponentially, standard curve fitting will result in a fitted model that is hypersensitive to the fluctuations in the last part of the data record, and hence in great uncertainties in the estimated model parameters. This problem is solved by making the fit to the log-data rather than to the original data. By making fits excluding and including the data point for 2016 in Fig.1 I wanted to illustrate that standard curve fitting makes the result for the logistic fit extremely sensitive to this single data point, i.e. extremely sensitive to a fluctuation that may not reflect the long-term trend.

As discussed above, it is methodologically flawed to draw conclusions from one year's observation, so I wouldn't care much about whether the inclusion of the last point would give increased or decreased limit to growth in the logistic model. This is illustrated in Fig.1b where the growth limit is essentially unchanged by the last data point when the fit is done to the log-data. Nevertheless, in the light of Fig.1a I am surprised about the following H&A comment:

"adding data for wind and solar installed capacity from 2016 only strengthen this observation. A decreasing growth rate is a prerequisite for a logistic development."

It seems that H&A interpret the 2016 data as an additional point on the downward trend of the instantaneous growth rate. However, Fig.1a shows that, although this last data point is still slightly below the exponential curve, the standard curve fitting method lifts the saturation limit of the logistic curve by 50 percent when this point is included.

Hence, by following the logic of H&A, this point could be interpreted as an early warning of a growing saturation limit, i.e. as a recovery of exponential growth. These conflicting interpretations illustrate that it is impossible to avoid subjectively biased judgments when applying the non-robust methodology of H&A.

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