Energy performance relative to R&D investment: Analysis of logarithmic curves applied to photovoltaic.

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Looking at the history of growth of technologies, they often exhibit an S-shaped logarithmic curve[1]. These curves show a period of slow growth, followed by an accelerated improvement and finishing with a diminishing phase. Plotting the efficiency or performance of a technology against time, money or effort invested results in a visualisation of why some technologies thrive and others don't [2]. In this work, technology performance in kWh/$ derived from the LCOE are being used as plotted against the RD&D investment made. It can be seen that PV technology gives the best future prospective on a cost effective basis with a limit of 0.014$/kWh in the US. Breaking down the S-curve into several sub-technologies and looking at the recent developments shows which technologies are more likely to evolve further and which ones need innovation to stay in competition. As mentioned, basic innovation do not trickle down all the time but they come in waves [3]. A plateau for each sub-technology indicates a technological bottleneck and helps to identify them before they occur, this is when innovation occurs.

a) b)

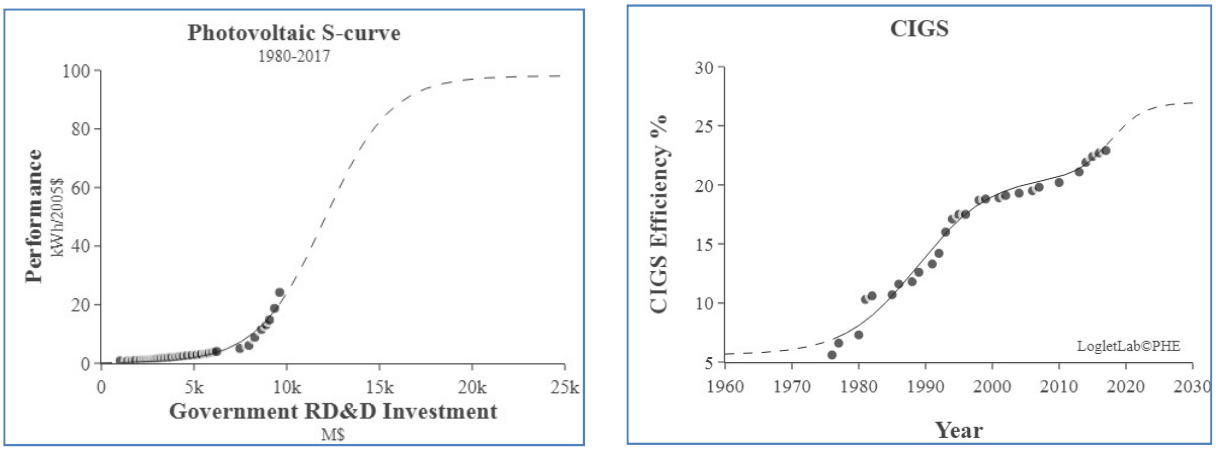

Fig. 1: S-curve plots of; a) S-curve prediction of the performance relative to RD&D investment US b) Double waved S-curve of CIGS photovoltaic cells giving the efficiency evolution of 1 cell over time.

[1] Morris S, Pratt D. Analysis of the Lotka-Volterra competition equations as a technological substitution model. Technological Forecasting and Social Change. Vol. 70; 2003. p.103-133.
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[3] C. Marchetti, « The long-term dynamics of energy systems and the role of innovations », in *Energieinnovation: Realität und Vision*, K. Friedrich et W. Wallner, Éd. Österreichischer Verband für Elektrotechnik, 1994, p. 19‑36.