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## Materials and energy : a story of linkages

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## STELLINGEN

Behorende bij het proefschrift

" *Materials and energy: a story of linkages, Materials requirement of new energy technologies, resource scarcity, and interconnected material flows*"

te verdedigen op 5 september 2012

door René Kleijn

1. Renewable energy is by definition more metal intensive than our current fossil fuel based energy system, simply because it means a shift from concentrated to diffuse energy sources. (*This thesis, Chapter 3 and 4*)
2. If the IPCC goals for stabilizing global climate are to be met, global metal supply needs to be scaled up significantly within the next four decades. (*This thesis, Chapter 3 and 4*)
3. The development of a consistent life cycle based framework that goes beyond the *ceteris paribus* assumption in LCA i.e. Life Cycle Sustainability Analysis (LCSA), is essential for the assessment of the sustainability of new energy technologies. (*This thesis, Chapter 6*)
4. We have reached a point in time where for the first time in human history metal scarcity is not only caused by a surge in demand but also by limitations in the supply chain. (*This thesis Chapter 5*)
5. Scarcity of metals is not related to the number of atoms in the Earth's crust but only to the (environmental, social and economic) costs of making them available.
6. Recycling can only significantly contribute to a sustainable materials supply if it coincides with a leveling off of demand simply because of the time lag (lifetime of the product) between manufacturing and waste treatment.
7. A sustainable energy and metal supply can only be accomplished through a set of policy measures which include a substantial shift in the incentives in our current socio-economic system i.e. a shift in taxes from labor and VAT to emissions and resource use.
8. The incorporation of solar cells in devices like mobile phones, while superficially a clear step towards sustainability, is in fact a step back when considered on its LCA merits.
9. The current unsustainable state of the world is not caused by a lack of technologies but by a lack of public support and/or political courage. However, technological breakthroughs can make the transition to a sustainable economy a lot easier because it could make sustainable technologies competitive.
10. The next technological breakthrough in the area of renewable energy technologies will originate in China.
11. The fact that thousands of scientists around the world claim that *their* discoveries will be a panacea for the world's problems, proves them wrong.
12. When their articles are refused by scientific journals, climate skeptics like to compare themselves with paradigm breakers like Galileo and Einstein, when in fact they are much more like creationists.