

Life Cycle Assessment of Advanced Materials

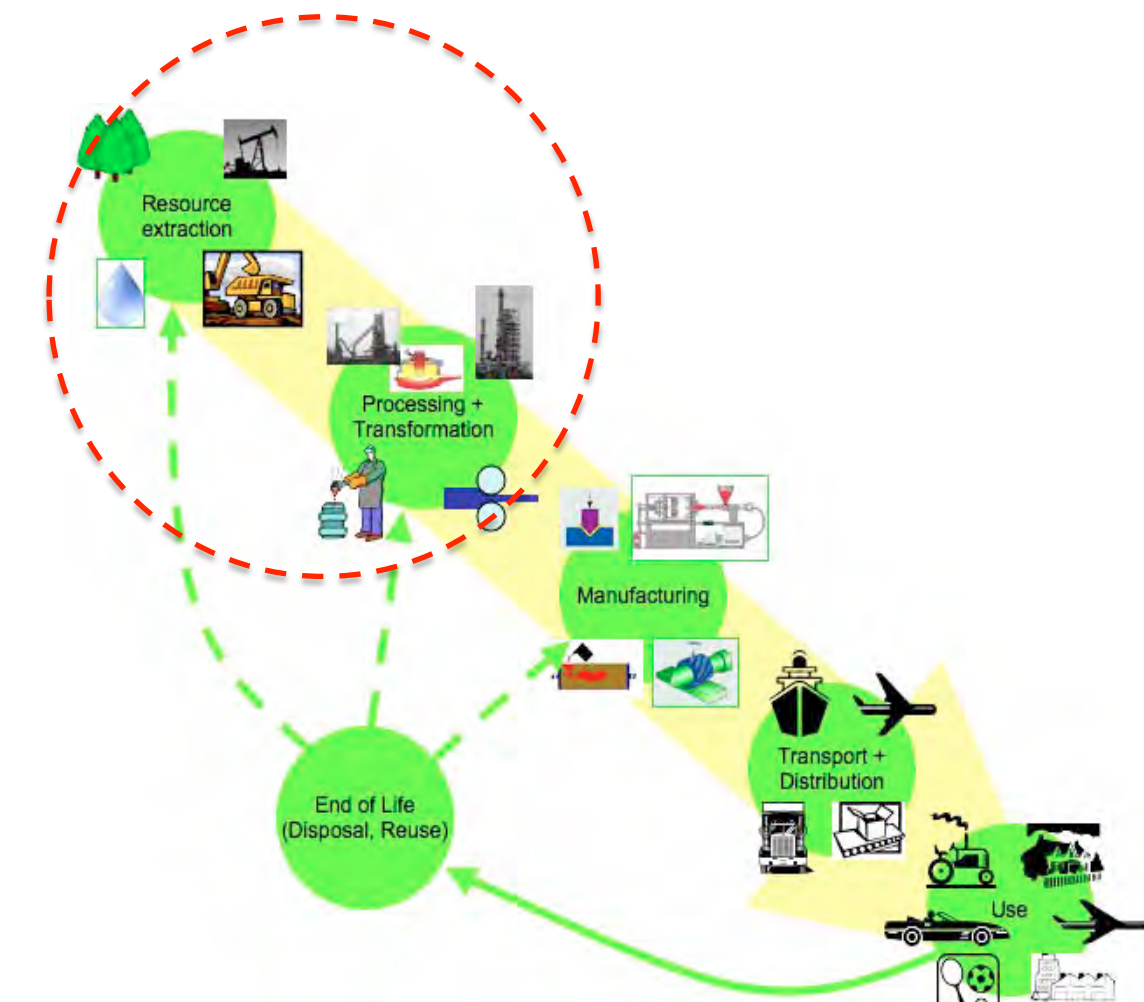
Funding Sources: Siemens Corporation and KAUST

- Apply life cycle assessment (LCA) to the production of materials
 - Specifically advanced & difficult to obtain materials
- Identify areas for environmental improvement of the processes involved
- Develop a set of recommendations for further research & development based on assessment



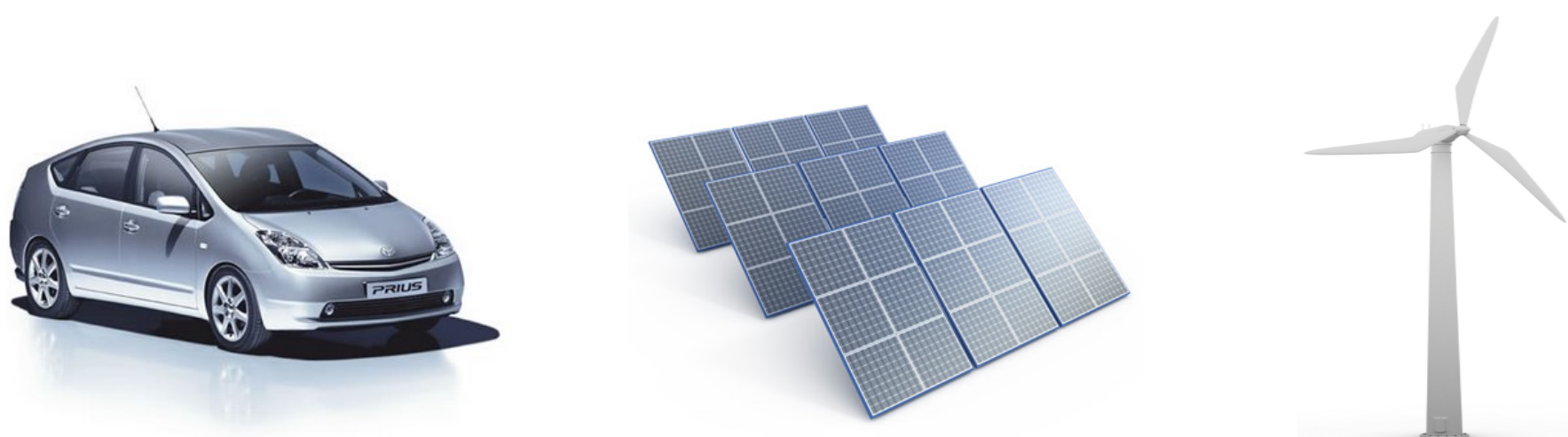
Sources: Fiona Doyle, ngenewsafrika.org

- Environmental impacts over life cycles of products and technologies are becoming increasing concerns for manufacturers, suppliers, designers, and consumers
- Material extraction & processing represent important stages that can have significant impacts due to the potentially hazardous processes involved



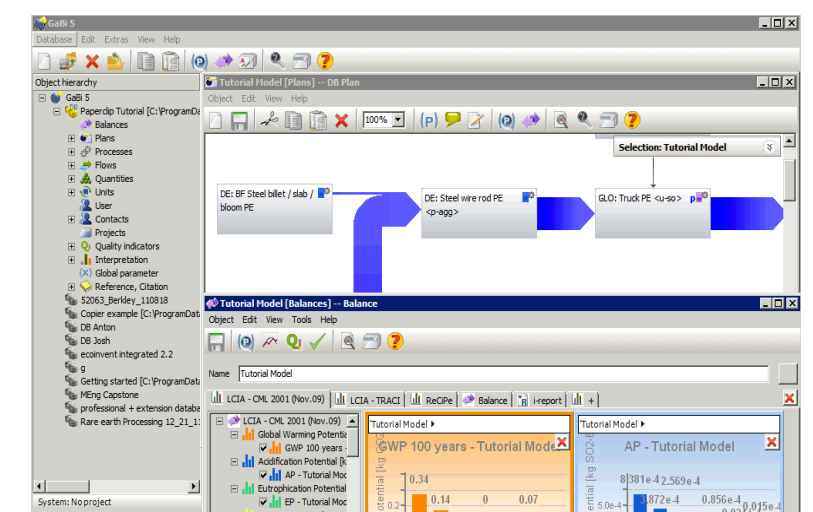
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- Many high performance products require advanced materials that have properties superior to those of conventional materials
- Advanced materials are typically difficult to obtain and require many complex processing steps
- LCA can be used to find the most ecological way to improve product manufacturing and material processing methods



Sources: Mark Hobbs, CNET, etap.com

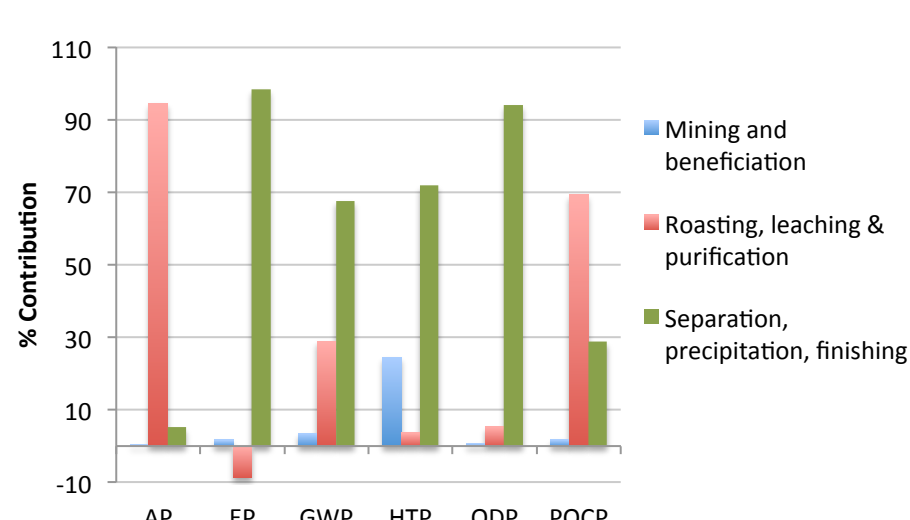
- Conducted "cradle-to-gate" LCAs of the production of:
 - Rare earth oxides
 - Conductive inks
- Created models of processes using GaBi LCA software
- Impact categories that were analyzed:
 - Energy & water use
 - Global warming potential
 - Acidification potential
 - Eutrophication potential
 - Ozone depletion potential
 - Photochemical ozone creation potential



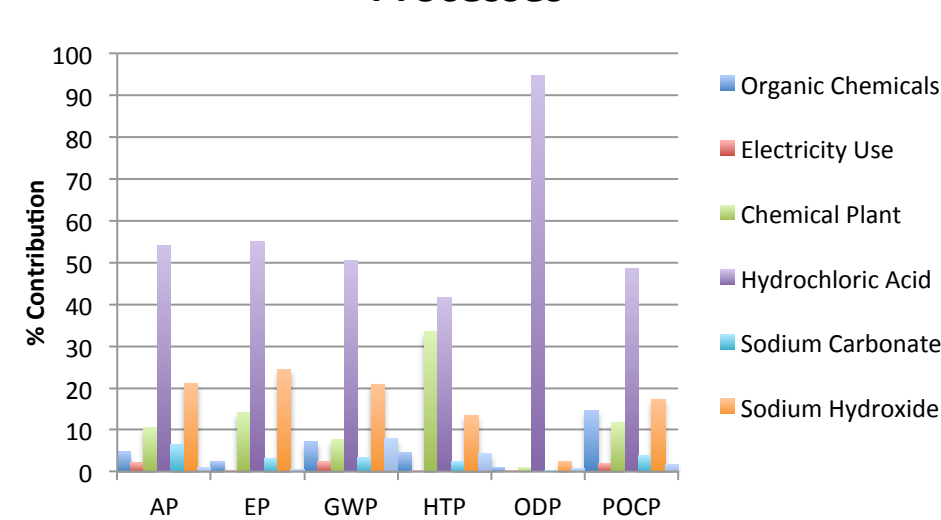
Case Study 1: Rare Earth Oxides

- Major processes involved in rare earth oxide production were analyzed and areas with most significant contributions to impacts were identified to determine areas for improvement

Life Cycle Impact Assessment Results (Rare earth oxide production from monazite)



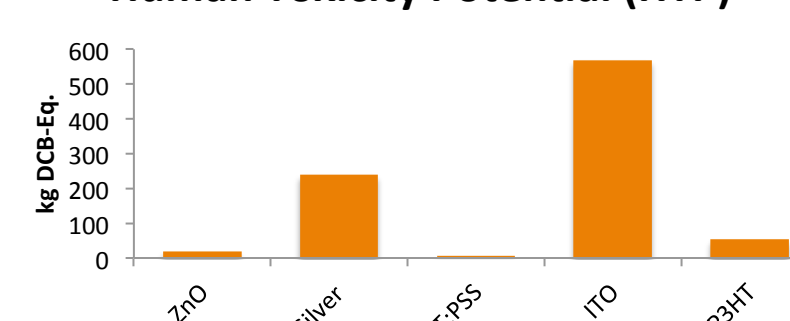
Inventory Breakdown of Separation, Precipitation, and Finishing Processes



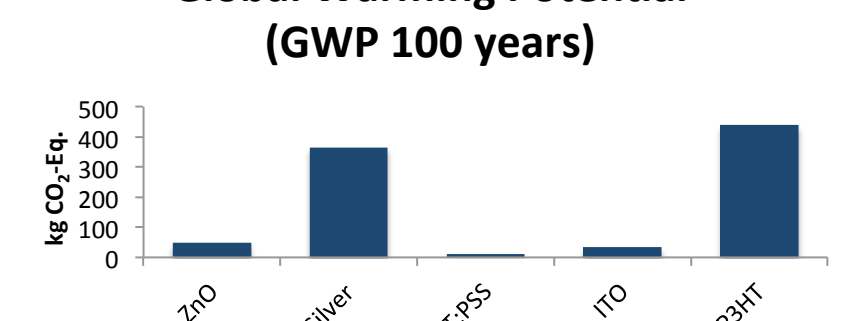
Case Study 2: Conductive Inks

- Several commonly used inks used in the printing of devices such as photovoltaics and electronics were assessed and compared

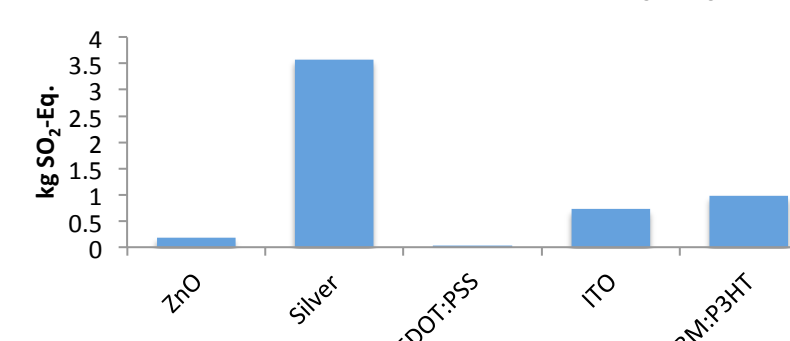
Human Toxicity Potential (HTP)



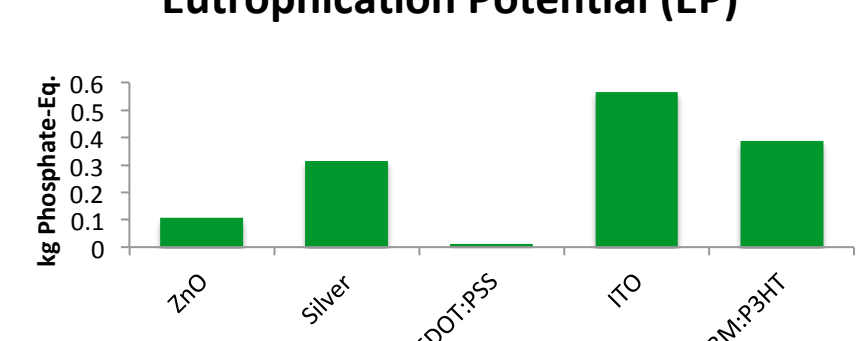
Global Warming Potential (GWP 100 years)



Acidification Potential (AP)



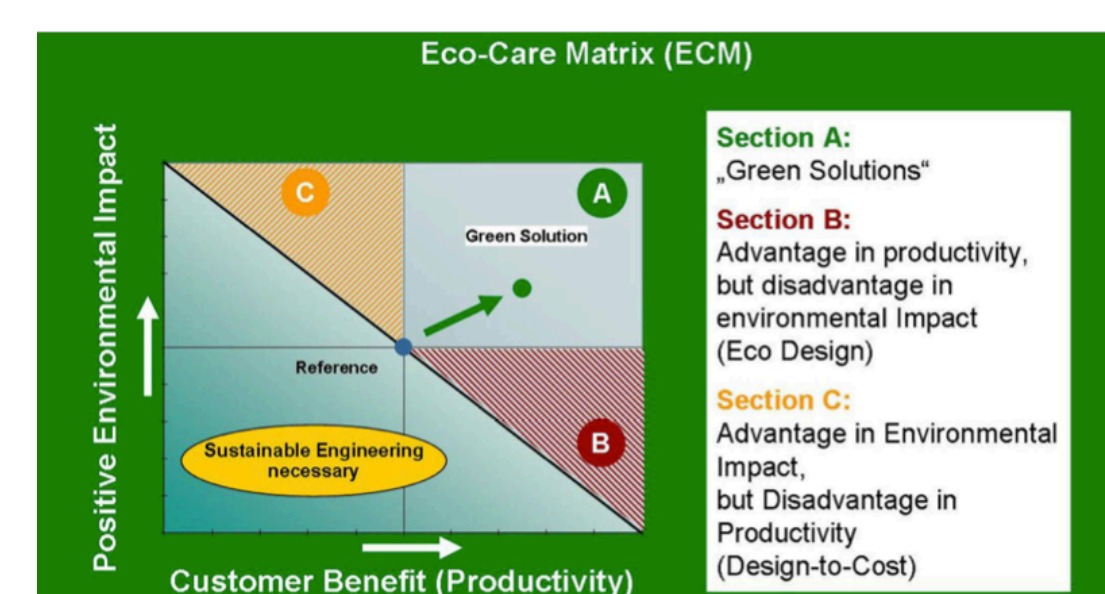
Eutrophication Potential (EP)



Conclusions

- Intense energy and chemical use in processing methods play significant roles in environmental impacts of advanced material production
- In some cases, environmental performance depends on the impact categories being considered
- Materials and processes that have the most significant impacts in the case studies should be areas of focus for environmental improvements
- Many assumptions and proxy data needed to be used in analysis due to lack of available information

- Results from assessments can be used in tools such as the Eco Care Matrix to compare alternative processes to determine sustainable solutions
- The collection of primary data for processes would allow for more accurate results to be obtained
- The models created can be built upon in LCAs of products and systems that contain or use these materials



Source: Siemens AG, Corporate Technology