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In Germany, the Federal Ministry of Education and Research funds more than 30 projects to investigate in new technologies dealing with CO2 emissions with a total budget of 100 million Euro. The co-funding from industry is of a similar magnitude. The research cluster "Technologies for Sustainability and Climate Protection" is part of the German High-Technology strategy and an element to support industry to reach the ambitious climate goals in Germany. Next to an increase in energy efficiency of the chemical sector, the development of technologies to use CO2 in products and the disclosure of new functional liquids to store CO2 offer innovative ways to mitigate climate change.

The study presented here analysed the potential environmental and economic benefits of that research cluster. Each project had the task to carry out a life cycle based assessment of the environmental impacts associated with the new products or technologies. The results contribute to a consolidated evaluation with respect to the three themes: CO2 as raw material, new functional fluids and energy efficiency. Three questionnaires were developed and served as the basis to obtain the data from the individual projects in respect to self-evaluation of data quality, market development for the new technology or product, saving potential on greenhouse gases, fossil fuels and energy consumption. The results from the assessment of nearly 66% of the projects show a potential of saving a total of 2.2 Mt CO2 in the year 2020 and 13.8 Mt CO2 in 2030. The data quality was judged between good and average. Energy efficiency savings in the range between 20% and 50% compared to the respective benchmark process were identified. Although, for some projects the market penetration still needs time the potential economic benefit is high due to the long-time perspective and registered patents. The remaining 34% of the projects will be assessed until April 2015. Results for the total contribution of the cluster with regard to the sustainability goals of the research strategy will be presented.

Poster

Using Life-Cycle Assessment and Risk Assessment to Make Better Decision About Nanotechnologies

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This poster presents ongoing work in the area of using life cycle assessment (LCA) and risk assessment for informed decision making in the area of nanomaterials and nanotechnologies. Both LCA and risk assessment are two useful tools from which important decisions can be made regarding innovation, benefits, sustainability, safety and risk. These tools are often used by different decision makers for different purposes. The complimentary use and possible integration of these two tools is explored more concretely using a specific case study on the development of organic photovoltaics that employ the engineered nanomaterial, fullerene (C60).

A prospective cradle-to-gate LCA has been completed for an organic photovoltaic cell. This technology was further compared to two traditional silicon (multi-crystalline and amorphous) solar cells as a benchmark comparison. The LCA results demonstrate that organic photovoltaics have many potential life cycle impacts per watt-peak of energy produced, including lower climate change effects, for example. One advantage of organic photovoltaics embodied in this study are the lower amount of materials (i.e. fullerenes) to make the active layer and the lower environmental demands to create those materials during the procurement and production phases.

However, what is not communicated in the LCA results are the impacts resulting from the fullerenes themselves in terms of human health and/or environmental impacts. To this extent, LCA fails to make informed decision for nanotechnologies and is dependent on other tools such as risk assessment to make informed decisions. This relationship will be explored further by completing a qualitative and/or quantitative risk assessment for fullerenes in select life cycle stages for this case study. The experience and results of the risk assessment will be used to identify ways in which more complete decision making processes can be made for nanotechnologies, including the possibility to integrate these two tools in a meaningful way for decision makers.

The authors would like to note that the work on the risk assessment has not yet been completed, however results and data will be available at the time of the conference.

Poster

Biomass feedstock production into LCA of bio-sourced chemicals: a palm oil-based surfactant case study

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When companies focus on environmental considerations, the use of bio-sourced compounds is often highlighted. Arguments put forward are the renewable aspect and the independence from oil, implicitly promising low environmental impacts. However, the environmental burden of the biomass feedstock may highly vary. Only a Life Cycle Assessment (LCA) from the biomass feedstock production up to the downstream transformation steps of chemicals can allow for ascertaining whether bio-sourced chemicals are better for the environment than their fossil equivalents.

This paper deals with the LCA of a surfactant (alkyl polyglucoside) partially produced from palm oil. We studied the varying contribution of the Fresh Fruit Bunches production (FFB), within the assessment of the whole production chain of the surfactant, according to various agricultural alternatives. These alternatives were based on a literature review highlighting the key drivers of palm oil environmental impacts. These are the soil (mineral vs. peat), the previous land use (i.e. deforestation or not), the lifespan of palm plantation, the crop inputs, the palm oil yield, and the waste and co-product use (locally produced electricity, waste treatment plant, etc.).

We carried out the LCA of 1 kg of surfactant at plant level with the International reference Life Cycle Data system (ILCD) as LCIA method. In the reference scenario, we considered most common industrial practices for FFB production and average yield from FAO statistics (2008-2012). In this surfactant reference scenario, the contribution of FFB production varies across the impact categories from 18% (human toxicity, non-cancer effect) to 85% (land use); the median value is 32%. It contributes to 77% of the climate change impact. The feedstock production is clearly one of the main drivers of the final product impacts. When exploring the agricultural alternatives, the variations in contributions highly depend on the impact category. The range is small for human toxicity, non-cancer effect, 18% ±4.5%; higher for land use 85%±20%; but tremendous for climate change 77%±133%.

These results highlight that agricultural choices during the FFB production influence the environmental assessment of the palm oil-based surfactant. This work underlines the importance of considering detailed production systems for the feedstock source for bio-based products, while generic background data are often used for this step.

Poster

Comprehensive assessment of sustainability aspects for the selection of materials and technologies

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Electric vehicles are expected to reduce the environmental burden of the mobility sector. However, if these vehicles shall represent a significant share of the future vehicle fleet, their batteries, electric motors and lightweight materials will require large amounts of elements that have only been interesting for niche applications until now. Hence, the consequences related to their large scale use need to be evaluated before the transition actually takes place and corrections become difficult.

The proposed assessment method includes all three pillars of sustainability and uses various established tools, namely life cycle assessment, material flow analysis and life cycle costing. Further, the material supply risk was measured according to an established criticality analysis. Social implications were evaluated by a novel generic approach combining prices of materials and intermediates, global production data and indicators from the social hotspot data base. The developed evaluation method is applicable to a broad variety of materials such as metals, minerals and substances of organic origin.

Such an analysis was executed comparing steel, aluminium and fibre composites as car body materials, lithium ion batteries with nickel-manganese-cobalt (NMC) and iron-phosphate cathode, and electric motors with and without rare earth magnets. Each material or technology was assessed for being used primarily in the future vehicle fleet.

The results reveal several surprises: whereas today's iron and aluminium reserves are sufficient, those of crucial alloy elements like molybdenum and niobium might be too small. Also, an intensive use of carbon fibre composites in the future can exceed the existing naphtha reserves. Batteries with NMC cathode cause less global warming potential but rank worse than batteries using iron phosphate in all other assessed impact categories. While lithium reserves are sufficient for the expected increase in demand, this is doubtful for cobalt and natural graphite. Motors with rare earth magnets lead to a lower environmental impact and rare earth reserves are abundant. Nevertheless, despite suffering a serious supply risk for rare earth elements, the related social indicators rank similarly alarming as those for the production of cobalt.

The evaluation method generates a comprehensive picture of various sustainability aspects but at acceptable effort. This makes it an interesting and adequate tool even for small and medium enterprises.

Poster

Incorporation of Life Cycle Management in producing chemical assets: a Brazilian experience with Sodium Lauryl Ether Sulfate (SLES)

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The intensification of government sanctions and market pressures, along with an increase of sense of responsibility, have led Chemical Industry to introduce more environmentally sustainable practices in their management. The bases of this transition are often the proper use of resources and the loss prevention along the supply-chain. Aware of the benefits that this approach can bring to the business, especially with regard to exports, a Brazilian Chemical Industry has decided to review the technologies used for obtaining assets that are market leaders, in order to identify improvement focus. The expectations of the company were reduce production costs and convey to customers a proactive image. In order to carry out the initiative it was created a management program based on LCM principles, which was structured in four phases: Phase 1: Environmental diagnosis of the chemical asset's processing; Phase 2: Identification and ranking of opportunities for potential improvement; Phase 3: Conception and dimensioning of solutions; Phase 4: Environmental and economic analysis of the selected solution. The first asset to be analyzed was Sodium Lauryl Ether Sulfate (SLES), a surfactant widely used in formulation of household detergents – for dishwashing and laundry – and personal care products – shampoos, toothpastes and soaps. The LCA technique was applied (cradle-to-gate approach) over the technological arrangement regularly employed by the company to production of the asset. The environmental loads were calculated to a reference flow of 1.0t SLES. The LCIA was carried out by the method ReCiPe Midpoint (H) for the impact categories of Climate Change, Freshwater Eutrophication, Terrestrial and Freshwater Ecotoxicity, Agricultural Land Occupation, Water and Fossil Depletion. It was observed that the main environmental impacts along the life-cycle were associated to (i) palm cultivation and palm kernel oil extraction, both conducted in Malaysia, (ii) generation of thermal energy and (iii) electricity consumption. Supported by this result, the company's