SUSTAINICUM COLLECTION
LEHRMATERIALIEN FÜR BILDUNG ZUR NACHHALTIGKEIT

SPIonWEB – Life Cycle Assessment for Processes and Products

(Resource ID: 149)

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This teaching resource is allocated to following University:
TUG - Graz University of Technology

http://sustainicum.at/en/modules/view/149.SPIonWEB-Life-Cycle-Assessment-for-Processes-and-Products

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Individual work
Work in pairs
Group work

Independent of the number of students

Up to 3 lecture units

Internet connection necessary

English, German

The web-based calculator provides lecturers with a simple tool to evaluate ecological sustainability of processes and products along the whole life cycle. The calculator offers evaluation of the ecological footprint according to the Sustainable Process Index (SPI) method as well as Global Warming Potential (GWP). It provides insight into different factors defining the ecological footprint as well as the contribution of the steps within the life cycle to the ecological pressure of the process or product.

The idea of the ecological footprint is to provide an easily understandable measure for the pressure human activities exert on nature. Simply put, the more resources an activity requires as input and the more emissions it generates (which may diminish the ability of the natural compartments soil, water and air to provide services due to degradation and loss of

biodiversity), the greater the ecological footprint of the activity becomes.

This leads directly to the concept of a "natural budget" that is at the disposal for each person to cover his/her life style. If a person creates for all his/her activities, services and products an ecological footprint larger than the area statistically available for one person, the life style pursued is not sustainable.

The SPI is one method to calculate ecological footprints that takes emissions to air, water and soil besides resource provision into account. The method compares anthropogenic and natural flows according to the following sustainability criteria:

Principle 1: Anthropogenic mass flows must not alter global material cycles;

Principle 2: Anthropogenic mass flows must not alter the quality of local environmental compartments.

The SPI is a tool based on these criteria and is compatible to the modus operandi described in the ISO 14000 standard for life cycle assessment. It calculates ecological pressures for all technologies from the generation of their resources to the emission the whole life cycle generates until providing the product or service in question. It aggregates different ecological pressures to one number; this single number is the area necessary to embed a process or service sustainable into the ecosphere, in accordance with the tenets of the concept of "strong sustainability" that requires sustainable development to be based on the natural income rather than allowing for unrestricted substitution of different kinds of natural and human capital. As the natural income of our planet is mainly the energy radiated from the sun to the surface of our world, human (and natural!) processes will compete for "surface" as the basic resource to utilise this natural income. This is the normative background of all Ecological Footprint calculations and also of the SPI.

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In addition to that the SPI also takes the quality of life supporting ecological compartments (soil atmosphere and water) into account as degradation in their quality will diminish the ability to utilise our natural income. It therefore focuses on aspects of environmental sustainability

based on material and energy fluxes that processes exchange with their environments. The corresponding data for natural systems are the sedimentation rate of carbon in oceans, the natural concentrations of substances in soil and water, the exchange rates per area unit of airborne pollutants between forests and air as well as the replenishment rates for soil and water.

SPIonWEB allows for comparison between different ways to provide a product or service, taking the whole life cycle into account. The results of the footprint calculations are broken down into partial footprints for direct area consumption, fossil resource consumption, renewable resource consumption and emissions to air, water and soil for every process step within the life cycle as well as for the whole industrial process.

Using the results for fossil resource consumption calculated by the SPI evaluation the software will calculate the Carbon Footprint as an auxiliary measure to discuss the specific climate change impact of the touristic activities in question. By using the same data base for the SPI and the Carbon Footprint the software guarantees compatibility of both evaluations. The calculation uses the partial area for fossil carbon as a reference. This area refers to the sedimentation to the ocean bed, the major process that replenishes the long term storage of carbon (from which fossil resources are drawn) within the global carbon cycle. The current imbalance between the (natural) flow to the long term carbon storage and the (anthropogenic) flow of carbon dioxide from burning fossil resources is at the heart of global climate change.

In the calculator the natural sedimentation flow is set to 73 kg CO_2 equivalent per hectare and year. A car that runs 10,000 km per year and emits 2,800 kg CO_2 has a fuel-related ecological footprint of 38 ha (equal to 35 soccer fields). The statistical area that an Austrian person may use as ecological footprint is 6.6 ha (including the aliquot sea area) for comparison.

On top of the CO_2 emissions SPIonWEB also calculates emissions of other gases that contribute to global climate change (e.g. methane or nitrous oxides). The accumulated impact on climate change over the whole life cycle is calculated according to the rules of the Global Warming Potential (GWP).

SPIonWEB will provide results in graphical form as well as in (exportable) tables. Graphs are provided depicting the life cycle, the contribution of particular steps within the life cycle to the overall pressure and the breakdown of the pressures exerted by every step according to the

different kinds of environmental impacts described above. This allows pinpointing the most important impact within the life cycle according to its position within the life cycle and the kind of impact incurred. Besides that the tables offer a detailed list of the whole inventory together with the particular impact of every flow exchanged with the environment and the GWP.

SPIonWEB allows the evaluation of interlinked life cycles. This may be important if a product provided by the industrial process is used as an input to another (upstream) process step within the life cycle. This feature allows students to evaluate e.g. the production of bio-diesel based on agriculture that itself utilises bio-diesel as fuel.

Teaching Tools & Methods

Computer program

Learning Outcomes

The concept of the Ecological Footprint raises in particular awareness for the consequences of human activities regarding ecological sustainability. SPIonWEB addresses industrial processes and their impact on the environment. Students may gain insight into the impact of industrial technologies as well as the analysis of life cycles providing products and services.

Relevance for Sustainability

The industrial sector is a particular sensitive actor in the interaction between society and the environment. Awareness of the impact on the environment and climate of industrial processes and the whole life cycle of the provision of products and services by industry is therefore a key for understanding the implications of sustainability on the very fibre of an industrial society. The more resources are used, the more emissions caused by a life cycle the less sustainable are the services and products that are generated by it. SPIonWEB offers the possibility to compare different technological options as well as to identify "ecological hotspots", i.e. process steps that cause particularly high contributions to the impact of the provision of a certain process or service, within any given industrial

life cycle. On top of that the identification of those material flows that contribute prominently to the pressure exerted by any step within the life cycle allows students to optimise processes ecologically.

Related Teaching Resources

Knowledge about life cycle assessment

Preparation Efforts

Medium

Access

Free

Sources and Links

http://spionweb.tugraz.at/en/welcome

Krotscheck, C., M. Narodoslawsky, 1996. The Sustainable Process Index - A new Dimension in Ecological Evaluation. Ecological Engineering 6/4 (1996) pp. 241-258.

Narodoslawsky M. and C. Krotscheck, 2000. Integrated ecological optimization of processes with the sustainable process index. Waste Management 20:599-603

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