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Facts for the energy decisions of tomorrow

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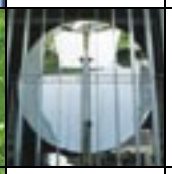

NO. 11 / JUNE 2004

ENERGIE-SPIEGEL

FACTS FOR THE ENERGY DECISIONS OF TOMORROW

Order in the Eco-Inventory Jungle

You'd like to build a climate-friendly heating system in your new house? A range of specialists can advise you. But where does the engineer's office turn, that needs data to provide such advice? Quite simple – over the internet to the Swiss Center for Life Cycle Inventories. The new ecoinvent database delivers the necessary numbers for important areas of the economy: energy, transport, building, waste disposal, chemicals, paper and agriculture.

FürFor PSI, ecological inventories and assessments are a familiar topic. It has long been concerned with life cycle assessments of electricity and heating systems. These play decisive roles in practically all economic processes. It is increasingly important for sustainable economic policies to put these energy systems systematically under the magnifying glass.

The Swiss Center for Life Cycle Inventories came out of the cooperation of institutes from the ETH domain and several Swiss federal agencies. Each organization brought its specific expertise and an enormous quantity of data. These data were suitably formatted, made consistent and combined. In their new form, they enabled the creation of the new ecoinvent database, unique in its comprehensiveness, consistency, quality and transparency.

The ecoinvent database can inform the decision-making processes that judge between various energy options. In the end, this should contribute to minimizing environmental burdens and establishing integrated product policies. A life cycle assessment can bring surprising results to light, and significantly influence decisions.

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Content

Inputs and Outputs

The Swiss Center for Life Cycle Inventories is not just the product of a common initiative of several partners from the ETH domain and different federal agencies. It also offers a comprehensive and user-friendly database that includes the most important branches of the economy and provides surprising results..

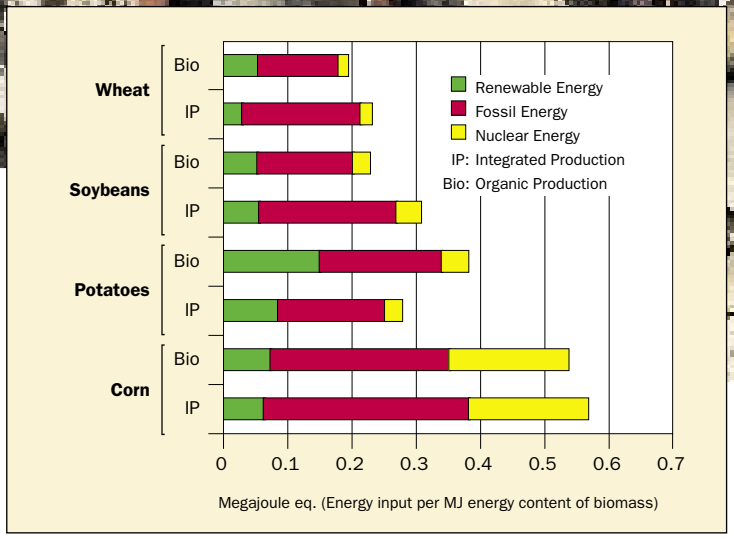


Figure 1: Energy Inputs for Production of Agricultural Crops

Energy Inputs in Agriculture

A Swiss farmer, for example, can consider how much energy he must put into the production of potatoes or soybeans, according to whether he grows his crops conventionally or organically, and the different sources of this energy. Figure 1, shown to the right, was taken from ecoinvent results. It shows the energy inputs from renewable, fossil and nuclear sources required for the production of some common agricultural products.

The nuclear energy content comes from the Swiss electricity mix used in agriculture. The fossil share reflects predominantly the energy used for heating greenhouses, producing fertilizers, pesticides, machinery, fuels, buildings and transport. Renewable energy in this instance includes not only hydroelectricity and organic fertilizer, but also the energy contained in the seed. This share is so large for potatoes, because entire tubers are used as seed.

The energy input is only one indicator of a comprehensive ecological evaluation. A full analysis also contains total emissions to the air, soil and water - and the ecoinvent has the full picture.

Greenhouse Gas Outputs from the Electricity Mix

A sample application from the energy area is the greenhouse gas emissions from electricity production in different European countries. How climate-friendly the power offered over the grid is can be seen in Figure 2, generated from ecoinvent data.

> How climate-friendly is electricity from the Western European grid?

It shows that the country-specific differences in greenhouse gas emissions are very large. In the end, the greenhouse gas content of a manufactured product will therefore depend significantly on the location of the manufacturing plant – in view of climate policies, an important difference.

This example was calculated for the electricity in the grid, including all electricity imports. The Swiss value is therefore higher than expected, compared to a calculation based on domestic electricity production.

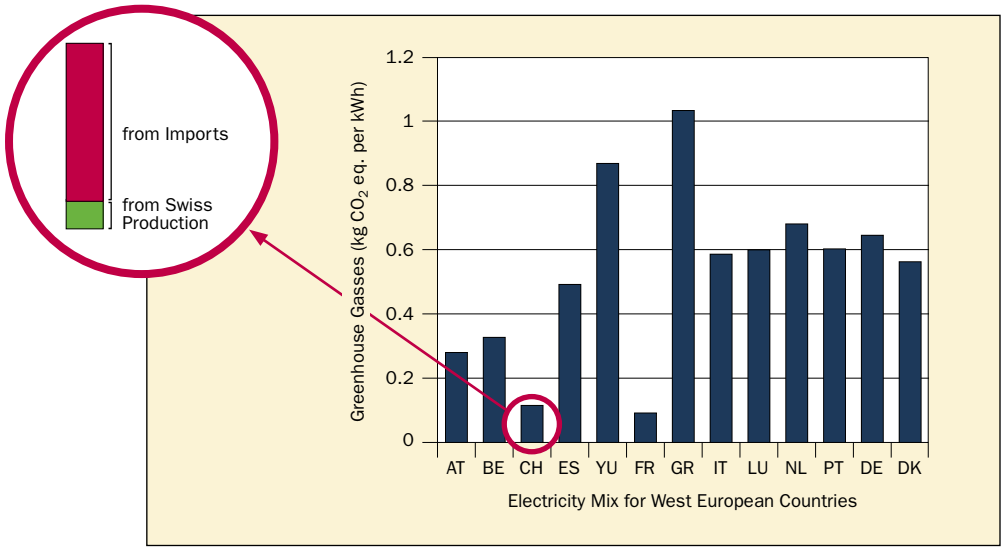


Figure 2: Greenhouse Gas Emissions from Electricity Production in Europe

EMPA hosts the Swiss Center for Life Cycle Inventories and the new ecoinvent database. It is also mainly responsible for data related to materials, while PSI is concerned with energy carriers and energy conversion. All data for around 2500 individual processes, about half energy-related, and around 1000 pollutants and resources were suitably formatted, made consistent and combined, and will be updated in the future. The data are valid for Swiss and western European conditions, and are available to specialists in industry, service providers, management and the sciences for a license fee.

Profile of Heating Systems

The ecoinvent database is based on life cycle analyses: All energy and material flows for a product are calculated, including all quantitative emissions, to produce the entire spectrum of environmental burdens. A detailed environmental profile of a product or process is thus created. It shows all emissions to the air, soil and ground- or surface-water, as well as the consumption of resources and land use.

What is LCA?

Life cycle assessment (LCA) considers all material and energy flows for a process or a product in the three life phases of production, operation and disposal. All elements of the production chain are analyzed, from raw materials production through processing steps, transport, energy transformations, and waste disposal. Therefore not only direct, but also indirect emissions and wastes, e.g. from energy and material inputs, are calculated.

If we look at six Swiss heating systems currently in use, heating installations using fossil energy carriers are significantly the worst with regard to greenhouse gas emissions. For this comparison we selected from each technology's environmental profile three air pollutants, i.e. greenhouse gases (using CO2 equivalents), NOx and particulates (PM10, particles smaller than 10 micrometers), as well as high and medium level radioactive waste..

Low Greenhouse Gas Emissions with Wood Pellet Heating

The emissions and volume of waste are divided by the maximum value for the six heaters compared. The results are divided into direct burdens and indirect burdens from the rest of the energy chain. These indirect burdens result, for example, from the supply of each energy carrier, or from the electricity used to produce the components (e.g. boilers or solar collectors) or operate them (e.g. heat pumps).

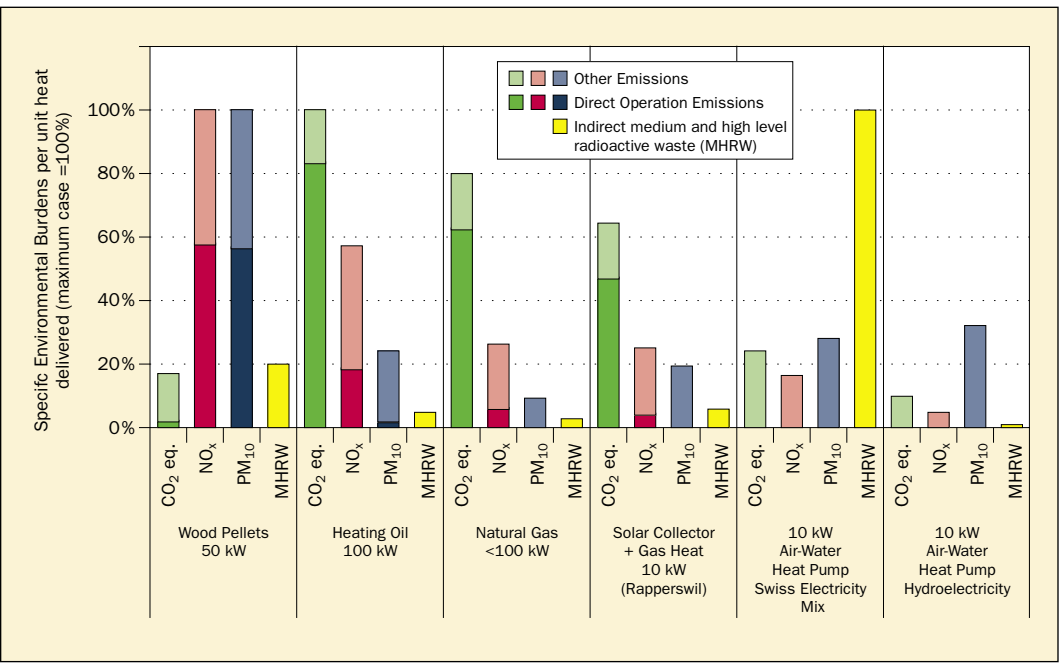
Comparisons are Worthwhile

Heat from burning wood pellets produces very low greenhouse gas emissions, because the CO2 from the combustion is compensated for by the CO2 taken up during the wood's growth, but also shows the highest NOx and particulate emissions. The lowest particulate emissions are shown by gas heating..

The heat pump driven using the Swiss electricity mix produces the highest volume of radioactive waste, due to the share of nuclear generation. However the greenhouse gas and NOx emissions are small, caused mainly by imported power. For heat pumps, the source of the electricity used is therefore important. The difference between the two cases shown lies in the electricity mix – in one case it is the average Swiss mix, and in the other case it is "green power" composed of 100% hydroelectric generation. The choice of a certain heating system or electricity mix can therefore allow the targeted and significant reduction of specific environmental burdens. For this reason, weighting tradeoffs between different environmental burdens is unavoidable in most cases..

Best Overall: the Heatpump using Hydroelectricity

Figure 3: Comparison of Part of the Environmental Profile of Current Heating Systems



ecoinvent 2000 – Participants

- ETH Zürich und EPF Lausanne
- Paul Scherrer Institut (PSI)
- Swiss Federal Laboratories for Materials Testing and Research (EMPA)
- Swiss Federal Institute for Environmental Science and Technology (EAWAG)
- agroscope FAL Reckenholz

Further Participants:

- agroscope FAT Tänikon
- Chudacoff Oekoscience
- Doka Ökobilanzen
- ESU-services

Participating federal agencies:
ASTRA, BBL, BFE, BLW, BUWAL

Overall project leadership:
Dr. Rolf Frischknecht, ESU-services

Leader, energy systems:
Roberto Dones, PSI

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National Standards, International Signals

Dr. Xaver Edelmann graduated in physics from ETH, and is a director of the Swiss Federal Laboratories for Materials Testing and Research (EMPA). He leads the department of Information, Reliability and Simulation Technology and is Chairman of the ecoinvent Board.

Dr. Christph Rentsch is a chemist and has been active since 1979 at BUWAL as leader of the Products section. He is coordinator for the introduction of Integrated Product Policy (IPP) in the Swiss Strategy for Sustainable Development 2002, and a co-founder of ecoinvent.

Why is BUWAL involved in ecoinvent 2000?

Ch. R.: With the introduction of the Integrated Product Policy (IPP) as part of the Strategy for Sustainable Development 2002, the Swiss federal council has emphasized the significance of the concept of sustainability in the area of providing goods and services. This means, among other things, examining problems over the whole life cycle of products. Although the environmental focus has long been on the methodological side, recognition has grown that only ecological accounting based on high quality and comparable life cycle assessments can lead to trustworthy results.

And why is EMPA a participant?

X. E.: Foremost is our duty to sustainable materials and systems technologies, which are the central activities of EMPA. This is one of the most promising concepts of the previously mentioned IPP. The IPP needs current and generally accepted data of high quality for its implementation. EMPA is ready with its good reputation as a neutral and scientifically based institution to play an important supporting role in helping ecoinvent achieve broad acceptance. But it is also important that an entire network of institutions should continue to contribute to ecoinvent's operation and further development.

Mr. Rentsch, are you satisfied with the co-operation between the organizations involved and the results achieved?

Ch. R.: I am highly pleased that the whole ETH domain and the interested federal agencies could agree on the current ecoinvent project. A very good solution has emerged, which is unique in the world.

Has it been ensured that ecoinvent data will be included in the economic and political decision-making processes?

X. E.: The strongest indicators of this are the good contacts with the LCA software producers. Fortunately, it has been possible to integrate an interface in the relevant programs, which allows user-friendly import and export of ecoinvent data. EMPA has already begun some demanding projects for customers in which the ecoinvent data play a central role. Our customers recognize and appreciate ecoinvent for its strengths.

Ch. R.: Federal tasks for the examination of ecological balances are tied to applying the ecoinvent data and, if necessary, generating new data conforming to ecoinvent standards. Business will also apply the ecoinvent data, because it is also interested in working with the most current documentation.

What do you expect personally from the center?

Ch. R.: I myself hope that the good experiences will lead to a further, ongoing cooperation between science and politics. Ecoinvent should also provide an impetus for life cycle analysis outside the environmental realm, e.g. for the economic and social life cycle analysis of products, as attempted by the Life Cycle Initiative of the UNEP/SETAC with Swiss assistance (ETH Lausanne), or the product labeling already practiced by Max Havelaar.

X. E.: One first national goal is to maintain and further develop the database, so as to keep it current on a continuous basis, and offer the users maximum added value. The end goal must be that ecological questions will always be answered based on the ecoinvent data, independently of the software used. Internationally, I hope that ecoinvent will be widely used, and also provide a signal effect for analogous developments in other countries.

A bridge between the different national databases would be great. For this it will be necessary to have a generally recognized procedure, as well as a unified data format. Research in coming years should be concentrated in these areas. This will finally mean that the principles of sustainable development can be much better and more efficiently implemented.

Impressum

Energie-Spiegel, or Mirror On Energy, is the newsletter of the GaBE project at PSI. GaBE is the abbreviation for Ganzheitliche Betrachtung von Energiesysteme, which translates as Comprehensive Analysis of Energy Systems. The Energie-Spiegel appears every four months. Contributors to this edition include Roberto Dones, Christian Bauer, Thomas Heck and Stefan Hirschberg..

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Energy Systems Analysis at PSI: The goal of energy systems analysis at the Paul Scherrer Institute in Villigen is to analyze present and future energy systems in a comprehensive and detailed way, considering in particular health, environmental and economic criteria. On the basis of Life Cycle Assessment (LCA), energy-economic models, risk analysis, pollution transport models and finally multi-criteria decision analysis, it is possible to compare different energy scenarios to create a basis for political decision-making.

GaBE works together with:
ETH Zürich; EPF Lausanne; EMPA; Massachusetts Institute of Technology (MIT); University of Tokyo; European Union (EU); International Energy Agency (IEA); Organization für Economic Cooperation and Development (OECD); United Nations Organization (UNO)