Establishing a data framework for Life Cycle Management in India

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Abstract National LCI databases require a certain amount of background LCI data before they can cover at least some sectors of an economy. The Indian LCI Initiative is using the existing framework of the global LCI database ecoinvent to facilitate local data collection. Integrating local databases into ecoinvent allows linking to global supply chains. Environmental documentation in emerging economies is scarce, so in some cases, existing datasets can serve as the basis for localized adaptations, while in other sectors India-specific technologies require more studies. The current approach reduces the costs of inventory generation and the time before collected data can be utilized in studies and policies. The demand for LCM and LCA is high in India due to pressing environmental concerns and an Indian LCI database will help optimize efforts to increase sustainability.

1 Introduction

In an increasingly globalized world, many emerging economies currently undergo a period of rapid industrialization. Production chains are more and more commonly spanning continents or even the whole globe. This offers great opportunities for economic development in developing and transition countries. However, increasing development can, and often does, lead to additional environmental impacts due to resource uses or emissions to the environment. Many emerging countries now deal with the effects of these increased impacts and are looking for ways to reduce them.

Life Cycle Management (LCM) and Assessment (LCA) can be important tools in these efforts to reduce environmental impacts from growing industrialization. Identifying the most significant causes of environmental impacts along supply chains can be an invaluable tool when improving the sustainability of a production process. However, the data requirements for LCA studies are quite high - detailed production inventories of all processes along the life cycle need to be evaluated. In developing countries, such activities are supported by the availability of Life Cycle Inventory (LCI) databases, such as the ecoinvent database [1]. Without background data, an LCA study can get very complex to produce due to the efforts of data collection. Therefore, comprehensive databases of local background data are a critical factor for the application of LCM and LCA in developing and transition countries.

Furthermore, LCA is already being used in environmental regulations in some European countries. Producers in these countries have a high demand for LCI data covering their global supply chains. More importantly, it is important that such regulations do not prevent emerging economies from participating in global trade. Therefore, the Swiss government is sponsoring a project to support establishing localized LCI databases in several emerging economies, including India.

2 Project Methodology

The ecoinvent Centre is cooperating with national LCI initiatives in India, South Africa and Brazil to increase awareness of LCM and LCA, to build expertise in the application of LCA and in LCI data collection and to actively collect LCI data. Data collection focuses on important industrial and agricultural processes and sectors. The primary collection goals were first selected at a large, international stakeholder conference and include heat and electricity generation, construction, transport, waste treatment and others. These data will be included in future releases of the ecoinvent database and will be reviewed free of charge by ecoinvent editors.

During the inception of the national LCI initiatives, several problems were identified that interfere with the successful creation and application of local LCI data. These were the lack of local background data, the lack of existing studies on production conditions in emerging economies and the often drastically different technologies applied in such countries.

Lack of background data

One critical issue for a beginning national LCI database initiative is the lack of adequate background data. Since many industry sectors are interlinked, LCI data

even for basic industries are only fully usable once their upstream processes are also covered by available LCI data. Without an existing database to fall back on, the first datasets collected are therefore less useful, which can be discouraging. To solve this problem, the ecoinvent centre is creating a set of global background data for the upcoming version 3 that can be a framework into which national databases can be integrated. During the linking of the database, local, e.g. Indian, datasets will be linked to upstream data based on local consumption. Should no such data be available, a global background dataset will serve as a placeholder with documented, higher uncertainties until localized data become available. In this way, the first datasets created in India can be directly utilized in LCA studies and later additions of further localized datasets are then automatically "plugged" into the supply chains when they become available, replacing the global placeholder data.

Lack of documentation

Production processes in developed countries are often relatively well documented due to regulatory demands, safety concerns and internal auditing. Our finding has been that less documentation and measurement data of mass and energy flows exists for processes in India on average. This relative lack of existing documentation can be a handicap in inventory collection. To reduce the amount of basic research necessary for data collection, the existing ecoinvent datasets are used as templates for local datasets where appropriate. Given that there are relatively few industry experts in India experienced in LCI collection, a template dataset that indicates which flows are relevant for a process is often a useful communication tool and allows industry experts to better understand the requirements of LCI generation. The option of basing new, local datasets on a global parent for a given technology description (a feature introduced in the new ecospold 2 data format) facilitates this further. If the local process is similar to the global dataset, this can be a solid basis for the generation of an adequate localized process.

However, this approach is only useful if the technology is comparable to the one documented in the existing ecoinvent data. In other cases, only a detailed study of local conditions can adequately reflect the Indian scenario.

Low-tech or frugal process approaches

Even in a globalized economy, different countries often have different technological approaches to the same process. In these cases, existing data for developed countries cannot serve as a template for Indian conditions. Examples include the cottage-scale industries of India and the current waste treatment scenarios in emerging economies in general.

3 Experiences and Results

The challenges of gathering LCI data in India and the differences to experiences in developed countries are demonstrated on two examples: the cottage-scale production of reeled silk and the production of electricity in a coal power plant.

3.1 Coal Power Plant

Coal power plants are the main source of electricity in India, representing almost 70% of electricity generation. Comparing the inventory generated by the Indian LCI initiative with an established dataset reveals several issues that are exemplary of the larger difficulties in creating LCI data in developing and transition countries. As Table 1 shows, the coal used in India is of rather poor quality and has high ash content [2] when compared with, for example, Germany. This change of the main input alone has significant consequences on emission factors. In addition, the emission abatement technologies utilized in India are less efficient than in Germany, leading to much higher emissions of NOX, SOX and particulate matter. This example demonstrates that the inventories do not differ much qualitatively (i.e. in the types of flows involved) in many cases, but there may still be differences over orders of magnitude on the values.

Tab.1: Key findings on differences of coal power plant operation in India and Germany (data for Germany: ecoinvent v2.2).

	Germany	**India**
Calorific value of burned coal	27.7 MJ/kg	15.7 MJ/kg
Emission abatement	Desulphurisation, denitrification, and dedusting operations in most power plants	In most power plants dedusting only
CO2	92 g/MJ coal	96 g/MJ coal
NOx	0.06 g/MJ coal	0.6 g/MJ coal
SO2	0.07 g/MJ coal	0.9 g/MJ coal
PM2.5	0.005 g/MJ coal	0.2 g/MJ coal
Net efficiency of power plant	36 %	32 %

Another problematic factor in the electricity sector is grid losses. These add up to 25.7% in India [1] compared to 5.4% in Germany [1]. However, a significant part of grid losses in India represent non-technical and unaccounted losses, e.g. theft, the size of which cannot be determined with the available infrastructure. Therefore, estimations are the only option at the moment.

A further issue is the disposal of fly ash generated by the power plants. In India, most ash is disposed in so-called ash ponds, which routinely leak and are a known cause of environmental issues [5, 6]. An analysis of the emissions caused by leakage and by ash disposal in general is on-going.
A comparison of preliminary LCA results of Indian coal power with German coal power for several impact assessment methods revealed minor increases in Global Warming Potential and Cumulative Energy Demand, while EcoIndicator 99 scores were 5 times higher for Indian coal power, mostly due to higher particulate matter emissions affecting Human Health. This is an example of how the differences in local conditions can affect the environmental impacts of a process.

3.2 Silk reeling as an example of cottage-scale industries

Silk reeling in India is mostly carried out by a large number of very small enterprises which are subsidized by the government. The technology level is therefore unlike most industries in developed countries and no inventory data from other areas exist, as most current inventory databases cover large-scale production processes. Hand-operated reeling machines, small back-up kerosene generators and the relatively small wood-fired stoves utilized in this industry are examples of technologies that have not been studied from an LCA perspective in the past. An existing Mass Flow Analysis [5] of silk reeling in India was an excellent starting point for creating inventories on silk reeling. However, the lack of comparable technologies in existing inventory data demonstrated the problematic issues arising when a new inventory system cannot be integrated into an existing database. Several additional datasets on ovens, pumps and boilers had to be generated to supply upstream data for the silk reeling process. Since no experts for these processes were available in the project, most additional datasets had to be based on very basic estimation models.

4 Conclusions

Based on the experiences of the ecoinvent centre when creating the ecoinvent database, establishing a new inventory database is burdened with the problem that a critical mass of LCI data need to be collected before any of the data are applicable in full LCA studies. The approach of the Indian LCI initiative to integrate its data into the existing, global framework of ecoinvent shows how local data collection efforts can immediately improve the results of local LCA studies

while offering a flexible environment for Indian data to grow and improve. The interest in LCA in India is strong and is expected to grow further once local data become available. Due to the sharp increase in environmental issues in India, the need for improvement is clear. As funds for environmental protection are scarcer in developing countries, detailed LCA studies can guide the way for an optimal allocation of such funds to maximize benefits.

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6 References

[1] <http://www.ecoinvent.org>, (Accessed 15.4.2011).

[2] Mittal M. L. and Sharma C, Anthropogenic Emissions from Energy Activities in India: Generation and Source Characterization - Emissions from Thermal Power Generation in India. Ohio Supercomputer Center, Ohio, USA, 2003. <http://www.osc.edu/research/archive/pcrm/emissions/thermalemissions.shtml>, (Accessed 28.3.2011)

[3] Central Statistics Office of India, Statistical Year Book India, 2011. Ministry of Statistics and Programme Implementation, Government of India, New Delhi, India. <http://mospi.nic.in/Mospi_New/upload/statistical_year_book_2011.htm>, (Accessed 28.3.2011)

[4] Megha Shenoy, Rashmi Kumari, Lokanath S., Shilpa I. Pattanshetti, An industrial ecology approach to optimize resources in the silk reeling sector in Sidlaghatta, South India, Resource Optimization Initiative, Bangalore, India, 2010 <http://www.roi-online.org/uploads/ROI_2010_Silk%20Case%20Study%20Final.pdf>, (Accessed 15.4.2011)

[5] Sushil, S. and V.S. Batra, Analysis of fly ash heavy metal content and disposal in three thermal power plants in India, Fuel, Vol. 85, No.17-18, 2006, 2676-2679.

[6] Prasad, B. and K.K. Mondal, Heavy Metals Leaching in Indian Fly Ash, Journal of Environmental Science & Engineering, Vol. 50, No. 2, 2008, 127-132.