Status of North American Life Cycle Inventory Data

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Introduction

In North America, as elsewhere, consideration of life cycle environmental impacts in public policy and consumer communication is creating greater demand for life cycle assessment (LCA) inventory data. For example, the U.S. 2007 Energy Independence and Security Act requires a comparison of fuel life cycle greenhouse gas (GHG) emissions for government fuel purchasing contracts. Also, product category rules and environmental declarations (as in ISO 14025) use LCA for product comparison and market-driven improvement. Yet other examples come from nongovernmental organizations such as the U.S. Green Building Council and the Green Electronics Council (EPEAT), who are increasingly looking to use LCA data and methods to reward industry best practices. Given these policy and market developments, we informally review the North American life cycle inventory data over two decades of development.

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Data Development by Governments

North American governments began developing LCA data in the 1990s. Environment Canada funded three LCA data projects,[1] with the first in 1991 as an investigation of building materials. In the mid-1990s, the Canadian "Athena Project" made these data available as spreadsheets, and in 2002 the data were converted into what is now called the Athena Impact Estimator for Buildings. The tool is widely used in building LCAs, but only some of the data are currently available as documents and the full set is not extractable from the tool. In 1998 the first version of the GHGenius model was released in spreadsheet form, providing data representing the production and distribution of conventional and alternative fuels in Canada. GHGenius covers specific regions (east, central, or west) of Canada, the United States, and Mexico, and for India as a whole, and was most recently updated in October 2011. The third Environment Canada project collected data from materials production industry associations. These data became available in 2000 as the Canadian Raw Materials Database (CRMD). Although the CRMD was available from the University of Waterloo from 2001 to 2004, no LCAs citing the use of CRMD data were found and the Athena website makes reference only to the CRMD softwood lumber data.

In the United States, the Department of Energy (DOE) and more recently the U.S. Department of Agriculture (USDA) have led data development. At the DOE, the LCAD database was first conceived in 1993 and became a part of the Pacific Northwest National Laboratory/Battelle Life-Cycle Advantage™ software suite in 1997. Only two LCAs were identified using that tool (Blanchard and Reppe 1998; Doctor et al. 2001), which is no longer supported or available.

However, the DOE LCA activity did not wane, with two substantial, public-facing projects active today. In 1999 Argonne National Laboratory released the first version of the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model in spreadsheet form. GREET originally covered conventional and some alternative fuels, adding vehicle materials in 2007 and a wide range of alternative energy data as recently as 2011. In 2003 the National Renewable Energy Laboratory (NREL) created the U.S. Life Cycle Inventory Database[2] (NREL USLCI). Today the database includes 593 U.S. data sets in a variety of software-compatible formats representing some agricultural and wood products, aluminum, fuels and fuel conversion, iron and steel, logistics, organic and inorganic chemicals, painting of automotive parts, Portland cement, and plastics and resins. Data are formatted for use either in LCA software or in spreadsheets. Recent activities include the development of a database roadmap (U.S. Department of Energy 2009) and updated data submission requirements.

The USDA is a more recent presence in the government LCA space. In 2012 the LCA Digital Commons is scheduled to

DOI: 10.1111/j.1530-9290.2012.00506.x

Volume 16, Number 3

release 667 field crop data sets (for corn, cotton, oats, peanuts, rice, soybeans, and wheat) for select years and states. The data will provide a more complete representation of operations, and will provide more specific geographic and temporal information as compared with what are currently available. Whereas the initial data release will use the ecospold v1 format, subsequent releases will use parameterization to propagate raw data uncertainty (Cooper et al. 2012). The resulting data will therefore be compatible with LCA software that uses the International Reference Life Cycle Data System (ILCD) and both the ecospold v1 and v2 data formats.

Data Development by Academia

Starting in the 1990s, U.S. universities developing and disseminating data have taken a different approach. Instead of compiling process-level data, as in the government data described above, the two most prevalent U.S. LCA data dissemination projects use an economic input-output approach. Specifically, Carnegie Mellon first released their Economic Input-Output LCA (EIOLCA) in 1995, and faculty at the University of California first released the Comprehensive Environmental Data Archive (CEDA) in 2004.[3] Both EIOLCA and CEDA offer far broader coverage of U.S. industrial activities (with EIOLCA also covering Canada) at the expense of operating detail, inventory completeness, and temporal representativeness. Despite the reliance on economic data that are a decade old, use of these data continues today, sometimes with technology-specific data in what have been called "hybrid" LCAs.

In Canada, a data development effort announced in 2011 will instead follow the process-level data approach, with the Interuniversity Research Centre for the Life Cycle of Products, Processes and Services (CIRAIG) leading the way. Specifically, CIRAIG is partnering with the Swiss database Ecoinvent[4] to adapt Ecoinvent data to represent operations in Québec (Estrela 2011). Efforts will begin with data from energy, mines and metals, and pulp and paper[5] and should provide a model for regional adaptations of LCA data.

Data Development for Modeling Software

LCA software tools such as GaBi and SimaPro get some data from Ecoinvent. Ecoinvent includes some North American data, in fact, among those listed for release in Ecoinvent v3, 3% (122 data sets of the 4,089 named[4]) represent North American operations. Forty-eight of the Ecoinvent North American data sets represent electric power generation and the remainder represent mining, extraction, and refining; manufacturing other than basic chemicals; agricultural production; manufacturing of basic chemicals; construction; fuels from biomass; machining; and rail transport. As in all the efforts described above, no data specifically representing Mexican operations are included. However, an additional 9% (370 data sets) are for global operations, with about half representing the manufacturing of electronic components and boards, materials recovery, and the manufacture of basic chemicals.

For North American data beyond Ecoinvent, LCA software developers[6] have taken different approaches. For example, PE International's GaBi software also offers the NREL USLCI database, some industry association data, as well as hundreds of "thoroughly representative" North American data sets. These data sets cover select industrial and agricultural chemicals, plastics, and fibers from conventional and bio-based feedstocks; electricity, heat, and steam from a variety of conventional, bio-based, and waste-based feedstocks (including electricity generation in Mexico); and a broad choice of transport technologies. Alternatively, PRé Consultants' SimaPro includes the NREL USLCI database, some industry association data, as well as the CEDA economic input-output data (described above) and thousands of "indirectly representative" North American data sets in the Earthshift US-EI Database. The Earthshift database has two parts: one containing many of the NREL USLCI data sets in which most data gaps are filled using Ecoinvent data, and a second containing Ecoinvent processes (Ecoinvent v2 European data) indirectly adapted to represent U.S. rather than European electricity. Thus the difference in approach lies in the trade-off between the quantity and representativeness of North American data.

Closing Notes

It seems that a growing wealth of LCA inventory data representing Canadian and U.S. operations is available, albeit with less information for Mexico. We note that the CRMD and LCAD data were lost along the way, perhaps as a result of the time it took for LCA to find its way into use in public policy and product comparison. It may make sense to find, reevaluate, update, and format these lost data sets for use in current software, and to ensure that data being developed today are not lost or allowed to expire in the future.

We are also inspired by regional data efforts, such as in Québec, but also by more established efforts abroad, such as that of the German Network on Life Cycle Inventory Data,[7] which is developing a web portal for harmonized, high-quality data by engaging German research centers, universities, and industry associations. In North America, similar goals may emerge from a U.S. intergovernmental working group convened in 2011 to leverage ongoing efforts in data gathering by different agencies, to improve consistency in data usage, and to make the data more easily available for public use.

North Americans were also well represented along with participants from Europe, Asia, and Africa at a joint United Nations Environment Programme/Society for Environmental Toxicology and Chemistry (UNEP/SETAC) life cycle initiative workshop. The workshop resulted in the publication of the *Shonan Guiding Principles for LCA Data Bases*, which provide global guidance for the development and maintenance of data and databases.[8] However, as data for North America must ultimately capture our role in global resource use and waste generation, highlighting the need for improved data for all regions will lead us toward an ultimate goal of global representation.

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Notes

1. See http://www.athenasmi.org/our-software-data/lca-databases/available-reports/, http://www.ghgenius.ca and http://crmd.uwaterloo.ca/eng.html
2. See http://www.nrel.gov/lci/
3. See http://www.eiolca.net/ and http://www. cedainformation.net/
4. See http://www.ecoinvent.ch/ and http://www. ecoinvent.org/ecoinvent-v3/ecospold-v2/
5. See http://www.ciraig.org/CIRAIG_LCI_DB/
6. See e.g., http://www.gabi-software.com/, http://www.pre-sustainability.com/content/databases, and http://www.earthshift.com/software/simapro/USEI-database
7. See http://www.netzwerk-lebenszyklusdaten.de/cms/webdav/site/lca/shared/Materialien/21420%20Lebenszyklus%20 Daten%20FLYER%20RZ%20Internet.pdf
8. See http://www.estis.net/sites/lcinit/default.asp?site=lcinit&page_id=ABD68212-F8D8-48A6-83A0-9D82DE7ED61A

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