

# **U.S. LCI Database Project— Phase II – 2<sup>nd</sup> Quarterly Report and Development Plan Update: April 2003**

*Athena<sup>TM</sup> Sustainable Materials Institute  
Merrickville, Ontario, Canada*

*Franklin Associates, Ltd.  
Prairie Village, Kansas*

*Sylvatica  
North Berwick, Maine*



**NREL**

**National Renewable Energy Laboratory**

1617 Cole Boulevard  
Golden, Colorado 80401-3393

NREL is a U.S. Department of Energy Laboratory  
Operated by Midwest Research Institute • Battelle • Bechtel

Contract No. DE-AC36-99-GO10337

# **U.S. LCI Database Project— Phase II – 2<sup>nd</sup> Quarterly Report and Development Plan Update: April 2003**

*Athena<sup>TM</sup> Sustainable Materials Institute  
Merrickville, Ontario, Canada*

*Franklin Associates, Ltd.  
Prairie Village, Kansas*

*Sylvatica  
North Berwick, Maine*

NREL Technical Monitor: M. Deru

Prepared under Subcontract No. LDC-3-32452-01



**NREL**

**National Renewable Energy Laboratory**

1617 Cole Boulevard  
Golden, Colorado 80401-3393

NREL is a U.S. Department of Energy Laboratory  
Operated by Midwest Research Institute • Battelle • Bechtel

Contract No. DE-AC36-99-GO10337

## NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy  
and its contractors, in paper, from:

U.S. Department of Energy  
Office of Scientific and Technical Information  
P.O. Box 62  
Oak Ridge, TN 37831-0062  
phone: 865.576.8401  
fax: 865.576.5728  
email: [reports@adonis.osti.gov](mailto:reports@adonis.osti.gov)

Available for sale to the public, in paper, from:

U.S. Department of Commerce  
National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
phone: 800.553.6847  
fax: 703.605.6900  
email: [orders@ntis.fedworld.gov](mailto:orders@ntis.fedworld.gov)  
online ordering: <http://www.ntis.gov/ordering.htm>



# Table of Contents

<b>1</b>	<b>INTRODUCTION.....</b>	<b>1</b>
<b>2</b>	<b>SUMMARY OF PROGRESS TO MARCH 31, 2003 .....</b>	<b>1</b>
2.1	TASK 1: DEVELOPMENT PLAN, REPORTING, AND PROJECT MANAGEMENT.....	1
2.2	TASK 2: DATABASE FORMAT.....	1
2.3	TASK 3: ADDITIONS TO RESEARCH GUIDELINES/REPORT ON REVIEW OF GUIDELINES & DATABASE .....	1
2.4	TASK 4: DATA COLLECTION .....	1
2.5	TASK 5: USER’S GUIDE.....	3
<b>3</b>	<b>WORK PROGRAM ELEMENTS AND SCHEDULE .....</b>	<b>3</b>
3.1	TASK 2 .....	3
3.2	TASK 3 .....	5
3.2.1	<i>Input screening tool.....</i>	5
3.2.2	<i>Elementary flow reporting guidelines.....</i>	5
3.2.3	<i>Extensive guidelines testing and revision .....</i>	5
3.3	TASK 4 .....	5
3.3.1	<i>Fuels, Energy, and Transportation .....</i>	5
3.3.2	<i>Other Materials .....</i>	6
3.3.3	<i>Transformation Processes .....</i>	7
3.3.4	<i>End-of-Life.....</i>	7
3.4	DATABASE USER’S GUIDE.....	7

# 1 Introduction

As discussed in the 1<sup>st</sup> Quarterly Report and Development Plan Update: December 2002 for the U.S. LCI Database Project<sup>1</sup>, quarterly progress reports serve two functions. First, they provide an overview of the progress made during the quarter. Second, the quarterly reports provide an opportunity to update and adjust the project development plan to accurately reflect the planned focus for the subsequent quarter.

In the next section, we present a brief overview of progress since January 1, 2003. Updates to the work program and timeline are then discussed in Section 3.

## 2 Summary of Progress to March 31, 2003

### 2.1 Task 1: Development plan, reporting, and project management

1. The U.S. LCI Database Project Development Guidelines<sup>2</sup> have been completed and will be updated as necessary in this and future quarterly reports.

### 2.2 Task 2: Database format

1. Based on discussions with European database developers and feedback from life-cycle assessment (LCA) tool developers, the project team and NREL jointly agreed to use a streamlined version of the EcoSpold format. This format will serve the needs of those submitting to the database as well as the needs of the majority of North American database users. It was agreed that the ability to use the full detailed EcoSpold format should also be preserved to facilitate data exchanges with European databases, and for use by tool developers requiring that level of detail.
2. A draft streamlined EcoSpold format spreadsheet has been developed and is being tested as a template, using LCI data for coal production.
3. Work is underway to convert other completed databases to the agreed format.

### 2.3 Task 3: Additions to research guidelines/report on review of guidelines & database

1. The sections dealing with co-product allocation have been expanded and revised to clarify the treatment of waste and scrap materials and to expand on the subject of economic allocation. The final guidelines revisions will be completed and the guidelines reissued and posted to the web site when the emissions characterization factors have been prepared (item 2, below).
2. Emission characterization factors are being collected for use in the list of required emissions.

### 2.4 Task 4: Data collection

1. Specific fuels and energy database work was undertaken, as follows:

---

<sup>1</sup> U.S. LCI Database Project information available at: <http://www.nrel.gov/lci>

<sup>2</sup> Formerly U.S. LCI Database Project Research Protocol

- **Electricity Generation** — The cooperative work between the project team and SAIC, a contractor to the Environmental Protection Agency’s (EPA’s) National Risk Management Research Laboratory, was essentially completed. SAIC had been commissioned to produce a U.S. electricity database for the national average fuel grid for a base year of 1999. One of EPA’s objectives for this work was to produce data that could be used in the U.S. LCI Database. The database project team participated through conference calls, and through an exchange and review of data between Franklin Associates, Ltd., and SAIC. Several data sets provided by Franklin Associates were included in SAIC’s electricity model, including data sets for the mining and processing of three types of coal and all steps in the production of nuclear fuel. Franklin Associates utilized SAIC’s data documentation format for transparency.

SAIC’s work product, a draft electricity model consisting of multiple (about 60) linked unit-process worksheets includes data sets for the extraction, processing, and delivery of fuels such as natural gas, residual oil, coal, and nuclear fuel. The combustion of fossil fuels in utility boilers is also included. Due to budget and time constraints and the lack of readily available data, SAIC was not able to develop and include data on the operation and maintenance of utility plants (other than the combustion of the primary fuel), nor on environmental burdens associated with the generation of electricity via hydropower, wind, geothermal, biomass, and other non-fossil generating technologies.

The SAIC electricity model contains data sets for many of the unit processes in the fuels and energy database that Franklin Associates is currently developing. Franklin is also using e-GRID, or “Emissions and Generation Resource Integrated Database,” data for the year 2000 to develop electricity generation data for three regional grids in addition to the national grid. SAIC’s well-documented data sets on fuel production and transportation and fuel combustion in utility boilers will serve as a useful starting point for Franklin’s review and update of corresponding data sets for the fuels and energy database.

Data sources, methodology, and assumptions used by SAIC to develop each data set will be evaluated and supplemented with additional data sources identified by Franklin Associates. Work is also ongoing to improve the transparency of the calculation of pre-combustion energy and emissions burdens. Pre-combustion energy is the energy required to extract, process, and deliver fuels used for process energy, transportation energy, and electricity generation. Transparency is difficult to maintain because these calculations are circular and iterative in nature; for example, electricity is used in the production of coal, and coal is used to generate electricity.

- **Crude Oil** — Production and distribution data are now complete and entered in the EcoSpold format.
- **Coal** — Production and distribution data are now complete for three distinct types of coal (anthracite, bituminous, and lignite). Data for coal combustion in utility boilers has been developed and documented. Data for coal combustion in industrial boilers is 90% complete.
- **Uranium** — Production and processing data are now complete and entered in the EcoSpold format.

- **Natural Gas** — Production and distribution data are now complete.
- **Refinery Fuels** — Data for the production and distribution of refinery fuels (residual fuel oil, distillate fuel oil, gasoline, and liquefied petroleum gas) are 90% complete.
- **Transformation Processes** — Part of the data for aluminum casting technologies for complex parts like engine blocks has been received from the Vehicle Recycling Partnership (VRP) of the U.S. Car Project (Ford, General Motors, and Daimler Chrysler).

## 2.5 Task 5: User's guide

1. An outline of the User's Guide has been developed and discussed. The Guide will provide users of the database with important information about the data and use of the modules in LCA.

## 3 Work Program Elements and Schedule

Figure 1 details the work program by task elements. The thicker bars indicate periods of relatively more intensive work on specific task elements, while the thinner bars indicate periods of less intensive or uncertain activity. The chart shows the program on a more detailed monthly basis for the next quarter, and on a quarterly basis for the remainder of the project term. The remainder of this section provides a more detailed description of key elements for the main tasks listed in the figure.

### 3.1 Task 2

This task has taken longer than anticipated but is now essentially complete with the streamlined EcoSpold format being tested with actual data. Testing will be ongoing throughout the next quarter. A summary document explaining how EcoSpold differs from, and complies with, ISO 14048 is in preparation and will be included in the User's Guide (see Section 3.4).

	2002		2003						2004			
	Nov	Dec	1st Quarter	Apr	May	Jun	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
<b>Task 1 - Planning, reporting</b>												
Prioritize Fuels and Energy data modules	■											
Review/prioritize other data for material modules	■											
Develop/up-date work program		■	■			■	■	■	■	■	■	
Develop/up-date cash flow projections		■	■			■	■	■	■	■	■	
Final project report												■ X
<b>Task 2 - Database/web formats</b>												
Review of recent format developments		■										
Survey of tool developers		■										
Initial web format development (with NREL)		■	■	■								
Provision of test data to NREL				■								
Ongoing development/testing (with NREL)				■	■	■						
<b>Task 3 - Protocol revisions/annexes</b>												
Develop input screening tool		■			■	■						
Standardize substance nomenclature						■						
Develop elementary flow reporting guidelines	■			■	■	■						
Develop economic allocation annex	■	■	■	■	■	■						
Review and revise protocol as required				■	■	■	■	■	■	■	■	
<b>Task 4 — Data collection &amp; analysis</b>												
Fuels, Energy, Transport — High Priority	■	■	■	■	■	■	■	■				
Fuels, Energy, Transport — Lower Priority			■	■	■	■	■	■	■	■	■	■
Other materials				■	■	■	■	■	■	■	■	■
Transformation Processes	■	■	■	■	■	■	■	■	■	■	■	■
End of Life									■	■	■	■
<b>Task 5 — Database User's Guide</b>												
Preparation of initial version				■	■							
Revision and up-dating as necessary							■	■	■	■	■	
Legend:	■	More intensive work program										
	■	Less intensive or uncertain program										
	■	Outside funding -- does not affect NREL budget										
	Dimmed headings are completed tasks.											

Figure 1. Work Program Elements and Schedule.



## **3.2 Task 3**

Progress on this task has been slower than anticipated.

### **3.2.1 Input screening tool**

The input-screening tool to help analysts screen for missing inputs to a product class, to identify the relevance or potential environmental significance of small inputs to a unit process, and to test for the potential influence of missing flows, was to have been completed during this quarter. However, the Missing Inventory Estimation Tool (MEIT) developed by CML (Leiden University, Netherlands) has not yet been updated to cover 500 sectors of the U.S. economy. The current 100-sector version of the tool is considered too highly aggregated to meet the objective of testing for missing flows using Input/Output (I/O) techniques and U.S. I/O and environmental data.

As indicated in the previous version of the work program, our approach will be to directly use the CML tool as feasible, augmenting it with Sylvatica's OpenLC software where necessary and where the benefits are significant. The most cost-effective approach is to wait for CML to complete its work rather than duplicating the effort. The tool will then be used to determine the total upstream environmental burden (e.g., via TRACI, CML method, and Eco-Indicator 99 method) associated with each input to each of 500 sectors in the U.S. I/O model. That information, in turn, will be provided in a document that data providers can download from the Web site and use as a checklist. We now anticipate completing this task by the end of the second quarter, assuming there are no further delays in CML's release of the updated tool.

### **3.2.2 Elementary flow reporting guidelines**

The guidelines annex and the related standard substance nomenclature will be completed during the second quarter. Other related work described in the December 2002 quarterly report and development plan update (i.e., undertaking life-cycle characterization analysis for selected process types, ranking inventory flows by percentage contribution to each impact category, and determining the flows that must be included in each supply chain in order to account for at least 99% of the impact in each category) will be postponed indefinitely, primarily because of funding restrictions. This work, which is desirable but not essential, will be rescheduled when funding permits.

### **3.2.3 Extensive Guidelines testing and revision**

An extensive review and revision of the Guidelines is still planned for after the first round of data collection. This work will be completed by the end of 2003.

## **3.3 Task 4**

### **3.3.1 Fuels, Energy, and Transportation**

The highest priority was attached in Phase I to modules related to fuels and energy, including fuels extraction, processing, and transportation; fuel combustion effects; electricity generation; and transportation fuel use and emissions by mode. The more detailed prioritization of the specific fuels and energy modules shown on the next page was presented in the December 2002 quarterly report. Here, the modules that are either complete or very close to completion have been dimmed.

Work is ongoing on the remaining high priority fuel uses, with the schedule unchanged. However work on the remaining second priority fuels may have to be postponed until the next fiscal year because of funding constraints.

Investigations of various databases have led to a decision to use the GREET (**G**reenhouse gases, **R**egulated **E**missions, and **E**nergy use in **T**ransportation) database developed by Argonne National Laboratory under contract to the U.S. Department of Energy Office of Transportation Technologies as the foundation for the mobile energy use modules.

### 3.3.2 Other Materials

Work has been started and will continue on the adaptation of existing Athena Institute databases, with the priority on those that already have a U.S. component or that can be readily adapted in a manner consistent with the research guidelines. The immediate priority will be to extract a basic steel production data module that can be linked to selected energy production modules (e.g., coal

<b>Highest Priority</b>	<b>Second Priority</b>
<p><b>Primary Fuel Production</b></p> <ul style="list-style-type: none"> <li>Coal: Bituminous</li> <li>Coal: Anthracite</li> <li>Coal: Lignite</li> <li>Natural Gas</li> <li>Crude Oil</li> <li>Uranium</li> </ul> <p><b>Electricity Generation</b></p> <p><b>Primary Fuel Consumption</b></p> <ul style="list-style-type: none"> <li>Coal in utility boilers</li> <li>Coal in industrial boilers</li> <li>Residual oil in utility boilers</li> <li>Residual oil in industrial boilers</li> <li>Distillate fuel oil in utility boilers</li> <li>Distillate fuel oil in industrial boilers</li> <li>Natural gas in utility boilers</li> <li>Natural gas in industrial boilers</li> <li>Natural gas in industrial equipment</li> <li>Diesel powered industrial equipment</li> <li>Gasoline powered industrial equipment</li> <li>LPG in industrial boilers</li> <li>Wood in industrial boilers</li> <li>Uranium fuel use</li> </ul> <p><b>Mobile Sources</b></p> <ul style="list-style-type: none"> <li>Tractor-trailer (gasoline)</li> <li>Tractor-trailer (diesel)</li> <li>Single-unit truck (gasoline)</li> <li>Single-unit truck (diesel)</li> <li>Locomotive (diesel)</li> <li>Barge (diesel)</li> </ul>	<p><b>Primary Fuel Production</b></p> <ul style="list-style-type: none"> <li>Residual oil</li> <li>Distillate oil</li> <li>Gasoline</li> <li>LPG</li> <li>Jet fuel (kerosene)</li> <li>Other-Hydropower</li> <li>Other-Biomass</li> <li>Other-Wind</li> <li>Other-Ethanol</li> <li>Other-Geothermal</li> </ul>

Barge (residual fuel oil)  
Ocean freighter (diesel)  
Ocean freighter (residual)  
Airplane (kerosene)

production) for the purpose of developing and testing the data format and web site (see Section 3.2). As well, data on various wood building products developed through the CORRIM project have now been examined in detail, adjusted, and made ready for entry in the streamlined EcoSpold format.

In general, however, the Figure 1 schedule for other materials has been delayed as indicated. In the December 2002 quarterly report, we anticipated a period of more intensive activity during this first quarter with less intensive activity during the second and third quarters in order to maintain the focus on high priority energy and transportation modules. The reality is that we have had to slow the entire 'Other Materials' program, with an expectation of more intensive activity starting in the third quarter and continuing in the fourth quarter.

### **3.3.3 Transformation Processes**

As indicated in Section 2.4, some of the aluminum casting data is now in hand and has been reviewed. Aggregation and conversion to the EcoSpold format is awaiting receipt of the remaining data from the VRP. The more intensive study team work on this task has therefore been shifted in Figure 1 to the end of the second quarter. Future VRP work will focus on other transformations of interest to the automobile industry, with painting and other casting processes as possibilities. Figure 1 shows a shift in the more intensive transformation process work toward the end of the second quarter, with less intensive or uncertain activity after.

We should also note that, while the intention is to provide data modules for the database project, there still has to be ultimate approval from senior auto industry management before data will be released for public use.

### **3.3.4 End-of-Life**

The development of end-of-life process modules related to recycling or ultimate disposal of products or materials remains as an uncertain activity for 2004 for the reasons noted in the December work program.

## **3.4 Database User's Guide**

This task has been delayed, but an outline has been developed and discussed as noted in Section 2.5. Completion of a full draft is now scheduled for the end of May. The guide will then be reviewed, revised, and updated as a routine ongoing activity throughout the rest of the project period.

REPORT DOCUMENTATION PAGE			Form Approved OMB NO. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE August 2003	3. REPORT TYPE AND DATES COVERED Subcontractor report		
4. TITLE AND SUBTITLE U.S. LCI Database Project—Phase II - 2 <sup>nd</sup> Quarterly Report and Development Plan Update: April 2003			5. FUNDING NUMBERS  LDC-3-32452-01 WF9V.5501	
6. AUTHOR(S) Athena Institute, Franklin Associates, Ltd., and Sylvatica				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  Athena Sustainable Materials Institute Merrickville, Ontario, Canada			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393			10. SPONSORING/MONITORING AGENCY REPORT NUMBER  NREL/SR-550-34292	
11. SUPPLEMENTARY NOTES  NREL Technical Monitor: Michael Deru, Ph.D.				
12a. DISTRIBUTION/AVAILABILITY STATEMENT National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This report gives a brief overview of the progress of the project since January 1, 2003. The ultimate goal of the project is to develop publicly available LCI Data modules for commonly used materials, products, and processes.				
14. SUBJECT TERMS LCI; LCI Database Project; Review panel; Athena Institute; life-cycle inventory			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT  UL	