

# **U.S. LCI Database Project**

## **Quarterly Progress Reports, 2003**

*Athena™ Sustainable Materials Institute  
Merrickville, Ontario, Canada*



**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

Contract No. DE-AC36-99-GO10337

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*Athena™ Sustainable Materials Institute  
Merrickville, Ontario, Canada*

NREL Technical Monitor: M. Deru

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



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## Acronym List

APC - American Plastics Council
CML - Leiden University, Netherlands
CMU - Carnegie Mellon University
CORRIM - Consortium for Research on Renewable Industrial Materials
e-GRID - Emissions and Generation Resource Integrated Database
GREET - Greenhouse gases, Regulated Emissions, and Energy Use in Transportation
LCA - Life-cycle Assessment
LCI - Life-cycle Inventory
LPG - Liquefied Petroleum Gas (Propane)
MEIT - Missing Inventory Estimation Tool
OSB - Oriented Strand Board
SAIC - Science Applications International Corporation
SETAC - Society of Environmental Toxicology and Chemistry
TRACI - Tool for the Reduction and Assessment of Chemical and other Environmental Impacts
VRP - Vehicle Recycling Partnership

**U.S. LCI Database Project**  
**Quarterly Report**

**January - March 2003**

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# 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***

The U.S. LCI Database Data 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 the Data Development 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.

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<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



## 2.4 Task 4: Data collection

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

- **Electricity Generation** — The cooperative work between the project team and SAIC (Science Applications International Corporation), 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**

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**

Table 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 Table.

## **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).

**Table 1. Work Program by Task Elements**

	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.											

## **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 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 Consortium for Research on Renewable Industrial Materials (CORRIM) project have now been examined in detail, adjusted, and made ready for entry in the streamlined EcoSpold format.

**Table 2. Data Module Priorities**

<b>Highest Priority</b>	<b>Second Priority</b>
<b>Primary Fuel Production</b>	<b>Primary Fuel Production</b>
Coal: Bituminous	Residual oil
Coal: Anthracite	Distillate oil
Coal: Lignite	Gasoline
Natural Gas	LPG
Crude Oil	Jet fuel (kerosene)
Uranium	Other-Hydropower
<b>Electricity Generation</b>	Other-Biomass
<b>Primary Fuel Consumption</b>	Other-Wind
Coal in utility boilers	Other-Ethanol
Coal in industrial boilers	Other-Geothermal
Residual oil in utility boilers	
Residual oil in industrial boilers	
Distillate fuel oil in utility boilers	
Distillate fuel oil in industrial boilers	
Natural gas in utility boilers	
Natural gas in industrial boilers	
Natural gas in industrial equipment	
Diesel powered industrial equipment	
Gasoline powered industrial equipment	
LPG in industrial boilers	

Wood in industrial boilers  
Uranium fuel use

### **Mobile Sources**

Tractor-trailer (gasoline)  
Tractor-trailer (diesel)  
Single-unit truck (gasoline)  
Single-unit truck (diesel)  
Locomotive (diesel)  
Barge (diesel)  
Barge (residual fuel oil)  
Ocean freighter (diesel)  
Ocean freighter (residual)  
Airplane (kerosene)

In general, however, the Table 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 Table 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. Table 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.

**U.S. LCI Database Project  
Quarterly Report**

**(April – June 2003)**

**and**

**(July – September 2003)**

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# Quarterly Reports

## April – June 2003 and July – September 2003

### 1 Introduction

As discussed in the December 2002 Quarterly Report and Development Plan, 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.

This report covers two quarters, and in the next section we present a brief overview of progress since April 1, 2003. Updates to the work program and timeline are then discussed in Section 3.

### 2 Summary of Progress to September 30, 2003

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

The development plan will be updated as necessary in this and future quarterly reports.

#### ***2.2 Task 2: Database format***

1. The streamlined EcoSpold format spreadsheet has been finalized based on several months of discussions with NREL and external experts.
2. A test module, using LCI data for bituminous coal production, has been developed and is being used to test functionality.
3. Work is underway to convert other completed databases to the agreed format.

#### ***2.3 Task 3: Additions to Data Development Guidelines***

1. The Data Development Guidelines section dealing with co-product allocation has been revised, and an economic allocation annex has been prepared. The final guideline revisions will be completed and the guidelines reissued and posted to the website when items listed in 2 and 3 below are completed.
2. The most recent National Toxic Inventory, Toxic Release Inventory and criteria air pollutants have been collected, and the data is currently being analyzed to develop a list of required emissions.
3. A comprehensive nomenclature system is being developed based on a review of the nomenclature lists of existing tools, the SETAC working group document and EcoSpold.
4. A testing strategy has been developed to investigate the feasibility and pitfalls of attempting to use IO-LCA as a method for estimating required emission flows and for

estimating flows that are missing for specific processes. This exploratory investigation will compare data sets with different levels of aggregation (Portland cement, aluminum casting and bituminous coal) using either the Missing Inventory Estimation Tool or the Carnegie Mellon University (CMU) tool. The results will be posted on the website as a working paper to show findings related to the treatment of missing flows and the development of minimum sets of required emissions.

## **2.4 Task 4: Data collection**

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

- **Coordination with SAIC Consulting**

The SAIC electricity model contains data sets for many of the unit processes in the fuels and energy database that are currently being developed for the U.S. LCI database. SAIC's data are transparent and well-documented on a module-by-module basis. However, it is very difficult to trace all links among the modules in order to evaluate the accuracy of the final outputs.

As a method for validating its own data on primary fuels production, Franklin Associates compared its data with SAIC's data. In cases where similar data sources are used, the data are in agreement. In cases where different data sources are used, there are discrepancies between the Franklin and SAIC data. For instance, differences were identified in data sources used to develop crude oil and natural gas data sets. The project team is discussing a decision process to use when there are multiple data sources presenting different values for the same environmental data.

A fuels and energy issue that is problematic in terms of transparency for the U.S. LCI database is the calculation of precombustion energy and emissions burdens. SAIC's electricity model uses a complex series of links between spreadsheets to incorporate precombustion calculations; however, these linked calculations are extremely difficult to trace and verify. Therefore the SAIC precombustion model will not be adopted; rather the Franklin Associates model, which involves conducting precombustion calculations in a separate set of spreadsheets, will be used.

- **Primary Fuel Production.** Eleven unit processes are complete, including crude oil, natural gas, anthracite coal, bituminous coal, lignite coal, uranium, residual fuel oil, distillate fuel oil, gasoline, liquefied petroleum gas and jet fuel. (See Table in Section 3.3.1.)
- **Primary Fuel Combustion.** The data for the combustion of primary fuels in utility and industrial boilers is nearing completion. Data is still being collected for wood combustion and coal-fired industrial boilers.
- **Mobile Sources.** The GREET transportation model was reviewed and it was concluded that it is transparent and uses reliable sources. Data development is

nearing completion for combination and single-unit trucks, locomotives, barges, ocean freighters and airplanes.

- **Precombustion.** A description of Franklin Associates' precombustion methodology (including a flow diagram showing the relationships among unit processes) was developed to improve the transparency of precombustion data.

### **2.5 Task 5: User's guide**

Work is still proceeding on a draft User's Guide. 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**

Table 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 Table.

### **3.1 Task 2**

This task took longer than anticipated but is now complete and being tested with actual data. Testing will be ongoing throughout the next quarter.

### **3.2 Task 3**

Progress on this task to date has been slower than anticipated, but all of the components of Task 3 are scheduled for completion in the fourth quarter of 2003.

#### **3.2.1 Input screening tool**

This task has not been high priority because there have not been outside data providers to date. As discussed in Section 2.3, an exploratory investigation will be undertaken and finished by the end of 2003. Because MIET is now a commercial tool, the focus is more closely on the CMU tool.

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

This task has taken longer than anticipated. Work is currently ongoing to finish the research data development guidelines annex and the related standard substance nomenclature. The nomenclature portion will be completed by the end of October 2003, while the rest of this task will be finalized by the end of 2003.

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

A review and revision of data development guidelines has been undertaken during the first round of data collection rather than upon its completion [an example is the revision of Section 14]. No further revisions are planned before the end of 2003.

**Table 1: Work Program Elements and Schedule**

	2002		2003						2004			
	Nov	Dec	1st Quarter	2nd Quarter	3rd Quarter	Oct	Nov	Dec	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/update work program		■	■		■			■	■	■	■	
Develop/update 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 -- Low Priority					■	■	■	■	■	■	■	■
Other materials						■	■	■	■	■	■	■
Transformation Processes	■	■	■	■	■	■	■	■	■	■	■	■
End of Life									■	■	■	■
<b>Task 5 - Database User's Guide</b>												
Preparation of initial version				■	■	■	■	■				
Revision and updating as necessary									■	■	■	
Legend:	■ More intensive work program ■ Less intensive work program ■ Outside funding -- does not affect NREL budget Dimmed headings are completed tasks.											

### 3.3 Task 4

#### 3.3.1 Fuels, Energy and Transportation

Data for fuel combustion in mobile sources will be finished in the fourth quarter of 2003. Once the transportation data is complete, electricity and precombustion data will be finalized. The more detailed prioritization of the specific fuels and energy modules shown below was presented in the December 2002 work program. Completed modules or those very close to completion have been dimmed. These completed modules will be put into the finalized EcoSpold format and provided to NREL for inclusion on the website over the next quarter. Work on the remaining second priority fuels was postponed until 2004 because of funding constraints.

<b>HIGHEST PRIORITY</b>	<b>SECOND PRIORITY</b>
<b>Primary Fuel Production</b>	<b>Primary Fuel Production</b>
Coal: Bituminous	Residual oil
Coal: Anthracite	Distillate oil
Coal: Lignite	Gasoline
Natural Gas	LPG
Crude Oil	Jet fuel (kerosene)
Uranium	Other-Hydropower
<b>Electricity Generation</b>	Other-Biomass
<b>Primary Fuel Consumption</b>	Other-Wind
Coal in utility boilers	Other-Ethanol
Coal in industrial boilers	Other-Geothermal
Residual oil in utility boilers	
Residual oil in industrial boilers	
Distillate fuel oil in utility boilers	
Distillate fuel oil in industrial boilers	
Natural gas in utility boilers	
Natural gas in industrial boilers	
Natural gas in industrial equipment	
Diesel powered industrial equipment	
Gasoline powered industrial equipment	
LPG in industrial boilers	
Wood in industrial boilers	
Uranium fuel use	
<b>Mobile Sources</b>	
Tractor-trailer (gasoline)	
Tractor-trailer (diesel)	
Single-unit truck (gasoline)	
Single-unit truck (diesel)	
Locomotive (diesel)	
Barge (diesel)	
Barge (residual fuel oil)	
Ocean freighter (diesel)	
Ocean freighter (residual)	
Airplane (kerosene)	

### **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 data development guidelines. Now that the streamlined EcoSpold format is finalized, data on various wood building products developed through the CORRIM project will be entered, starting with plywood and lumber in the next quarter and continuing with OSB and Laminated Veneer Lumber in the first quarter of 2004.

### **3.3.3 Transformation Processes**

A few final issues with the aluminum casting data sets are being resolved and then they will be finalized and submitted for inclusion in the database. VRP is in the process of collecting steel stamping and iron casting data, so the next focus will be on those data sets as they are provided. Table 1 shows more intensive transformation process work in the next two quarters, with less intensive or uncertain activity thereafter.

### **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 Task 5**

Completion of a final draft of the User's Guide is scheduled for the end of October 2003. The guide will then be reviewed, revised and updated as a routine ongoing activity throughout the rest of the project period.

**U.S. LCI Database Project**  
**Quarterly Report**  
**(October – December 2003)**

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# **U.S. LCI Database Project:**

## **Quarterly Report and Development Plan Update**

### **1 Introduction**

As discussed in the December 2002 Quarterly Report and Development Plan, 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.

This report covers the last quarter of 2003, and in the next section we present a brief overview of progress from October 1, 2003 through December 31, 2003. Updates to the work program and timeline are then discussed in Section 3.

### **2 Summary of Progress to December 31, 2003**

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

The development plan will be updated as necessary in this and future quarterly reports.

#### ***2.2 Task 2: Database format***

- The streamlined EcoSpold format spreadsheet has been modified over the quarter in conjunction with NREL and external experts to resolve design issues and further enhance the spreadsheet.
- The bituminous coal module was submitted to NREL for input into the database and is being used to test the functionality of the website.

#### ***2.3 Task 3: Additions to Data Development Guidelines***

- A partial list of required emissions has been developed and is in use.
- A comprehensive nomenclature system is being developed based on a review of the nomenclature lists of existing tools, the SETAC working group document and EcoSpold.

#### ***2.4 Task 4: Data collection***

1. The following modules were submitted to NREL, including a streamlined spreadsheet, working papers and data details (mini-report) for each:

##### **Primary Fuel Production**

- Coal (Anthracite) Production
- Coal (Bituminous) Production
- Coal (Lignite) Production
- Crude Oil Extraction

Natural Gas Extraction  
Natural Gas Processing  
Petroleum Refining-Distillate Oil  
Petroleum Refining-Gasoline  
Petroleum Refining-Kerosene  
Petroleum Refining-LPG  
Petroleum Refining-Residual Oil  
Uranium Fuel Production

**Coal Combustion**

Anthracite combustion in utility boilers  
Bituminous combustion in utility boilers  
Lignite combustion in utility boilers  
Anthracite combustion in industrial boilers  
Bituminous combustion in industrial boilers  
Lignite combustion in industrial boilers

**Non-Coal Fuel Combustion**

Distillate oil combustion in industrial boilers  
Distillate oil combustion in utility boilers  
Residual oil combustion in industrial boilers  
Residual oil combustion in utility boilers  
Natural gas combustion in utility boilers  
Natural gas combustion in industrial boilers  
Natural gas combustion in industrial equipment  
LPG combustion in industrial boilers  
Uranium consumption by nuclear utilities  
Diesel combustion in industrial equipment  
Gasoline combustion in industrial equipment

**Transportation**

Diesel barge transport  
Residual oil barge transport  
Diesel combination truck transport  
Gasoline combination truck transport  
Diesel single-unit truck transport  
Gasoline single-unit truck transport  
Diesel locomotive transport  
Widebody air cargo transport

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

- **Transportation Emissions.** Emissions data for the combustion of fuels in the following mobile sources were developed from the GREET transportation model: tractor-trailer (diesel), single-unit truck (diesel), locomotive (diesel), barge (diesel and residual fuel oil), and ocean freighter (diesel and residual fuel oil). Emissions data for gasoline combustion in tractor-trailer and single-unit trucks are not available in the GREET transportation model because they represent a small portion of the transportation

industry; data for these transportation modes were estimated from data for similar processes.

- **Transportation Fuel Requirement Factors.** Fuel requirement factors for all modes of transportation except ocean freighter have been completed.
- **Industrial Boiler Emissions.** Data for the combustion of coal and wood in industrial boilers have been completed and were reviewed internally.
- **Pre-combustion.** Pre-combustion calculations are ongoing. Once the electricity generation module has been completed, the pre-combustion calculations will be completed.
- **Electricity Generation.** The most recent version of the E-GRID database was sorted to determine the fuel profiles for electricity generation for utilities and non-utilities in different regions of North America. The sorted database was reviewed and discrepancies within the database are being resolved.
- **Alternative Fuels.** Research began on alternative energy technologies (hydropower, biomass, wind, ethanol, and geothermal energy).

## **2.5 Task 5: User's guide**

A draft of the User's Guide was completed during the quarter and underwent further editing and modification. Once completed, it will be posted on the website to provide data providers and users of the database with important information about the data, the data format and use of modules in LCA.

## **3 Work Program Elements and Schedule**

Table 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: Database format**

Testing of the format will be ongoing throughout the next quarter.

### **3.2 Task 3: Additions to data development guidelines**

As discussed in the last quarterly report, progress on this task to date has been slower than anticipated. However, a revised version is scheduled to be posted to the web site early in the first quarter of 2004. Further revisions will be posted later in the year as data development work proceeds and comments are received from users.

#### **3.2.1 Input screening tool**

This task has not been high priority. The exploratory investigation about using IO-LCA as a method for estimating required emission flows and for estimating flows that are missing for

specific processes has been on hold with the expectation that work will start during the first quarter of 2004.

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

This task has taken longer than anticipated. Work currently ongoing to finish the standard substance nomenclature system is scheduled to be completed by the end of March 2004.

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

As stated above, the data development guidelines will be reissued in the first quarter of 2004 and thereafter as required.

## **3.3 Task 4: Data collection**

Table 2 shows the delivery dates and progress for upcoming modules. This section provides a more detailed description of the data collection work program in upcoming quarters.

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

Electricity and precombustion data are currently being researched, and are expected to be completed in the first quarter of 2004. All other high priority and second priority nonrenewable data modules have been completed as noted in Section 2. Work on second priority renewable energy has been deferred as shown in the chart.

### **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 data development guidelines. To ensure transparency, data from the CORRIM project cannot be posted for use in the Database Project until March 2004, when the detailed CORRIM reports will be made available on the CORRIM web site. At that time, data on various wood building products developed through the CORRIM project will be entered, starting with plywood and lumber and continuing with OSB and Laminated Veneer Lumber. Work will also start in the upcoming quarter on adapting steel data for use in the Database Project.

Work on commodity materials will begin in February 2004 and continue at a more intensive level into the second quarter of 2004. These modules include limestone mining, soda ash mining, salt mining, chlorine/caustic soda production and aluminum production.

Recently, an American Plastics Council (APC) project has gotten underway with the intention of providing data on basic polymer production to the Database Project. The initial project kickoff meeting was held in Kansas City on October 22, 2003. The meeting involved APC staff and broad representation of the industry. APC is recruiting companies to commit to participate in the project by providing primary data. Franklin Associates staff has requested input from the attending company representatives regarding the LCI data collection forms and the flow diagrams for the various resins to be studied (14). The flow diagrams and data collection forms will be finalized in January 2004, and data gathering is scheduled to begin in the first quarter of 2004.

### **3.3.3 Transformation Processes**

The following aluminum casting unit process modules have been put in EcoSpold format and submitted to the Vehicle Recycling Partnership (VRP) for final review: semi-permanent molding, precision sand casting and lost foam. Pending approval by VRP, the modules will be submitted in the first quarter of 2004. VRP is currently in the process of collecting data on steel stamping and iron casting, but has not yet submitted any data on these processes to the Athena team.

### **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 2002 work program.

## **3.4 Task 5: User's guide**

The User's Guide will be posted to the web site during the first quarter, and will be reviewed and revised as a routine ongoing activity throughout the rest of the project period.

**Table 1: Work Program Elements and Schedule**

	2002		2003				2004					
	Nov	Dec	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Jan	Feb	Mar	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/update work program		■	■		■	■			■	■	■	
Develop/update 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		■	■	■	■	■						
Revise data development guidelines as required			■	■	■	■	■	■	■	■	■	■
<b>Task 4 - Data collection &amp; analysis</b>												
Fuels, Energy, Transport -- High Priority	■	■	■	■	■	■	■	■	■	■	■	■
Fuels, Energy, Transport -- Low Priority					■	■	■	■	■	■	■	■
Other materials						■	■	■	■	■	■	■
Transformation Processes												
End of Life												
<b>Task 5 - Database User's Guide</b>												
Preparation of initial version				■	■	■	■	■	■	■	■	■
Revision and updating as necessary								■		■	■	
Legend: ■ More intensive work program												
■ Less intensive work program												
■ Outside funding -- does not affect NREL budget												
Dimmed headings are completed tasks.												

**Table 2: Progress and Delivery Schedule for Unit Processes**

<b>Dataset</b>	<b>Progress</b>	<b>Expected Delivery Date</b>
<b>PRIMARY FUEL COMBUSTION</b>		
Wood in industrial boilers	Ready to submit	1/31/2004
<b>MOBILE SOURCES</b>		
Ocean freighter (diesel)	Currently being researched	2/29/2004
Ocean freighter (residual)	Currently being researched	2/29/2004
<b>ELECTRICITY GENERATION</b>		
Research nearing completion		1/31/2004
<b>FUEL PRECOMBUSTION</b>		
Awaiting completion of electricity generation data		2/15/2004
<b>ALTERNATIVE FUELS</b>		
Hydropower	Research beginning	3/31/2004
Biomass	Initial research completed	2/29/2004
Wind	Start date postponed	9/30/2004 (Tentative)
Solar	Start date postponed	9/30/2004 (Tentative)
Geothermal	Start date postponed	9/30/2004 (Tentative)
<b>MATERIALS USED IN THE MANUFACTURE OF AUTOMOBILES/OTHER DURABLES</b>		
Steel	Currently being researched	3/31/2004
Aluminum Production	Research beginning	3/31/2004
Plastic Resins - Basic Polymers	Work at preliminary stages	
<b>BUILDING AND CONSTRUCTION PRODUCTS</b>		
Structural Wood	Awaiting CORRIM reports	4/30/2004
Structural Steel	Currently being researched	3/31/2004
<b>COMMODITY CHEMICALS/MATERIALS</b>		
Limestone Mining	Research beginning	3/31/2004
Soda Ash Mining	Research beginning	3/31/2004
Salt Mining	Research beginning	3/31/2004
Chlorine/Caustic Soda Production	Research beginning	2/29/2004
<b>TRANSFORMATION PROCESSES</b>		
Lost Foam Aluminum Casting	Undergoing final review at VRP	2/29/2004
Precision Sand Aluminum Casting	Undergoing final review at VRP	2/29/2004
Semipermanent Mold Aluminum Casting	Undergoing final review at VRP	2/29/2004
Iron Casting	VRP currently collecting data	
Steel Stamping	VRP currently collecting data	
<i>Note: Shading indicates 3rd party data production effort</i>		

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