

iNEMI Statement of Work (SOW) Environmentally Conscious Electronics TIG iNEMI PVC Alternatives Project

Version 3.0

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Basic Project Information

Scope of Work

The goals of this project are three fold. In Phase 1, we will conduct a cradle-to-grave life cycle assessment (LCA) on PVC and PVC-free alternatives, with emphasis on power cord applications. Phase 2 will consist of establishing an understanding of electrical, mechanical, and safety aspects of PVC-free alternatives and developing, managing, and executing performance testing of different PVC-free alternatives. The results from this project may form a basis for additional material assessment studies.

Toward the first objective, an LCA analysis, we expect that some effort will go toward developing an understanding of how to run LCA studies. Because the majority of PVC in computer systems is based in power cords, we will focus on the use of PVC-free alternative in power cords. Connectors will be included in this evaluation. The team will identify the type of plugs to be considered. We will obtain information from recyclers to model end-of-life scenarios for US detachable power cord sets. The team will identify “hot spots” within the life cycle that can be influenced to minimize environmental impacts.

To achieve the additional goals of the project, understanding the properties of PVC-free alternatives and performing testing, we will need to determine which PVC and PVC-free formulations are to be evaluated. We will evaluate standard PVC with phthalates, PVC/phthalate-free, and PVC-free/phthalate free systems. Information on the UL designation, temperature ratings, and other pertinent parameters of power cords will be compiled, with a preference for resins having UL approval.

Purpose of Project

- Explain how the project aligns to the roadmap and what gaps will be filled.
 - Project is already listed on the 2009 iNEMI Environmentally Conscious Electronics Roadmap.
 - Given the emphasis on power cords, this project will be most applicable to the Consumer/Portable industry sector; however the results may also be relevant to other industry sectors.
- Will the project provide a complete solution or be part of a complex solution.
 - Provide a complete solution for selected power cord applications.
- List anticipated benefits to participants, to the iNEMI membership in general, and the industry.
 - Participants will gain valuable information on PVC alternatives, both from a technical, supply chain and EHS perspective. The participants, iNEMI membership and industry can use this information to make more informed decisions with respect to material substitution, as well as address growing NGO and governmental pressures to phase-out certain environmentally-sensitive substances.

What the Project Is / Is Not

This Project IS:	This Project IS NOT:
Phase 1	
Environmental life cycle assessment (LCA) comparing PVC compounds with PVC-free compounds for power cord applications (cable and connectors)	Economic, social, toxicological assessment
Comparison of equivalent functional units that meet UL requirements	A evaluation of new unproven material systems
Cradle-to-grave LCA, including end of life aspects (recycling, incineration, landfill, etc)	Cradle-to-gate LCA only
Focused on US power cords for PC applications (detachable power supply cords)	Other cables or cords (for initial assessment)
Multi-stakeholder	Electronics industry only

This Project IS:	This Project IS NOT:
Phase 2	
Gain a better understanding of the electrical, mechanical, and safety aspects of “PVC-free” alternatives. (Phase 2)	Development of standards
Develop, manage, and execute performance testing of different “PVC-free” alternatives. (Phase 2)	

Previous Related Work

- Review any related research or development done within the industry
 - In Phase 1, the project team will review prior work and document findings in the final report. Given the recent development of a number of different “PVC-free” resins for cable applications (PE, PPO, TPU, TPE, Nylon, Neoprene, etc), it is unlikely that all have been evaluated from

- cradle-to-grave using a consistent life cycle analysis nor have a complete technical assessment for use in power cords.
- Need to document the existing work.
- Have there been comprehensive LCA studies on some of the PVC alternatives comparing them to the exiting PVC material systems.
- The team agreed it would be valuable to use multiple LCA tools in the evaluations/assessments.
- Summarize, briefly, directly related academic research, if any.
 - There are a number of governmental and academic reports on environmental, health and safety aspects of PVC resins used in a variety of end product applications (electronics, building materials, etc.); however, information on “PVC-free” resins used in electronics is limited.

Participants

- List prospective participants and their companies. Strive to include representatives of all facets of the industry, including customers, suppliers, and manufacturers.
 - OEMs
 - ODMs
 - EMS
 - Cable Manufacturers
 - Resin Manufacturers
 - Raw Material Manufacturers – fillers, flame retardants, etc.
 - Safety Standards Organizations – UL, CSA, etc.
 - Universities
 - LCA consultants – PE International, EarthShift, etc.
 - Governments – US EPA
- State role and expected contributions of each project team member.
 - Each project member will contribute to the project per their areas of expertise and interest. It is expected that the cable manufacturers and resin manufacturers will be most active, as well as LCA consultants. OEMs, ODMs and EMS providers will provide guidance on boundaries of the LCAs, as well as input on the technical evaluation test matrix.
- List any known background IP for each participant.
 - As life cycle assessments typically require complete information on the product material composition and manufacturing processes, it is expected that IP will be of most concern to the cable manufacturers and resin manufacturers in the project. The project team will need to establish a mechanism to protect IP for this project to be successful.
 - Neutral 3rd parties have been used in iNEMI projects to be a clearing house for sensitive / confidential information (NIST, Georgia Tech, ...).
 - Team discussed and generally agreed that LCA consultants running the assessments could provide the confidentiality required by the chemical manufactures and formulators only providing the results of the LCA to the rest of the team. This would be similar to how the EPA study was run.

Project Plan

Schedule with Milestones – Phase 1

Definitions, Methodology, and Analysis	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Research Project Information – Define and collect data												
1.1. Power Cord sets – US desktop power cord												
1.2. Define environmental specifications – RoHS compliant, RoHS revision compliant, BFR/PVC-free												
1.3. Understand candidate Resins and Additives												
1.4. Document use phase assumptions (fires, etc?)												
1.5. Document end of life assumptions												
1.6. Execute NDAs between resin and cable manufacturers and LCA consultant(s)												
1.7. Exchange BOM and process data between manufacturers and LCA consultant(s)												
1.8. LCA consultant(s) to provide formal quotes, project team to review												
1.9. Project team to decide on which resin and cable combinations will be modeled using LCA.												
2. Modeling												
2.1. Define Methodology												
2.2. Model LCI data in each tool												
2.3. Model alternatives in each tool												
3. LCA Analysis												
3.1. Analyze alternatives, do sensitivity analyses in each tool												
3.2. Review analyses with the team												
3.3. Revise as needed												
4. Create Training Materials for Participants												
5. Reporting												
5.1. Create internal report												
5.2. Determine and document key findings about PVC vs. alternatives												
5.3. Determine and document key findings about datasets												
5.4. Create presentation from report												
5.5. Present results to team members												
5.6. Create summary report for iNEMI members												
5.7. Create report for general public, if desired												
6. Develop Project Plan for Phase 2 – Materials Testing												

Resources Required from Participants:

The PVC Alternative Project requires each participating company to commit to the following:

- 1) Agree to commit appropriate resources to meet the project timeline and targeted end dates.
- 2) In the event project expenses are incurred, the costs will be shared evenly among participants.
- 3) Agree that this consortium will provide technical support within its membership in sharing knowledge regarding LCA methodologies and eco-environmental information.
- 4) Design and carry out tests and evaluations as agreed to, with other members of the project, to fulfill the Statement of Work.
- 5) Collaborate on input to final report. Document results and publish findings to iNEMI members.
- 6) Collaborate on defining the elements and project plan for Phase 2 – Materials Testing.

Phase 1 – Cradle-to-Grave Life Cycle Assessment (LCA) of PVC and PVC-Free Alternatives for Power Cord Applications

Task 1 – Research Project Information - Define and Gather Data, Including Completion of LCA Goal & Scope (see Annex A)

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Task 1 is not expected to need any additional funding.
- Materials and Processes
 - Identify LCA consultant(s) to carry out the LCI and material modeling.
 - Identify LCA consultant(s) to perform the defined cradle to grave LCA studies.
 - Execute NDAs between resin and cable manufacturers and the LCA consultant(s) to facilitate exchange of bill of materials (BOM) and process data required for LCA.
 - Resin and cable manufacturers to exchange BOM and process data with LCA consultant(s).
 - Based on BOM and process data, LCA consultant(s) will provide formal quotes (cost) to the project team for review.
 - Complete the LCA Goal & Scope (see Annex A).

Task 2 – Modeling

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Funding for Task 2 will need to be provided by the participating organizations. Funding will be based on the quotes developed by the LCA consultants using the information generated in Task 1 as the input.
- Materials and Processes
 - The current plan is to use LCA Consultants to work with the project team members to
 - ✓ Define Methodology
 - ✓ Model LCI data

- ✓ Model alternatives
- ✓ Identify and record all assumptions
- Testing Procedures
 - Testing procedures will follow common industry practices for modeling LCI data.

Task 3 – LCA Analysis

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Funding for Task 3 will need to be provided by the participating organizations. Funding will be based on the quotes developed by the LCA consultants using the information generated in Task 1 as the input.
- Materials and Processes
 - The current plan is to use LCA Consultants to work with the project team members to
 - ✓ Analyze alternatives, do sensitivity analyses in each tool
 - ✓ Review analyses with the team
 - ✓ Revise Testing Procedures as needed
 - Explain design protocol. Use standard design practices and commonly used software to reduce costs and widen applicability of results.
 - At what stages testing will be done and time needed.
- Testing Procedures
 - Testing procedures will follow common industry practices for modeling LCI data.

Task 4 – Reporting

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Funding for Task 3 will need to be provided by the participating organizations. Funding will be based on the quotes developed by the LCA consultants using the information generated in Task 1 as the input.
- Materials and Processes
 - The LCA Consultants will work with project team to provide any training as outlined in the quote provided by the LCA Consultants.

Task 5 – Reporting

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Task 5 is not expected to need any additional funding.

- Materials and Processes
 - The project team will work together to:
 - ✓ Create internal report
 - ✓ Determine and document key findings about PVC vs. alternatives
 - ✓ Determine and document key findings about datasets
 - ✓ Create presentation from report
 - ✓ Present results to team members
 - ✓ Create summary report for iNEMI members
 - ✓ Create report for general public, if desired

Task 6 – Develop Project Plan for Phase 2 – Materials Testing

- Resources
 - Each project participant is expected to contribute approximately 4 hours per month (2 hours for meetings and 2 hours preparation time).
 - Task 6 is not expected to need any additional funding.
- Materials and Processes
 - The project team will work together to define the project elements for Phase 2 and make recommendations on whether to continue the physical evaluation of the Power Cord Sets manufactured with alternative materials to PVC.

Phase 2 – Understand the electrical, mechanical and safety aspects of PVC alternatives for power cord applications. Develop, manage, and execute performance testing. Phase 2 could be run as an independent materials evaluation project for PVC Alternatives already certified for use.

Project Monitoring Plans

How will you ensure open lines of communication among participants?

Planned teleconference schedule.

Request progress reports as tasks are completed.

Dates of technical reviews (2 per year) and progress reports and what they will contain.

Practice risk analysis by anticipating problems and having alternate solutions ready.

Use opportunity analysis to identify new areas or topics that might be addressed in additional projects.

This will prevent the scope of the current project from expanding and keep the project focused on original goals.

Review project requirements with suppliers before the project begins.

Outcome of the Project

Define project success, including what gaps will be closed.

List all deliverables.

State which project results will be shared, with whom, and by what means.

General and Administrative Guidelines

General and Administrative Guidelines for this project and all other iNEMI Projects are documented at http://thor.inemi.org/webdownload/join/gen_guidelines.pdf.

Annex A – LCA Goal & Scope

5.2 Goal and scope definition

5.2.1.1 The goal of an LCA states

- The intended application,
- The reasons for carrying out the study,
 - To understand how PVC-free alternatives (including additives) compare to existing PVC power cords (including additives) from a cradle-to-grave LCA perspective
 - To understand what are the significant environmental aspects & impacts within the power cord lifecycle (from raw material extraction to end of life disposal), and which are insignificant.
 - To assess whether LCA can adequately model toxicity impacts across the life cycle.
 - To understand the life cycle inventories used in popular LCA tools (SimaPro and GaBi) and how well these models reflect the current state of the electronics industry.
 - If they do not reflect the current state, and this difference makes a difference in our analysis, understand what can be done in the future to make the data more useful.
 - To understand how the LCA tools and LCI address end of life aspects (recycling, incineration, landfill, etc).
 - To gain an understanding of data quality issues such as spatial location and how these can be addressed.
 - To provide a learning platform from which to address future non-PVC developments
 - To provide a learning platform that will help participants create their own LCAs in the future.
 - To understand the differences between popular LCA tools.
- The intended audience, i.e. to whom the results of the study are intended to be communicated, and
 - The audience for this report will be primarily iNEMI members. Secondary audiences include cable manufacturers and plastics manufacturers and possibly policy-makers.
- Whether the results are intended to be used in comparative assertions intended to be disclosed to the public.
 - The results of the study will end up being a comparative assertion disclosed to the commissioners of the study. Because the commissioners are in essence a panel of interested parties including customers, competitors, and LCA experts, and because the project will be modeled in two different LCA tools, the commissioner believes that the requirements for a critical review will be met.
- The scope should be sufficiently well defined to ensure that the breadth, depth and detail of the study are compatible and sufficient to address the stated goal.

5.2.1.2 The scope includes the following items:

- The product system to be studied;
- The first product system will be a 6-foot US desktop computer power cable UL rated to 60 degrees C, ROHS compliant, NEMA 5-15 Plug, 18/3 SVT attached to IEC 60320 - C13, 6 ft long. The second product system will be a 6-foot US desktop computer power cable UL rated to 105 degrees C, ROHS compliant, NEMA 5-15 Plug, 18/3 SVT attached to IEC 60320 - C13. In each case, one PVC-containing and one or more PVC-free cables will be studied.
- The functions of the product system or, in the case of comparative studies, the systems;
 - The function of the power cable is to safely provide power from a standard wall outlet (110VAC +/-) to a desktop computer for the life of the computer.
- The functional unit;
 - The functional unit is one 6-foot power cable UL rated to 60 degrees C, used in the US for 3 years. (is there any issue with longevity of the cable that is not addressed by the UL rating?) A second functional unit is one 6-foot power cable UL rated to 130 degrees C used in the US for 3 years.
- The system boundary;
 - The system boundary will include all life cycle stages with the exception of the use phase which is assumed to be the same for all cables. (Is this a valid assumption? Do we want to model 1 million cables and x% that burn during the use phase?) We will use a preliminary cut-off rule of 1% of impacts across all life cycle stages in all impact categories. The analysis will be a 3rd order assessment, including primary flows, material and energy flows including operations, and infrastructure. Employee commuting and transport beyond the factory gate will be ignored.
- Allocation procedures;
 - Initial analysis will use mass based allocation using the cut-off approach to recycled material. We will then use economic allocation and one or more of the economic-based approaches to recycled material (BRE, 50/50, and/or market-based) to test the sensitivity of the results to allocation method.
- Impact categories selected and methodology of impact assessment, and subsequent interpretation to be used;
 - TBD. ReCiPe and USEtox should be considered in light of the goals of the study.
- Data requirements;
 - Data for the cables will be provided by the cable manufacturers and averaged as necessary to provide confidentiality to the participants. Data for the PVC alternatives will be provided by their respective suppliers. This data may be aggregated to maintain confidentiality. Data for PVC will be secondary data, as this data has already been collected and averaged. Both European and US PVC data will be considered. We will attempt to gather primary data for additives. Where primary data

is not available, we will use secondary data. Data for all other materials (copper, etc.) will be secondary data from available datasets.

- Data for end of life will be based on US disposal data. This will require some primary data from US recyclers. The first pass will rely on secondary data for incineration and landfill, but may require additional data collection to answer questions concerning end-of-life.
- Assumptions;
 - The first assumption is that the cables are equivalent during the use phase.
- Limitations;
 - There will be some limitations based on the availability of data, particularly in the areas of additives and end of life models.
- Initial data quality requirements;
 - Time period: 2007-2011
 - Geography:
 - Cable production: Asia (China)
 - Plastics production: US
 - Metals production: Asia
 - Additive production: US
 - Technology:
 - Best available technology. Where PVC alternatives are still developing, future technology may be considered.
 - Representativeness
 - For PVC data, data from US and European industry associations will provide sufficient representativeness
 - For PVC alternatives and additives, data from a single supplier will be sufficient.
- Type of critical review, if any;
 - The nature of the project provides for the type of oversight required by ISO 14044. If the study is to be presented outside of iNEMI, a full panel review may be required.
- Type and format of the report required for the study
 - The study will begin with a screening LCA performed using two LCA tools. This report will comply with the requirements for ISO 14044 for a screening LCA. The final report will conform to ISO 14044 requirements for a comparative assertion.