

## **NATIONAL ELECTRONICS RECYCLING CENTER A REUSE ALTERNATIVE**

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### **INTRODUCTION**

On August 21-22, 1996, the Department of Energy (DOE) sponsored a two-day workshop in San Jose, California to explore business partnerships with some 80 representatives of the electronic manufacturing, recycle and reuse industries. The Environmental Protection Agency and the U.S. Postal Service attended as well. The primary recommendation from the workshop was to establish a national electronic recycling/reuse pilot project – sponsored by business and government. The rationale for creating the National Pilot Project was:

- A National Pilot Project would serve as a template for the United States to establish an environmental regulatory framework to enhance competitiveness and protect the environment.
- A National Pilot Project would harness the unique capabilities of the Department and other agencies, along with those of the private sector to develop a systematic approach to solving problems.
- A National Pilot Project would serve to “incubate” technologies for the market place.

The following subject areas should give each of you a good project overview and better understanding of the pilot project:

- Why do we need a National Center?
- How does the National Center Operate?
- What are the goals of the Center?
- What is the role of the Federal Agencies?
- What is the role of the Private Sector?
- What plans are needed for the future?

### **WHY DO WE NEED A NATIONAL CENTER?**

The United States continues to see a rapid growth in the markets for electronic products that are driven by new advancements in computers and information and communications technology. As the Information Highway becomes increasingly a part of our everyday life, it seems that computers and electronic equipment are on every office desktop, school, retail store and, more and more, in every home. The ingenuity and productivity of the computer and electronics industries produce machines that do more work than ever before, and do it faster. However, this amazing technological proliferation raises a new concern: What happens to all of this equipment when it is no longer useful?

The pace of development is so swift that it has shortened product sales cycles in some instances to less than 1 year. This has made increasing numbers of electronic products obsolete and resulted in millions of tons of electronic products either being stored or disposed of in landfills, much of it as hazardous waste. A recent study by researchers at Carnegie Mellon University (CMU), Pittsburgh, estimates that by the year 2005 more than 45 million personal computers will become obsolete worldwide every year. In total, from 1990 to 2005, the CMU study indicates that nearly 300 million computers will have reached the end of their lives. Solving the Y2K problem may have an added impact on the disposal of computer and electronic hardware items.

The prospect of these additional discards into waste streams poses a considerable problem for public and private sector waste management specialists. But for scrap and recycling professionals this field represents tremendous opportunity – especially in light of the strong push from the high technology industry to embrace principles of Design for the Environment (DFE) as developed by the Institute of Scrap Recycling Industries Inc. (ISRI), Washington.

The industry estimates that over 70 percent of existing excess electronics are being held in storage. Particularly for large organizations, including Federal agencies, that statistic translates to increased warehousing costs and downstream waste disposal costs.

While a large quantity of “obsolete” computer and electronic equipment finds a new lease on life through the President’s initiative for school use, the time will come when these units will, in fact, reach the end-of-life (EOL) and their disposition will have to be addressed. The same type of thinking can be used on obsolete and excess televisions that are stored in 90% of U.S. households.

The DOE recognized the need to encourage activities that maximize the economic reuse and recycle of discarded electronic products and, at the same time, minimize the waste associated with their disposal.

In August 1996, DOE sponsored a conference entitled “Asset Management: Electronic Products Disposition” in an attempt to establish a working partnership with a newly emerging electronics recycle and reuse industry. This conference evaluated issues concerning the volume and potential hazards of components and materials in electronic products as well as the desire to recapture residual value in end-of-life products. A fundamental objective of the conference was to investigate the possibility of DOE moving into electronics recycling/reuse as both a major supplier of discarded equipment and as a supporter of research activities.

It was evident to the conference participants that, unlike the conventional recycle programs that were in place (scrap paper, beverage cans/bottles, and scrap metal, etc.); a real need existed for assisting the newly emerging “electronics recycling industry”. The primary focus at that time was on the recovery of precious metals from components within the electronic products. It was agreed that a wide range of issues needed to be addressed in order to mature the industry and build an economically viable model for wholesale recycle/reuse to fund electronics. Specific areas of opportunity identified included transportation cost and logistics of collection, quality and quantity of obsolete equipment, and the economical recovery of plastics, metals, and glass.

In April of 1998, DOE, working through the Office of Worker and Community Transition, authorized the creation of the National Electronics Recycling Center (NERC) and \$3.5 million was appropriated for the project. The Community Reuse Organization of East Tennessee (CROET), as part of their reindustrialization program, was directed to provide the lead role for this work. The mission statement of the Center is shown in Figure 1.

#### **NATIONAL ELECTRONICS RECYCLING CENTER (NERC) MISSION STATEMENT**

The Oak Ridge Facility will be a test bed for the development and demonstration of new technologies, processes, and products. These technologies, processes, and products will improve the economics of electronics recycling, create spin-off companies, and develop the East Tennessee work force to support the expansion of the electronics industry.

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# PROCESS FLOW DIAGRAM

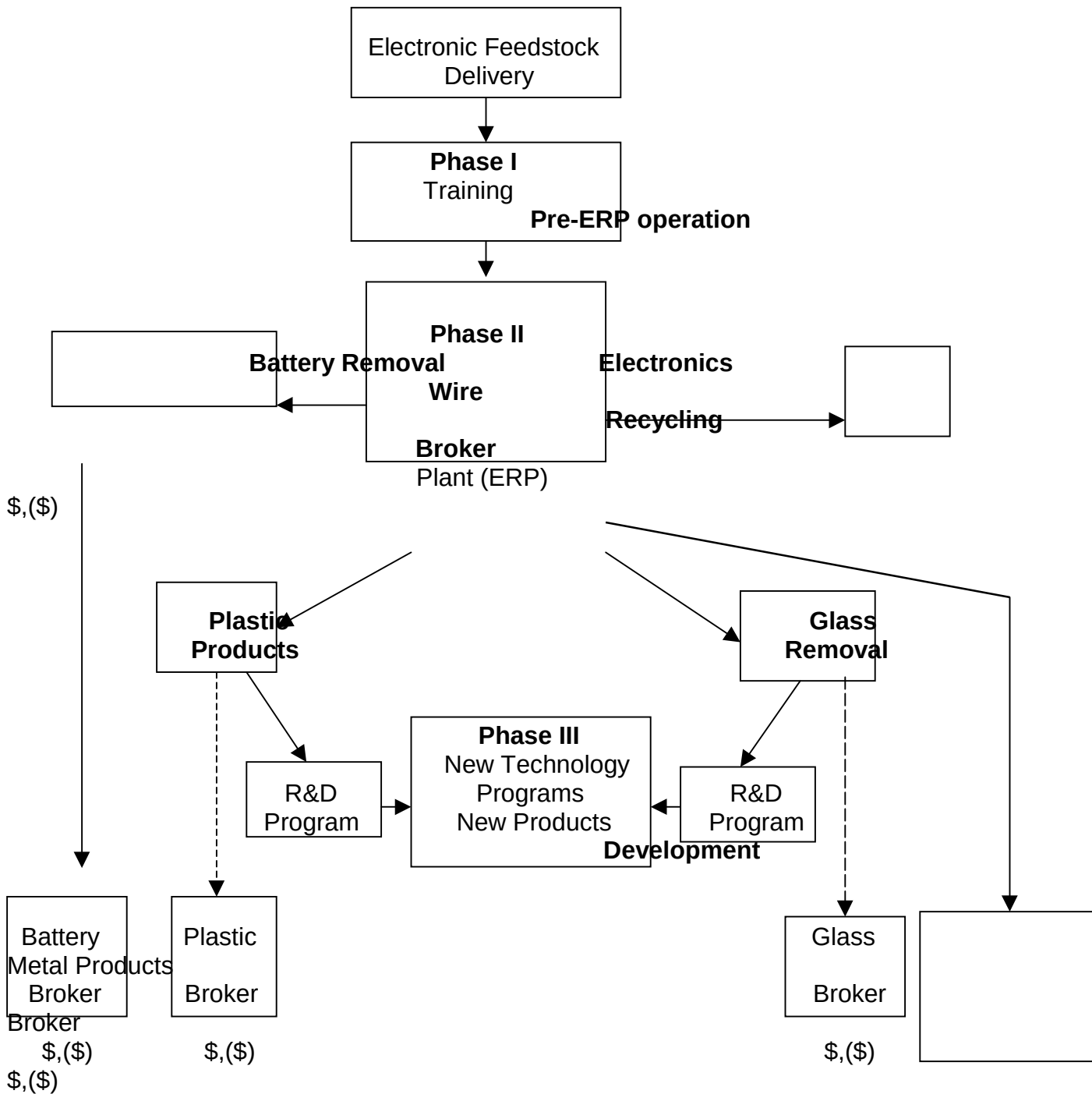


Figure 2

## **HOW DOES THE NATIONAL PILOT PROJECT OPERATE?**

The recycling pilot facility is located at the East Tennessee Technology Park (ETTP) in five (5) structures being leased by CROET to Scientific and Technical Resources. The five structures comprise a total of 40,000 square feet and will be used for start up operations. Three of the structures are permanent buildings that were constructed in 1945. The other three buildings are portable metal frame structures with a membrane fabric covering. These three buildings which total 18,000 square feet will be used for storage of equipment to be processed as well as for storage of finished products (material that have gone through the recycling process). The configuration of these buildings/structures does present some major problems in achieving processing efficiencies, but lessons learned from their use will be helpful when configuring new facilities. The siting of the demonstration facility at ETTP provides some major advantages as relative to transportation access, expansion needs and location within the ETTP complex.

The pilot facility involves a sorting and triage operation whereby feedstock (obsolete equipment items) are readied for the demanufacturing process. The term “triage” refers to the process of rapid evaluation or to the best course of action – save for possible reuse or demanufacture and/or scrap. It should be noted that improved technology and the competitiveness have eroded the after-market for reuse of equipment and/or components. In this regard, astute recovery managers at one time had markets for and recovered used four-megabyte memory chips for a sale price that ranged from \$8 to \$14. Changes in the global chip market have been considerable since 1995. The same chips now sell for as low as 50 cents each – again, a decrease in recovered value approaching 90%. Electronic scrap is composed of metal, plastic, cathode ray tube (CRT) glass, and various other materials. The most valuable materials, and the easiest to recover, are the metals (including precious metals such as gold and silver). PC Industry manufacturing changes over the last decade, however, have gradually reduced the use of precious metals in printed circuit boards. In many cases, the computer industry has reduced use of precious metals by over 90%. There are a few companies who are developing methods to recycle plastics, although at present, plastic recycling is considered uneconomical. There are even fewer companies exploring economic means of recycling CRT glass, which has a relatively high lead content. The pilot facility plans to integrate these operations, bringing the more profitable aspects of refurbishment/resale together with the currently uneconomic glass and plastics recycling. This integration, combined with research into more economical means of recycling and an aggressive, innovative product development effort, should improve the overall economics of recycling electronic products.

The facility, as established, uses three unique phases as shown in Figure 2. The beginning of a new phase will be dependent on the successful completion of the preceding phase. A facility plan will address the above objectives and illustrate how they will be achieved. Planned facility phases are:

1. (Phase I) Perform sorting and triage operations – This is a low capital cost, labor intensive phase requiring a facility, feedstock handling equipment, testing equipment, training of workers, and developing a distribution system for reusable materials. The sources and quantities of the feedstock materials are being evaluated through marketing programs.
2. (Phase II) Perform select de-manufacturing and recycling operations – This requires additional capital, industry knowledge, and workers. Many different

de-manufacturing operations are possible to varying degrees, and each shall be justified by an analysis showing the cost will be offset by an increase in recycled materials value. A total workforce of 25 to 30 individuals will be required to operate on a two-shift basis. Total through put is projected at 15 million pounds on an annual basis.

3. (Phase III) Incorporating results of the research projects – This is the final and most important phase and can be started when economically promising technologies emerge from the research projects. The facility will demonstrate and evaluate whether or not the research results/concepts can economically be incorporated into private sector operations.

### **WHAT ARE THE GOALS OF THE CENTER?**

The goals of the Center are to improve the economics of recycling and stimulate new economic growth in Oak Ridge. The long-term goals would be the creation of 50 to 100 new jobs that result from a new recycling approach and, more importantly, from new businesses, which are spawned from the success of Research and Development (R&D) studies.

The recycling objectives of the facility and program as operated by Scientific and Technical Resources, Inc. are as follows:

1. Train personnel to screen electronic equipment that will enable the units to be resold and to process equipment for total and complete recycling.
2. Train personnel in demanufacturing operations on electronic equipment in preparing R&D test feedstock.
3. Process materials derived from demanufacturing operations into a more efficient form of recycle scrap.

The business objectives of the facility and program as operated by Scientific and Technical Resources, Inc. are as follows:

1. Provide assistance to federal agencies in the reduction of stockpiled and obsolete electronic equipment and achieve cost avoidance from unnecessary storage.
2. Assist in testing innovative technologies to help improve the recycling industry.
3. Provide the interest required and basic recycle raw materials to produce new products.
4. Evaluate the start-up of new companies producing new products from recycled materials.
5. To investigate partnerships with municipal governments for recycling of consumer electronics.

The environmental objectives of the facility and program as operated by ORR-II are as follows:

1. Maximize the reuse of all materials from obsolete electronic equipment.
2. Reduce the quantity of obsolete electronic deliveries that go to landfills.
3. Develop the expertise and leadership to promote improved environmentally friendly recycling programs.

### **WHAT IS THE ROLE OF THE FEDERAL AGENCIES?**

The DOE has a large amount of excess electronic equipment as well as industrial, research and development assets that could be part of the National Center Program. At the current time, DOE-Oak Ridge Operations (DOE-ORO) office has been a major supporter of this project. This is very consistent with Oak Ridge's strategic plan called "Vision 2000" where the Department's intellectual and physical assets at the site are used to leverage private economic development in the region. The reindustrialization program at ETTP is an excellent example of this concept. In addition to DOE, the following agencies have been asked to provide assistance to the start up of the Center.

- U.S. Postal Service – The Postal Service is phasing out excess electronic equipment including computer terminals, keyboards, display screens, and personal computers. The critical aspect of the transportation issue in movement of surplus electronics is an area in which the Postal Service may play an important role.
- The Department of Defense – While DOD has not been directly involved in this effort, it has a potentially major role to play. Downsizing of facilities and base closures bring about an additional need for efficient recycling.
- The Environmental Protection Agency – The EPA has had and continues to have a key role in terms of helping to establish a workable regulatory framework to support the electronics recycling industry. Towards this objective, the EPA has established its "Common Sense Initiative" and has also sponsored national conferences on electronic recycling and reuse.

Some thoughts on "The Common Sense Initiative":

Support for environmental protection has never been stronger in this country. American citizens demonstrate concern and support for the environment. But living in an ever complicated world and an increasingly global economy has demanded new ways of protecting the environment – ways that not only protect and enhance environmental health for future generations, but that also keep our economy growing.

One way the Environmental Protection Agency (EPA) is striking this balance is through the Common Sense Initiative, or CSI. CSI represents a new approach for EPA in creating policies and environmental management solutions that relate to industry sectors.

For each industry, known as a “sector” in the CSI program, EPA convenes a team of stakeholders that look for opportunities to change complicated and inconsistent environmental policies into comprehensive sector environmental strategies for the future. The process, while sometimes lengthy, is producing better, more applicable environmental protection strategies that are developed by those who have to live with them – avoiding costly and time consuming adversarial processes later.

Sector teams and work groups meet frequently to discuss progress in the various projects underway, policy considerations, and other issues. Team decisions, issues and data are forwarded to the CSI Council, comprised of high-level decisionmakers from all the stakeholder groups and across all involved industries. The Computers and Electronics Sector is one of the six industries impacted and has a subcommittee of 25 members which meet about 6 times per year to work on recommendations submitted by work groups.

### **WHAT IS THE ROLE OF THE PRIVATE SECTOR?**

The existing electronics reuse/recycling infrastructure is fragmented and specialized, leading to inefficiencies and lost opportunities. To improve industry economics and increase reuse/recycling will require partnerships and broad cooperation among public and private organizations. Demonstrating the viability of this to industry will require a focused effort to identify, evaluate, and demonstrate the best technologies; develop process models for integrated facilities; and create a complete and integrated concept that systematically addresses the distribution of recycled products and services, transportation costs, and logistics.

The primary objective of this project to improve the economics of electronics recycling and environmentally sound dispositioning of discarded surplus electronic equipment. Additional objectives include the establishment or expansion of reuse/recycling companies, the creation of jobs, and demonstration of advanced recycling technologies, etc. As more discarded electronic products are reused/recycled and less are disposed in landfills, more resources including venture capital will necessarily be required by the reuse/recycling industry.

A secondary objective is to transition NERC from a federally supported endeavor to a self-sustaining center by attracting private sources of funding, generating revenue from recycling surplus electronics and patent assignments associated with technologies garnered from research and development (R&D). The goal is that all developed and licensed technology be made available to the industry as a whole.

Although it is the ultimate mission of the NERC to address all relevant issues associated with electronics recycling, the initial R&D funding is focused on improving the ability to recycle plastics and glass from EOL products. Research projects, which have been funded during the fiscal year, are described below.

West Virginia University Research Corporation, teamed with MBA Polymers, Inc., D.N. American, and the Polymer Alliance Zone, Inc., will focus on plastics recycling from electronic products and on the development of marketable plastic and hydrocarbon products. The work scope will focus on improving processes for the separation of high value plastics from electronic scrap.

Separated plastics at various purity levels will be characterized and properties will be evaluated. Specifications will be developed from these characterizations and used to identify and develop potential products, thereby increasing the market value of separated plastics.

Adherent Technologies, Inc., provides an alternative approach to plastics recycling using a unique low temperature catalytic conversion process. The process has been successfully demonstrated on electronic scrap, producing separate hydrocarbon and metal/inorganic conversion products. Key to the viability of the process is the economics associated with separation of valuable hydrocarbons from the liquid stream and separation/purification of valuable metals and other products from the solids stream.

Envirocycle, Inc. will focus on development of alternative products from glass and development of economic performance data from deployment of CRT separation systems at three regional sites. The remelt/reformation of CRT glass into marketable glass products has the potential of significantly improving the economics of glass recycling. Addressing the reprocessing of CRT and the potential for alternate reuse present the biggest challenge.

Industry needs will be determined via surveys of industry members, identified, and stored in an industry profile database. This database will contain information about all known industry participants, including names, addresses, products, services, and specialization areas. Also, information about the economics of the reuse/recycling business will be gathered, and an expertise concerning the cost of reprocessing electronic equipment will be maintained. This expertise is needed to identify the areas of greatest potential pay back to the industry from research funds.

An example of an industry R&D need is for recycled material standards that will allow expansion of markets for de-manufactured materials, such as plastics. The lack of standards discourages the use of recycled materials because physical properties vary widely and are unpredictable. A standard will allow final product manufacturers to have confidence that physical requirements of their products can be maintained using recycled materials.

In addition to applied research, grant money will fund demonstrations, tests, and evaluations of technologies, integration of technologies, and operations concepts. This will be accomplished primarily in a dedicated facility located at the East Tennessee Technology Park (ETTP). The facility will also support research efforts and will generate income from the sale of reusable equipment, components, and materials. This income will supplement and leverage funds received from the grant. The facility will also be an incubator for new electronic product reuse/recycling companies and will have the following objectives:

1. Be a platform for the demonstration of technologies developed from R&D.
2. Be a platform for independent testing and validation of existing technologies.
3. Provide a de-manufactured feedstock for research as needed.

4. Demonstrate the integration of multiple technologies for verification and validation of concepts and to promote technology transfer.
5. Provide occupational training for the reuse/recycling industry.
6. Incubate and/or encourage the formation/expansion of recycling companies and related jobs—particularly those that specialized in processing downstream of initial sorting and triage.
7. Be a showcase operation for industry and process enough feedstock to make a significant contribution to offset the cost of facility operations.
8. Develop an expertise in the reuse/recycling industry and advise government asset managers on how to maximize the value of their electronic feedstock.
9. Demonstrate state-of-the-art recycling systems.

#### **WHAT PLANS ARE NEEDED FOR THE FUTURE?**

The National Center Vision – “Commercial visibility for reuse/recycle of all electronic products” can only happen if interest in the pilot project continues at an increased level. More importantly, funding needs to remain in place to ensure that the facility becomes functional. Successes from R&D efforts have to be publicized and improvements applied to the recycling process. New concepts and ideas, not tested due to a lack of R&D funding, have to be continued and funding secured to make it happen.

New products need to be developed from the recycle materials which, in turn, will create new spin-off business opportunities with increased employment. New products need to be developed which helps improve the recycling process. Last, but not least, work needs to be started to ensure that an interaction between original equipment manufacturer (OEM) and the recycling industry remains active to ensure we will be ready when and if “take back” legislation is enacted.