

The Institute for Recovery, Remanufacturing Recycling and Reuse (R⁴-I)

Seeking Sustainable Stewardship of our Earth's Resources

The Institute is dedicated to a future that values and increasingly strives to achieve materials sustainability. We are progressing towards a time when materials recovery and recycling are no longer an afterthought, but rather represent a critical consideration in the design and manufacture of materials and products. In the future, the efficiency of materials recovery from the waste stream will increase and recycled scrap will be the preferred input material for materials processes yielding both energy and cost saving.

Vision

The Institute's goal is to be the premiere industry-national laboratory-university collaborative dedicated to the sustainable stewardship of our Earth's resources. The institute will be a regionally focused national network. The regional centers will have specific foci that seek to take advantage of regional needs and skill sets. By using the regional-national network concept, we will serve collaborating members' needs by establishing the needed knowledge base, and by educating future industrial leaders. Technologies will be developed and, demonstrated in a manufacturing demonstration facility setting and transferred to industry with the goal of achieving materials sustainability from initial product design through manufacture to end-of-life disposition in a manner that yields both energy savings and profitability.

Mission

The Mission of the Institute is to collaborate with industry, academics, and other national laboratories to:

- Establish generic basic recovery and recycling science;
- Develop technologies to identify and separate scrap materials from the waste stream;
- Build strategies and technologies to enable greater scrap utilization within materials processes;
- Extend and demonstrate the research and development already underway at other facilities such as NSF's CR3; and
- Establish materials recovery and recycling curricula that in combination with national laboratory, university, and industrial research experiences will grow both engineering and technician workforces equipped to address the challenge of achieving material sustainability.

Description of the Institute

The Institute for Recovery, Recycling, Remanufacturing and Reuse (R⁴-I) is an ideal application for, and realization of, the concept of the U.S. Department of Energy's (DOE) Manufacturing Demonstration Facilities. It is driven by, and responds to, the needs of industry. It brings together the world's leading experts in all relevant areas, across the entire materials lifecycle, to tackle the problems from a systems view that assures the availability of materials with essential properties in applications that impact the generation, conversion, transmission or utilization of energy. It

has the combined skills of industry, academia and government laboratories to identify the most pressing problems and opportunities, and promises technological approaches based on sound science and rigorous economic and risk analysis, with the ability to focus its resources, flexibly, on the innovative solutions that have the greatest impact. It provides extensive real and virtual facilities for information dialog and exchange. With strong basic science underpinnings linked to applied and commercialized technologies, R⁴-I has the capacity to develop new theoretical and experimental approaches, as needed, the aptitude to reduce the technology risk of new discoveries that emerge from the team, and the competence to deploy these new technologies rapidly into the marketplace. R⁴-I brings together a diverse, broad-ranging team that is comprehensive, agile, strategic, and bold in its thinking. It is unique in the recognized expertise of its members, and the comprehensiveness of its approach.

Short, Intermediate, and Long Term Goals of the Institute

The R⁴-I will focus its attention initially on the critical area of recycling of electronic materials, aluminum, water, glass, and metals with emphasis on the transition metals, followed by possibly addressing the “medium-term, near-critical” elements, lithium and tellurium.

The most urgent goal of this Institute is to assure that recovery and recycling of electronics is performed in an energy and environmentally conservative manner. Recognizing that the viability of electronics recycling hinges upon efficient and environmentally-responsible separation and extraction processes, and that these ventures are also vulnerable to price fluctuations and manipulation during start-up phases, R⁴-I will focus significant resources to enhance the robustness of recycling’s primary extraction economics. It will introduce significant new technologies that improve extraction efficiency, and develop new uses for underutilized co-products.

Lithium resources are addressed as a medium term priority by developing new chemical extractants that will be available if or when lithium-ion battery demand overwhelms the current supply. These will significantly shorten the production timescale for lithium extraction, making the supply-chain more flexible and responsive, and therefore ready to meet the demand as it arises.

Longer term efforts will focus on qualifying new materials for use in existing products, and redesigning products to accommodate new materials, which can take several years to achieve. R⁴-I has correspondingly longer-term goals to develop a range of materials that incorporate significantly smaller amounts of critical metals in electronic components and include an emphasis on deployment of new products into the marketplace.

Crosscutting all short, medium and long term goals are the basic scientific tools that R⁴-I will develop to enhance the understanding of a wide variety of materials to enable better approaches to separation, reduction, re-use, recycling and substitution. Such tools include advanced theoretical skills, and world-class computational and experimental resources that will be used to establish and continually improve the nation’s ability to create innovations that assure the value chain across the entire materials lifecycle.