**PROJECT TITLE: RESOURCE RECOVERY FROM E-WASTE TO CONSERVE NATURAL RESOURCES**

**I. PROJECT STATEMENT**

The goals of this study are to:

1. Identify specific success factors and barriers for material recovery from e-waste in Minnesota;
2. Identify opportunities to **modernize** equipment, technologies, and processes to ensure safe recovery of valuable and hazardous components of electronic waste (e-waste) in Minnesota;
3. Compare the e-waste management systems in Minnesota with e-waste recovery in regions where material recovery is operating successfully (these countries/states include Finland, Sweden, Belgium, Germany, South Korea, Japan, New York, California, and others) via literature search;
4. Establish analytical methods to characterize materials present in the e-waste.
5. Characterize the chemical composition of e-waste from certified recyclers in the Minnesota Metro area
6. Provide the State of Minnesota with a report that includes: 1) state-of-the-art information about e-waste material recovery technologies, equipment, and processes; and 2) data on the material and chemical composition of electronic waste; and 3) a technology roadmap for establishing state-of-the-art processing of e-waste in the State.

Electronic waste is the fastest growing domestic waste stream. According to the Minnesota Pollution Control Agency’s (MPCA) [2013 Waste Characterization Study](https://www.pca.state.mn.us/sites/default/files/w-sw1-60.pdf), electronic products made up about 1.2 percent (70 million pounds) of all material disposed of as mixed municipal solid waste in 2012. Moreover, the U.S. [Environmental Protection Agency](https://www.epa.gov/sites/production/files/2017-08/documents/national_strategy_for_electronics_stewardship_accomplishments_report_final_8_7_17.pdf) (EPA) estimates that over 720 million new electronic products were sold, and **6.7 billion pounds** of used electronics were ready for end-of-life management in 2014 alone. With aggressive goals (75% by 2030), for recycling in Minnesota statute (MN [115A.551 Subd. 2a](https://www.revisor.mn.gov/statutes/cite/115A.551)) for the seven-county Metro Area, there is a growing need for material recovery and recycling infrastructures and their capacity for handling the increasing number of obsolete electronic devices. Additionally, given the need to curb **natural resource depletion** and **climate change**, there is a growing need for recovery of resources domestically in a way that decreases the **environmental burdens** associated with extraction of primary raw materials. In [Minnesota](https://www.pca.state.mn.us/sites/default/files/lrp-p2-2sy17.pdf), approximately 199.4 million pounds of household electronic waste was collected for recycling between 2013 and 2018. Minnesota **does not** have certified resource recovery facilities to convert the e-waste materials into **useable** products. As a result, it is a common practice for registered recyclers, retailers, and equipment manufacturers in Minnesota to **export** the electronic waste materials to downstream vendors in other states or **international markets** for material and value recovery. At present, registered recyclers in Minnesota have **minimal capabilities** to convert e-waste into valuable raw materials. By accomplishing the aforementioned objectives, a technology roadmap will be created to guide the State of Minnesota in establishing **state-of-the-art** processing infrastructure to provide the value-added processing services.

**II. PROJECT ACTIVITIES AND OUTCOMES**

|  |  |  |
| --- | --- | --- |
| **Activity 1 Title: Assess Current Practices at Existing E-Recycling Facilities**  **Description:**The project team will visit [certified recycling facilities](https://www.pca.state.mn.us/electronics/registered-stakeholders) in the Metro area and review their existing material recovery practices. The team will also identify opportunities for and barriers to increasing the recyclability of electronic devices, specifically addressing recycling or safe disposal of electronic devices and low-value materials recovered from those devices.  **Activity 2 Title: Review Existing Best Practices in Material Recovery from E-waste**  **Description:**The project team will perform a combination of literature research and stakeholder surveys to review best practices for material recovery from electronic wastes*.* The project team will review the literature to gather information related to equipment, technology, and processes that are currently used to recover plastics, glasses, metals, and hazardous materials from electronic wastes. The team will also interview experts from industry, original equipment manufacturers, recyclers, and academia to obtain their views on challenges and opportunities for material recovery from e-waste.  **Activity 3 Title: E-waste Composition Analysis**  **Description:** A compositional analysis of metallic and non-metallic streams of e-waste collected from certified recyclers will be performed using scientifically established methods. The waste characterization will include toxicity characteristic leaching procedure (TCLP), heavy metals, rare earth metals, precious metals, base metals, and high technology metal elemental analysis. Additionally, the plastic fractions from e-waste will be characterized for furans, dioxins, poly brominated diphenyl ethers (PBDE), poly brominated biphenyls (PBBs), and polychlorinated biphenyls (PCB's). | | **ENRTF BUDGET: $60,126**  **ENRTF BUDGET: $25,789**  **ENRTF BUDGET: $113,095** |
| **Outcome** | **Completion Date** |
| *1. A database of existing best practices to recover valuable metals, plastics, and glass from end-of-life electronic devices.* | *06/30/2021* |
| *2. Identify bottlenecks for material recovery at a certified recycling facility in Minnesota* | *06/30/2021* |
| *3. Categorize material characteristics of e-waste and e-scrap at certified recycling facilities* | *06/30/2021* |

**III. PROJECT PARTNERS AND COLLABORATORS:** Shashi Rao. M. S. (Principal Investigator), George Hudak Ph. D. (Geology), Kevin Kangas M. S., MBA (Chemical Engineer), Eric Singsaas Ph. D (Wood Products and Bio-economy), Brett Spigarelli Ph. D. (Chemical Engineer), Meijun Cai Ph. D.(Environmental Engineer), Will Bartsch M. S., (Water Resources Scientist), Victor Krause B. S. (Chemistry) and Matthew Mlinar MBA. (Electrical Engineer).

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

This project will provide data for initial execution of the transition to near zero waste and circular economy for electronic waste in Minnesota. This will be done by identifying the current state of the art technologies, processes, and equipment used to **increase recovery/recyclability** of materials from e-waste, and identifying additional**, specialized capacity** that would be needed at existing recycling facilities to convert waste materials into **usable products**.

In the long term, recovering materials from e-waste has three significant benefits.

* One: E-waste represents a significant opportunity to recover scarce raw materials and thereby helps in **conserving natural resources**.
* Two: E-waste contains toxic materials such as mercury, cadmium, lead, hexavalent chromium, and brominated flame-retardants that **pose hazards to public health** and the **environment** if not properly disposed or recycled. Emissions resulting from the end of life treatment may **release hazardous compounds** into the environment, such as dioxins and furans.
* Three: Recovering materials implies **reduction** in the need for new raw materials, thus minimizing **greenhouse gases**, waste, and energy while creating **new jobs** and **business opportunities**.