PURDUE UNIVERSITY | Environmental and Ecological Engineering

EEE Research Seminar

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Material flow analysis of end-of-life electric vehicle batteries using agent-based modeling

Abstract

The first generation of mass market electric vehicles (EVs) was adopted in the U.S. in the early 2010s and is now reaching the end of its life, creating a new stream of vehicle-derived end-of-life (EOL) critical materials. Uncertainty over the desired and actual EOL pathways for EV batteries has implications for the development of recycling infrastructure and logistics coordination. If batteries are diverted to stationary energy storage or other second use applications, there will be a delay in when their embodied materials become available for recycling. This potential delay makes forecasting the supply of materials for recycling challenging and reliable supply forecasts are needed for the optimal design of recycling infrastructure. Recycling facility size, expected yield, and costs – and other factors affecting long-term market viability, for recycling and other second use applications – depend on reliable knowledge of the quantity and composition of supply. Plausible projections on how the reuse of EOL EV batteries in secondary applications may affect the supply of batteries available for recycling and by extension the supply of secondary materials that can be used to offset primary critical material demand would aid in planning regional closed loop supply chains for battery critical materials. To that end, we use an agent-based model (ABM) that incorporates the decisions made in determining the end-of-life fate of EV batteries to provide insight into how their supply may be diverted to available second use pathways including remanufacturing, repurposing, and recycling. We then estimate the expected supply of recycled commodities that would become available over time given the reuse pathway projections from the model. A framework developed by the US National Renewable Energy Laboratory (NREL) for circular economy strategies for solar PV, wind energy systems, and hard disc drives has been adapted to capture the dynamics of an EV battery collection system in which cost, battery state of health, and the subjective likelihood of firms to reuse batteries are factored into a battery's selected EOL pathway. To bolster EV battery recovery, starting with the first generation of EVs, this work is focused on the dynamics affecting the collection of nickel-metal hydride (NiMH) hybrid electric vehicle batteries along with lithium-ion batteries (LIBs).

Bio

Miriam Stevens is a PhD Candidate in Environmental and Ecological Engineering (EEE), working under the supervision of Professor Shweta Singh. She primarily works on modeling the expected availability of reusable critical materials in the US. Miriam has a bachelor's degree in Geophysical Sciences from the University of Chicago and a master's degree in EEE from Purdue University.