Empa
Materials Science and Technology

Master project proposal – spring semester 2021

Assessing the environmental benefits of recycling car-embedded electronic devices by developing a life cycle assessment tool

Recycling car-embedded electronic devices – why is it important?

Modern passenger cars contain a wide range of geochemically scarce and technologically important metals (STMs), i.e. precious metals, rare earths and other special metals. They are mainly used in the manufacture of electrical and electronic equipment (EEE) which are increasingly embedded in vehicles. Therefore, in the coming years, a considerable increase in the quantities of STMs in end-of-life vehicles is to be expected. In the current waste management system, whose primary aim is to ensure environmentally friendly treatment of hazardous materials and the recovery of industrial base metals (such as iron, aluminium and copper), STMs are often lost. However, those metals have a high economic value, and their primary production generates considerable environmental impacts, caused by a combination of several factors such as their low concentration in the earth's crust, or the specific refining processes involved. Moreover, the deposits are often rare and located in only a few countries, that thus control the world supply. Knowing that many renewable energy production technologies rely on those metals, those challenges threaten our efforts to improve the sustainability of our society. For environmental, economic and strategic reasons, it is thus crucial to "close the loop" of the STMs by improving their recovery and recycling. Our project, named EVA II, in the frame of which your Master's thesis will be realized, addresses this issue.

Our project – EVA II

The overall purpose of the EVA II project is to support policy decisions on the handling of car-embedded electronic devices (EEDs) at the end of their useful life or at the end of the life of passenger cars in which they are integrated, especially with regard to the possible recovery of STMs.

In order to achieve this goal, the core of the project is the development of a dynamic mass flow analysis model (dMFA), which allows to calculate the flows of EEDs and materials between the different actors of the system, from their entry into the Swiss vehicle fleet to their export, recycling or disposal. In order to complement this information, the EVA II project also includes the development of a module on financing mechanisms and a module on life cycle assessment to translate material flows into economic and environmental impacts. These elements will make it possible to monitor the system on the basis of relevant environmental and economic indicators, as well as to compare different possible system alternatives, or even simulate their evolution in the future.

Your contribution – developing the LCA calculation module

In the frame of your Master thesis, you will develop a simplified calculation tool based on LCA principles (hereafter called LCA module) that will be linked to our broader dMFA model of the whole system, allowing to assess its environmental impact and compare several waste management system variants.

The LCA module will have the following specificities:

- It must be standardised, partially automated and easily replicable, so that evaluations can be carried out regularly and their results compared.
- It will take into account new automobile technologies, such as electric or autonomous cars, thus anticipating the future composition of the waste stream
- It must be able to compare the environmental impact of several recycling system alternatives under different scenarios

The software or coding language to be used for this work is yet to be discussed.

Organisational aspects

- **Organisation**: Empa, Technology and Society Laboratory, CARE group
- **Our project team**:
    - Lorena Toledo
    - Charles Marmy
    - Rolf Widmer
    - Roland Hischier
    - Didier Beloin-Saint-Pierre
- **Location**: Empa site of St. Gallen. The collaboration could also be virtual.
- **Date and duration**: February to July 2021
- **Working language**: French, English or German

In case of interest or for additional questions or information, don't hesitate to contact us

Charles Marmy
+41 58 765 79 15
Charles.marmy@empa.ch
https://www.empa.ch/web/s506/care