# Section Sciences et Ingénierie de l'environnement

## Design Project 2021 (semestre de printemps)

## Proposition n°28

# Development of a metal recycling simulation module for electric and electronic devices embedded in EoL vehicles in Switzerland


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**Empa**

Taille de l'entreprise (nbre de collaborateurs) : **1000**

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**Descriptif du projet**

The main subject of this project is the recycling of embedded electronic devices from end-of-life vehicles

Metals play a central role in motor vehicle industry where steel and aluminum account for the majority in the car's composition. However, the current electrification of the car fleet has increased the demand of other metals such as copper. These metals, steel, aluminum and copper, also called industrial base metals (IBMs) are recovered today in an almost closed material loop.

The electrification of the car fleet has also increased the number of electric and electronic equipment embedded in modern vehicles. These embedded electrical devices (EEDs) contain a wide range of scarce technology metals (STM), i.e. precious, rare earth and other special metals; in fact, they are STM hotspots since they contain most of the STM in a car. STM can have high economic value (e.g. Au, Ag or Pd) and their primary production

generates significant environmental impacts mainly due to mining and geographical location of those raw materials. The rapidly changing metal composition of the car fleets challenges the current car recycling industry. The recycling processes in use have difficulties in handling EED and much of the STM are lost.

Therefore, the yield of STM needs to be improved and this issue is addressed by BAFU's EVA II project which aims to provide support for policy decisions regarding optimal dismantling and treat-ment of defined EEDs from EoL vehicles (ELV).

EVA II will produce important elements for a system to monitor the performance of the future car recycling, in particular to keep track of STM recovery. For that, a model of the Swiss car fleet and its EoL treatment is developed. It consists of a module, which is based on dynamic material flow anal-ysis (dMFA) and calculates stocks and flows of EED and STM in the Swiss car fleet, in particular flows of EoL cars leaving the fleet for treatment. A second module, based on a static model, covers the EoL treatment and metal recovery. The two modules are linked to a third module, which allocates financial and environmental costs to the EoL material flows. Simulations with these linked modules will allow to monitor the system through relevant environmental and economic indicators, as well as to compare different scenarios and their evolution in the future.

**Objectif et buts**

This design project will be part of the BAFU project EVA II and will address the recovery of metals from EoL vehicles. The students will support the development of the second module described above that will allow to predict recovery efficiency of metals from selected EEDs.

The students will build a simple model of a generic waste electrical and electronic equipment (WEEE) treatment plant in Switzerland and will simulate current WEEE recycling to calibrate and validate the model. Recycling performance of selected EEDs that are dismantled from ELV will be simulated using this model.

**Descriptif tâches**

To build the model, data from existing e-waste processing plants in Switzerland will be available (simplified flow sheets and treatment tests). The model will be implemented in RepTool (a tool to simulate WEEE treatment plants) or a similar numerical simulation tool. The project's results include the well-documented model und its operational implementation as well as a comprehensive discussion of simulation results of the recycling of certain EEDs.

There is no experimental part.

**Divers**

This project doesn't require the presence of the students in our facilities. The collaboration and communication can be done through Zoom, Skype, or similar tools.

However, an initial and final physical meeting, in Lausanne or St. Gallen, could be helpful facilitate the collaboration.