

# Futu

Future availability  
of secondary  
raw materials

# RaM

## A Swiss case study on embedded electronics in end- of-life vehicles

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Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
**State Secretariat for Education,  
Research and Innovation SERI**

EU Framework Programmes

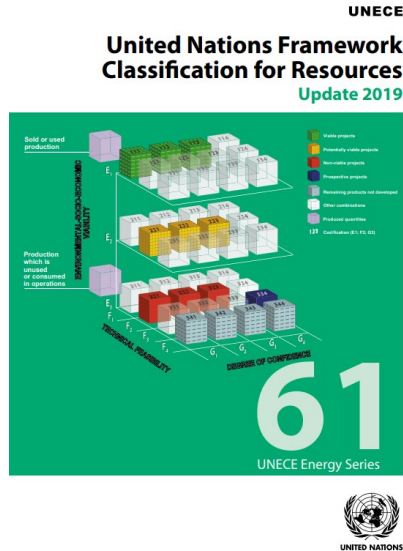


Funded by  
the European Union



# Empa

# Motivation



*“The project plan may be detailed or conceptual (in the case of long-term national resource planning)”*

Test application on a national level:

Embedded Electronics Devices (EED) in End-of-Life(EoL)  
Vehicles in Switzerland

*Funding: Swiss Federal Office for the Environment (FOEN)*

# Approach

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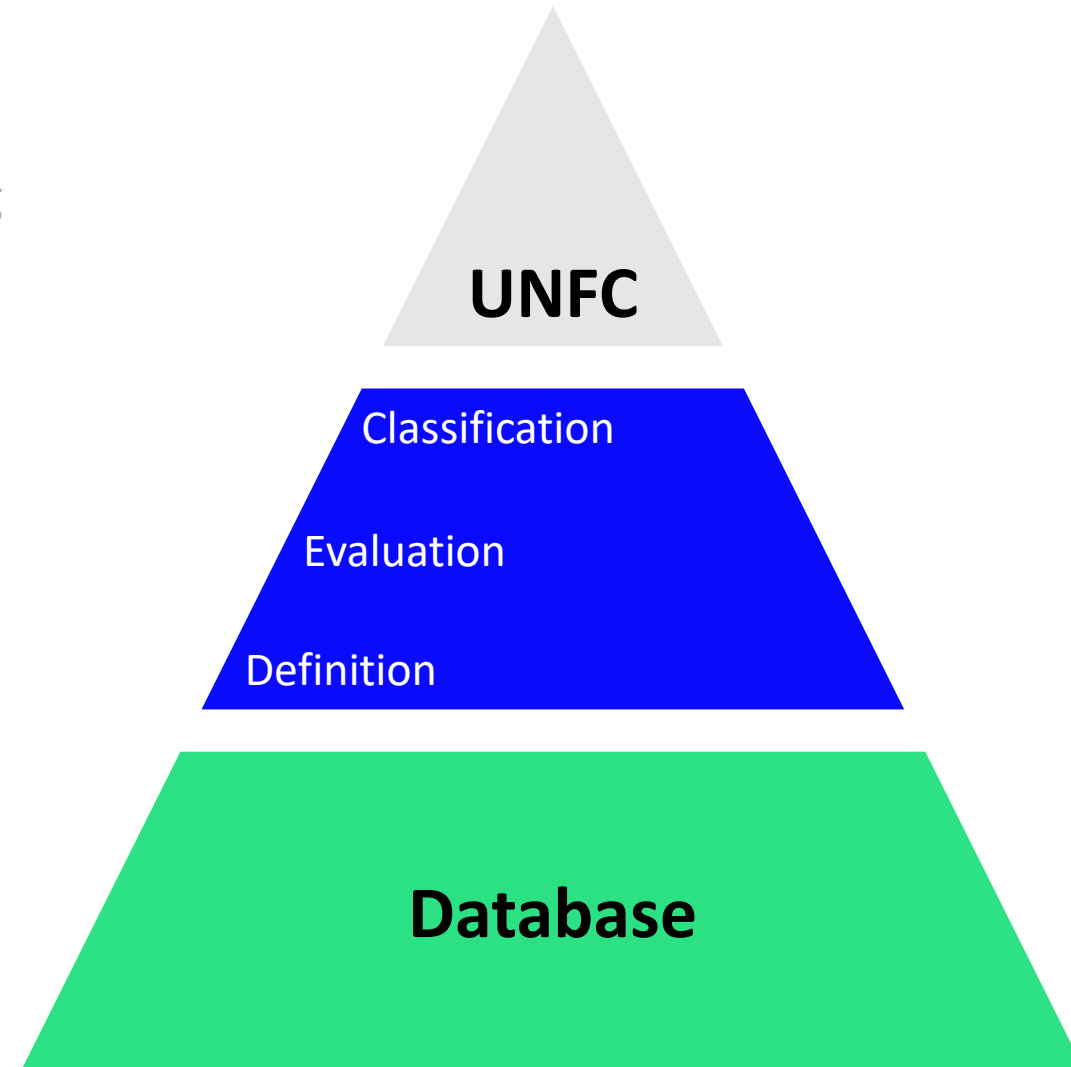
Consistent, transparent and comparable reporting

## Applying UNFC to Swiss FOEN Project

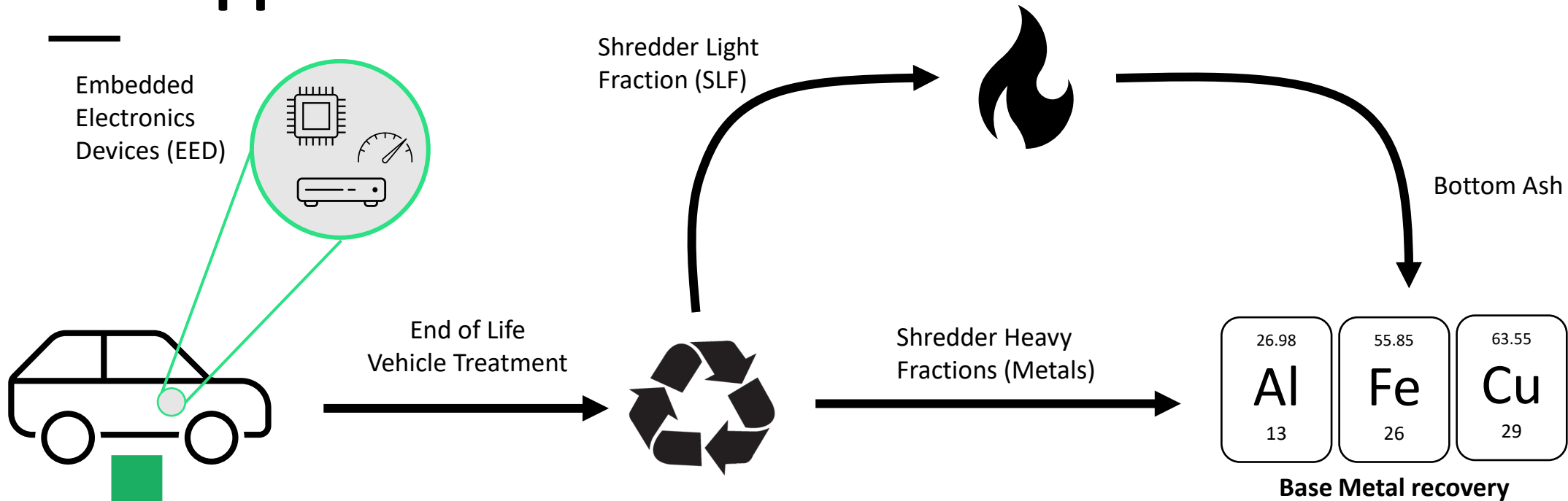
- Chose Factors to analyze Criteria (Axis)
- Allocate Categories (e.g. E1, E2, E3)
- Classify

## Embedded Electronics Devices (EED) in End-of-Life (EoL) Vehicles - Swiss FOEN Project

- Baseline : No specific CRM recovery from EED
- Recycling: CRM recovery from EED

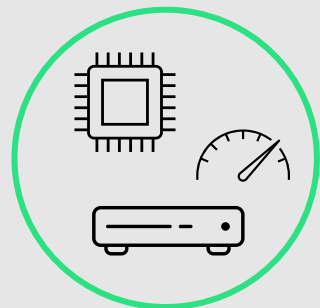


# Test application on a national level



Baseline : No specific CRM recovery from EED

Recycling: CRM recovery from EED



Using existing Swiss WEEE recycling system



Recovery of some CRMs enabled

# Applying UNFC - Selection of Factors



## E-Axis

### Environmental-socio-economic

- Legislation
- Policy implementation
- Awareness of raw material criticality
- Political willingness
- Stakeholder interest
- Social license
- Environmental impacts
- Financial capability
- Profitability

## F-Axis

### Technical feasibility

- Infrastructure
- Technology readiness level (TRL)
- Operating License

## G-Axis

### Degree of confidence

- Knowledge of material regarding quantity and quality
- Supply continuity

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# G-Axis - Supply continuity

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Factor	Evaluation Method	Scenario	Result	Category
Supply continuity				

# G-Axis - Supply continuity

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Factor	Evaluation Method	Scenario	Result	Category
Supply continuity	Dynamic Material Flow Analyses (dMFA) and Simulations			



# G-Axis - Supply continuity



Factor	Evaluation Method	Scenario	Result	Category
Supply continuity	Dynamic Material Flow Analyses (dMFA) and Simulations	Baseline: No specific CRM recovery		
		Recycling: CRM recovery from EED		

# G-Axis - Supply continuity



Factor	Evaluation Method	Scenario	Result	Category
Supply continuity	Dynamic Material Flow Analyses (dMFA) and Simulations	Baseline: No specific CRM recovery	CRM do not enter relevant WEEE recycling chain	G4
		Recycling: CRM recovery from EED		

# G-Axis - Supply continuity



Factor	Evaluation Method	Scenario	Result	Category
Supply continuity	Dynamic Material Flow Analyses (dMFA) and Simulations	Baseline: No specific CRM recovery	CRM do not enter relevant WEEE recycling chain	G4
		Recycling: CRM recovery from EED	CRM enter WEEE recycling chain increase in supply is to be expected	G2

Secondary raw materials supply continuity from EoL products strongly depends on external factors

→ High uncertainties

# F-Axis - Technology Readiness

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Factor	Evaluation Method	Scenario	Result	Category
Technology readiness		Baseline: No specific CRM recovery		
		Recycling: CRM recovery from EED		

# F-Axis - Technology Readiness



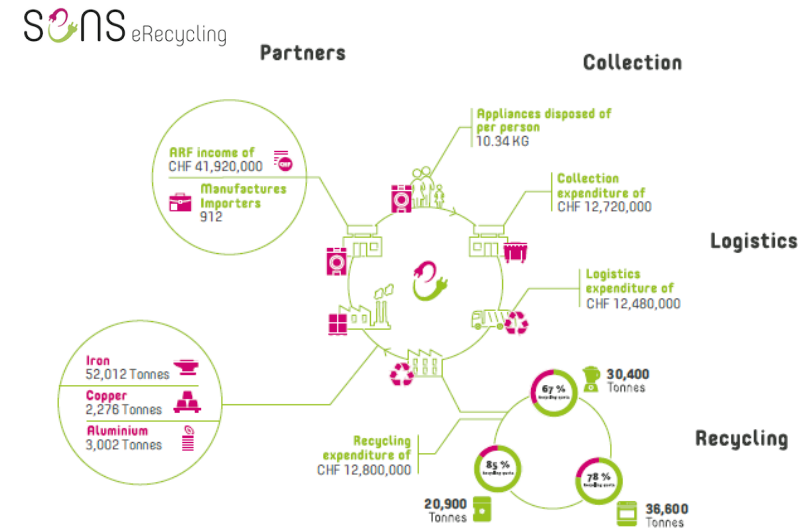
Factor	Evaluation Method	Scenario	Result	Category
Technology readiness	Technology Readiness Level (TRL)	Baseline: No specific CRM recovery		
		Recycling: CRM recovery from EED		



Whole recycling chain needs to be analyzed as it is an integrated system (SWICO, SENS)

→ System readiness approach is needed

→ System readiness approach is going beyond technical evaluation, hence beyond F-Axis



# F-Axis - System readiness

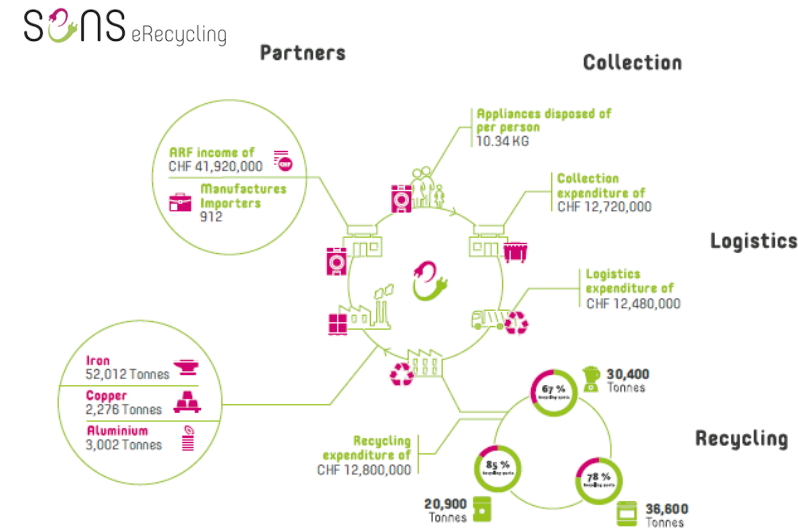


Factor	Evaluation Method	Scenario	Result	Category
System readiness	System readiness level	Baseline: No specific CRM recovery		
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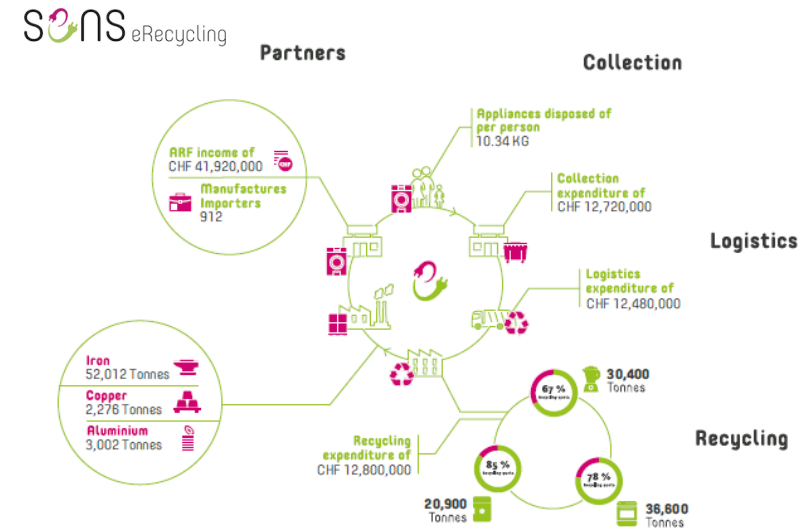


Factor	Evaluation Method	Scenario	Result	Category
System readiness	System readiness level	Baseline: No specific CRM recovery	No specific WEEE recycling system is applied	F4
		Recycling: CRM recovery from EED		

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# F-Axis - System readiness

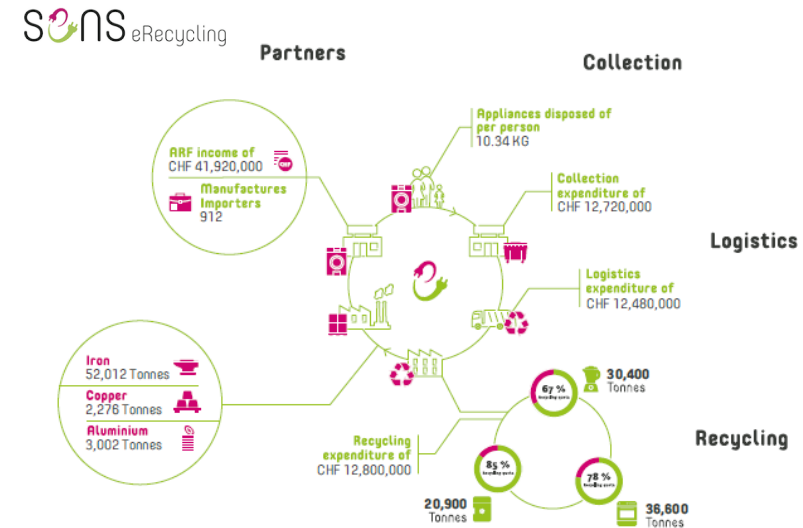


Factor	Evaluation Method	Scenario	Result	Category
System readiness	System readiness level	Baseline: No specific CRM recovery	No specific WEEE recycling system is applied	F4
		Recycling: CRM recovery from EED	WEEE recycling system is operational	F1

Whole recycling chain needs to be analyzed as it is an integrated system (SWICO, SENS)

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# E-Axis - Environmental impacts



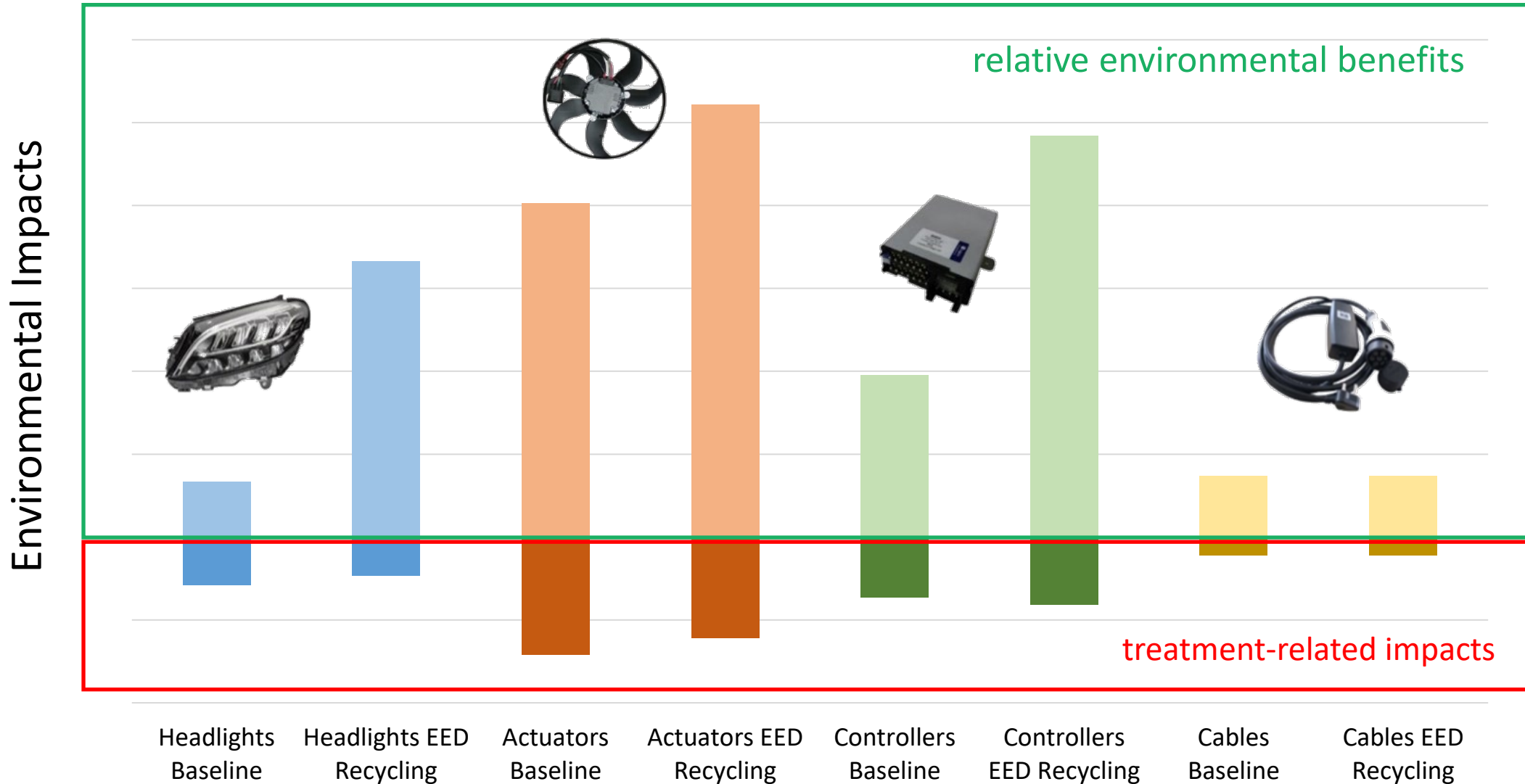
Factor	Evaluation Method	Scenario	Result	Category
Environmental impacts		Baseline - Current system: No specific CRM recovery		
		EED Recycling – Future scenario: CRM recovery from EED		

# E-Axis - Environmental impacts



Factor	Evaluation Method	Scenario	Result	Category
Environmental impacts	Life cycle assessment (LCA)	Baseline - Current system: No specific CRM recovery		
		EED Recycling – Future scenario: CRM recovery from EED		

# Results - Life cycle assessment



# E-Axis - Environmental impacts



Factor	Evaluation Method	Scenario	Result	Category
Environmental impacts	Life cycle assessment (LCA)		Functions as reference scenario in LCA evaluation	E1
		Baseline: No specific CRM recovery	No specific CRM recovery, hence not possible to evaluate	NA
		Recycling: CRM recovery from EED		

# E-Axis - Environmental impacts



Factor	Evaluation Method	Scenario	Result	Category
Environmental impacts	Life cycle assessment (LCA)	Baseline: No specific CRM recovery	Functions as reference scenario in LCA evaluation	E1
			No specific CRM recovery, hence not possible to evaluate	NA
		Recycling: CRM recovery from EED	EED recycling leads to an overall environmental benefit for headlights, actuators controllers	E1

LCA is as a suitable method:

- to evaluate environmental impacts on system level
- to identify hotspots for potential projects
- to be legally compliant with Swiss E-Waste legislation (ORDEE) → Direct link to further E-Axis factors political willingness and legislation

*“Embedded electronic devices from vehicles need to be separately recycled if it is economically viable and environmentally sound”*

# Lessons learned and FutuRaM Roadmap

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## Lessons learned:

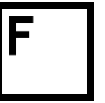
- Secondary raw materials supply continuity from EoL products strongly depends on external factors
- System readiness approach going beyond TRL, hence beyond going F-Axis
- LCA is as a suitable method to evaluate environmental impacts on system level and to identify hotspots for potential projects

## FutuRaM Roadmap:

- Develop a consistent procedure to assess and classify SRM recoverability in line with the UNFC
- Use case studies to test, further develop, validate and demonstrate the procedure in line with the UNFC

# Thank you for your attention

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