

Towards a Circular Economy of Heavy-Duty & Off-Road Vehicles and Associated Key Components

Michael Saidani, Bernard Yannou, Yann Leroy, François Cluzel

▶ To cite this version:

Michael Saidani, Bernard Yannou, Yann Leroy, François Cluzel. Towards a Circular Economy of Heavy-Duty & Off-Road Vehicles and Associated Key Components. Journées Université-Industrie sur le Développement Durable, Oct 2016, Montreuil, France. 2016. hal-01571580

HAL Id: hal-01571580

https://hal.science/hal-01571580

Submitted on 2 Aug 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



SAIDANI Michael, PhD Candidate YANNOU Bernard, LEROY Yann, **CLUZEL François, Supevisors**

Laboratoire Génie Industriel, CentraleSupélec Université Paris-Saclay, France Contact: michael.saidani@ecp.fr

Towards a Circular Economy of Heavy-Duty & Off-Road (HDOR) Vehicles and Associated Key Components (KC)

Contextual Framework

HDOR Features & Issues

- Mass of EoL HDOR = Mass of ELV in France [ADEME 06]
- Poor traceability after sales & Recycling channels are marginal
- Shipment of HDOR by illegal operators is still a flourishing business [EC & Bio by Deloitte 14]

Emerging Technologies

- **Intelligent** Transportation System
- More & more devices connected to the OBD (On Board Diagnosis)
- GPS + RFID + IoT + Telematics + Big Data Analytics applied to transportation and construction industries

Regulations

- Absence of a regulatory framework for EoL & CO₂ emissions of HDOR, contrary to ELV (2000/53/EC)
- Extended Producer Responsibility for some spare parts
- Beware: Geographical disparity of EoL & Emissions Regulations
- REACH; WEEE; RoHS

Industrial Needs

- Anticipate upcoming regulations
- Develop new Business Model (e.g. PSS, Telematics Offers)
- Eco-management in real-time (e.g. eco-drive, preventive maintenance)

Waste Management & Treatment

Reduce dependency on oils & precious raw materials

Climate Change & Global

Warming, Human Health & Air Quality Issues [IPCC 14]

Natural resources depletion & European dependency on "Critical raw materials" [EC 12]

Environment

HDOR Vehicles & Sustainability Issues

Social

- **Human** Rights & Conditions in mines to extract precious metals contained in HDOR
- **Strikes & Job Destruction** related to mining conflict
- Job Creation through Circular Economy [Ellen McArthur 13]



 Price volatility of rare and precious raw materials such as Platinum Group Metals [EC 12]

Economic benefits of the ELV Directive outweigh the costs of its implementation [EC 14]

Economic

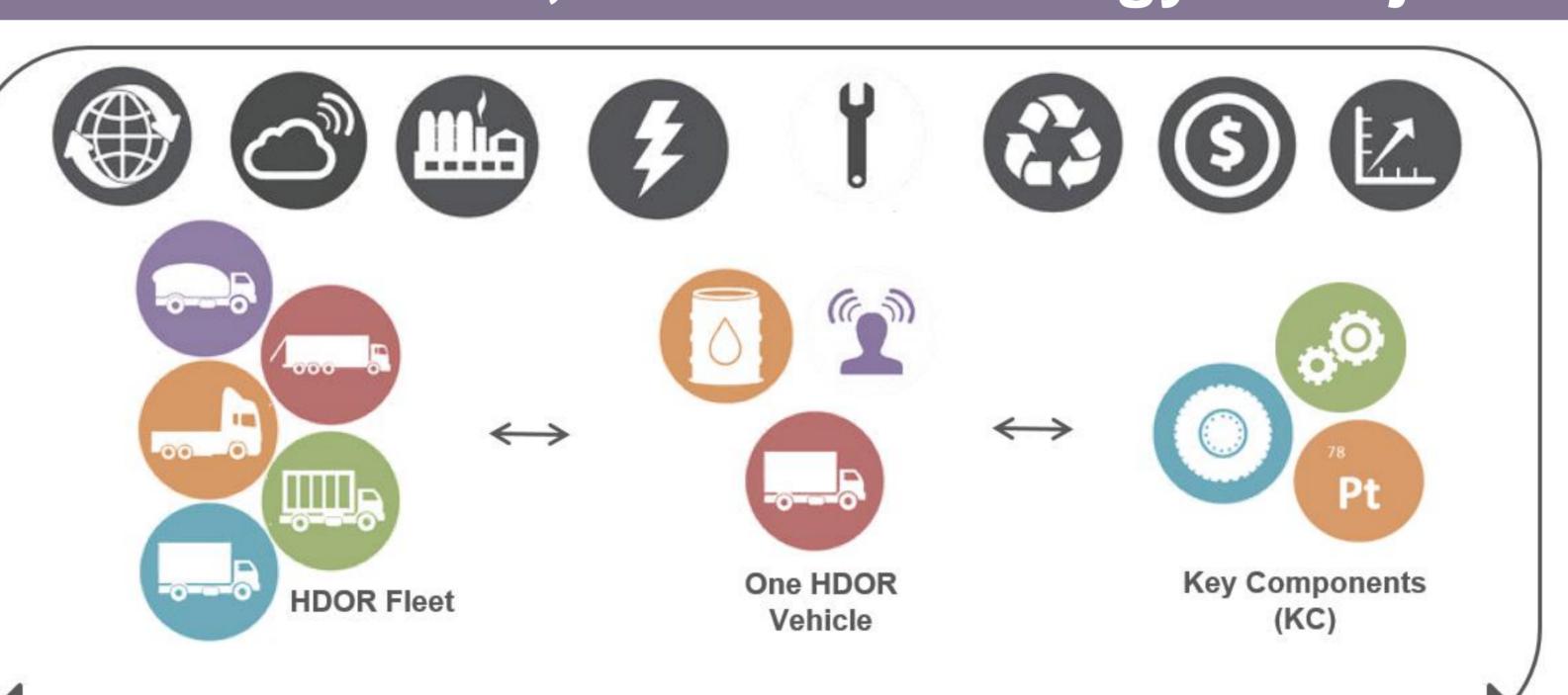
Research Question, Multimethodology & Objectives

Research Question

How to enhance the sustainable management of **HDOR Vehicles** all along their life cycle, at different scales and for all stakeholders thanks to the help of **new** and emerging technologies, in the context of Circular Economy?

Multimethodology

Holistic & integrated framework that combined the **strengths** of complementary methods & tools



Multi-Scales & Multi-Stakeholders Approach Throughout All Life Cycle

Objectives

- For Academics = To develop relevant frameworks to handle the 3 sustainability pillars within socio-technical complex systems
- For **Industrial Sector** = To foster and help companies in a more sustainable management of their HDOR fleet all along life cycle
- For **Policy-Makers** = To support strategic policy decisions on the End-of-Life of HDOR Vehicles

Case Study on 1 KC - The Catalytic Converter

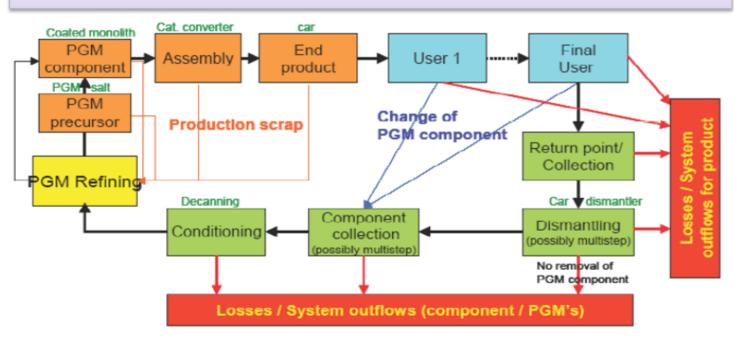


Why is it a Key Component?

- Emission regulations are increasingly strict Essential control device to make the air cleaner
- Contains Precious Group Metals (e.g. Platinum)
- Tremendous cost and environmental impacts



Previous Work & Current Situation



- Open loop recycling for catalytic converters
- → Overall platinum recycling rate below 50%

[Hagelüken et al. 16]

Data Construction

- Life cycle thinking approach
- Mix of data from mining operators, equipments manufacturers, users, market trends, recycling centers, environmental agencies reports, ...
- → Consolidation of all the data in one standardized Excel data sheet

1. Cognitive Mapping

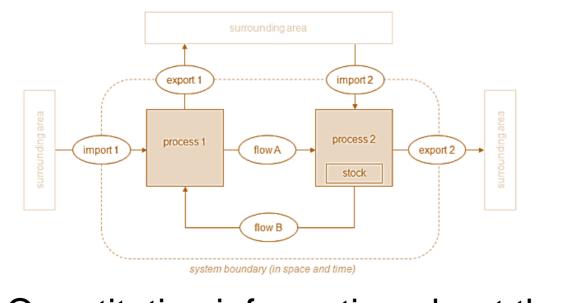


- To list and link all influencing parameters
- Comprehensive overview of the system

SD Simulations

Modelling Stages

2. Up-to-date MFA of the value chain



 Quantitative information about the existing channel, stock and losses

3. Refined Graphical Model

- System Dynamics model
- Feedback loops that fit to the circular economy paradigm

Simulations & Forecasts

[Farel & Yannou 13]

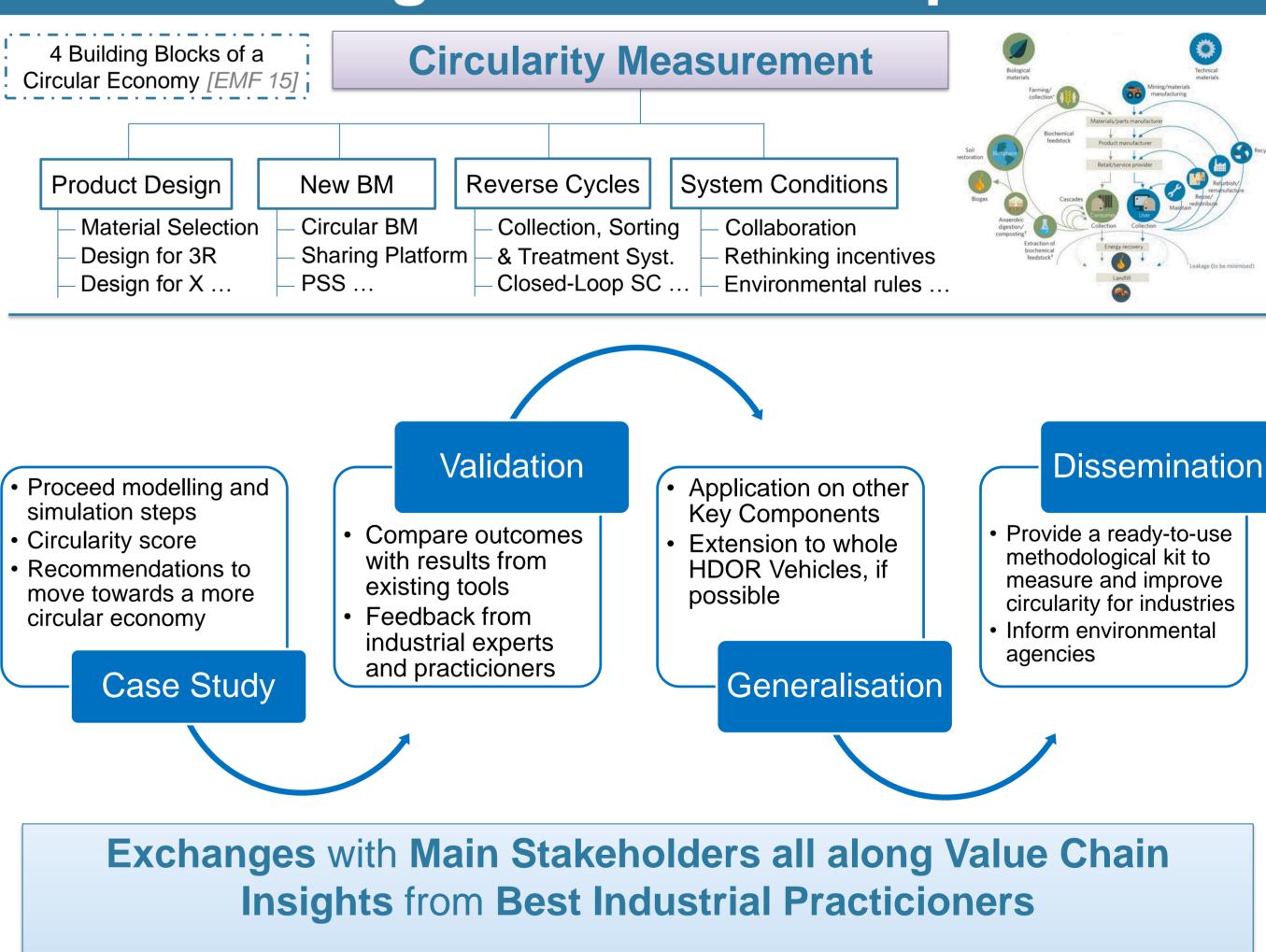
How to close the loop of Platinum from Catalytic Converters of HDOR Vehicles?

- -> Prospective scenarios construction to evaluate potential environmental & economic impacts
- What will happen if a minimum mandatory recycling rate of HDOR Vehicles is implemented?

JUIN-DD'16

What if collection rate is improved by 10% or if design is modified for easy disassembly? ...

Progress & Next Steps



BOUYGUES CONSTRUCTION











References

[EMF 15] Ellen Mc Arthur Foundation, Towards the circular economy: Business Rationale for

- [EC 12] Report on Critical Raw Materials for the EU, European Commission, 2012.
- [EC 14] Ex-post evaluation of certain waste stream Directives, European Commission, 2014.
- an accelerated transition, 2015. [Farel & Yannou 13] Farel R., Yannou B., A Method to Design a Value Chain from Scratch,
- ICoRD' 13, Lecture Notes in Mechanical Engineering, India, 2013. [IPCC 14] Climate Change 2014: Synthesis Report, IPCC, 2014.
- [Hagelüken et al. 16] Hagelüken C., et al., The EU Circular Economy and Its Relevance to Metal Recycling. Recycling Volume 1, Issue 2, 2016.

