Adding Transparency to the Circular Flow of Batteries

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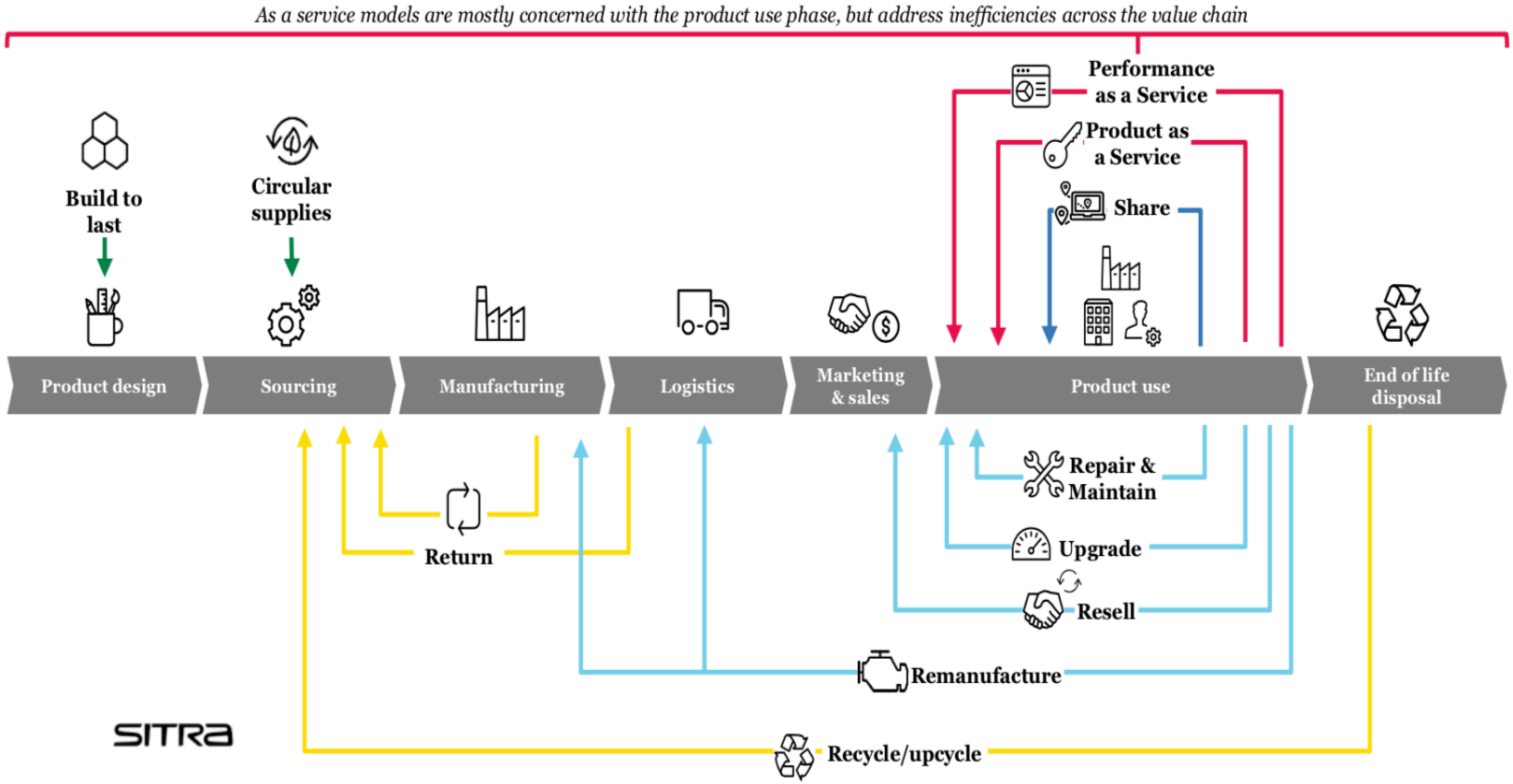
EV Ledger

Circular Economy



Additional circular business models

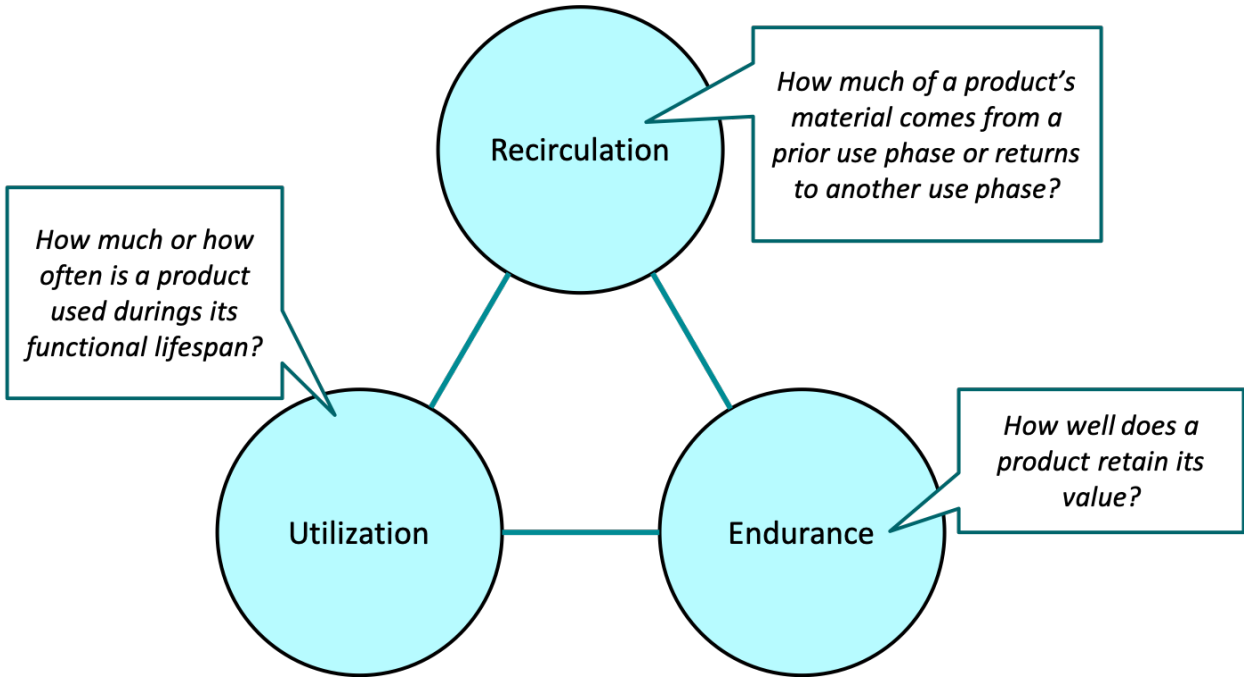
Circular supply chain
- Recycled direct materials
- Sustainable indirect materials

Sharing platform
- Virtual sharing platform
- Physical sharing platform

Recovery & Recycling
- Recover
- Downcycle

Product life extension
- Restore
- Repurpose
- Refresh

Three-dimensional product circularity and material flow



Source: Boyer et al. (2020)

Project: Adding Transparency to Circular Flow of Batteries by Blockchain Technology

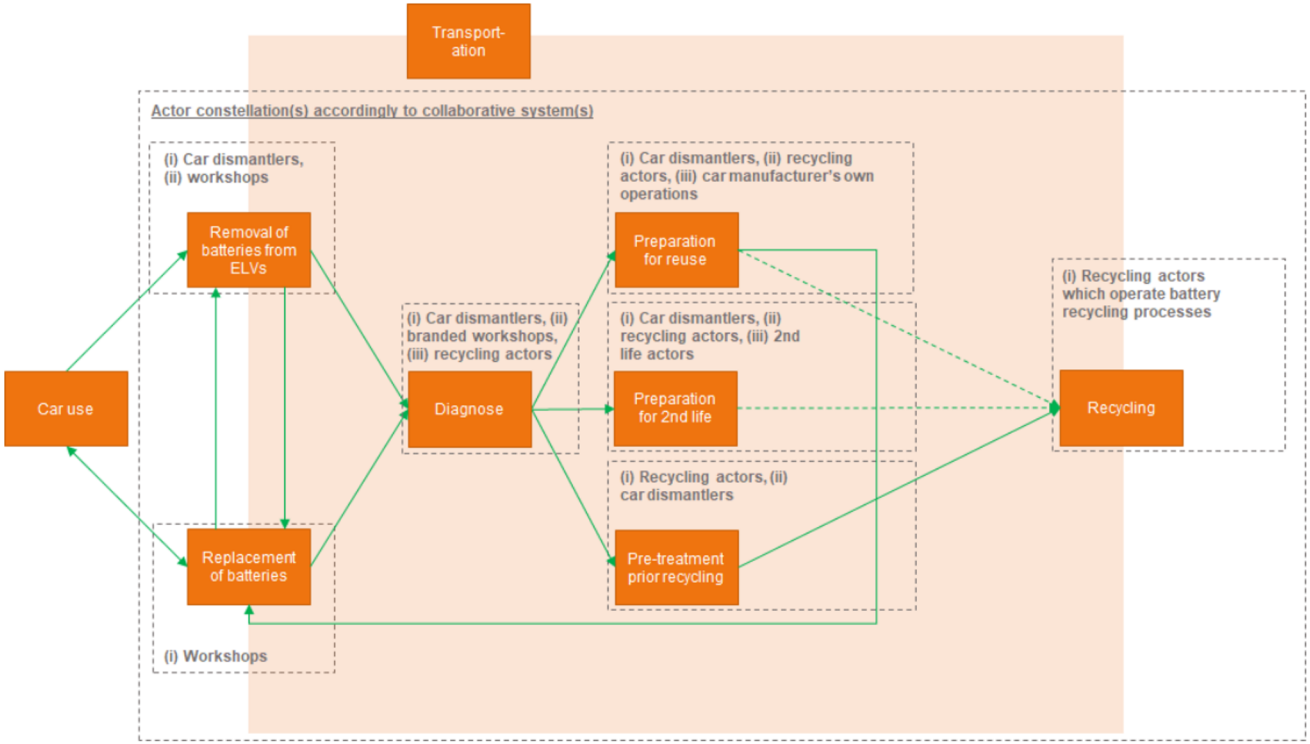
Aim: to increase trust and transparency between actors in a circular value chain of batteries by developing and validating a tool that uses blockchain to verify and track performance of individual battery cells.

Method: Ecosystem mapping, business model conceptualization and verification

Duration: 2019-11-01 - 2021-06-30

SCAR 2015-2018

Sustainable Collection, Aftermarket and Recycling of lithium car batteries

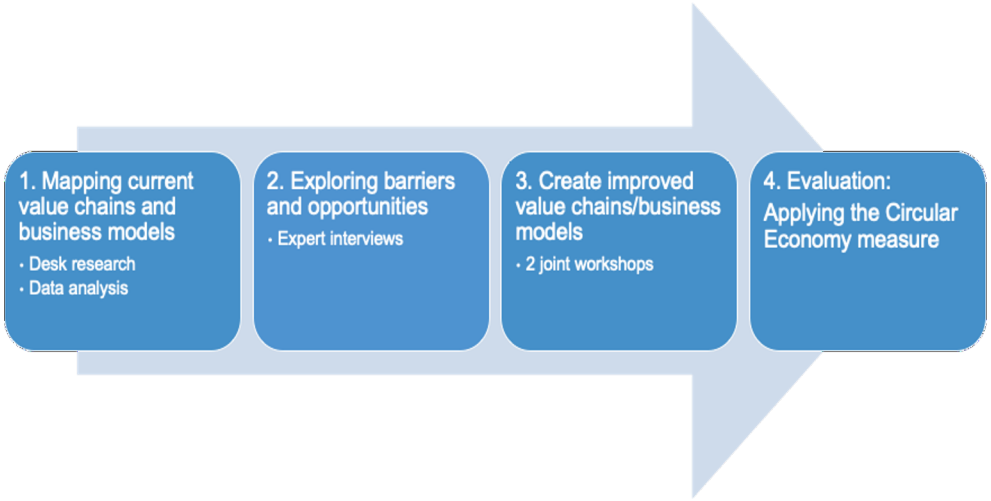


Purpose: identify and assess various models of efficient **take-back system**

Energimyndigheten
Batterifondsprogrammet

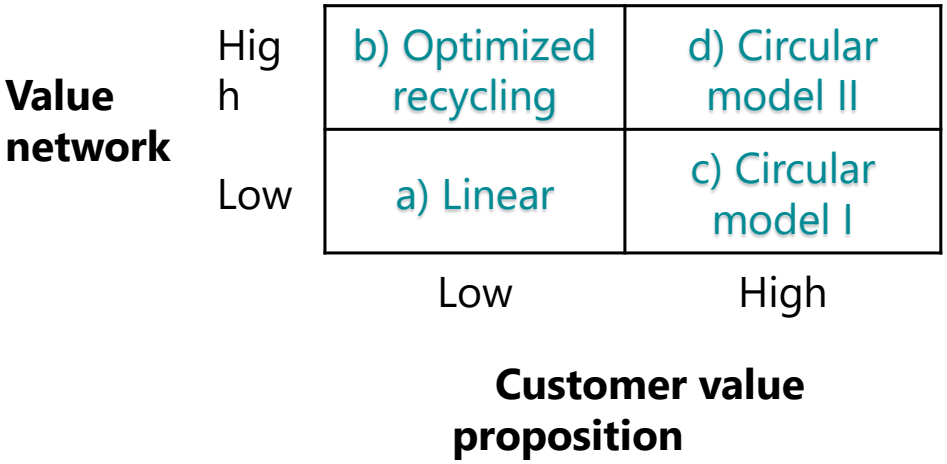
Circular business models for EV batteries (2017-2018)

- Purpose: Analyzing barriers and opportunities with an extended battery value chain
- Method: desktop research, 20 interviews, and 2 workshops



RI. SE VOLVO VATTENFALL STENA RECYCLING VINNOVA

Four business model scenarios



a) **Linear model:** battery production and use in vehicle + currently practiced recycling

b) **Optimized recycling:** battery production and use in vehicle + state of the art recycling

c) **Circular model I:** battery production and use in vehicle + repair and refurbishing for second use in vehicle in the same or a new market + state of the art recycling.

d) **Circular model II:** battery production and use in vehicle + repackaging and second life in a different application + state of the art recycling

Insights on potential opportunities for circular business models

Application	Actors	Comments
Storage of solar or wind power	Households, property owners	Small or large scale, off-grid or grid-connected
Peak shaving	Industries	Reducing power demand
EV charging	Property owners, grid owners	Reducing power demand at time of charging
Increased grid capability and stability	Grid owners	Instead of installing larger cables, or to avoid fluctuation
Backup	Industries, property owners	In case of electricity loss
Electricity trading	Electricity companies	Having a battery farm for electricity trading
Vehicle propulsion	Vehicle manufacturers	E.g., ferries, forklifts

Insights on potential barriers for circular business models

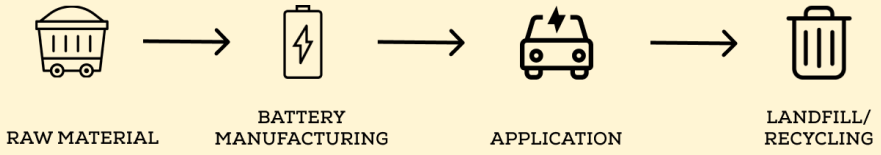
	strategy barriers	Organizational barriers	Technological barriers
Second life	Lack of interest in second life applications that are conflicting with the existing business models.	Regulatory uncertainties in relation to producer responsibility and the definition of the product during the second life.	Lack of standardization beyond the cell level, and in module and pack levels.
	Not realizing the potential value in second use in the existing market(s).	Not investing in collection of existing batteries due to low volumes.	Lack of knowledge on the remaining capacity after first life.
		Lack of collaboration along the value chain.	
Recycling	Aligning investments with previous business models based on selling raw materials.	Risk of investment in large scale automated processes when future technology advancements are uncertain.	Variations in number and type of cell, physical shape and chemistry.

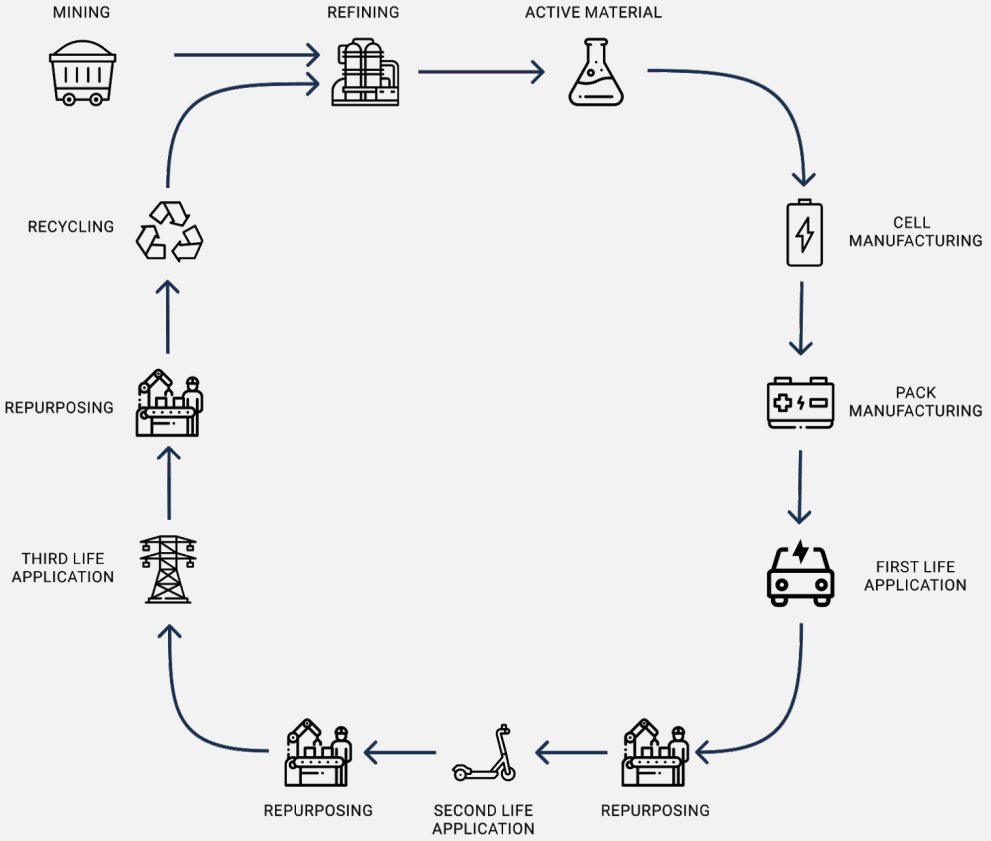
More results in *Batteries, vol. 4, issue 4*

Enabling a sustainable and transparent battery lifecycle.

A distributed data verification model that optimizes reuse of knowledge and minimizes both cost and environmental impacts of battery flows.

With blockchain technology, the web gains a new layer of functionality.





Future circular battery ecosystem

Interviewed actors:
OEMS, dismantlers, repair workshops, PTA, insurance companies, recycling companies, energy companies, fleet owners, battery refurbishing/repurposing companies, …

Inquiry about:
Roles and positions in the future ecosystem, information access, and data needs in a circular value chain

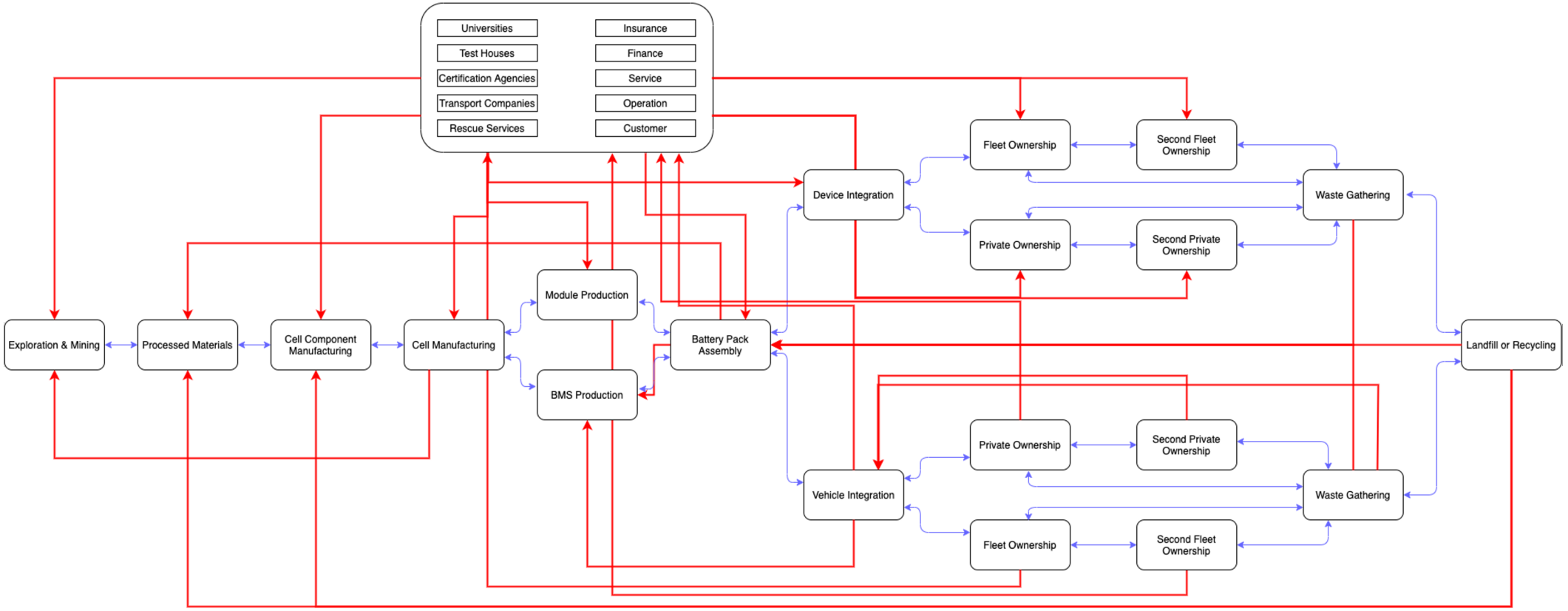
Findings:
Need to have more information on:

- battery health status
- details about design/construction
- Specifications about the chemistry

- Traceability is currently more discussed with regards to material sourcing and recovery, rather than value preservation.

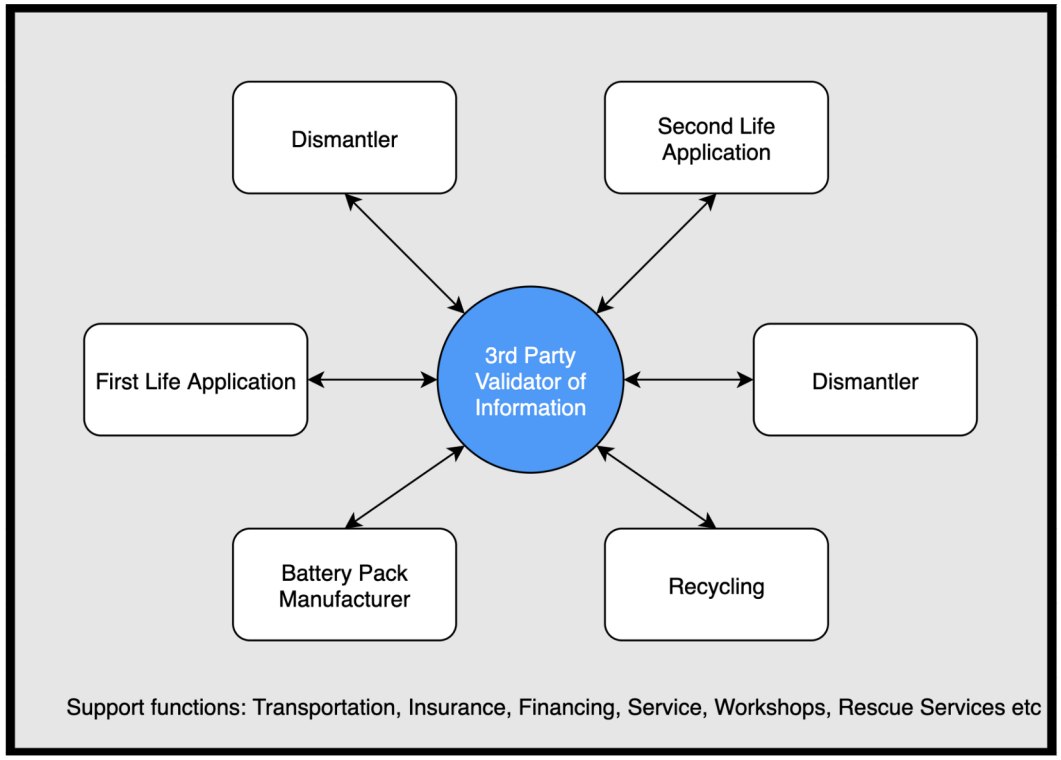
- Need for distributed collection points taking care of pre-treatment, dismantling and preparation for recycling.

Very complex and distributed ecosystems



Blue lines represent current battery flow.
Red lines represent just some of the nonexistent but needed informations flows

An alternative setup



Orchestrating that complex data sorting and data sharing network and the infrastructure required for that goes beyond the current business models of the involved stakeholders.

This could be resolved by a battery information gathering entity that:

- distributes individual battery information throughout the ecosystem.
- act as a 3rd party validation of the information.
- Increase the effective usage of batteries in their life-time.

Potential outcomes

Business effects

- Enabling the operation of circular business models where batteries are effectively repurposed and reused according to their remaining life in different applications.
- Enabling reverse logistics of the batteries and emergence of new markets (e.g. more naturally in B2B context, but also in C2C and C2B setups where customers can sell their used batteries in a safe and verifiable system to OEMs or to other customers.)

Societal effects

- Contribution to improved resource efficiency in consumption and production of batteries.
- Increasing trust in circular battery value chains.

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