POLITECNICO DI MILANO

THE SUSTAINABILITY ASSESSMENT IN THE FINEFUTURE PROJECT WITH A FOCUS ON LCA

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Assessment on WAste and REsources

FineFuture

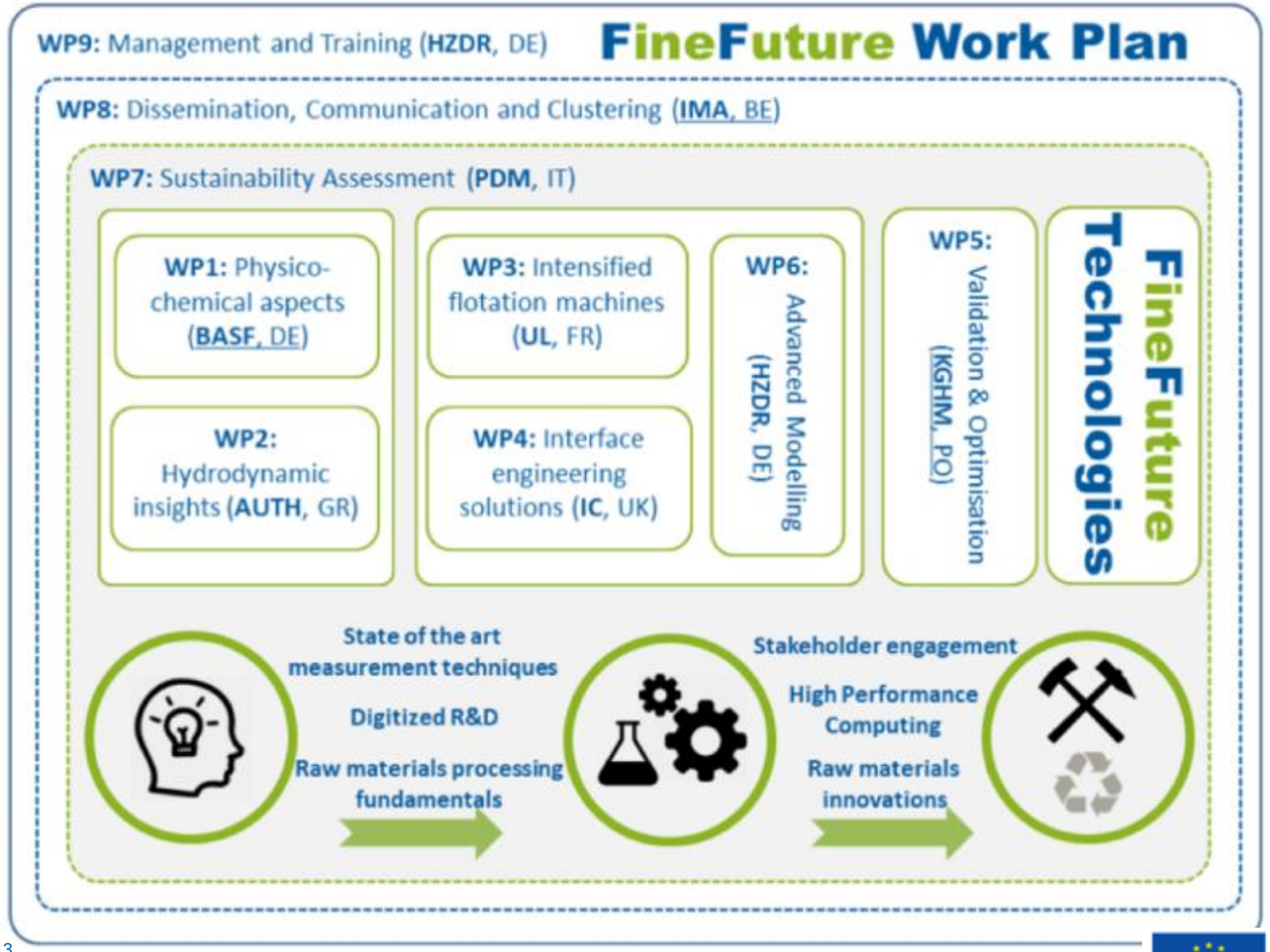
Innovative Technologies and Concepts for Fine Particle Flotation: Unlocking Future Fine-Grained Mineral and Critical Raw Materials Resources for the EU

https://finefuture-h2020.eu/

June 2019 – May 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821265.

Structure of FineFuture project



flotation needs to be entirely re-engineered for the separation of very fine particles of multiple mineral resources (e.g. copper, manganese, and magnesite) at large scale through cutting-edge technological investigations guided by industrial partners (TRL: 3-5)

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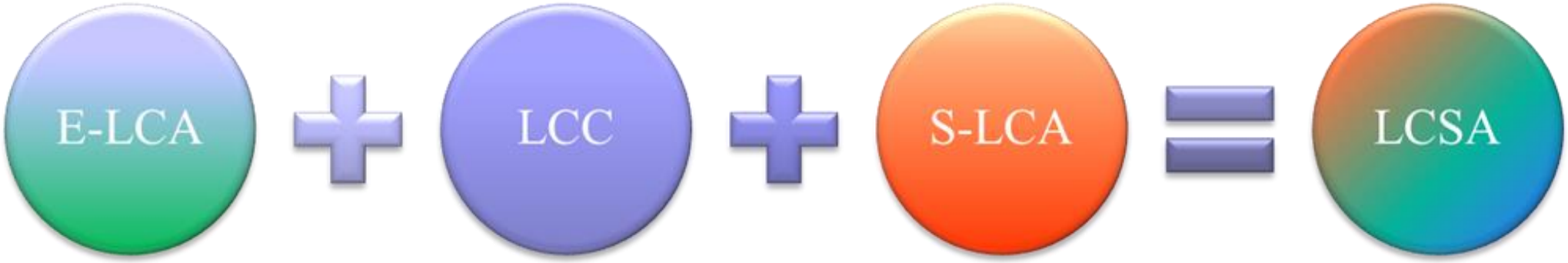
Sustainability assessment

Life Cycle Sustainability Assessment (LCSA) refers to the evaluation of all **environmental, social and economic impacts and benefits in decision-making processes towards more sustainable products throughout their life cycle**.

The analysis deals with the development of **Environmental Life Cycle Assessment (E-LCA), Social Life Cycle Assessment (S-LCA)** and **Life cycle costing (LCC)** studies for the different applications of the FineFuture **emerging flotation technology**.



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Structure of WP7

Task 7.1 LCA goal and scope definition & life cycle inventory (PDM) (M4-M30)

Task 7.2
Life Cycle Impact Assessment and interpretation of the results (PDM) (M9-M36)

Task 7.3
Preliminary LCC and preliminary social-LCA (PDM) (M17-M34)

Task 7.4
Preliminary business plan (HZDR)
(M24-M36)

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Setting up the sustainability assessment

MATERIALS AND METHODS

	CHALLENGES	POSSIBLE SOLUTIONS	OUR ANSWERS
SYSTEM DEFINITION	• One or more technologies will be developed • Technologies not yet defined • Application of the technology to a broad spectrum of sources, materials and beneficiation processes (processes that already include flotation either not) • To be applied to a site/material dependent process	a) Identification of an **average** case b) Selection of **representative** case studies	**Representative** case studies: comparative LCAs of the system before and after the implementation of the technology/ies Exemplary materials and processes selected: ✓ Copper ore extracted with flotation ✓ Magnesite ore extracted with flotation ✓ Magnesite ore extracted without flotation ✓ Manganese from tailings ✓ Copper from tailings

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Case studies

4 case studies were established by involving **all industrial partners**

Case study		Industry	System boundary	Confirmation status
1	flotation is in use at the current beneficiation plant; FineFuture flotation will complement the traditional one to treat the fines	KGHM	production with traditional flotation vs. production with traditional + FineFuture flotation technologies	Feasibility is under study
		Magnesitas Navarras		Feasibility is under study
2	the current beneficiation does not include flotation; FineFuture flotation will be implemented to treat fines	Grecian Magnesite	current beneficiation without flotation vs. current beneficiation + FineFuture flotation technology	Feasibility is under study
3	the current beneficiation does not include flotation; FineFuture flotation will be applied to tailings	Eramet	tailings pond vs. tailings processed with FineFuture technology	Feasibility is under study
4	the flotation is in use at the current beneficiation plant; FineFuture flotation will be applied to tailings	KGHM	tailings disposal vs. tailings processed with FineFuture technology	Feasibility is under study

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On-going:

S-LCA

LCA + LCC

LCA

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Setting up the sustainability assessment

MATERIALS AND METHODS

	CHALLENGES	POSSIBLE SOLUTIONS	OUR ANSWERS
FUNCTIONAL UNIT (FU)	Defining the functional unit of a system producing an intermediate product (the concentrate) whose characteristics might change after the implementation of the technology (first of all the concentration, but also granulometry, etc.)	a) Input based functional unit (the ore minerals/tailings rather than the concentrate) b) Including the downstream processes until the refined mineral/metal is obtained c) Commodity oriented Functional Unit (i.e. the valuable content in the concentrate)	**a) Input based functional unit** ✓ Effects downstream are not an issue ✗ It is not the function of the system ✗ It creates a multi-functionality in the system (the concentrate) **c) Commodity oriented functional unit** ✓ It represents the real function of the system ✗ It disregards the effects that other characteristics of the product might have downstream

Review paper submitted to the **International Journal of LCA:**

"Life Cycle Assessment of flotation for raw material production: A review"

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Setting up the LCA of Case Study 3 - ERAMET

GOAL

To compare the environmental performance of tailings disposal in ponds *vs* tailings processed with FineFuture technology

SCOPE

Functional unit = management of 1 t slurry (slimes + water)

Temporal coverage = period 2016-2020 → 2030-2035 (FineFuture implementation)

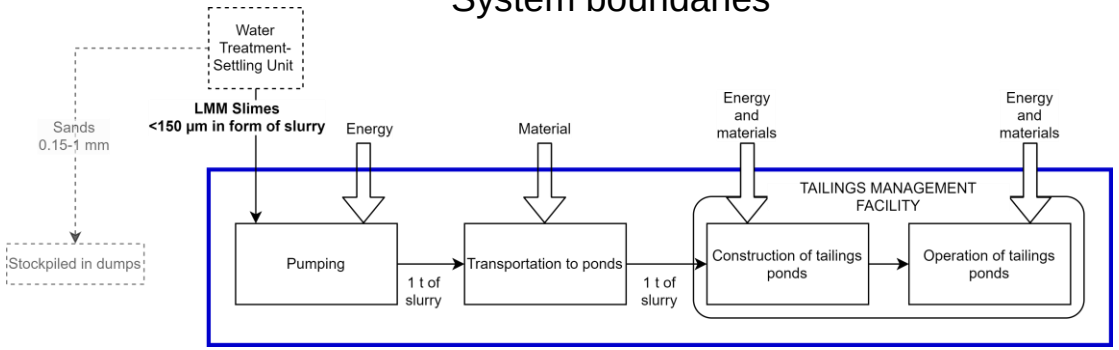
Technical and Geographical coverage = beneficiation plant in Gabon

Baseline scenario: *tailings disposal in ponds*

Collection of primary data through questionnaires sent to ERAMET:

- Main data of the Mn-ore beneficiation plant
- Data on tailings management, in terms of equipment and energy/materials requirements
- Data on tailings characteristics

System boundaries



Dotted boxes= processes not included in the LCA system boundaries

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Setting the LCA of Case Study 3 - ERAMET

<u>Future scenario</u>: ***tailings treated with FF flotation (to recover Mn) before disposal in ponds***

System boundaries: set **a range of predictive scenarios** to tackle **uncertainties** about the industrial implementation of the FineFuture technology

Lower scenario

Minimum equipment

RANGE OF IMPACTS

MOST LIKELY SCENARIO

Upper scenario

Maximum equipment

Possible future plant lay-out (pre-treatments):

1. *No pre-treatment*: suitable particle size (no coarse particles)
2. *Microcycloning* before FF flotation (no chemicals): low pulp density not suitable for FF flotation
3. *Settling* + *Thickening* before FF flotation (flocculants): low pulp density not suitable for FF flotation

Possible future plant lay-out (for the recovered flow):

1. *(cold) Pelletizing* + *(pyrometallurgy)*: fine Mn product, adequate quality (>40%Mn), good mechanical properties
2. *Pelletizing* + *sintering*+ *(pyrometallurgy)*: fine Mn product, adequate or low quality (≤40%Mn), poor mechanical properties

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Setting the LCA of Case Study 3 - ERAMET

<u>Future scenario</u>: ***tailings treated with FF flotation (to recover Mn) before disposal in ponds***

Data sources

- Data related to the future full-scale implementation of the FineFuture technology should derived from the results of WP5 (mini-pilot plant) and WP6 (numerical simulations)
- Inventory data related to the background system (e.g. electricity production) will be secondary data (databases, literature) or proxy data

Data up-scaling

Scaling effects can significantly affect the LCA outcome (changes in energy and materials yields)

→ will be included in the assessment of environmental impacts by applying a **scale-up procedure**

Data availability and data quality can become a critical issue

→ results from laboratory tests shall be available compatibly with the time scheduling of WP7 activities. Industrial partners will be involved in validating the results from scale-up calculations

Data uncertainties related to the up-scaling of an emerging technology

→ will be identified and communicated; their effects on the LCA results will be quantified by building **a range of predictive scenarios** and by running **sensitivity analyses** for the up-scaled systems

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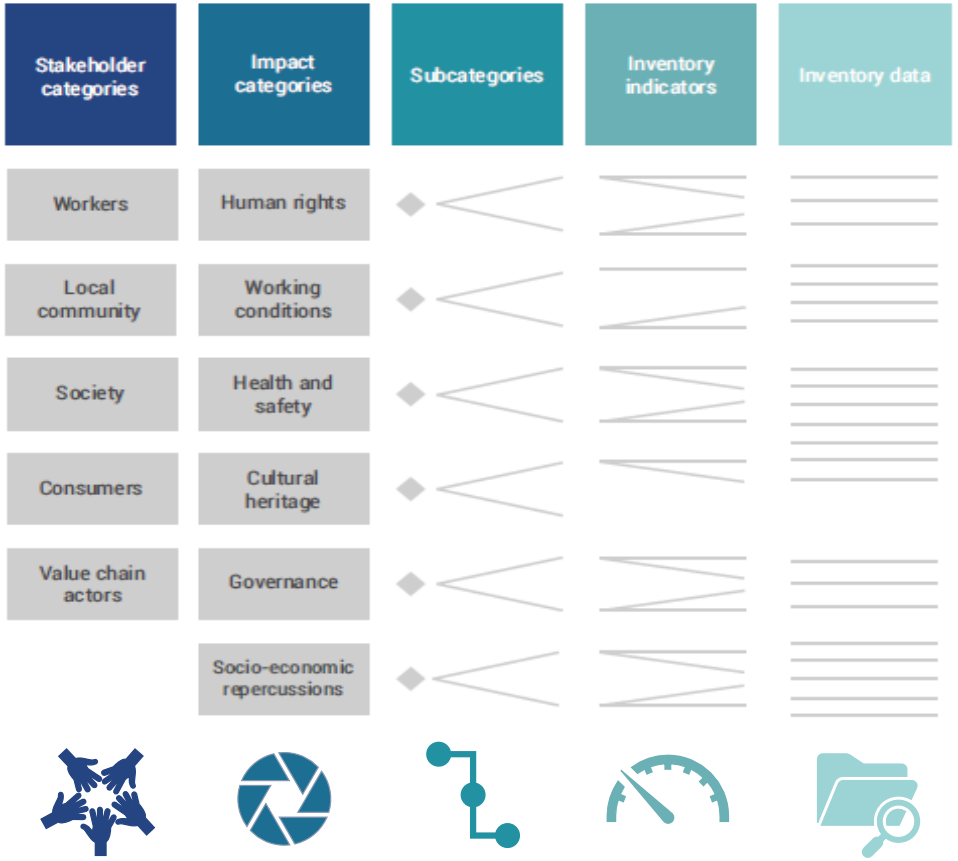
Social - LCA

The UNEP Guidelines for Social Life Cycle Assessment of Products proposes a methodology to develop life cycle inventories. A life cycle inventory is elaborated for **indicators linked to impact categories** which are related to stakeholder groups.



Stakeholder categories	Worker	Local community	Value chain actors (not including consumers)	Consumer	Society	Children
Subcategories	1. Freedom of association and collective barganing 2. Child lbor 3. Fair salary 4. Working hours 5. Forced labor 6. Equal opportunities / discrimination 7. Health and safety 8. Social benefits / social security 9. Employment relationship 10. Sexual harassment 11. Smallholders including farmers	1. Access to material resources 2. Access to immaterial resources 3. Delocalization and migration 4. Cultural heritage 5. Safe and healthy living conditions 6. Respect of indigenous rights 7. Community engagement 8. Local employment 9. Secure living conditions	1. Fair competition 2. Promoting social responsibility 3. Supplier relationships 4. Respect of intellectual property rights 5. Wealth distribution	1. Health and safety 2. Feedback mechanism 3. Consumer privacy 4. Transparency 5. End-of-life responsibility	1. Public commitments to sustainability issues 2. Contribution to economic development 3. Prevention and mitigation of armed conflicts 4. Technology development 5. Corruption 6. Ethical treatment of animals 7. Poverty alleviation	1. Education provided in the local community 2. Health issues for children as consumers 3. Children concerns regarding marketing practices

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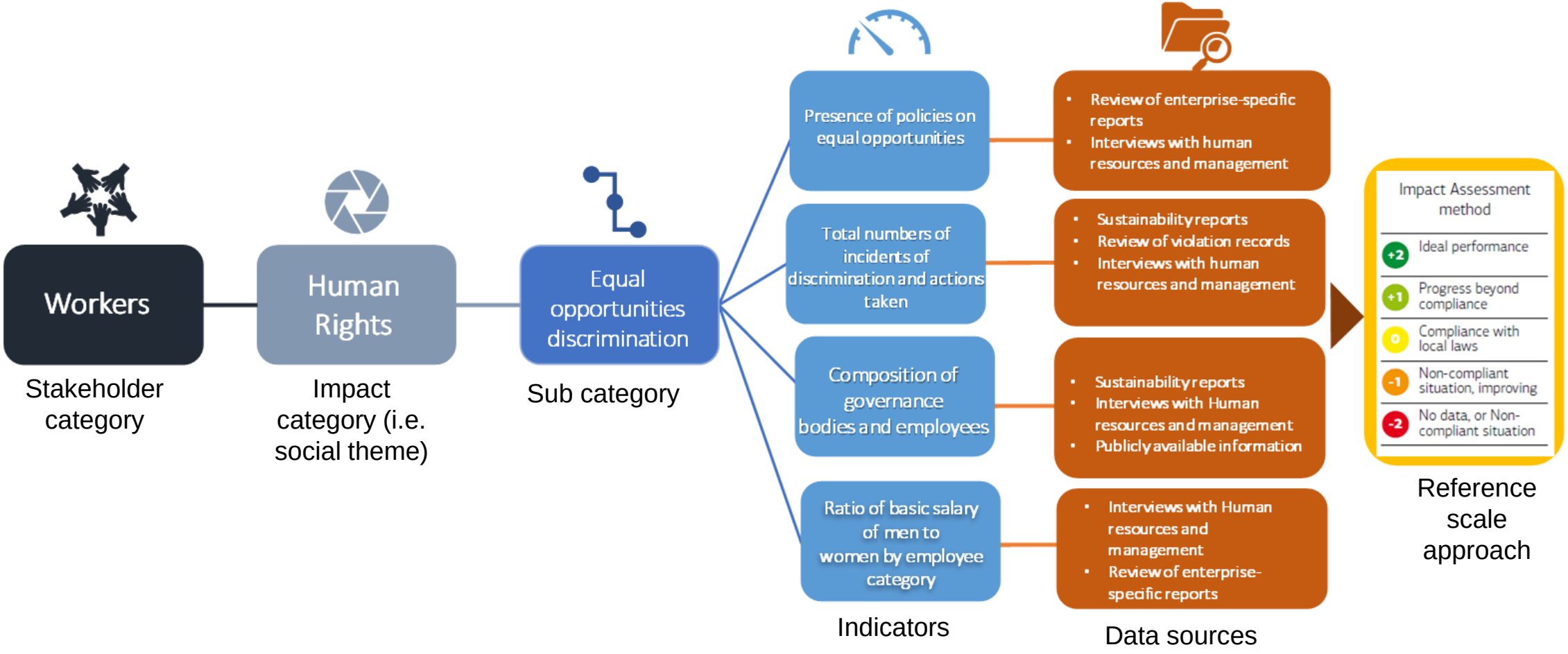
Social - LCA

Choice of the approach for the Social-LCA (i.e. **Reference Scale approach**)



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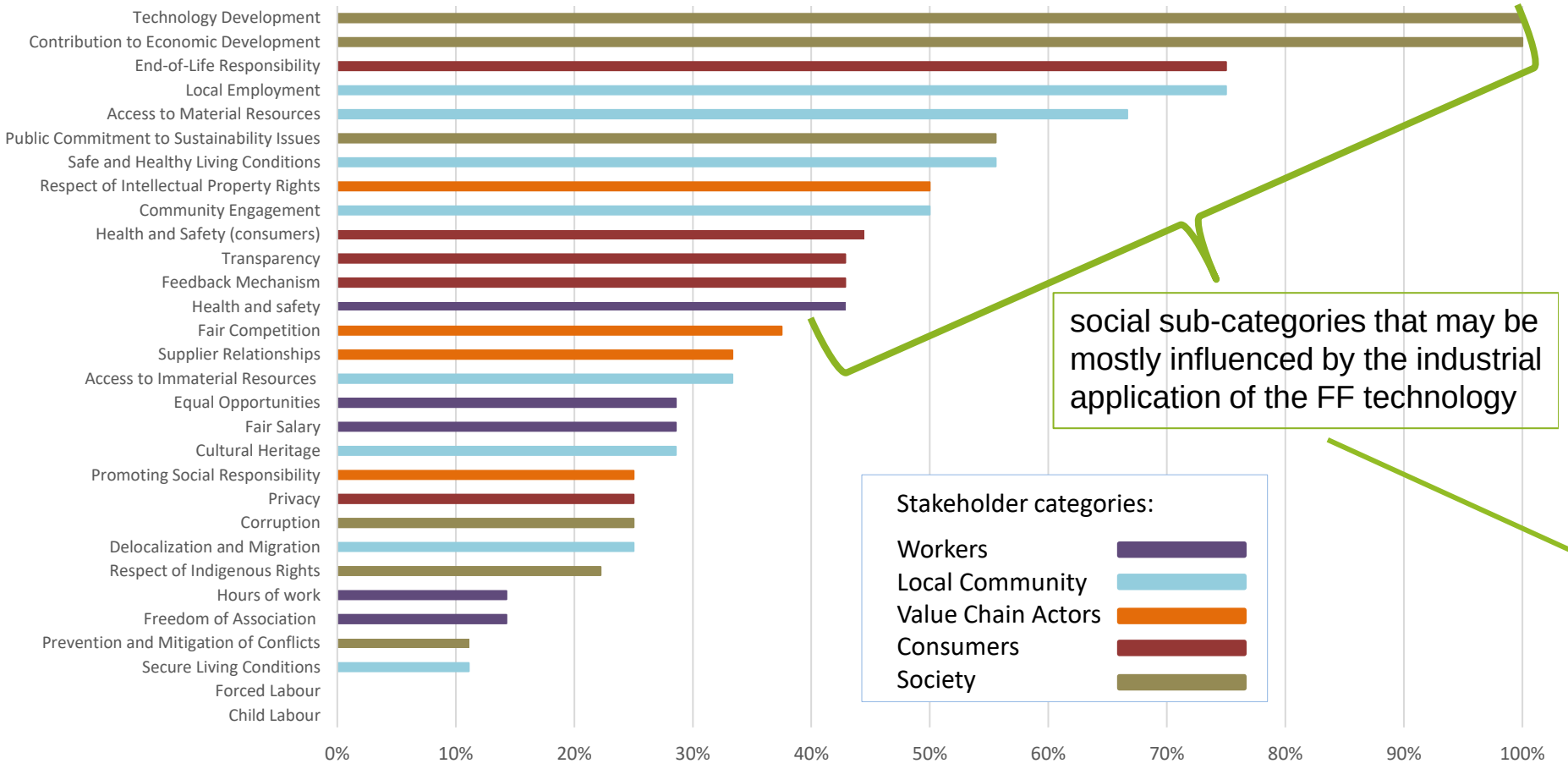
Social - LCA

Choice of stakeholder categories and social themes to be analysed in the S-LCA → **survey** administrated to the FineFuture consortium



social sub-categories that may be mostly influenced by the industrial application of the FF technology

AIM: identify the social sub-categories for each stakeholder category that may be influenced by the industrial application of the FineFuture technology

RESULT: **13** (out of 30) most selected sub-categories (**>40%**)

Evaluation of the corresponding indicators

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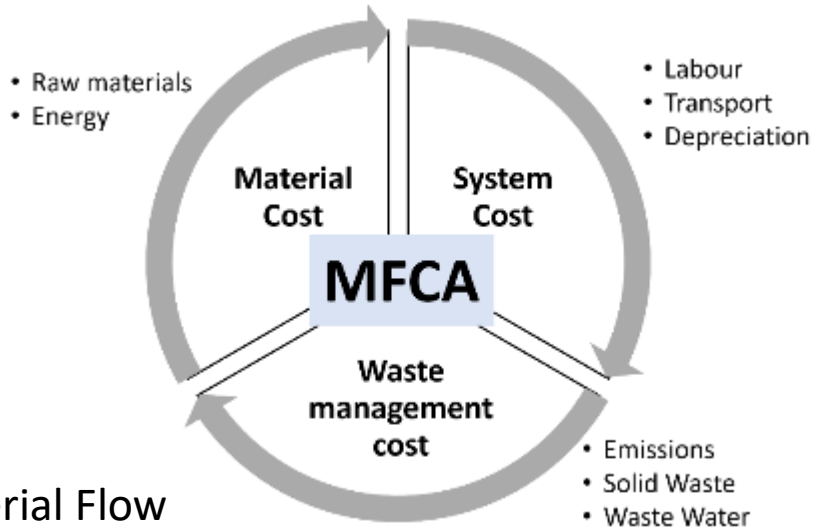
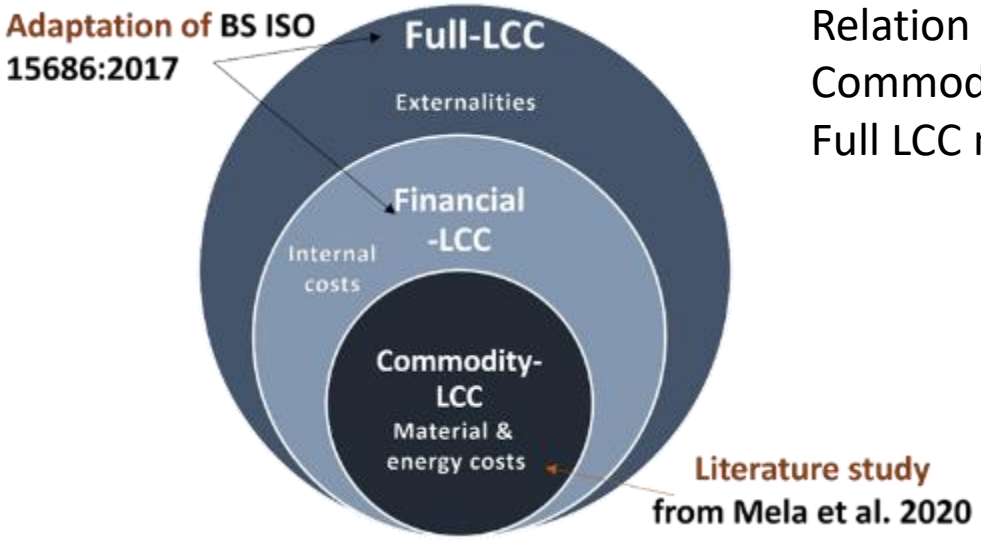
Life Cycle Costing



Material Flow Cost Accounting



Relation between Commodity, Financial and Full LCC methodologies

Few methodologies are being explored to carry out the LCC. **MFCA** accounts for direct costs associated to any material and energy flows and stocks within an organization. **Commodity-LCC** accounts for costs of raw materials for the whole life cycle of a product from the viewpoint of one specific actor, whereas **Financial-LCC** includes all internal costs for the whole life cycle of a product covered by all actors; if accompanied with external costs, a **Full-LCC** is achieved.

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Life Cycle Costing

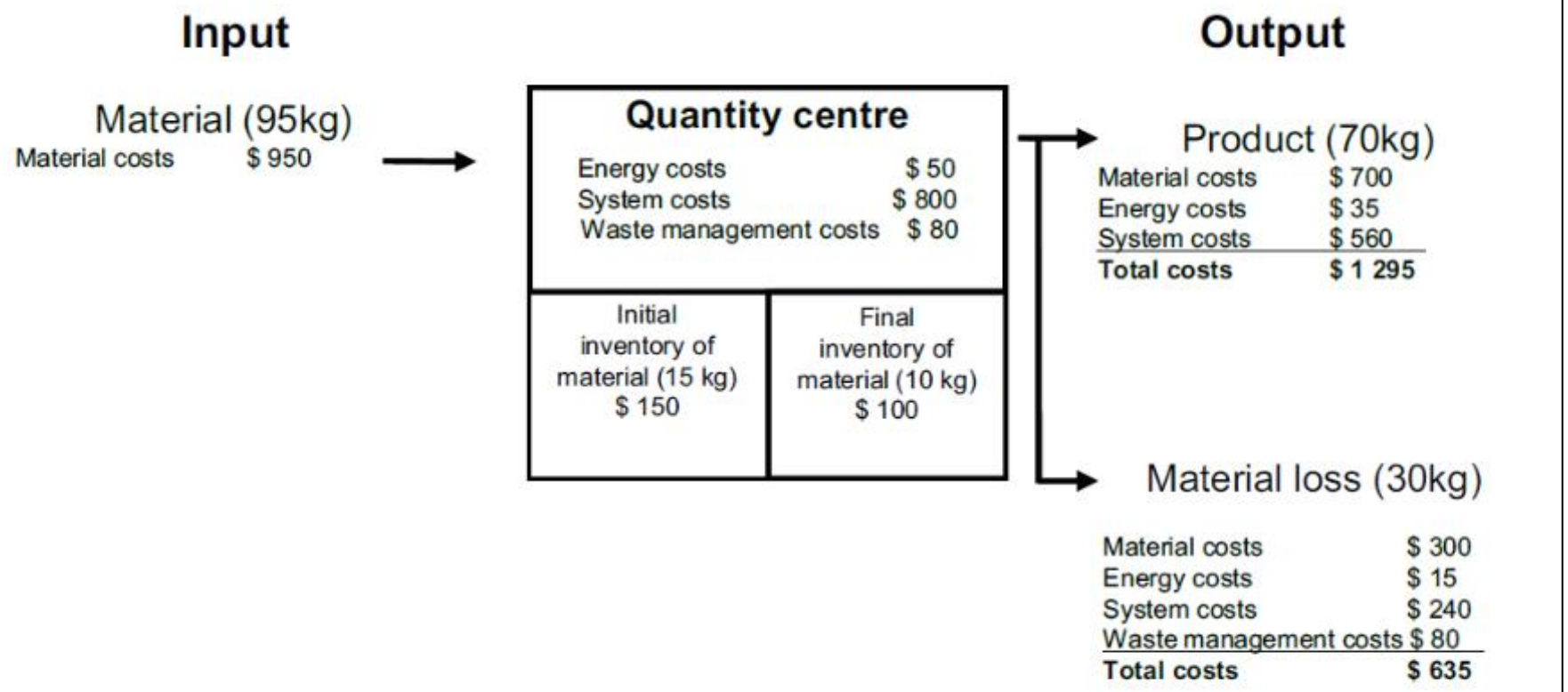

Figure 2 — Cost calculation in a quantity centre

2-STEP PROCEDURE:

Material flow model
+
Association of costs to any material and energy flows

MFCA: BS EN ISO 14051:2011

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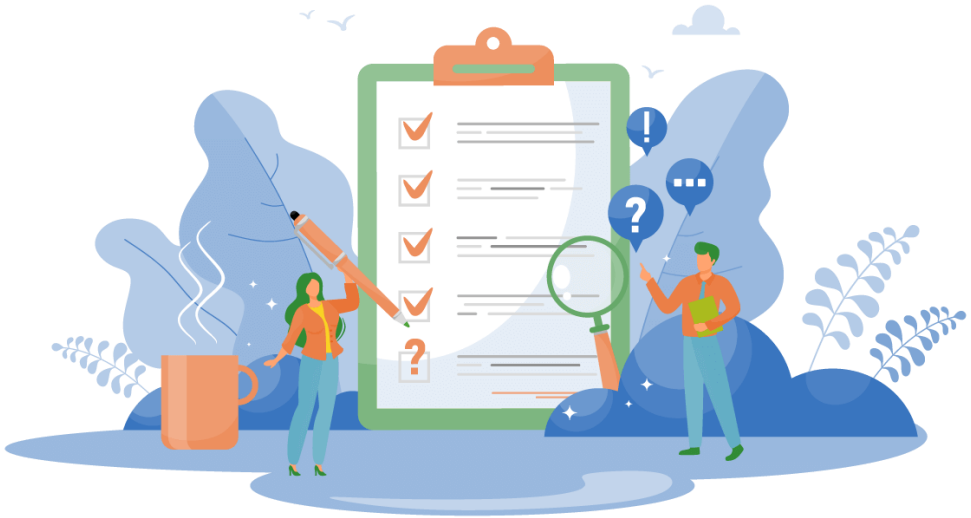
Conclusions

The application of **Life Cycle Thinking methodologies** to **emerging technologies** involve **several complications** due to the **assumptions needed** to develop **future scenarios**.

Data collection is the most time-consuming phase. The correct **identification of all the indicators** to be taken into consideration, together with the **sensitivity of the data** required, are a central issue of the analysis.

The application of the **impact assessment methods for the three different analyses** will provide the first results, which will help to assess the **sustainability** of the technological development linked to the FineFuture.

The sustainability analysis (**E-LCA, S-LCA and LCC**) developed for the different case studies will produce a significant **added value for the technology developed** within the project.



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THANK YOU!

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