FineFuture

Minerals recovery from beneficiation waste in mining industry: prospective LCA of Grecian Magnesite case study

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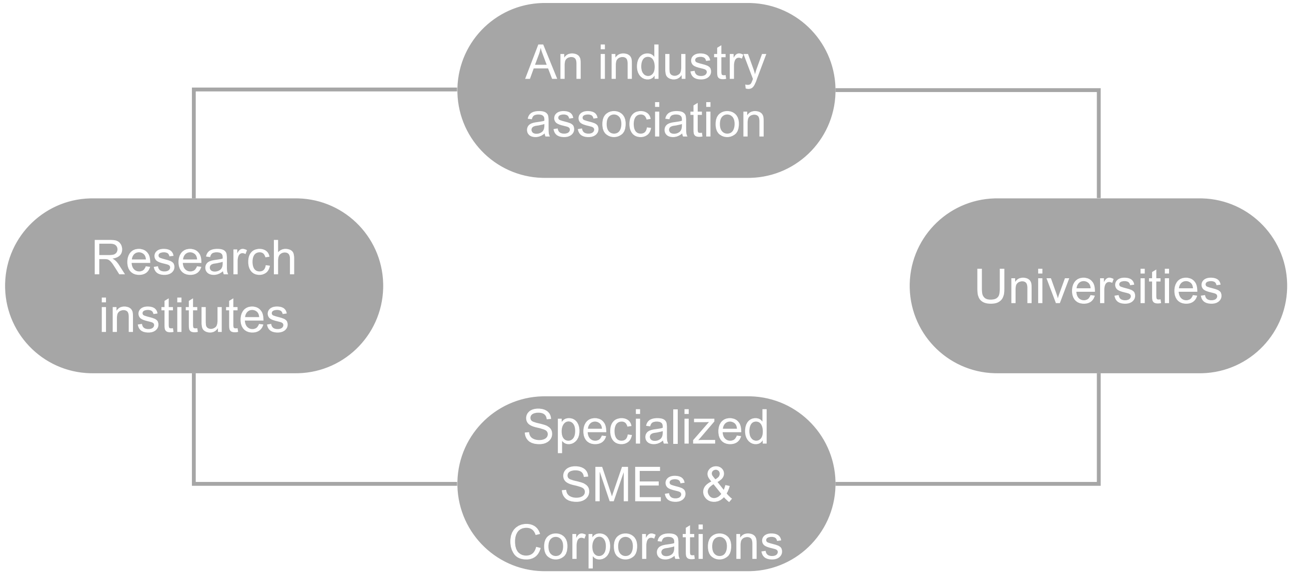
What is FineFuture?

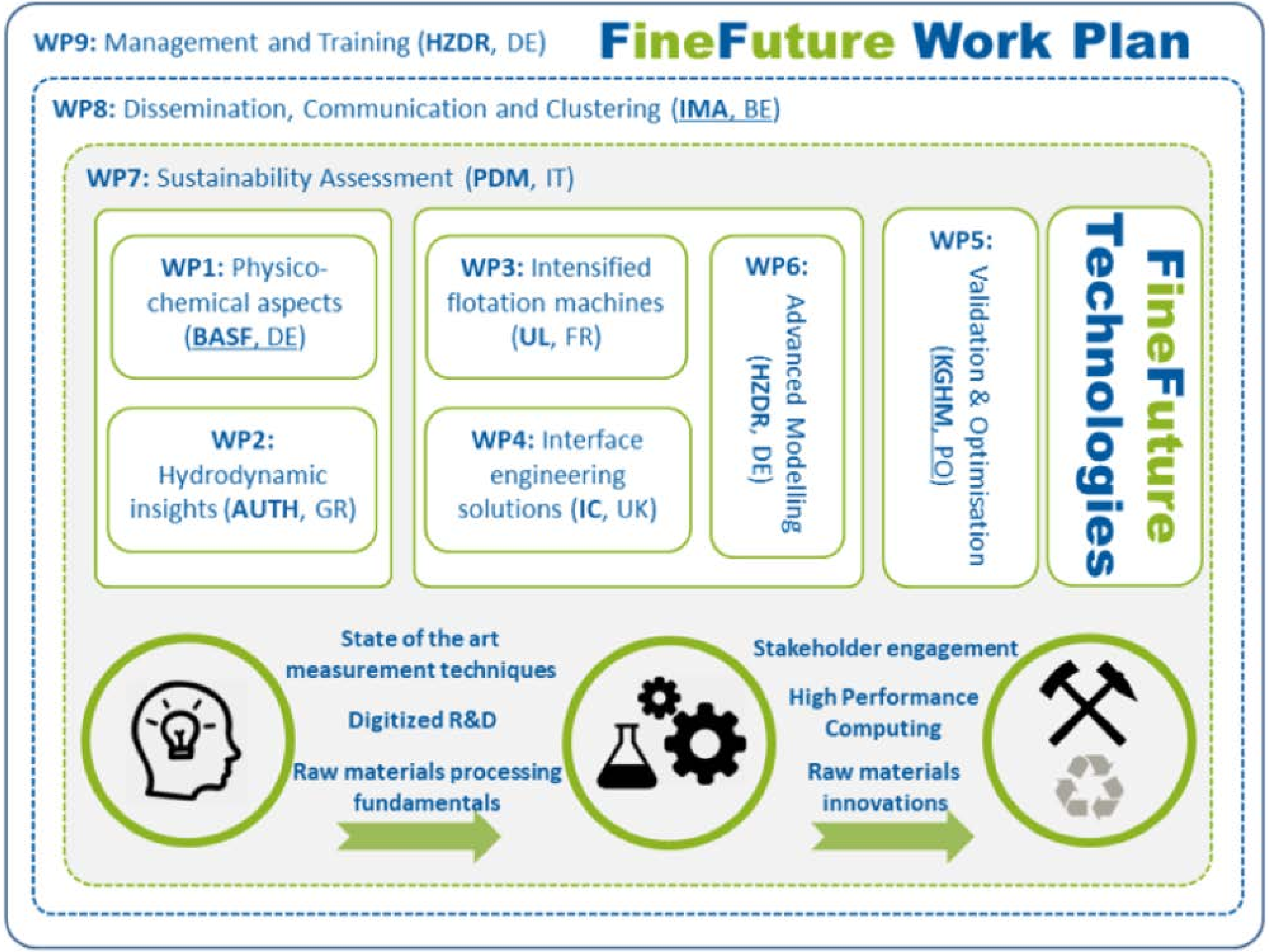
It is a European Horizon 2020 project whose main objective is to enhance the competitiveness of the European industrial minerals industry by developing new technologies to to exploit the fine particle fractions.

www.finefuture-h2020.eu/

The FineFuture consists of 16 partners from different European countries including:



What is FineFuture?



Prospective LCA

A new froth flotation technology (FF technology) is being developed aiming at valorising very fine mineral particles instead of discarding them as waste during beneficiation stage in mining industry

Does this mean that it is a sustainable solution?

Prospective life cycle assessment (LCA)

Case Study

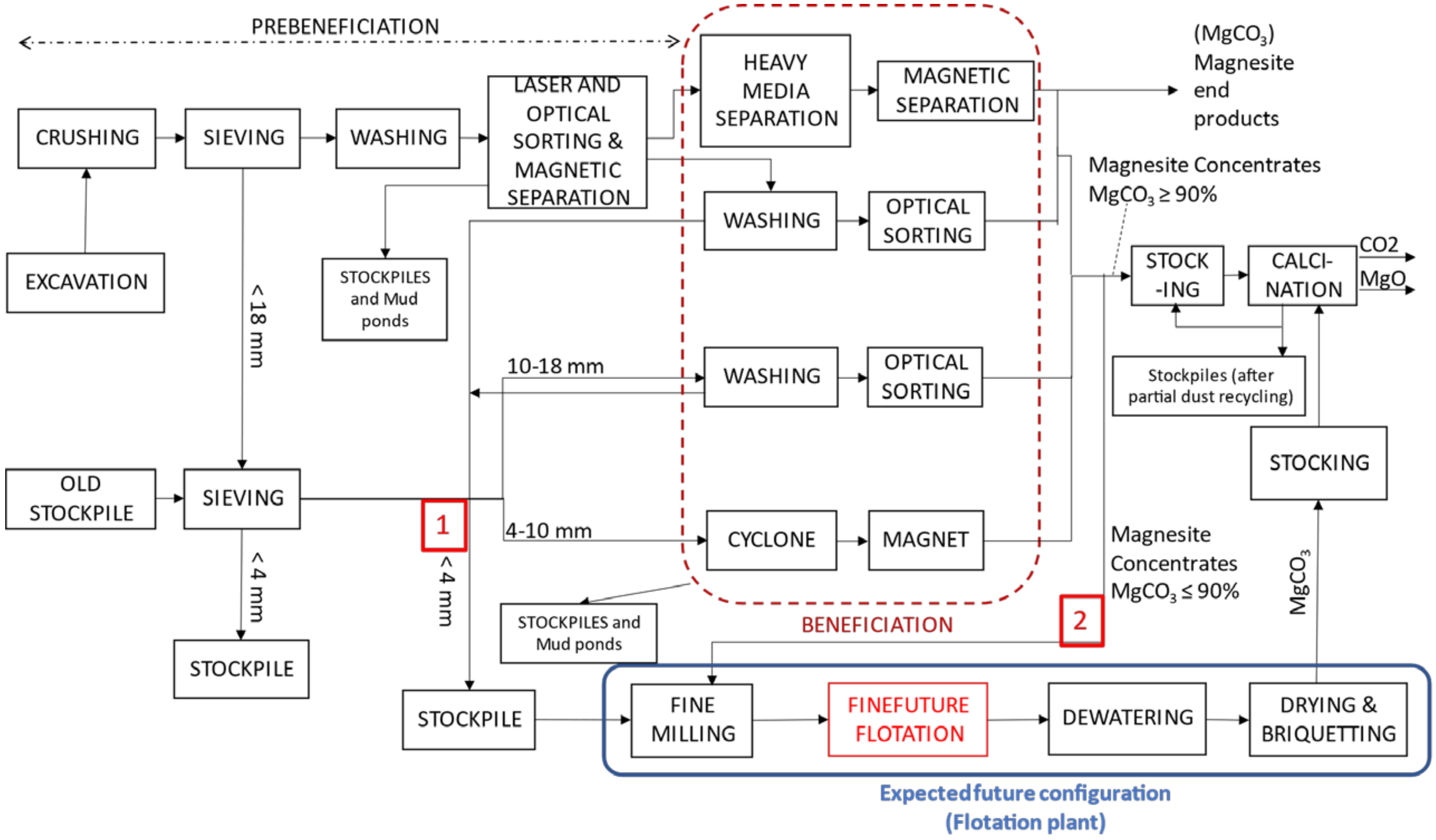
GRECIAN MAGNESITE

- Current beneficiation system does not include a flotation unit
- Main product: Magnesia (MgO) + High quality magnesite concentrates ($MgCO_3$)
- Company nationality: Greek

Setting up the LCA of Grecian Magnesite Case Study

GOAL

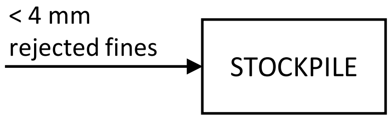
1. to compare the environmental performance of fines discarding in stockpiles *vs* beneficiation with FF technology
2. to compare the environmental performance in case FF technology is used to upgrade low quality MgCO3 before calcination to have average higher quality magnesia as a final product compared to current quality



Setting up the LCA of Grecian Magnesite Case Study

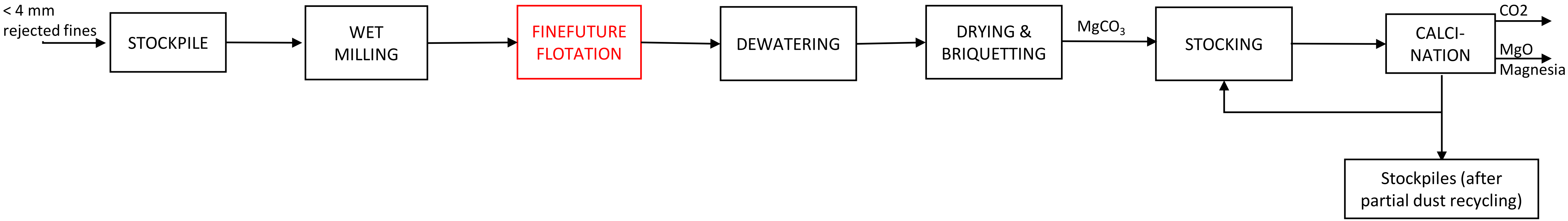
Case 1

Current Scenario:



Functional unit (F.U.): the management of *1 tonne* **of fines** with granular size <4 mm from washing step in beneficiation department

Future Scenario:



Setting up the LCA of Grecian Magnesite Case 1

Data collection

Primary data collection of current scenario **(May-June 2021)** → Data about current beneficiation plant of GM

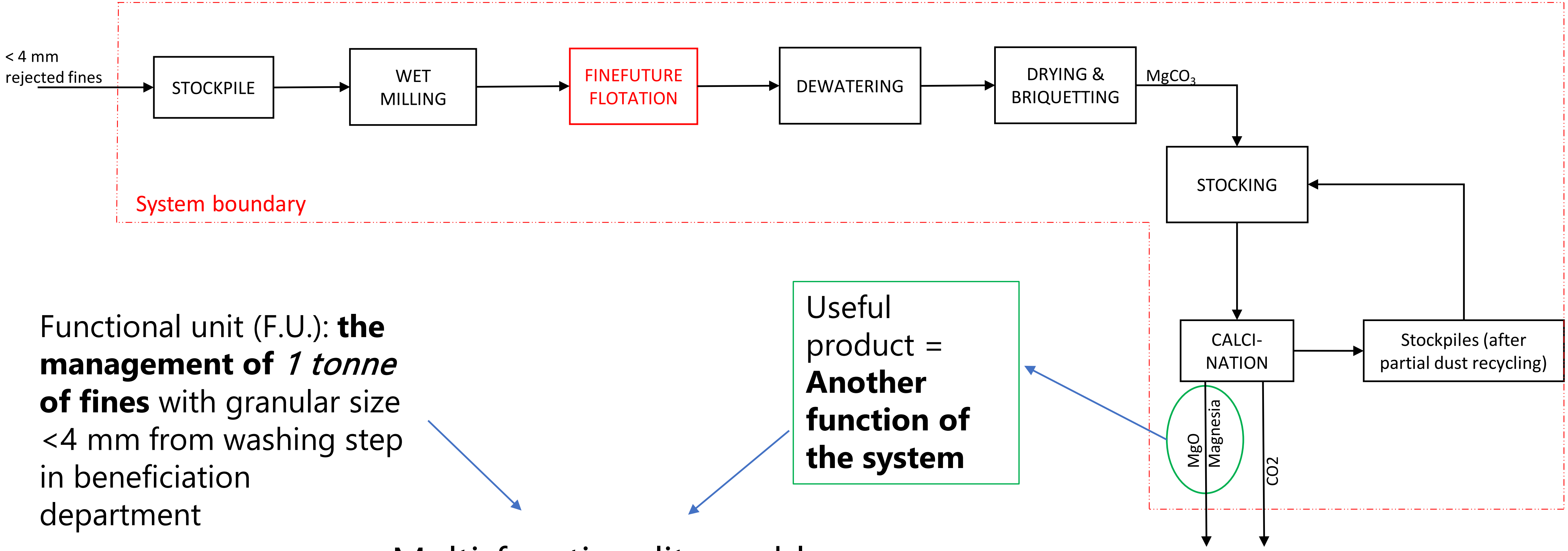
Primary data collection of future scenario (**October 2021 – Jan 2022)** →

- Data about the possible usage of energy and materials in the new flotation unit and other supplementary units (wet mills, rotary dryers… etc)
- Expected magnesite recovery efficiencies
- Quality of the final product (i.e. magnesia) and it varies in the two cases under study

Data regarding the future implementation of FF technology is being carried out through continuous communication with GM and the experts in lab-scale testing of the new flotation technology

Setting up the LCA of Grecian Magnesite Case 1

Solving the multi-functionality



Functional unit (F.U.): **the management of *1 tonne* of fines** with granular size <4 mm from washing step in beneficiation department

Useful product = **Another function of the system**

Multi-functionality problem

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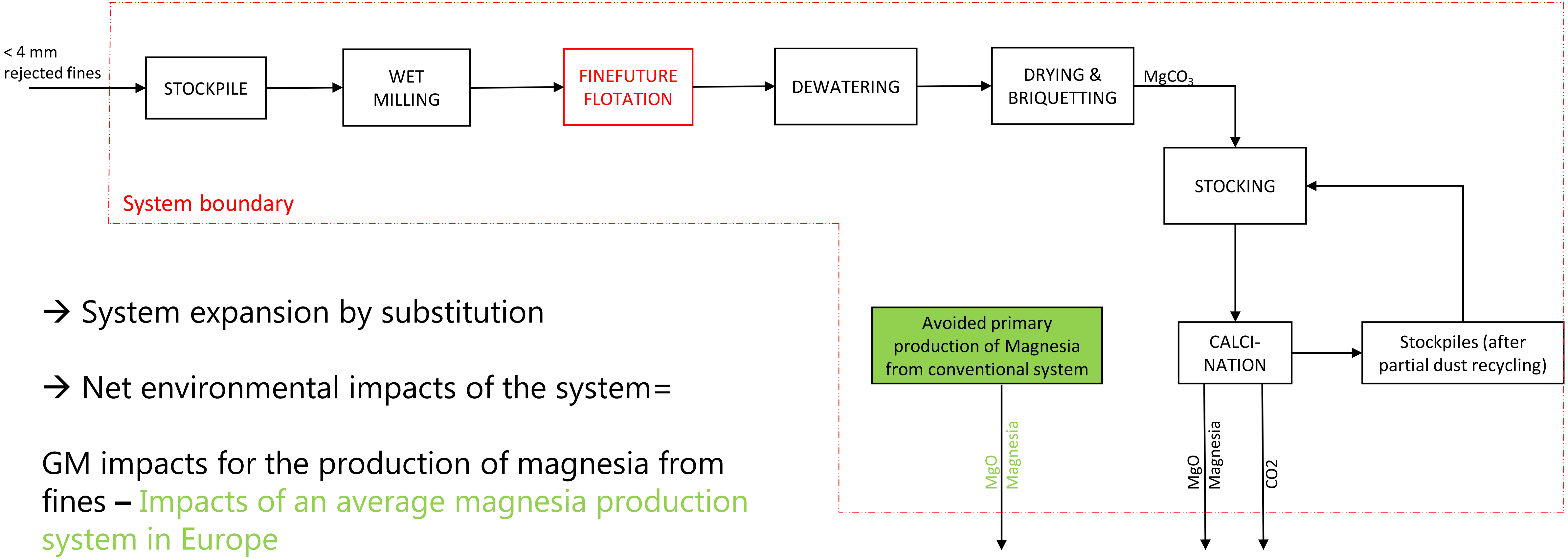
Setting up the LCA of Grecian Magnesite Case 1

Solving the multi-functionality



→ System expansion by substitution

→ Net environmental impacts of the system=

GM impacts for the production of magnesia from fines – Impacts of an average magnesia production system in Europe
(Substitution factor: 0.81)

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LCIA and interpretation of the results: GM Case 1

Preliminary impact assessment results

Current Scenario *vs* Future Scenario*

Impact category	Unit	Current system (stockpiling)	Future system (FF technology)
Climate change	kg CO2 eq	4.31E+00	**9.31E+01**
Ozone depletion	kg CFC11 eq	2.12E-06	**1.56E-05**
Ionising radiation	kBq U-235 eq	6,66E-01	**-6.38E-01**
Photochemical ozone formation	kg NMVOC eq	4.99E-02	**8.86E-01**
Particulate matter	disease inc.	9.30E-07	**-5.05E-05**
Human toxicity, non-cancer	CTUh	3.70E-08	**-1.15E-05**
Human toxicity, cancer	CTUh	1.78E-09	**-7.05E-07**
Acidification	mol H+ eq	4.21E-02	**1.99E+00**
Eutrophication, freshwater	kg P eq	2.46E-04	**4.12E-02**
Eutrophication, marine	kg N eq	1.59E-02	**3.20E-01**
Eutrophication, terrestrial	mol N eq	1.75E-01	**3.34E+00**
Ecotoxicity, freshwater	CTUe	7.69E+01	**-8.30E+03**
Land use	Pt	3.06E+02	**3.94E+02**
Water use	m3 depriv.	4.37E-01	**1.54E+01**
Resource use, fossils	MJ	1.38E+02	**6.05E+02**
Resource use, minerals and metals	kg Sb eq	8.51E-06	**1.69E-04**

*total net impacts of both systems using *EF life cycle impact assessment method*

Avoided amount of raw primary magnesite = 440 kg / t of treated fines

LCIA and interpretation of the results: GM Case 1

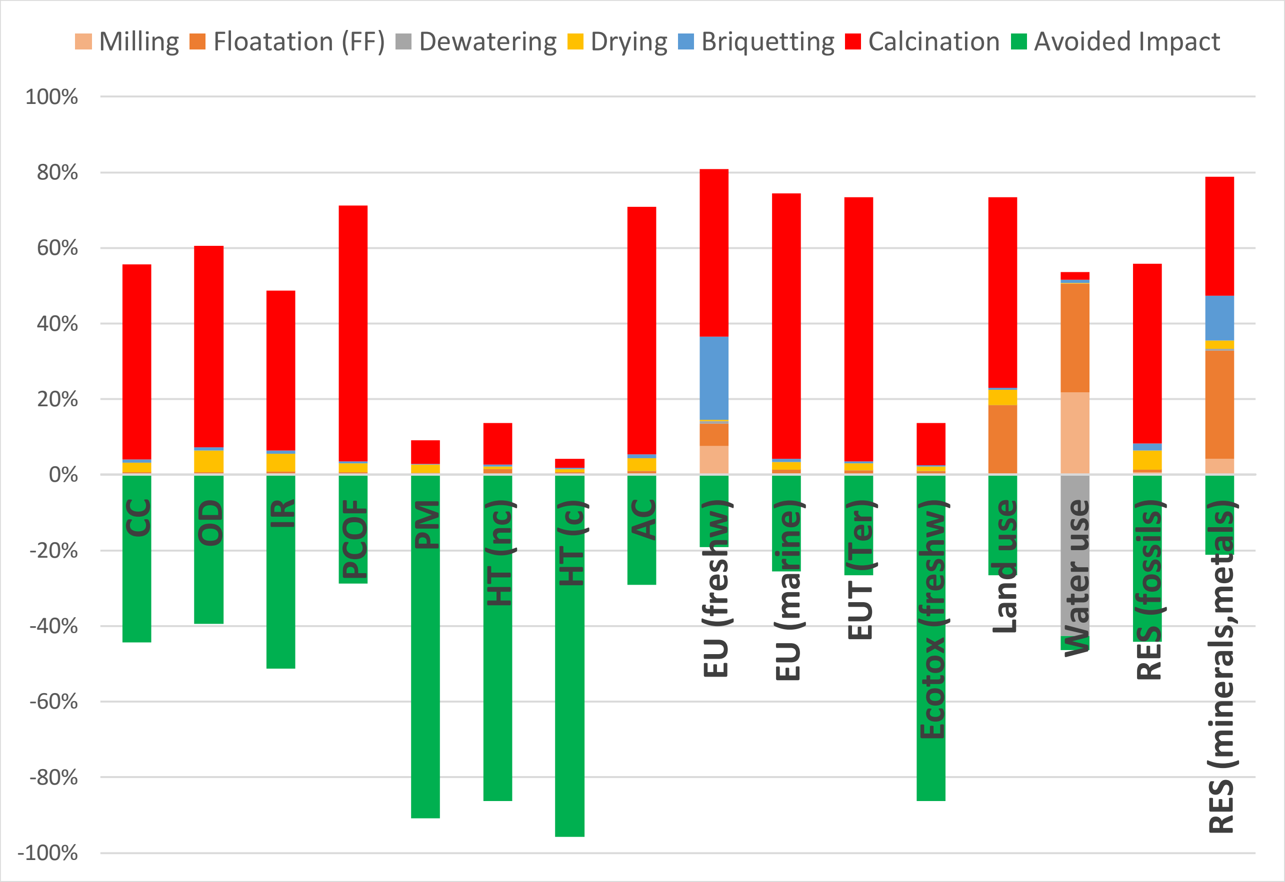
Aspects to be considered in the interpretation of the results

Current Scenario *vs* Future Scenario

- Current system (stockpiling) is modelled as inert landfilling
- Substitution ratio less than 1
- Avoided raw magnesite ore consumption is not characterized under the EF impact assessment method
- There is a lot of uncertainty regarding the ecoinvent dataset representing average Magnesia production in Europe (dataset used as avoided technology):
  1) the dataset was not modelled using primary data from magnesia production plant, but it was extrapolated from similar processes like iron mining and lime production
  2) the dataset represents only the production of caustic magnesia
  3) the heat energy consumption was too low → modified
  4) the heat energy mix was not accurate → modified

LCIA and interpretation of the results: GM Case 1

Contribution analysis for Future Scenario



- CC → direct CO2 from calcination
- OD → Halons from PetCoke supply in calcination
- PCOF →Direct NO2 from calcination
- AC → direct SO2 emissions from calcination
- EU fresh → phosphate form electricity usage in calcination
- EU marine → direct NO2 from calcination
- EU terr→ direct NO2 from calcination
- Landuse → Petcoke supply
- RES fossil → Petcoke supply (oil crude consumption)

Impact of FF technology can only be seen in:

- Land use (chemicals)
- Water use (high water input)
- Minerals consumption (chemicals)

LCIA and interpretation of the results: GM Case 1

Potential for improvement

Recommendation 1

Changing the current fuel mix fed to calcination kiln

✓As already expressed by GM, there is a mid-term plan to raise the share of biomass in the fuel mix to 40-50% on weight basis

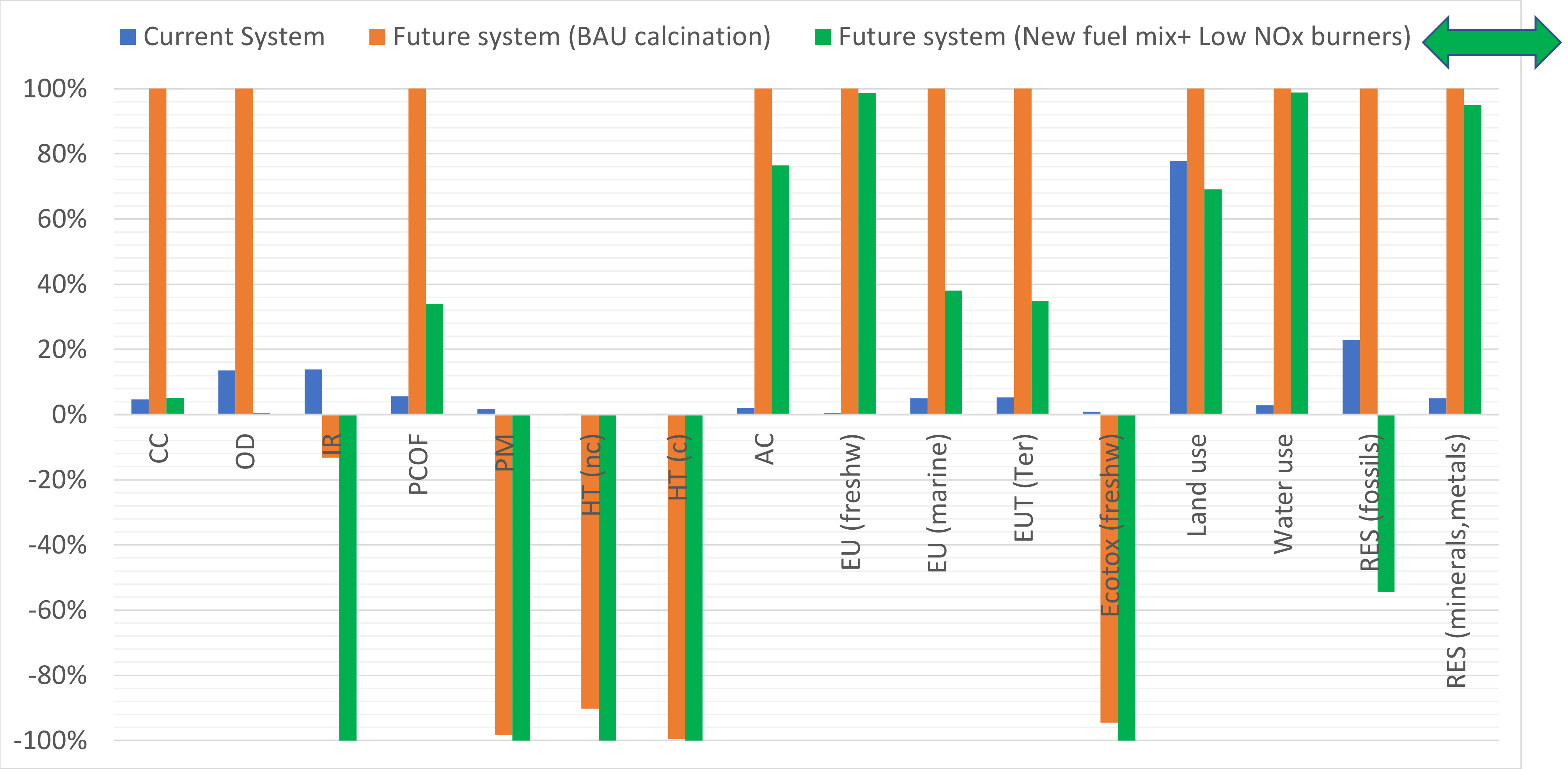
Recommendation 2

Installing a DENOX unit to reduce NOx emission

✓Low NOx burners are currently being tested by GM that could reduce NOx emissions by 25%

Future improved scenario

LCIA and interpretation of the results: GM Case 1



Future improved scenario

- 5 out of 16 impact indicators showed better results with future scenario vs current system
- 8 out of 16 impact indicators showed better results with future improved scenario vs current system

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Conclusions and next steps

- In a prospective LCA, collaboration with those who are developing the technology is fundamental: without it there is no data
- LCA can guide the implementation of a new technology into an existing system, so that the new system has better environmental performance than the old one
- Uncertainty in the application of the technology may be dealt with the definition of a range of scenarios

- LCA of Case 2
- Economic evaluation based on Material Flow Cost Accounting (MFCA) methodology
- Social-LCA (social hotspot analysis) based on PSILCA database

QUESTIONS?

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AWARE
Assessment on WAste and REsources

http://www.aware.polimi.it/

www.finefuture-h2020.eu/

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