MINE IT OR LEAVE IT?
INTEGRATING LANDFILLED MATERIAL STOCKS INTO MODERN RESOURCE CLASSIFICATION FRAMEWORKS

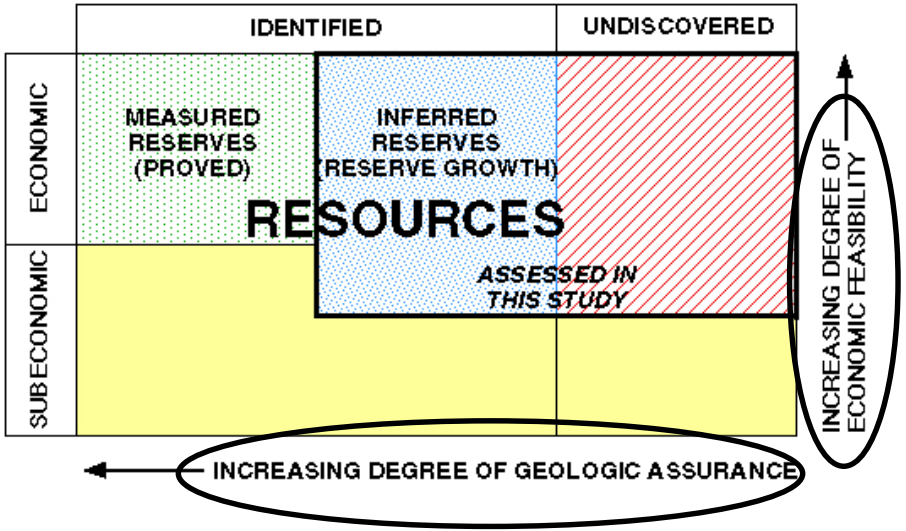
Andrea Winterstetter, MSc, PhD

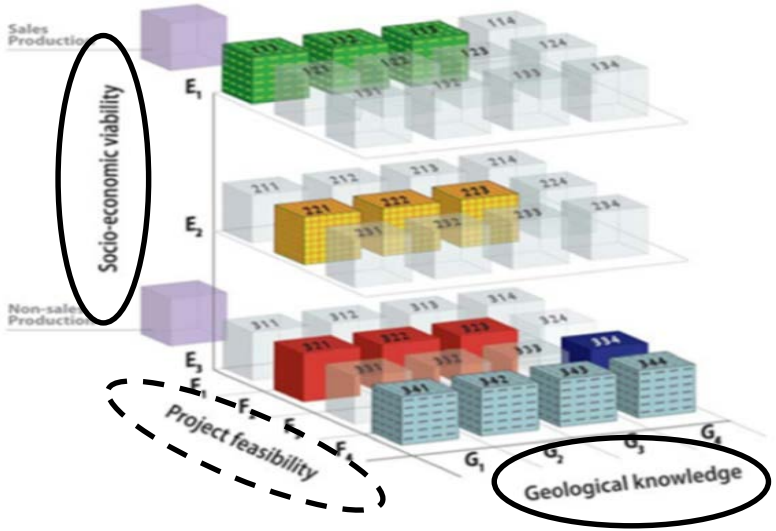
CONTENT

1. Background
2. Goal
3. How to classify landfills under UNFC
4. Case Studies: Historic landfills in Flanders
5. Results
6. Conclusions & Outlook

BACKGROUND:
Resource Classification & Landfill Mining

DEVELOPMENT OF RESOURCE CLASSIFICATION





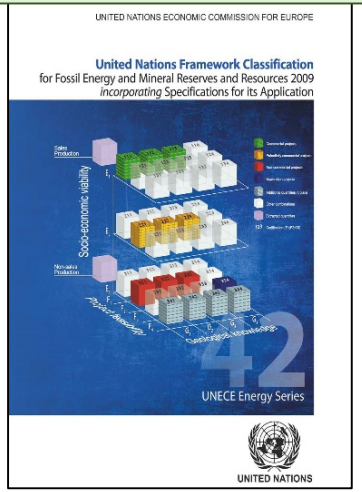
McKelvey Box, 1972 → UNFC, 2009

1. Geological knowledge
2. Economic viability
3. Technical feasibility & project status

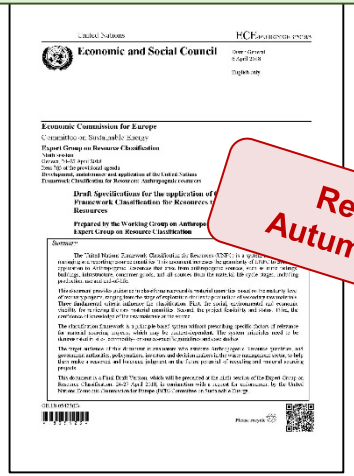
A GLOBAL STANDARD

United Nations Framework Classification for Resources (UNFC)

Generic Specifications for **all resources**

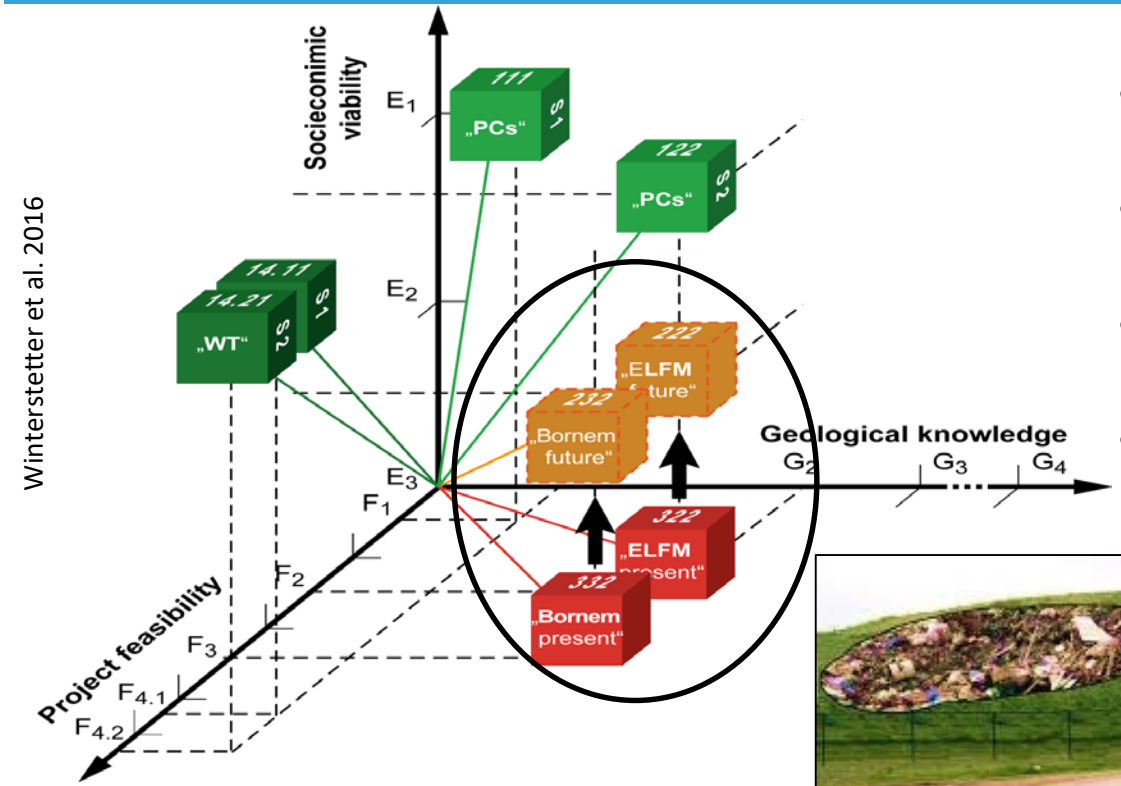


Specifications for **Anthropogenic Resources**



https://www.unece.org/fileadmin/DAM/energy/se/pp/unfc_egrc/egrc9_apr2018/ece.energy.ge.3.2018.5_e.pdf

CLASSIFICATION OF LANDFILLED MATERIALS



Winterstetter et al. 2016

- Lederer et al. (2014): **Phosphorus stocks, Austria**
- Winterstetter et al. (2015): **Remo landfill, Flanders**
- Krüse (2015): **Hechingen landfill, Germany**
- Winterstetter et al. (2018): **Diverse landfills, Flanders**

HISTORIC LANDFILL SITES IN FLANDERS

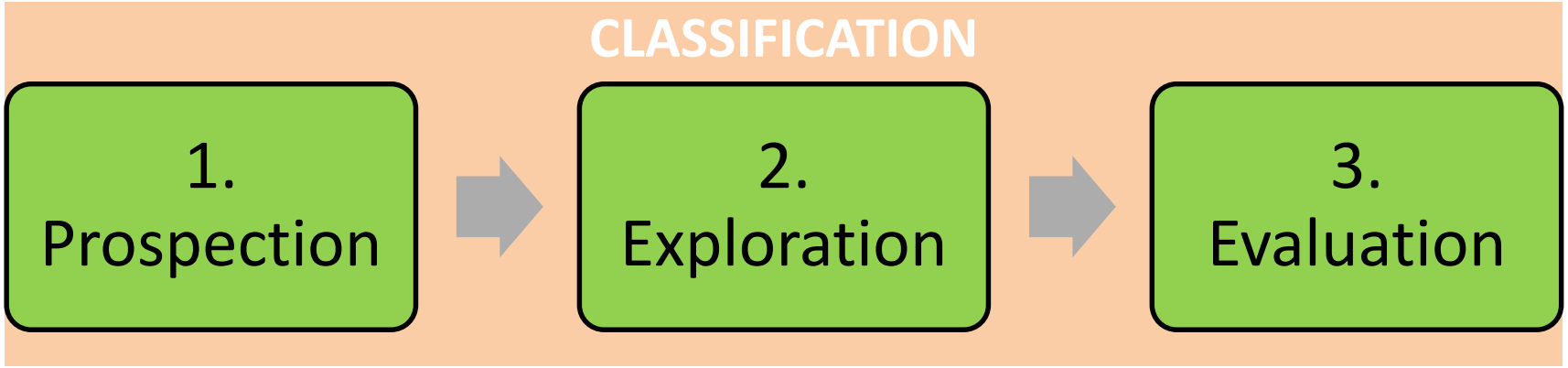
- > 2.000 landfills in Flanders
- Belgium: High population density 375 persons/km^2 (2015)
- Population expected to increase by 10% in 2050
- Rising land prices & the need for new clean land
  = Key drivers of landfill mining in Flanders
- FLAMINCO model by OVAM: Evaluate old landfills' contamination risks & roughly their resource potential
- Currently: Exploration of resource & land recovery potential of selected historic landfills using UNFC

GOAL

- Provide decision support for the management of old landfill sites in Flanders
- Compare & prioritize different potential landfill mining projects
- Communicate the results by using UNFC

How to classify landfills under UNFC

MINE IT OR LEAVE IT?



Screen data base
Estimate a landfill's resource potential & contamination level

Assess recoverable materials / land as a function of technology & project set-ups

Evaluate a landfill mining project under specific technical, legal, economic, environmental and social conditions

PROSPECTION

1

Map, screen and investigate old landfills in Northern Belgium for contamination risks and resource potential

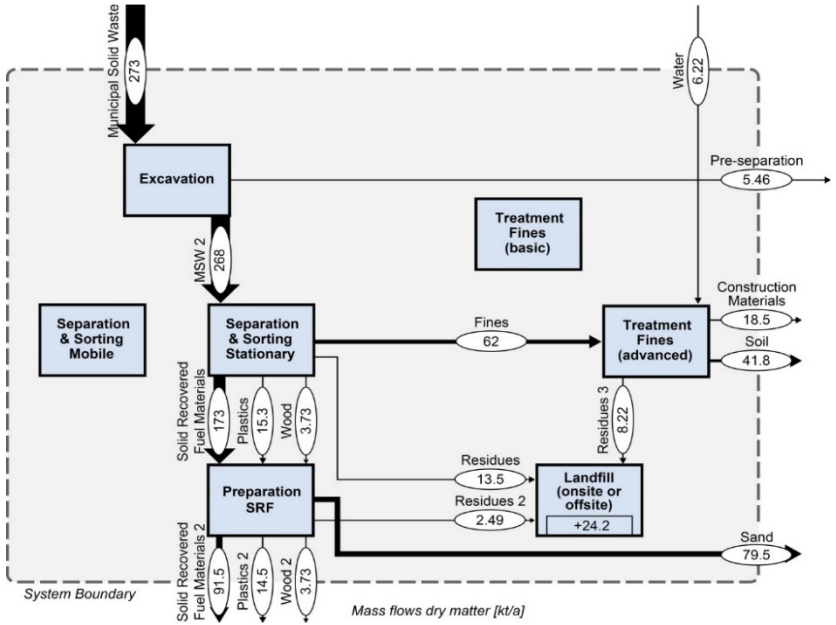
Select landfills & estimate recovery potential of materials / land & contamination level

Results:
1) Landfill Bornem
2) Landfill Turnhout

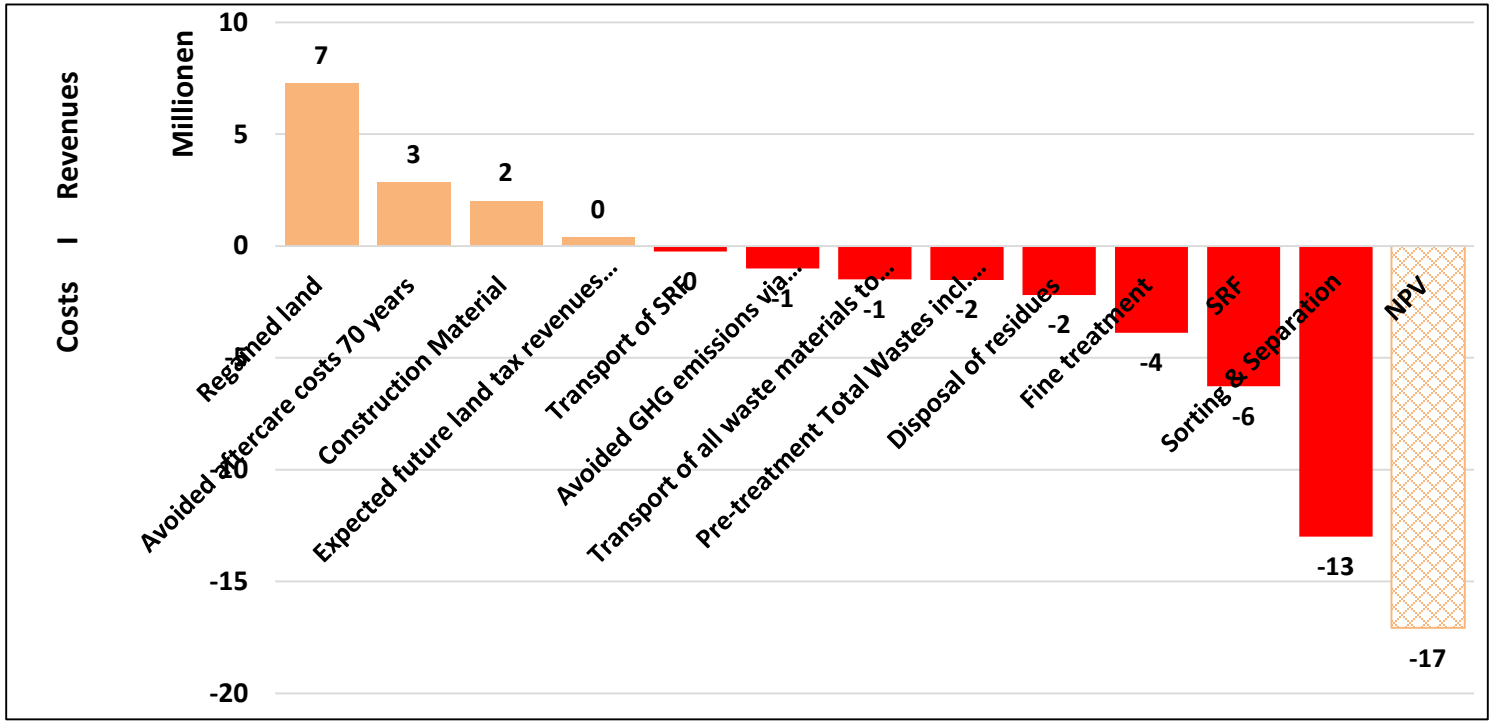
EXPLORATION

2

Asses the share of extractable materials & recoverable land & contamination level as a function of different technology alternatives & project set-up options



EVALUATION – PROJECT DEVELOPMENT?



Winterstetter et al. 2018

Case Studies:
Landfill sites in Bornem & Turnhout

BORNEM LANDFILL

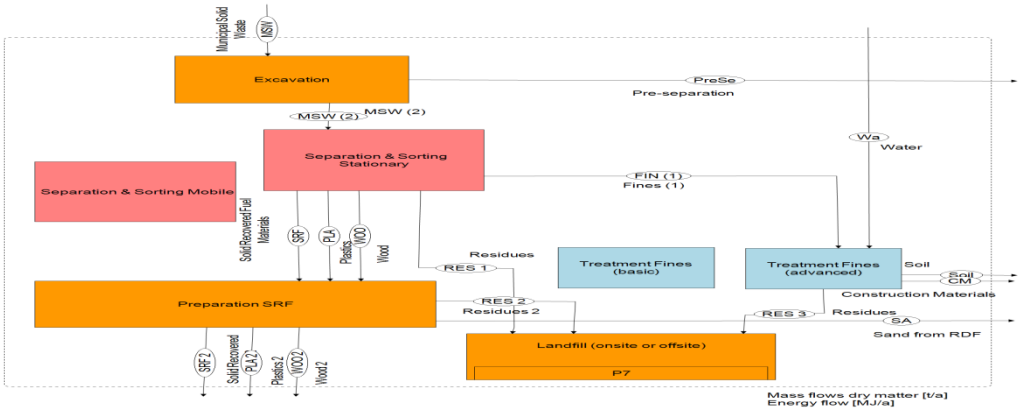
- Currently natural area
- Active landfill: 1947 – late 1970s (closed)
- 390,000 t of mainly municipal solid waste
- Area of 50,000 m^2
- No remediation need
- Metal share very low, not recovered
- Fine fraction sold as construction material
- Plastics & wood turned into Solid Recovered Fuel (SRF) used in cement kiln (fee)
- Regained cleaned-up land sold as building land & municipality gains land tax

OVAM, 2015

TURNHOUT LANDFILL

- Residential area, currently paddock
- Active landfill: 1945 – late 1963 (closed)
- 48,000 t of mainly municipal solid waste
- Area of 28,000 m^2
- No urgent need for remediation
- Private investor
- Costs of contaminated site, planning and permits, excavating, crushing and screening of materials, soil treatment, and costs for site development
- No materials recovered
- Recovered land sold as building land

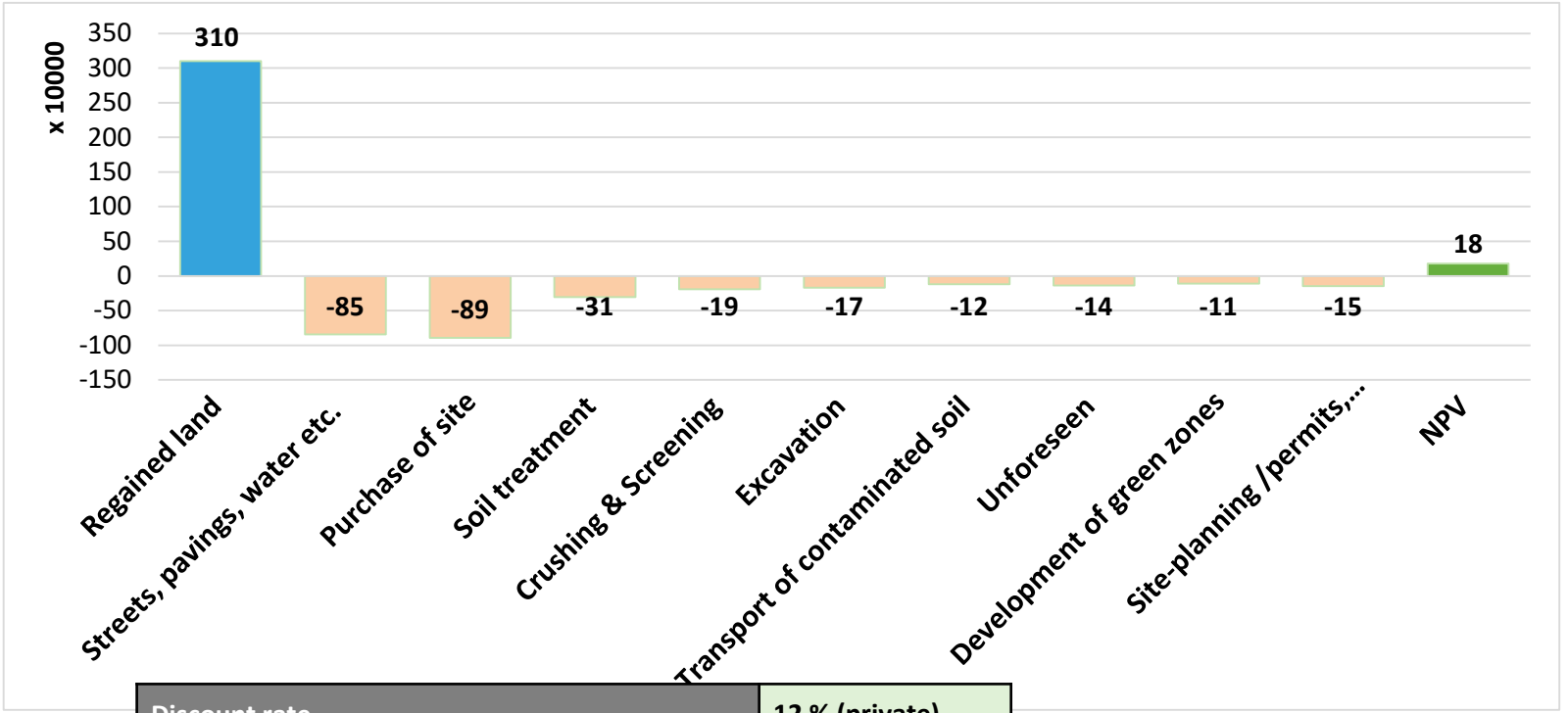
Results


Municipal Solid Waste
MSW
Excavation
PreSe
Pre-separation
MSW (2)
MSW (2)
Separation & Sorting Stationary
Separation & Sorting Mobile
Wa
Water
FIN (1)
Fines (1)
Solid Recovered Fuel Materials
SRF
PLA
Plastics
WOO
Wood
Residues
RES 1
Treatment Fines (basic)
Treatment Fines (advanced)
Soil
Soil CM
Construction Materials
Preparation SRF
RES 2
Residues 2
RES 3
Residues
SA
Sand from RDF
Landfill (onsite or offsite)
P7
SRF 2
Solid Recovered
PLA 2
Plastics 2
WOO2
Wood 2
Mass flows dry matter [t/a]
Energy flow [MJ/a]

RECOVERED MATERIALS / LAND

	Unit	Bornem	Turnhout
Regained salable land	[m^2]	50,000 (100 % of total area)	15,500 (55 % of total area)
Solid Recovered Fuel (SRF)	[t]	129,200 (disposal fee)	-
Soil / construction material		207,400	-
Amount of materials to be re-landfilled		34,600 Sorting residues landfilled offsite (disposal fee)	39,500 Re-landfilled onsite
Contaminated soil		-	8,600 (treatment fee)

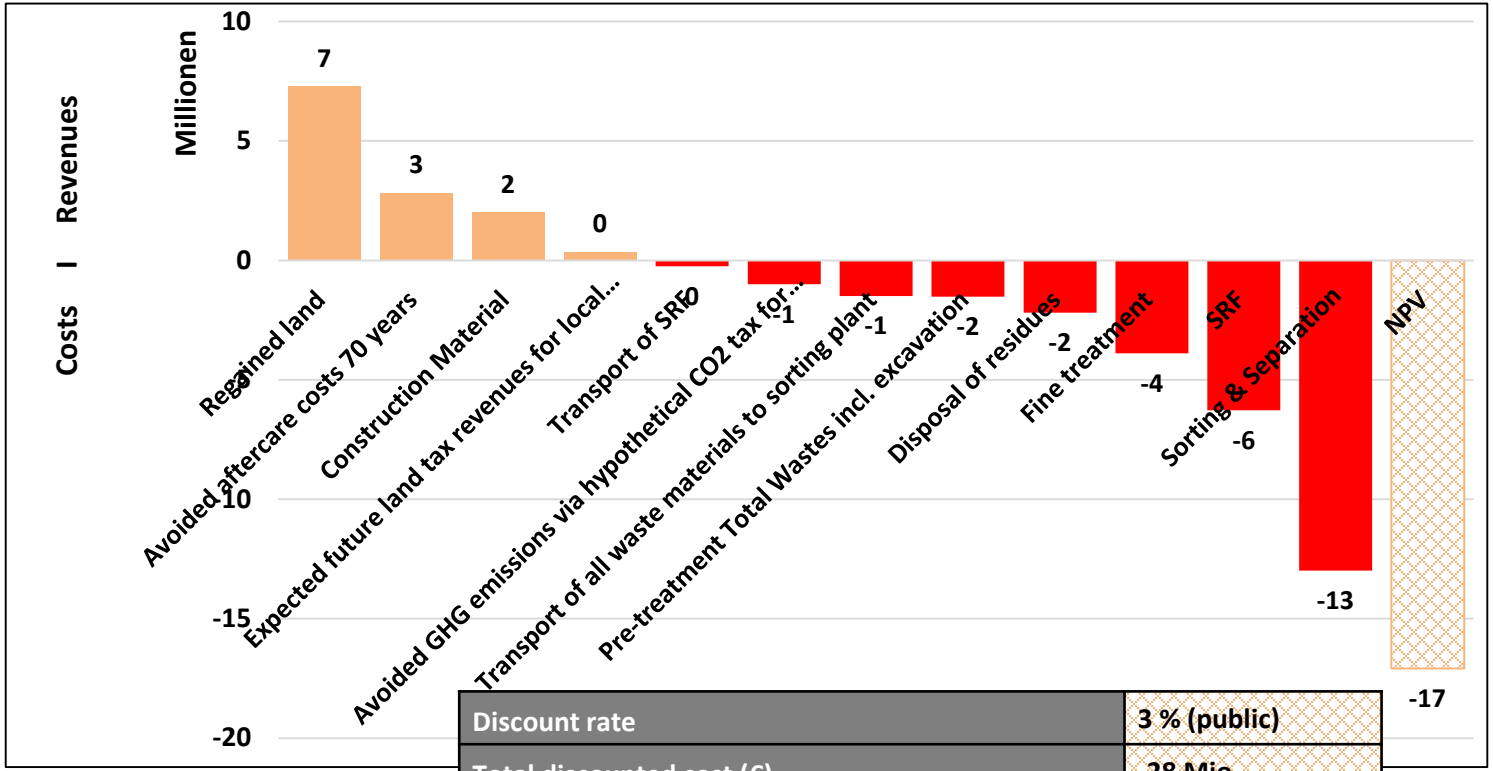
ECONOMIC RESULTS – TURNHOUT: POSITIVE



Discount rate	12 % (private)
Total discounted cost (€)	-2.9 Mio
Total NPV (€)	180,000
NPV in €/t excavated waste materials	4

vito

ECONOMIC RESULTS – BORNEM: NEGATIVE



Discount rate	3 % (public)
Total discounted cost (€)	-28 Mio
Total Net Present Value (NPV) (€)	-17 Mio
NPV in €/t excavated waste materials	-44

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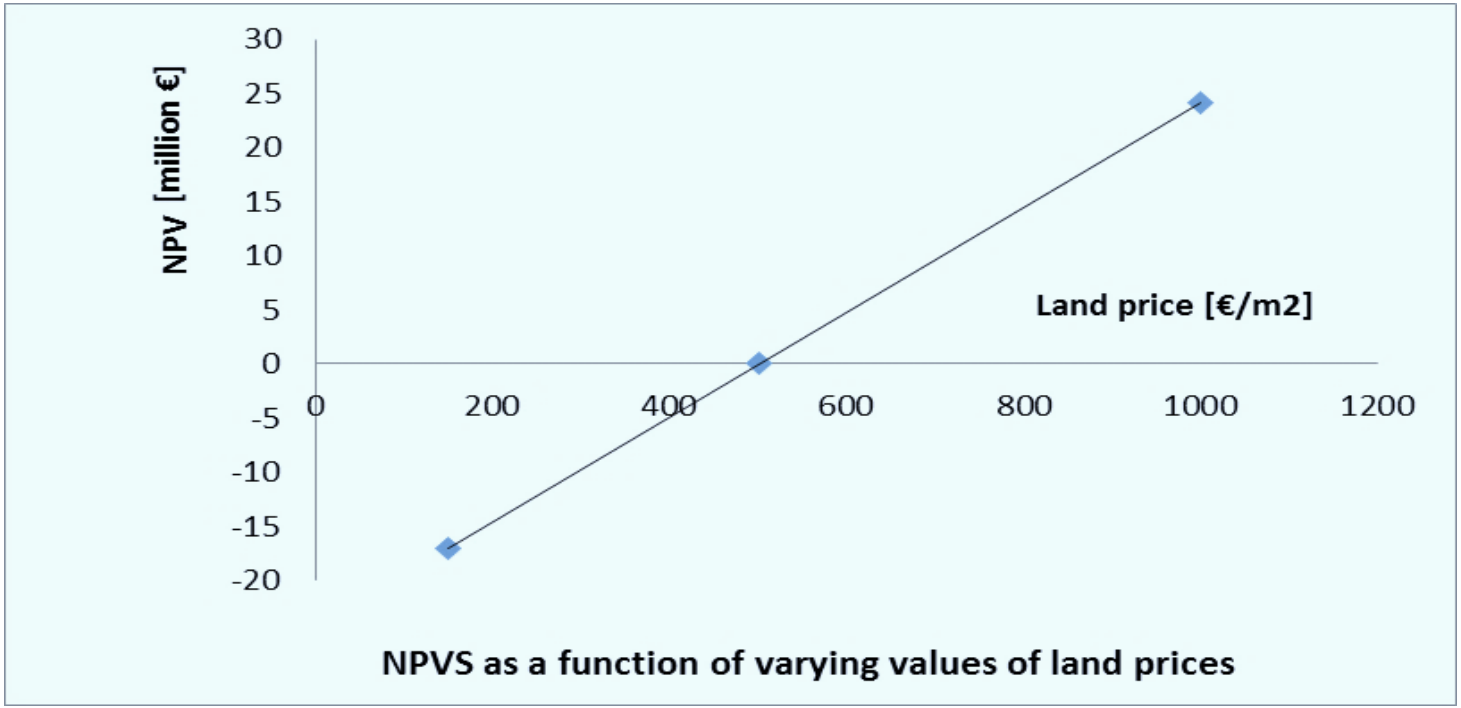
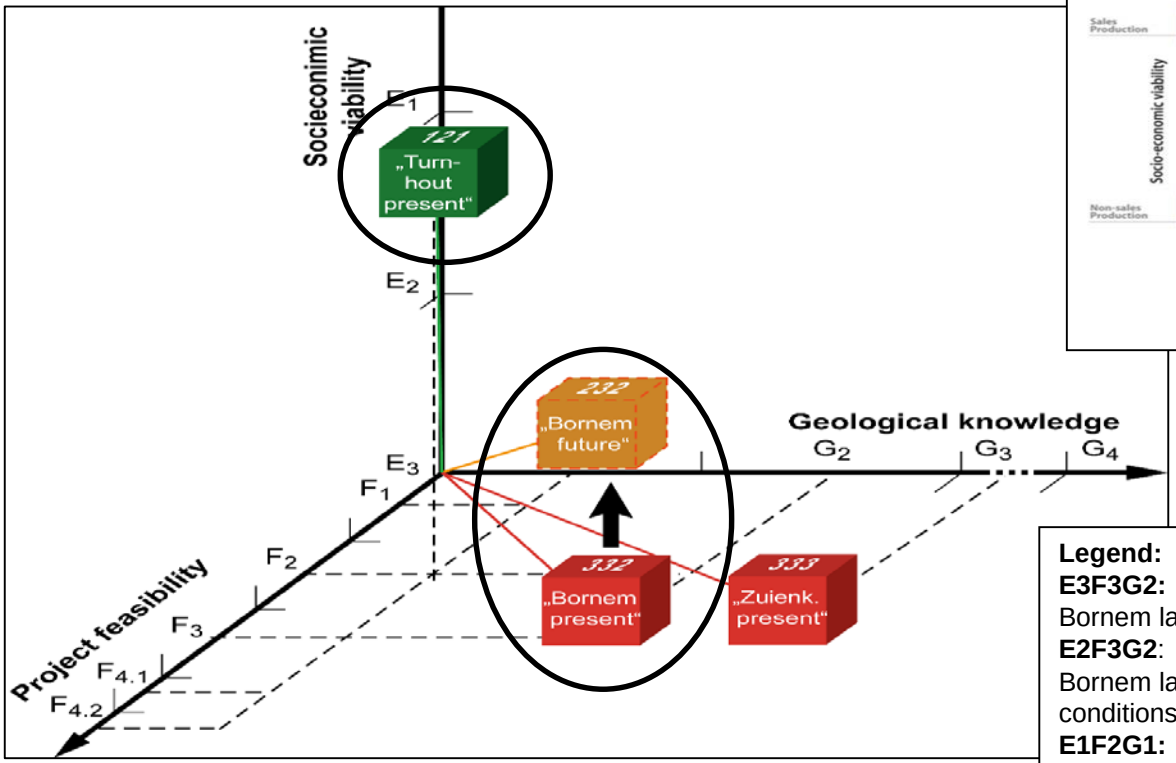
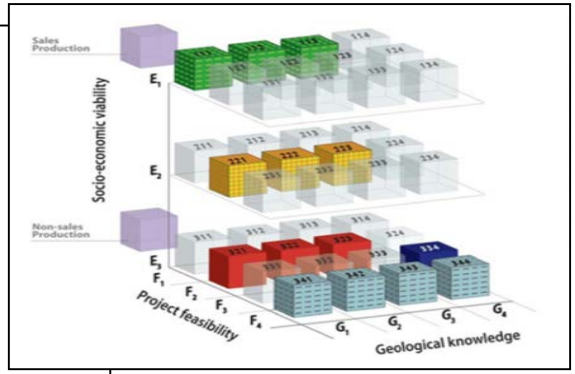
BORNEM: CUT-OFF LAND PRICE



CLASSIFICATION UNDER UNFC





Legend:
E3F3G2:
Bornem landfill under present conditions
E2F3G2:
Bornem landfill under potential future conditions
E1F2G1:
Turnhout landfill under present conditions

Winterstetter et al . 2018

CONCLUSIONS

Evaluation must be performed on a case by case basis:

- ✓**Preconditions:** “Push” (remediation) or “Pull” (resource / land recovery)?
- ✓**Site-specific parameters:** Type, location & land price, volume, composition,
- ✓**Project-specific parameters:** Stakeholder perspective (private or public investor), choice of technology, project set-up, licenses, neighbors etc.
- ✓**Systemic context:** Legislation, markets, regional infrastructure etc.
- ✓**Timing of mining:** Future development of costs, prices, legislation, available data and information.

UNFC allows for systematic comparison & prioritization of different potential LFM projects & other resource recovery projects

Thank you!

Contact:
Andrea Winterstetter, MSc, PhD
Postdoctoral Researcher

Tel: +3214335151
andrea.winterstetter@vito.be

LITERATURE

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ECLAR METHODOLOGY

Systemic factors

- Legislation (EU, national, local) & enforcement
- Institutional & organizational structures
- Political / governmental willingness
- Background energy system

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Phases	Goal	Influencing factors	
1.Pre-Prospection	Selection of a deposit to be mined	Preconditions	**Availability** • Obsolete stock **Mining / handling condition** • Push • Pull
2. Prospection	Identify the landfill's resource potential & contamination level	Site specific parameters	• Type • Location • Volume • Composition
3. Exploration	Knowledge on the deposit's share of extractable & potentially usable materials Technical feasibility & Project status	Project specific parameters	• Technology maturity & different options of project set-ups for extraction & processing with specific recovery efficiencies • Project status (public perception, licenses etc.)
3.Evaluation	Socioeconomic viability of extraction & utilization	Socioeconmic parameters	• Prices for secondary products (recovered resources / land/new landfill space) • Costs • Avoided costs • Indirect financial effects & monetized external effects (environmental, social)
4. Classification	Combination of all criteria & classification under UNFC		

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- Regional infrastructure (e.g. WtE gate fees)
- Markets for secondary products
- Commodity prices world market
- Regional land prices

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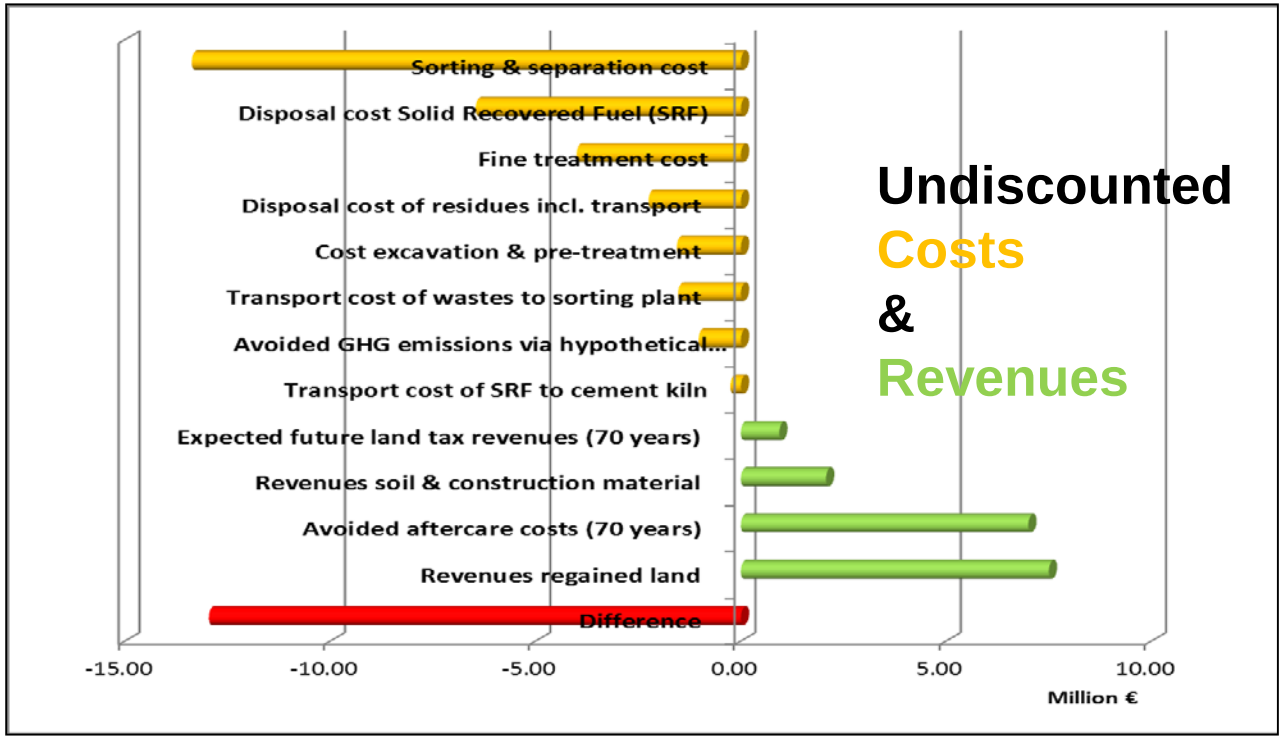
Winterstetter et al. submitted

Results II – Economics



Total discounted cost (million €)	-28
Total Net Present Value (NPV) (million €)	-17
NPV in € / t excavated waste materials	-44

Net Present Value (NPV)

Quantity

Class

Recovery project 1

20 kt
material per year

Commercial Project

On Production

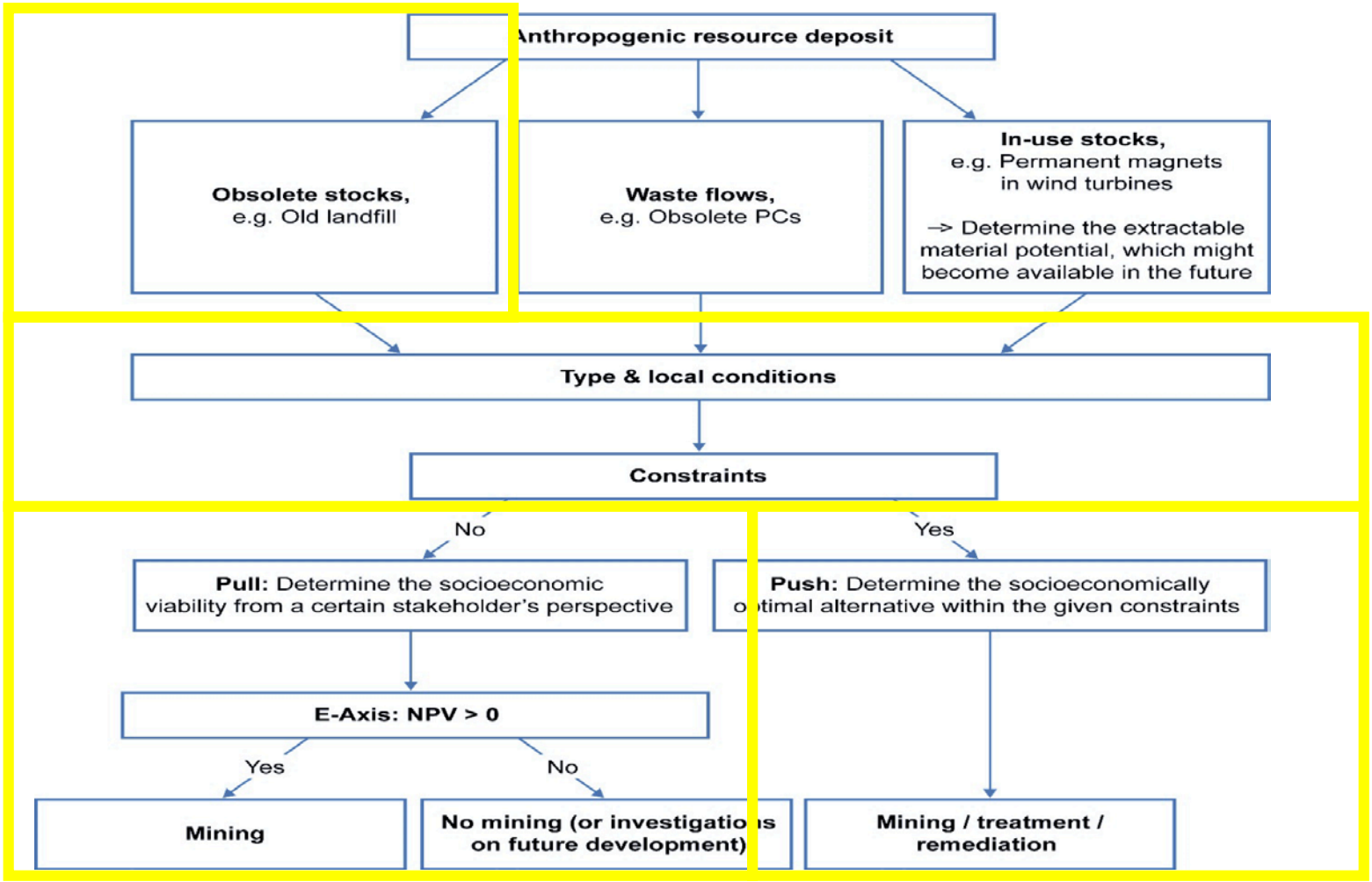
Recovery project 2

8 kt
material per year

Potentially com. Project

Development pending

Decision Guidelines for Anthropogenic Resources I



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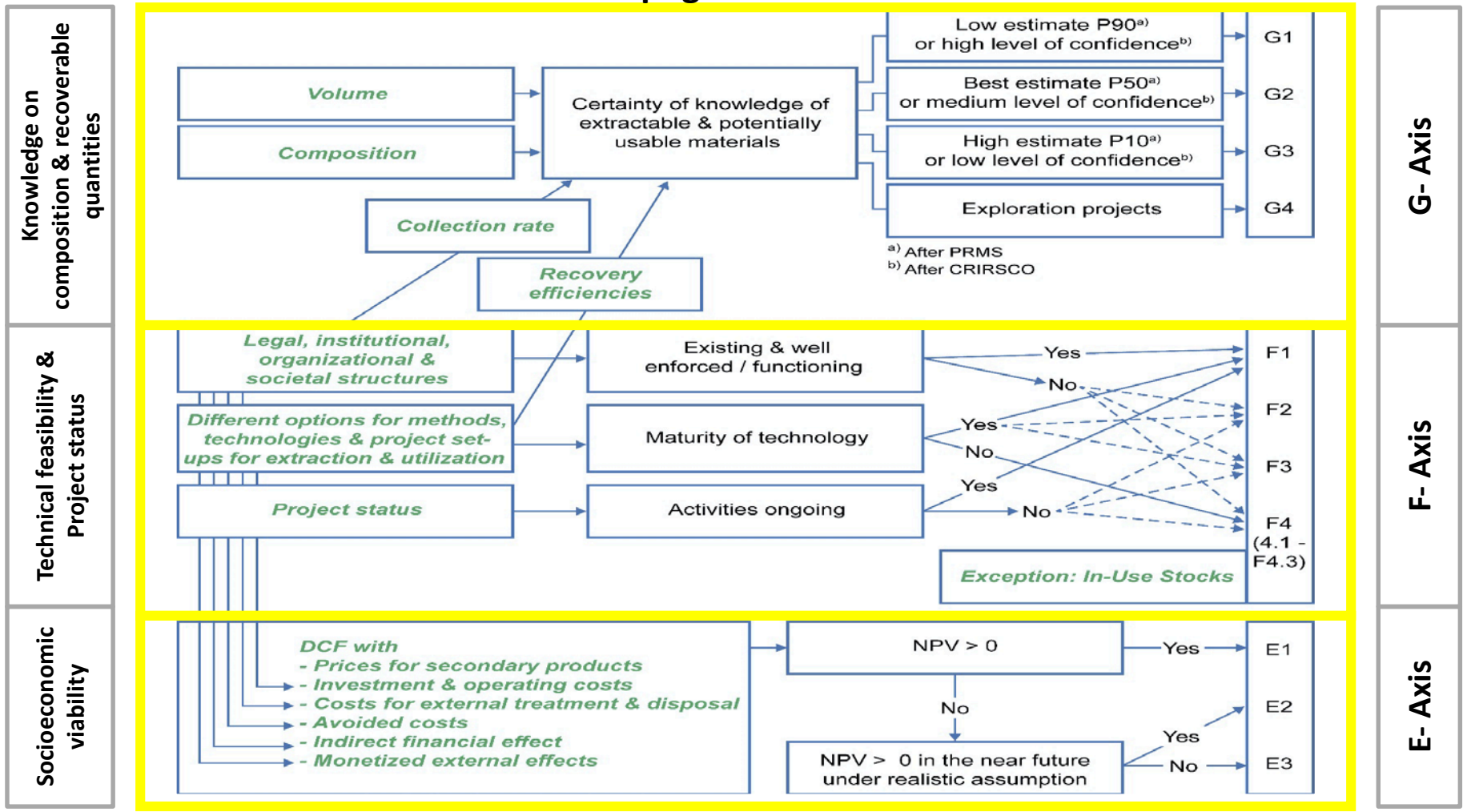
Decision Guidelines for Anthropogenic Resources II



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