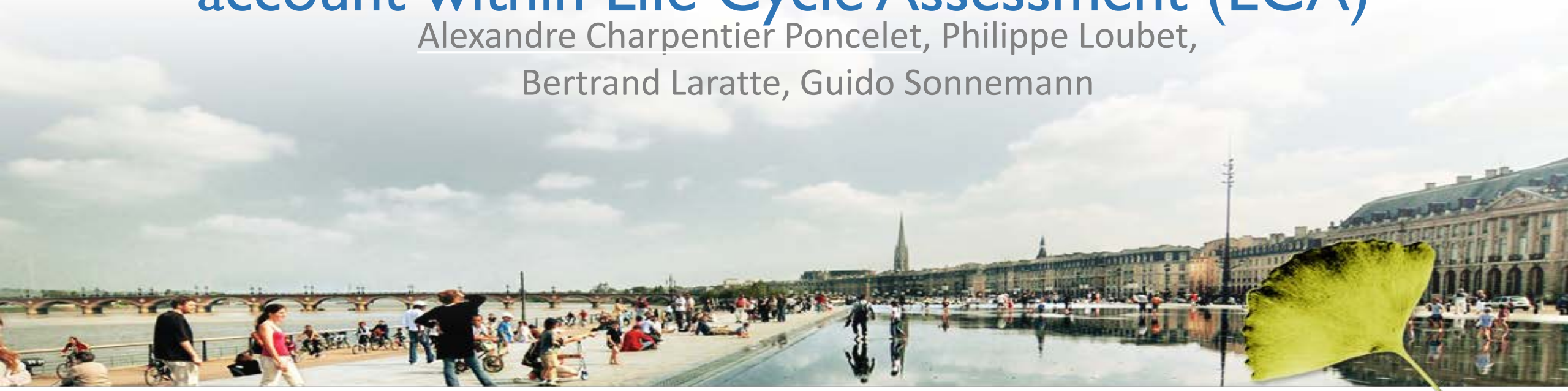
Development of a conceptual framework to take the dissipation of non-energetic abiotic resources into account within Life Cycle Assessment (LCA)

Alexandre Charpentier Poncelet, Philippe Loubet,
Bertrand Laratte, Guido Sonnemann



CONTENT

- Context
- Research question & Method
- Dissipation approach
  - Overview
  - Key considerations
  - Methodological developments
- Conclusions & future works

CONTEXT

- Recent developments for the Natural Resources Area of Protection (AoP) in Life Cycle Assessment (LCA) (eg. Dewulf et al. (2015); Sonderegger et al. (2017))

- Existing methods for abiotic resource use have been discussed and criticized by many in recent years (eg. Swart, Alvarenga, & Dewulf (2015); Drielsma et al. (2016); Sonderegger et al. (2017))

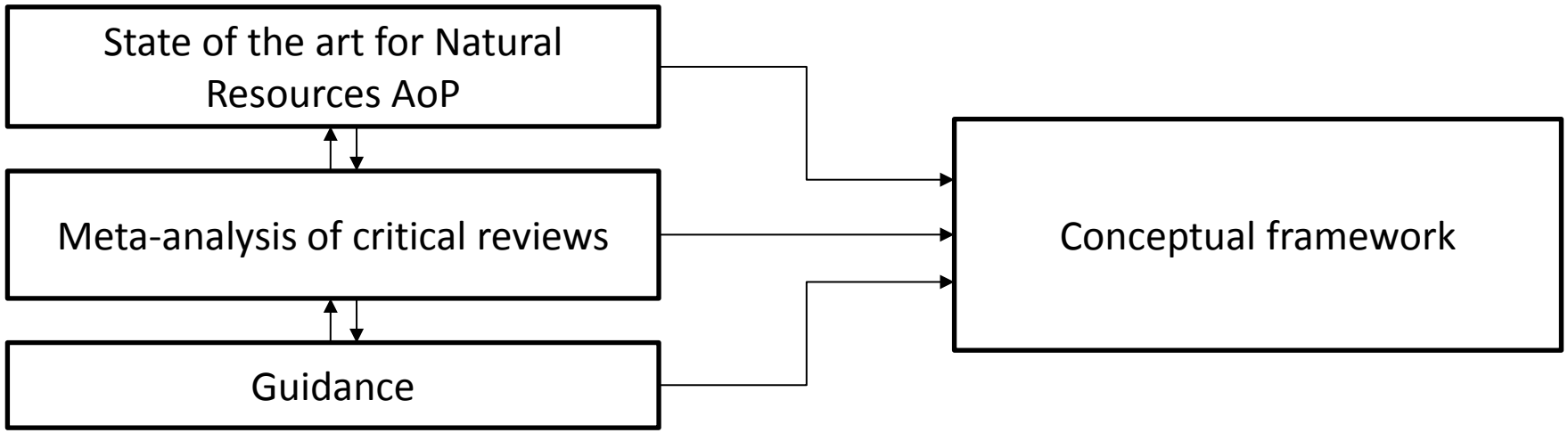
- Safeguard subject for non-energetic abiotic resources has been defined as *"the potential to make use of the value that mineral resources, as embedded in a natural or anthropogenic stock, can hold for humans in the technosphere"* (Berger et al., 2018)

- Damage to the safeguard subject happens when abiotic resources are dispersed in a way which make them unavailable for future use or when they are rendered inaccessible in technosphere through different mechanisms

- Dissipation approach is a promising way forward to account for this damage, and should be investigated further (Zampori & Sala (2017); Berger et al. (2018))

RESEARCH QUESTION & METHOD

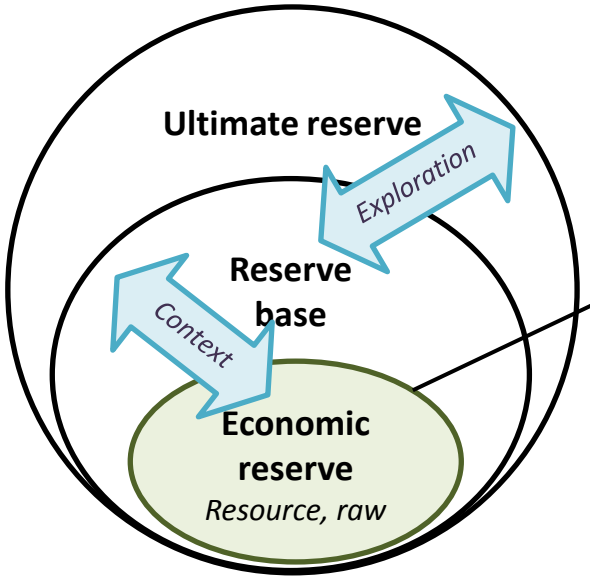
- **Research question**: In light of most actual knowledge, what has to be considered in a conceptual framework to account for abiotic resource dissipation in LCA?
- **Method:**



- Define abiotic resource use and Natural resource AoP
- Identify perspective for abiotic resources based on Dewulf et al. (2015)
- Critique existing methods
- Identify relevant guidance for method development
- Identify research needs for dissipation approach

- Take position on methodological choices
- Define key words and concepts
- Build conceptual framework
- Identify data collection needs / cross-sectoral complementary research

DISSIPATION APPROACH - OVERVIEW



Environment

Technosphere

Extraction, smelting, refining

Primary resource
Primary resource, in technosphere

Secondary resource
Secondary resource, in technosphere

Production

Product
Resource, in technosphere

Use

Recycling (smelting, refining)

Currently recyclable

Collecting/sorting

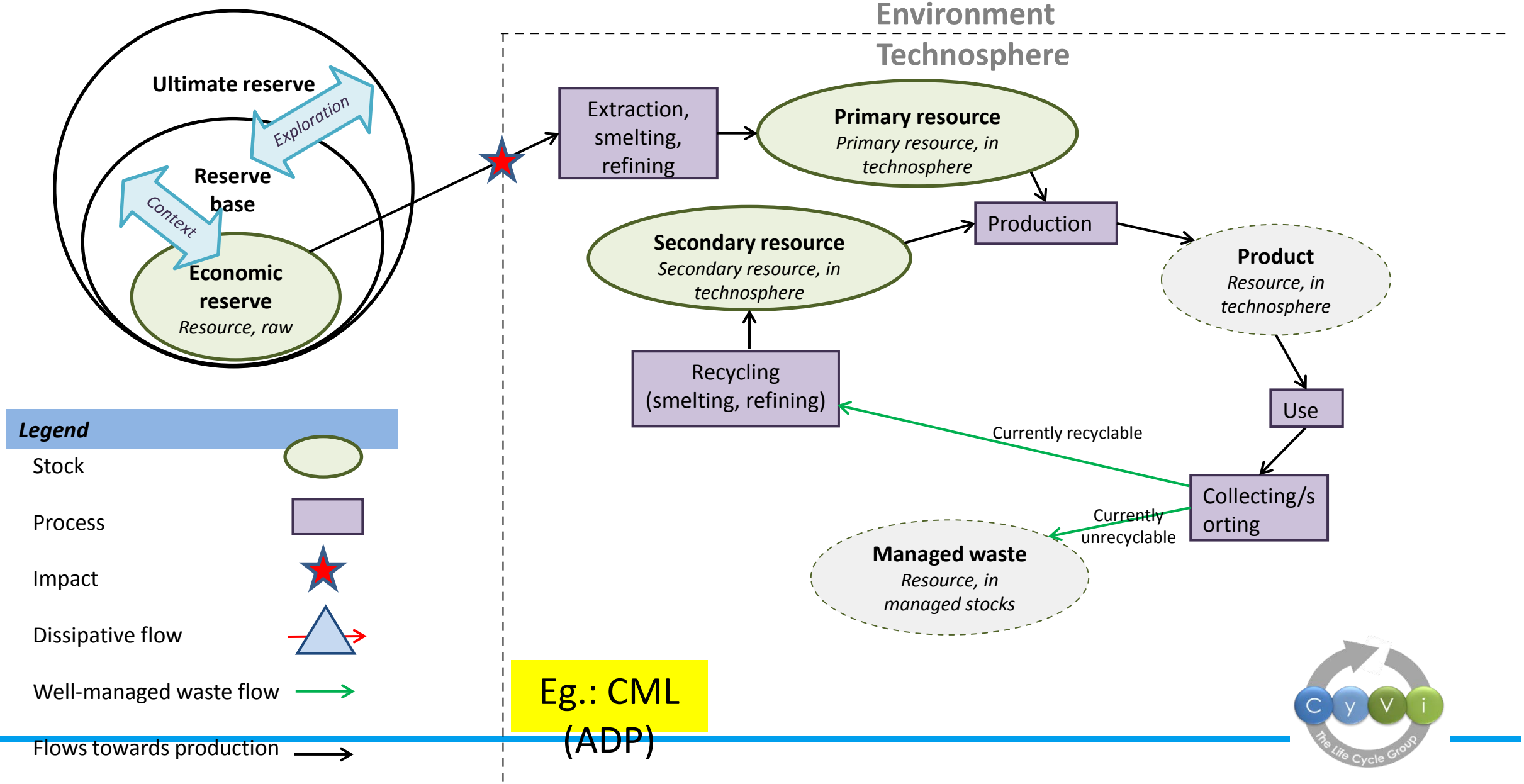
Currently unrecyclable

Managed waste
Resource, in managed stocks

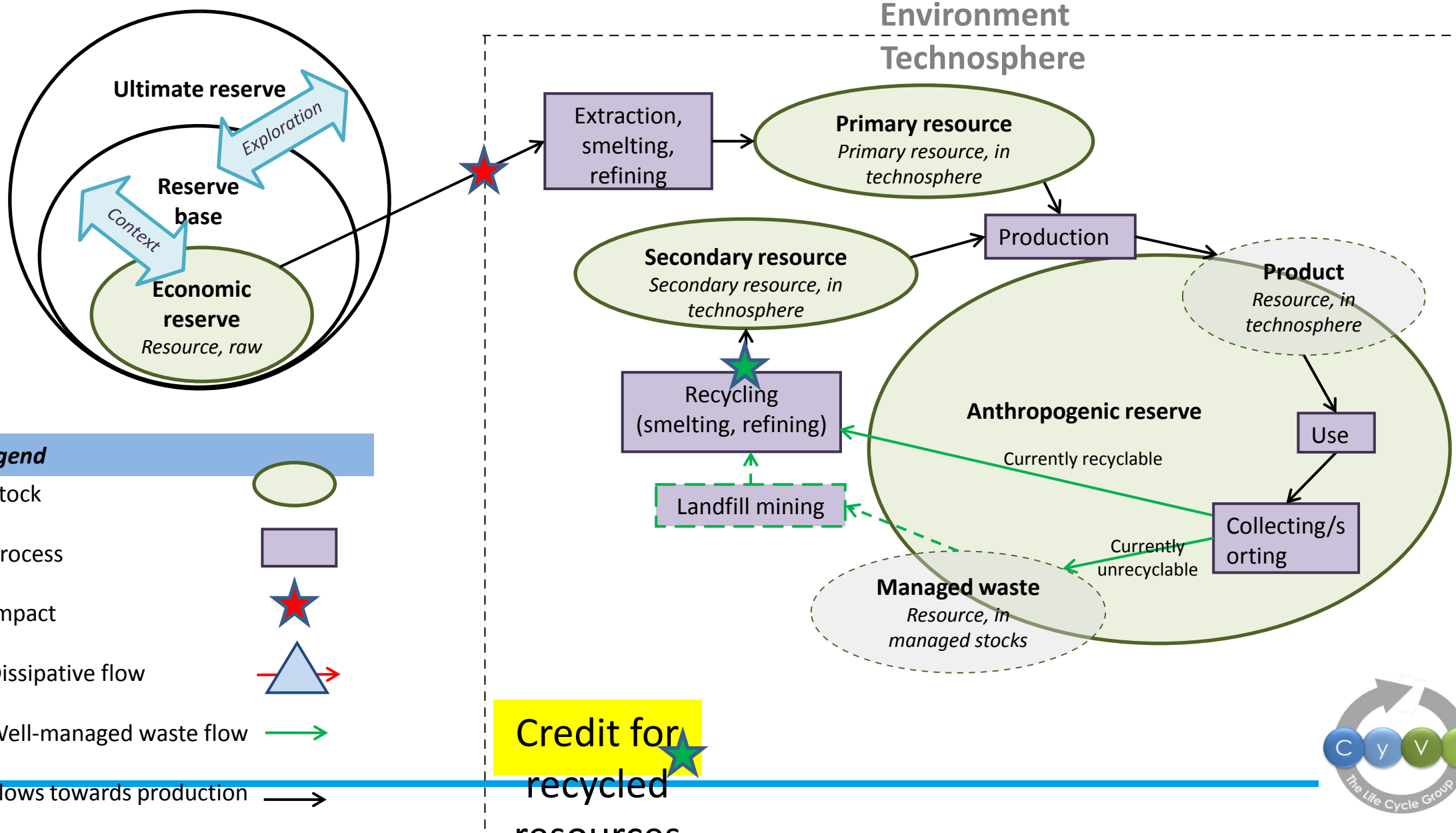
Legend

- Stock
- Process
- Impact
- Dissipative flow
- Well-managed waste flow
- Flows towards production

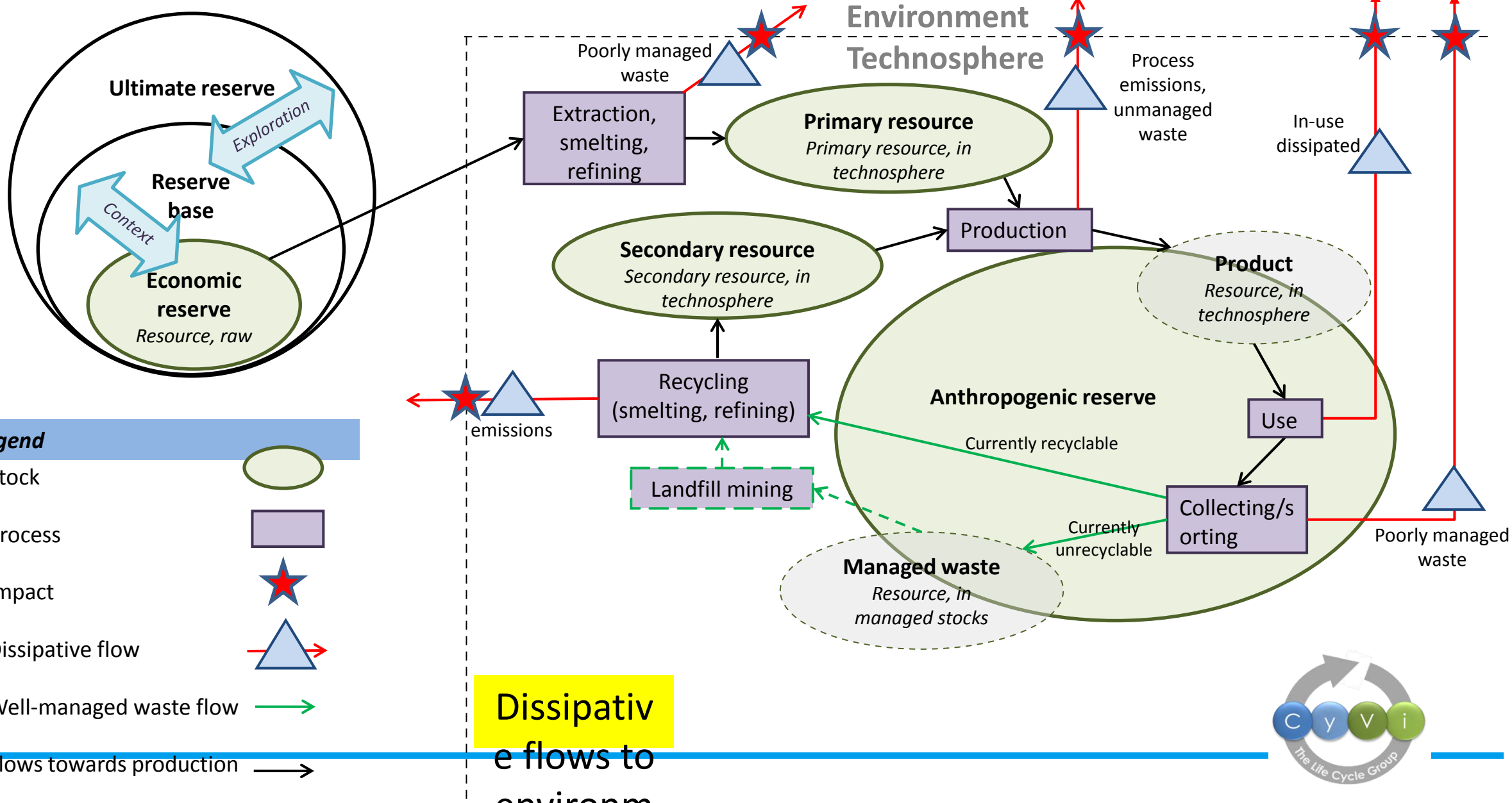
DISSIPATION APPROACH - OVERVIEW



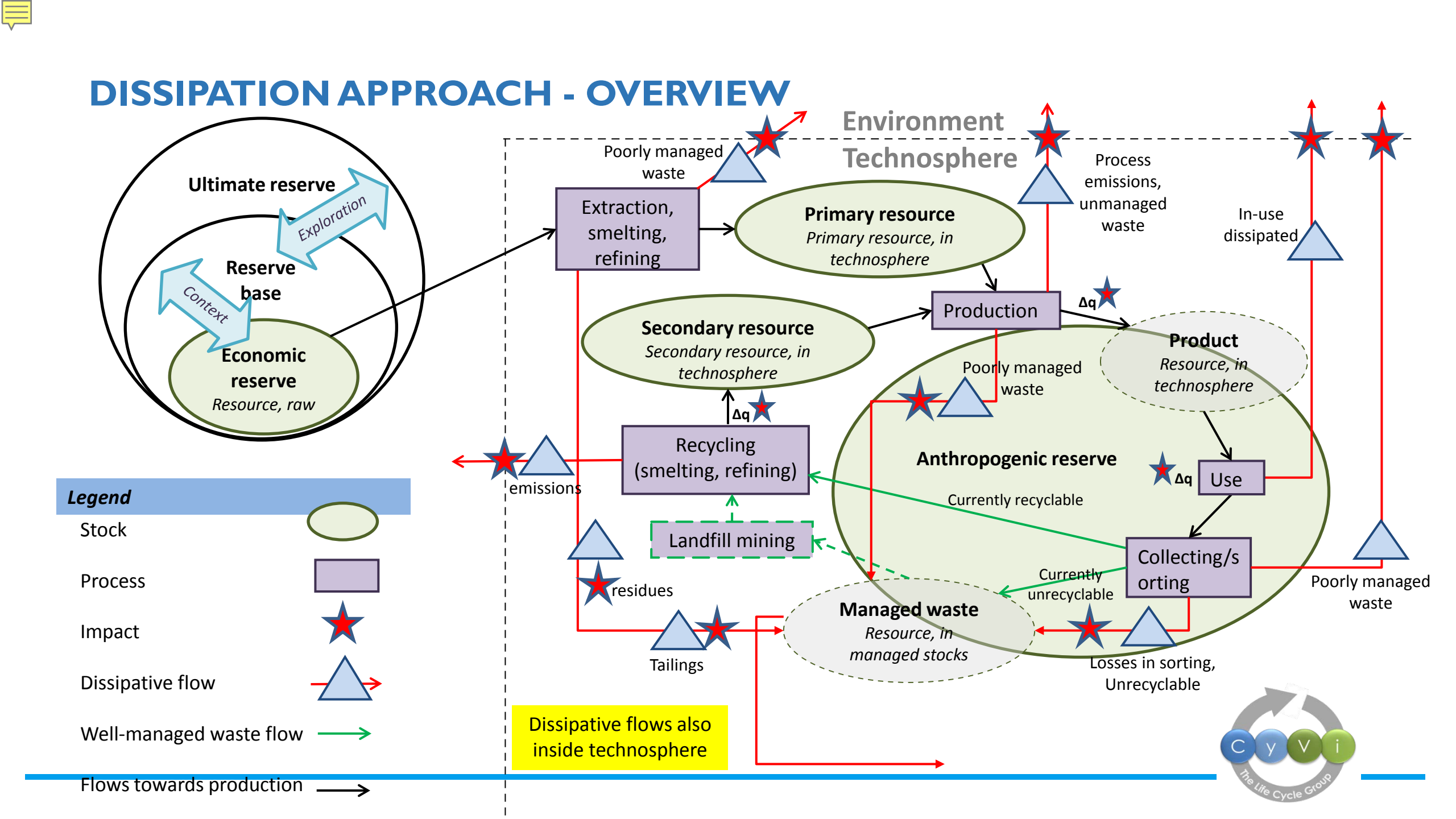
DISSIPATION APPROACH - OVERVIEW



DISSIPATION APPROACH - OVERVIEW



DISSIPATION APPROACH - OVERVIEW

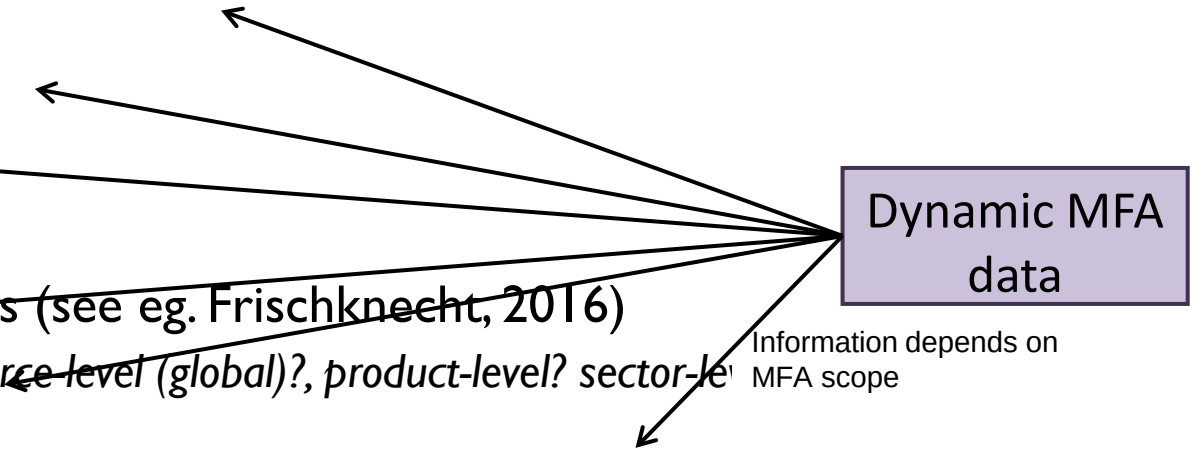


DISSIPATION APPROACH – KEY CONSIDERATIONS

- Dissipation (permanent loss of mass and/or quality) over the whole life cycle
  - Dissipation based on use type/design (eg. Lost by Design, Ciacci et al. (2015))
  - Dissipation in environmental compartments
  - Dissipation in techsnosphere (loss of quality, dissipated in managed waste, etc.)
- Time
  - Timeframe *(how long?)*
  - Resource occupation/borrowing uses (see eg. Frischknecht, 2016)
  - Dissipation patterns over time. *Resource-level (global)?, product-level? sector-level?*
- Geographical scale
  - Recycling rates
  - Product lifetimes variations

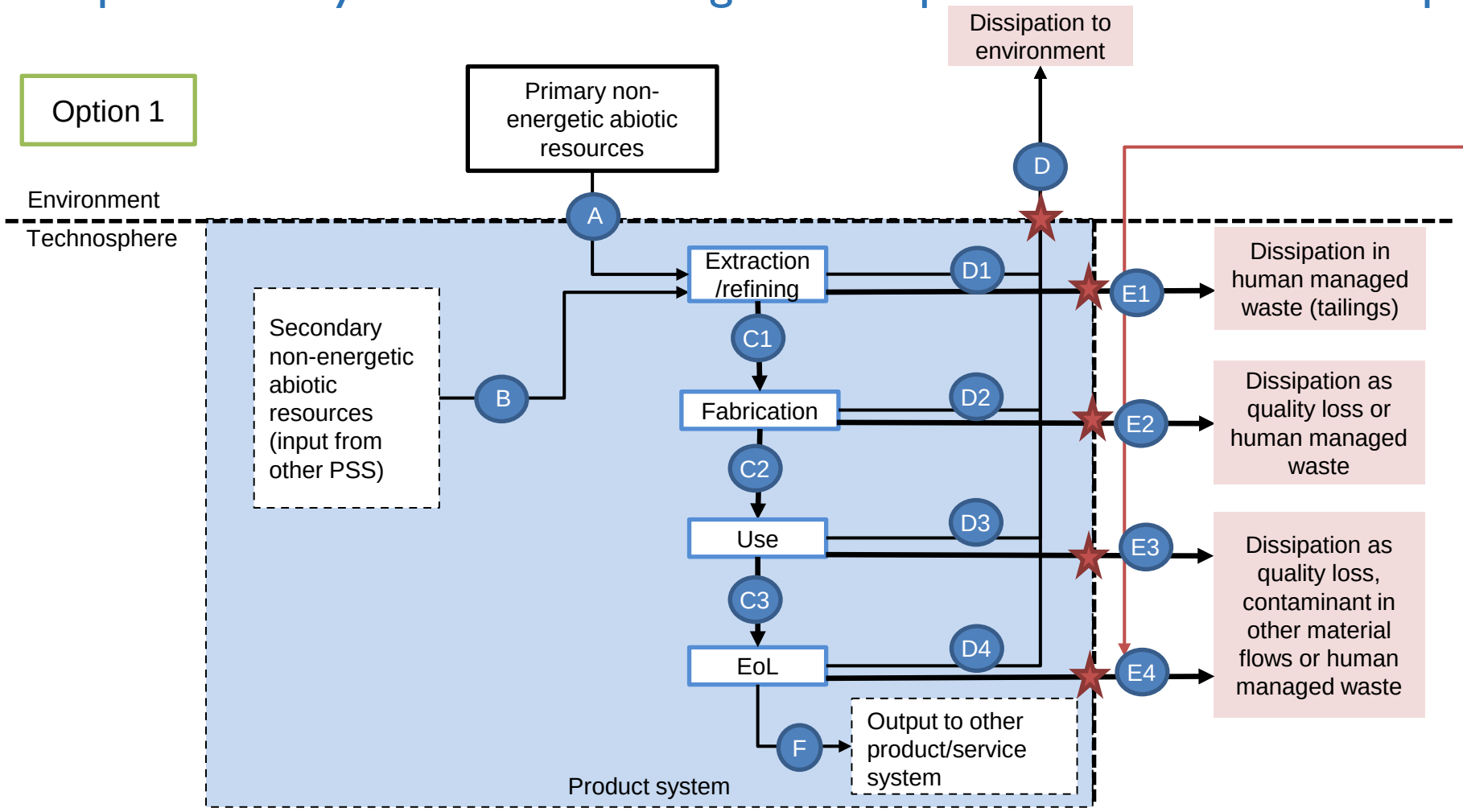
DISSIPATION APPROACH – KEY CONSIDERATIONS

- Dissipation (permanent loss of mass and/or quality) over the whole life cycle
  - Dissipation based on use type/design (eg. Lost by Design, Ciacci et al. (2015))
  - Dissipation in environmental compartments
  - Dissipation in other material flows
  - Dissipation in managed waste
- Time
  - Timeframe *(how long?)*
  - Resource occupation/borrowing uses (see eg. Frischknecht, 2016)
  - Dissipation patterns over time. *Resource-level (global)?, product-level? sector-le*
- Geographical scale
  - Recycling rates
  - Product lifetimes variations



DISSIPATION APPROACH – METHODOLOGICAL DEVELOPMENTS

- Two possible ways forward to integrate dissipation data in the conceptual framework



Dynamic MFA data

→ **Dissipation as determined with key considerations integrated in LCI**

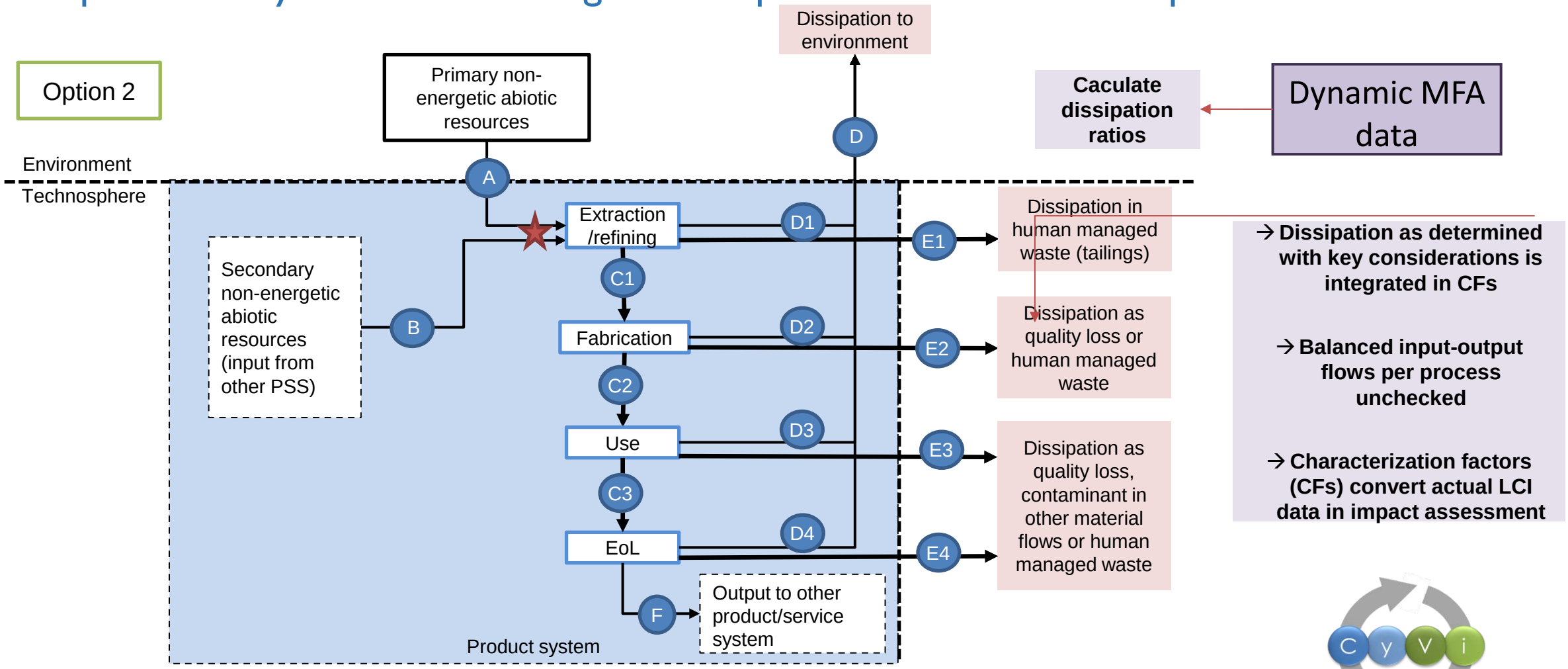
→ **Balanced input-output flows per process (ideally)**

→ **Characterization factors (CFs) convert LCI dissipation in impact assessment**

Example :
C1 – C2 = D2 + E2

DISSIPATION APPROACH – METHODOLOGICAL DEVELOPMENTS

- Two possible ways forward to integrate dissipation data in the conceptual framework



CONCLUSIONS

- More definite parameters have been selected to ameliorate abiotic resource use considerations in LCA using a dissipation approach
- Dynamic MFA can serve as a basis to calculate dissipation pattern over time
- 2 possible paths forward to implement dissipation in a conceptual framework have been presented

FUTURE WORKS

- Chose resource-centric perimeter for data collection (product-level, sector-level or global) and geographical granularization for different parameters
- Determine how to integrate quality considerations
- Make methodological decision between integrating data in LCI or LCIA (CFs) or mix of both
- Determine whether reserve size and/or dissipation curve is appropriate for the selected timeframe to include in CF calculations in order to account for availability (or loss of availability)
- Develop final conceptual framework and calculate CFs based on coherent inventory modelling

REFERENCES

- Berger, M., Sonderegger, T., de Alvarenga, R., Bach, V., Cimprich, A., Frischknecht, R., … others. (2018). Harmonizing the LCIA of mineral resource use. *EcoBalance 2018-13th Biennial International Conference on EcoBalance*, (October).
- Ciacci, L., Reck, B. K., Nassar, N. T., & Graedel, T. E. (2015). Lost by Design. *Environmental Science and Technology*, *49*(16), 9443–9451. https://doi.org/10.1021/es505515z
- Dewulf, J., Benini, L., Mancini, L., Sala, S., Blengini, G. A., Ardente, F., … Pennington, D. (2015). Rethinking the area of protection “natural resources” in life cycle assessment. *Environmental Science and Technology*, *49*(9), 5310–5317. https://doi.org/10.1021/acs.est.5b00734
- Drielsma, J., Russell-Vaccari, A. J., Drnek, T., Brady, T., Weihed, P., Mistry, M.,

Acknowledgements

Co-financing : Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME) and French geological survey (BRGM)
Jacques Villeneuve and Stéphanie Muller (BRGM)