

Webinair

Green Supply Chains

7.7.2020

The role of metrics for viable and sustainable supply chains

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QUESTIONS AT STAKE

How did the COVID-19 pandemic disrupt this effort and the "circular" or sustainable economic sphere?

How we can leverage lessons learned to optimize supply chain processes and protect against future shocks?

*Which metrics can be used to assess **Resiliency & Sustainability** of supply chains?*

THE CONCEPT OF

- Inspired from ecosystems networks
- Greater efficiency means environmental impact reduction – cost reduction (sustainability)
- Greater resilience: overall viability (robustness, stability, resilience)



“WINDOW OF VITALITY”

Which metrics?

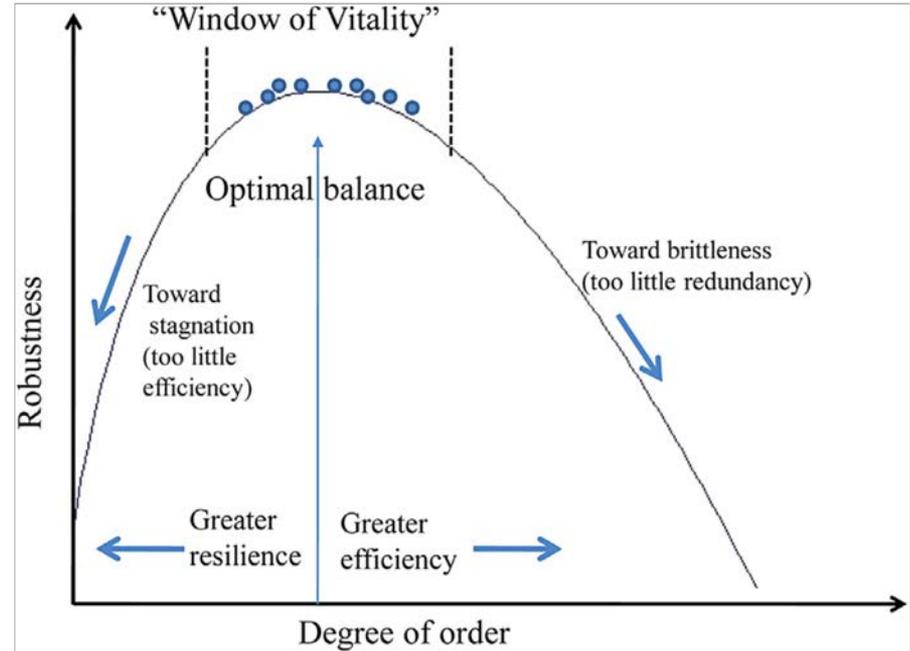
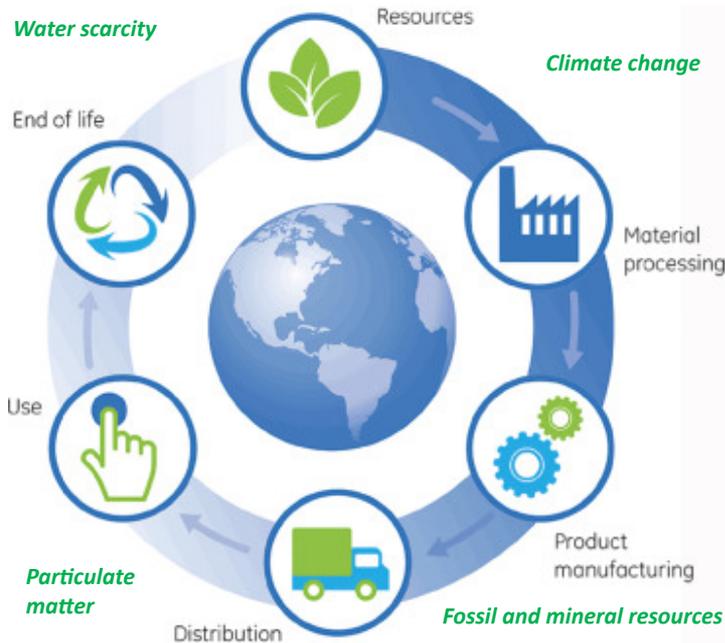


Fig. 6. The window of vitality occurs around the optimal position of the robustness measure.

Ulanowitz et al, doi:10.1016/j.ecocom.2008.10.005
Fath, doi.org/10.1016/j.ocecoaman.2014.06.020

METRICS FOR

Life cycle assessment (LCA) based metrics (ISO 14040)



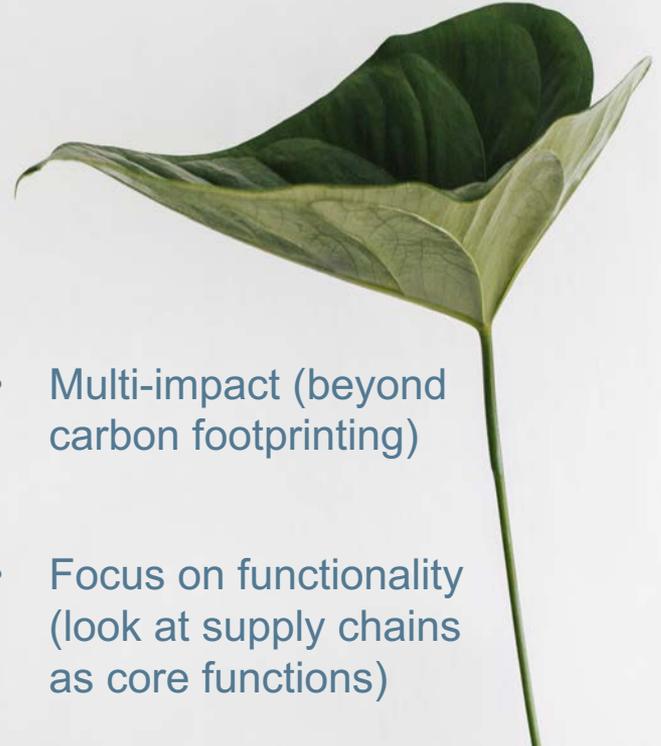
(Available from: <https://www.nist.gov/systems-integration-division/lifecycle-graphic>)

ENVIRONMENTAL SUSTAINABILITY

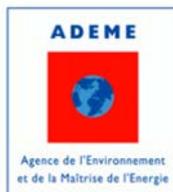
- Life cycle perspective (avoid pollution shift)

- Multi-impact (beyond carbon footprinting)

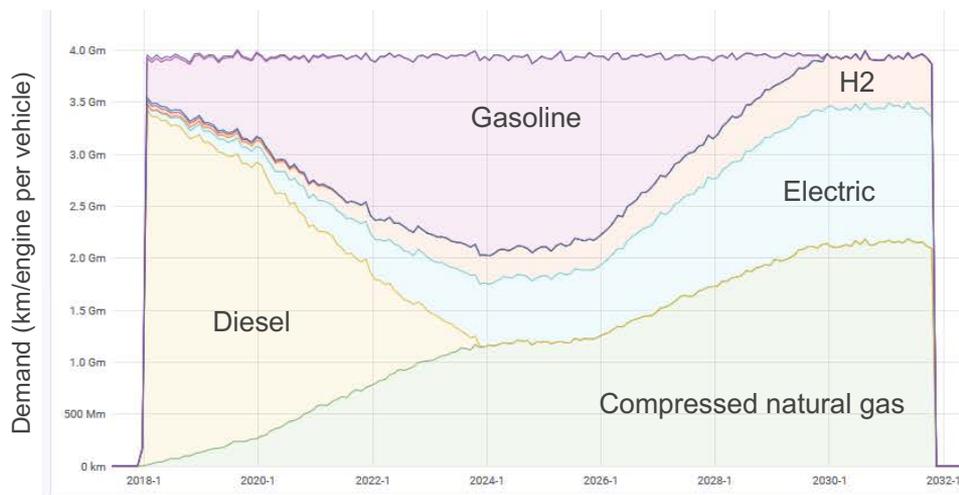
- Focus on functionality (look at supply chains as core functions)



CASE OF H2 FUELED UTILITY VEHICLES



Prospective assessment of utility vehicles fleets in Greater Paris (2018-2030)



Number of agents and number of vehicles per agent
Distance demand (km/day)
Number of days worked per year
Threshold for renewing vehicle and vehicle fleet
Desire to choose greener technologies



Price of vehicles
Autonomy range (km)
Fuel consumption
Loss of value when reselling

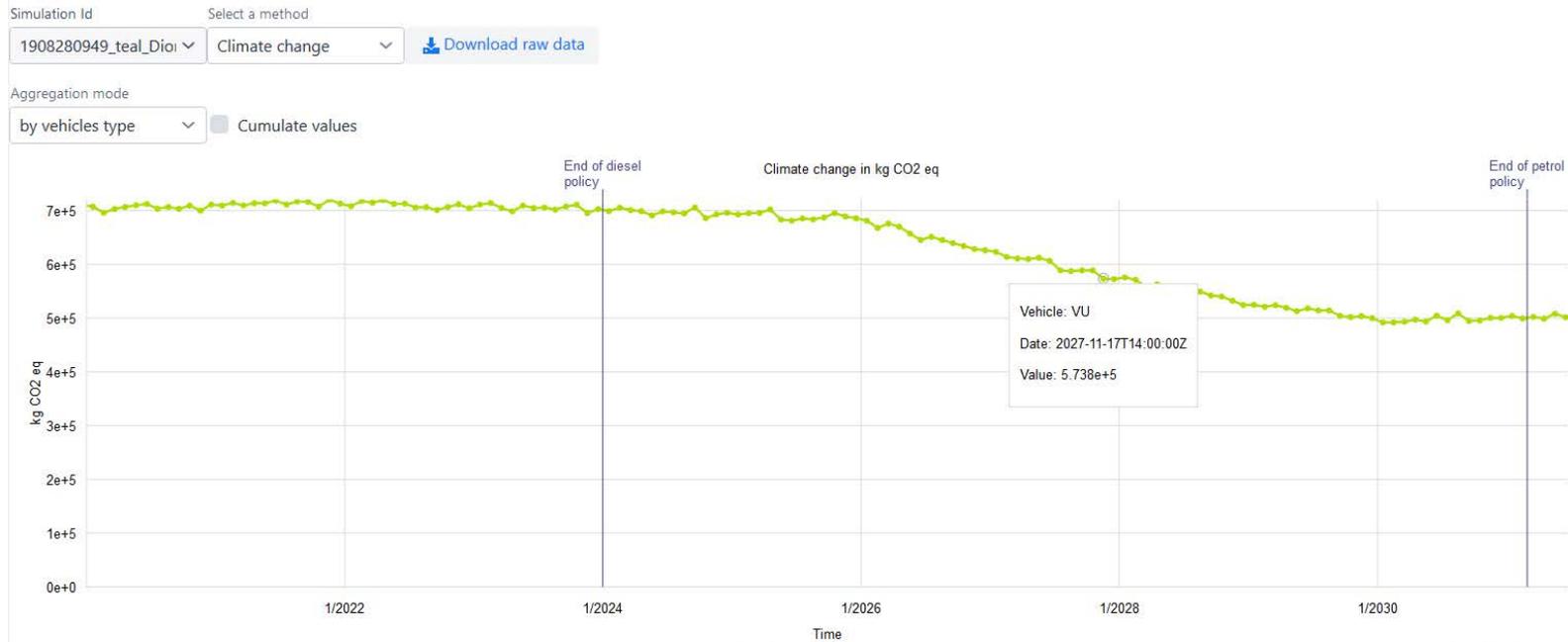


Price of fuels



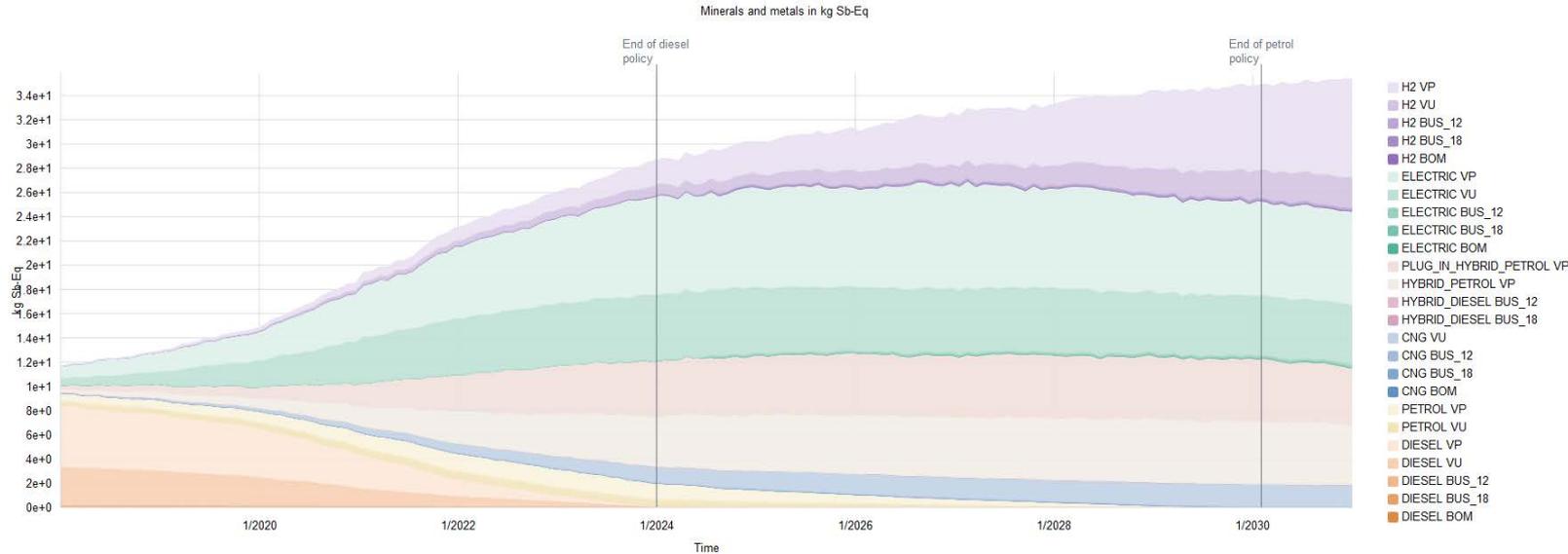
Subsidies and carbon tax
Ban on fuels

PROSPECTIVE CARBON FOOTPRINT



- Assess the impact of tipping points (e.g. end of diesel policy)
- Holistic carbon footprinting

PROSPECTIVE MINERAL RESOURCES CONSUMPTION



- Reduction of carbon footprint is counter balanced by significant increase in mineral resources consumption
- Overall balance for multi-fuel fleet of utility vehicles

METRICS FOR VIABILITY

Network analysis: assessing the importance of networks

Graphs: directed/undirected – weighted/unweighted

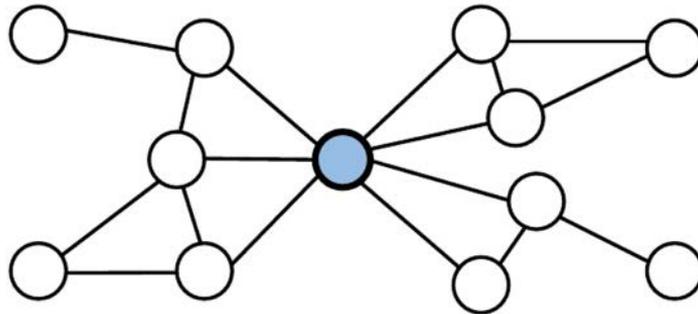
On the Complexity of Life Cycle Inventory Networks

Role of Life Cycle Processes with Network Analysis

Tomás Navarrete-Gutiérrez, Benedetto Rugani, Yoann Pigné, Antonino Marvuglia, and Enrico Benetto

Navarrete et al, doi.org/10.1111/jiec.12338

Centrality



Degree

Blue binary has dependencies to many other binaries

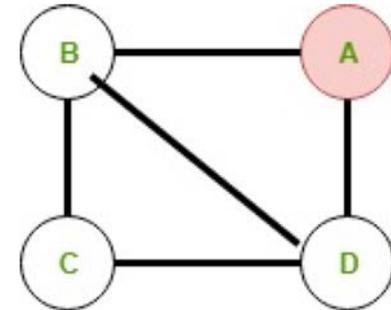
Closeness

Blue binary is close to all other binaries (only two steps)

Betweenness

Blue binary connects the left with the right graph (bridge)

Eccentricity



VIABILITY METRICS

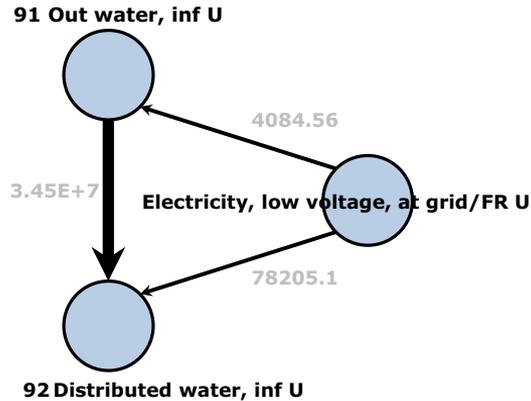
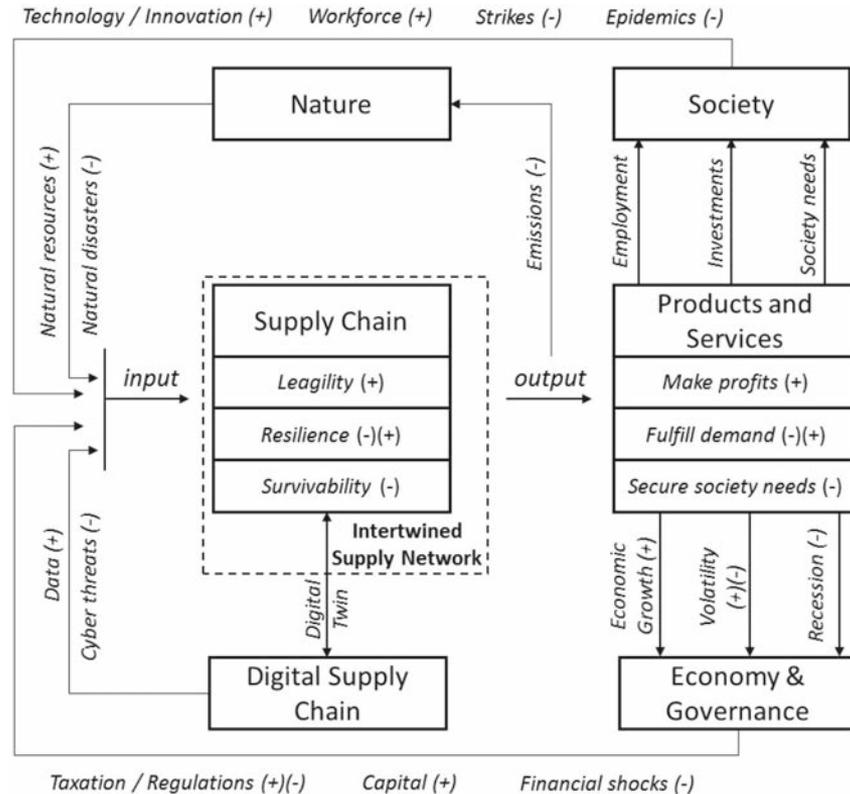


Figure 2 Example of compact representation of the graph describing the system's network involved in the production of potable water in a selected plant, taken as a case study (see Arbault et al. 2013a). The functional unit is 1 m^3 of potable water ($= 92$ Distributed water, inf U in the screenshot). In gray, the energy flowing from one process to the other is shown (in MJ of equivalent solar energy, seMJ), whereby arcs are proportional to the energy flow. *inf* = infrastructure; *FR* = electricity from the French grid; *U* = unit process; m^3 = cubic meters.

Navarrete et al, doi.org/10.1111/jiec.12338

- Understanding to what extent the network's structure can change following changes of even disruptions:
 - Hot-spotting criticalities
 - Determining which supplier is more effective or critical in terms of environmental footprint responsibility
- Finding a common numeraire for weighted networks?
 - Money
 - Energy/Mass
 - (share of) environmental footprint

COMBINING SUSTAINABILITY & VIABILITY



- Simulation using system dynamics or agent-based modelling
- Modelling of positive and negative feedbacks between SC and related agents (environment, production system, society)
- Identification of the boundaries of the “window of vitality”

Fig. 2 Viable supply chain ecosystem framework

NEXT CHALLENGES

- Implement the “window of vitality”
 - Sustainability & Vitality have “human well being” as common ground
 - Trade-off between short term and long-term perspectives

- Improve data availability
 - Trade-offs between transparency and confidentiality
 - Digitalization is an enabler : Digital Twin Luxembourg

