

# Model-based LCSA in the TREASoURcE project

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Alexander Koch  
GreenDelta GmbH

# Content

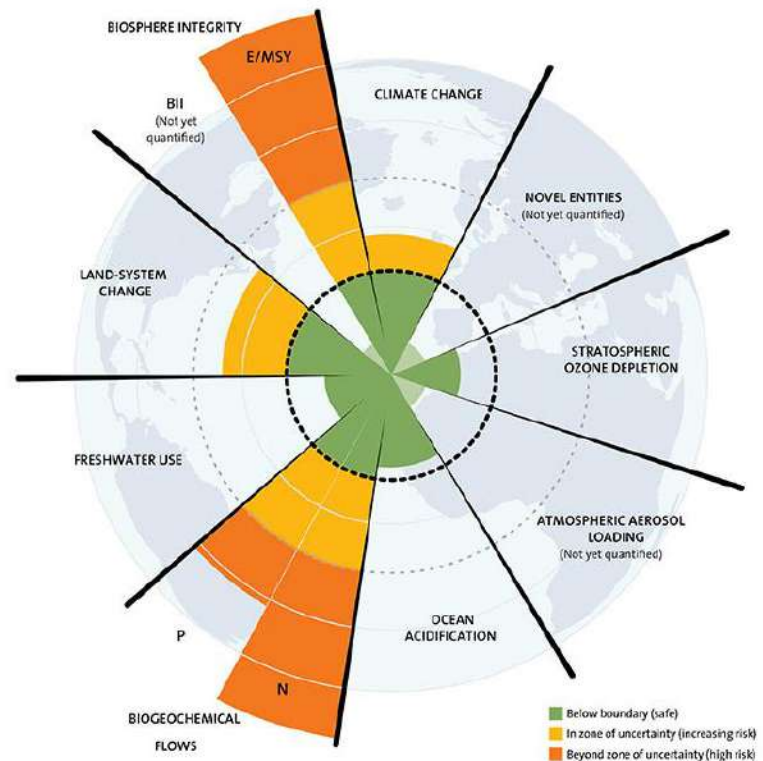
- Sustainability and LCSA
- System dynamics and sustainability modeling
- Conclusion and outlook



# Sustainability and LCSA

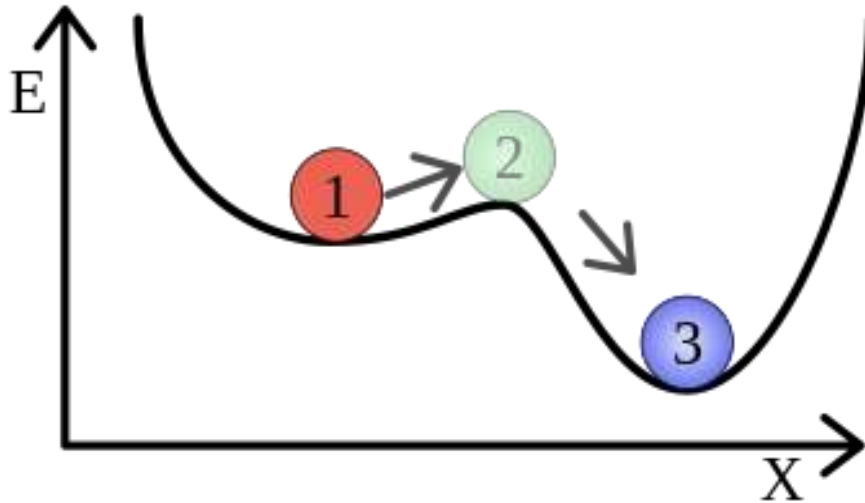
# Sustainability

- Brundtland commission (1987), for sustainable development :  
“*meeting the needs of the present without compromising the ability of future generations to meet their own needs*”
- So, sustainability refers to a multi-dimensional and dynamic system that needs to be maintained: *not exceeding certain boundaries*



# Sustainability

→ Sustainability is about the stability of a system under pressure



# Life Cycle Sustainability Assessment, LCSA

- Combination of three dimensions of sustainability, environmental impacts, economic impacts, social impacts: LCA, LCC, S-LCA
- Often-cited formula:

$$\text{LCSA} = \text{LCA} + \text{LCC} + \text{S-LCA}$$

## Limitations

Thresholds? Relations? Linear approach! Leads to recommendations with limited feasibility and replicability

The background of the slide is a scenic landscape. In the foreground, there are green and reddish-brown bushes and trees on a rocky slope. A chain-link fence is visible in the lower-left corner. In the middle ground, there is a dense forest of green trees. In the background, a large body of water (likely a lake or bay) is visible, with a small white building on the far shore. The sky is a clear, bright blue with some light, wispy clouds. A semi-transparent blue rectangular box is overlaid on the middle of the image, containing the title text in white.

# System dynamics and sustainability modeling

# System dynamics

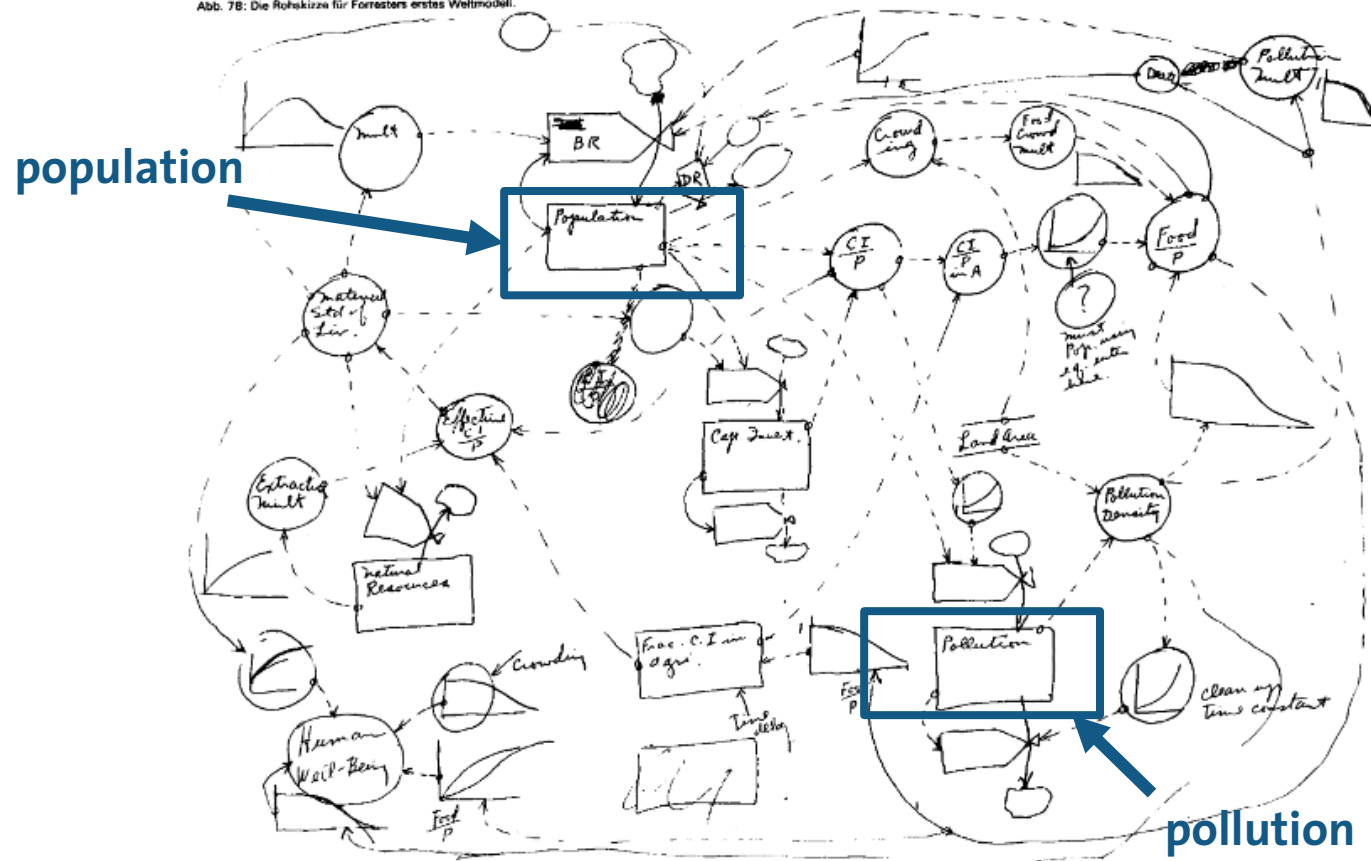
- Idea: modeling a system as a combination of stocks and flow rates
- Any system(!)
- Scope and level of detail totally up to the modeler



# System dynamics and sustainability modeling

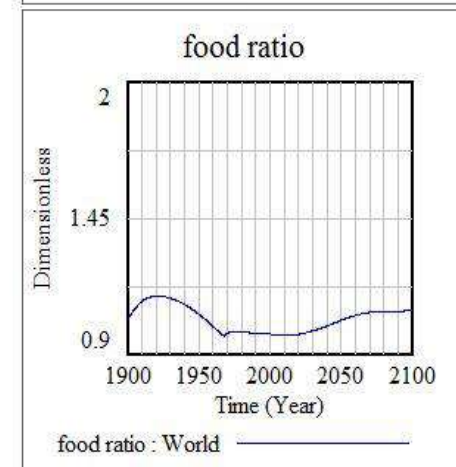
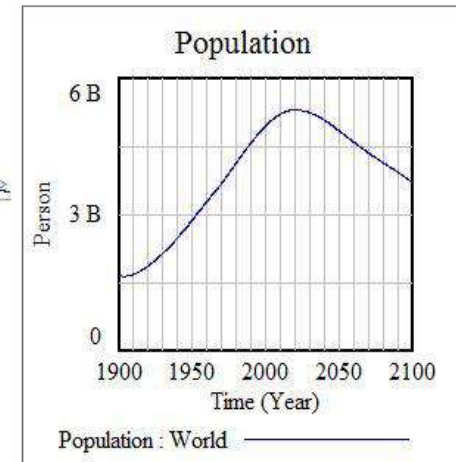
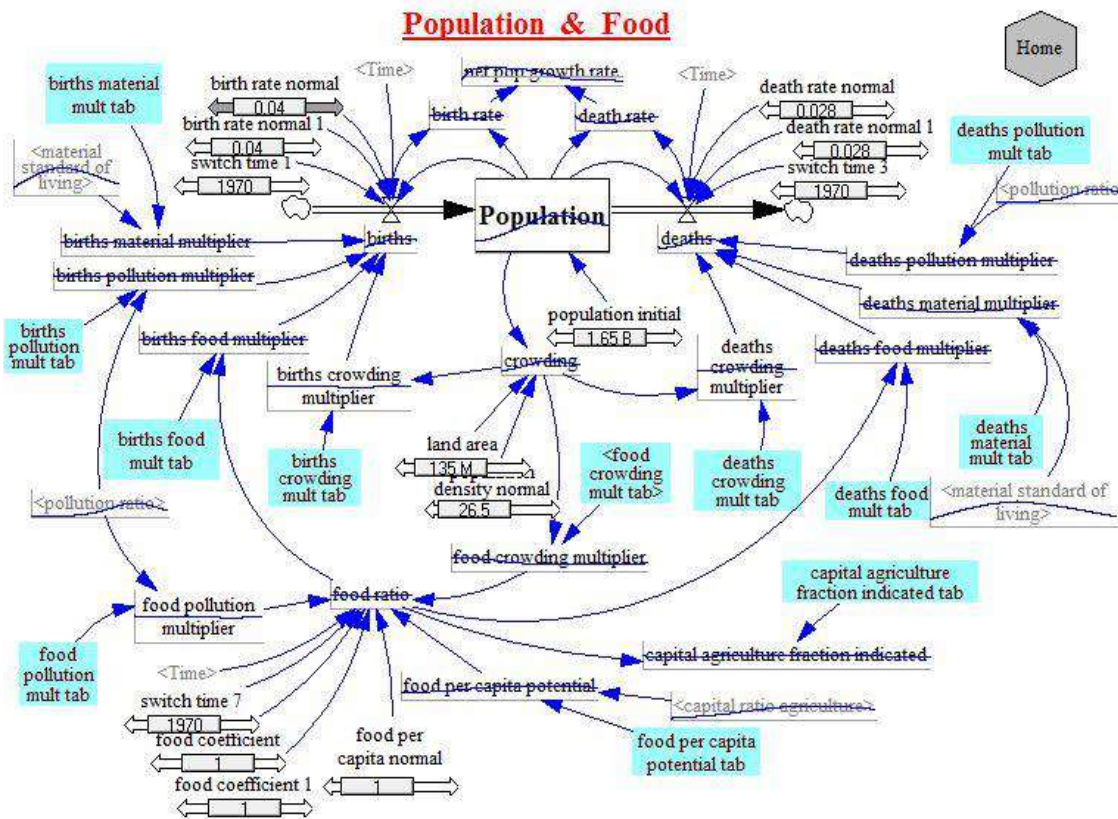
- Forrester et al. 1970's: a model of the entire world

Abb. 7B: Die Rohskizze für Forrester's erstes Weltmodell.



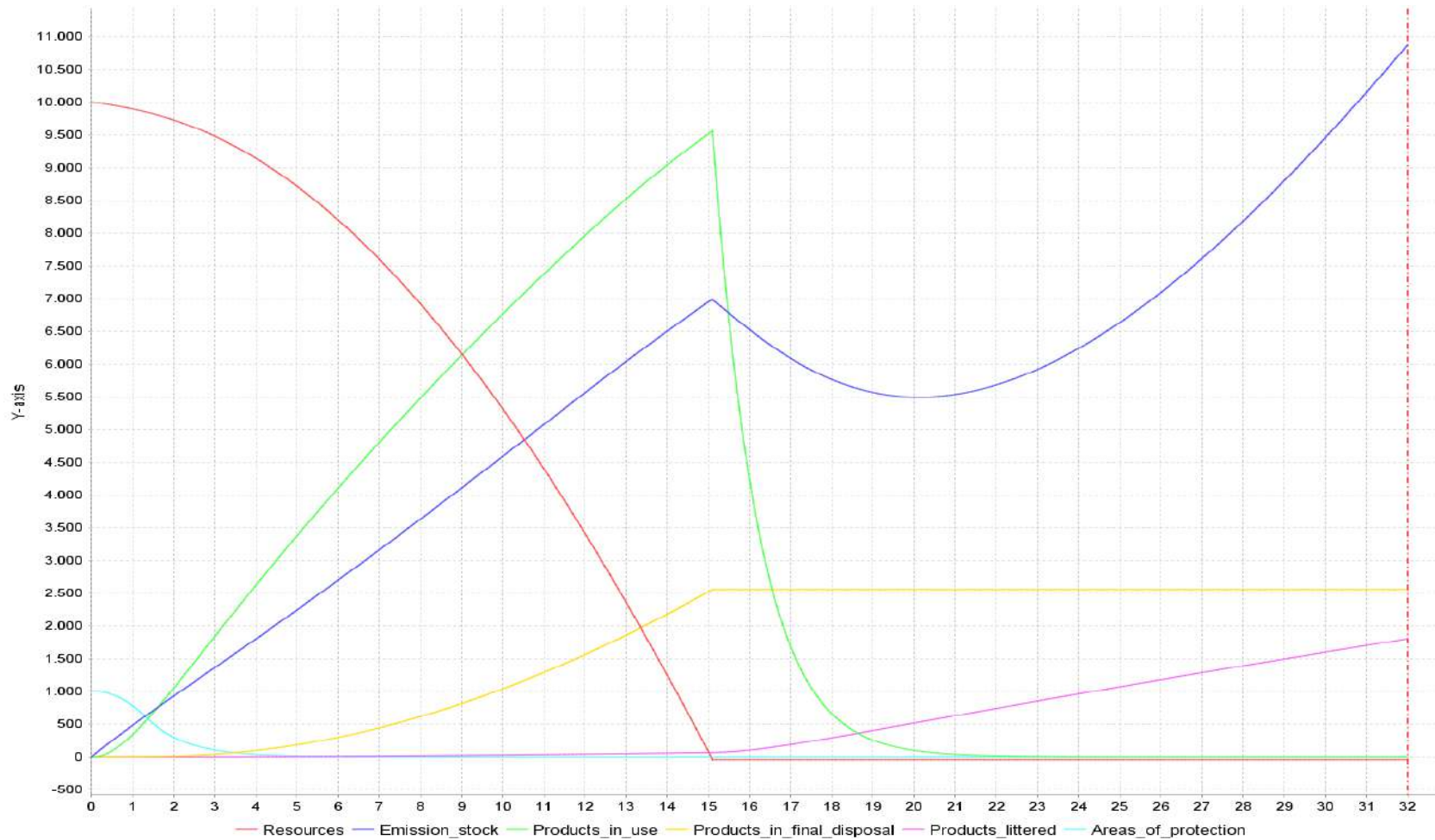
Forrester, Jay W. (1971). *World dynamics*. Cambridge, Mass: Wright-Allen Press

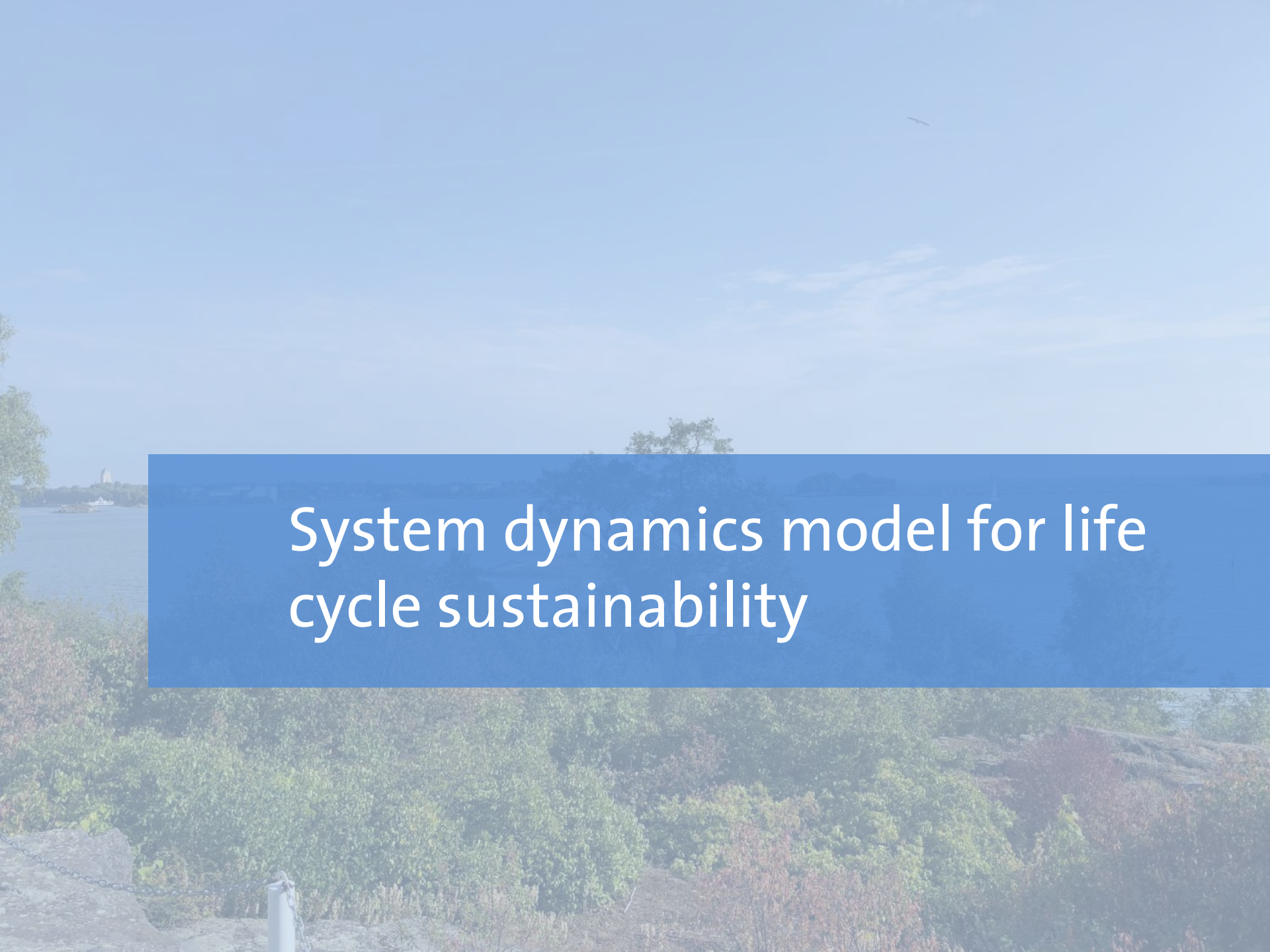
# System dynamics



Forrester, Jay W. (1971). *World dynamics*. Cambridge, Mass : Wright-Allen Press; In Software: Vensim

# System dynamics and sustainability modeling

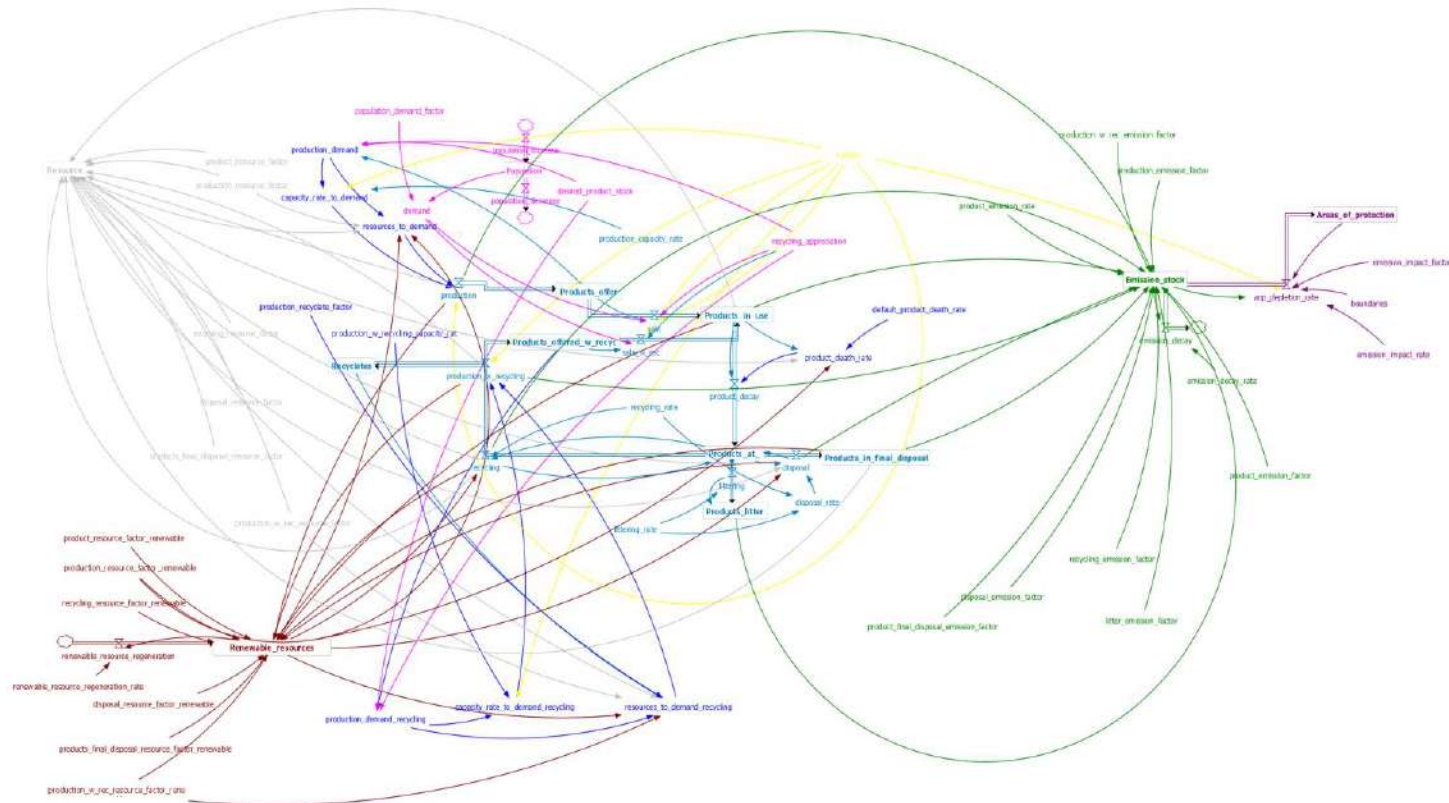


A scenic view of a body of water, likely a lake or bay, with a blue overlay containing text. The background shows a clear blue sky with a few wispy clouds, a small airplane in the distance, and a shoreline with trees and a building. The foreground is a rocky hillside with green and brown vegetation. A white post with a chain is visible in the lower left corner.

# System dynamics model for life cycle sustainability

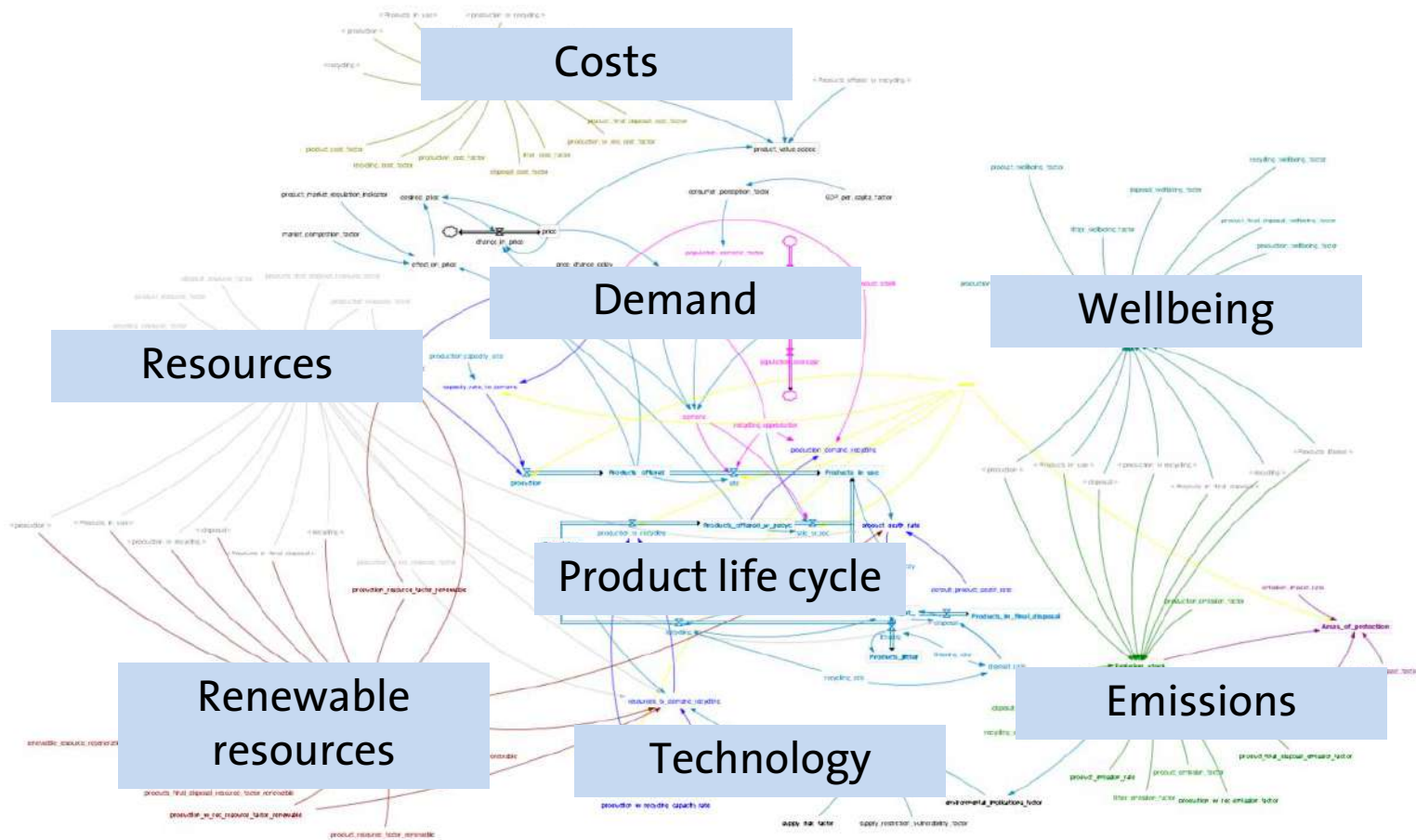
# A generic system dynamics model for life cycle sustainability

We developed a model to combine system dynamics and LCSA: “model-based LCSA”.



# A generic system dynamics model for life cycle sustainability

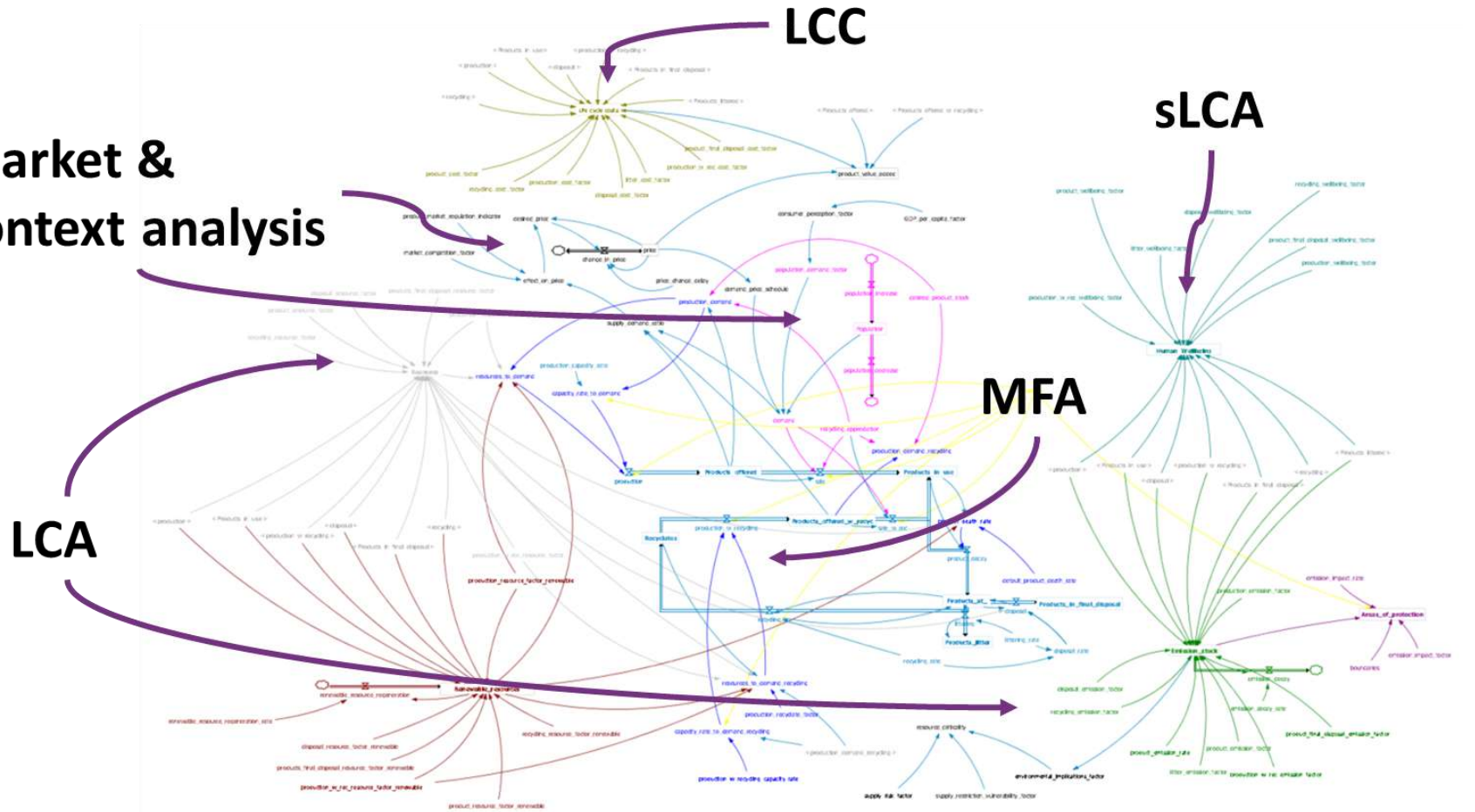
With eight main sections



# A generic system dynamics model for life cycle sustainability

Data required

Market & context analysis



# TREASoURcE

The treasure in resources: implementing circular economy practices for plastics, batteries and bio-based side and waste streams to take TREASoURcE **regions and their citizens** to the forefront of climate neutrality and circularity

## Systemic Circular Economy Solutions

Key Value Chain Demonstrations



Circular plastics



Circular batteries



Circular biobased  
side and waste  
streams

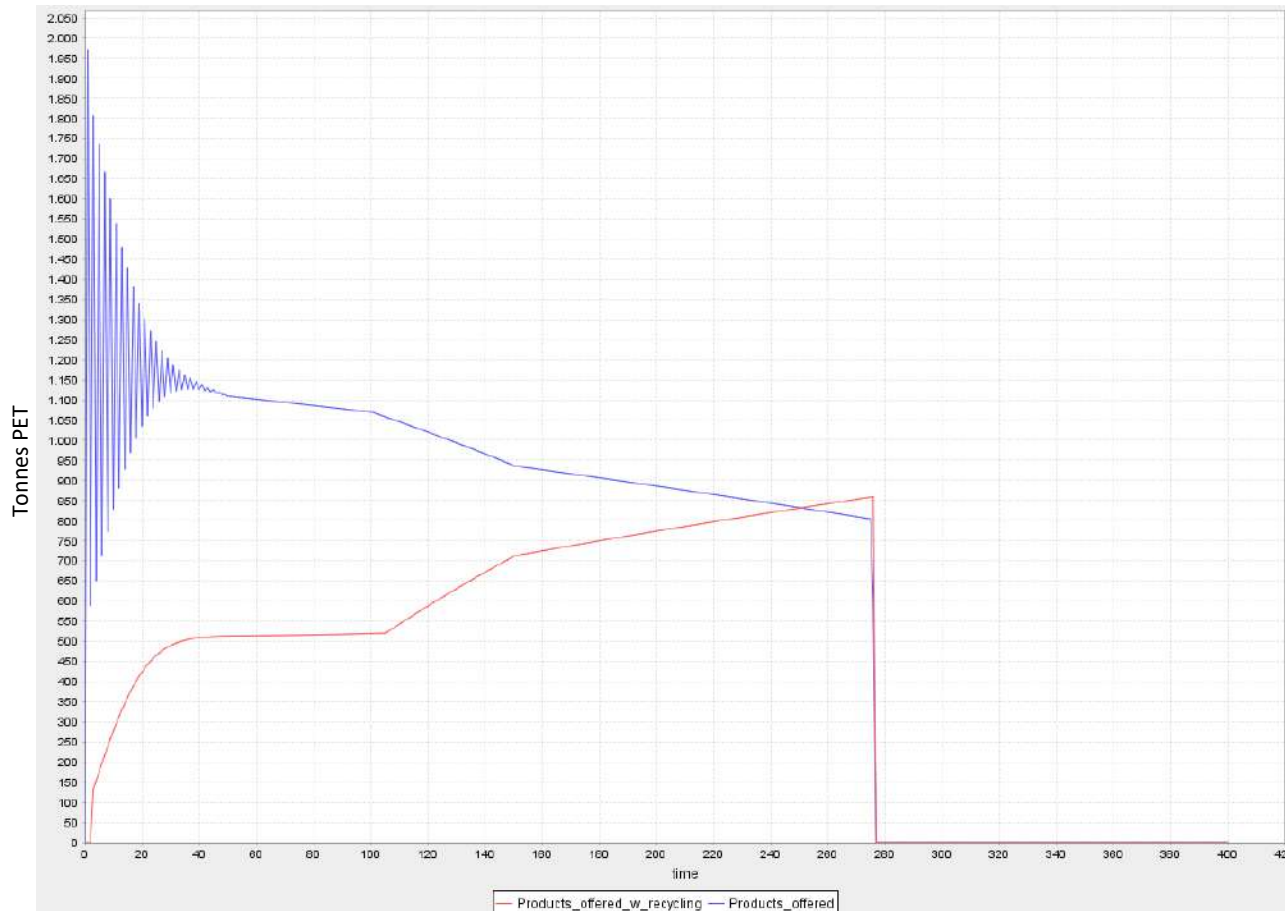


Stakeholder  
Engagement  
Demonstrations



# Case: PET recycling in Fredrikstad, Norway, over time

Primary material production (blue) and recycled material (red)



Assumptions made for:

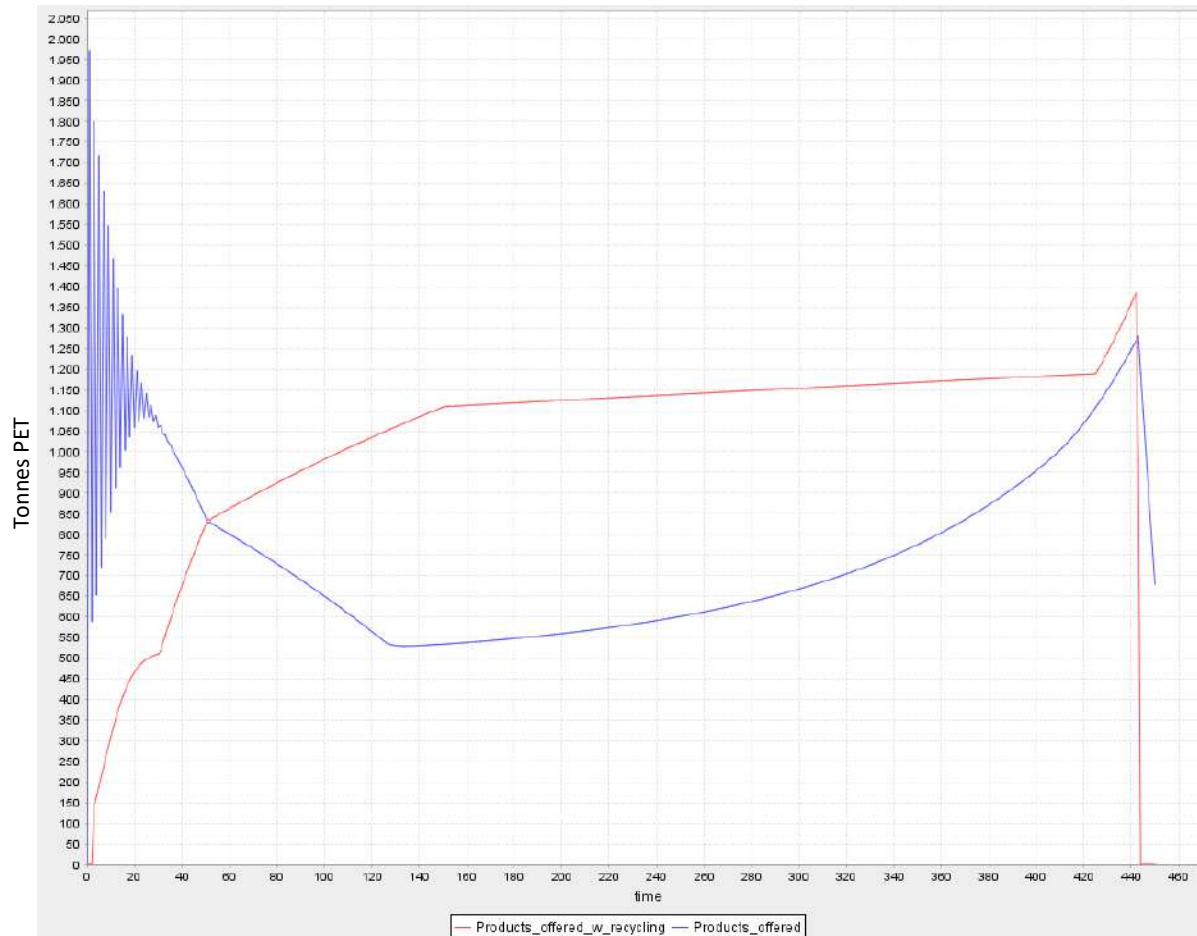
- Method for determining available resources allocated to Fredrikstad
- Market demand determinants
- Price determinants
- Development of recycling rates, recycling appreciation, production capacity

Data collected from:

- StatBank Norway
- Ecoinvent
- Abbasi et al. (2023): A high-resolution dynamic probabilistic MFA of 7 plastic polymers; A case study of Norway

# Case: PET recycling in Fredrikstad, Norway, over time

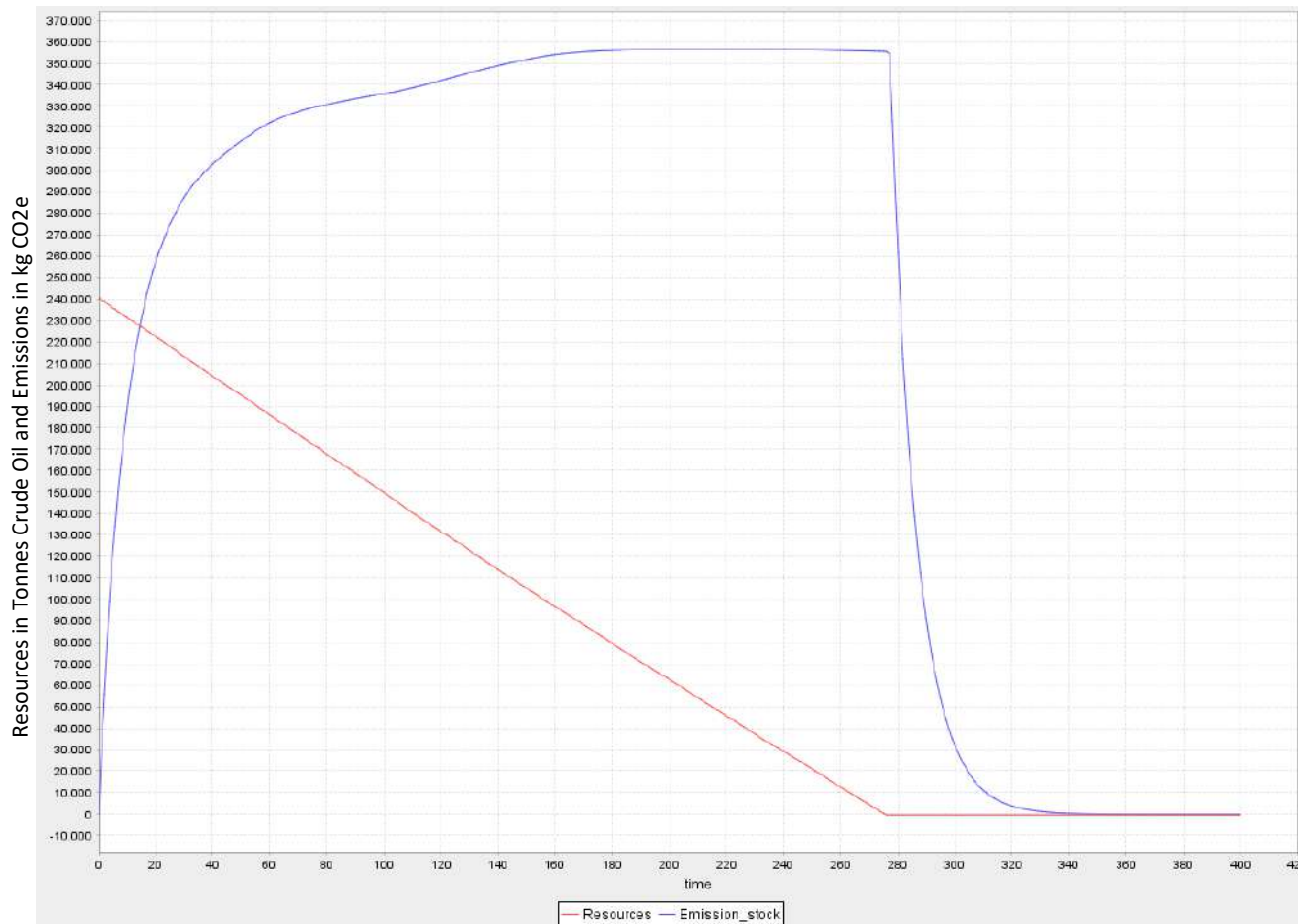
Primary material production (blue) and recycled material (red), with higher PET recycling appreciation and rates



- Initial recycling rate in Fredrikstad: 73.6%
- Here assumed to increase by 5% every 10 years until it reaches a stable rate of 95%.

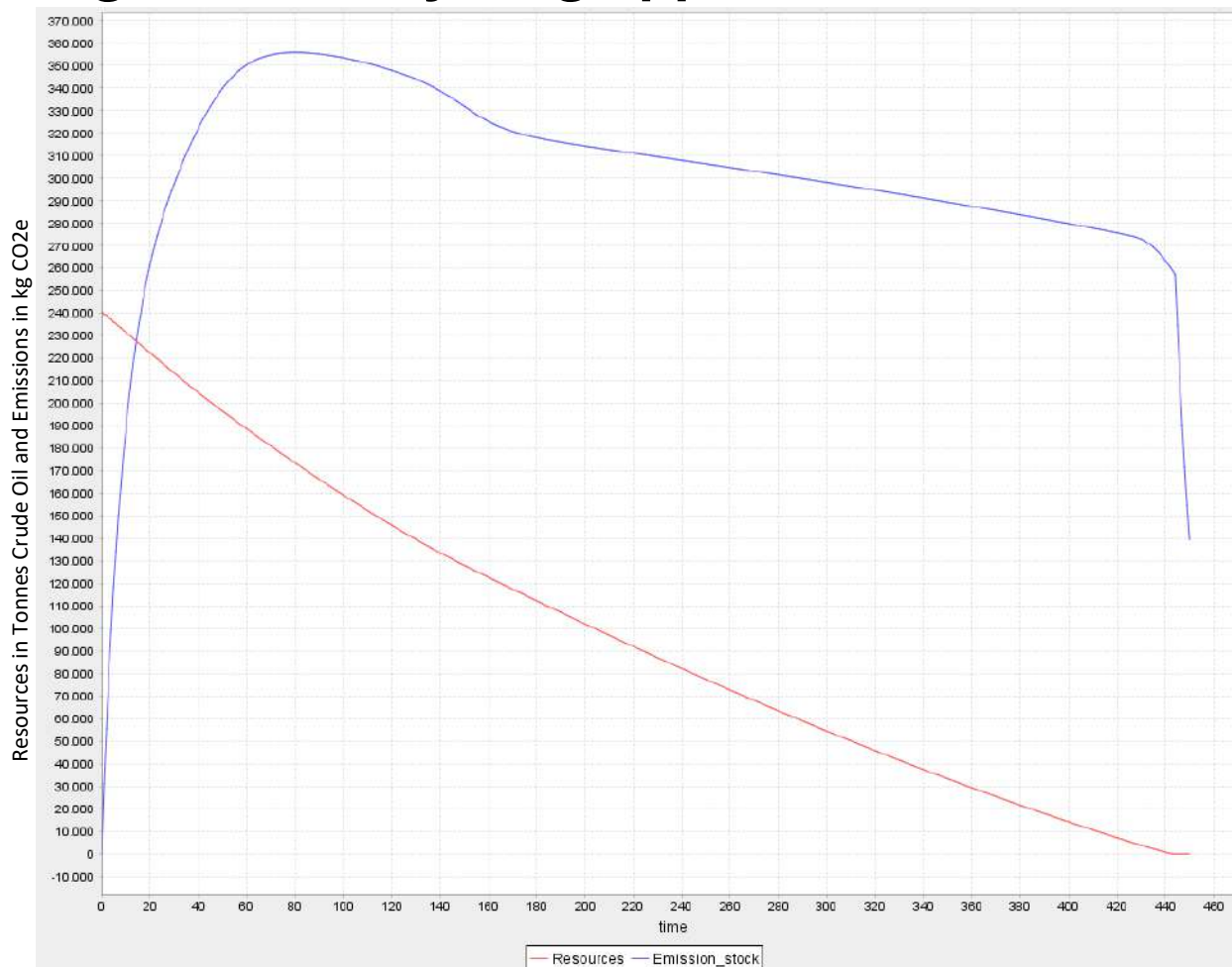
# Case: PET recycling in Fredrikstad, Norway, over time

Life cycle emissions (blue) and mineral resources (red)



# Case: PET recycling in Fredrikstad, Norway, over time

Life cycle emissions (blue) and mineral resources (red), **with higher PET recycling appreciation and rates**





# Conclusion and outlook

# Outlook

- System dynamics + LCSA = Model-based LCSA (!)
- This combination is better able to reflect sustainability, and system know-how as well.
- Promising and powerful.
- TREASoURcE: enables insights into the replicability and feasibility of solutions.
- Strong decision-making tool for sustainability strategies at all levels.
- To be tested and explored in future cases.

# GreenDelta

sustainability consulting + software



TREASoURcE

## Thank you!

Contact

Alexander Koch

[koch@greendelta.com](mailto:koch@greendelta.com)

GreenDelta GmbH

Kaiserdamm 13, 14057 Berlin

[www.greendelta.com](http://www.greendelta.com)