

System-level impacts of electrification on road freight transport efficiency - a System Dynamics approach

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TRAFIKVERKET



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Motivation

What is the impact of electrification on road freight transport efficiency?

electrification

Impact on

Freight transport efficiency



What is efficiency?

1. complex to define
2. many different types of efficiencies
3. two perspectives: efficiency for business and for society
4. dynamics and interconnection between different efficiencies
5. electrification adds more stakeholders and complexity to the game

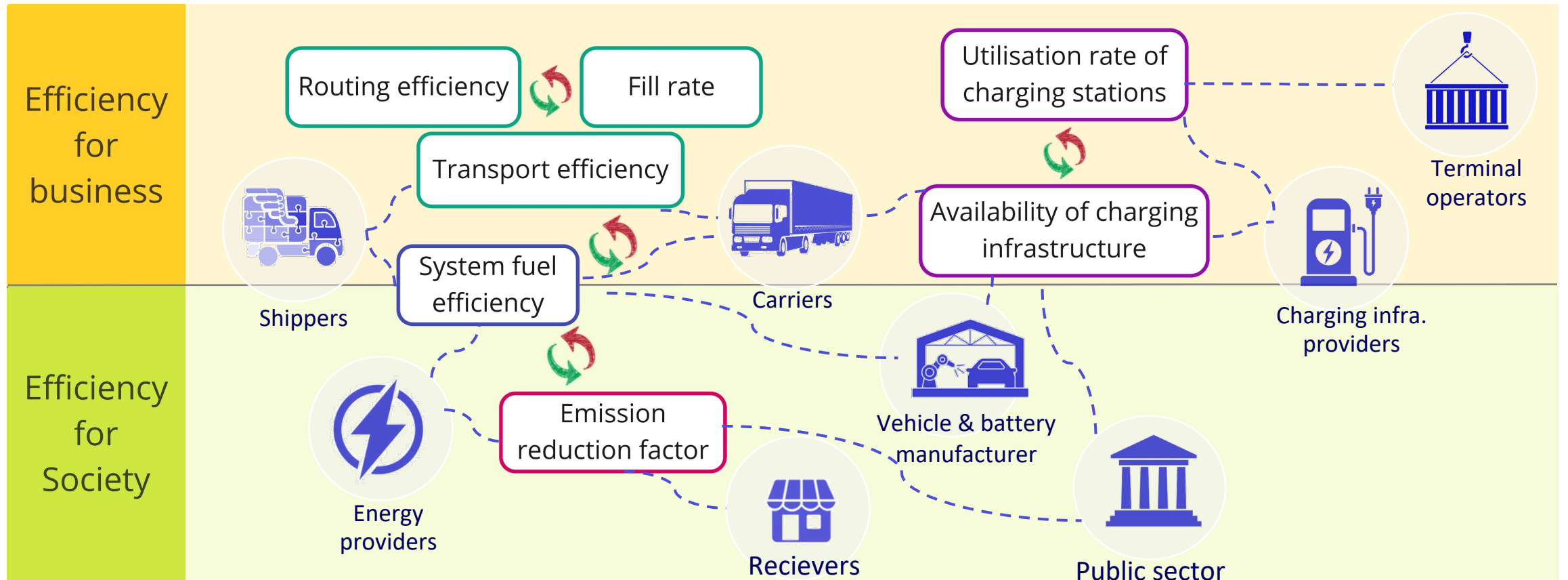


Literature review

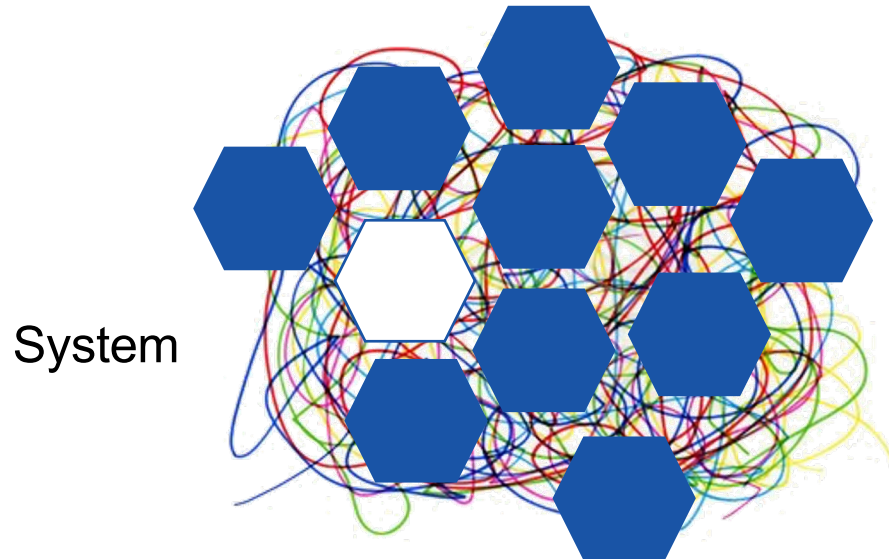


Interviews

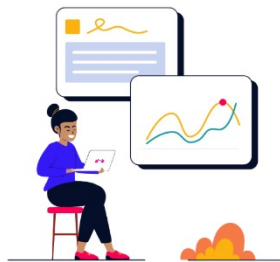
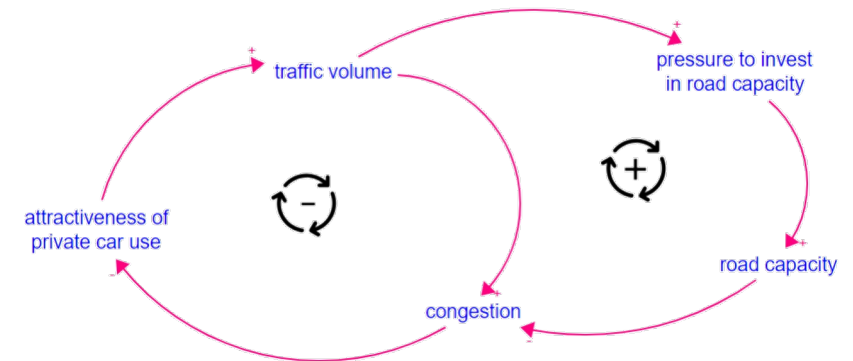
What is efficiency?



System dynamics



System representation



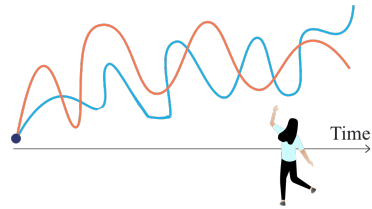
Method that enables the understanding of the structure and dynamics of **complex systems**

Rooted in systems thinking and control theory

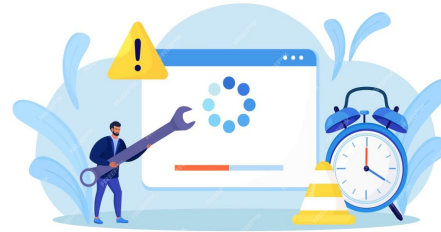
→ allows to create **conceptual and mathematical models**

Why system dynamics?

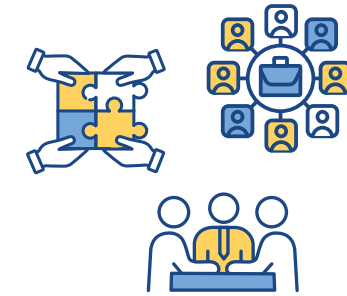
Freight transport efficiency as a complex concept



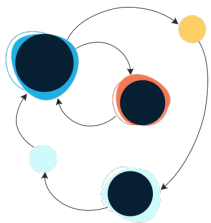
Dynamics



Accumulations and delays



Diversity of actors and stakeholders



Feedback and rebound effects

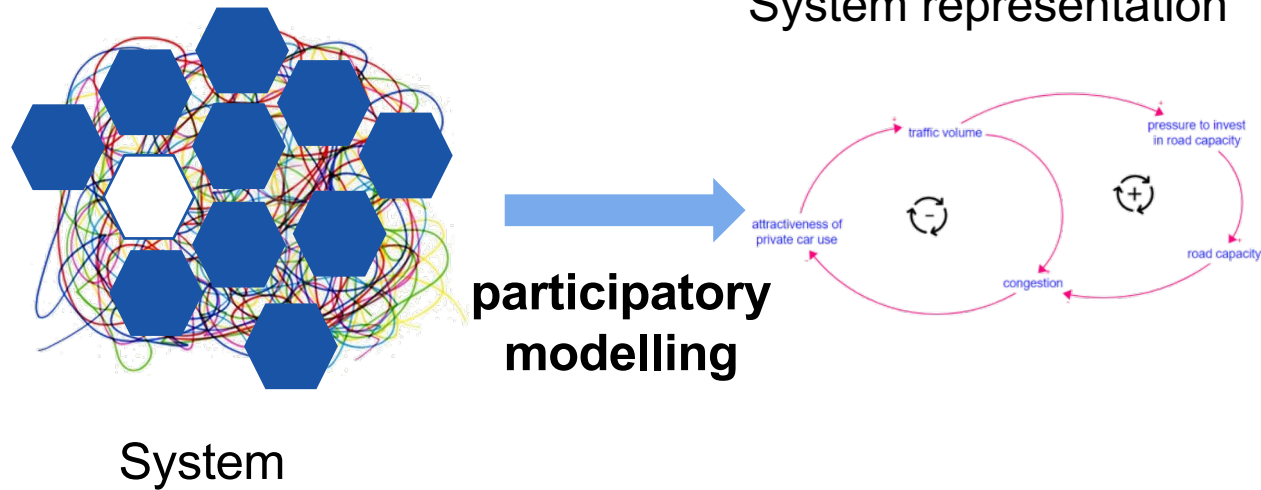


Non-linearity



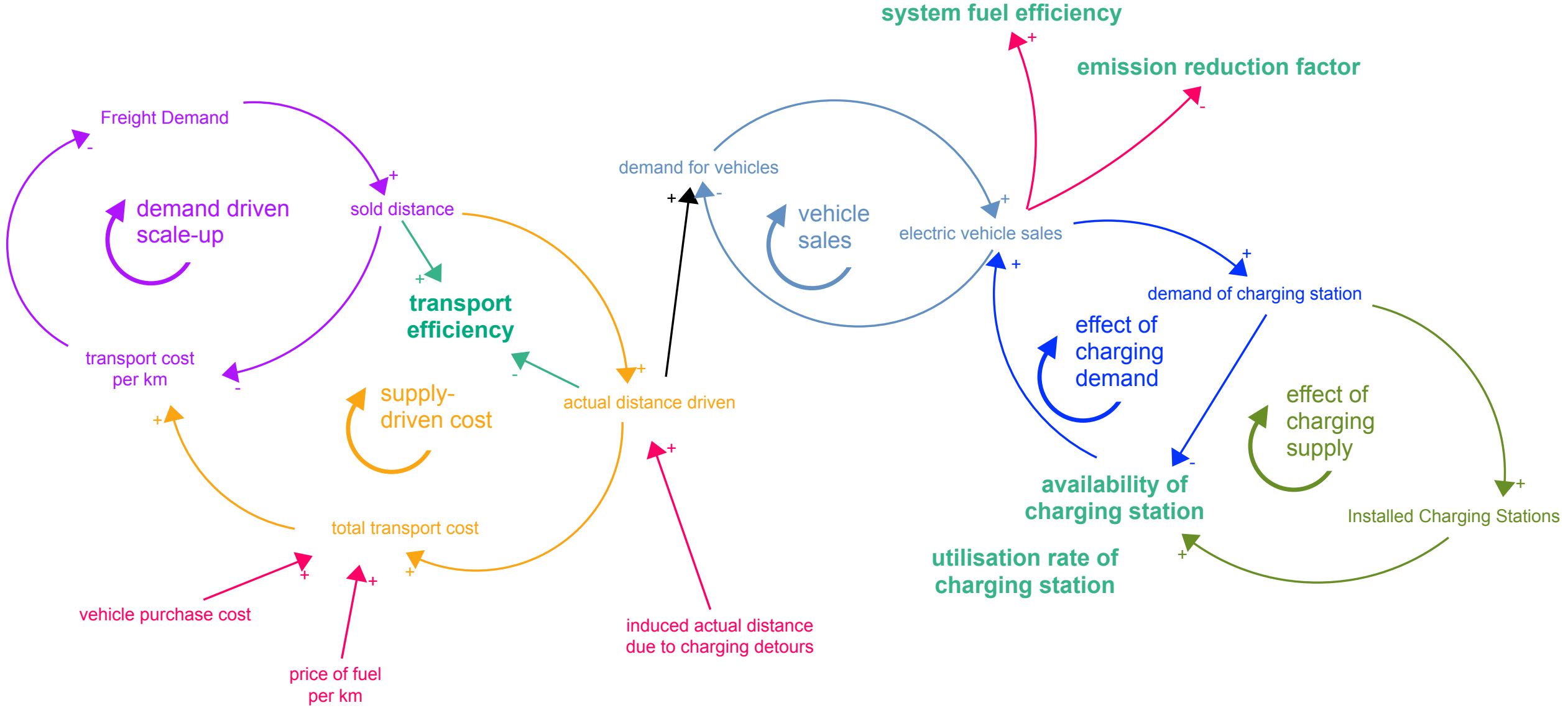
Importance of policy setting

Group Model Building Workshop



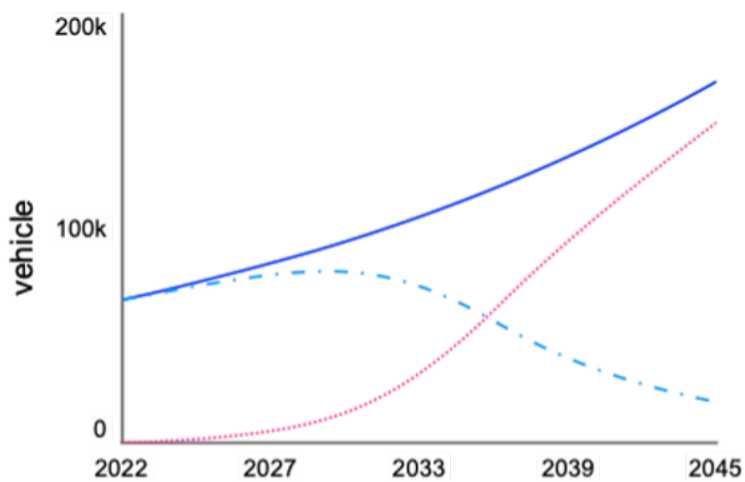
- Understand dynamics between different types of efficiencies
- How electrification changes existing or adds new dynamics

Causal Loop Diagram

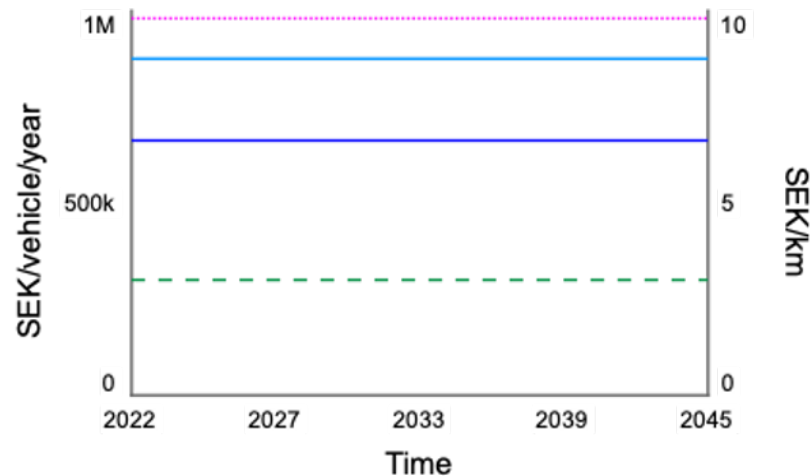


Preliminary Results

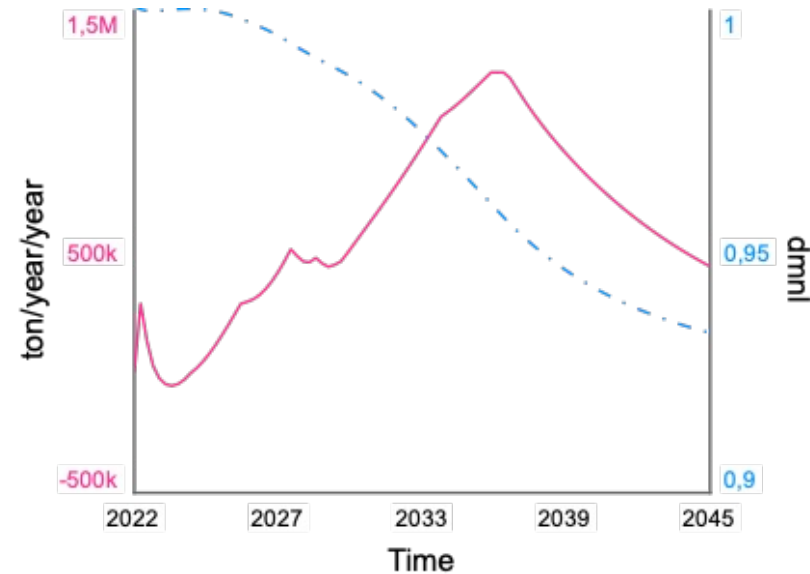
Vehicles, cost and induced demand



- total number of vehicles
- - Diesel Fleet
- Electric Fleet

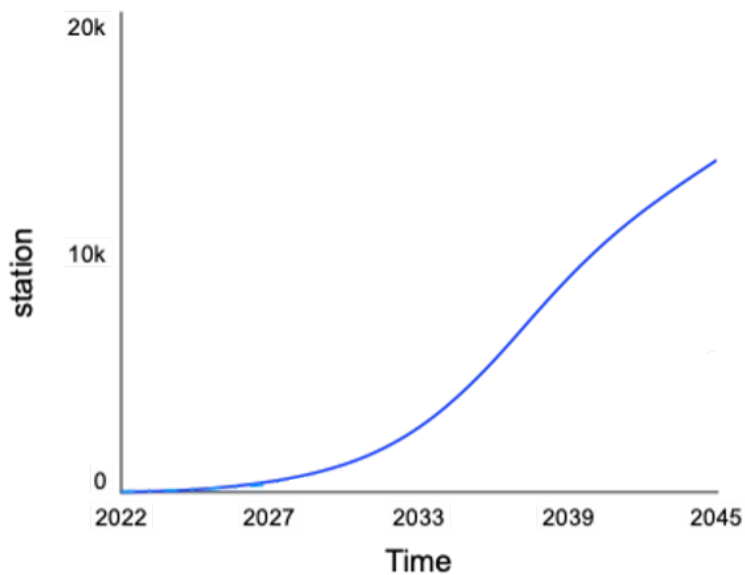


- cost per vehicle[Diesel]
- cost per vehicle[EV]
- price of fuel per km[Diesel]
- - price of fuel per km[EV]

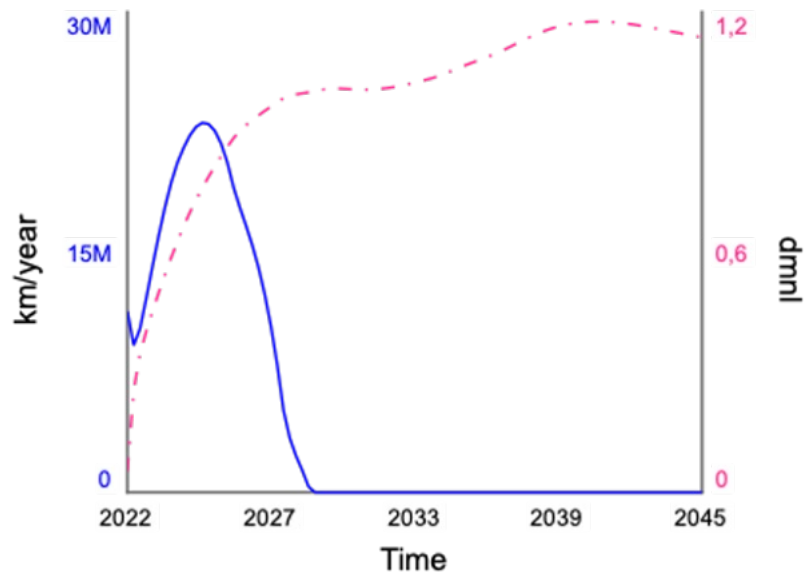


- induced demand due to price change
- - normalised transport cost per ton km

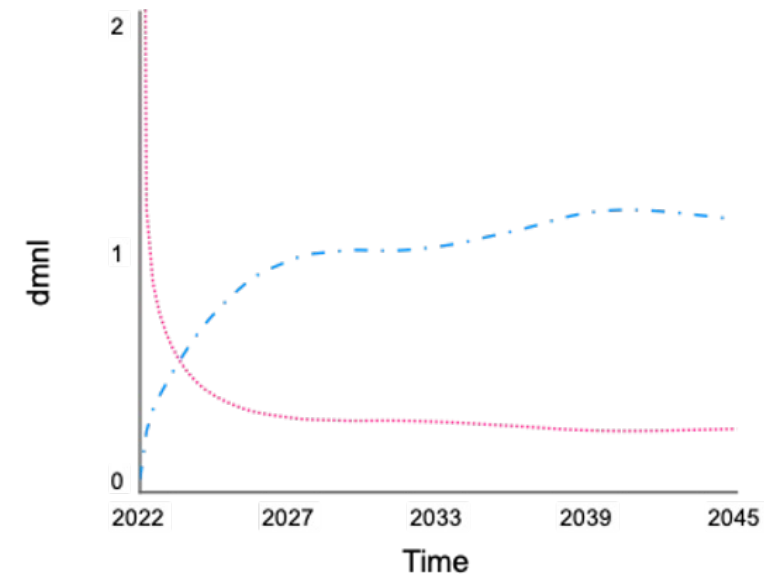
Infrastructure and induced distance



— Installed Charging Stations

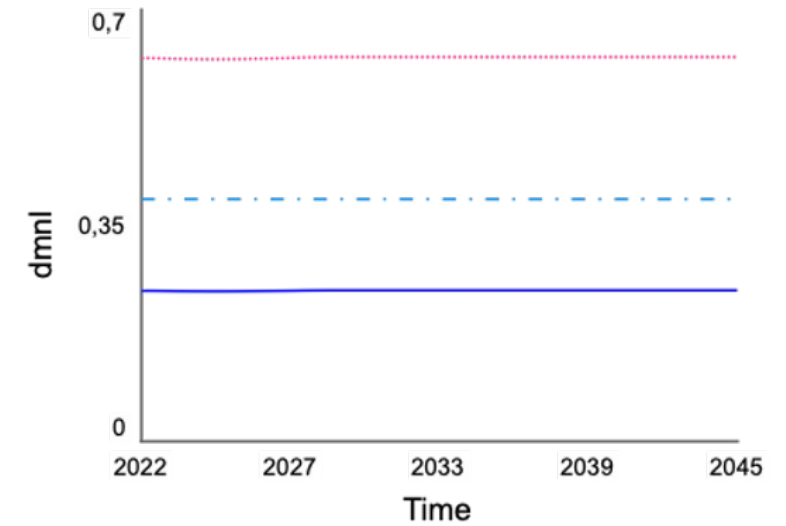


— induced actual distance due to charging detours
 - - - availability of charging infrastructure

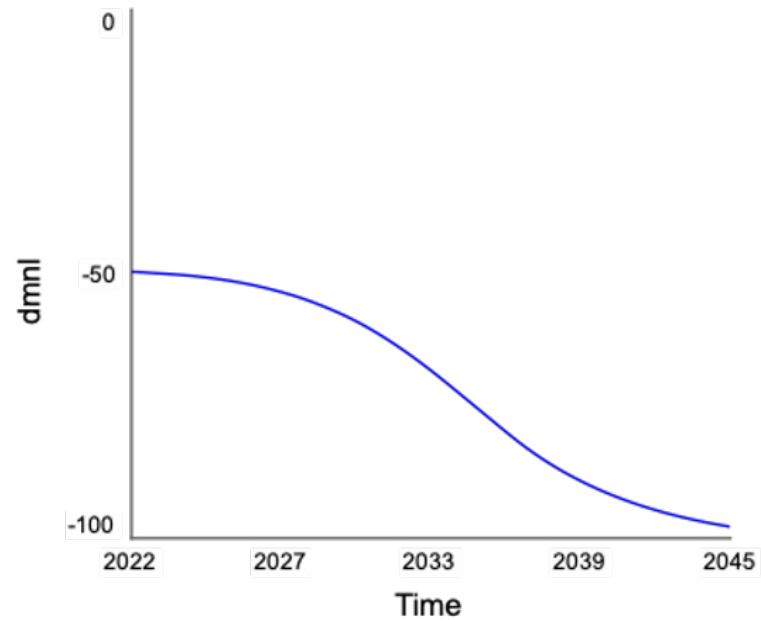


- - - availability of charging infrastructure
 utilization rate of charging stations

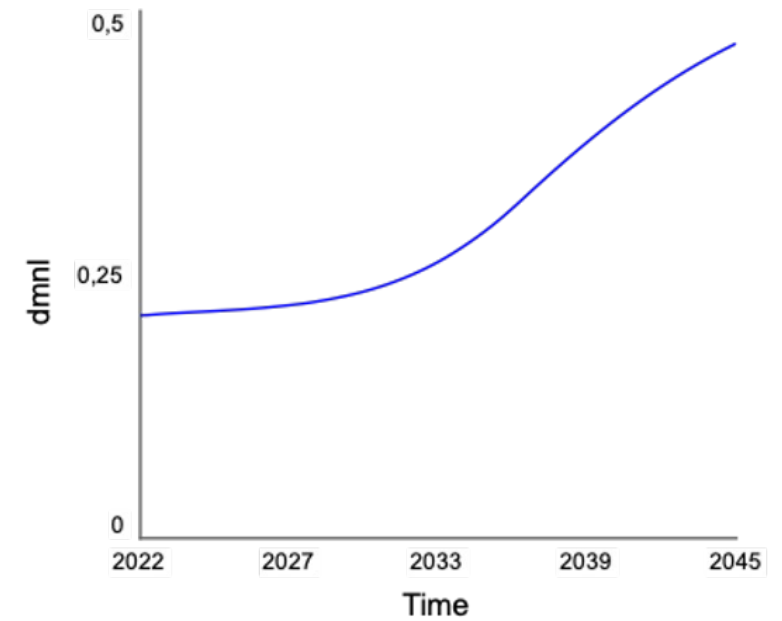
Different types of efficiencies



— transport efficiency (routing, fill rate, empty km)
- - - fill rate
..... routing efficiency

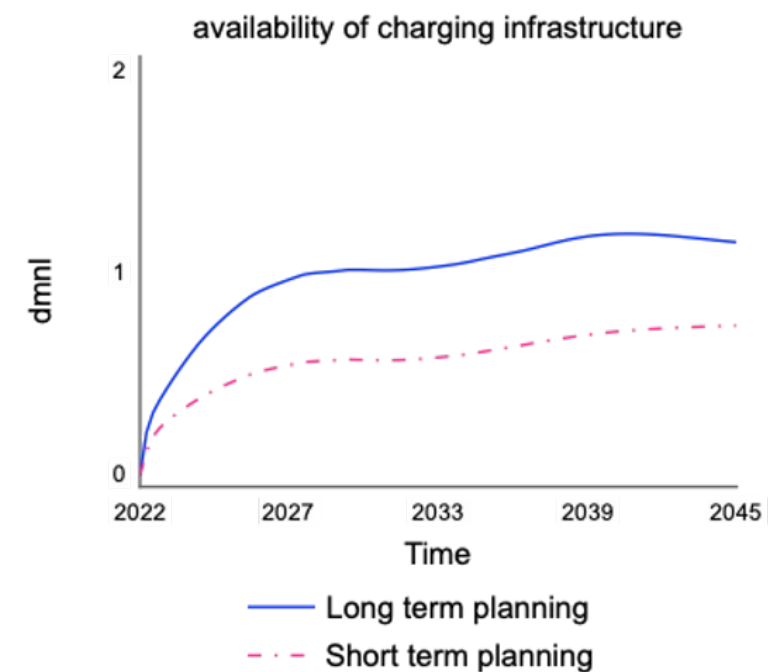
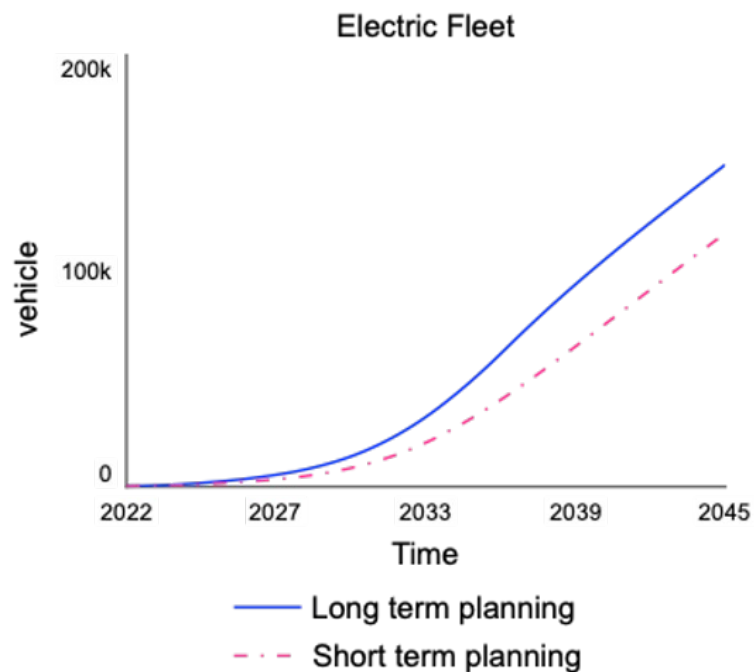
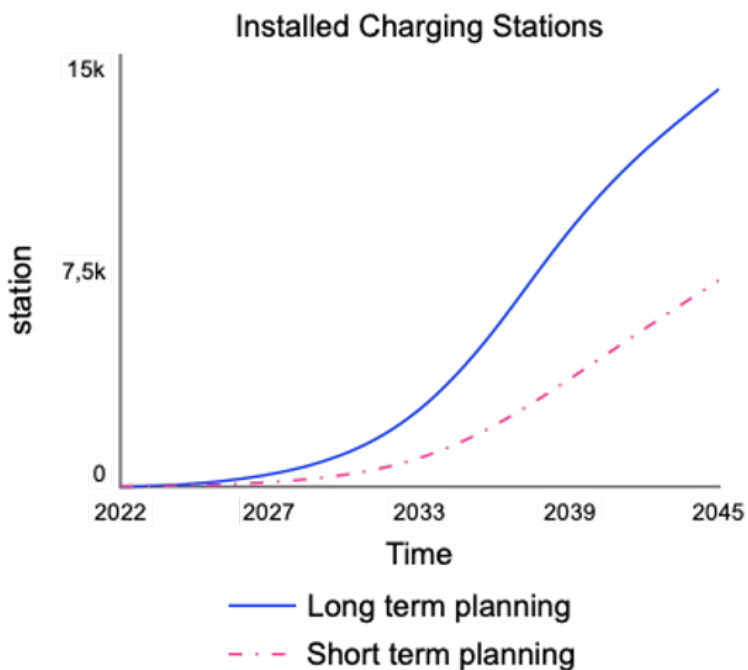


— emission reduction factor



— system fuel efficiency

Discussion: long term vs short term planning



Future work



Interviews, workshops
and expert meetings



Validate structure of
mathematical model and
more accurate results



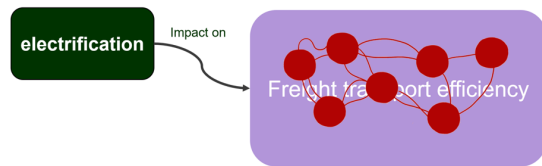
Validate data further
using Swedish freight
transport statistics

How can policymakers intervene
to improve the sustainability of
the freight transport system?



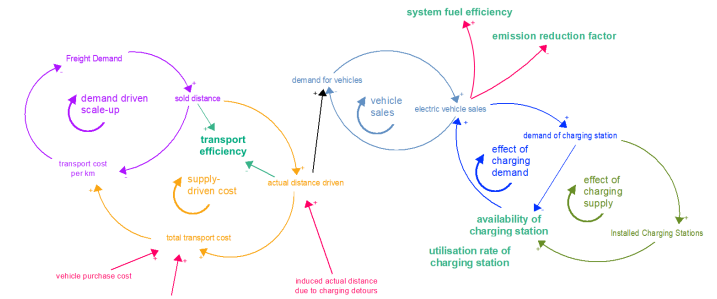
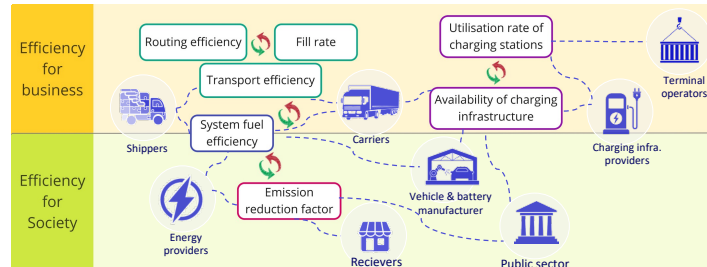
Use the model for
exploration of potential
policies and scenarios

Conclusion

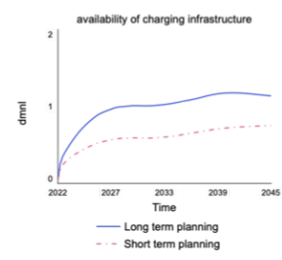
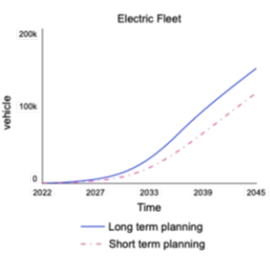


Impacts of electrification on freight transport efficiency

Different types of freight transport efficiency



System dynamics model



Future work

Use the model for exploration of potential policies and scenarios

Potential: use system dynamics more as a methodology to holistically understand complex dynamic systems

Thank you!

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