

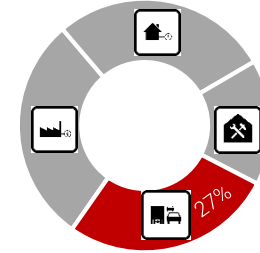
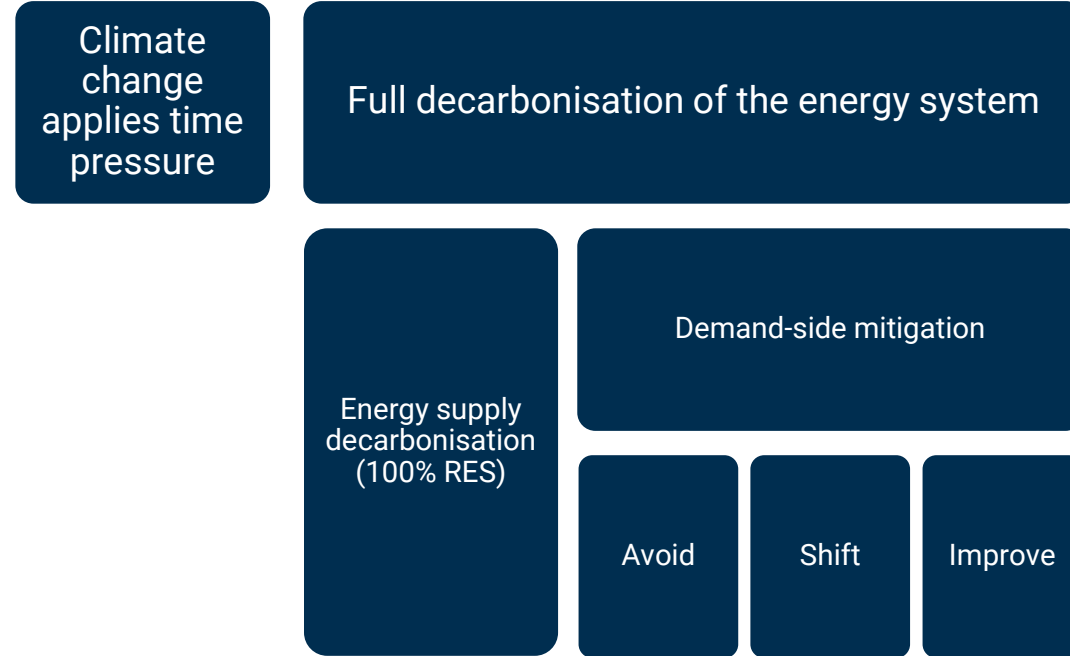
The impact of Avoid, Shift, and Improve strategies in passenger transport on the renewable energy system

ENERDAY, Dresden, 05.05.2023

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Kendziorski, Johannes Thema, Frauke
Wiese, Philipp Blechinger, Parinaz
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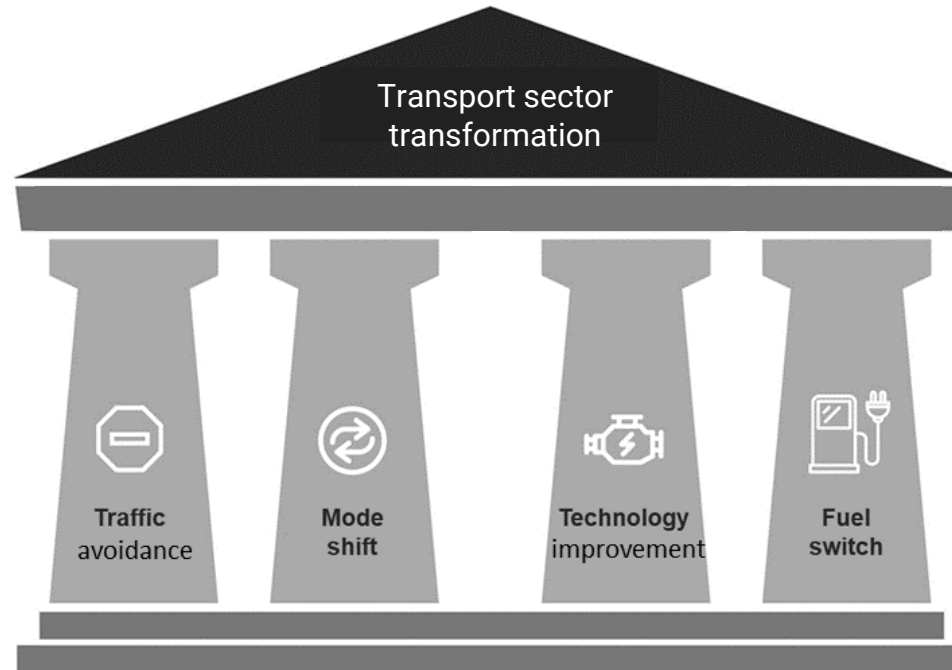
Motivation



Passenger transport consumes 18% of total German final energy demand

Avoid and Shift strategies are under-researched

Introduction: Transport sector transformation



Our approach:

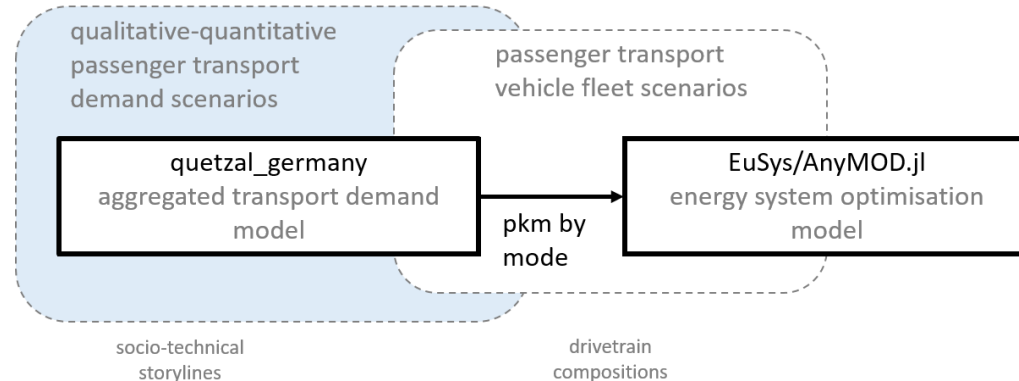
Sufficiency scenarios

Vehicle fleet
scenarios

100% RES
target

Model coupling and scenario analysis

Modelling and scenario framework



Avoid, Shift, Improve scenarios under analysis

Transport supply:		Reference developments for drivetrains*	100% BEV
Transport demand		Technology mix	Improve
	reference	Ref+Mix	Ref+Improve
	Avoid	Avoid+Mix	Avoid+Improve
	Shift	Shift+Mix	Shift+Improve
	Avoid+Shift	Avoid+Shift+Mix	Avoid+Shift+Improve

*: Take 2040 values from 'Technology Mix' scenario in Ariadne project: 30% ICEV; 14% PHEV; 56% BEV; other modes 100% direct electrification

Transport demand model quetzal_germany

Regional coverage:

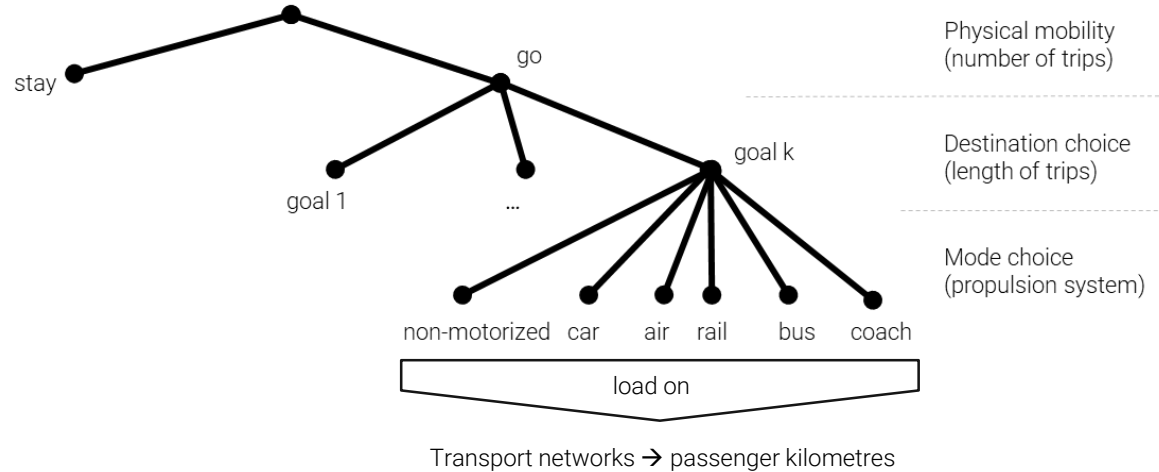
Germany

Temporal scope:

aggregated mobility of
one target year

Method:

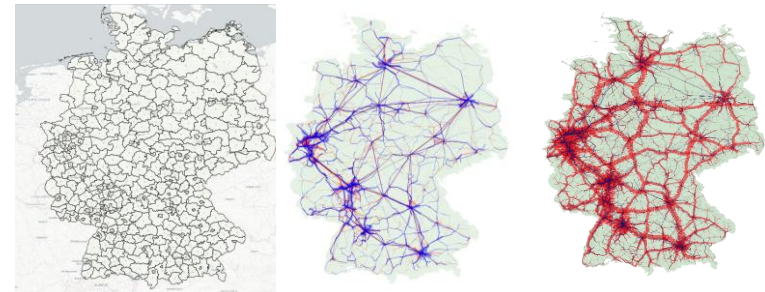
aggregated transport
model, discrete choice
modelling



Openly available and documented on github

https://github.com/marlinarnz/quetzal_germany

Arnz (2022): The demand-side mitigation gap in German passenger transport. Eur. Transp. Res. Rev. 14, 44, DOI: 10.1186/s12544-022-00568-9



Energy system model EuSys/AnyMOD.jl

Regional coverage:

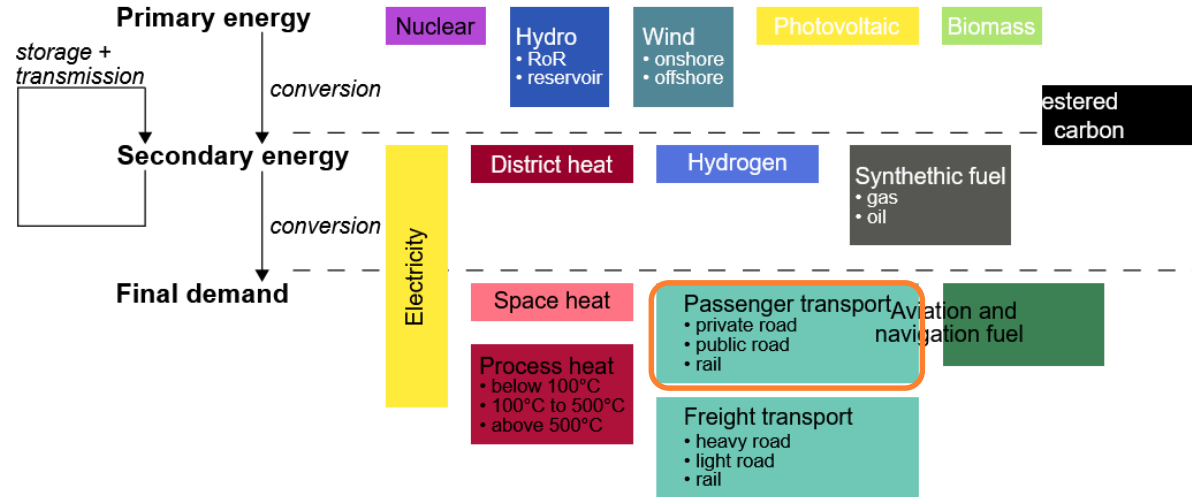
Europe

Temporal scope:

greenfield optimisation
for one target year

Method:

techno-economic cost
minimisation targeting
100% RES



Based on open source framework by Göke (2021), AnyMOD.jl:
A Julia package for creating energy system models,
SoftwareX.

<https://github.com/leonardgoeke/AnyMOD.jl>

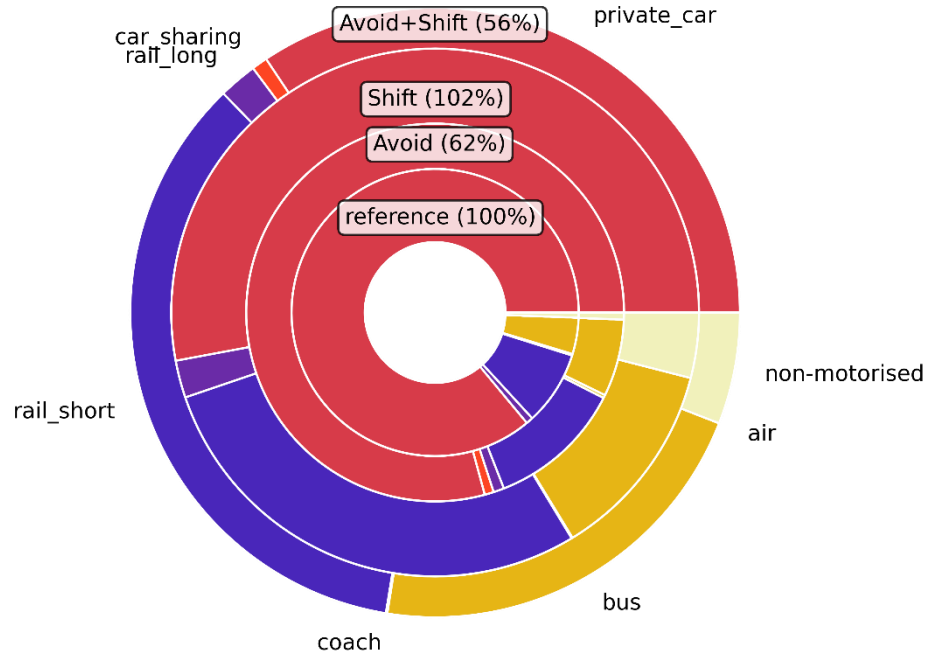
<https://leonardgoeke.github.io/AnyMOD.jl/stable/>

build passing codecov 91% chat on gitter license MIT



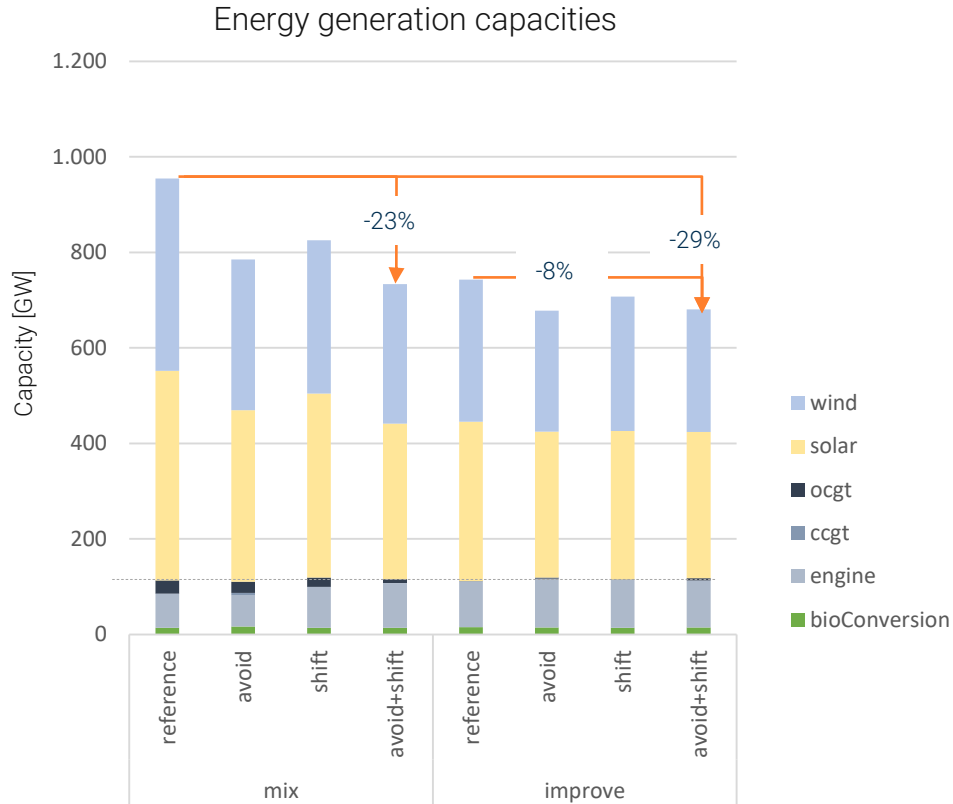
AnyMOD.jl

Transport demand scenario results



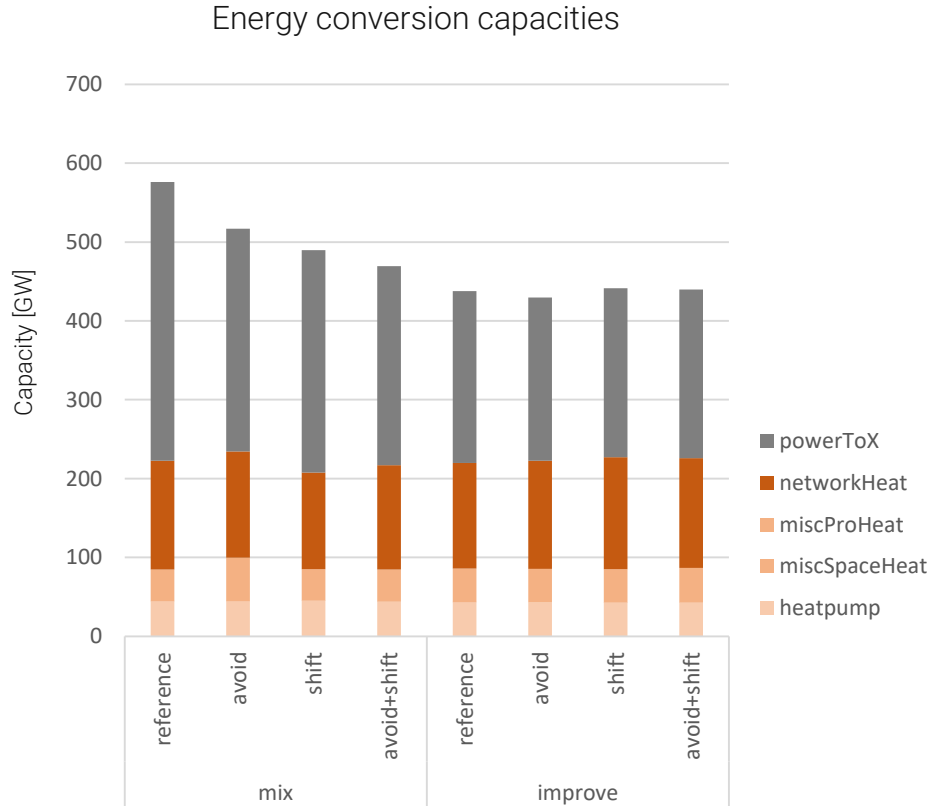
- PT can become very attractive
- Active mobility can increase starkly
- Car trips can be reduced to up to 40%
- Avoid measures can reduce trip frequency significantly (layer thickness; numbers)

Energy system generation capacities



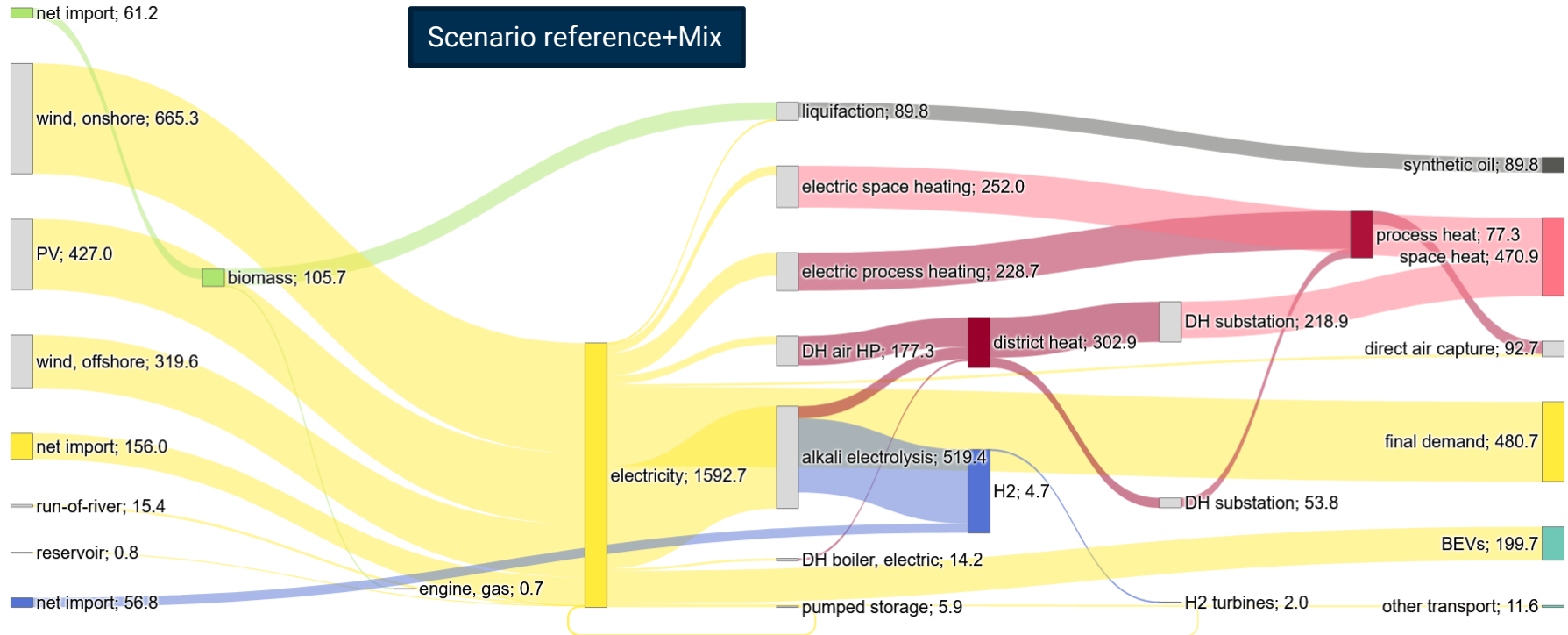
- Comparison Mix scenarios: up to 23% less capacities
- Comparison Improve scenarios: up to 8% less capacities
- Cumulated: -29% capacities

Energy system conversion capacities



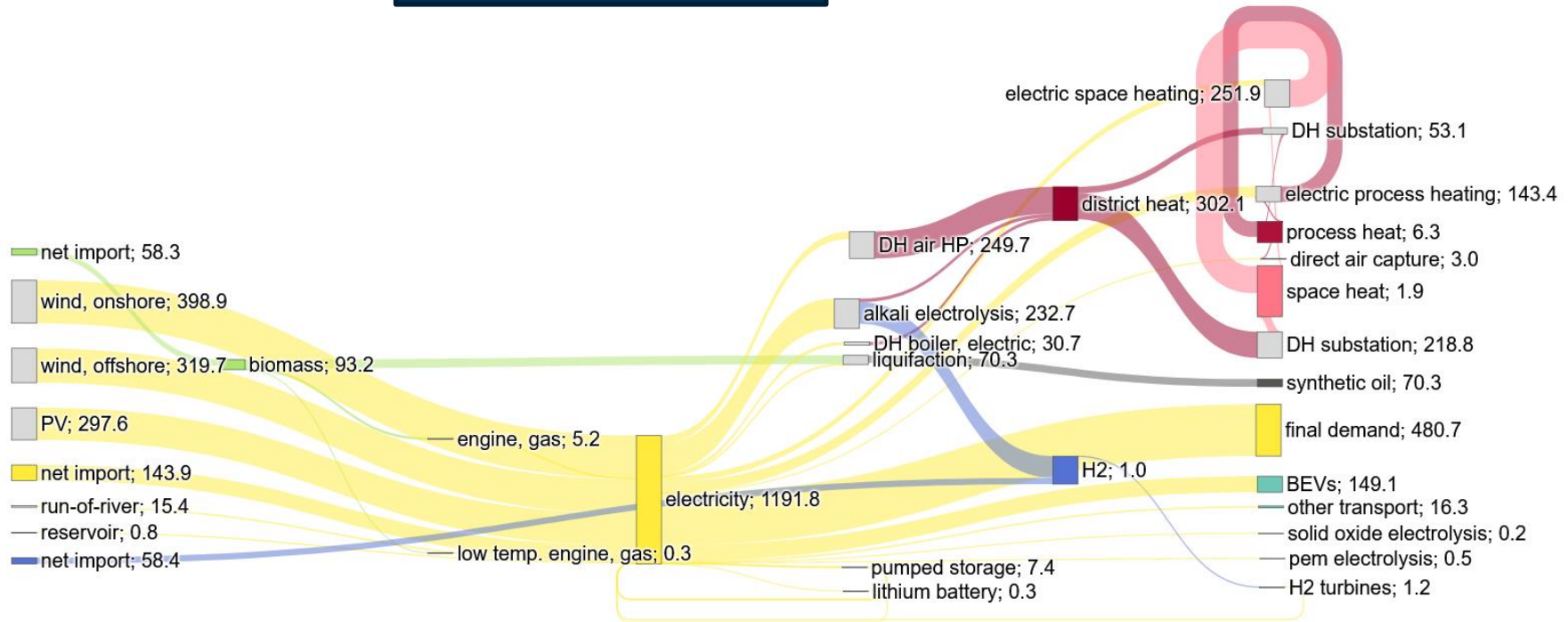
- Mix scenarios: Avoid+Shift reduces PtX capacities by 46%
- Improve scenarios: shift heat supply from heatpumps (-3%) to network heat (+7%) → flexibility

Energy flows without demand-side mitigation

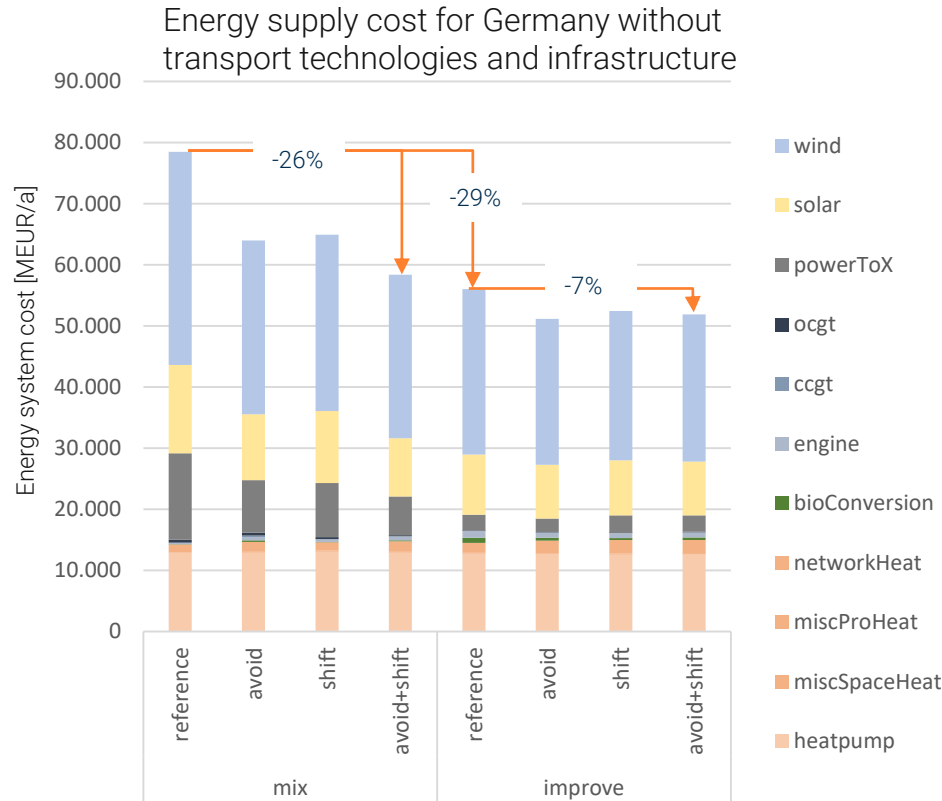


Energy flows with demand-side mitigation

Scenario Avoid+Shift+Improve



Energy system cost



- Avoid+Shift's additional cost of flexibility are lower than generation and conversion cost reduction
- Improve cost -29% in the reference case, declining gradually to -11% in Avoid+Shift
- Avoid+Shift cost -26% with a technology mix, declining to -7% with improved technologies

Conclusions

- Transport supply-side and demand-side mitigation have similar RES capacity and cost reduction potentials
- Cost of flexibility provision with Avoid and Shift measures is smaller than cost savings from lower energy conversion capacities
- All strategies are radical
- Full cost analysis pending



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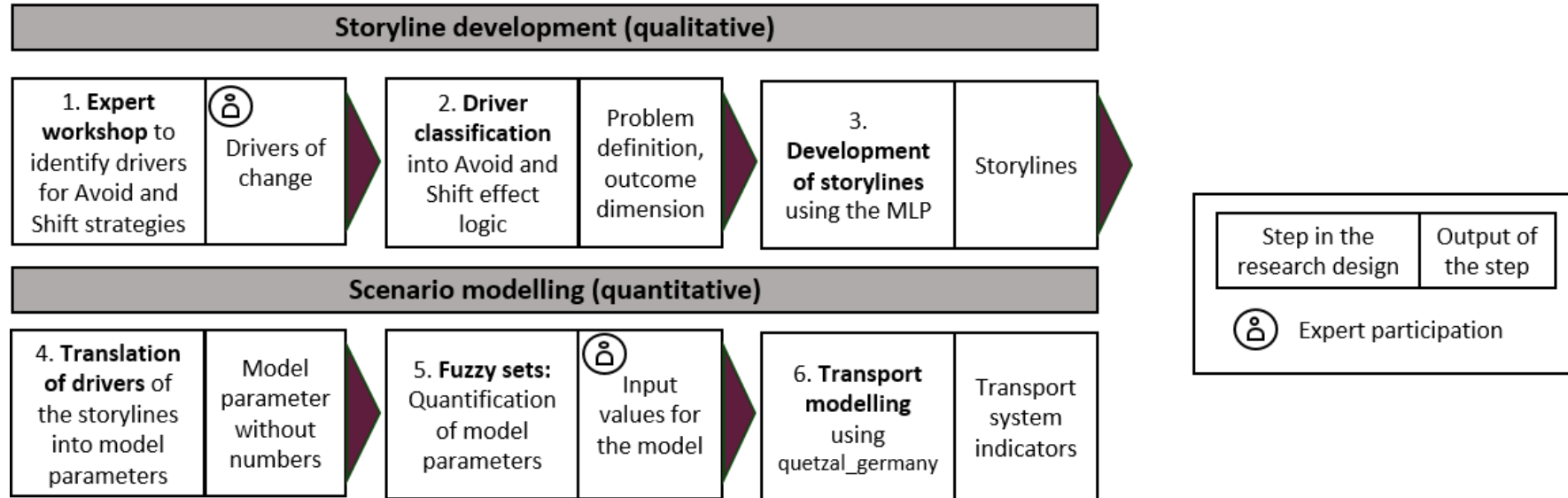


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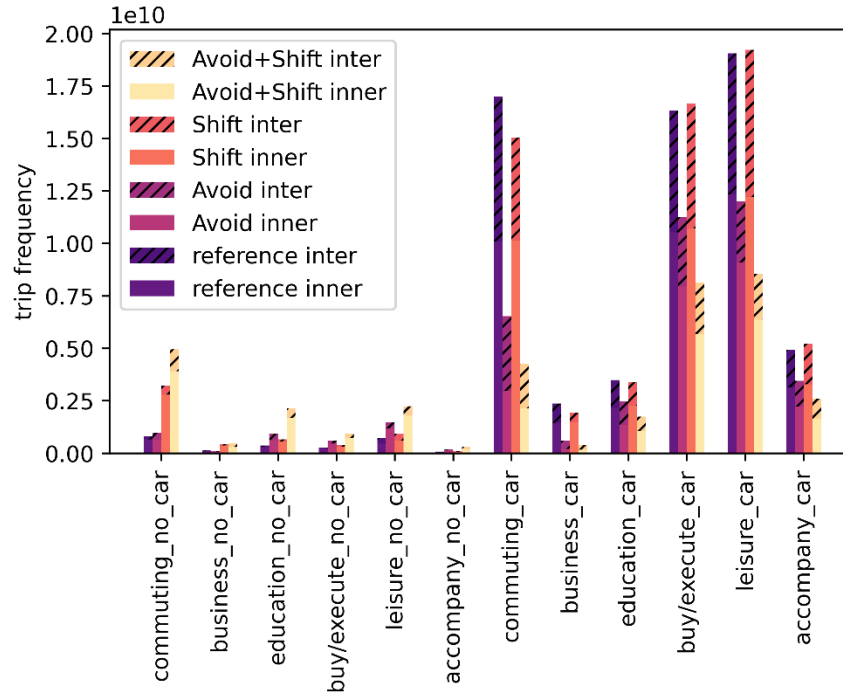
Research design sufficiency scenarios



Results: Storyline outcome dimensions

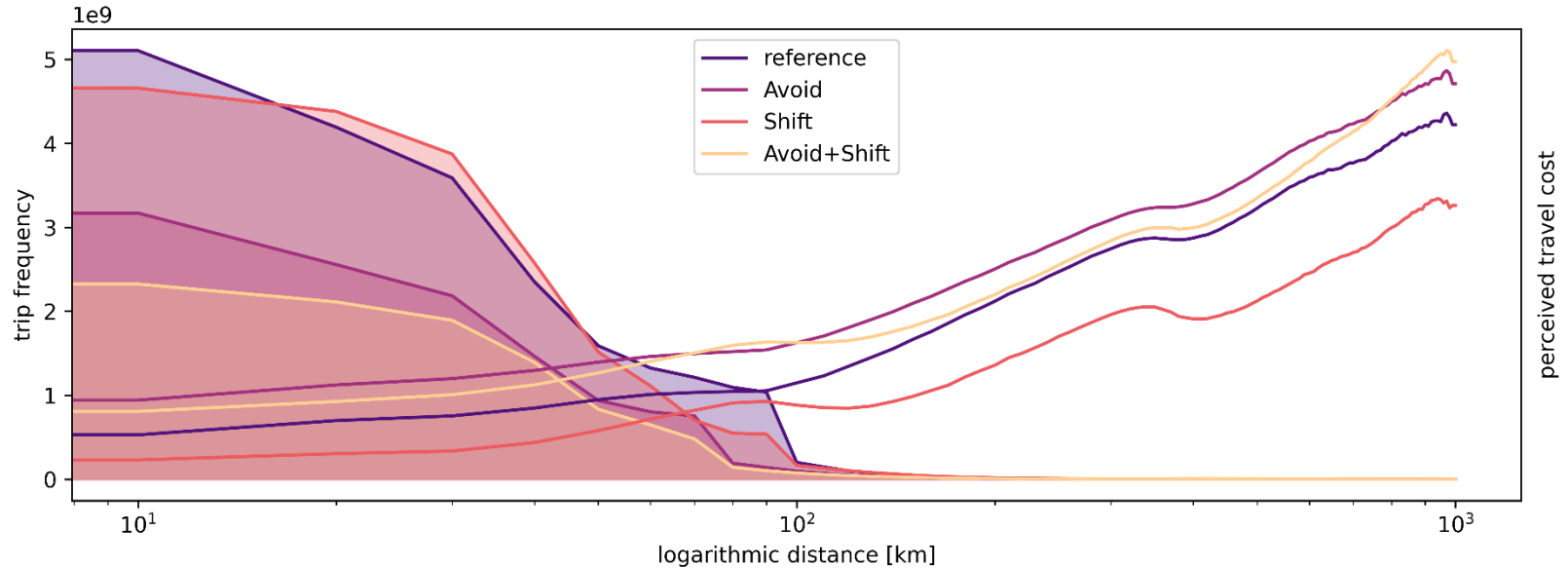
	Avoid	Shift	Avoid+Shift
Outcome dimension	• High availability of goods, services, amenities, and social activities in local environment • Digitisation in work relations and distant social contacts	• Minimum car dependency • efficient, attractive, interconnected PT • Safe and comfortable cycling infrastructure • increased public health	In addition to Avoid and Shift outcomes: • New core principles of integrated transport and spatial planning • private cars as anti-status symbol

Results: Trip frequency

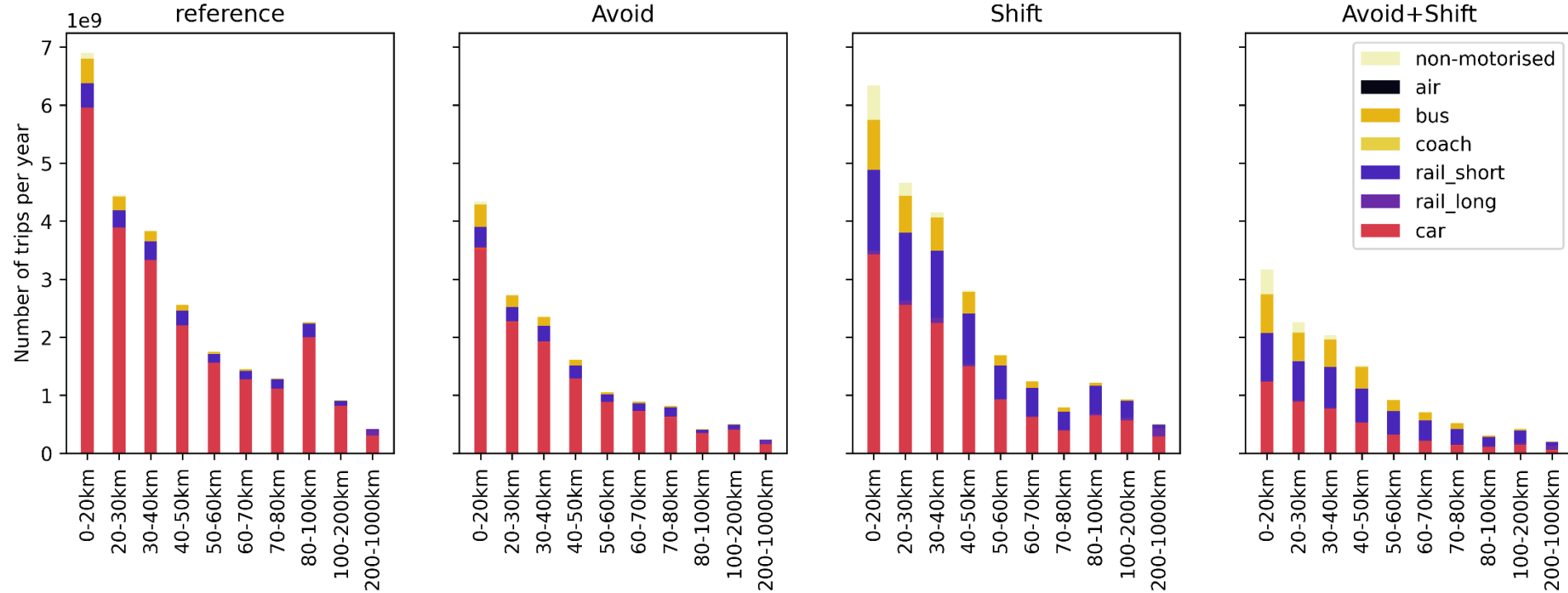


- Avoidable are mostly long compulsory trips
- Shift scenario allows participation on the labor market and education system for all
- Better PT slightly increases non-compulsory trips

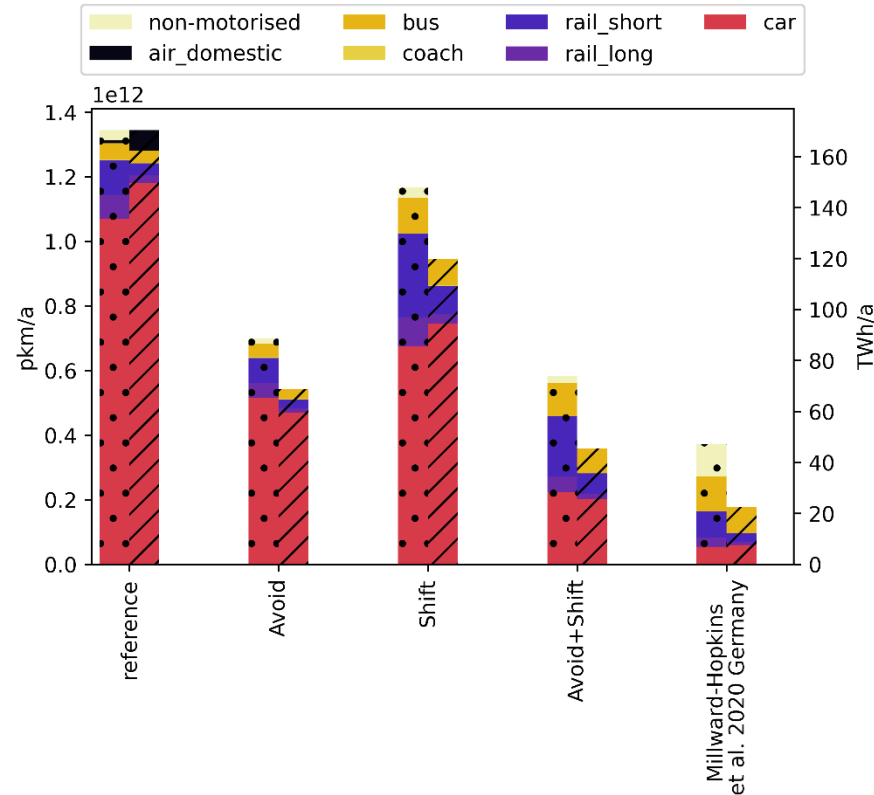
Results: Trip distribution



Results: Modal split distance distribution

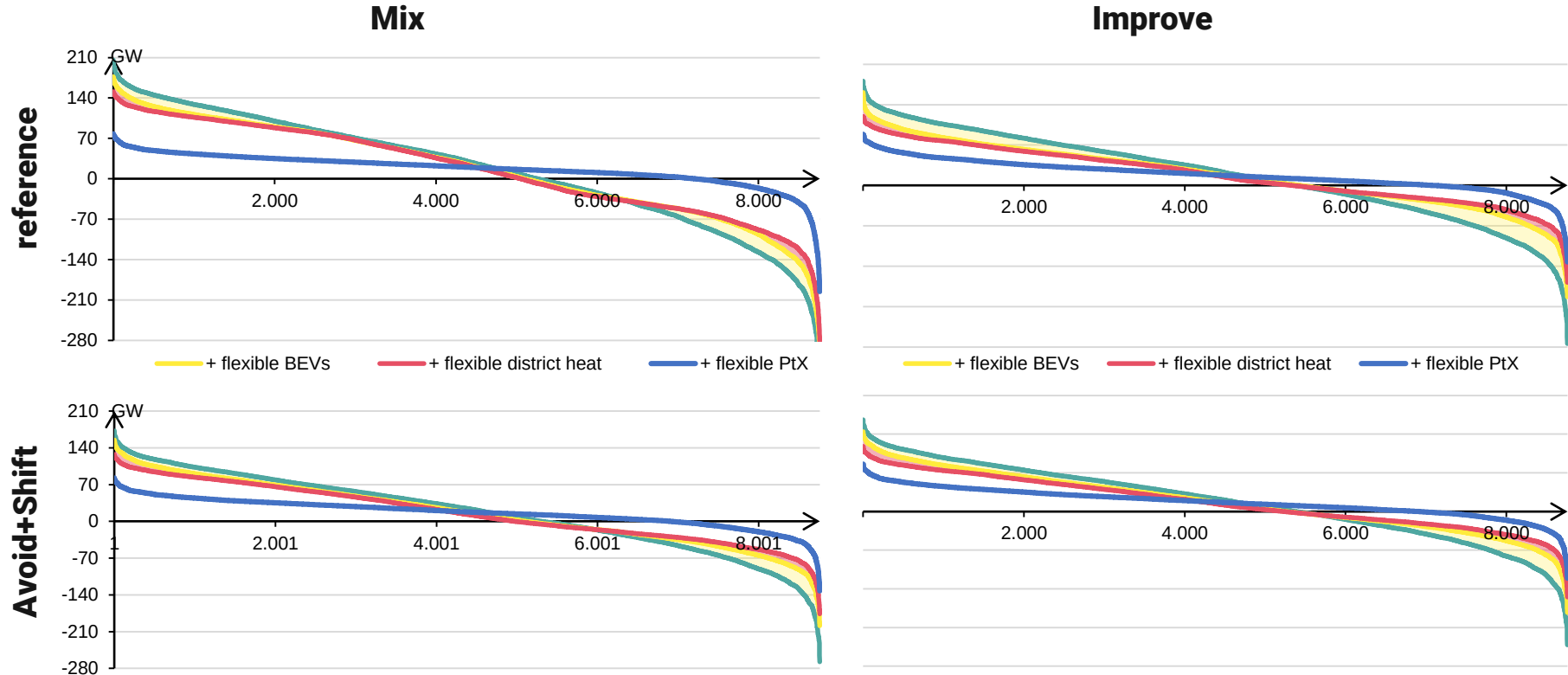


Transport demand scenario results



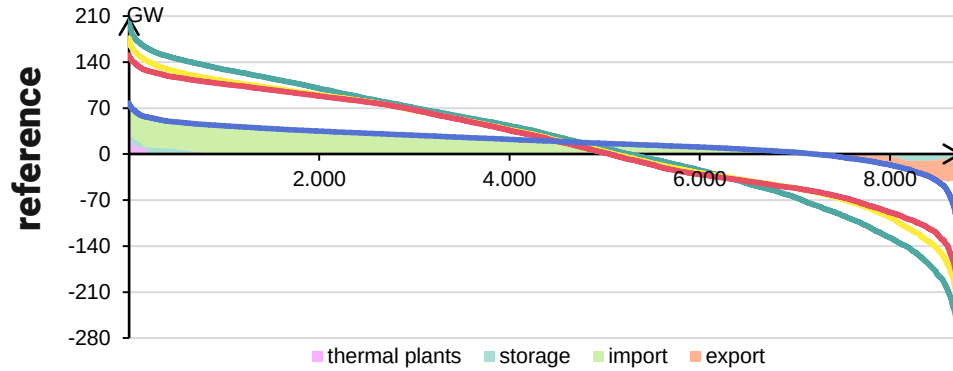
- Pull measures alone can reduce energy demand by 27%
- Avoiding traffic is important (56% reduction)
- Maximum sufficiency can reduce energy demand by three quarters
- Our scenarios are still well above lower boundary of sufficiency (i.e. decent energy needs)

Energy system results: flexibility provisioning

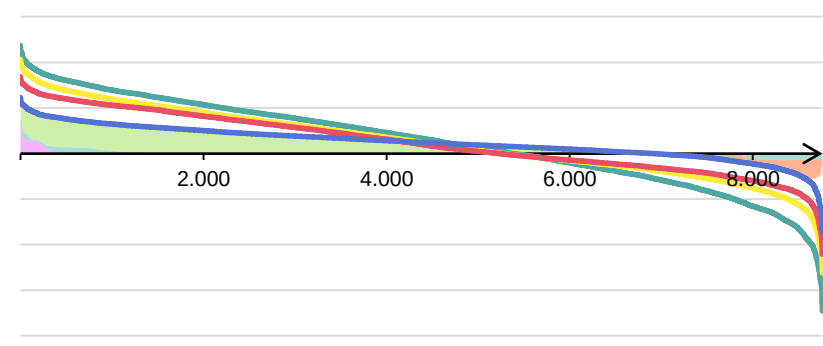
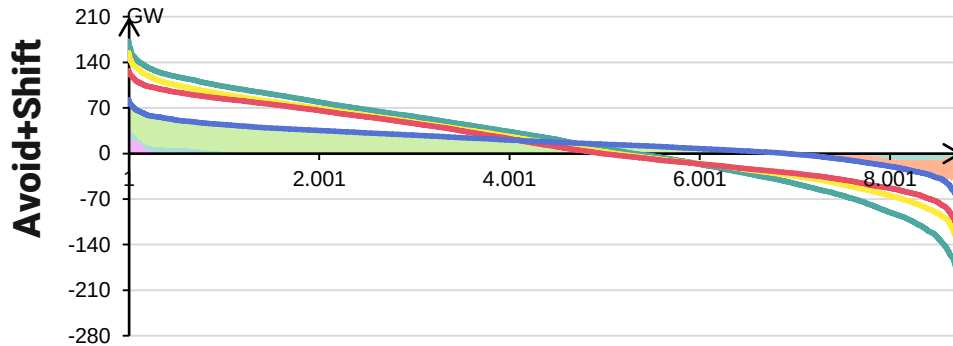
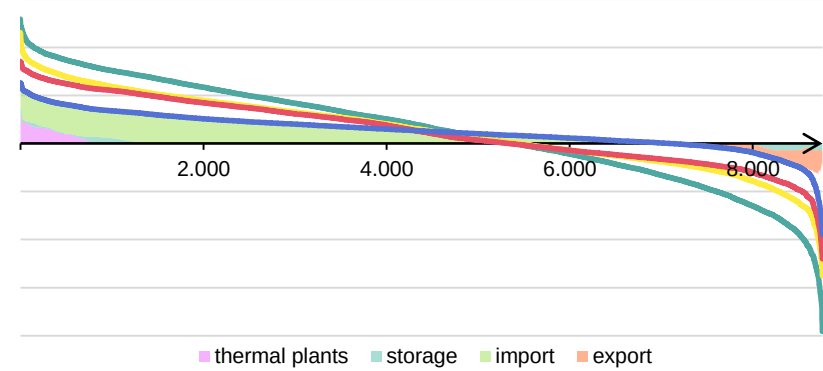


Energy system results: secondary flexibility prov.

Mix

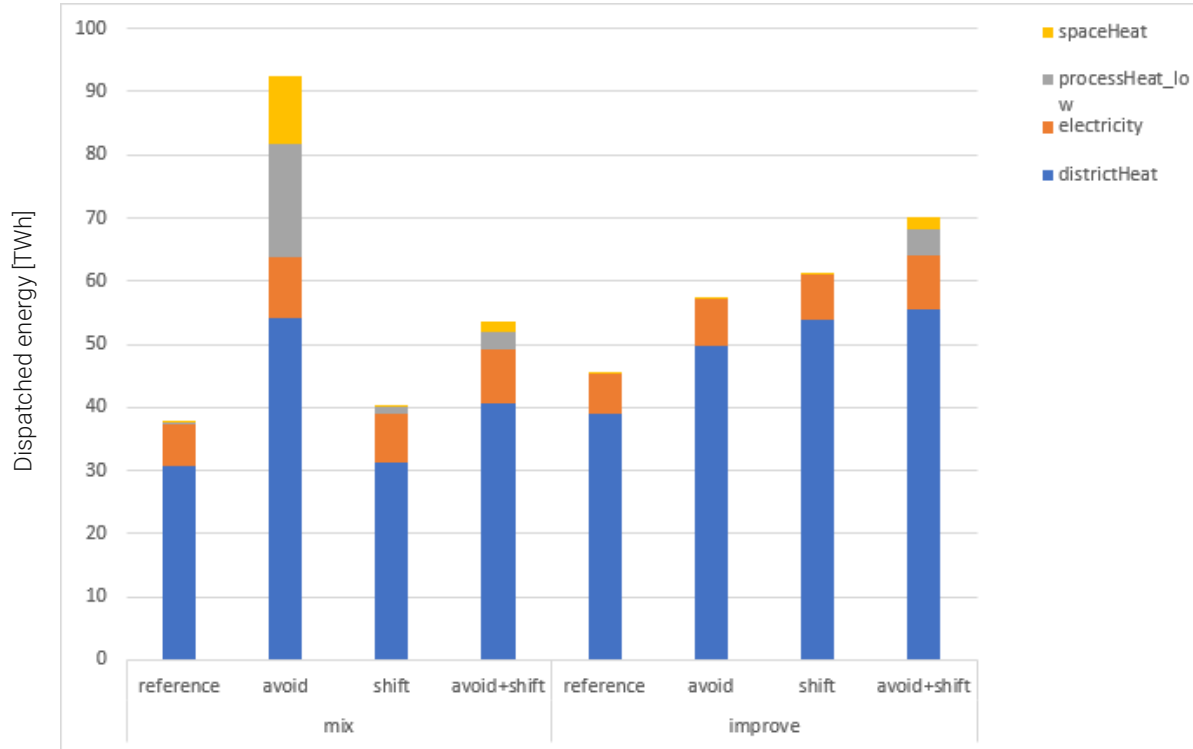


Improve

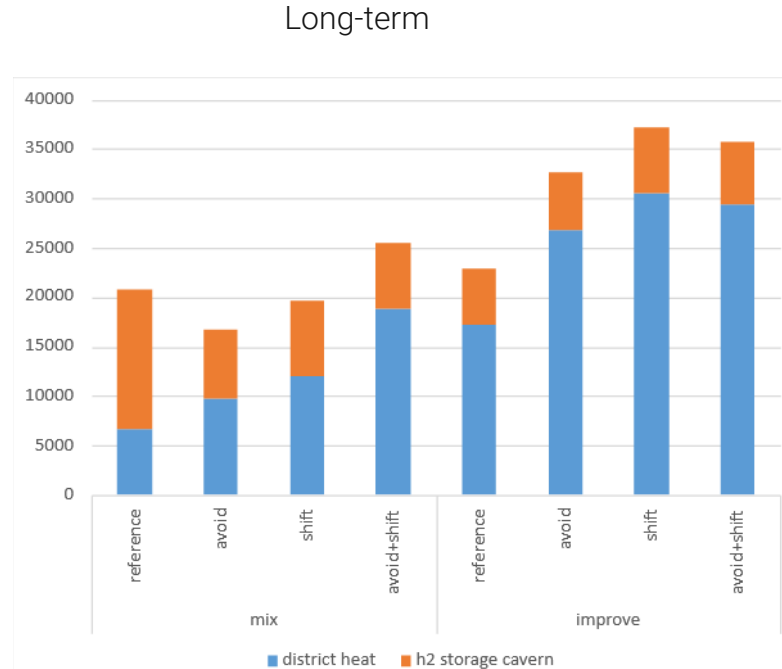
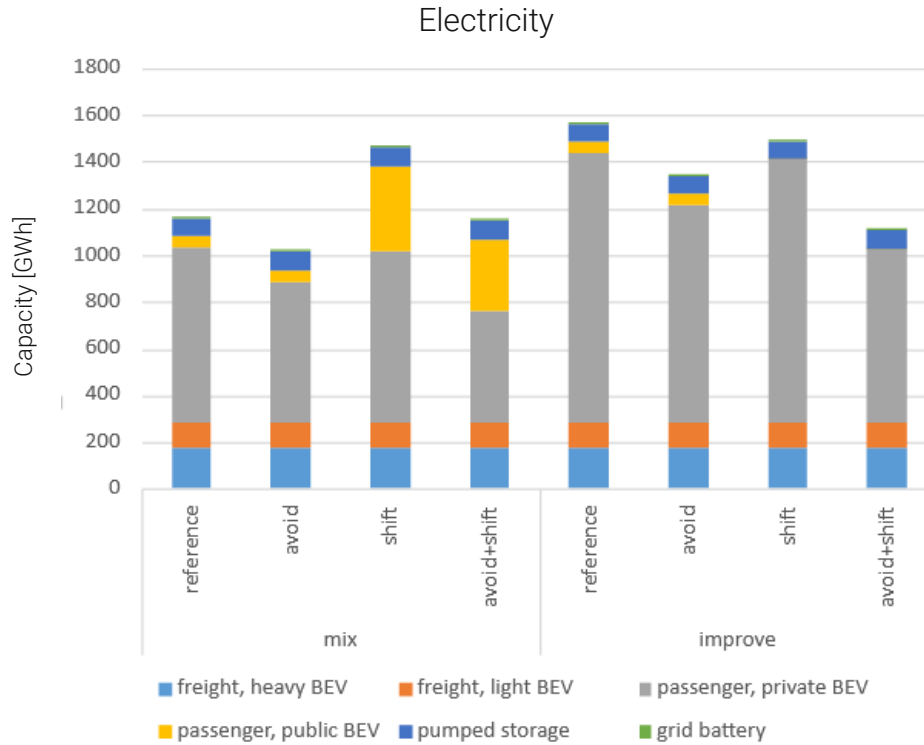


Energy system results: storage use

Dispatched energy by stationary energy storage type



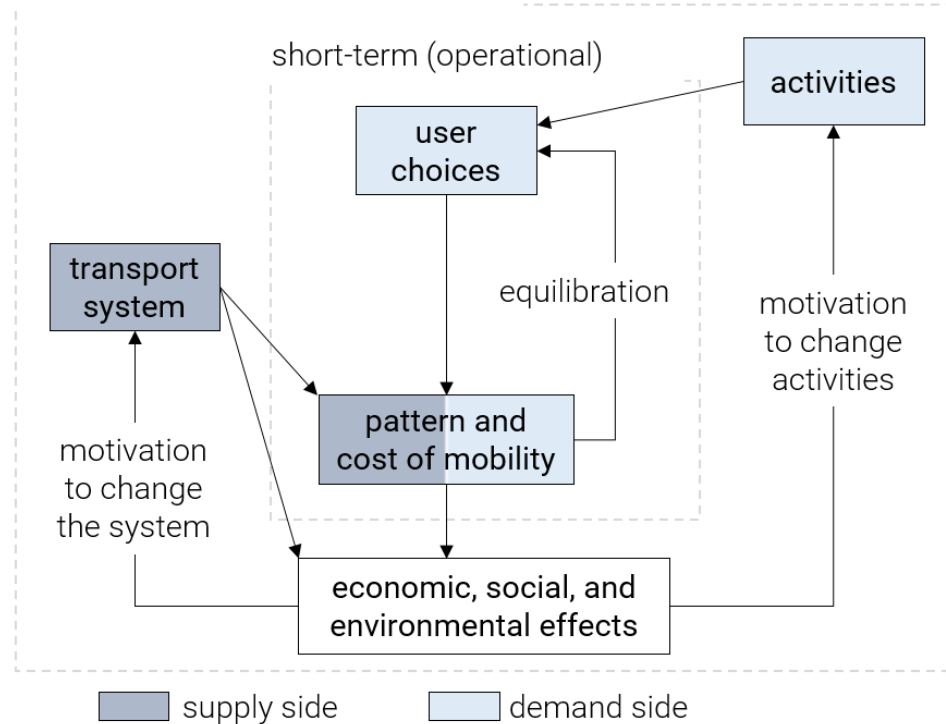
Energy system results: storage capacities



Appendix: Background

Transport systems

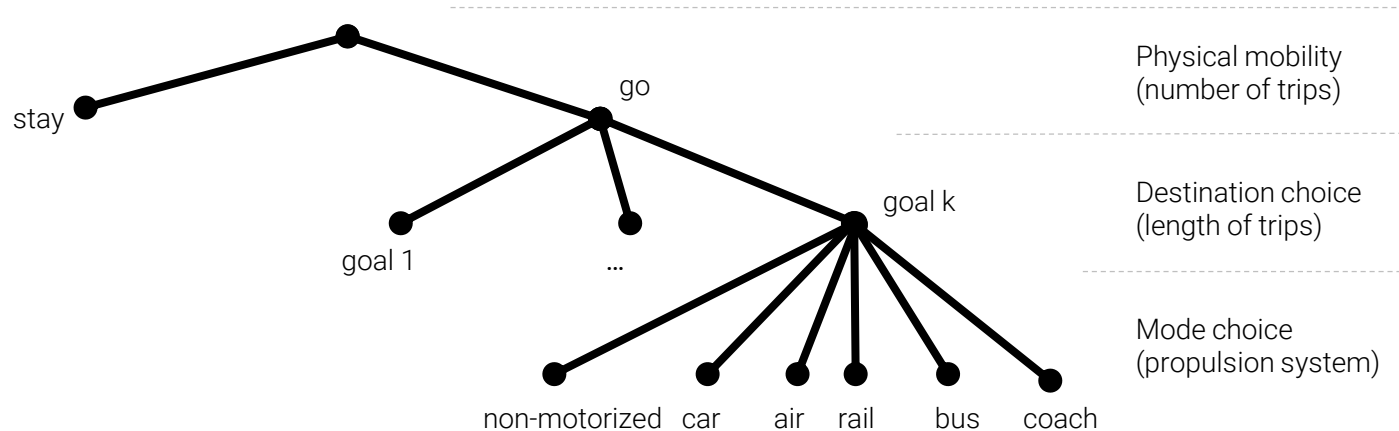
long-term (tactical and strategic)



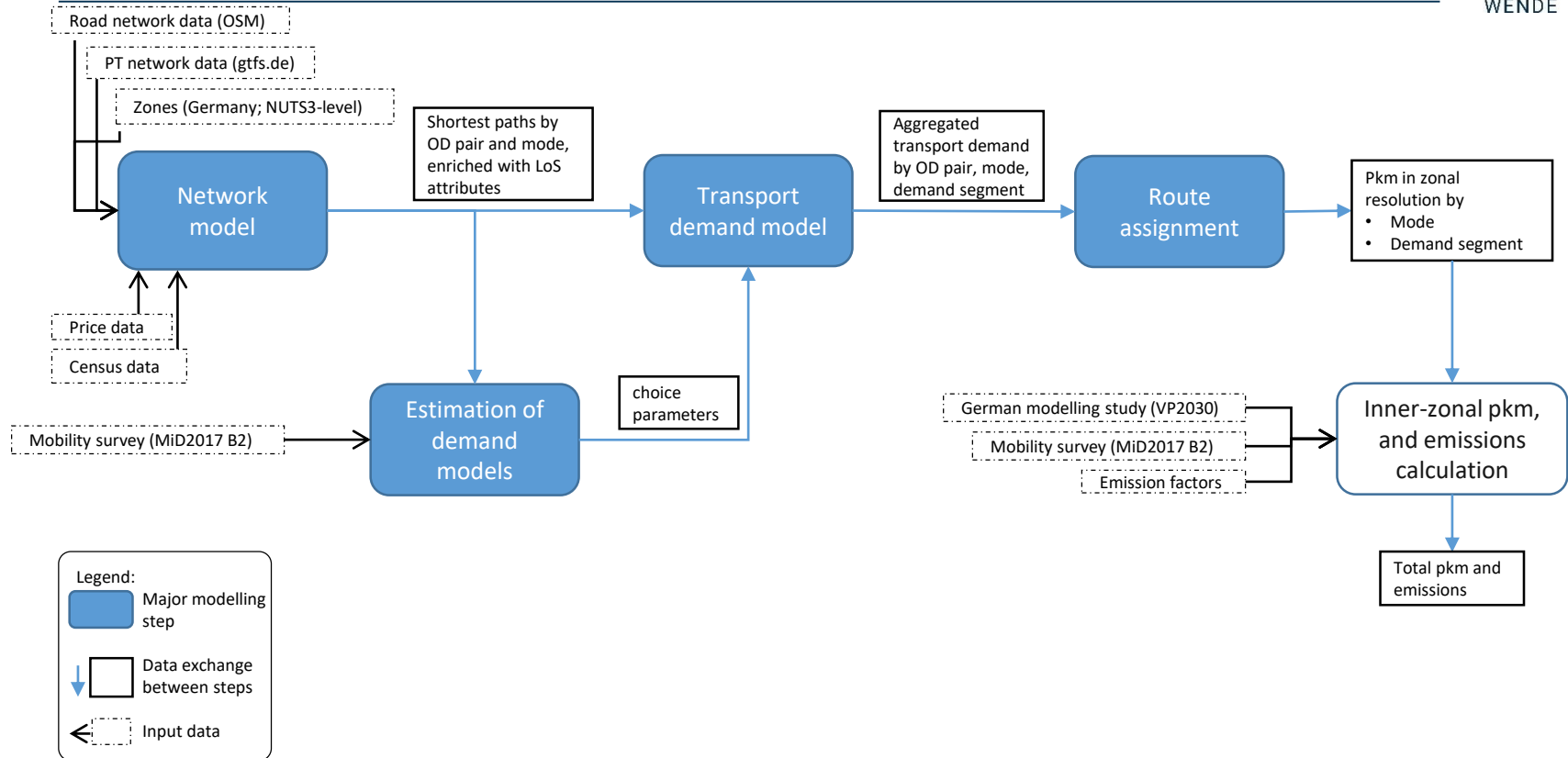
Source: Own illustration based on Allsop (2008): Transport networks and their use: how real can modelling get?. Philosophical Transactions of the Royal Society A, 366, 1879-1892

Appendix: Transport demand simulation

Hierarchical decision making; rational choice



Appendix: quetzal_germany structure



Appendix: quetzal_germany structure (disagg.)

