Regionalized Global Energy Scenarios
Meeting Stringent Climate Targets –
cost effective fuel choices in the transportation sector

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No biomass in the transportation sector
No biomass in the transportation sector

At least not in the long run.
The transportation sector is not the only CO$_2$-emitter
We will find out where in the energy system it is less costly to reduce CO$_2$-emissions
Global energy system model
Global energy system model

Optimisation
Global energy system model

Optimisation

Minimises the total cost under stringent atmospheric CO$_2$-concentration targets
1. When is it cost-effective to carry out the transition away from gasoline/diesel?
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2. To which fuel is it cost-effective to shift?
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2. To which fuel is it cost-effective to shift?

3. Will the choice of fuel in the transportation sector be different if a regionalized version is used rather than a globally aggregated model?
Basic Flow Chart of Supply and Fuel Choices

ENERGY CONVERSION

- Oil
- Coal
- Natural gas
- Nuclear
- Biomass
- Solar
- Hydro
- Wind

- Heat
- Transportation
- Fuel
- Electricity

- Petroleum products
- Hydrogen
- Natural gas
- Methanol
The model is set up to generate the energy supply mix that would meet given energy demands at lowest cost, assuming strong restrictions on CO$_2$-emissions.
Atmospheric CO$_2$-concentration target of 400 ppm
Energy demand
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  GDP from 20,000 USD/yr to 50,000 USD/yr
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• **Passenger transportation increases ten fold**
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- Vehicle use - average citizen of India from 150 km/year to 4,500 km/year
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- 0.5 cars/capita - current car density in Germany.
- 5 billion cars by the year 2100
### Some cost-assumptions and conversion effectiveness

<table>
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<th>Primary energy</th>
<th>Secondary energy</th>
<th>Capital cost [USD/kW]</th>
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<td>Electricity</td>
<td>700</td>
<td>0.6</td>
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</table>
Things not taken into account in this model
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• Local pollutions
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- Local pollutions
- Energy security
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• Local pollutions
• Energy security
• Afforestation
Global Supply 400 ppm [EJ/yr]
Energy Demand for Transportation  [EJ/yr]

- Demand TRAIN
- Demand AVIATION
- Demand FREIGHT
- Demand CARS

[Graph showing energy demand trends for transportation from 1990 to 2100.]
Transportation Fuel 400 ppm [EJ/yr]
Answer to question No 1

Transition away from gasoline/diesel starts around year 2030 in group freight

Some decades later in group cars
Answer to question No 2

Hydrogen is the most cost-effective fuel in the long run
Hydrogen need to be used in vehicles before 2030
Why not biomass in the transportation sector?
Electricity Production 400 ppm [EJ/yr]
Heat Production 400 ppm [EJ/yr]
Biomass is most cost-effectively used in the heat sector
CO2-emission 400 ppm [Mton/yr]
Transportation Fuel 400 ppm [EJ/yr]

Globally Aggregated Model

Regionalized Version
Answer to question No 3

Fuel choices –
same over all pattern no matter
global or regionalized model
Model results are not a prediction of the future.
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Model results illustrates the most cost-effective solution to supply the energy demand under the constraint that atmospheric CO$_2$-concentration should be stabilized at 400 ppm.
Currently 370 ppm
Currently 370 ppm

"Business as usual"
approx. 700 ppm, year 2100
Currently 370 ppm

"Business as usual”
aprox. 700 ppm, year 2100

Is a stabilization at
400 ppm possible?
It is possible to combine ambitious climatic goals with an increasing demand for energy services.
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Energy system costs are minimised if CO$_2$-emissions first of all are reduced in electricity and heat production.