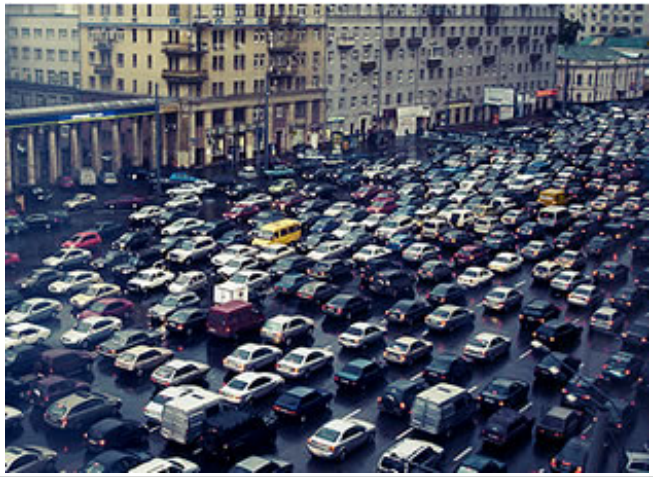
POTSDAM-INSTITUT FÜR KLIMAFOLGENFORSCHUNG

Making transport clean: cost-optimal decarbonisation options for the transport sector

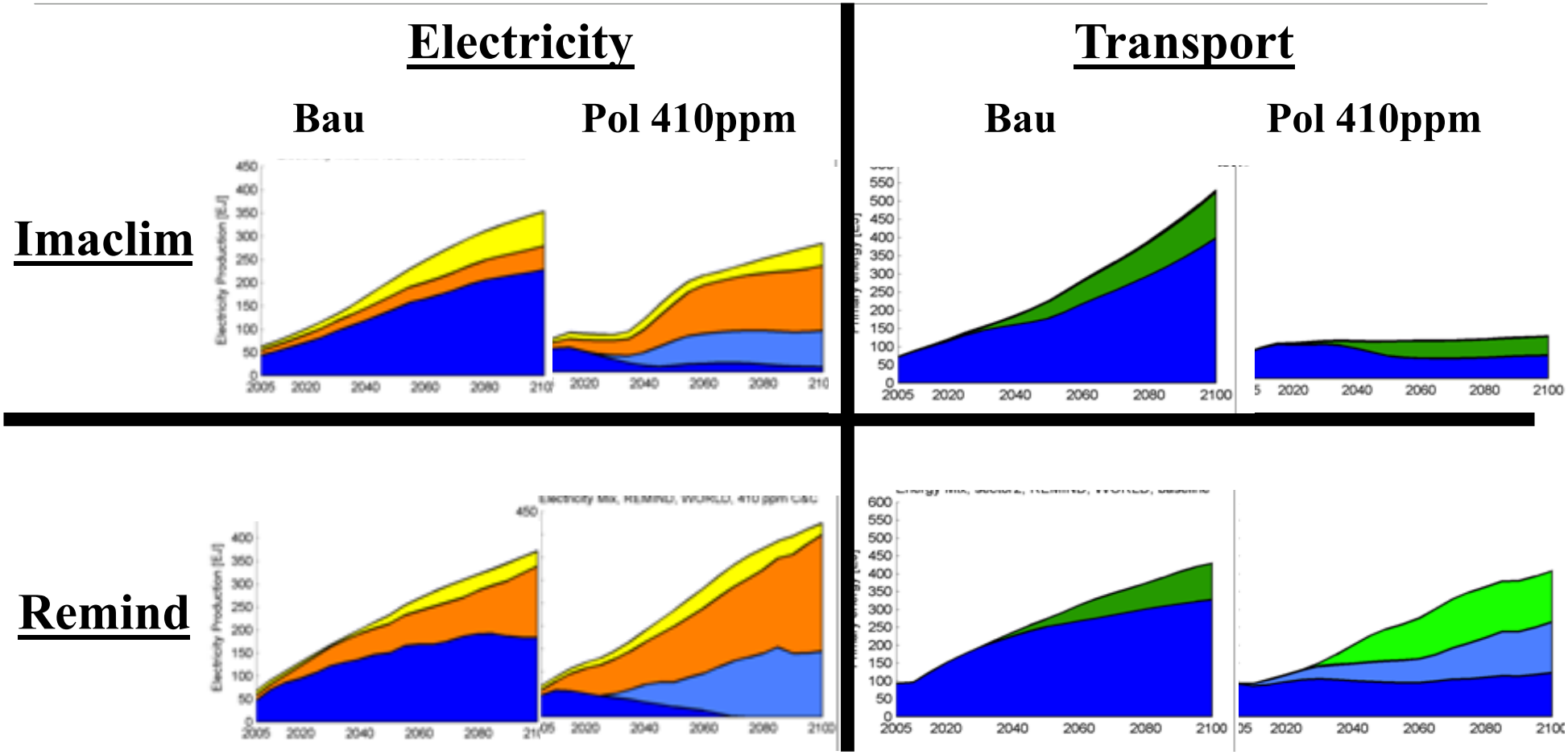


Robert Pietzcker
Eva Schmid, Nico Bauer, Gunnar Luderer

International Energy Workshop
July 8th, 2011

Leibniz Gemeinschaft

Why think about Transport?



➔ **Different models show very different behavior for transport!**

Source: Own calculations for the RECIPE report 2009

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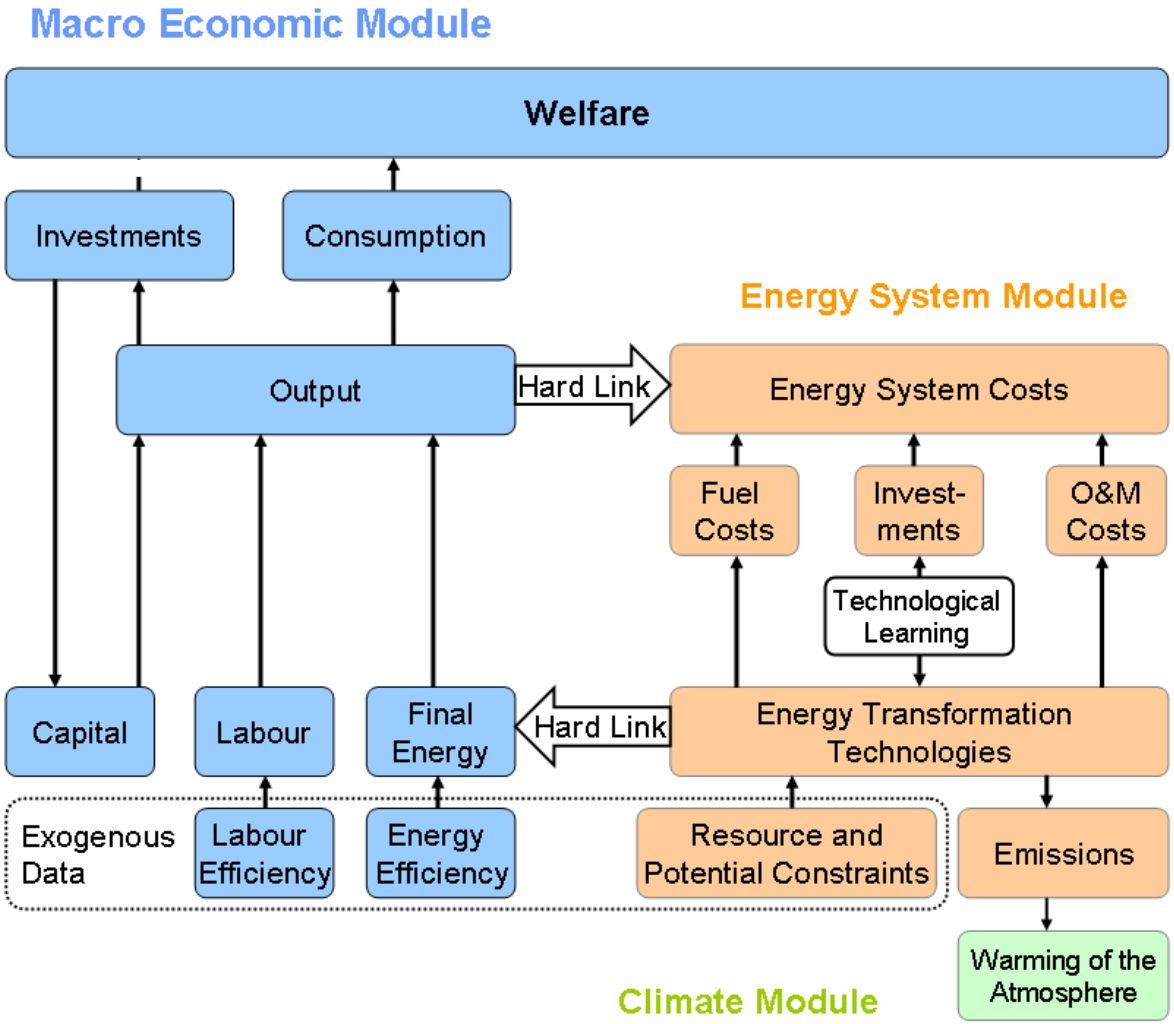
Basics of the ReMIND model



Basics of the ReMIND model

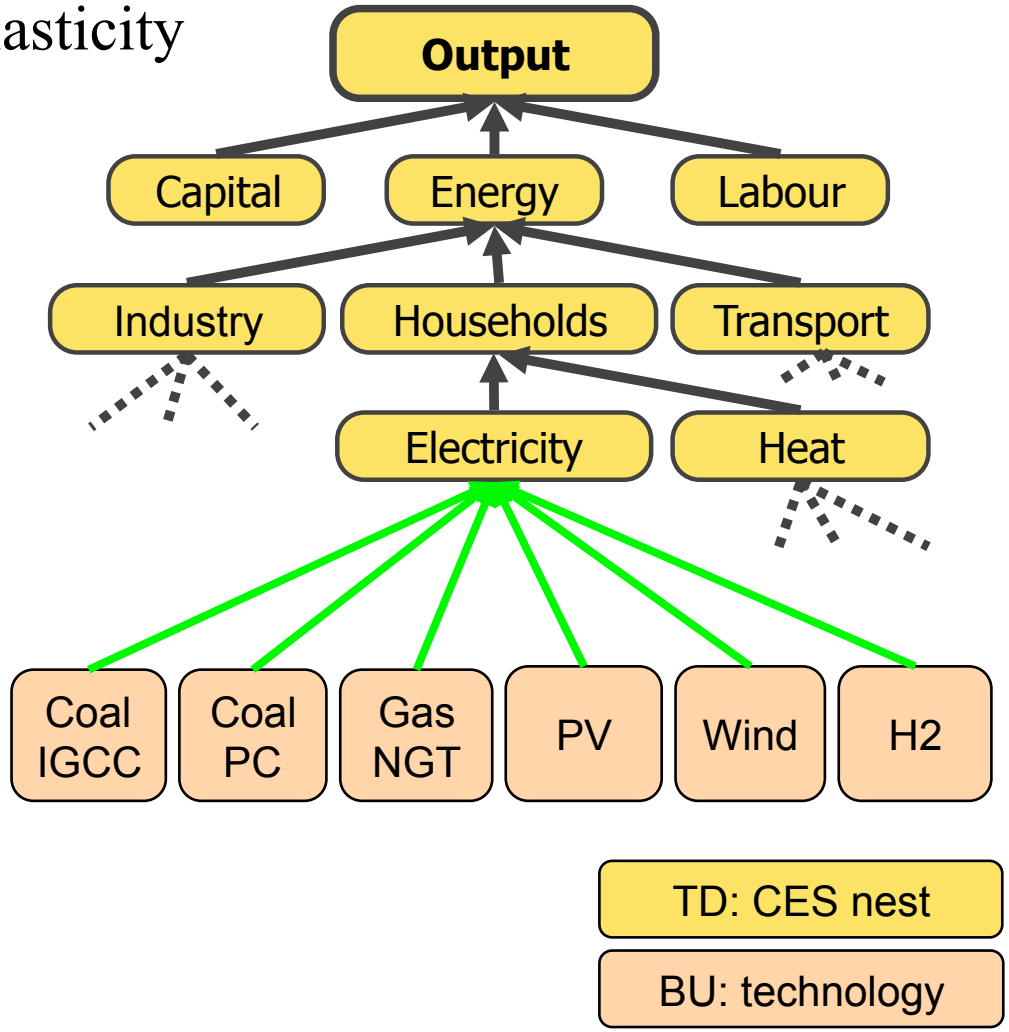
- Ramsey Growth Model: Intertemporal maximization of log(consumption)
- 2005-2100 in 5 year time steps
- Fully coupled macro-economy and energy system in equilibrium
- Heterogeneous capital stocks in energy sector
- Includes technological change through „**learning-by-doing**“:
  one-factor learning curve

Model Runs:

- Business-as-usual (no climate damages)
- Policy: 50% chance of staying below 2°C global warming
  (implemented through a 1000Gt CO2 budget from 2005-2100)

ReMIND: Top-Down and Bottom-Up

Macro side consists of constant elasticity of substitution (CES) functions



Energy System Model (ESM) side consists of linear energy-transforming technologies

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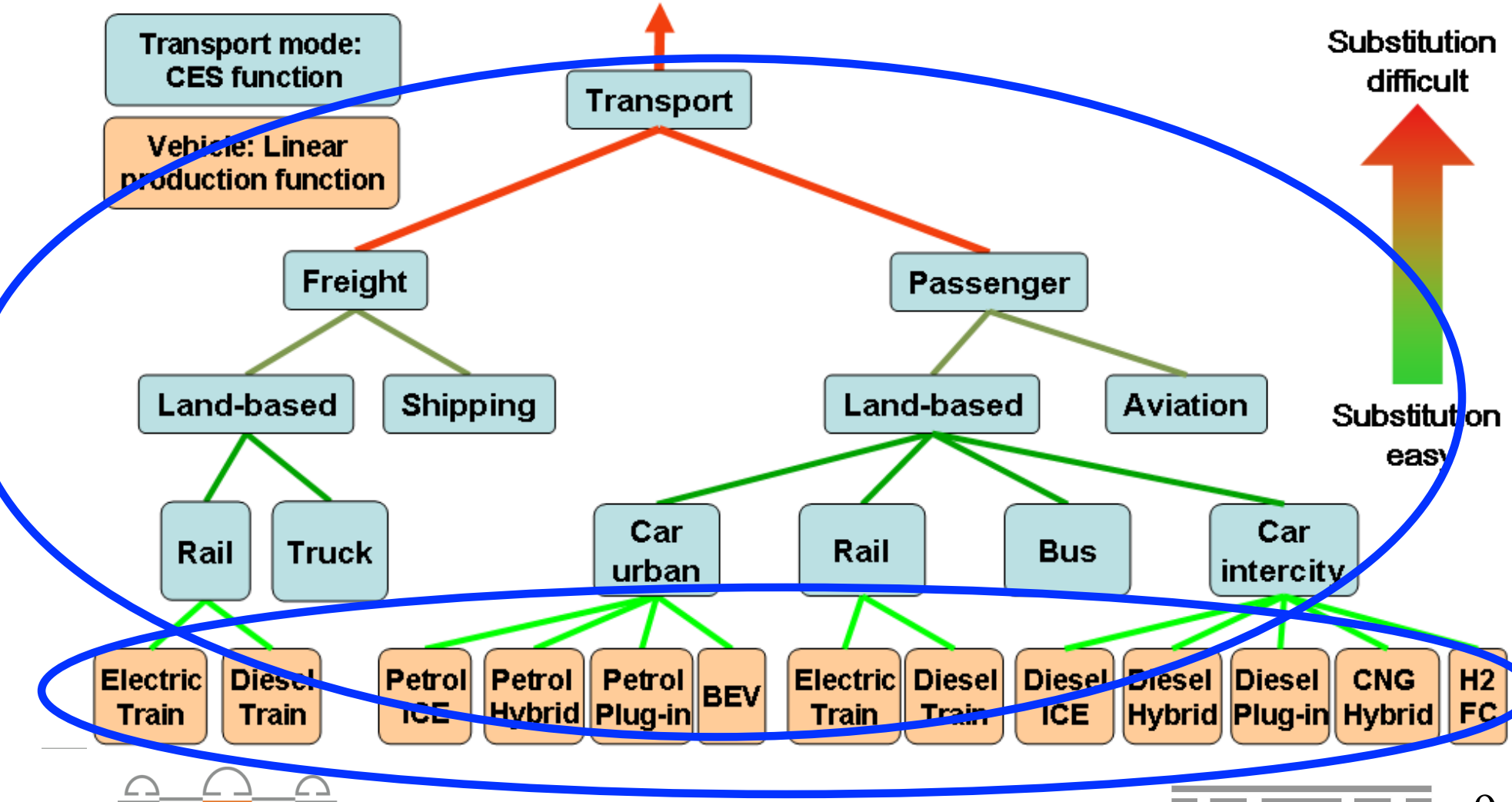
Implementation of transport as TD/BU-hybrid

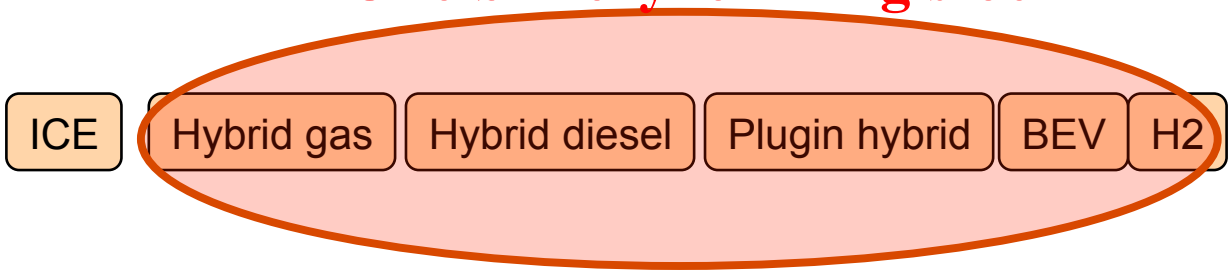
Idea: mixture of CES functions and vehicle technologies



Implementation of transport: Details

Cluster learning:

Different vehicle technologies use the combined cumulative capacity for batteries:



Lithium Battery:

Starting cost: 1100 $(2009)/kWh Learn rate: 15%

Floor cost: 275 $(2009)/kWh

Chronological technology ordering:

Hybrid vehicles > plug-in hybrid electric vehicles (PHEVs)
PHEVs > BEVs

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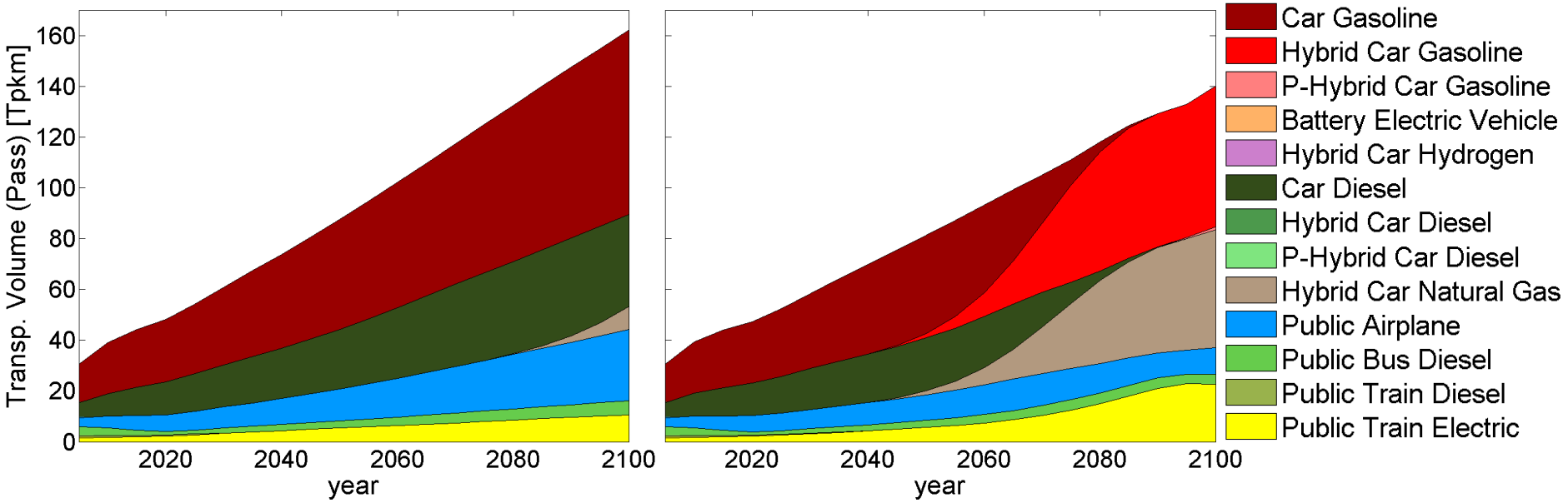
First results: Passenger transport

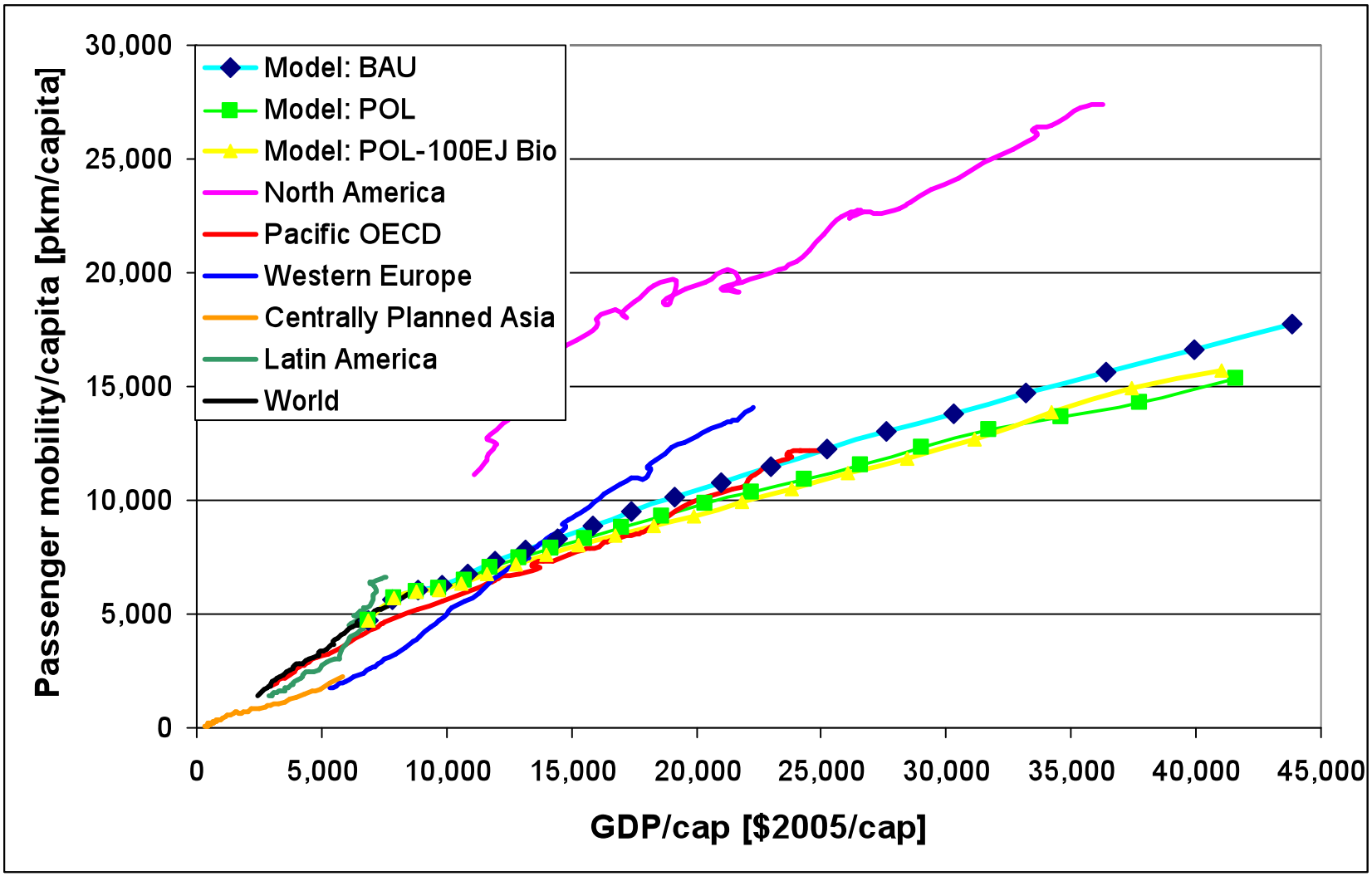
Transport volume and modal shares:

Bau **Pol: ~50% to reach 2°C**



- ➔ **Small volume reduction (~15%)**
- ➔ **Natural gas and gasoline hybrids come in after 2050**
- ➔ **air travel strongly reduced, partially replaced by rail**

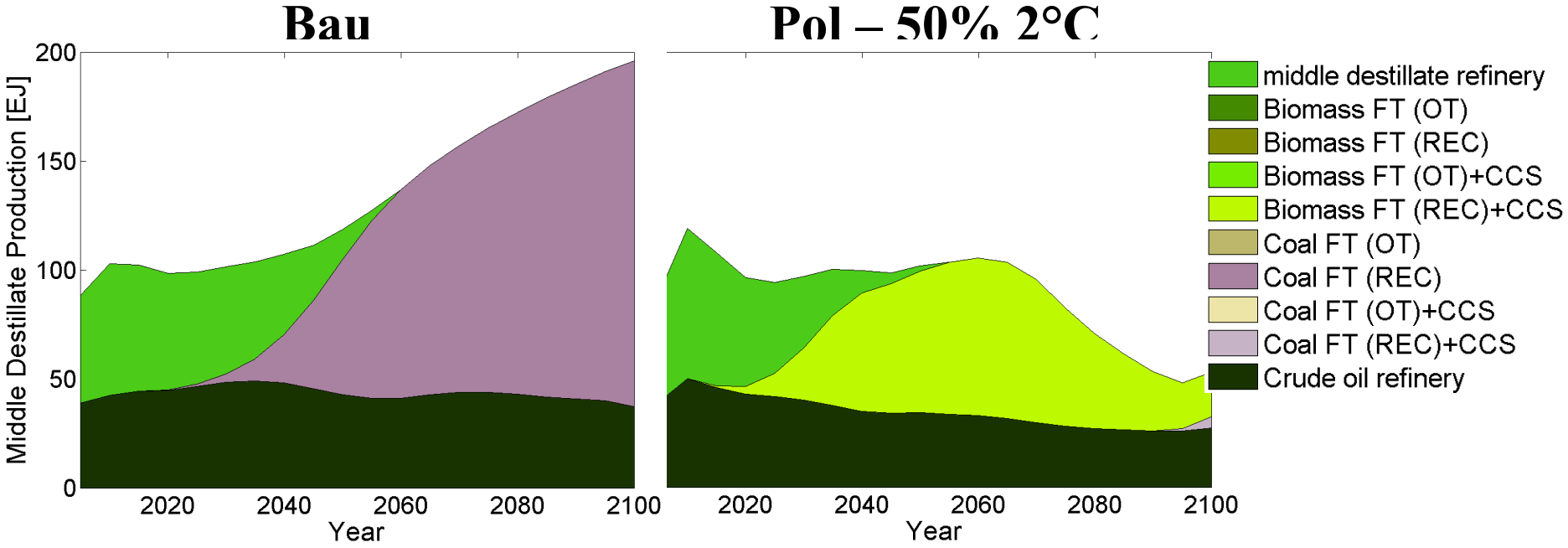
Reality check: History and ReMIND results



Source: Schäfer,A., Heywood, J.B., Jacoby, H.D. and I.A.Waitz: "Transportation in a Climate-Constrained World"

Fuel production

Production of middle distillate (used for diesel and kerosene)

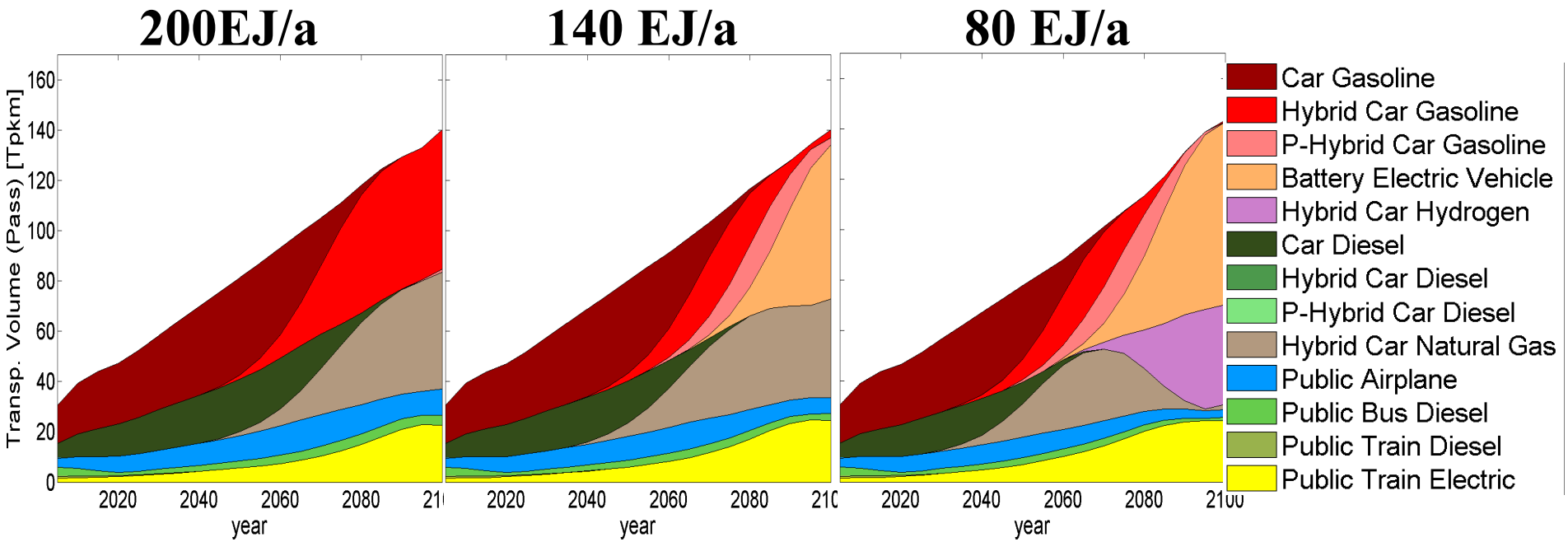


➔ **Total demand for middle distillate is reduced after 2050**

➔ **Emission reduction is mainly achieved by the replacement of coal Fischer-Tropsch with biomass-FT with CCS**

Biomass as main driver?

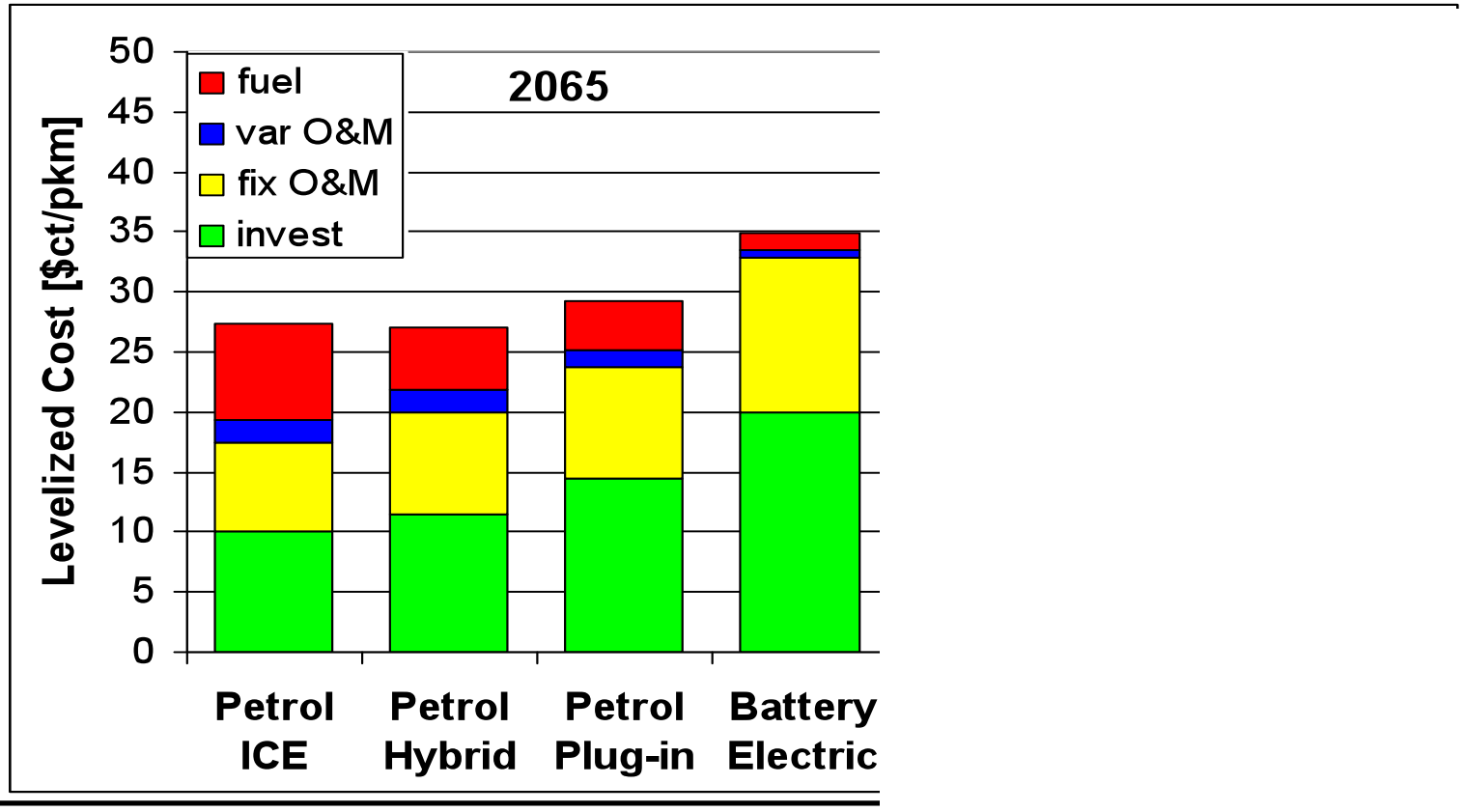
Changing Biomass availability in 50% 2°C policy runs



➔ **Strong effects:** **- First BEVs, then H2FCV enter**
- Further reduction of air travel

Levelized Costs of Transport

Pol – 140EJ/a Bio



➔ **Rising fuel prices for fossils vs. learning for batteries**

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Main Takeaways

- Important to consider all scarcities (primary energy, carbon emissions) across the whole energy system, as well as intertemporal effects (technology learning)

Preliminary modeling results:

- Under equal carbon pricing in all sectors, vehicle technologies seem to be minor contributors to decarbonization
- Biomass is a key factor of decarbonizing the transport sector
- Little change in modal shifts, except for decrease of aviation under climate policy

➔ Reality Check?

Problems of transport modeling

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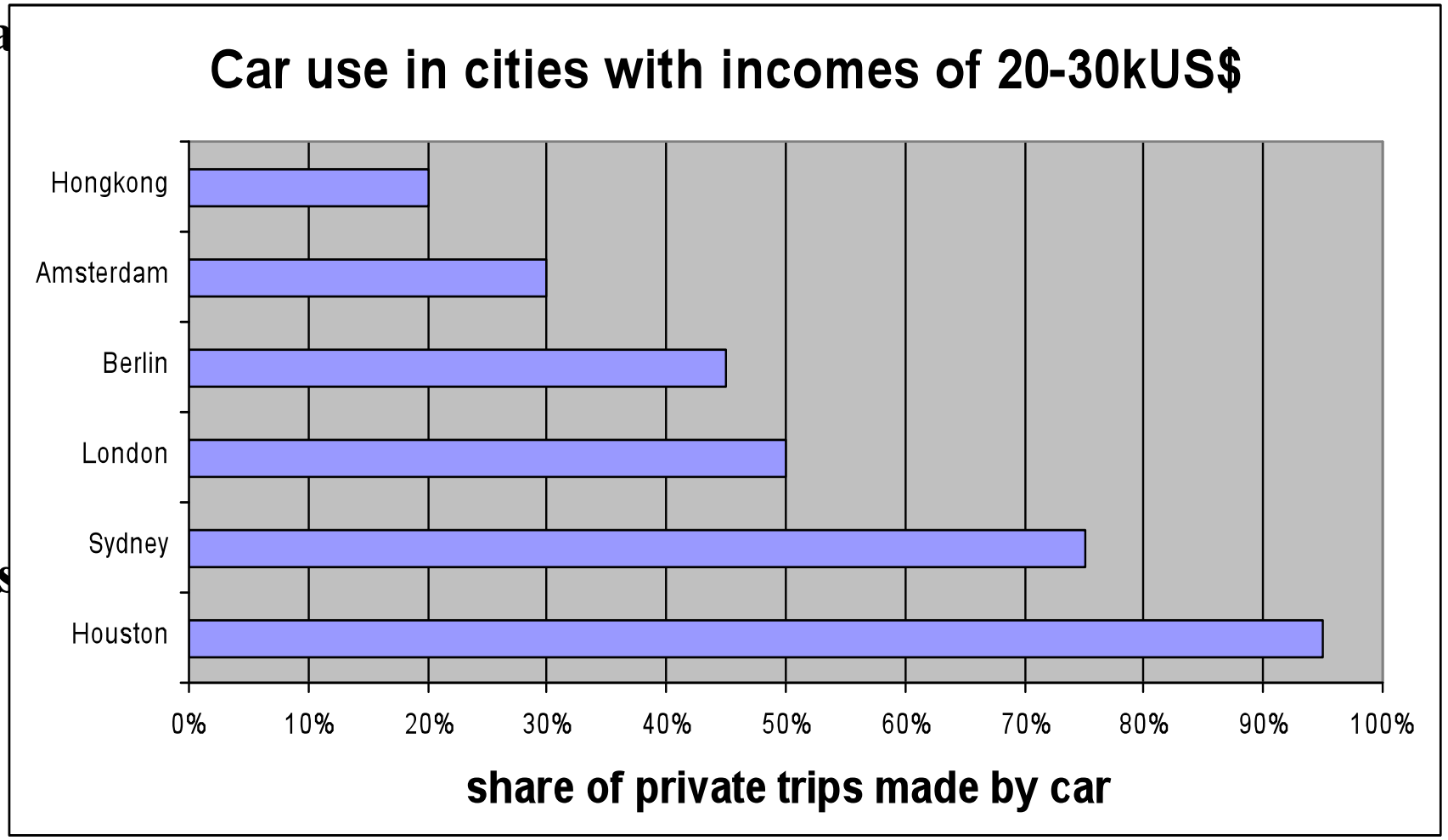
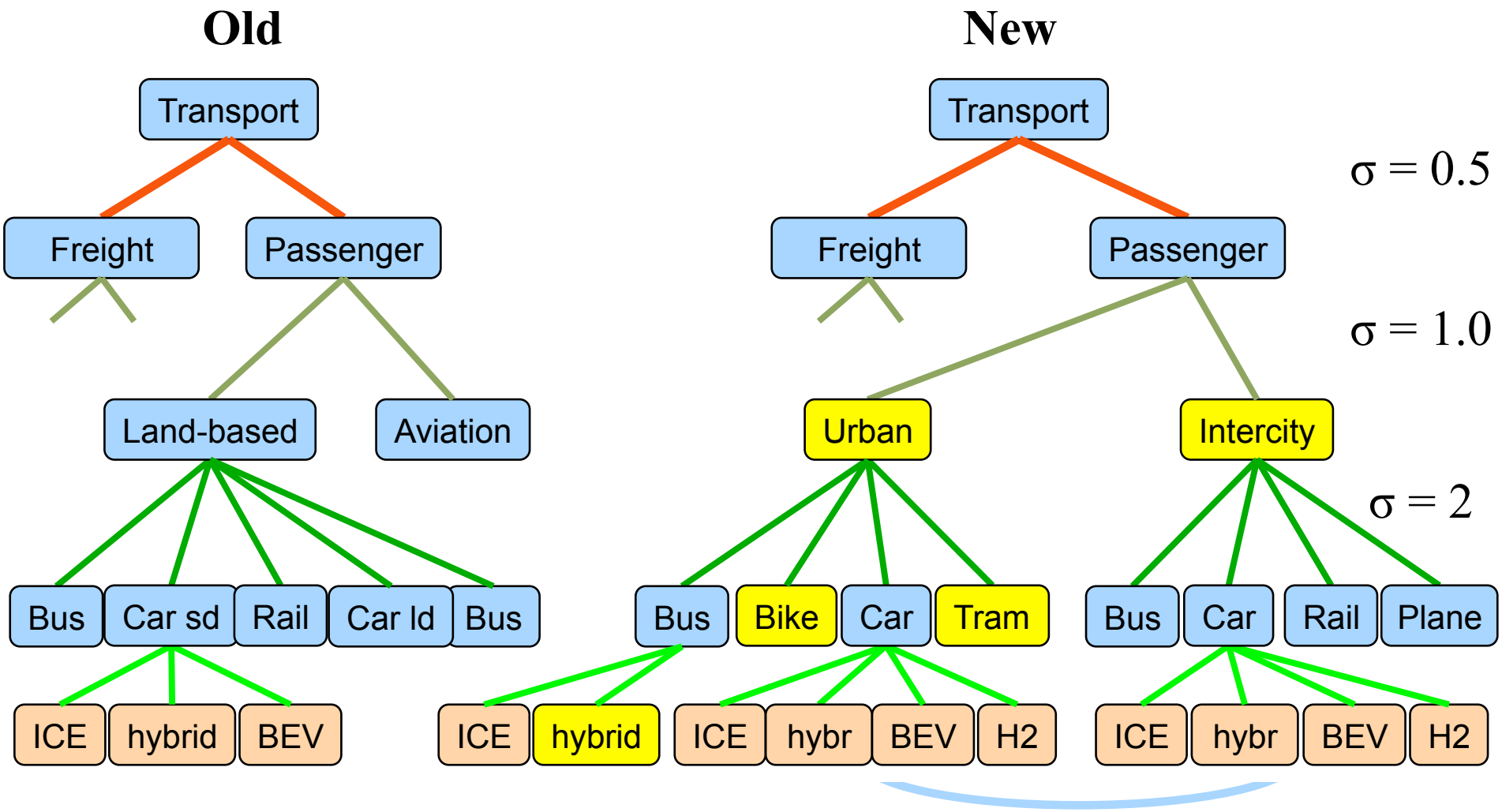


Source: IEA2009: „Transport, Energy and CO2“

Future developments of transport model I



Thank you for your attention!

Please share your thoughts on this work-in-progress