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PSI

Cost-effective technology choices in personal transport

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Presentation Outline

1. Technology Assessment
   - Alternative fuels production & distribution (hydrogen & biofuels)
   - Vehicle / drivetrains
2. Modeling Framework
3. Scenario Analyses
4. Conclusions

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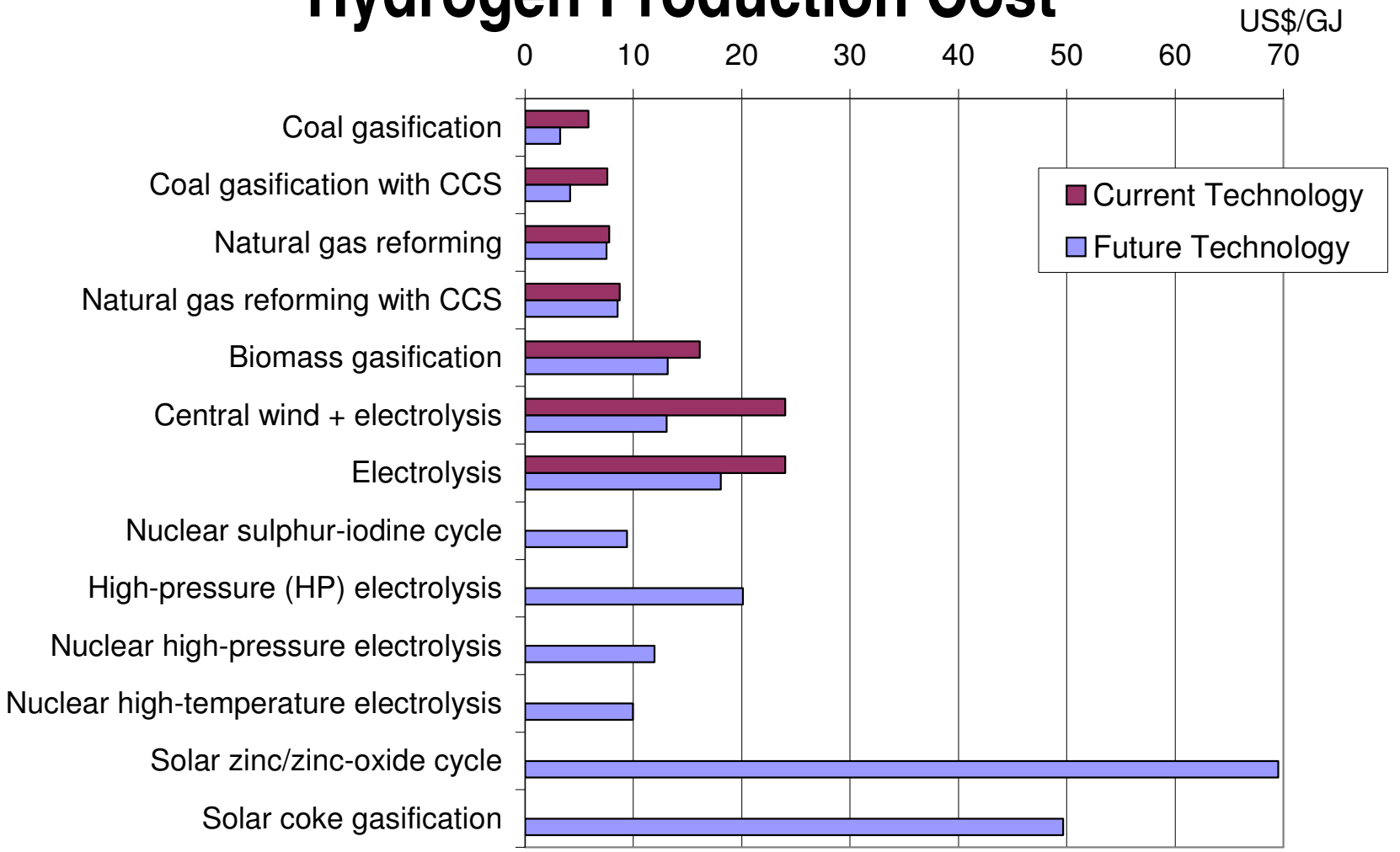
Part 1: Technology Assesment

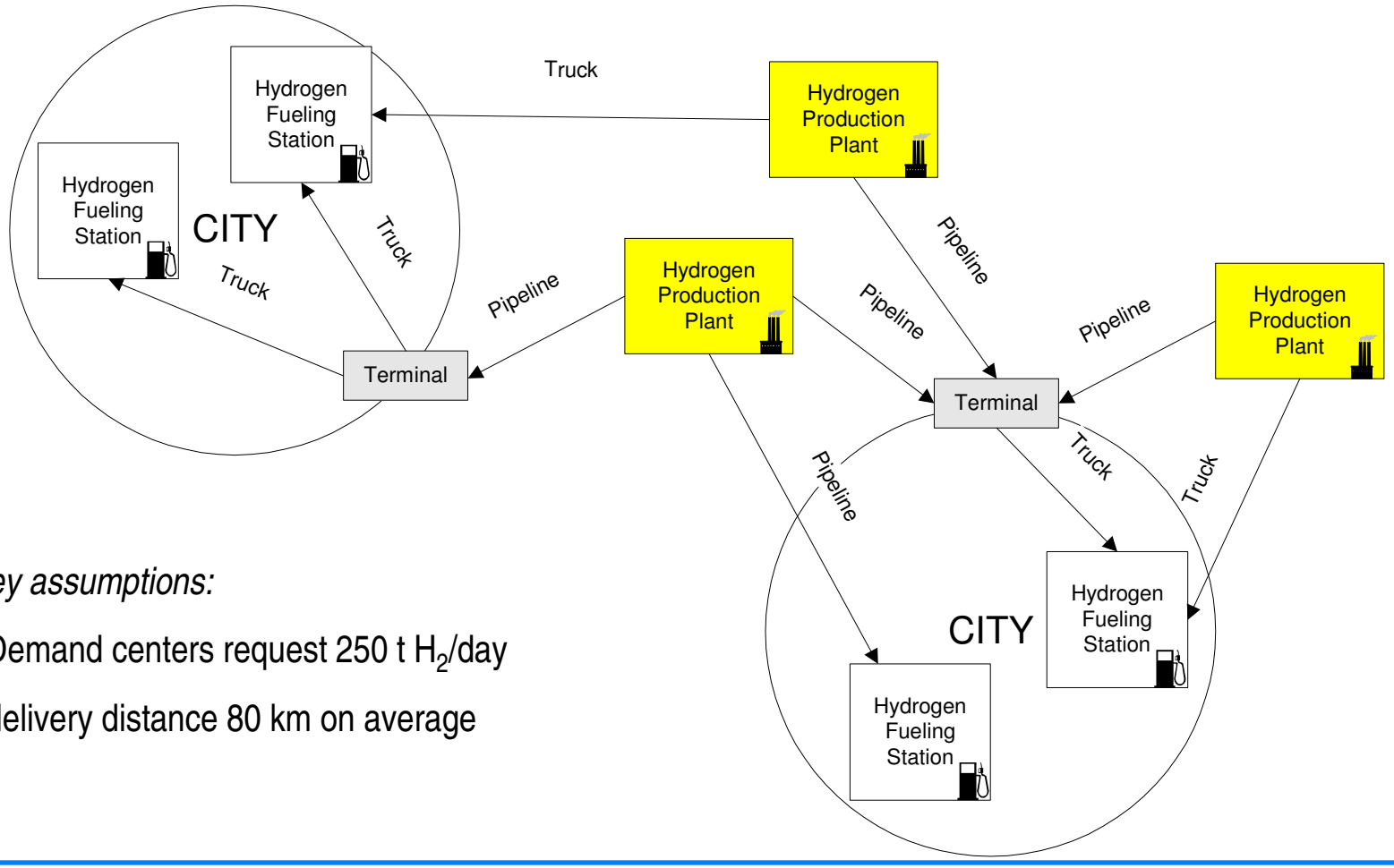
Hydrogen Production Cost



Sources: adapted from US DoE (2006) and Felder (2007)

Note: Interest rate 5%

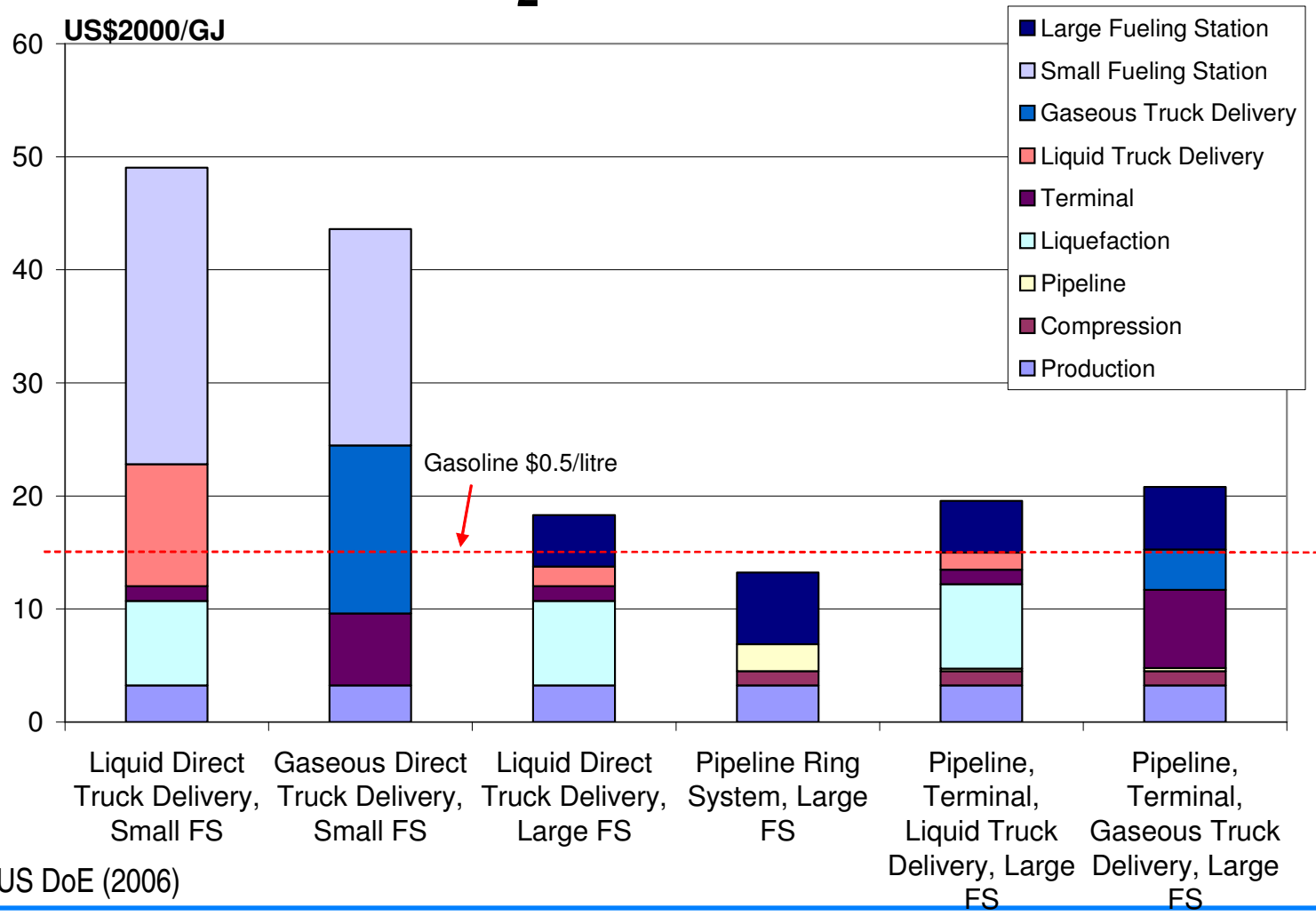
Hydrogen Delivery Options



Key assumptions:

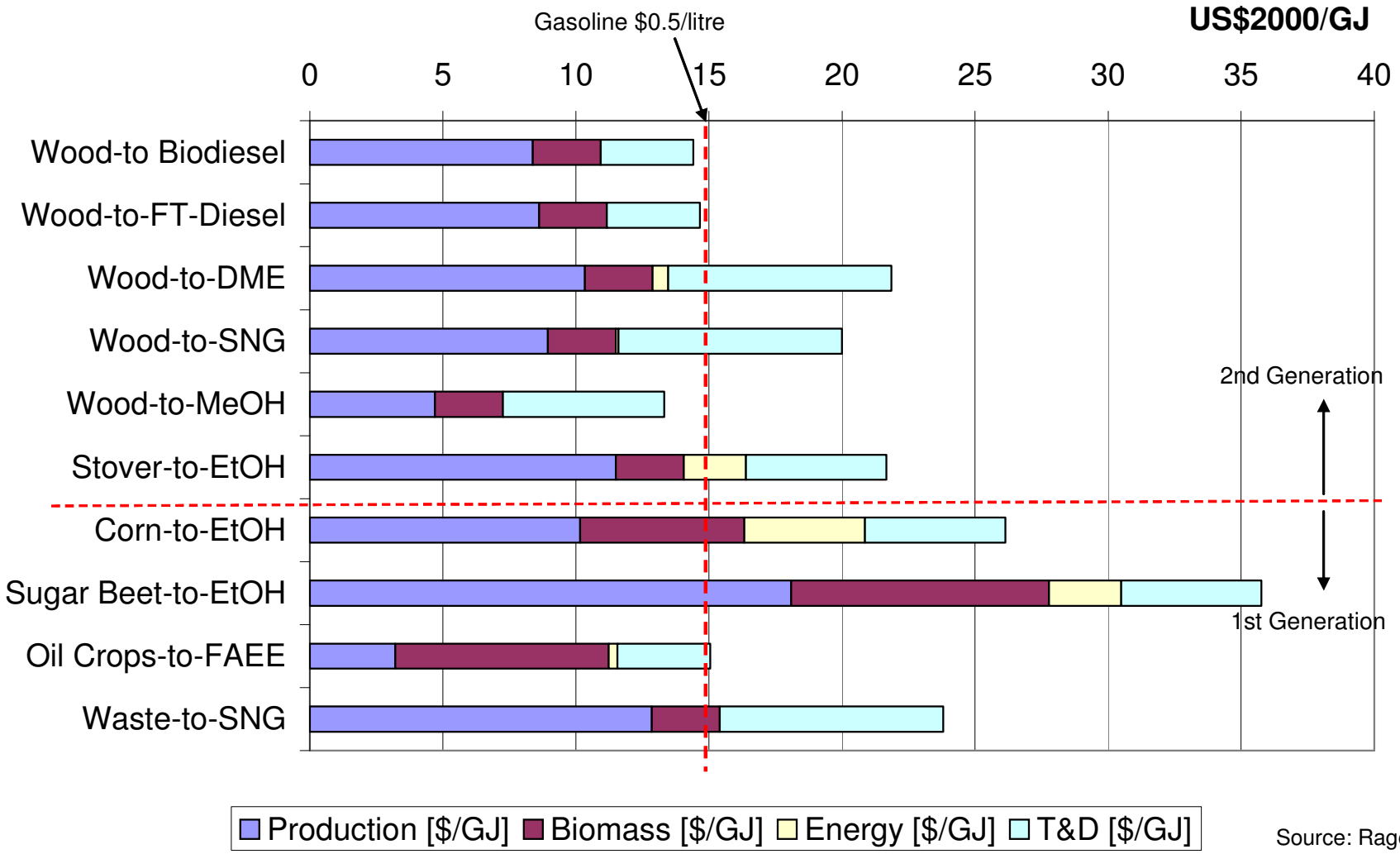
- Demand centers request 250 t H_2/day
- delivery distance 80 km on average

Cost of Delivered H_2 from Coal Gasification 2030



Source: US DoE (2006)

Biofuels Costs



Source: Ragettli (2007)

Technologies in Personal Transport

	ICE	ICE Electric Hybrid	Fuel Cell Electric Hybrid
Oil Products	X	X	X
Biofuels	X	X	
Natural Gas	X	X	
Hydrogen		X	X

Key learning components personal transport

Assumptions	Size [kW]	Initial Cost [US$/kW]	Future Cost [US$/kW]	
Fuel Cell	40	250	40	
Reformer	40	90	25	
Hybrid Battery System	28	2‘500	800	US$ per vehicle
Battery Electric	48 kWh	16‘250	12‘000	US$ per vehicle
Plug-In Hybrid	8.2 kWh	6‘500	2‘800	US$ per vehicle

Source: Turton (2006), Kromer (2007), own assumptions

- All these new vehicles assumed available as of 2010
- All vehicle costs are reduced along the same time trajectory, i.e. they reach their future lowest costs at the same time

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Part 2: Modeling Framework

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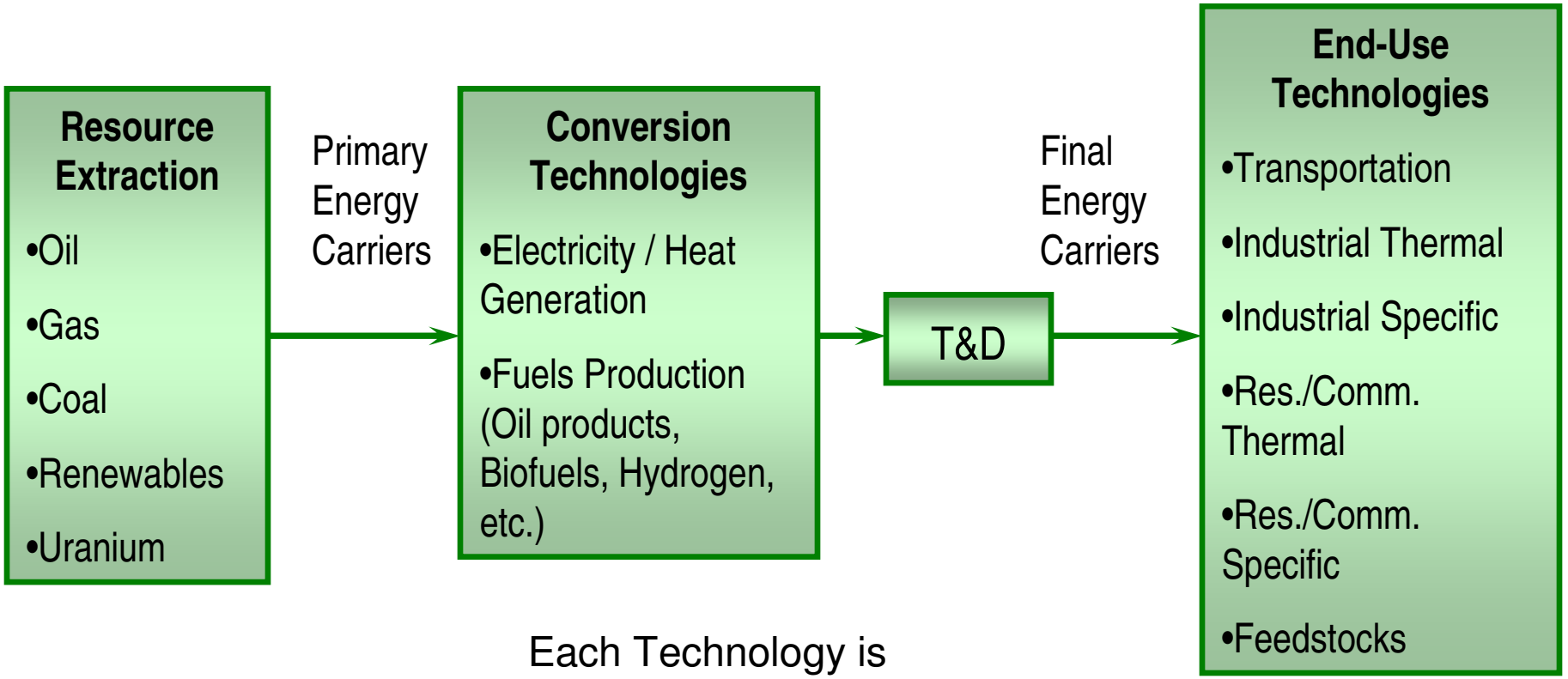
European Hydrogen Model EHM

- developed at Paul Scherrer Institute
- MARKAL-class model
- „bottom-up“ energy-system model with detailed representation of technologies
- **cost-optimization model: identifies least-cost solutions for the energy system under given sets of assumptions and constraints**
- based on IPCC-SRES B2 scenario („middle-of-the-road“), calibrated to year 2000 statistics from IEA
- represents the energy system of EU-29

EHM Reference Energy System - Structure



Each Technology is represented by its costs and efficiency!

Key Modeling Assumptions

- Oil price max. US$ 110 /bbl in 2100, natural gas price linked to oil price
- No restriction on the availability of fossil resources
- Only European biomass potential (7.2 EJ), no import of biomass or biofuels allowed

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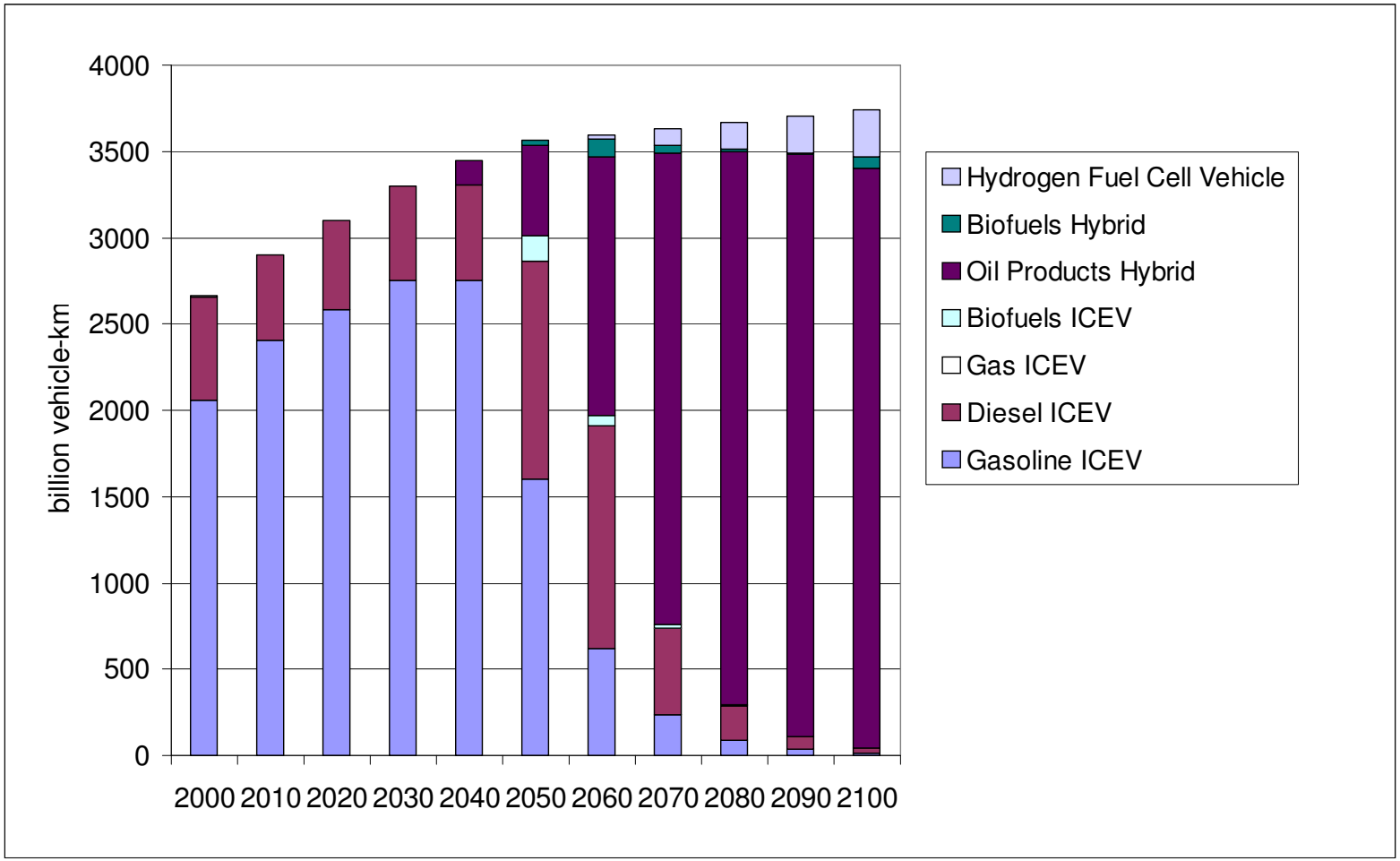
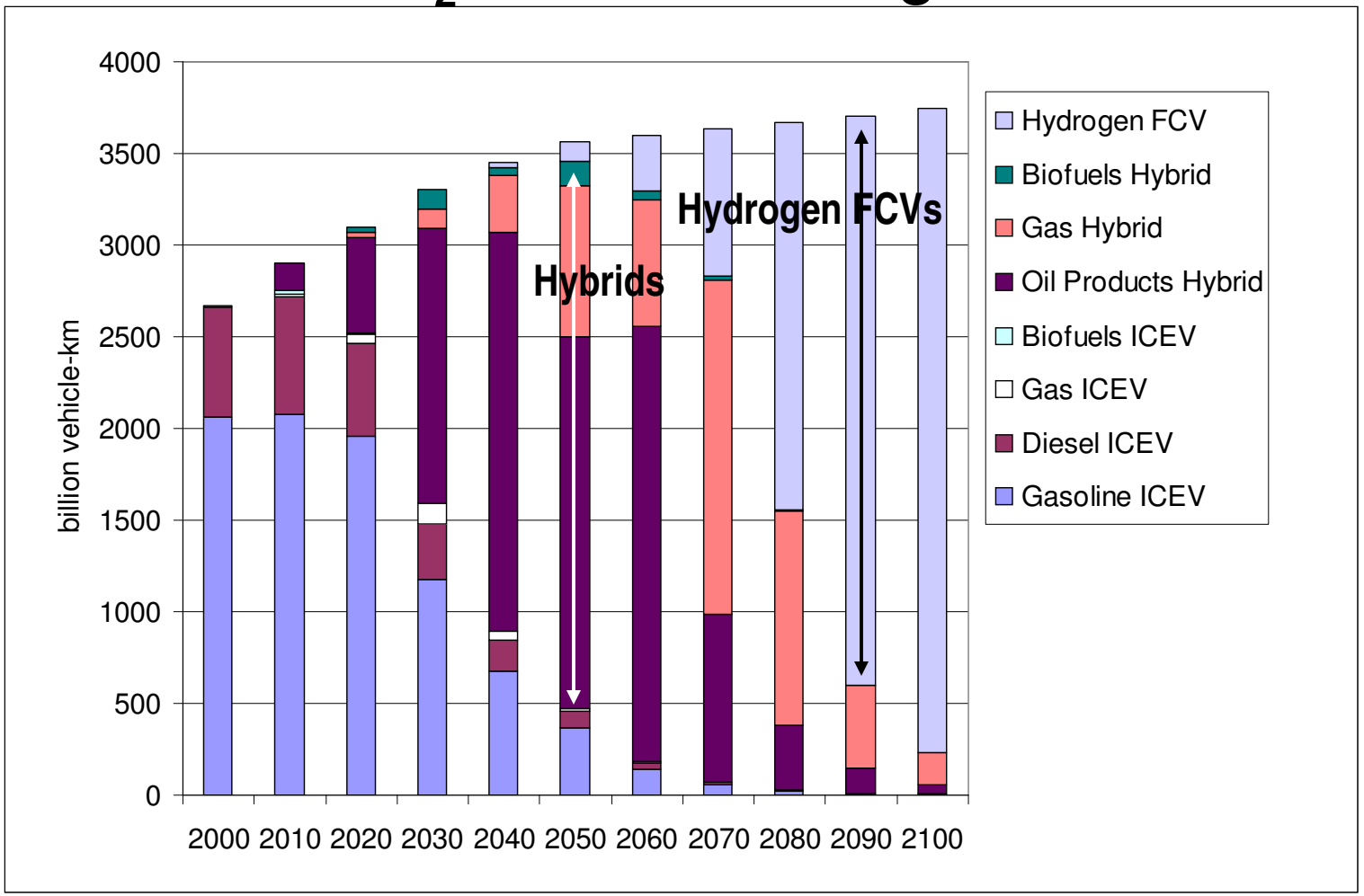
Part 3: Scenario Analyses

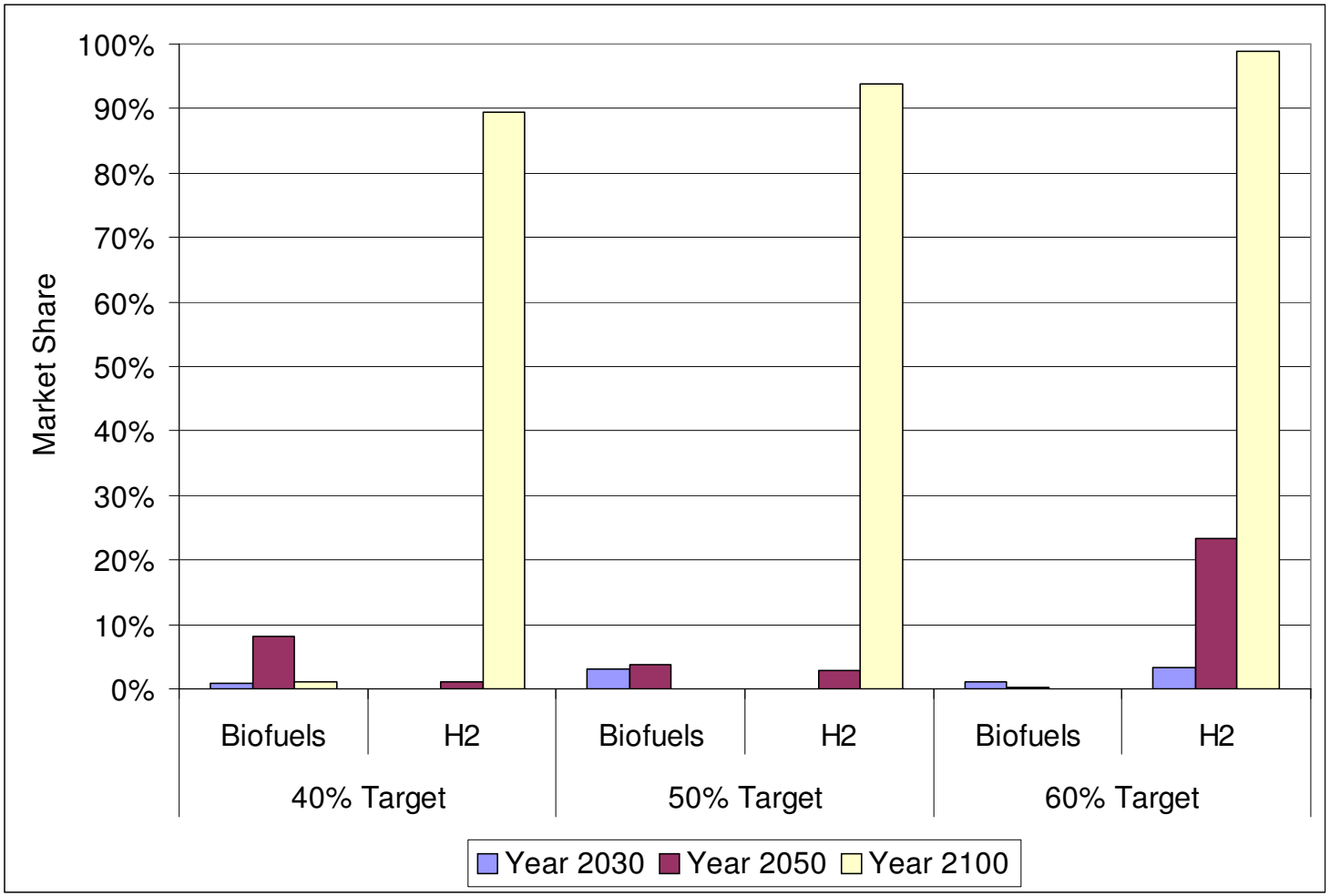
1. Baseline Scenario: Personal Transport EU-29



2. 50% CO_2 Reduction Target in 2050

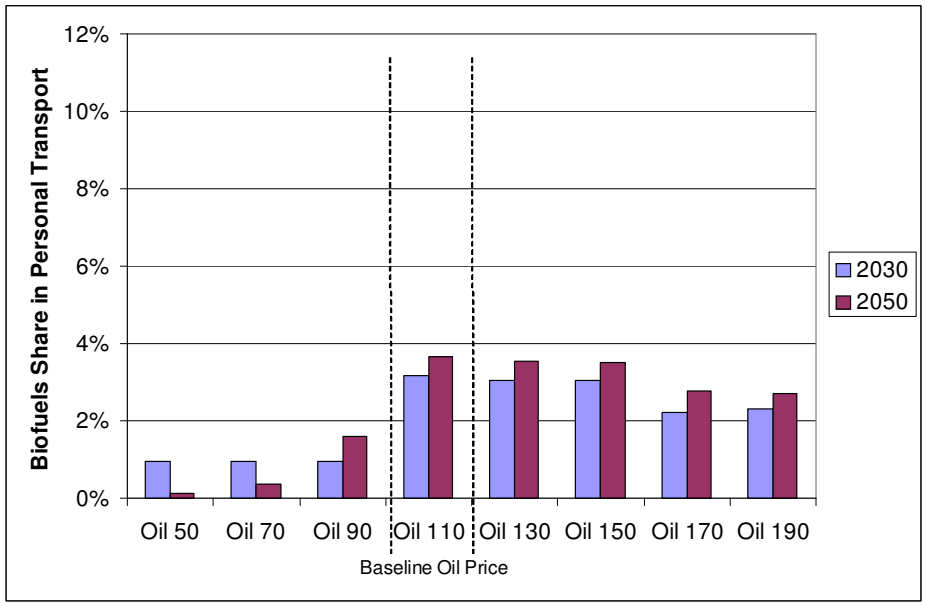


3. Varying CO_2 Reduction Targets

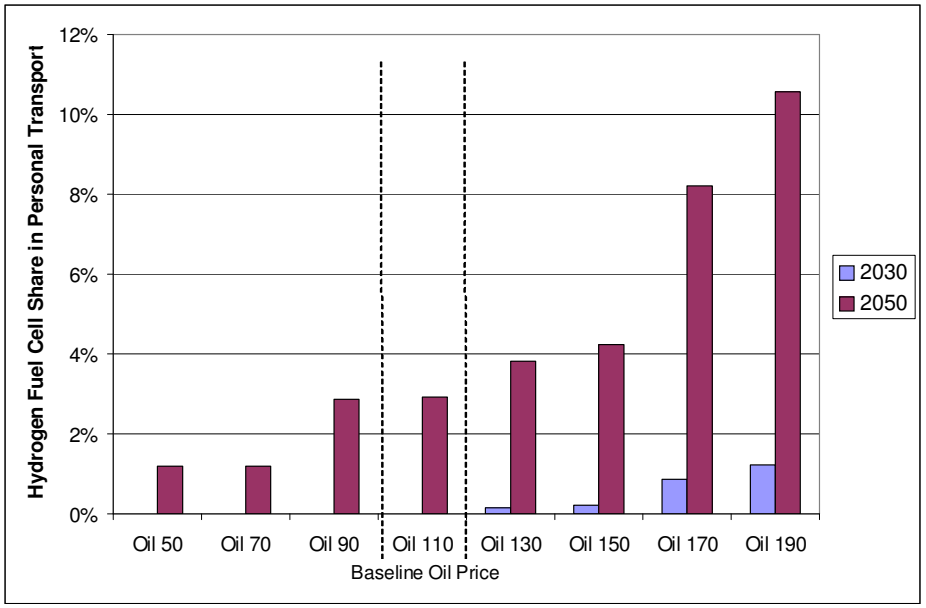


4. The Role of Oil Prices under a 50% CO_2 target

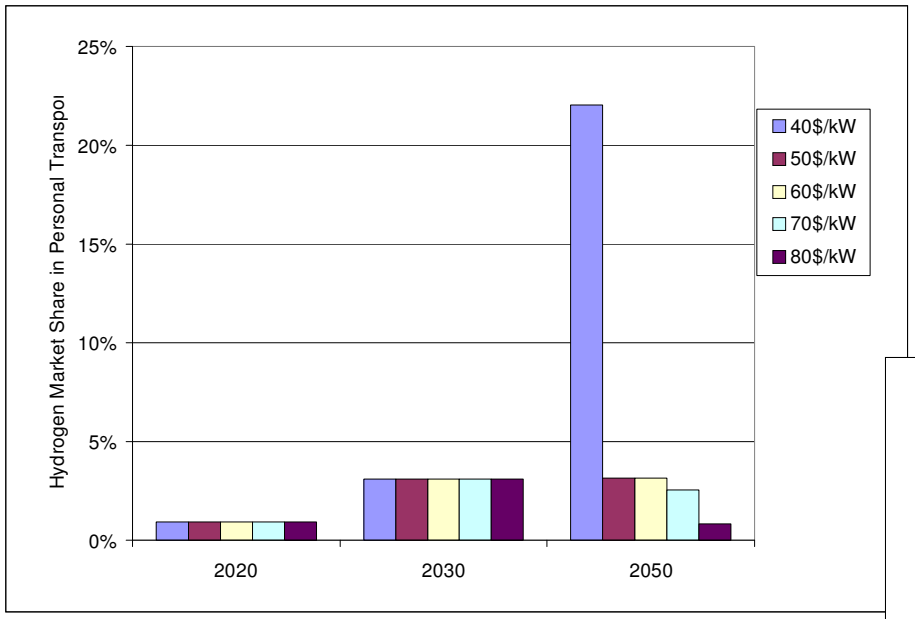
Biofuels Market Share



Hydrogen Market Share

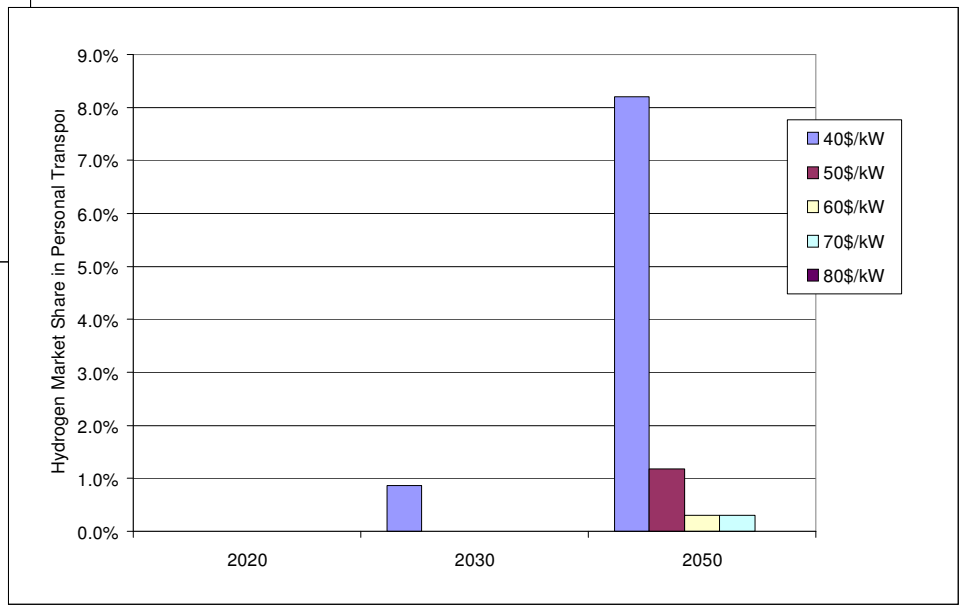


5. How could fuel cells contribute ealier?



Floor cost in 2020

Floor cost in 2050



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Conclusions

- Hybrid vehicles are a sound option for reducing CO_2 emissions from transport
- Hydrogen fuel cells can play an important role in reducing CO_2 emissions from personal transport, but the cost of the fuel cell needs to be reduced.
  - ➢ The lower the costs of the fuel cell become in a foreseeable future, the better the prospects for hydrogen in transport
- Limited biomass potential in Europe is a significant obstacle for the utilization of biofuels. Still, other factors than cost-optimization only could motivate the use of biofuels, i.e. energy security (reduction of fossil fuel imports, resource availability)

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Thank you for your attention