Hydrogen Economy: A Sustainable Transportation Option and Its Role in Mitigating Climate Change

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NIDECO Colloquium
"Selected Aspects of Sustainable Development"
Zurich, 17th June 2004

Hydrogen Economy: A Sustainable Transportation Option and Its Role in Mitigating Climate Change

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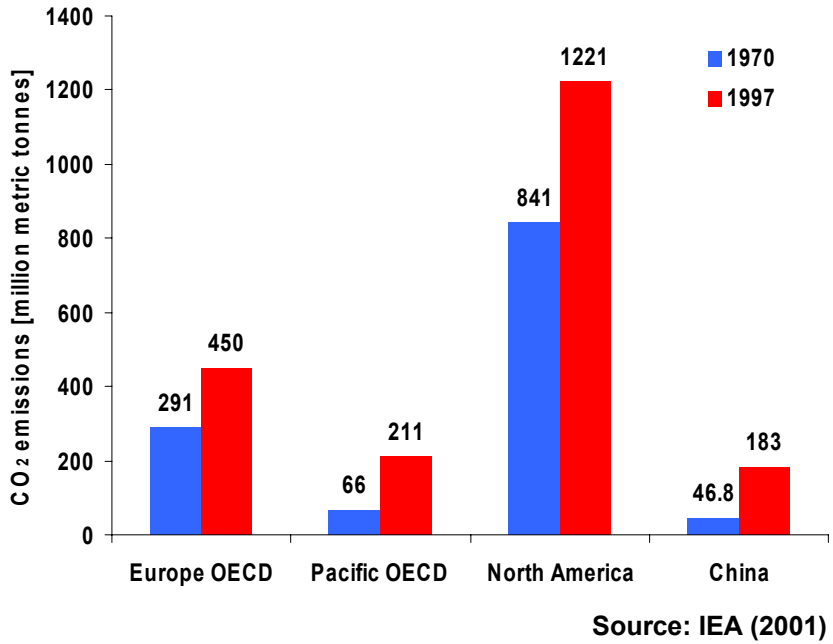
Research focus:

- Global Regionalized Transport Demand projections until the years 2050
- Market allocation of different technologies
- Evaluation of policies for reducing emissions resulting from transportation

Why to model transportation?

- Large emitter of CO_2 and other pollutants
- Increasing energy consumption
- Security of energy supply



Source: IEA (2001)

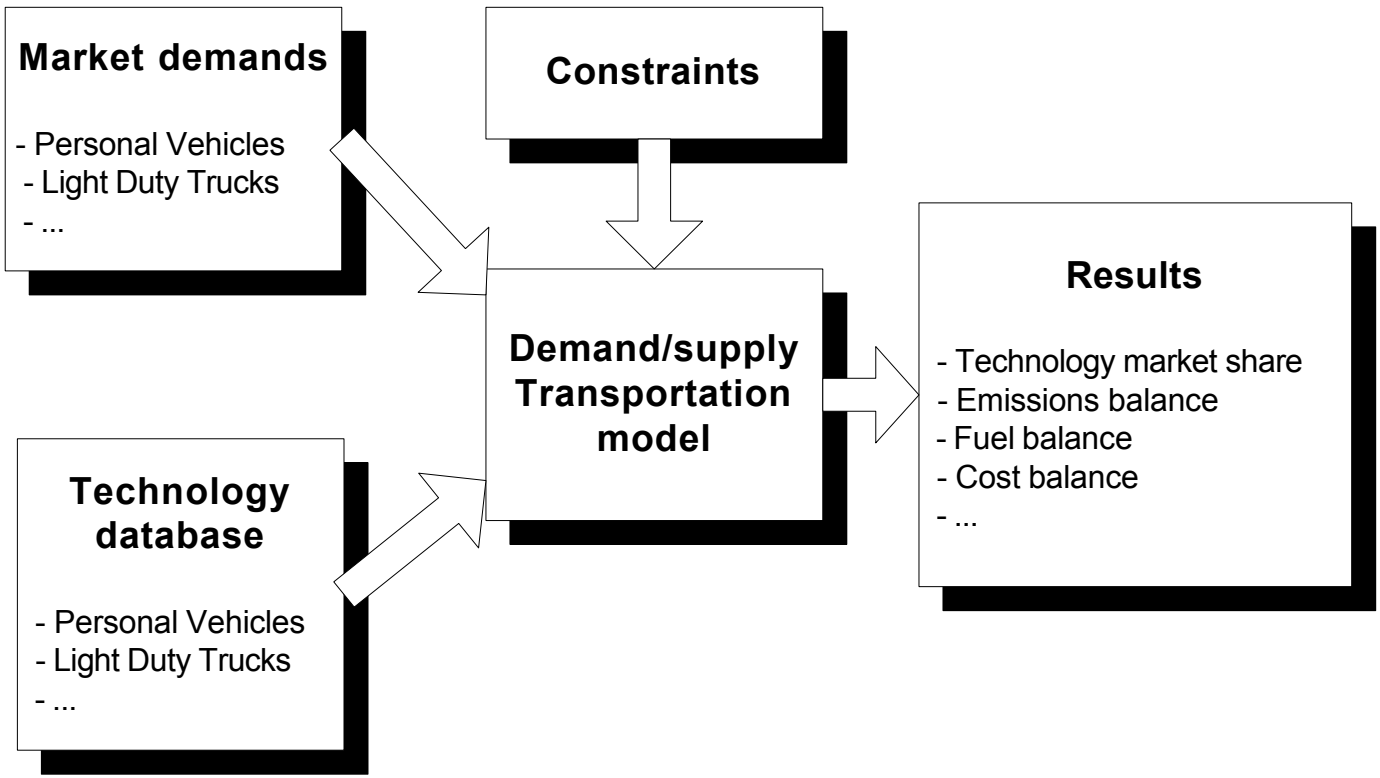
"*Sustainable mobility – the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future*"

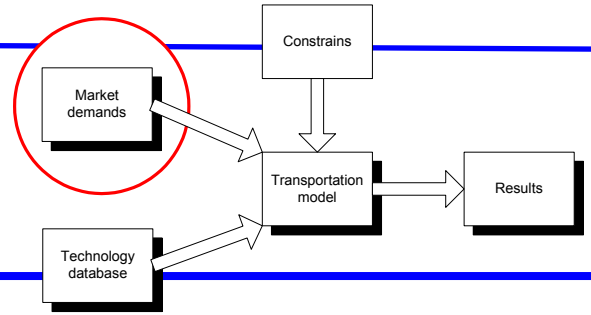
World Business Council for Sustainable Development (2001)

Approach

- Assessment of alternative technology pathways to comply with sustainability goals in the transportation sector
- Global, multi-regional model
- Scenario-based approach, based on cost optimisation
- Examination of climate and other policies

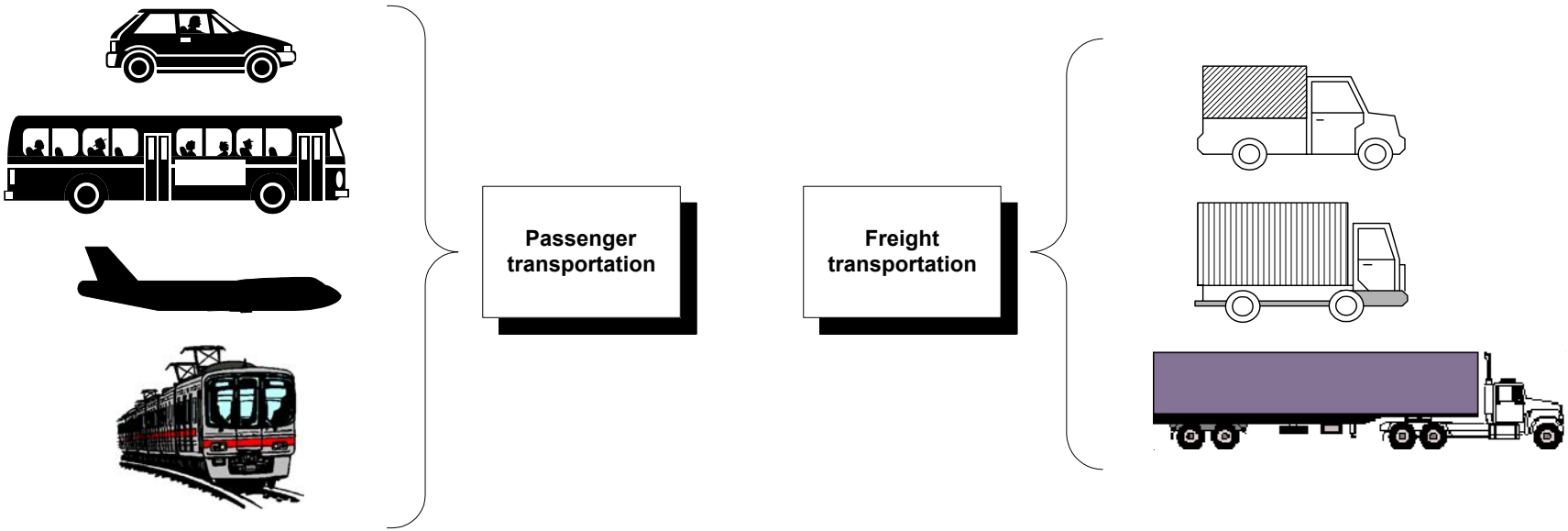
Overview diagram of the model

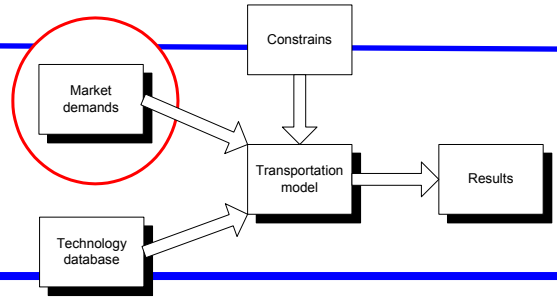




Market demands

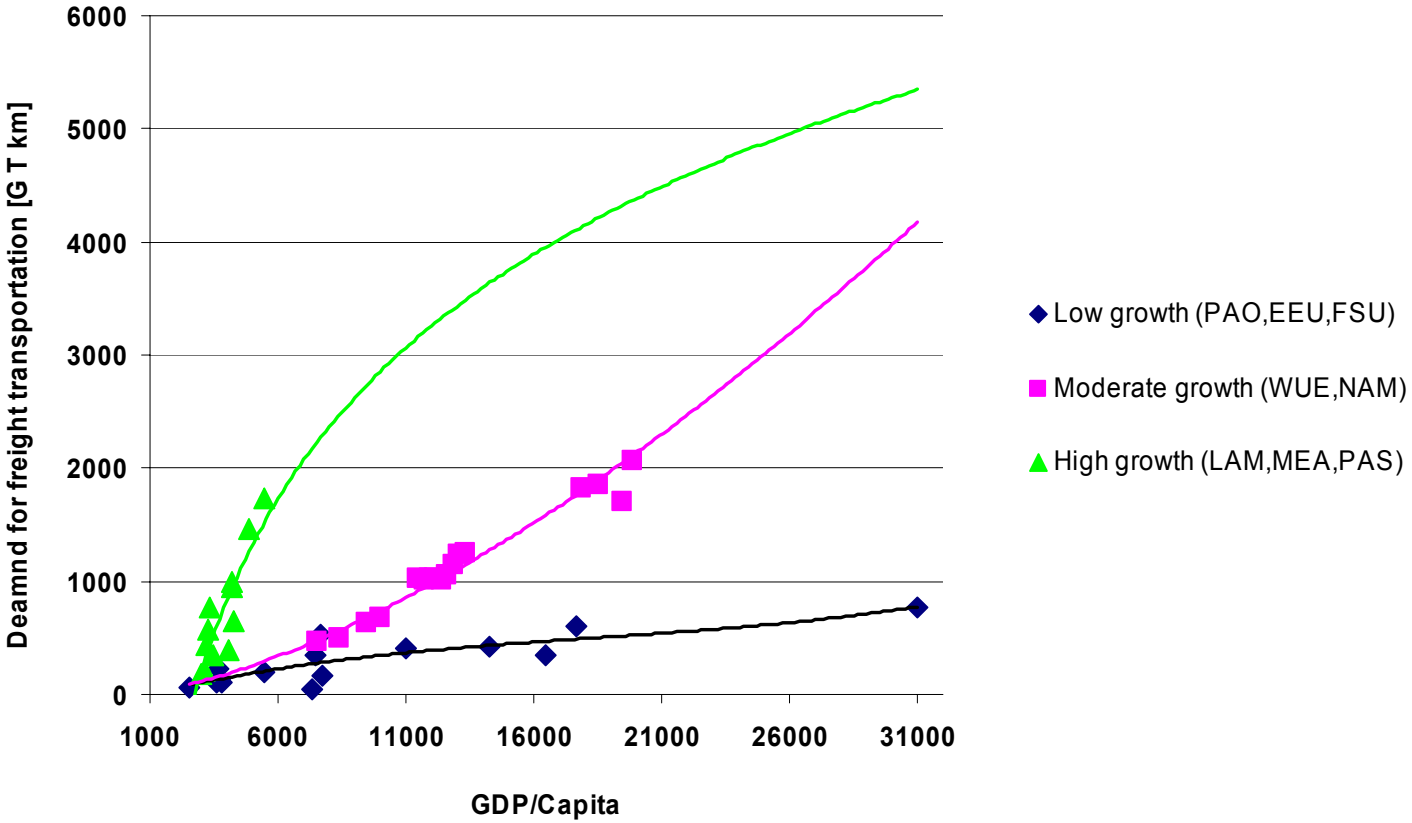
- 2 main types of transportation (freight and passenger)
- Different market sub-segments



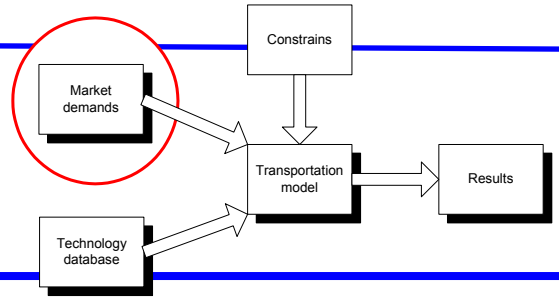


Market demands

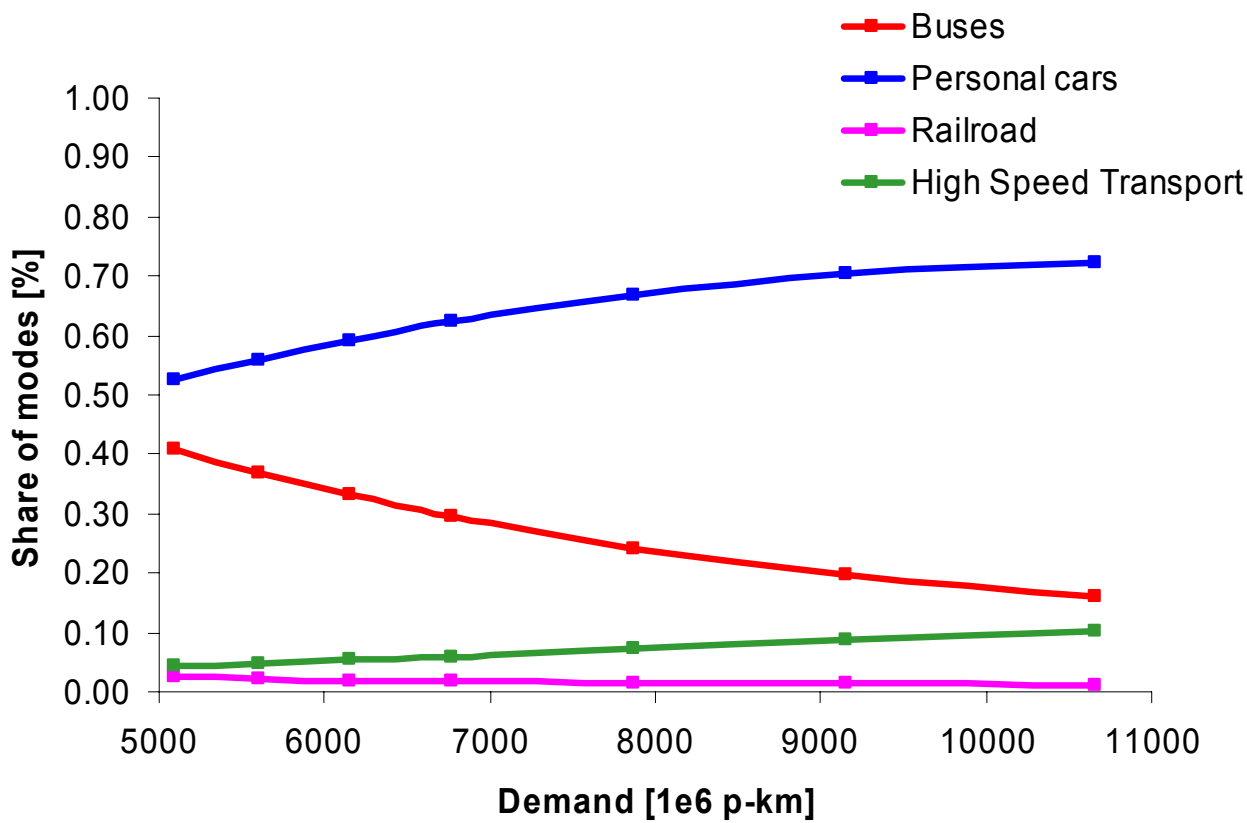
Worldwide demand for freight transportation



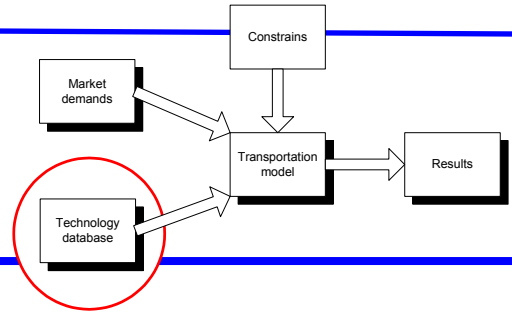
Market demands



Share of modes in Latin America



Technology database



Microsoft Excel - Case - Transport modelling.xls

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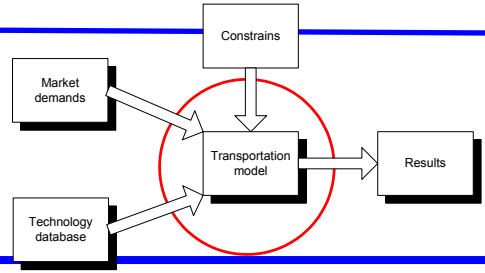
G	Fill Color (Automatic)	L	M	N	O	P	Q	R
		Diesel	Hybrid:gasoline-electric	Hybrid: gasoline-LPG	T2 Gasoline	T4 Improved Diesel	CNG	Improved CNG
		Mitsubishi Carisma	Toyota Prius	Volvo V40 bifuel	Ford Explorer XLS	VanHool A600	Orion V	Iveco CityClass
Chassy	USD	23000	20500	25000	27000	270000	320000	300000
Battery	USD							
Motor	USD							
Controller	USD							
Adapter plate	USD							
Other hardware	USD							
Total investment costs	**USD**	**23000.00**	**20500.00**	**25000.00**	**27000.00**	**270000**	**320000**	**300000**
Fuel demand	kWh-liter/100km	5.5	4.3	10.4LPG/8.1gasoline	12.7	62.8	80.2	70.85
Source		works.com	http://www.prius	http://www.volv	http://www.1	Pelkemans	Pelkemans	Pelkemans
Maintenece	USD/1000 p-km	33.6	33.6	33.6	38.3	67	67	67
Source		http://www	http://www.prius	http://www.volv	USA.xls inp	USA.xls inp	USA.xls inp	USA.xls inp
Load factor	passangers/tonn	1.6	1.6	1.6	1.6	45	45	45
Energy demand	**p-km/MJ**	**0.8215**	**1.2217**	**0.6319**	**0.3558**	**0.1253**	**0.1026**	**0.1161**
CO2	g/v-km		104	180	-	1633	1634	1475
CO	g/v-km		-	-	-	3.5	0.8	0.7
THC	g/v-km		-	-	-	1.7	7.5	0.2
NOX	g/v-km		-	-	-	15.2	25.1	1.8
Capital recovery factor		0.11	0.11	0.11	0.11	0.11	0.11	0.11
Annualised investment costs	USD/ p-km	0.10	0.09	0.10	0.11	0.01	0.01	0.01
Investment costs	**USD/ 1000 p-km**	**845.59**	**753.68**	**919.12**	**992.65**	**60.00**	**71.11**	**66.67**
Fixed Maintenece	**USD/ 1000 p-km**	**33.60**	**33.60**	**33.60**	**38.30**	**67.00**	**67.00**	**67.00**
Variable maintenece	**USD/ 1000 p-km**	**16.37**	**16.37**	**16.37**	**16.37**	**5.11**	**5.11**	**5.11**
Fuel costs	**USD/ 1000 p-km**	**13.44**	**10.81**	**21.62**	**32.08**	**5.46**	**13.37**	**11.81**
Total price	**USD/ 1000 p-km**	**909.00**	**814.45**	**990.70**	**1079.40**	**137.57**	**156.59**	**150.59**

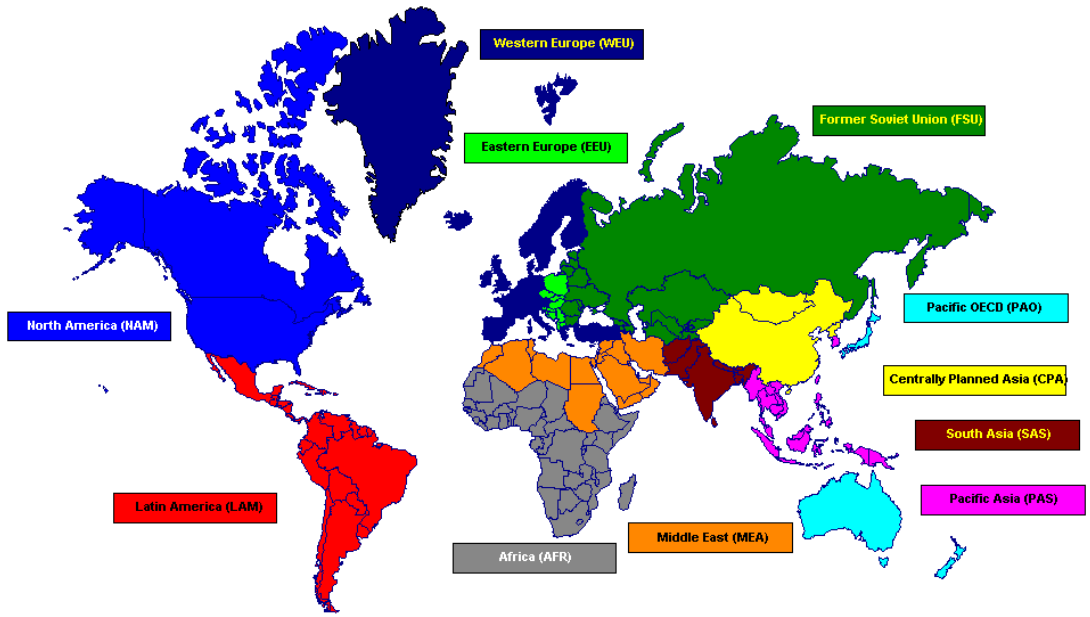
Specification of transport technologies:

- **Efficiencies**
- **Costs**
- **Emissions**
- **Fuels**
- **etc.**

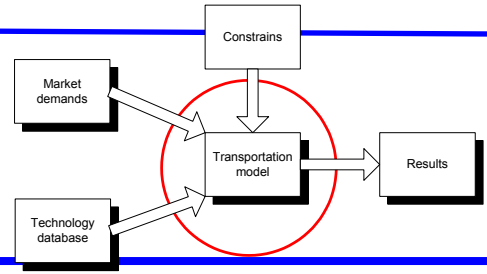
Transportation model



- Stand-alone model
- Optimisation for allocation of transport technologies
- Combination of market demand and supply
- 11 world regions

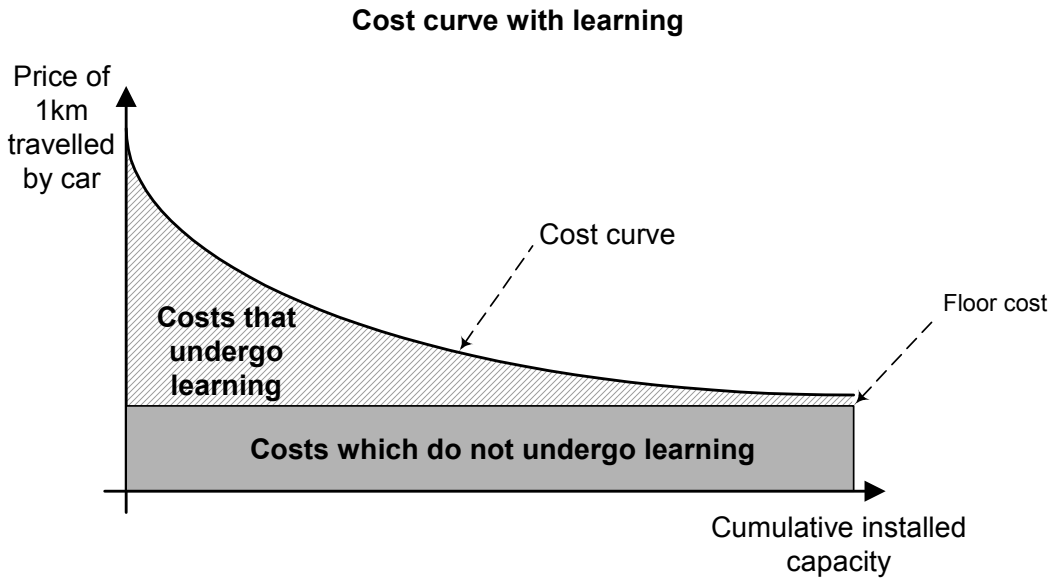


Transportation model

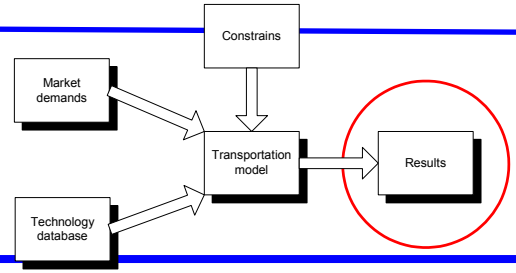


Technologies competing on the market:

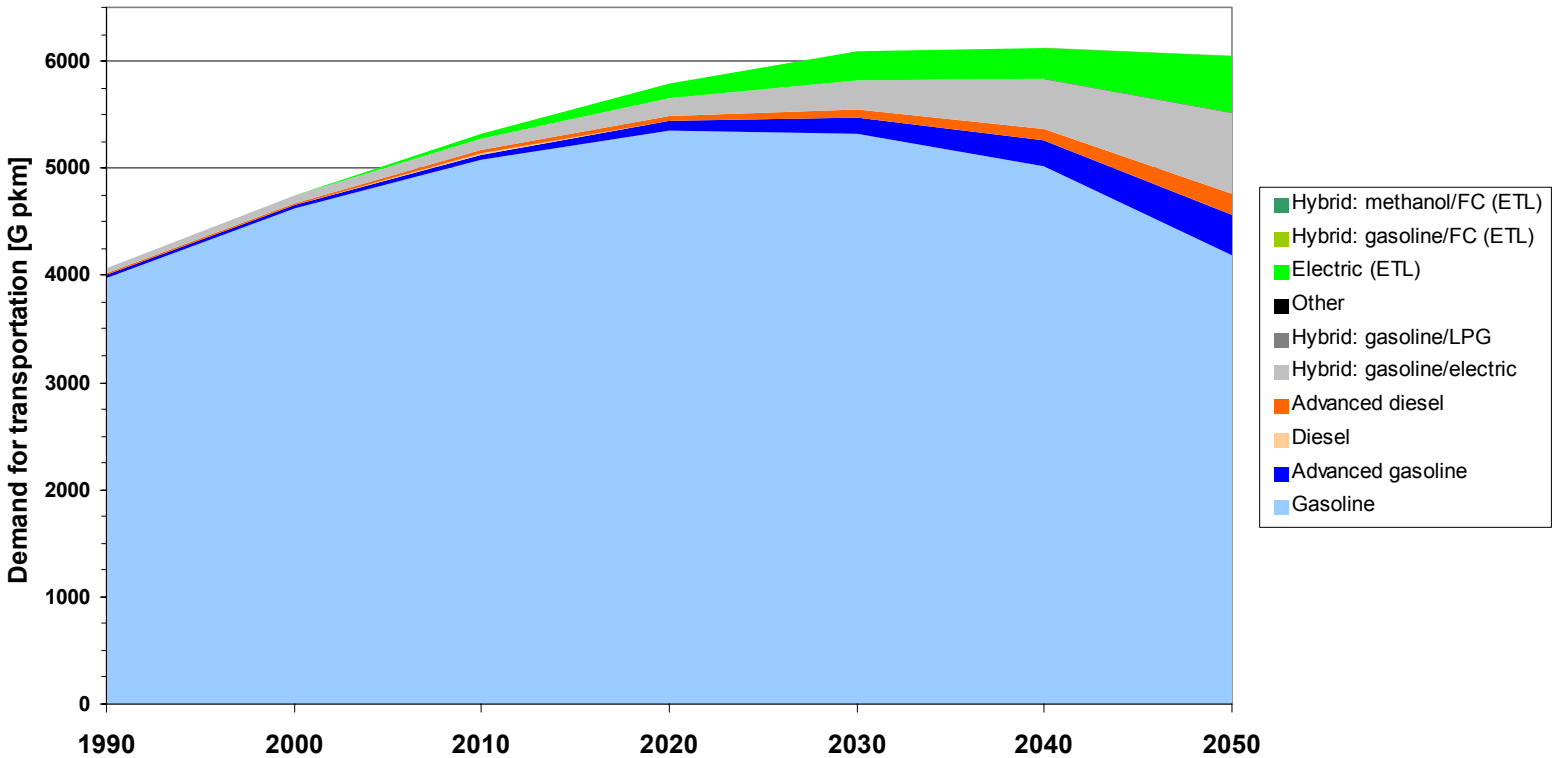
- **Non-learning**
- **Learning (ETL)**
- **Different sectors**



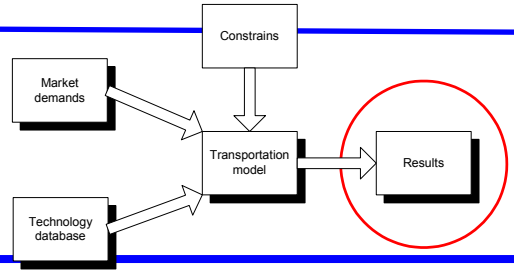
Illustrative results – market shares



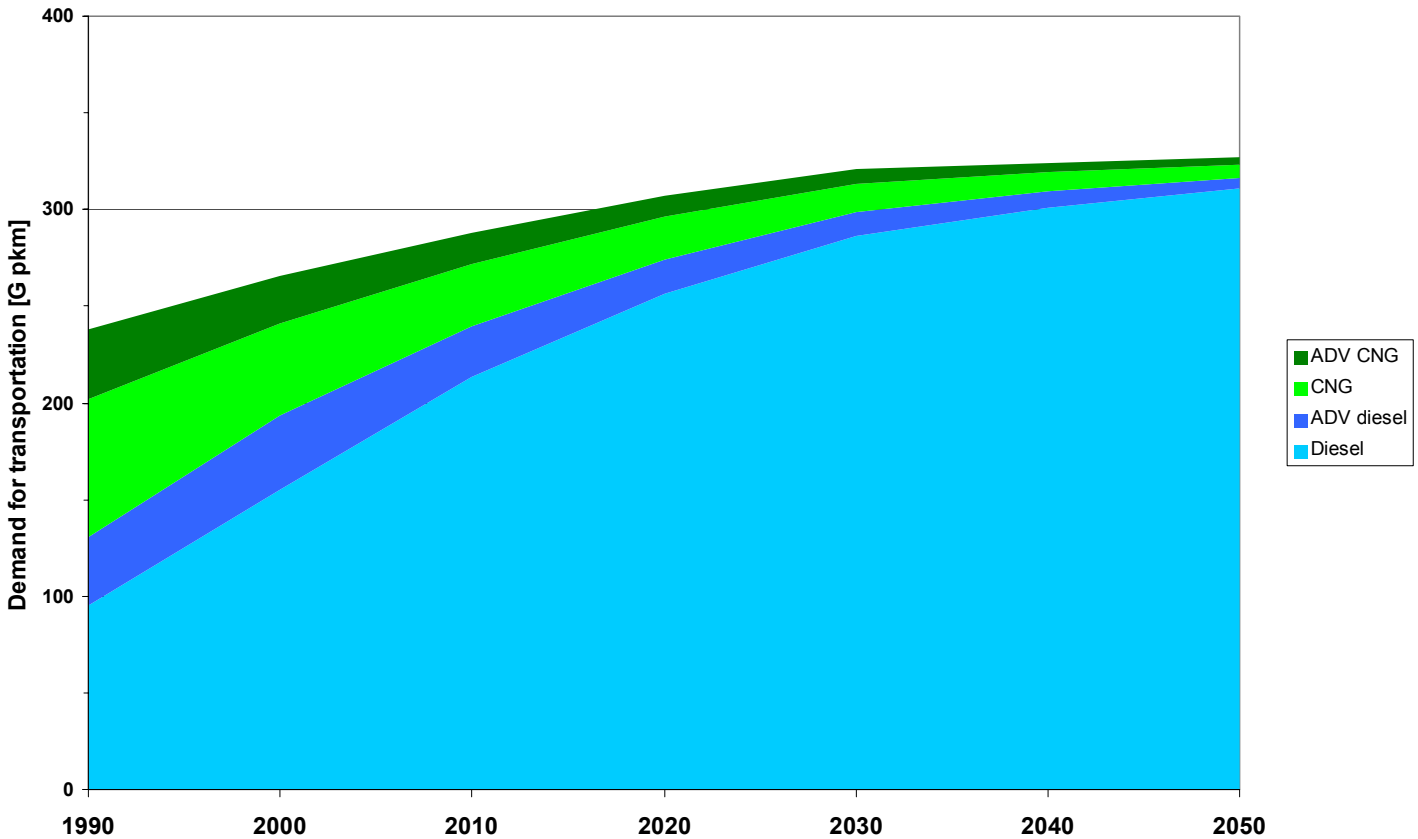
Personal cars in North America



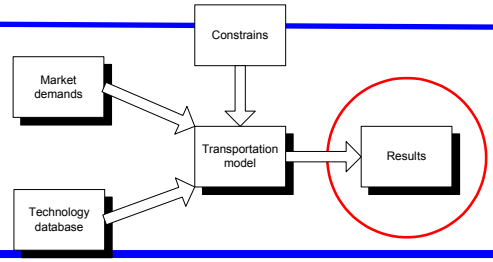
Illustrative results – market shares



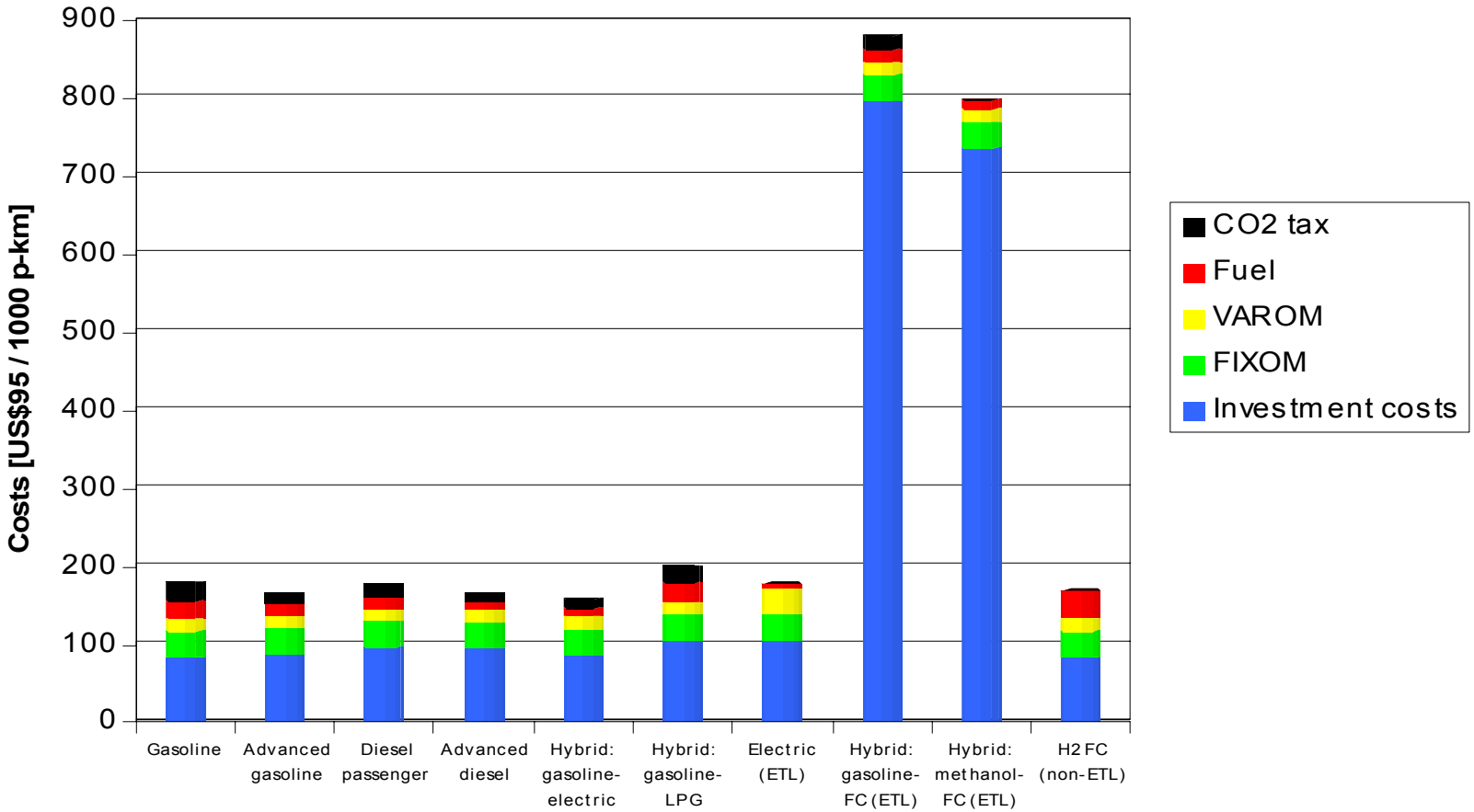
Buses in North America



Illustrative results – policy measures (example of CO_2 tax)



Changes in transportation prices for personal cars



Next steps

- Expansion to full 11-world region mode
- Implications of atmospheric policies
- Conditions for introduction of new technologies / fuels
- World / regional fuel balances
- Potential for renewable fuels
- Costs of sustainable development in the transportation sector
- Inclusion of fuel chains
- Different market share allocation algorithms