UIC ENERGY EFFICIENCY DAYS 2014

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Energy Efficiency in Transport

The "first fuel" for sustainable mobility

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Energy Efficiency, the best fuel to move our trains!

Energy consumption in transport (1/2)

World energy balances

Source: IEA Key World Energy Statistics 2013

1973

(Mtoe)

SUPPLY AND CONSUMPTION	Coal/ peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Biofuels and waste[a]	Other[b]	Total
Production	1 479.01	2 938.38	-	993.05	53.05	110.19	644.57	6.13	6 224.36
Imports	140.01	1 561.28	407.65	73.40	-	-	0.12	8.14	2 190.61
Exports	-130.40	-1 612.99	-442.73	-72.56	-	-	-0.19	-8.27	-2 267.15
Stock changes	12.30	-19.68	-16.40	-15.09	-	-	0.06	-	-38.82
TPES	**1 500.92**	**2 866.99**	**-51.48**	**978.80**	**53.05**	**110.19**	**644.55**	**6.00**	**6 109.01**
Transfers									
Statistical diff.									
Electricity plants									
CHP plants									
Heat plants									
Blast furnaces									
Gas works									
Coke ovens[c]									
Oil refineries									
Petchem. plants									
Liquefaction plants									
Other transf.									
Energy ind. own use									
Losses									
TFC									
Industry	361.89	16.42	432.21	356.95	-	-	91.52	286.35	1 545.32
Transport[d]	33.00		1 019.05	17.72	-	-	0.24	10.60	1 080.60
Other	239.14	0.00	520.05	259.26	-	-	524.80	218.67	1 761.93
Non-energy use	6.01	5.73	256.05	18.37	-	-	-	-	286.16

Transport in 1973

- 18% of TPES, mostly (94%) using oil products
- 36% of global crude oil supply

2011

(Mtoe)

SUPPLY AND CONSUMPTION	Coal/ peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Biofuels and waste	Other[a]	Total
Production	3 850.54	4 132.97	-	2 805.35	674.01	300.17	1 310.64	128.08	13 201.76
Imports	696.75	2 299.34	1 077.39	865.30	-	-	13.89	55.78	5 008.45
Exports	-726.24	-2 210.80	-1 164.02	-861.72	-	-	-11.64	-55.82	-5 030.23
Stock changes	-44.99	-1.94	3.05	-21.98	-	-	-0.74	-	-66.60
TPES	**3 776.06**	**4 219.57**	**-83.58**	**2 786.95**	**674.01**	**300.17**	**1 312.15**	**128.05**	**13 113.38**
Transfers									
Statistical diff.									
Electricity plants									
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Coke ovens[b]									
Oil refineries									
Petchem. plants									
Liquefaction plants									
Other transf.									
Energy ind. own use									
Losses									
TFC									
Industry	728.93	10.67	312.48	506.38	-	-	198.15	800.14	2 556.74
Transport[c]	3.41	0.02	2 265.21	92.52	-	-	58.61	25.16	2 444.94
Other	132.05	0.50	435.55	610.23	-	-	854.99	1 063.11	3 096.43
Non-energy use	39.22	7.56	601.27	171.36	-	-	-	-	819.42

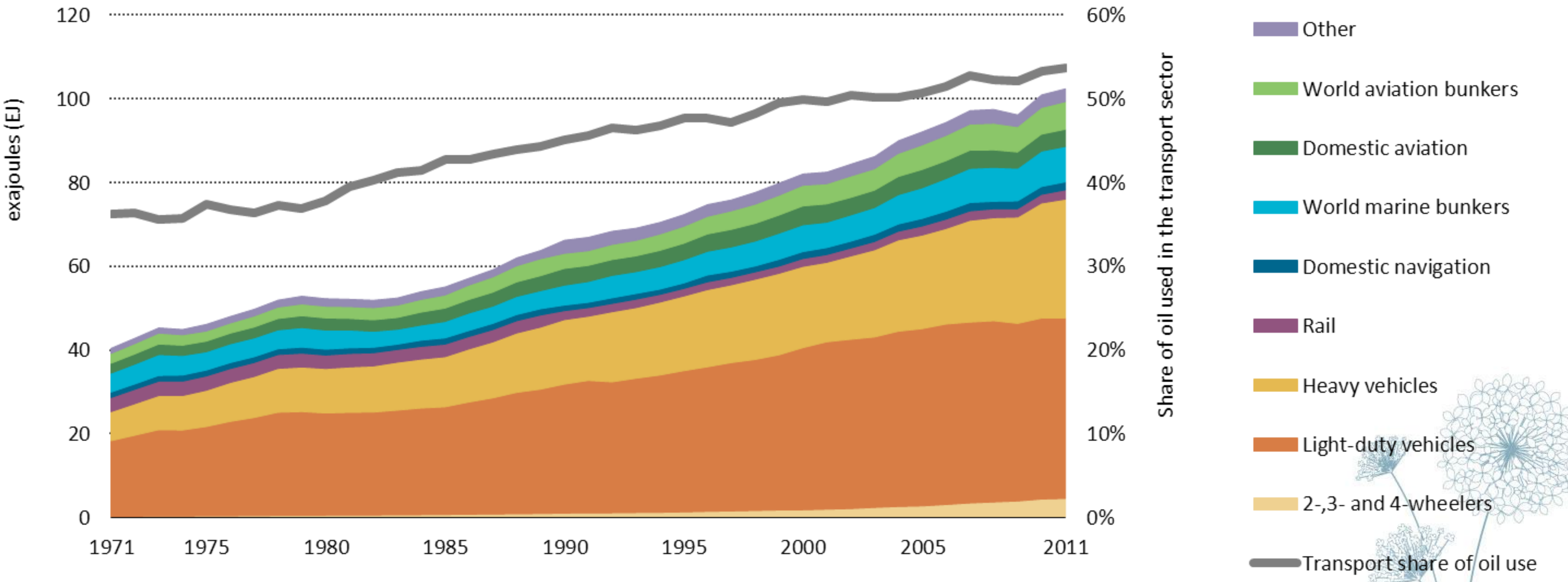
Transport in 2011

- 19% of TPES, mostly (92%) using oil products
- **54%** of global crude oil supply

- Transport: end-use with the least diversification

Energy consumption in transport (2/2)

Trends by mode



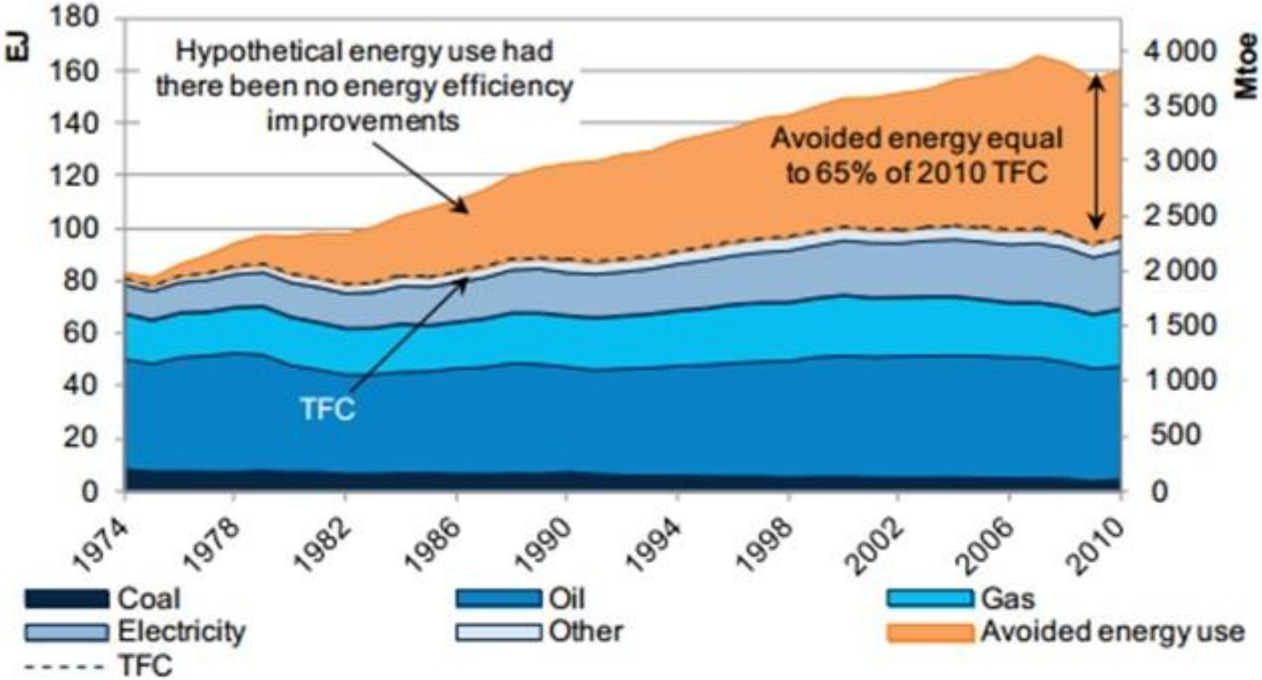
Source: IEA ETP

- Most energy consumption takes place in road modes
- Road share in total transport energy growing from less than 50% in 1973 to nearly 75% in 2011

Energy efficiency

The *hidden fuel*

- The impact of avoided energy use from energy efficiency in IEA member countries is comparable to the main fuel supply options
- Transport is no exception…



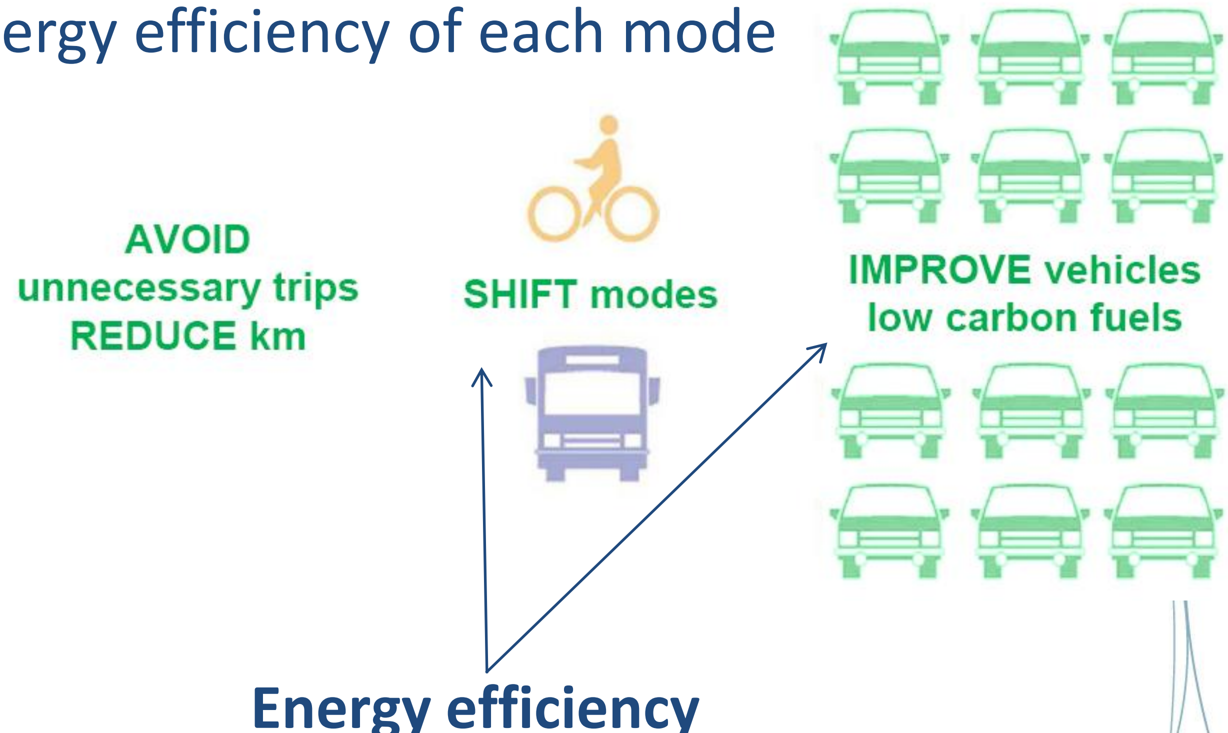
Source: [IEA Energy Efficiency Market Report, 2013]

Notes: TFC = total final consumption. The 11 countries are Australia, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States, those for which sufficient data is available to undertake analysis. "Other" includes biofuels plus heat from geothermal, solar, co-generation and district heating. Co-generation refers to the combined production of heat and power.

Energy efficiency in transport

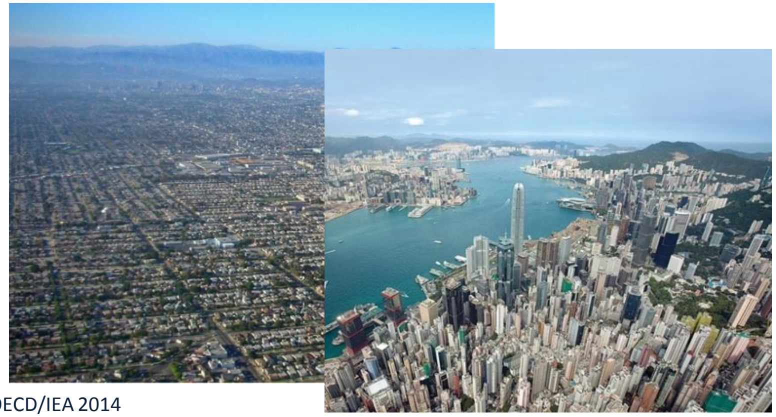
Available options

- **Avoid** unnecessary travel
- **Shift** travel to more efficient modes
- **Improve** the energy efficiency of each mode



Avoid & Shift policies for energy efficiency

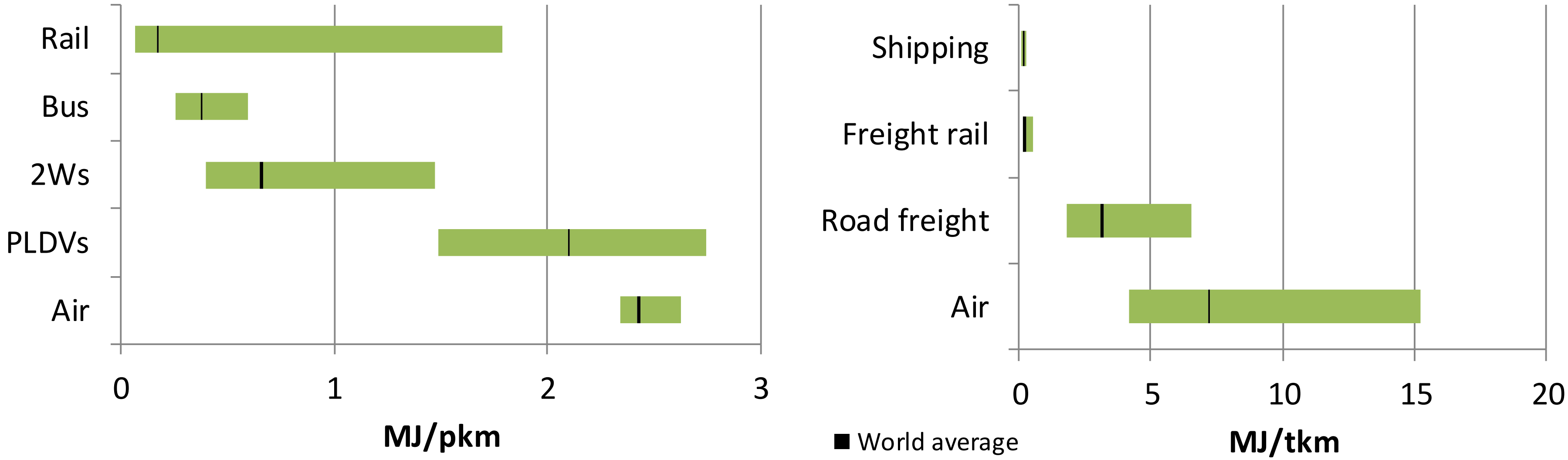
- Increases of the public transport capacity and quality improvements favored by high-density urban environments
- The time frame to alter urban design is long (decades)
  - Building cities from scratch is rarely possible
  - Fast-growing countries can (and need to) do that
- Integrated measures are needed for effective results
  - Land use planning, fees/pricing measures, environmental zones
- Larger effects seen in the long term



Energy efficiency

Modal choice

Energy efficiency of different modes of transport, 2010



Source: IEA Mobility Model

- Rail transport is amongst the most energy efficient mobility options available (both for passenger and freight)
- Other options include public passenger transport, two wheelers and shipping

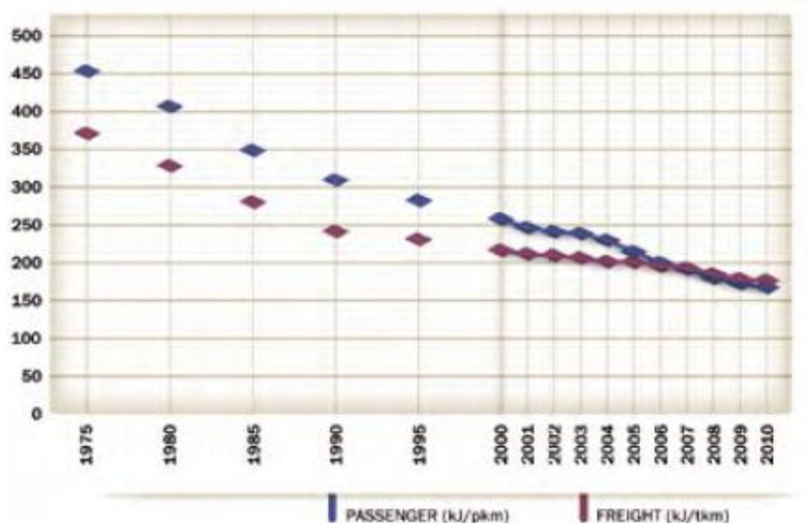
Improve policies

- Significant potential (energy efficiency and fuel switching)
- Technological maturity not homogeneous
  - Market pull (mature technologies, short-term)
    - Scrapping fossil fuel subsidies, fuel efficiency standards, labelling, fiscal charges/incentives on vehicle purchase
    - Need for performance-based instruments, no technology pick
  - Technology push (high-potential and lower maturity techs)
    - Support RD&D to reduce costs and foster tech uptake
    - May require focus on specific techs (e.g. EVs, NGVs)
    - Need for clear indications on long-term policy direction
- Behavioral aspects can play a role
- Time frame shorter than for urban transformation
- Risk of rebound effect: need for integrated measures

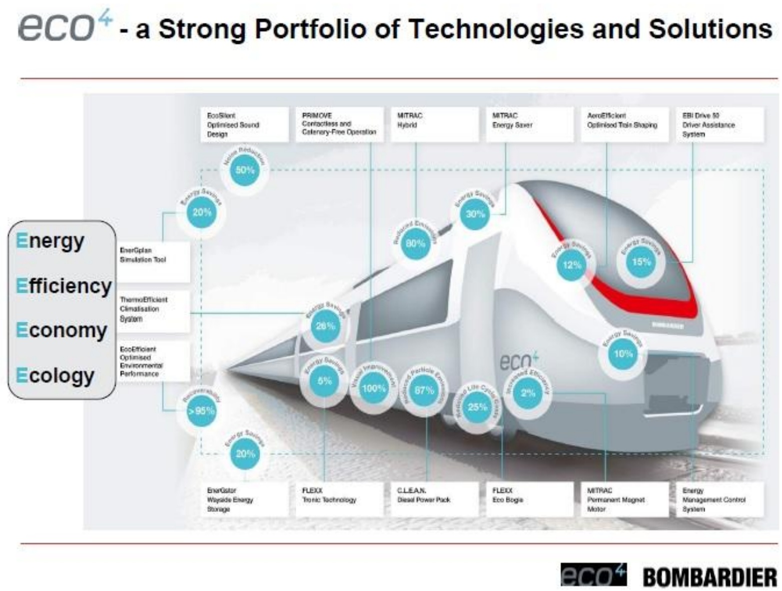
Improve policies for energy efficiency

- Energy use per rail pkm and tkm improved over the past decades
- Solutions/technologies for further improvements are available in the future

Rail: energy use per pkm and tkm



Source: [UIC-IEA Railway Handbook, 2013]()



Source: [Bombardier, 2011]()

- The long lifetime of rolling rail stock slows the improvement process associated with technological development

IEA Energy Technology Perspectives 2014

ETP 2014 – Focus on electricity

- Looking at what needs to be done to provide sustainable options for generation, distribution and end-use
- Three main scenarios:
  - 6DS: limited changes, pessimistic view (BAU)
  - 4DS: current strategies for energy efficiency extended to 2050
  - 2DS: CO_2 emission mitigation scenario
- Features a specific chapter (and scenario) on transport electrification
  - 2DS-ET – alternative to 2DS, focusing on electrification

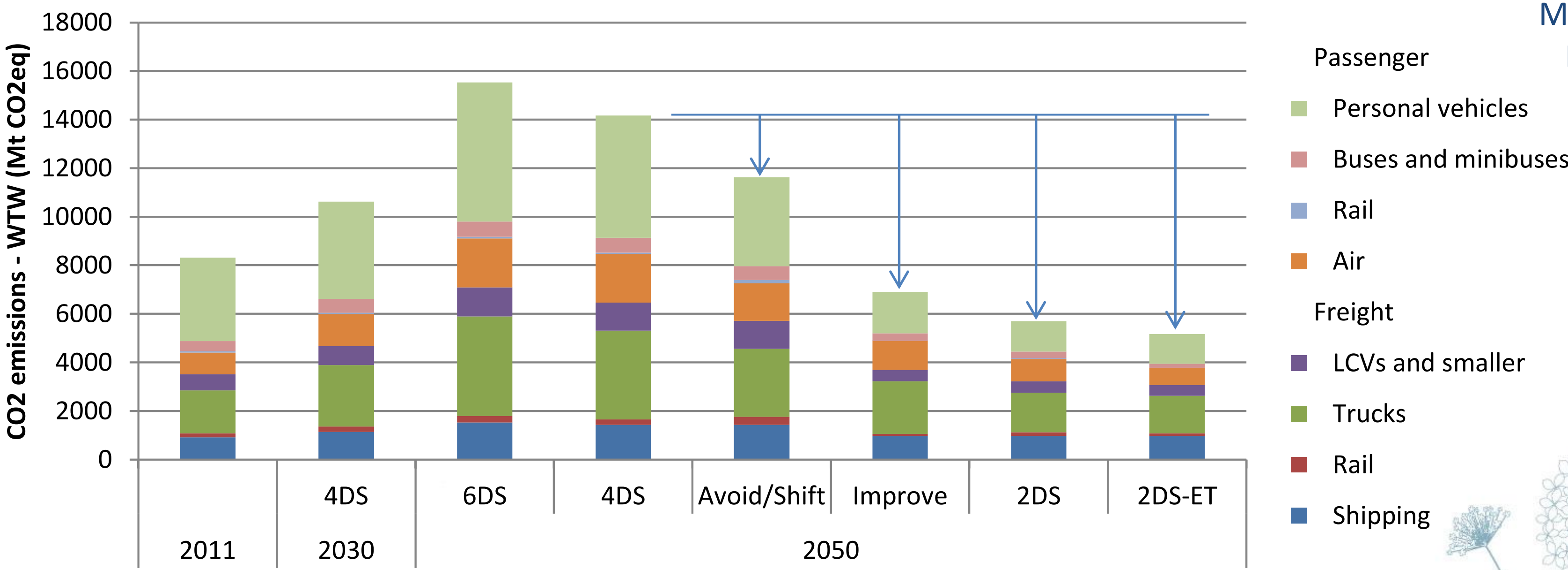
IEA Mobility Model (MoMo)

- Used to develop transport-related projections in ETP, since the first edition
- Covering activity, energy use, GHG emissions, expenditures for vehicles infrastructure, materials to 2050
- 29 regions, passenger and freight services, all transport modes except pipelines, several fuel pathways
- Supported by several partners (government, private, NGOs, academic)

Perspectives for 2050

CO_2 emissions in transport

Source: IEA Mobility Model



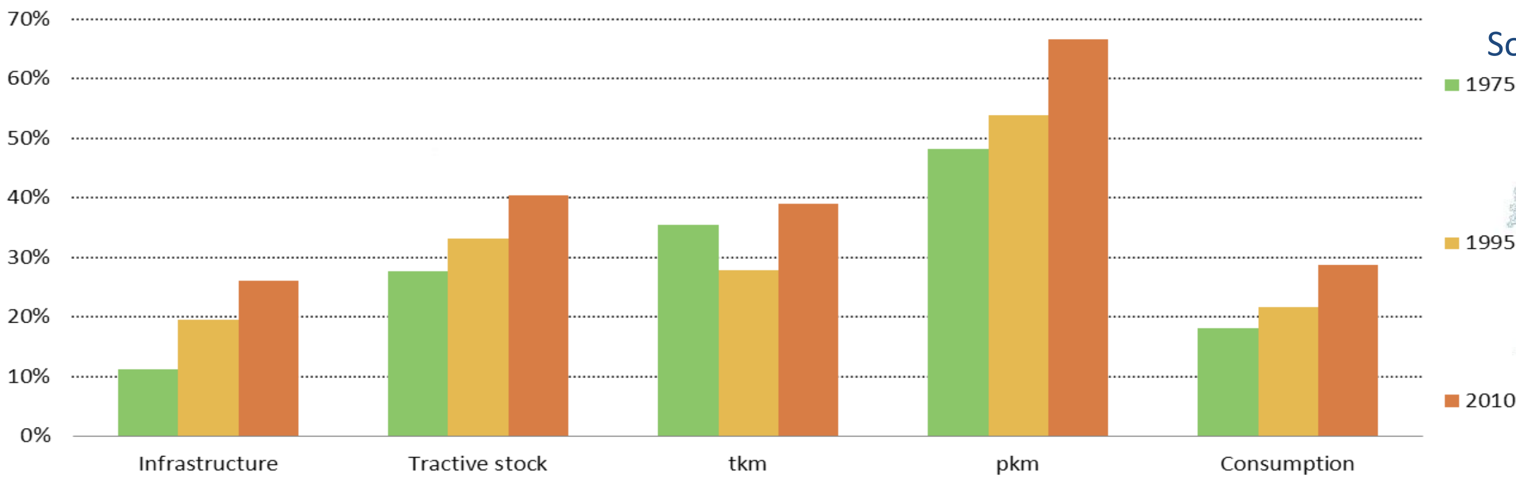
IEA ETP transport scenarios (6DS, 4DS and 2DS) reflect the contributions of key energy efficiency and CO_2 emission mitigation strategies for transport

- Avoid/Shift: avoid unnecessary travel, shift to efficient modes
- Improve the energy efficiency of each mode

Perspectives for 2050

Rail transport (1/2)

- Rail infrastructure worldwide: more than 25% electrified
- Electric locomotives: almost 40% of powered railway stock
- Rail electrification is increasing across five key metrics: infrastructure, tractive stock, transport kilometre (tkm), passenger-kilometres (pkm) and final energy consumption



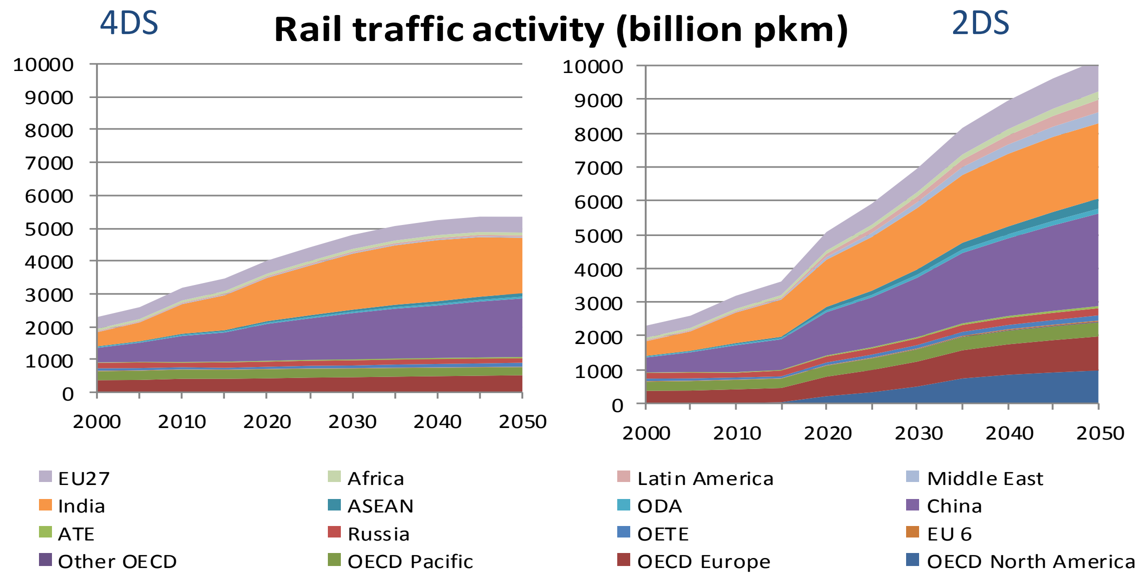
Source: IEA ETP

- Electric trains cheaper than diesel alternatives
- The electrification of the infrastructure is the key barrier

Perspectives for 2050

Rail transport (2/2)

- Urban rail systems: all electrified today (tramways, overhead light-rail, underground metro)
- Intercity and freight: potential for increased electrification exists
- Payback periods rail infrastructure electrification sensitive to the cost of the infrastructure, oil prices, and operating frequency
- Priority for rail network segments with the highest usage rates



Source: IEA Mobility Model

Conclusions

- Rail well placed when looking at energy efficiency for sustainable transport
- Encouraging signs from recent developments of rail electrification
- Rail electrification can become more relevant if transport activity is shifted towards collective transport modes, especially in cities
- Even if rail is more efficient than competing inland transport modes, the technical potential to save energy shall not be wasted
- Key barriers include
  - the long time frame needed to alter urban design
  - the long lifetime of rolling rail stock
- This puts pressure on the need for early action to move towards increased sustainability