Fuelling cars of the future : energy and environment issues

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Policy questions

- EU wants carbon free urban transport – as this is part of its ambition to reduce carbon emissions strongly and as it wants to reduce its dependence on imported fuels
  - does this make sense?
  - Should we promote electric cars? Why?
  - Do we need to promote trams/metro versus bus and cars?

Outline of this lecture

- Present and expected use of energy for transport
  - Expected world wide car market developments
- Climate policy objectives in international perspective
- Implications for energy policy objectives in transport

Main conclusions

- Reducing oil use in the transportsector in the EU is not a priority
  - As its effects on net carbon emissions may be 0
  - If it saves carbon emissions it does this at a very high cost
- More sensible policies in the transport sector
  - Discourage diesel use
  - Promote cheap fuel saving technologies

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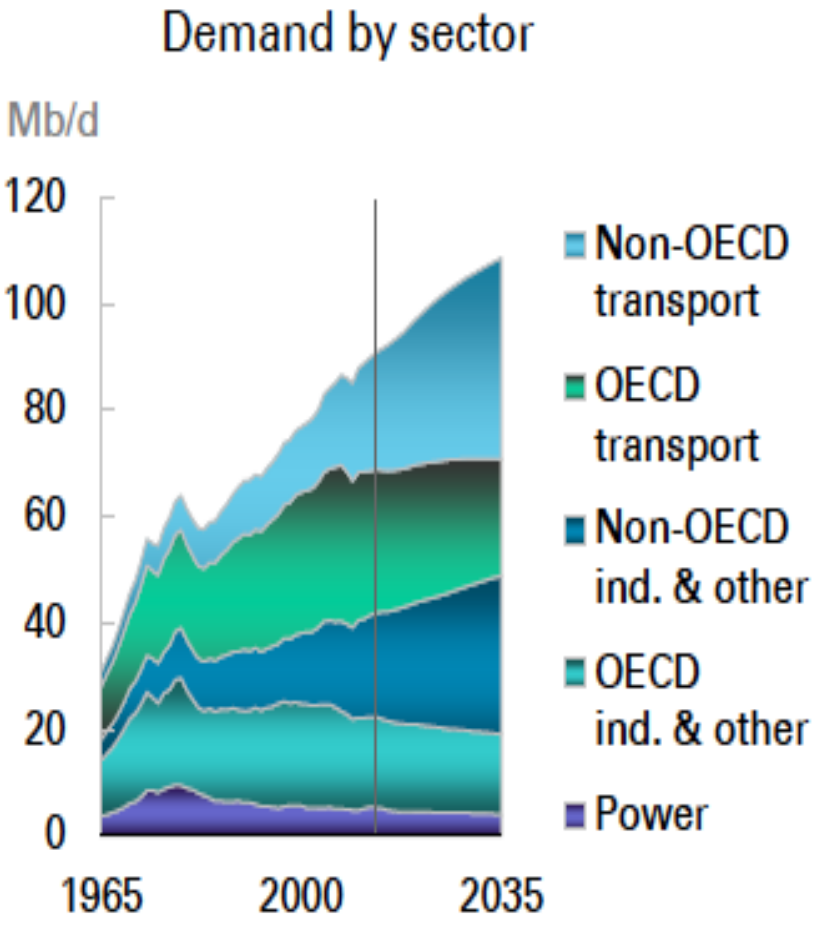
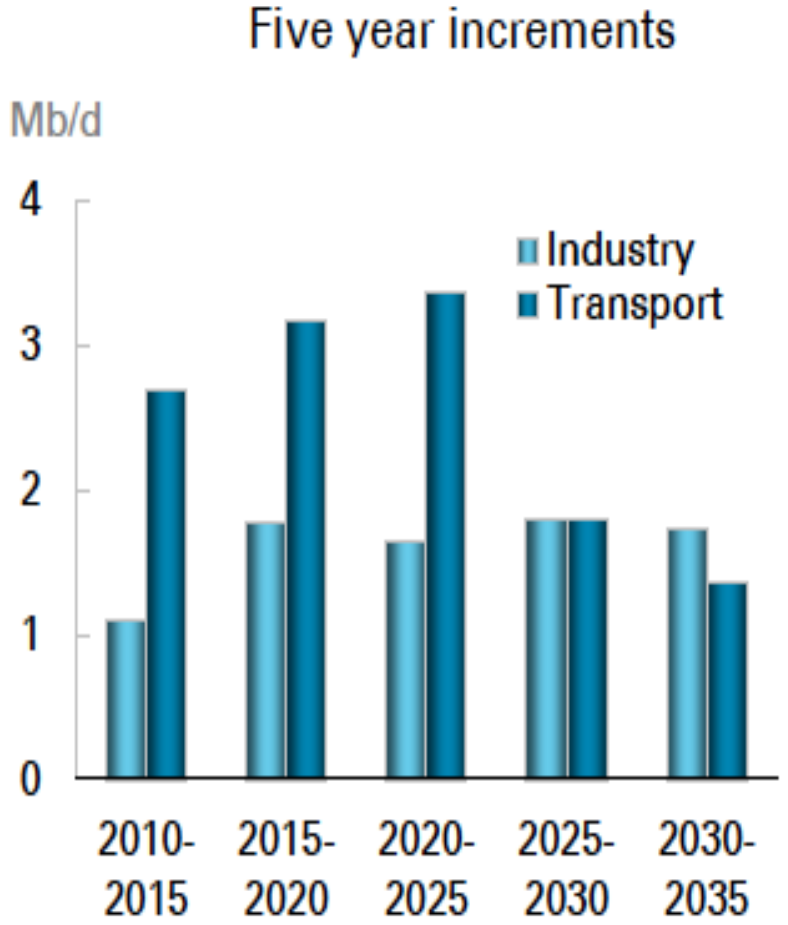
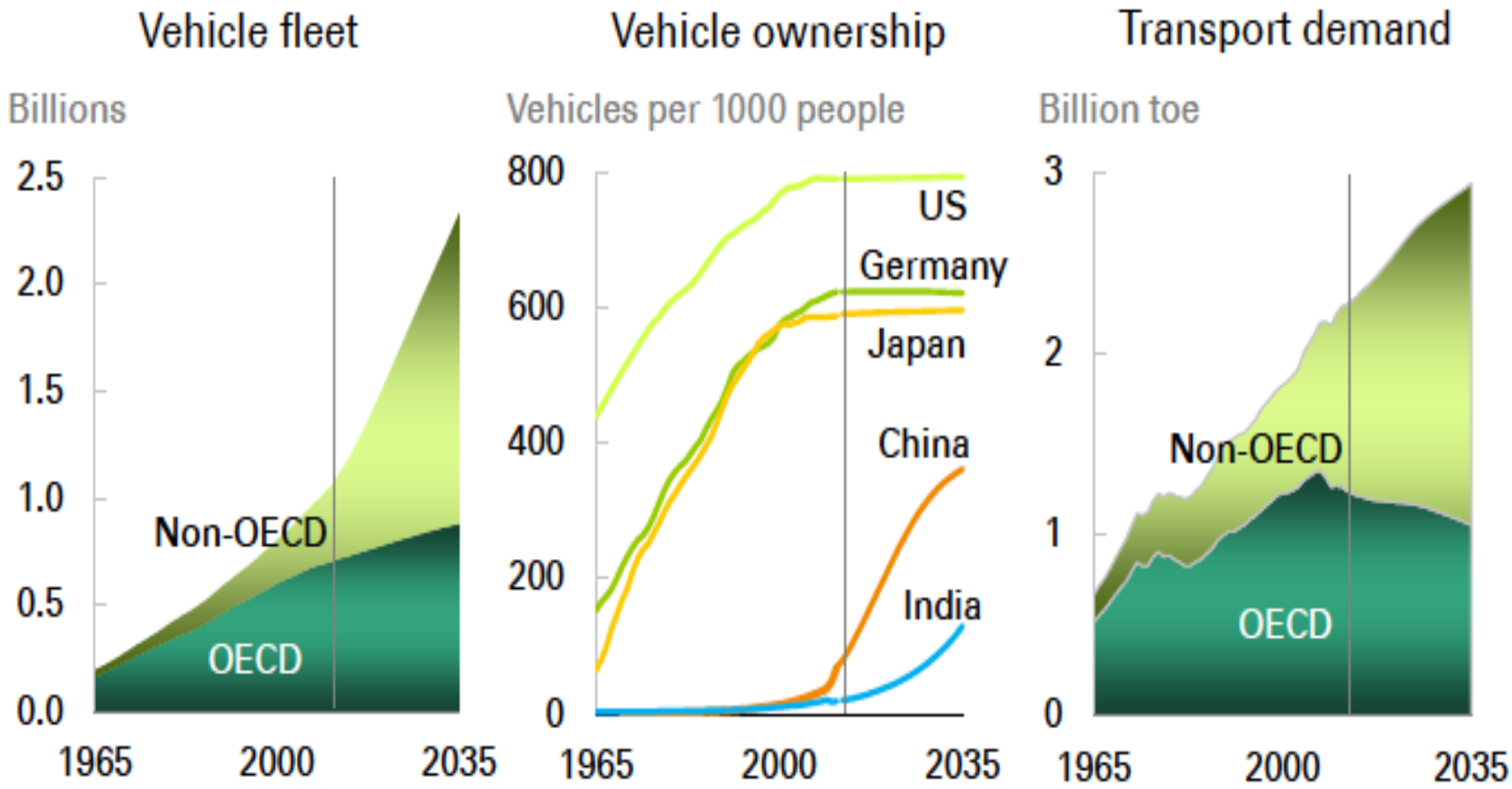
Half of all oil consumptions is used for transportation





Energy Outlook 2035

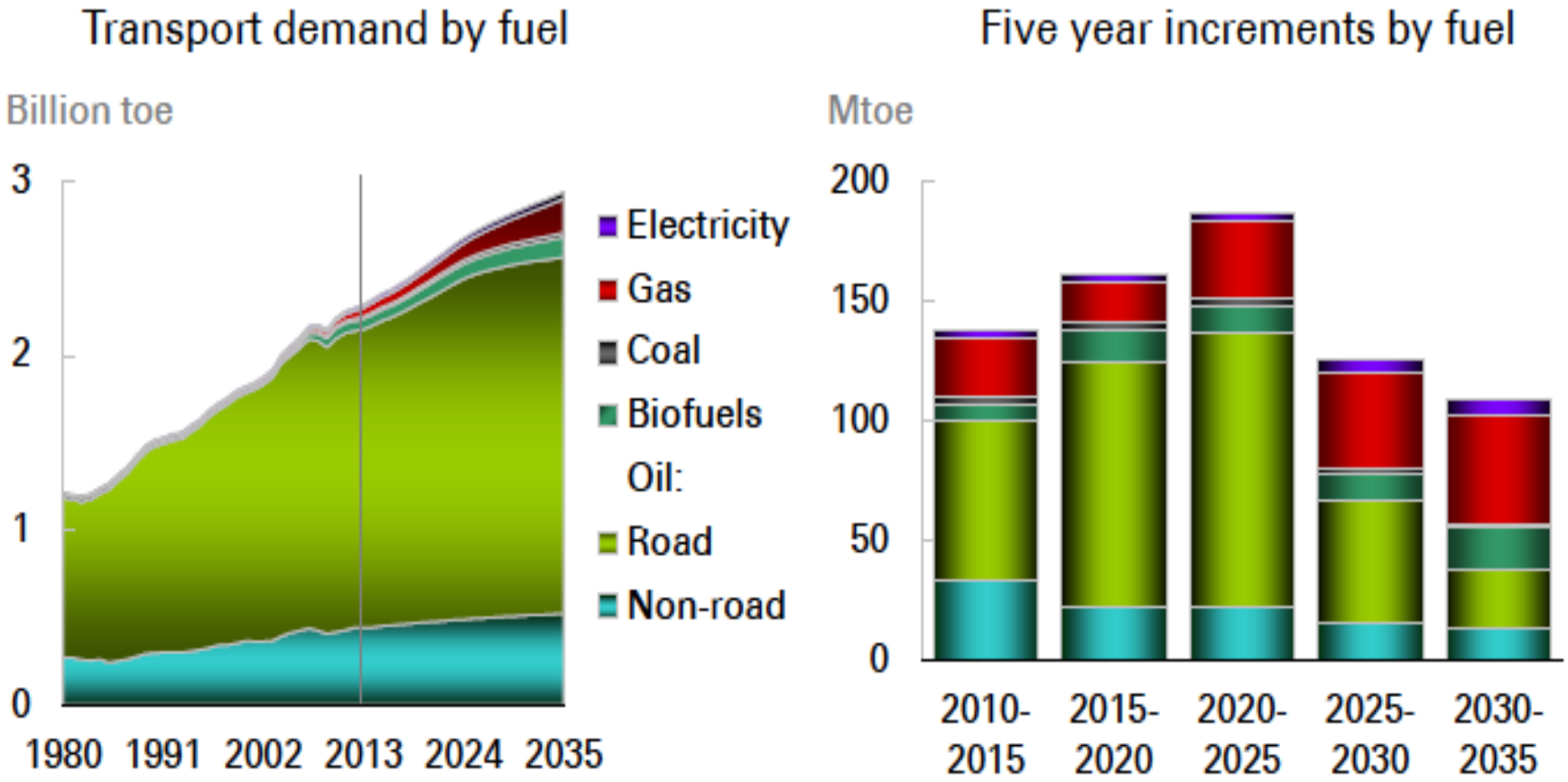
Developments in vehicle ownership and transport demand



Energy Outlook 2035

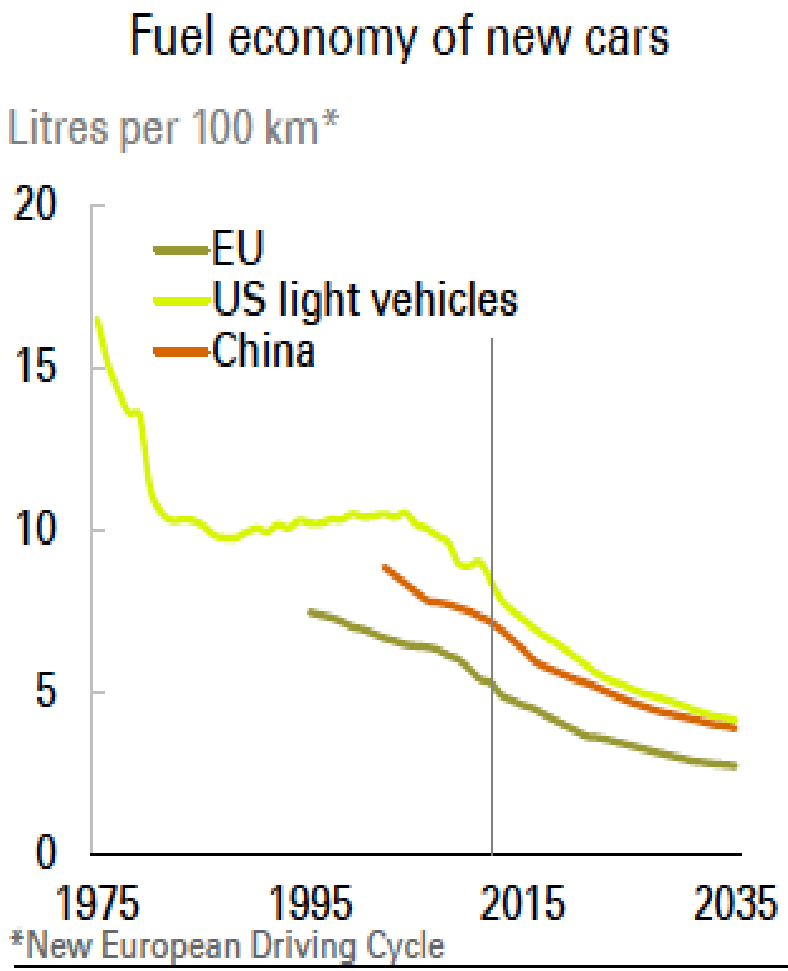
Use of fuels for transport

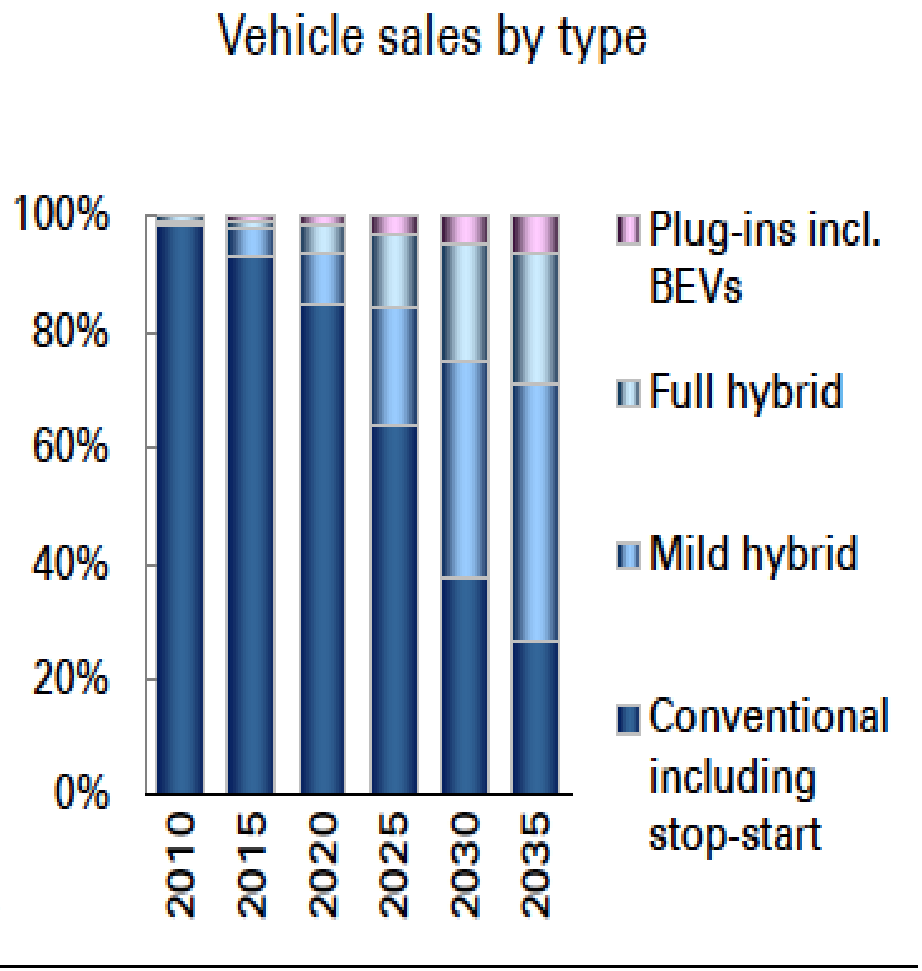
slowing down and slow substitution by gas (trucks, ships) and electricity (cars)



Energy Outlook 2035

Car fleet composition developments





Energy Outlook 2035

Outline of this lecture

- Present and expected use of energy for transport
  - Expected world wide car market developments
- **Climate policy objectives in international perspective**
- Implications for energy policy objectives in transport

Origin of Climate change process

1. Human behaviour is at origin of extra GHG emissions
    - Mainly under form of CO2 (75% of problem) but also methane, NO, HFC's count.
2. GHG accumulate in atmosphere (delays)
3. The increased concentration traps heat and generates global warming (decay 0.5% / year)
4. Global warming generates climate change (delay 30-50 years)
5. Climate change generates damage

All these relations are uncertain and we can only learn only slowly

Emissions by income and source (IPCC-WGIII AR5 - 2014)

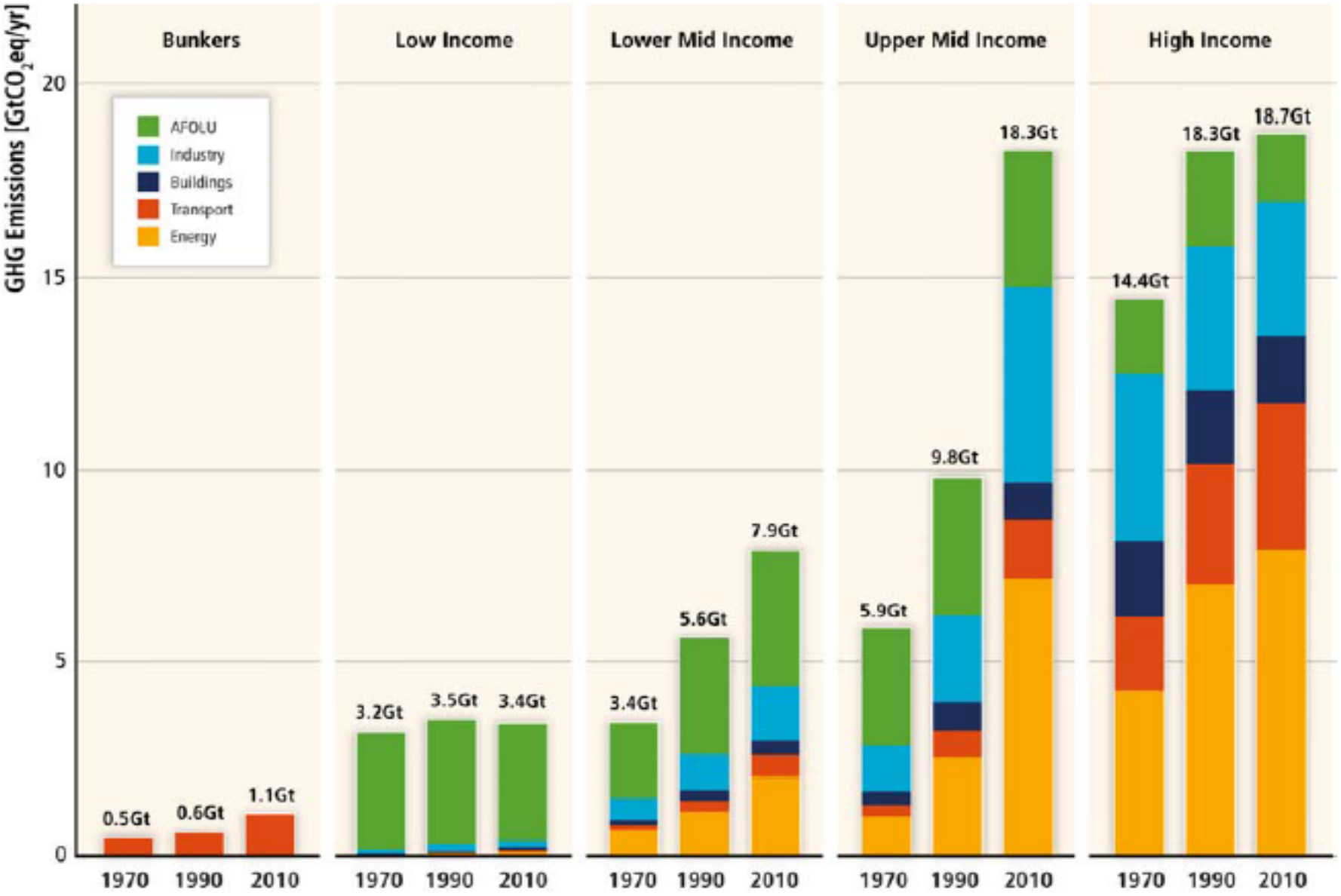
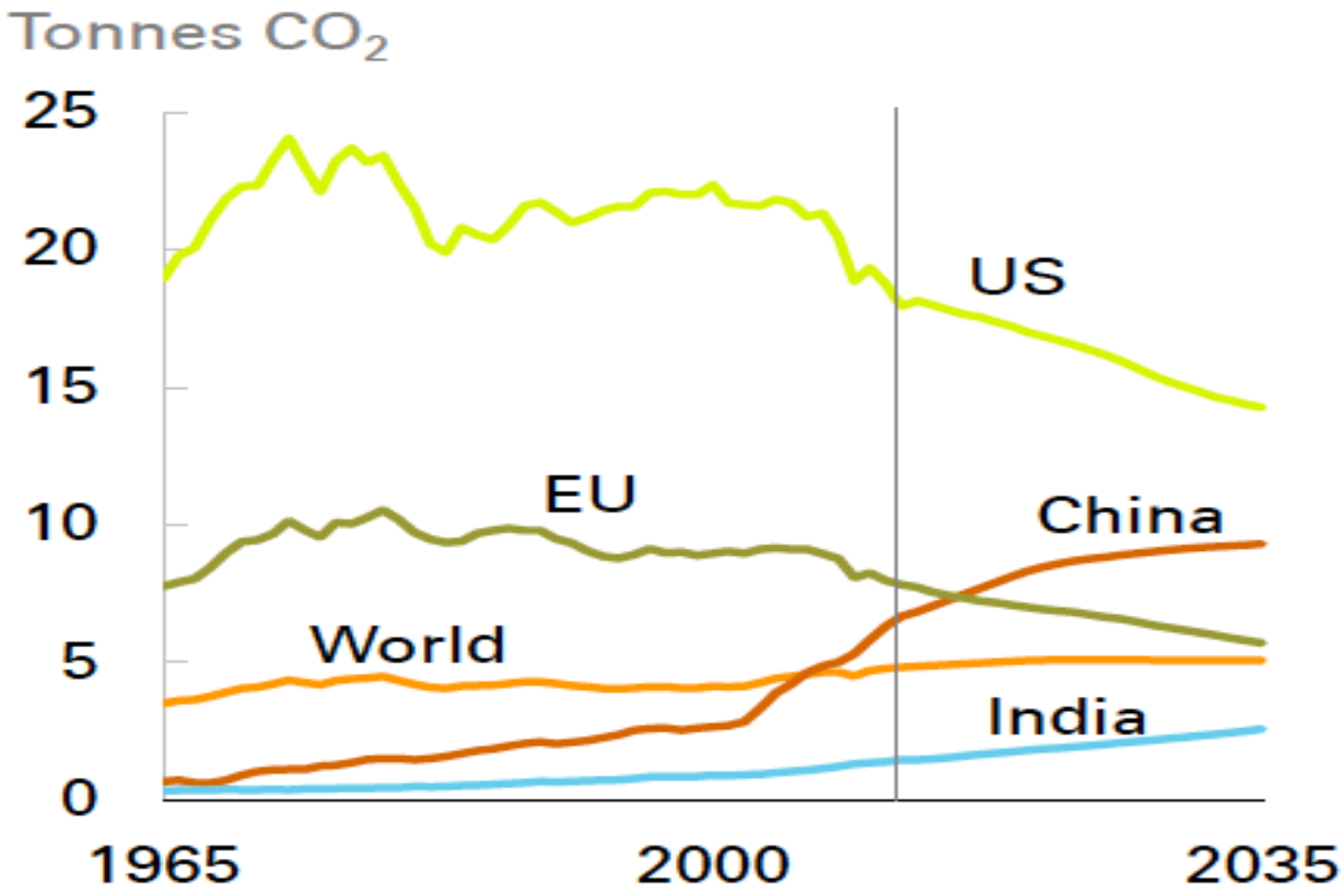


Figure TS.3. Allocation of GHG emissions across sectors and country income groups. Panel a: Share

Emissions per capita



Stabilisation of CO2 emissions?

- What reduction is required:
  - Stock pollutant (decay of 0.5%), so one needs strong decrease to reach an objective in 2050
  - Reduction of 30% in 2050
- Where are emissions coming from ?
  - Mainly energy use (2/3), deforestation (20%)
- As economy in 2050 may be 3 x as large as now, emissions per unit of output have to be reduced by 80 to 85%

NEED FOR STRONG EMISSION REDUCTION IN THE WORLD

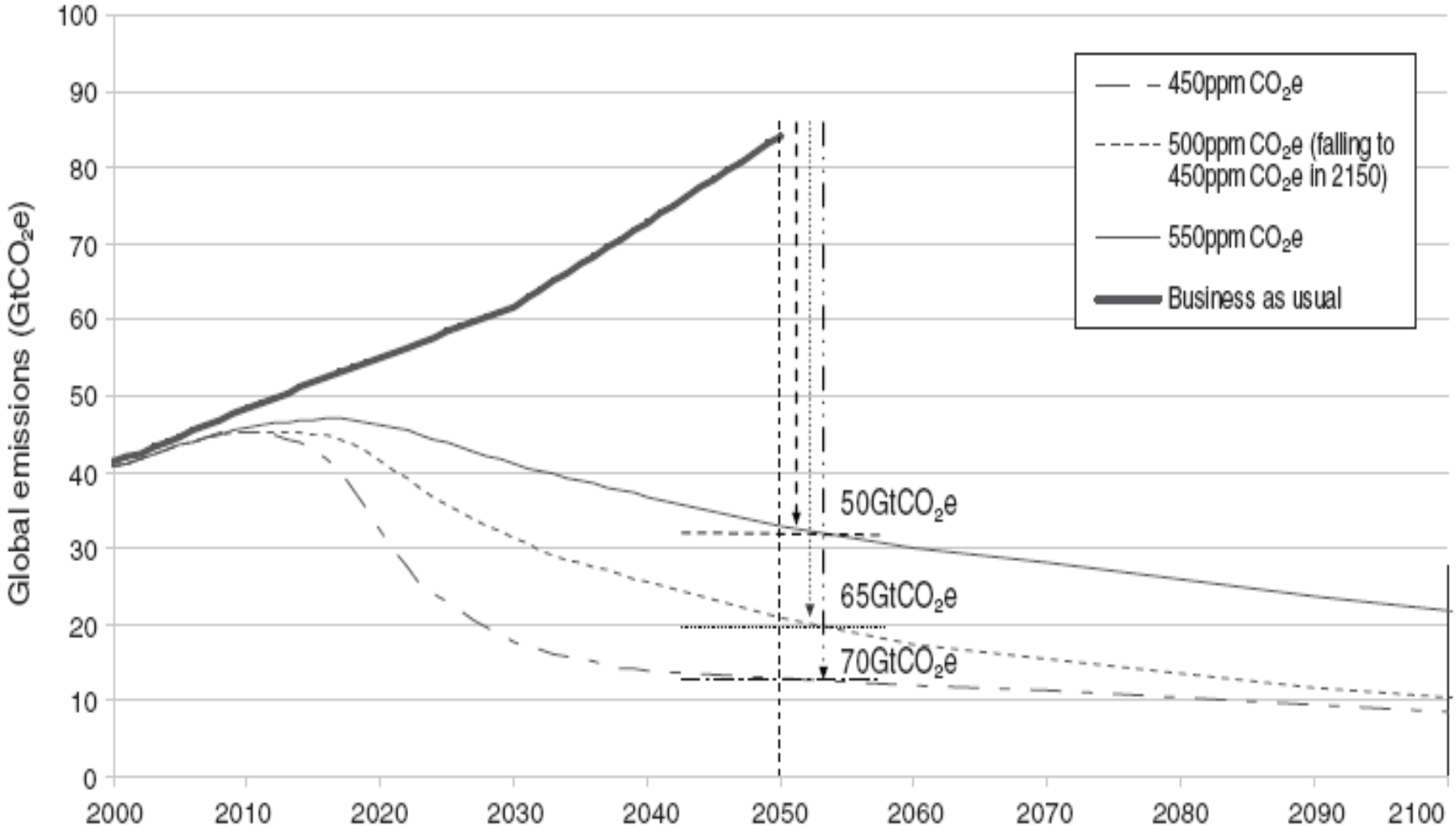


FIGURE 2. BAU AND STABILIZATION TRAJECTORIES FOR 450–550PPM CO_2e

Source: Stern Review, Figure 8.4 (Stern 2007, 233).

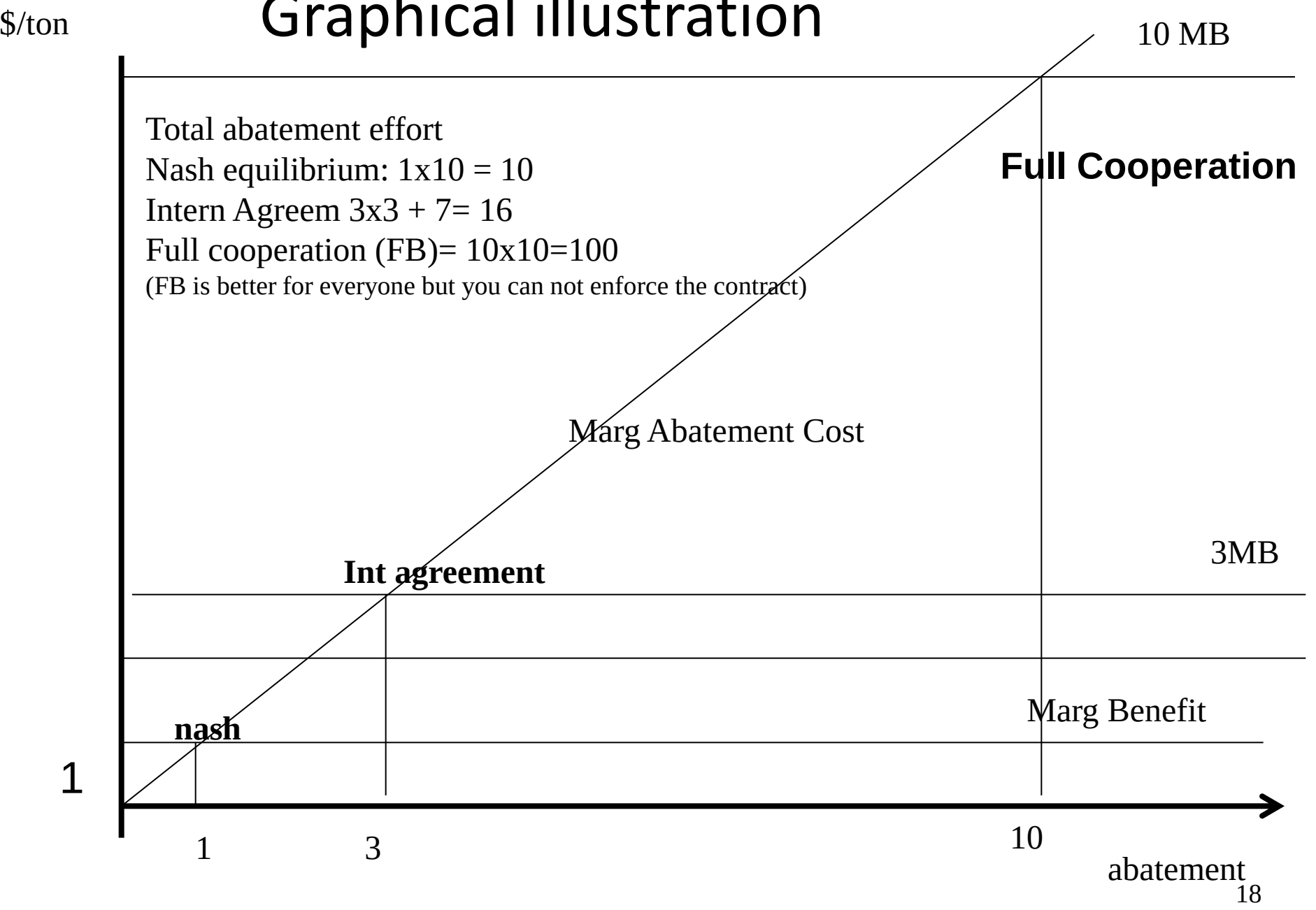
TRAGEDY OF THE COMMONS

- All carbon emissions mix in the atmosphere and affect the whole world for next 200 years
  - urgent action is needed
  - But how deep is still debated
- BUT
  - you can not exclude countries from the benefits of climate policy of the others
  - It is difficult to force countries to respect the international climate agreements they sign

Simplest model for Economics of international agreements 1

- **International Agreement needs to be ” Self Enforcing”**
  - Each country signing is as well off as a non signing country
  - A signing country maximizes the total welfare of the members of the group joining the agreement
- **Result**: only very few countries will sign an agreement and do more than caring about their own climate damage
- Typically: countries balance their costs of emission reduction with the climate damage they avoid for themselves

Graphical illustration



Simplest model for Economics of international agreements 2

- Typically: countries balance their costs of emission reduction with the climate damage they avoid for themselves
  - This means 10 to 15% of what is needed will be realized: this is the difference between MAC=MB for each country and MAC=∑MB
  - Empirical evidence? Since start of Kyoto (1997-2012) one never reached an international agreement with all Western countries
  - Expectation: Kyoto's successor (Paris, Dec 2015) is likely to fail
  - the EU provisional commitment (goes for 40% reduction in 2030) will become less ambitious

EU as climate policy forerunner

- EU policy justification?
  - Feels responsible for world damages of its emissions
  - Cooperative attitude: i make efforts if the others follow
  - Show the rest of the world it is not costly to realize deep cuts?
- But what can the EU really do and is it cost-effective?
  - Check effects on energy markets

Reactions of energy markets to unilateral EU climate policy

- Distinguish between
  - fossil fuels without rents (coal, non conventional oil and gas)
  - fossil fuels (oil, gas) with large rent element in price
- If EU reduces conventional oil use
  - it will ONLY DELAY emissions NOT REDUCE emissions (“green paradox”)

How do profit maximizing owners of oil reserves determine their production?

every owner of a resource Q will, under perfect competition, choose q_t t=0,..∞, such that:

$$Max \sum_{t=0}^{\infty} \frac{(p_t - c)}{(1+i)^t} q_t$$

subject to $\sum_{t=0}^{\infty} q_t \leq Q$

$$\Rightarrow (p_t - c) = (1+i)(p_{t-1} - c)$$

$$\Rightarrow \sum_{t=0}^{\infty} q^*_t = Q$$

Equilibrium profile of prices and production of exhaustible resource

- 3 properties:
  - Margin (p-c) increases with factor (1+i) over time
  - Resource is fully used
  - Price in latest period= choke price or max willingness to pay

Graphical model

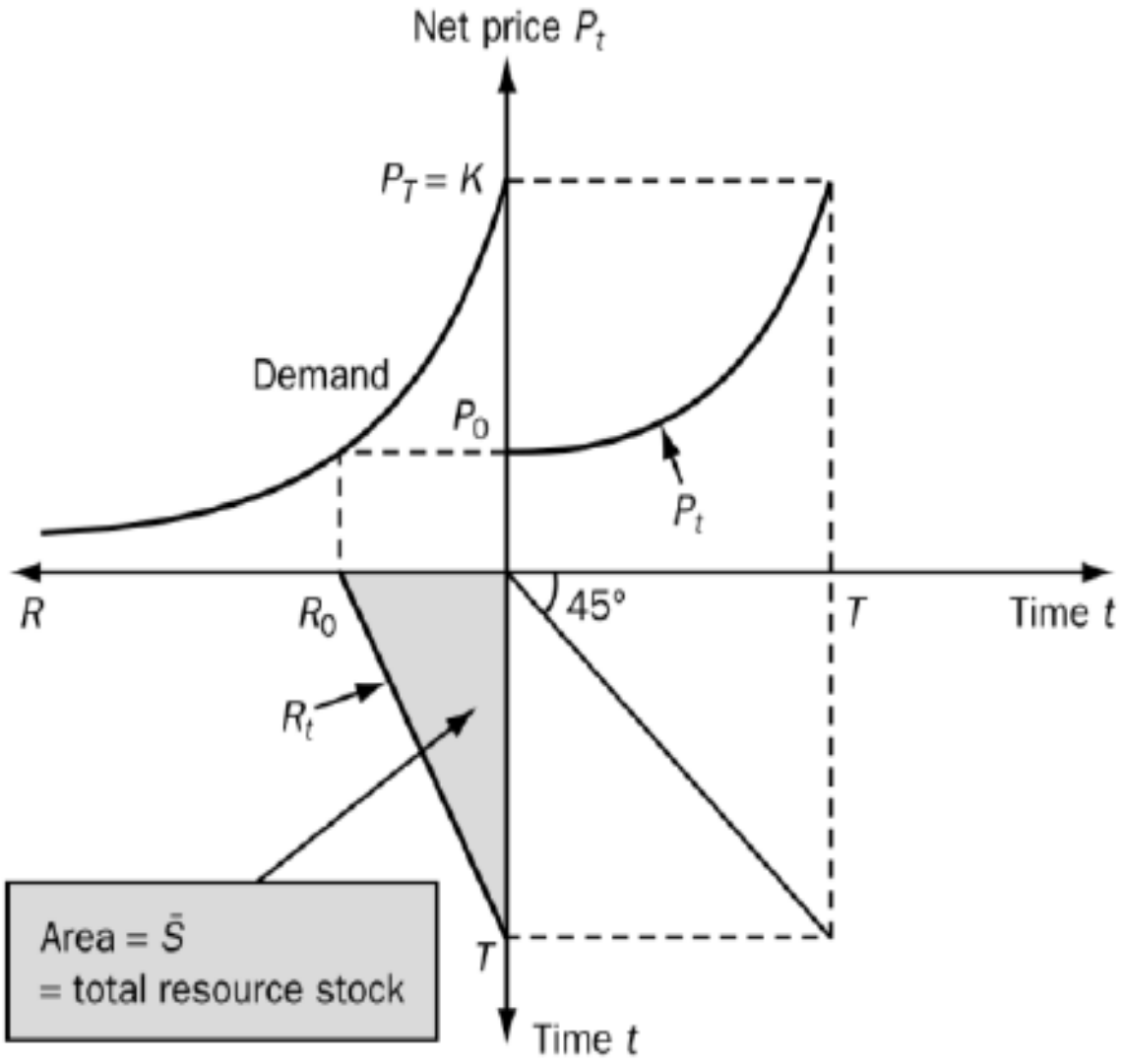
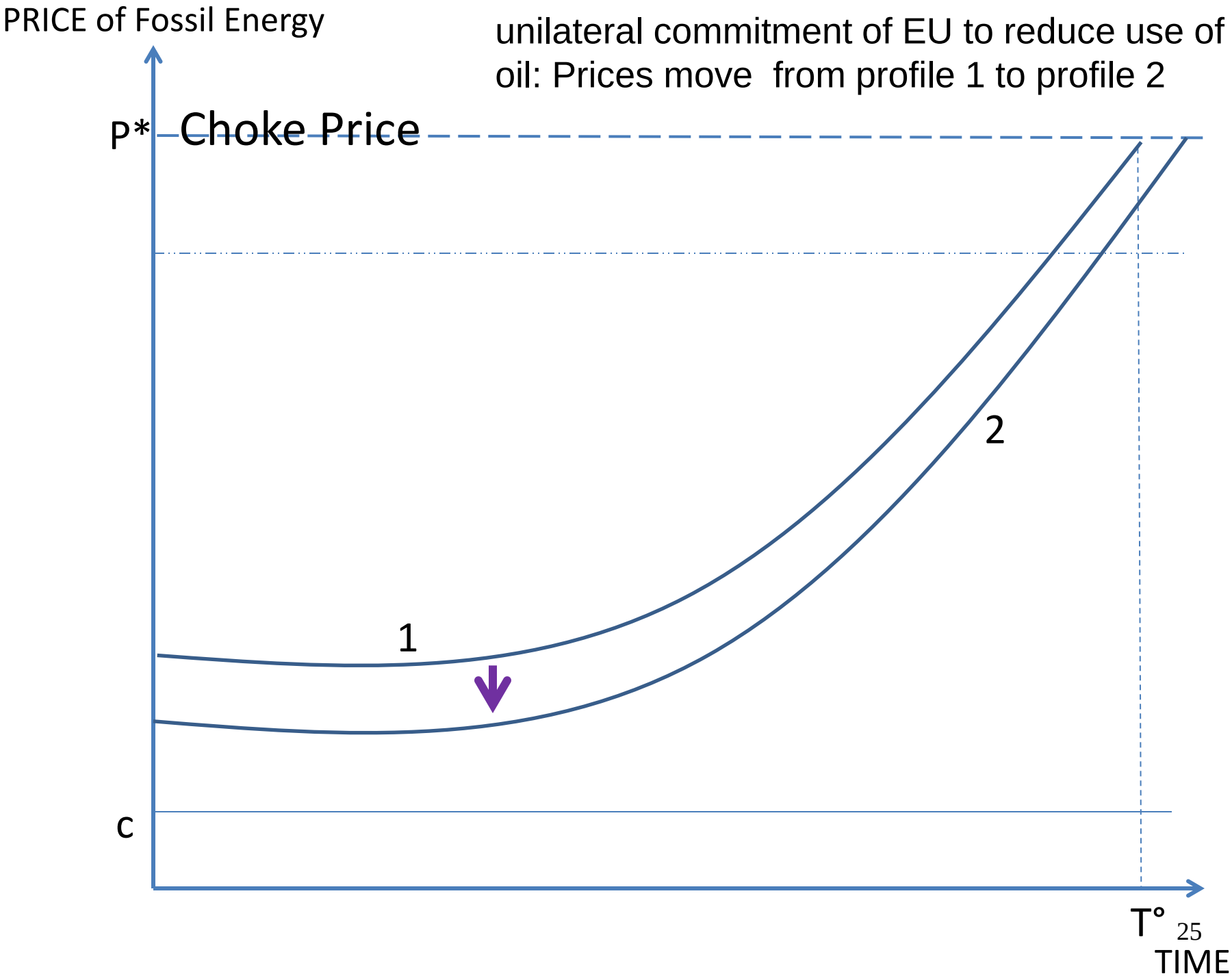


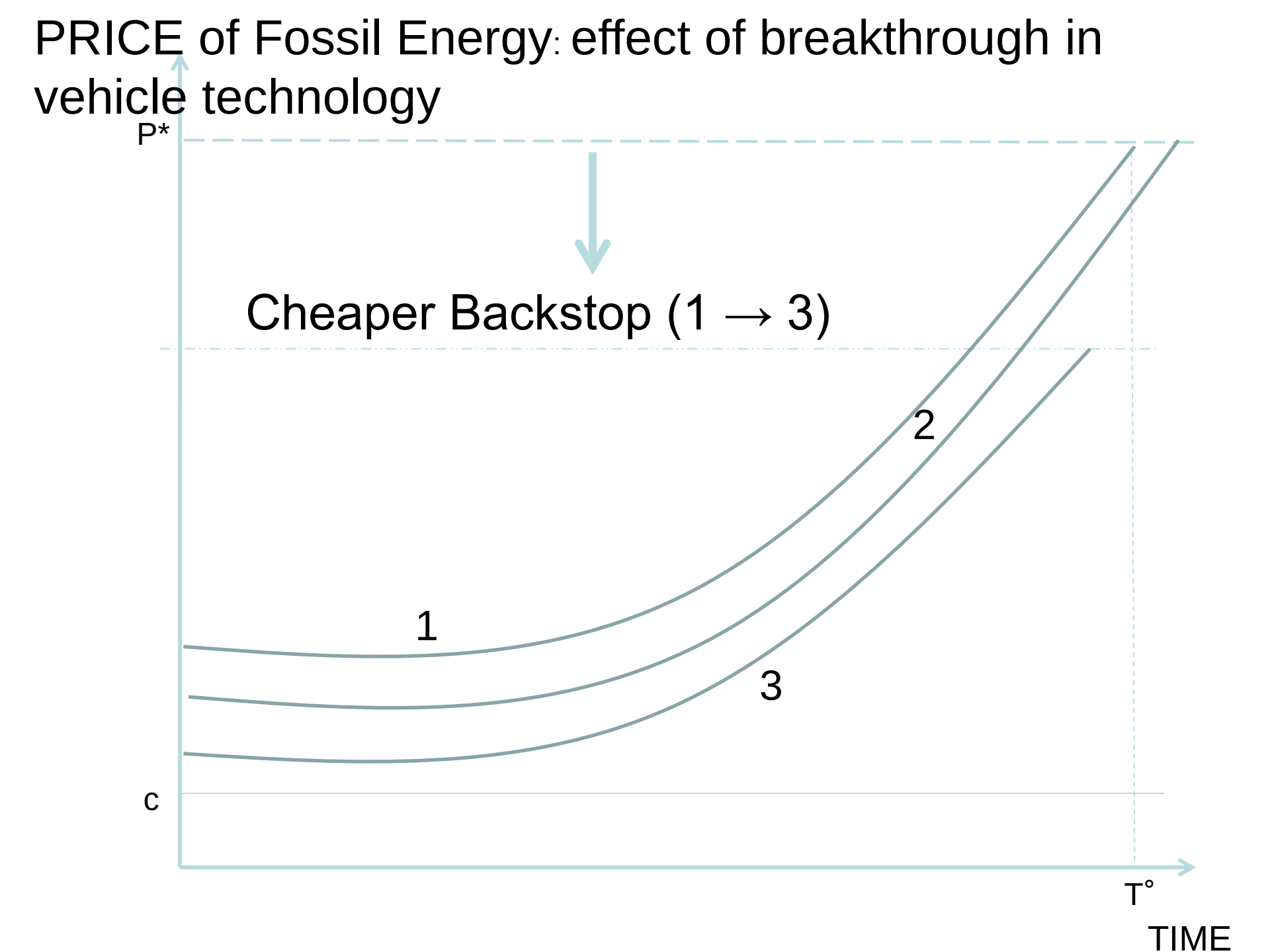
Figure 2.5 Optimal use of a scarce resource


PRICE of Fossil Energy
unilateral commitment of EU to reduce use of oil: Prices move from profile 1 to profile 2
P*
Choke Price
2
1
c
T°
TIME

Reactions of energy markets to unilateral EU climate policy

- If EU reduces conventional oil use
  - it will ONLY DELAY emissions NOT REDUCE emissions ("green paradox")
- If EU invests successfully in R&D for cheaper carbon free substitute for oil (car running on "water"in 2050)
  - it will INCREASE current emissions and advance exhaustion

PRICE of Fossil Energy: effect of breakthrough in vehicle technology



Provisional wrapping up

- The chances of an effective worldwide climate agreement are small
- Unilateral reductions of oil use by a goodwilling EU are not effective: they postpone emissions rather than reduce emissions
- Better to focus unilateral reductions on coal use: a ton of coal not used, is more likely a net reduction of coal use

Reducing oil use in transport is not cheap: it comes at a high cost

- Poorly understood by policy makers
- Two fallacies in current policy making:
  - Consumers are myopic: they underestimate the possible savings of gasoline when they buy a car
  - Gasoline is expensive

Myopic car buyers?

- Empirical question
- There is strong empirical evidence that consumers are over the last 10 years, on average 90% efficient
  - They compare almost correctly (90%) the possible (discounted) savings of gasoline expenditures with the additional cost of a more fuel efficient car
  - Of course there are many individual consumers that make mistakes but in both directions
    - See: Grigolon L., Reynaert K.,,Verboven F. (2014), Consumer valuation of fuel costs and the effectiveness of tax policy: Evidence from the European car market, CES Discussion Paper 14.34

What is the cost of gasoline?

- Consumer price (in EU) = 1.5 Euro/liter
  =0.5 Euro/liter + 1 Euro/liter of taxes
- What is the role of the 1 Euro of taxes?
  - 0.1 Euro CO2 taxes (30 Euro/ ton of CO2)
  - 0.9 Euro taxes to tax all other external costs (congestion, accidents, …)

What do car manufacturers and consumers do?

- They want the cheapest option for driving and are prepared to pay 1.5 Euro more for a car if it saves one more liter of gasoline
- But
  - these more fuel efficient cars are cheaper to use and will be used more (congestion, accidents etc..) and this is not what society needs

- If saving gasoline by buying more fuel efficient cars reduces emissions (remember the stock of oil)
- It will do this at high cost
  - As It saves CO2 at 200 to 300 Euro/ton in the absence of other external costs (congestion, accidents, ..)
  - As it may increase driving and and increase congestion, accidents etc…
  - Things get worse when governments give subsidies for more fuel efficient cars
  - In the end saving CO2 at more than 300 Euro/ton

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What makes sense 1?

- Not fuel use in EU (20% of world) counts, so transferable technology rather than behaviour
- Rest of world (ROW) is less interested in carbon emission reduction
  - One can delay climate change more efficiently by offering ROW cheap options to reduce fuel use by cars (500 Euro/car?) rather than to go for more fancy technologies (hybrid, pure electric at 5000 Euro/car) that are mainly used in EU?

What makes sense 2?

- Discourage diesel cars by making them pay taxes/veh km as large (or larger) than gasoline cars because diesel cars are more polluting than gasoline cars
- Diesel at 2 Euro/liter?

Emission standards for new cars in the EU (non CO2)

EU emission limits for gasoline passenger cars (in g/km)

	Effective date*	CO	HC	NMHC	NO_x	$HC+NO_x$	PM	PN
Euro 3	Jan 2000	2.30	0.20	–	0.15	–	–	–
Euro 4	Jan 2005	1.00	0.10	–	0.08	–	–	–
Euro 5	Sep 2009	1.00	0.10	0.068	0.06	–	0.0050	–
Euro 6	Sep 2014	1.00	0.10	0.068	0.06	–	0.0045	6.0×10^{11}**

EU emission limits for diesel passenger cars (in g/km)

	Effective date*	CO	HC	NMHC	NO_x	$HC+NO_x$	PM	PN
Euro 3	Jan 2000	0.64	–	–	0.50	0.56	0.0500	–
Euro 4	Jan 2005	0.50	–	–	0.25	0.30	0.0250	–
Euro 5	Sep 2009	0.50	–	–	0.18	0.23	0.0050	–
Euro 6	Sep 2014	0.50	–	–	0.08	0.17	0.0045	6.0×10^{11}**

*For new vehicle types

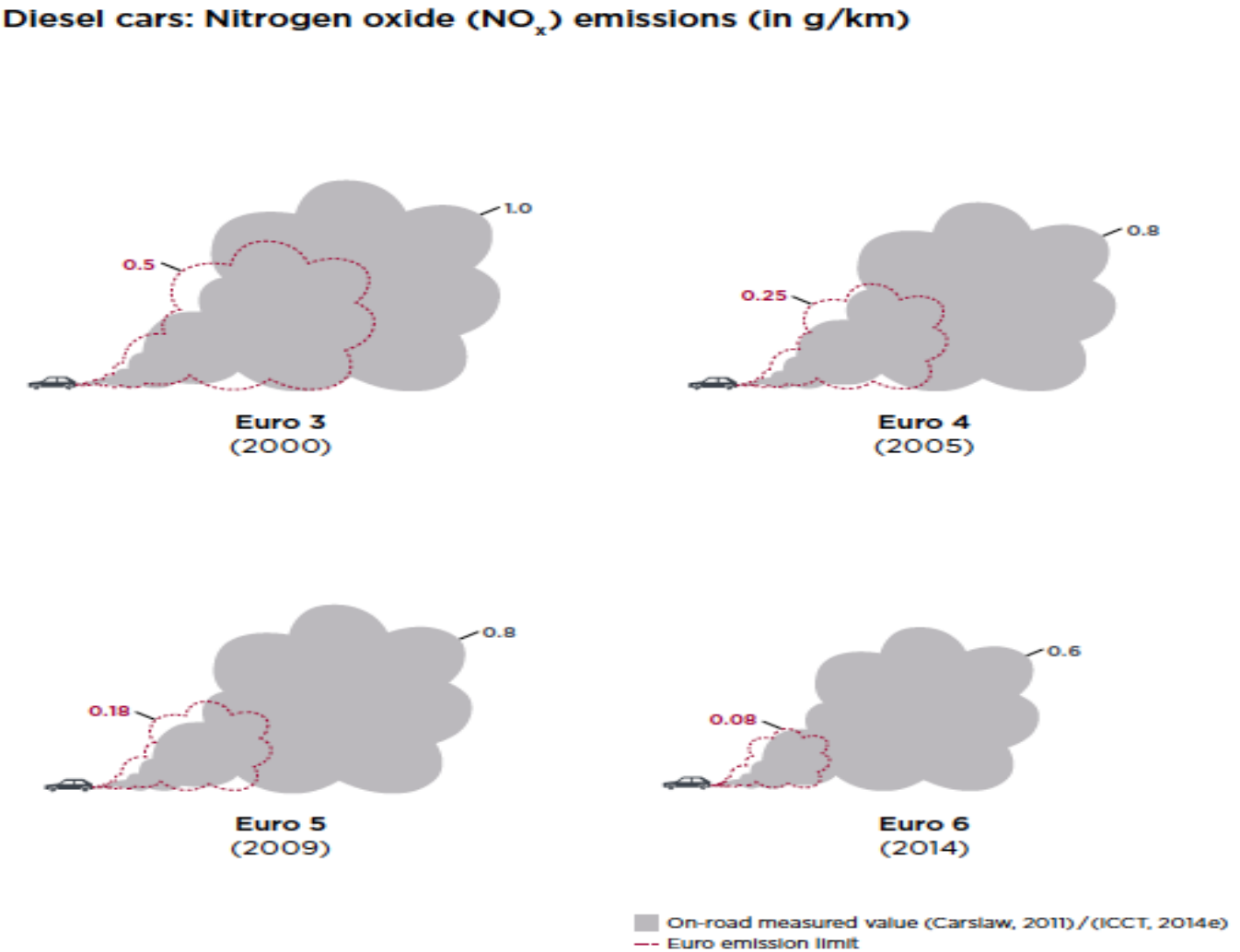
Tab. 6

EU emissio
for gasoline
diesel passe
cars

http://www.tran

Increasing difference between test cycle and real world emissions (NOx)

(compare small area (test) with big area (real))



Tax advantages for Diesel, Hybrid and Electric as side effect of carbon policy in transport

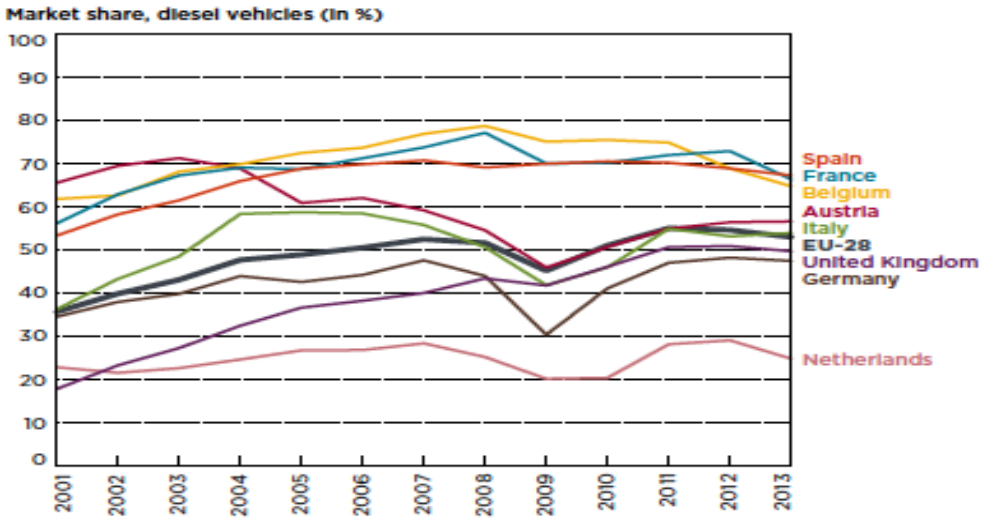


Fig. 4-1

Passenger cars: Market share, diesel vehicles by Member State

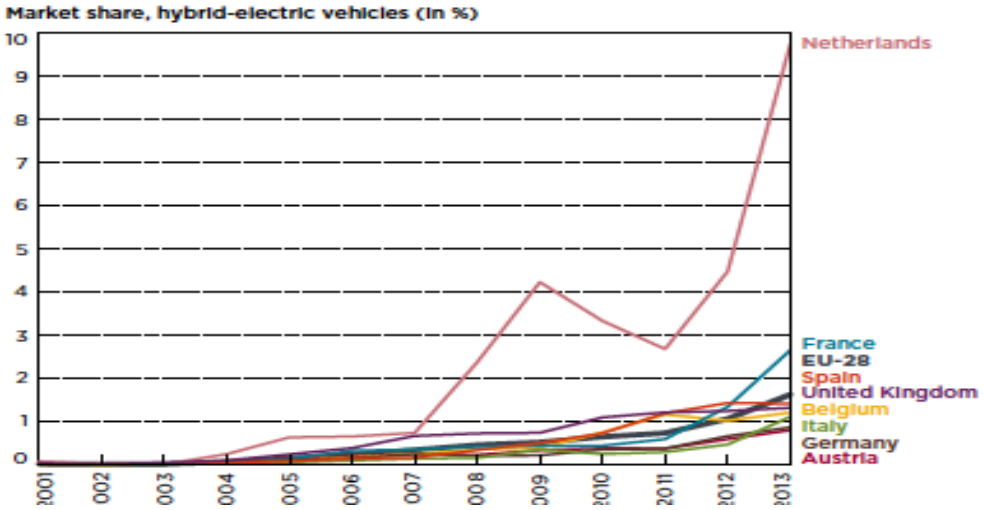


Fig. 4-2

Passenger cars: Market share, hybrid-electric vehicles (incl. PHEV) by Member State

Leuven: subsidised e-parking, insufficient parking for bikes

What policies make sense 3?

- Develop cheap, transferable technologies..
- Discourage diesel cars by making them pay taxes/veh km as large (or larger) than gasoline cars
- Making Electric cars pay the same excise taxes per vehicle km as gasoline cars
- Continue research on cleaner (conventional pollution) vehicles
- Substitute large part of fuel taxes by electronic road pricing

Thanks for listening

and I like people who disagree…