Electricity Policy Research Group

TSEC2

UNIVERSITY OF CAMBRIDGE

Emission trading and technology development in the power sector

Seventh Annual Workshop on
Greenhouse Gas Emission Trading
Paris
October 8/9 2007

Karsten Neuhoff

www.electricitypolicy.org.uk/tsec/2

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

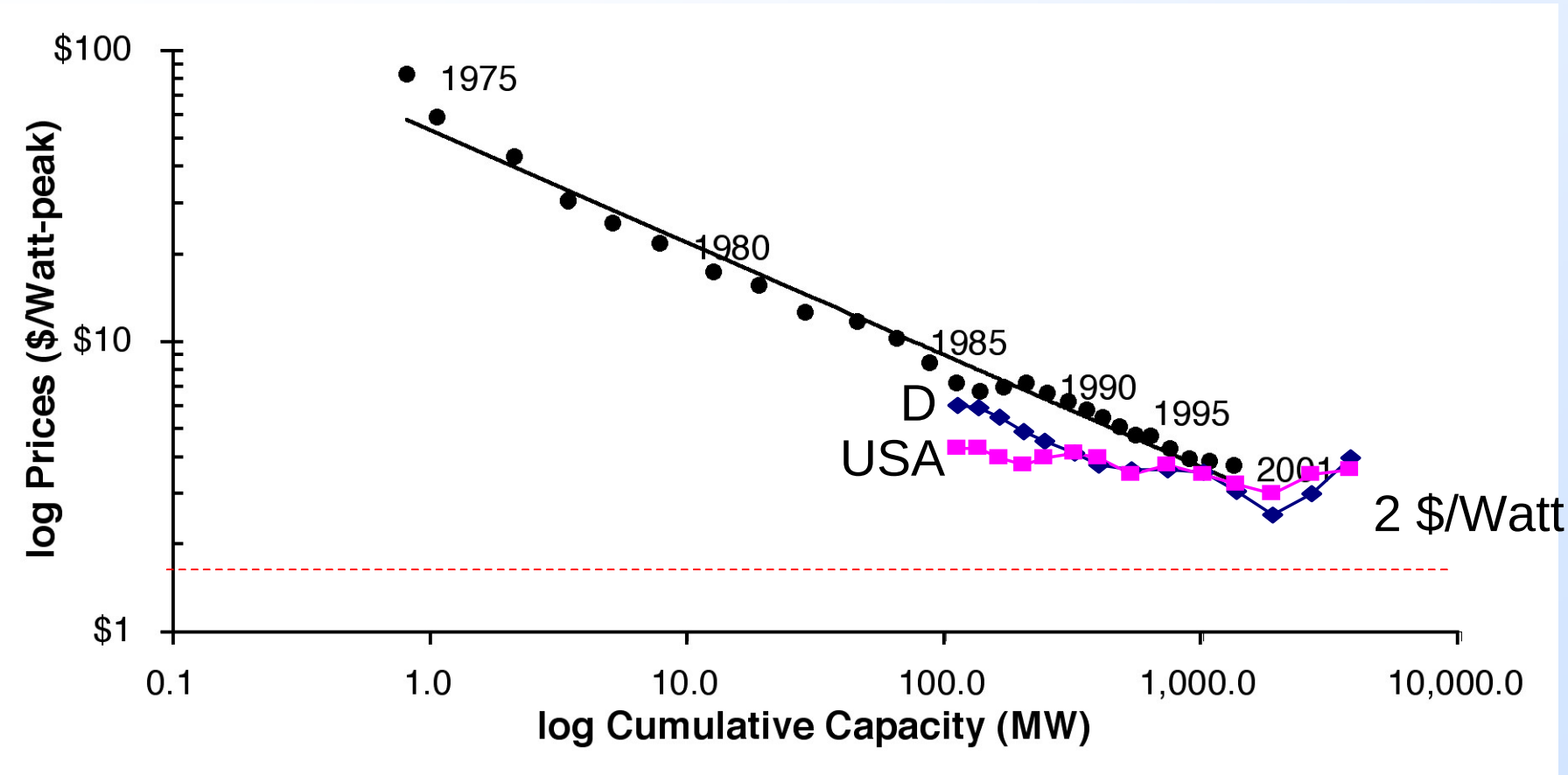
Web - version 9.10.2007

Emission trading and technology development

- Illustration of role of commercial incentives for innovation
- CO_2 prices as commercial innovation incentive
- The role of complementing technology policy
- Design of emission trading to deliver innovation

The role of commercial incentives for innovation

Price evolution for PV modules



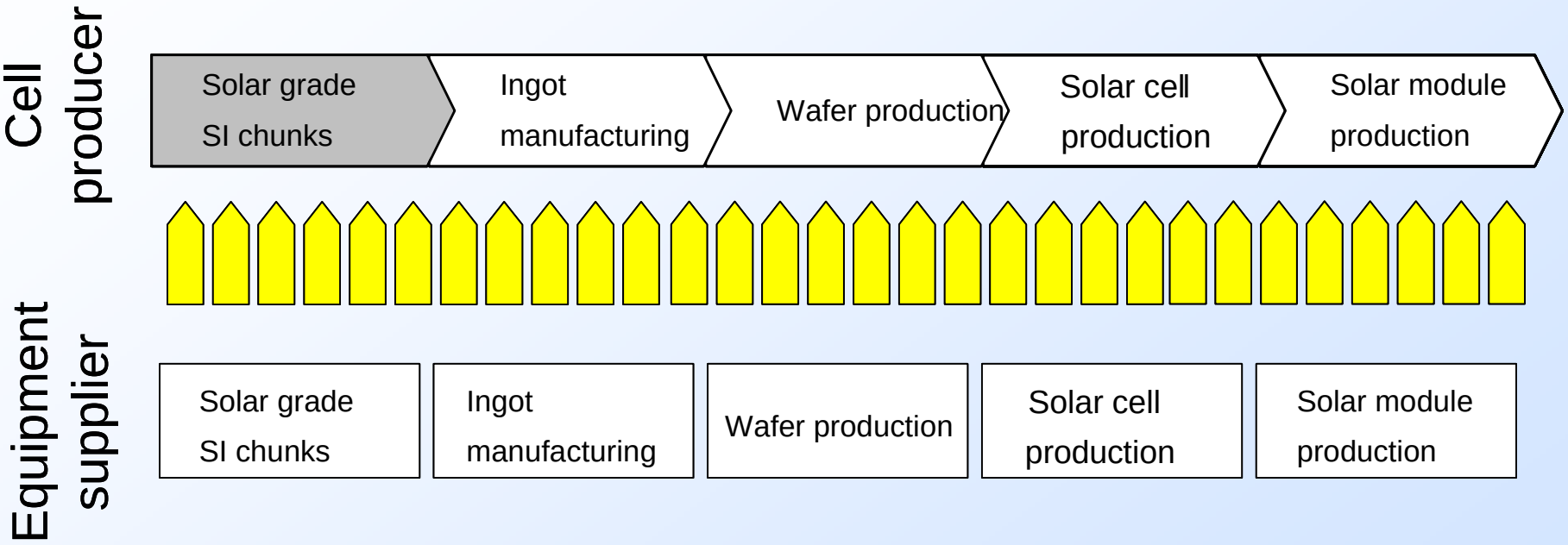
Recent profit margins (based on solarworld annual reports)

Euro/W	wafer	cell	module	Total
2005	0.286	0.079	0.063	0.427
2006	0.308	0.162	0.059	0.529

Source: IEA Implementing agreement solar PV, Maycock and News and Strategies Unlimited.

The role of commercial incentives for innovation

The PV industry structure



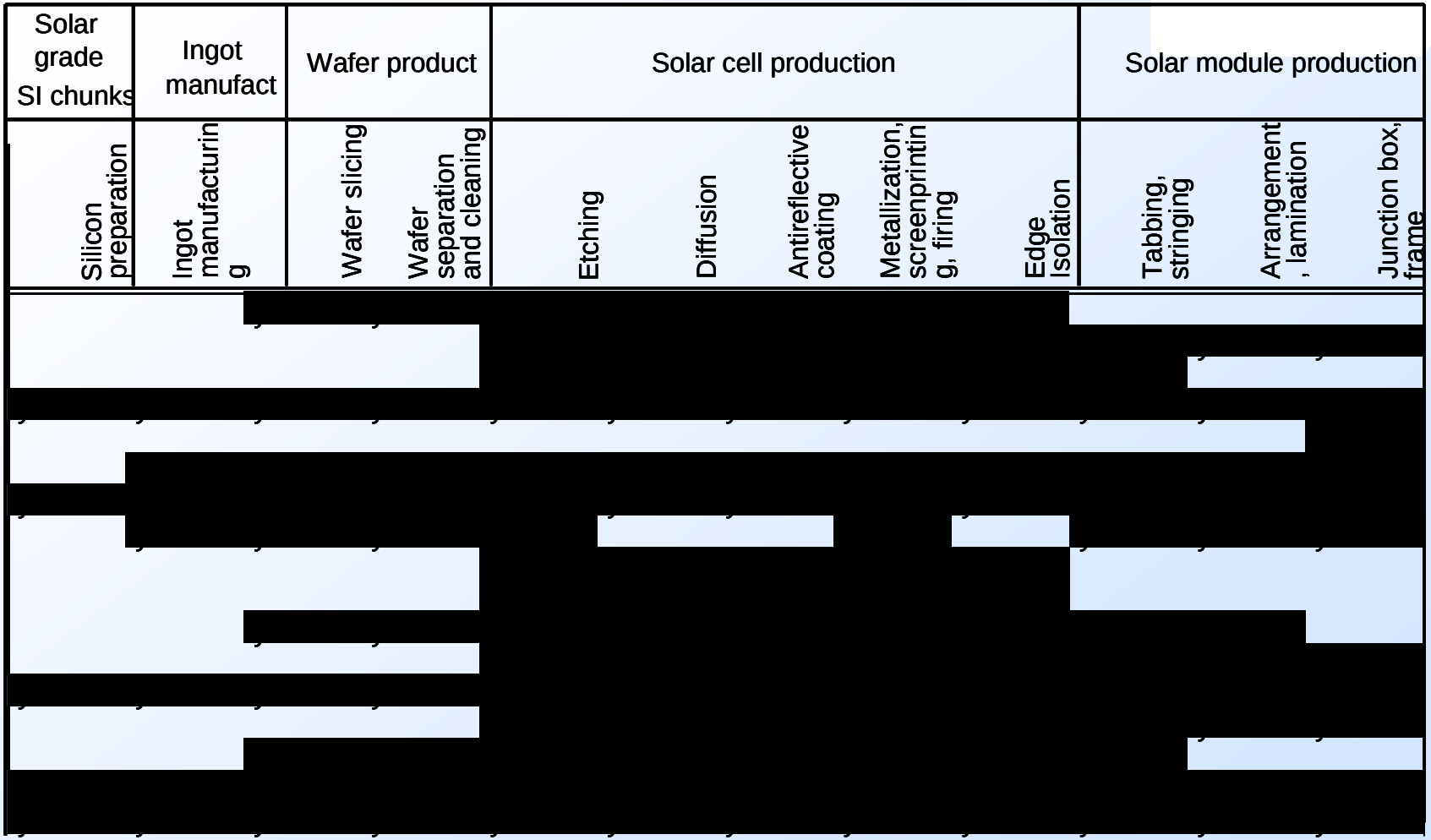
Work with:

Katja Schumacher DIW Berlin	Gregory Nemet University of Berkeley	Misato Sato University of Cambridge	Jan Lossen Ersol

Source: The role of the supply chain for innovation The example of Photovoltaic Solar Cells, forthcoming EPRG working paper, www.electricitypolicy.org.uk

The role of commercial incentives for innovation

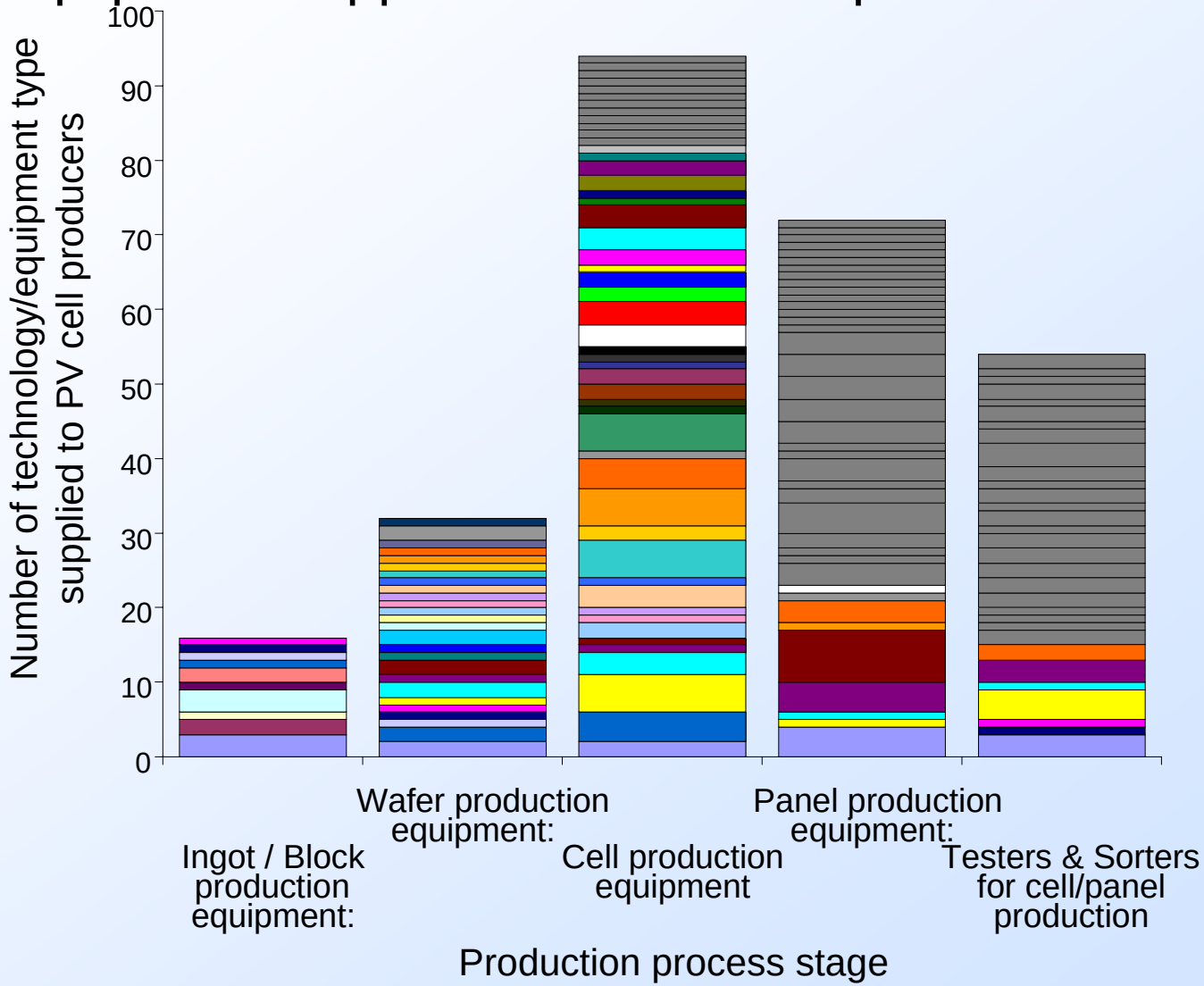
PV producers are horizontally integrated



Source: The role of the supply chain for innovation The example of Photovoltaic Solar Cells, forthcoming EPRG working paper, www.electricitypolicy.org.uk

The role of commercial incentives for innovation

Most equipment supplied for individual production steps



Source: The role of the supply chain for innovation The example of Photovoltaic Solar Cells, forthcoming EPRG working paper, www.electricitypolicy.org.uk

The role of commercial incentives for innovation

Survey:

n_{equip}=10

n_{cell}=17

Survey – Who initiated improvements?

	Equipment supplier	Cell producer	Industry network	University/ Research Institute
Equipment supplier	0.50	0.13	0.00	0.19
Cell producer	0.16	0.76	0.04	0.28

Survey - How did the idea come about?

	Research project	Suggested by equipment supplier	Problem identified in production process	Opportunity identified in production program	Transfer of idea from other industry sector
Equipment supplier	0.82		0.55	0.09	0.00
Cell producer	0.84	0.16	0.32	0.20	0.04

Source: The role of the supply chain for innovation The example of Photovoltaic Solar Cells, forthcoming EPRG working paper, www.electricitypolicy.org.uk

The role of commercial incentives for innovation

The modelling framework – what fraction of line to improve?

Period 1 → Period 2

Cell Producer innovates on $0 < \alpha < 1$ of new line

Production loss $(1 - \beta\alpha^2)$

Innovation cost αc_d

Capacity expansion I_1

Cost reduction $\gamma\alpha$

Capacity expansion I_2

Source: The role of the supply chain for innovation The example of Photovoltaic Solar Cells, forthcoming EPRG working paper, www.electricitypolicy.org.uk

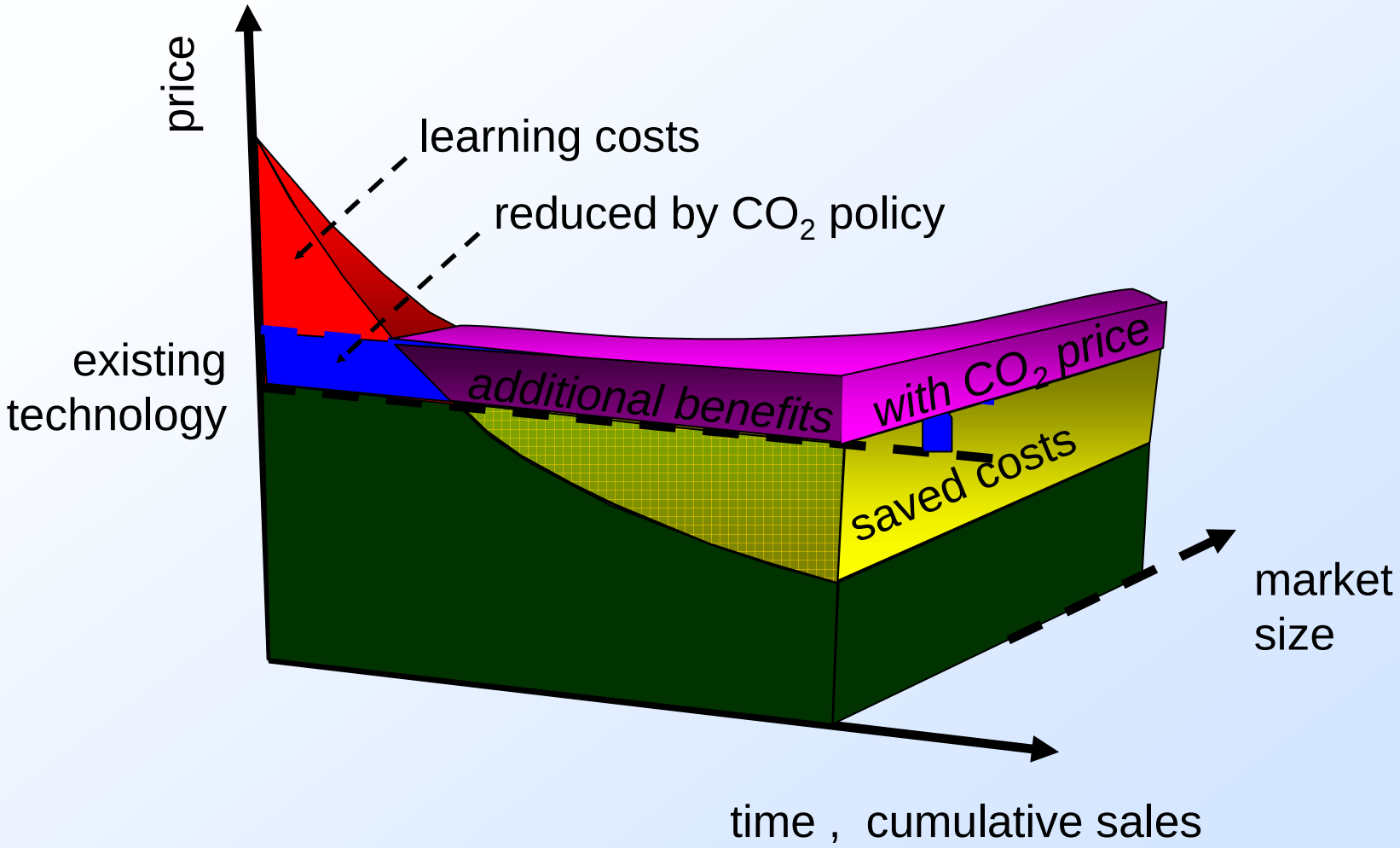
The role of commercial incentives for innovation

Results PV model (Insights for support policy)

- Breadth of innovation always below social optimum
  - Provide subsidy for production innovation (Japan)
- Bigger future market increases today's innovation
- Rapid (unexpected) current market growth
  - Creates profits for investment/innovation
  - High current margins are disincentive for experimenting (delays/downtimes)

CO2 prices as commercial innovation incentive

Carbon price increase technology viability & policy credibility

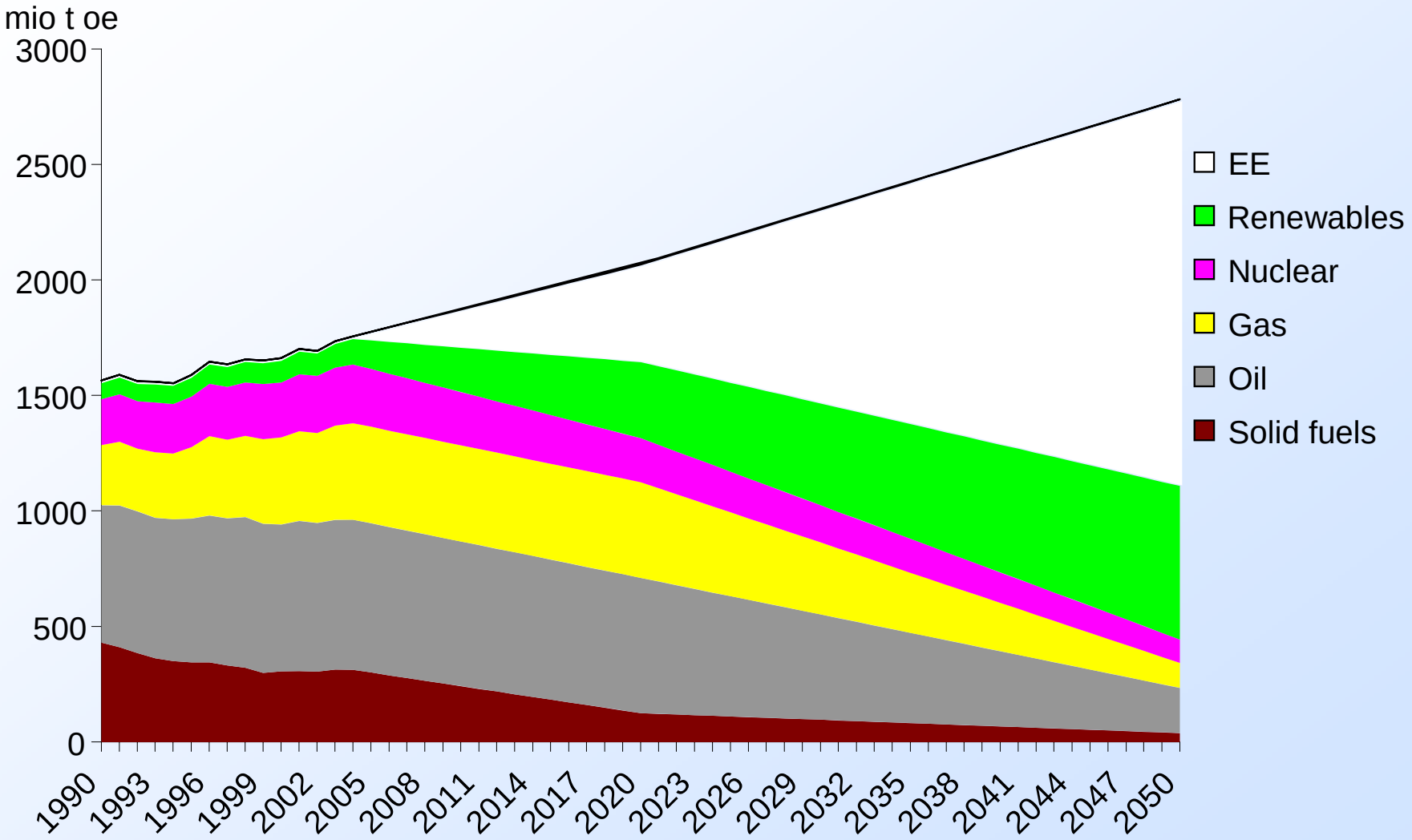


Source: Neuhoff, K., 2005, Large-scale deployment of renewables for electricity generation, Oxford Review of Economic Policy, 21 (1): 88-110.

The role of complementing technology policy

- Always opportunity for R&D support
- Should more active technology policy be applied?
  - Can learning benefits be appropriated?
  - Time frame?
  - Required investment volume?
  - Number of actors that have to work together?
  - Can policy understand & support technology?
- Renewable technology -> Strategic deployment

Can emission targets drive low Carbon innovation?



Historic data – Energy and Transport in Figures, 2006, EU Commission, DG energy and transport,
CCS fraction 2% in 2020, efficiency 85% in 2020 and 80% in 2050, all emission reduction domestically

Design of emission trading to deliver innovation

Prices for emission reduction technologies – uncertainty?

- Some projections give point estimates for future mitigation cost
- Large bands of uncertainty about future tech. costs
- Additional uncertainty about relative fuel prices

-> Difficult to predict exact CO2 price required to deliver emission target

-> Private sector investors tend to look at future market size/share

-> Emission trading might ensure that price will adjust to deliver target

Emission trading and technology development

- Important role of commercial incentives for innovation
- CO_2 prices as commercial innovation incentive
  - Reduces private sector cost for technology development
  - Makes low Carbon technologies more viable (earlier, at all)
  - Increases benefits from developing low Carbon technologies
- The role of complementing technology policy
  - Depends on appropriability, time frame, required investment volume, number of actors that have to work together
  - Conditional on ability to micro manage sector
  - R&D and e.g. for renewables strategic deployment
- Design of emission trading to deliver innovation
  - Role of technologies mix clear in macro picture
  - But what price will be required?
  - Avoid low price cap – we don’t know what mid-term price we need
  - Define what level of domestic emission reductions are required