Electricity Policy Research Group

SUPERGEN

TSEC

UNIVERSITY OF CAMBRIDGE

Economic and Policy Frameworks for Energy Technology Deployment

EPRG Research seminar

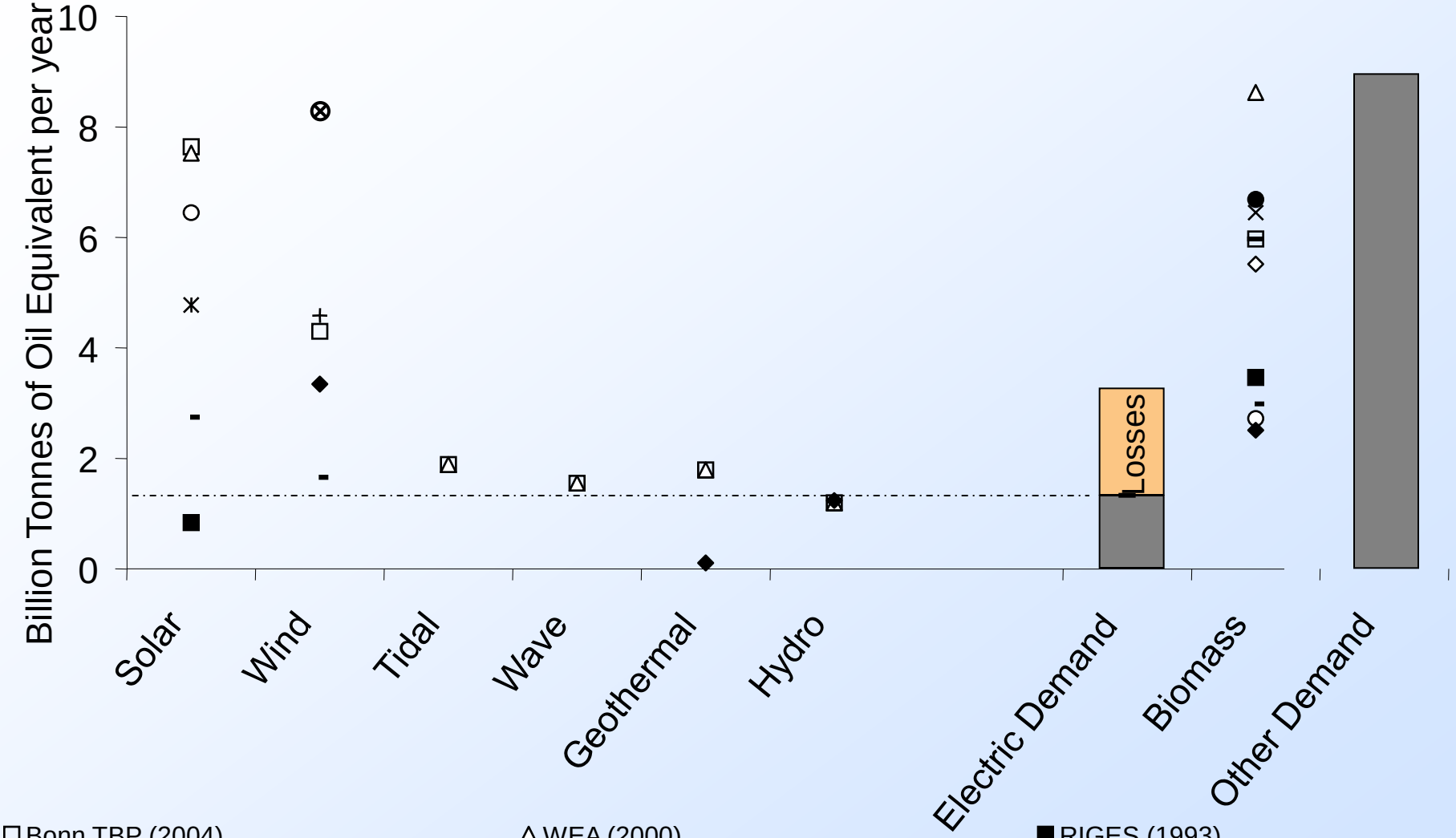
Cambridge, May 2006

Karsten Neuhoff

Energy Technology Deployment

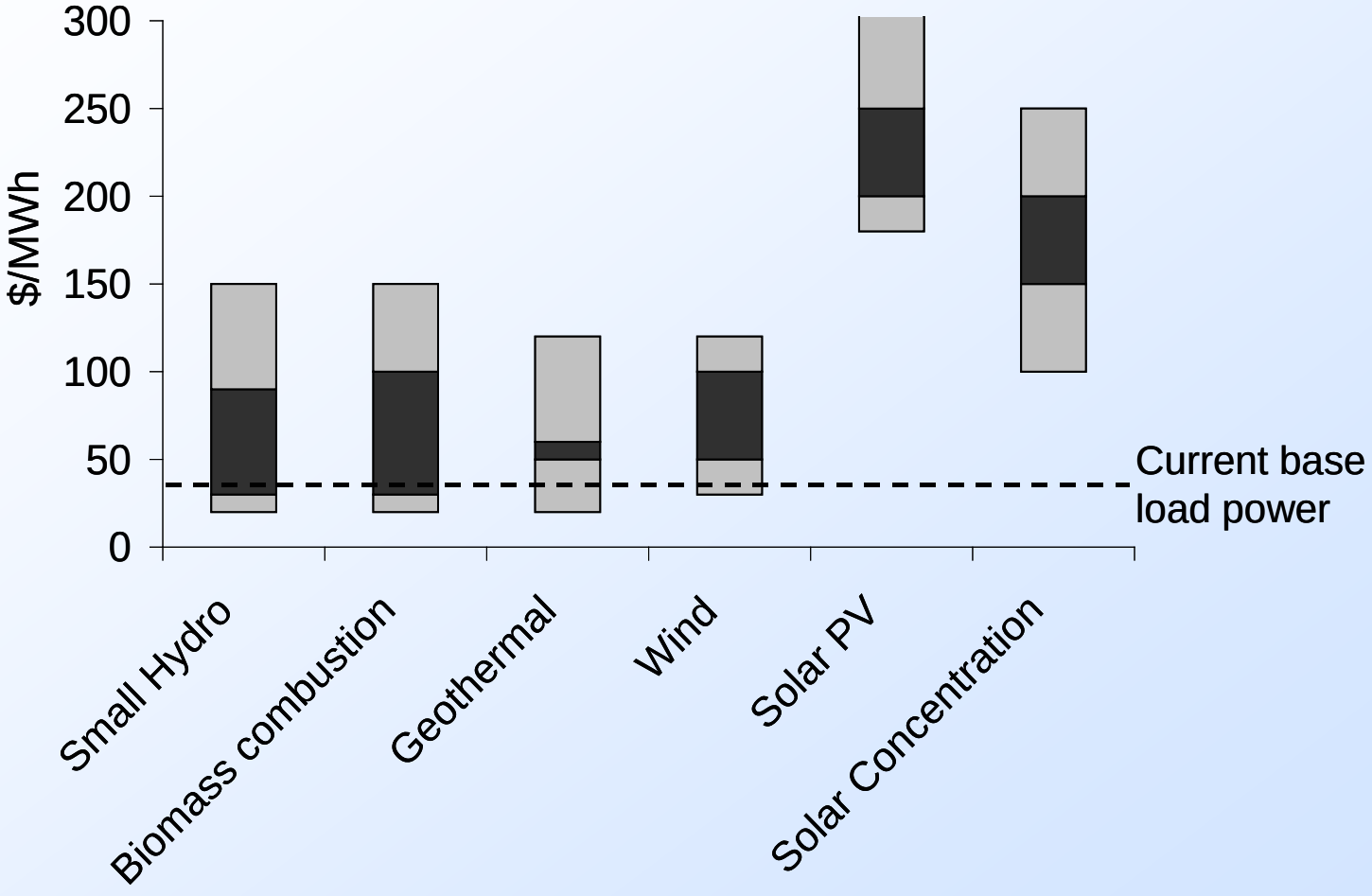
1. Resource and technology availability
2. Learning by doing principles
3. R&D expenditure – complement or substitute?
4. Growth to the limit
5. Strategic deployment
6. International cooperation
7. Conclusion

Resource base is available



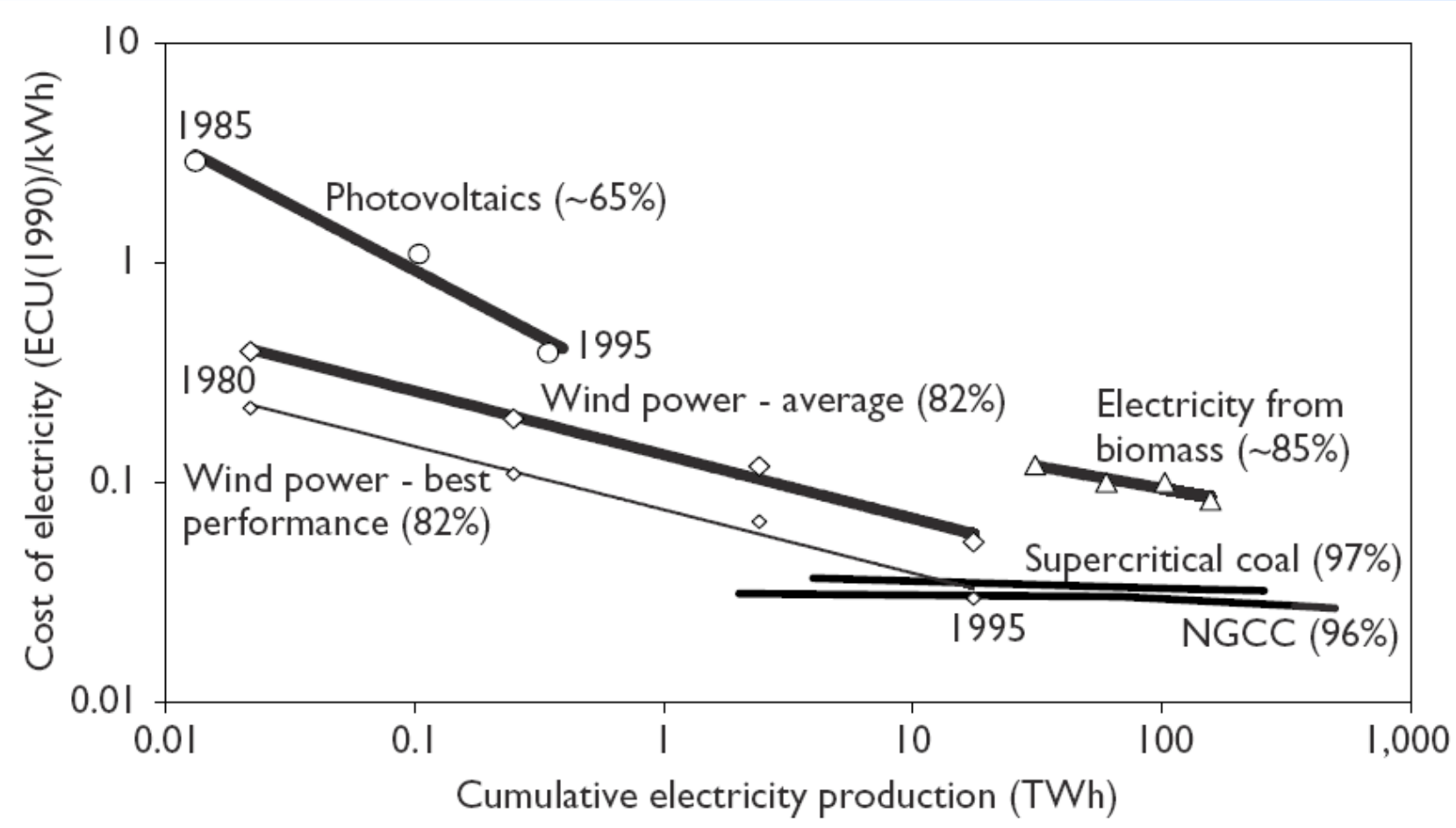
- Bonn TBP (2004)
- Shell (1996)
- WBGU (2004)
- WEC (1994)
- Hoogwijk et al (2004)
- WEA (2000)
- Greenpeace (1993)
- Fischer & Schrattenholzer (2001)
- IPCC (1996)
- Based on MIT, 1.5TW for 100years – 30mt Uranium (WEA 20mio to renewable)
- RIGES (1993)
- Grubb & Meyer (1993)
- IEA (2002)
- Hall & Rosillo-Calle (1998)

But costs for most technologies still higher



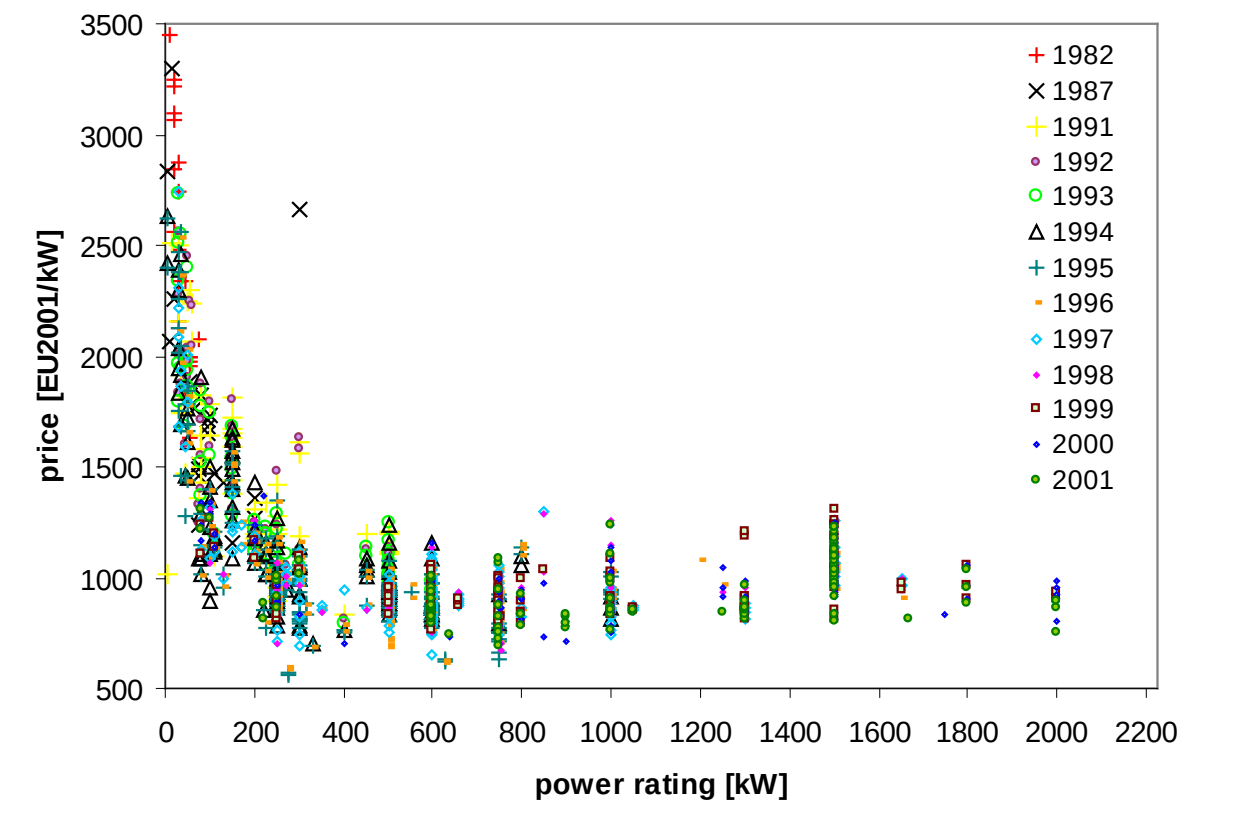
Source: International Energy Agency 2003.

Improvements through market experience - one perspective on cost evolution



International Energy Agency (2000) Experience Curves for Technology Policy. Paris.

Application to wind data

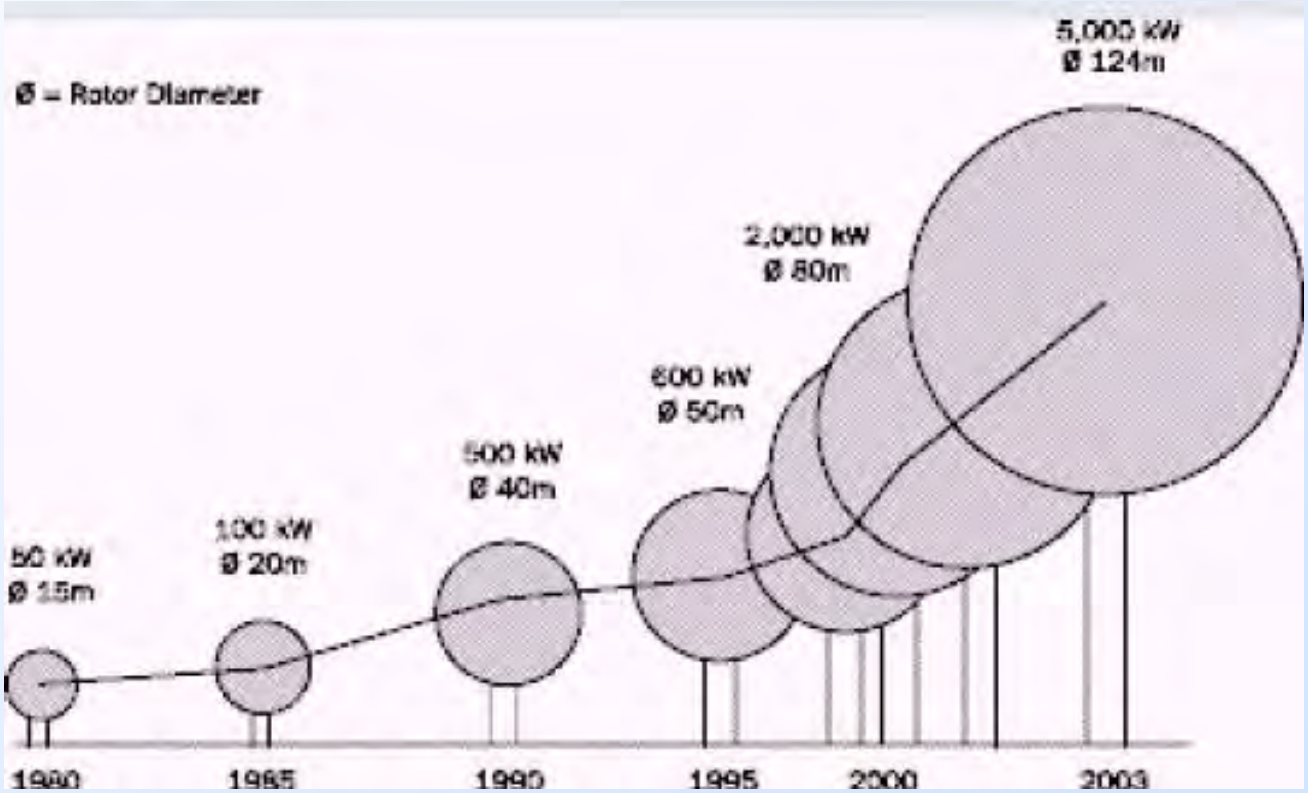


*B*ased on data compiled by M. Junginger from BWE editions 1991-2001, and Danish list prices for 1982, 1987. Adjusted using German and Danish GDP deflator (IMF, 2005), and exchange rates 1EU(2001) =1.956DM and 7.46DKK

Source: EPRG Working paper – Coloumb/Neuhoff 2005

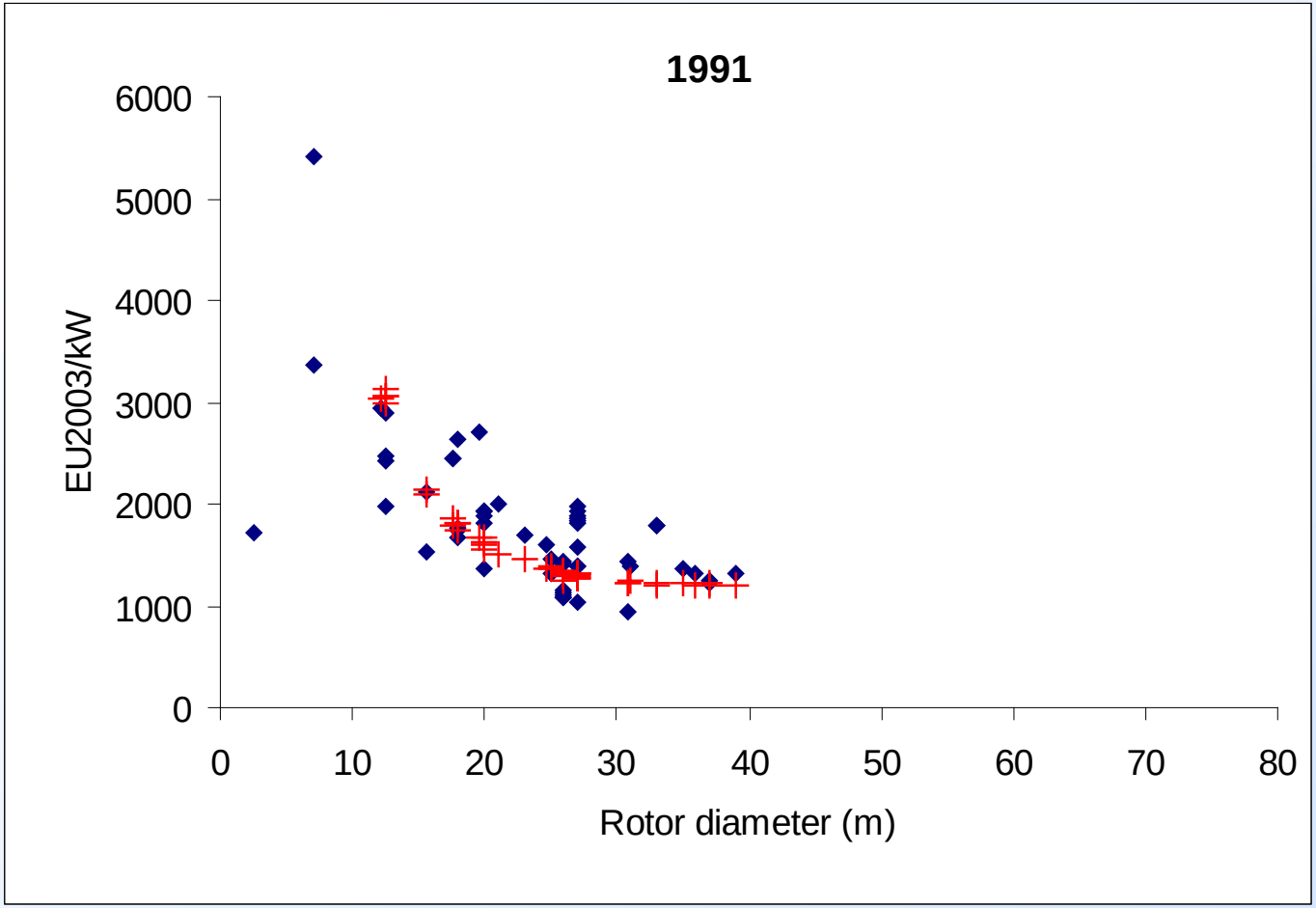
Wind energy costs – driven by multiple effects

- Production scale
- Experience effect
- Turbine scale



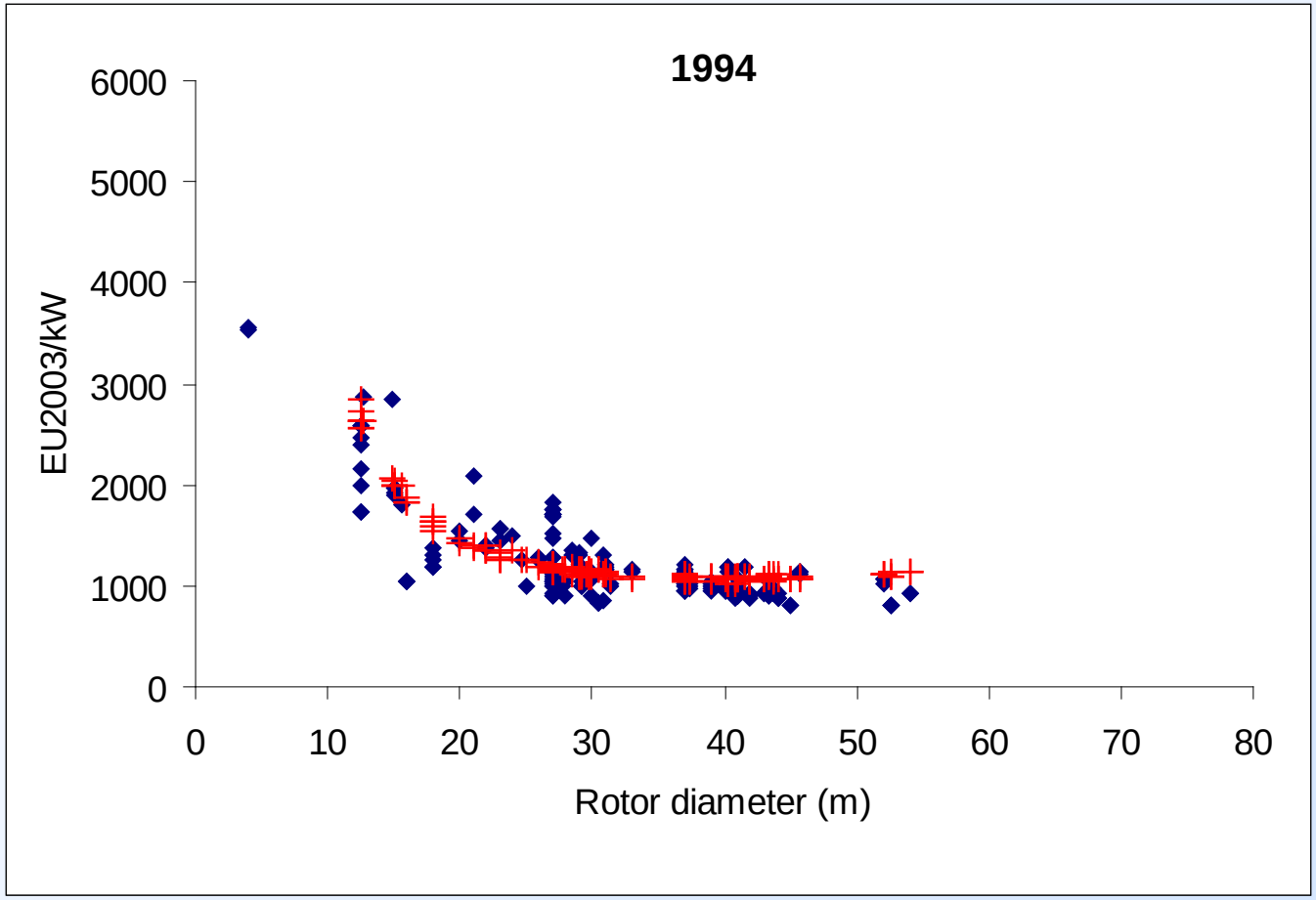
Source: EWEA (2004)

Price evolution

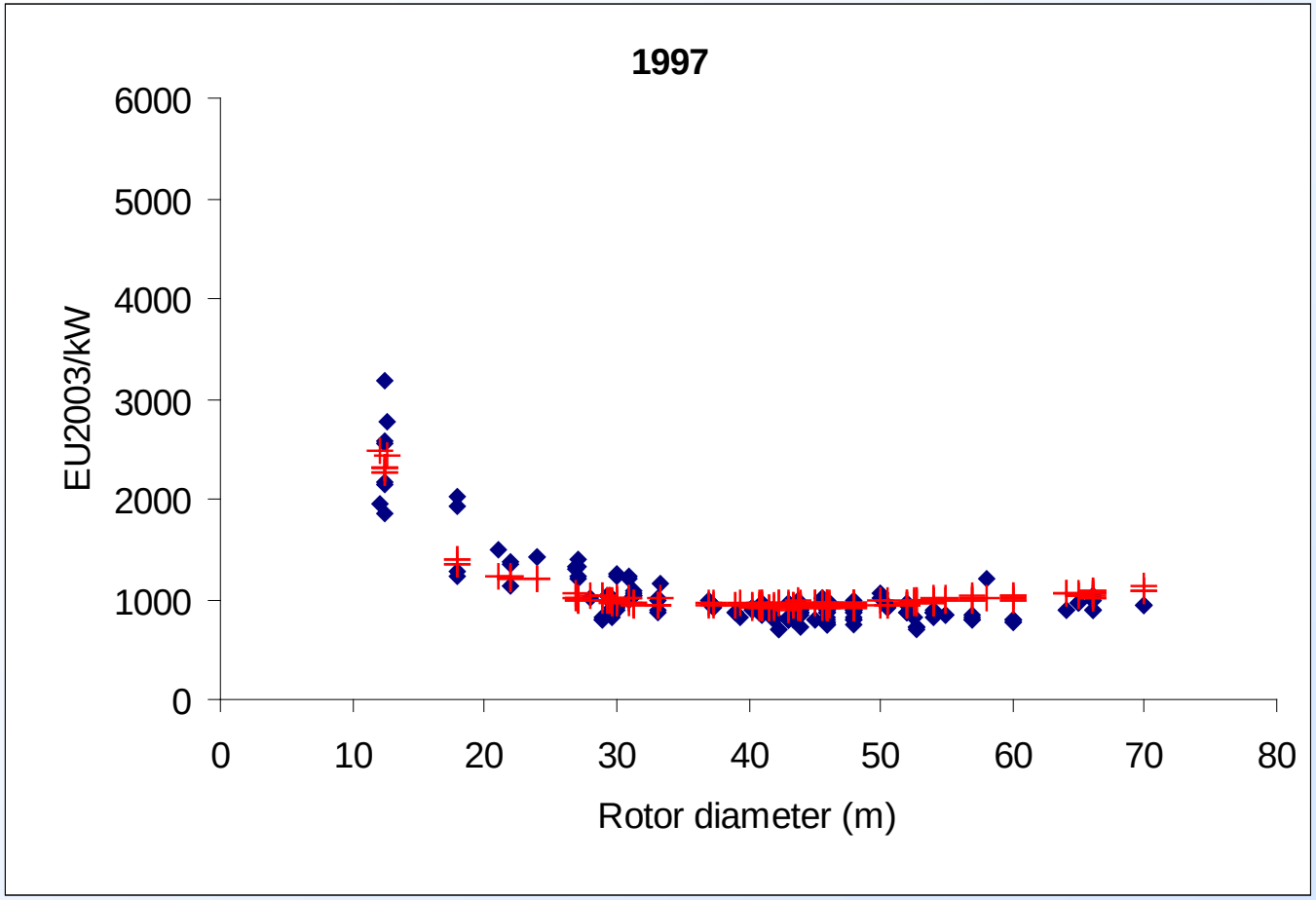


Source: EPRG Working paper – Coloumb/Neuhoff 2005

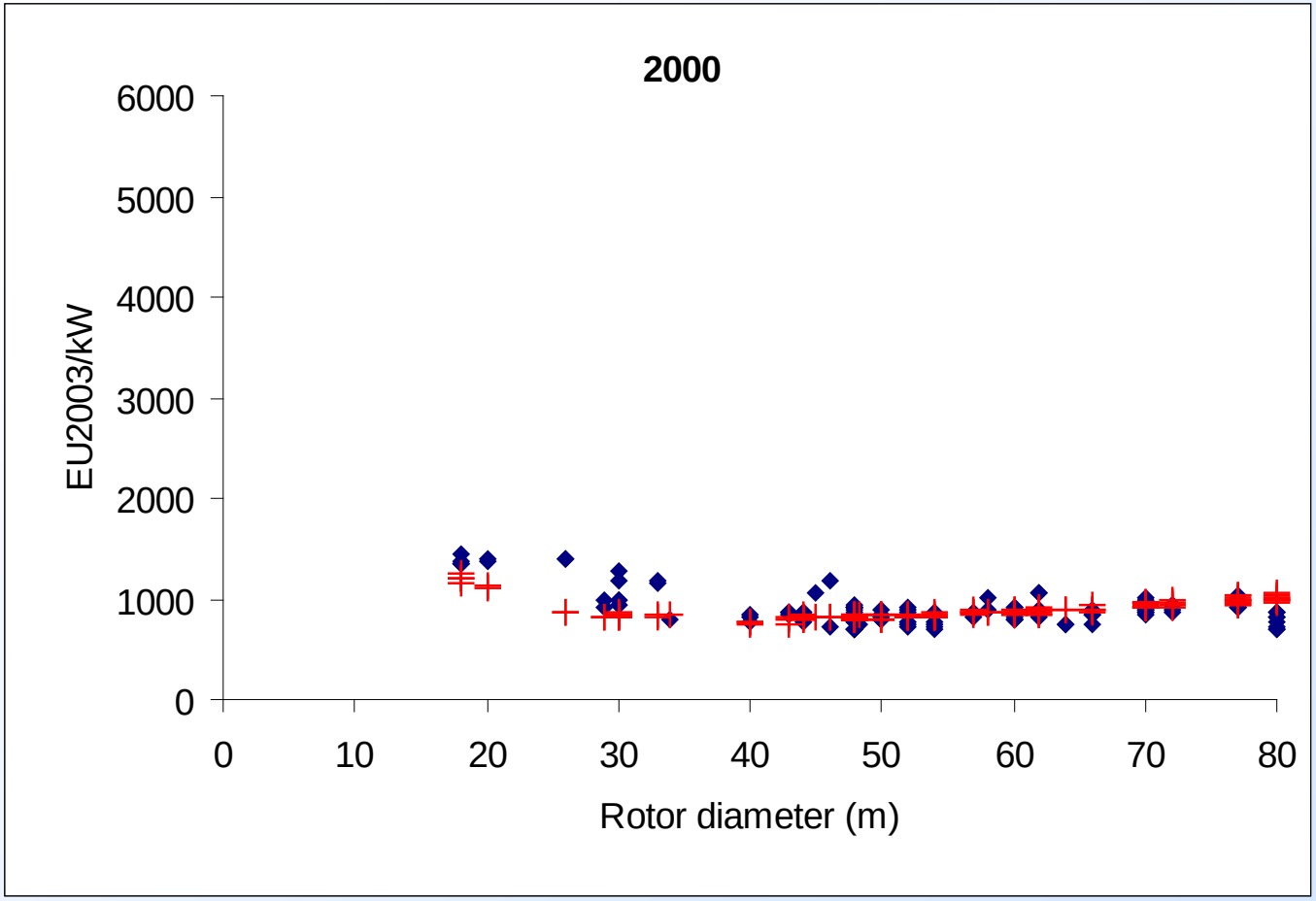
Price evolution



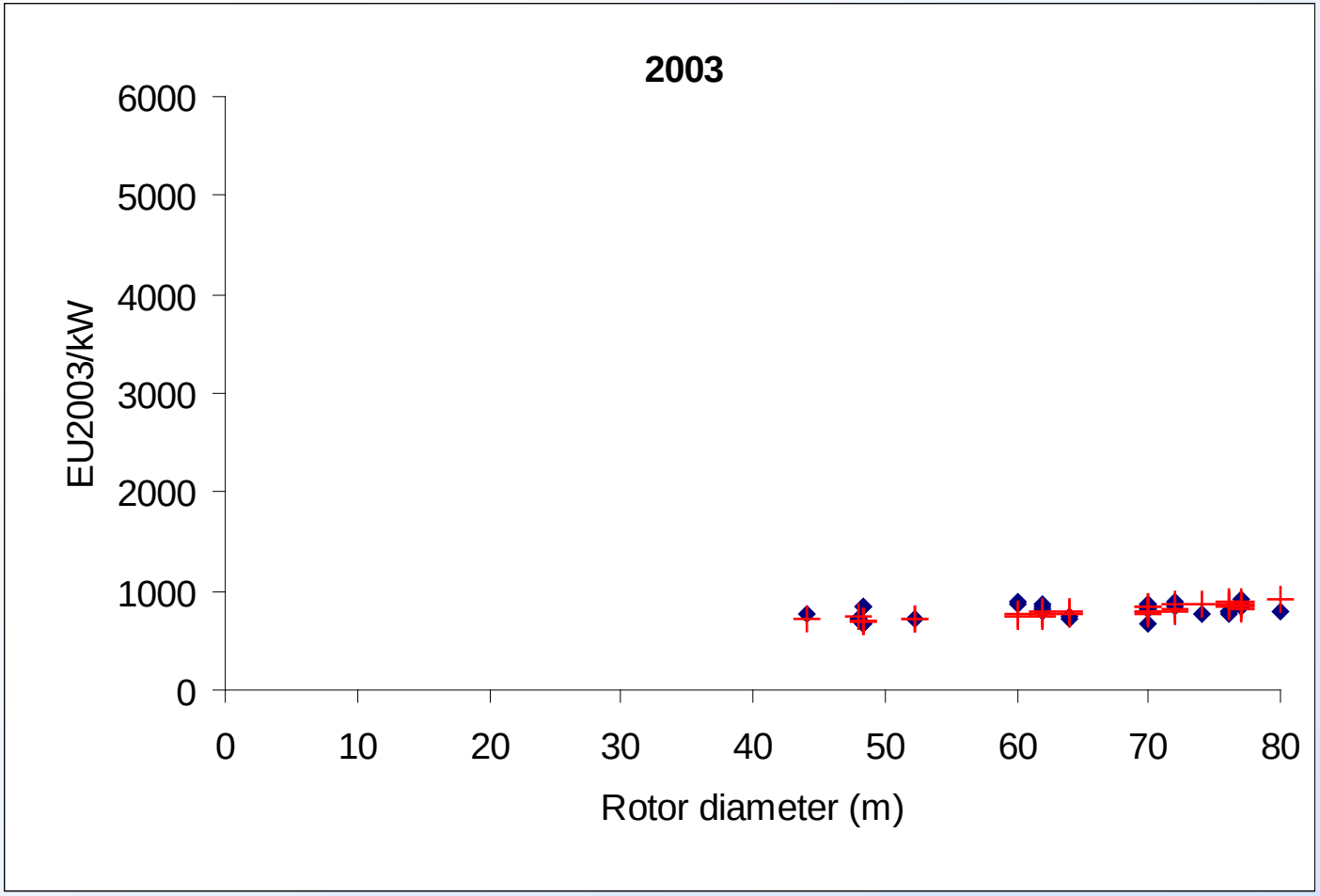
Price evolution



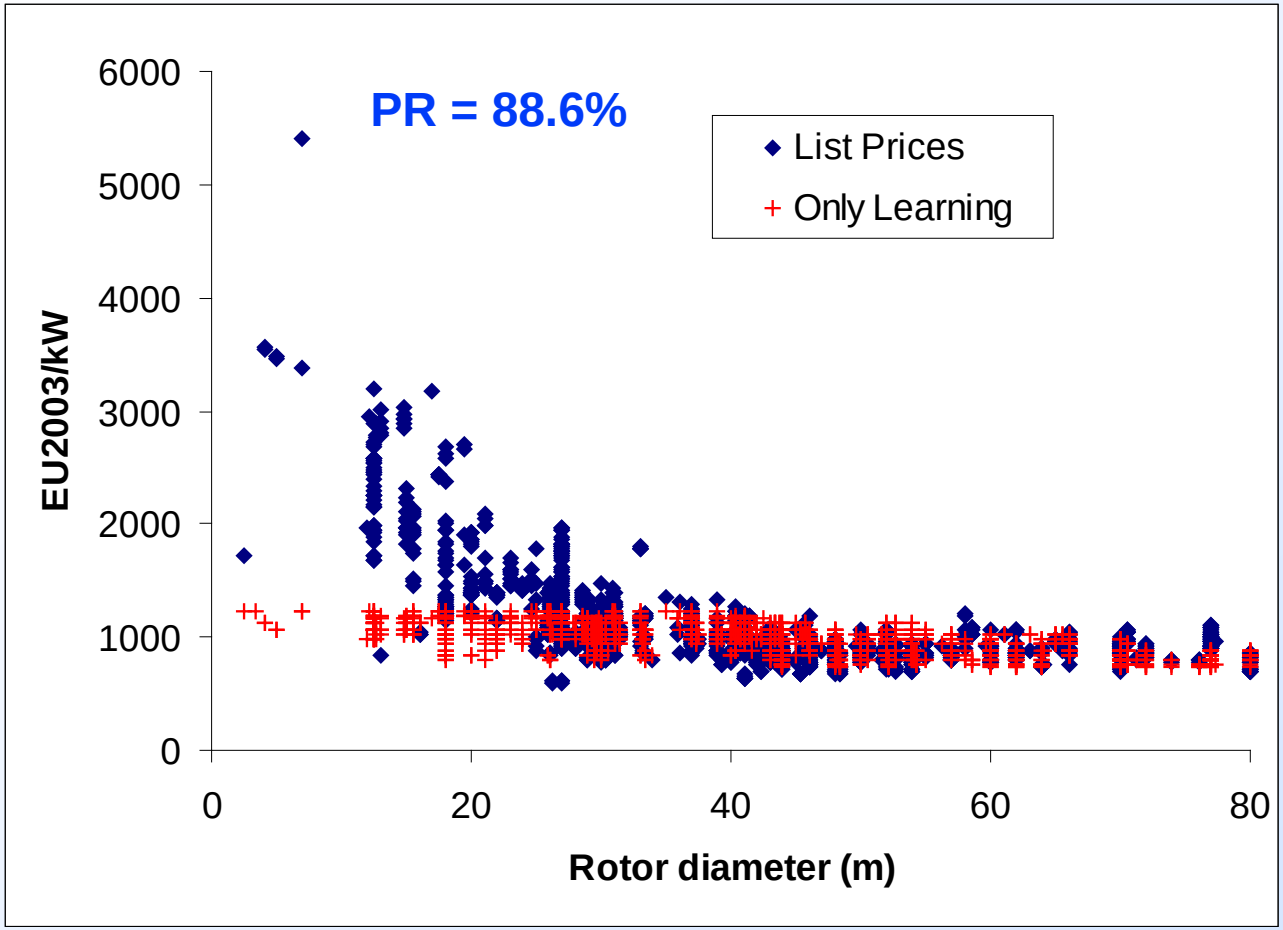
Price evolution



Price evolution



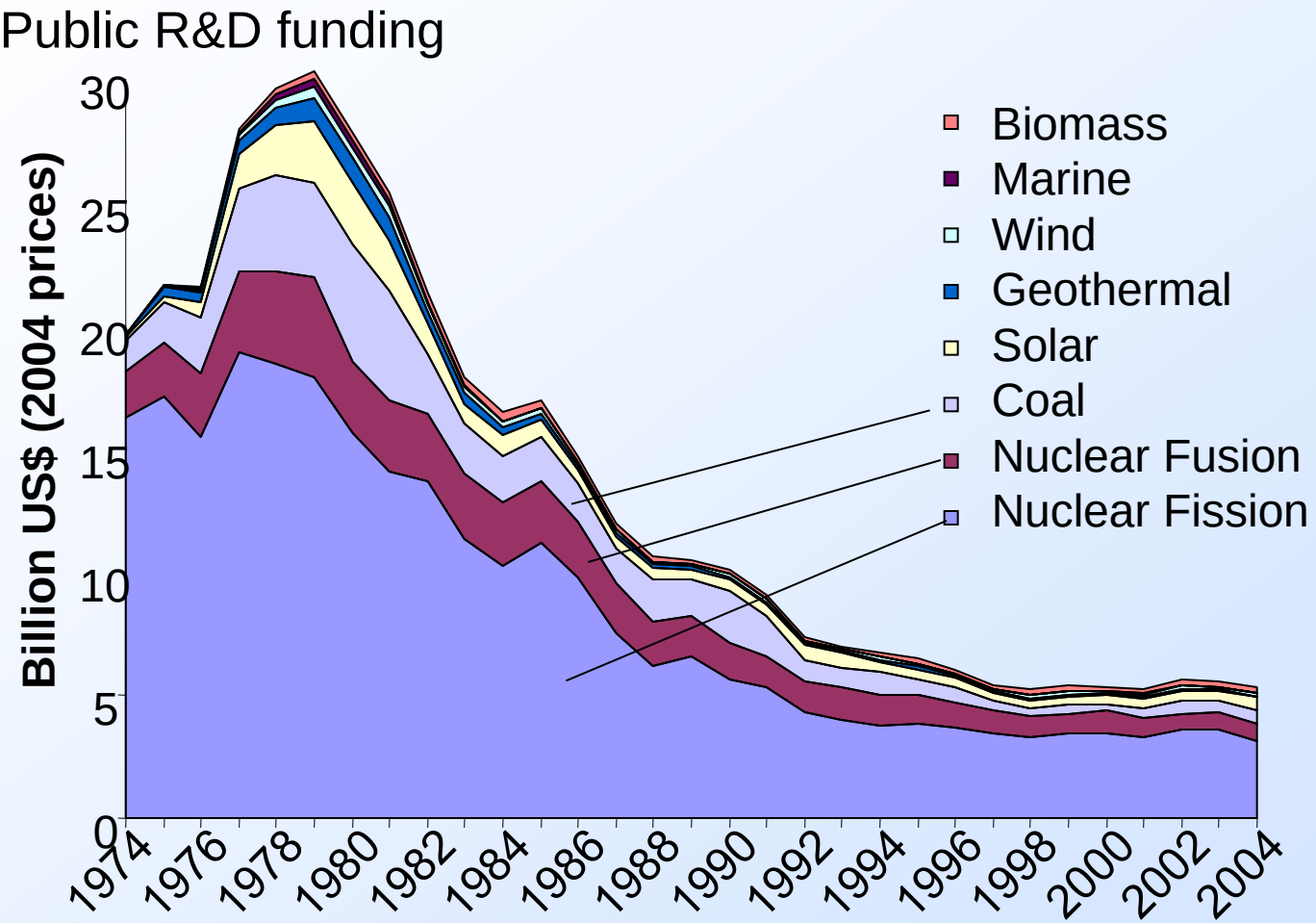
Learning only…



Based on:

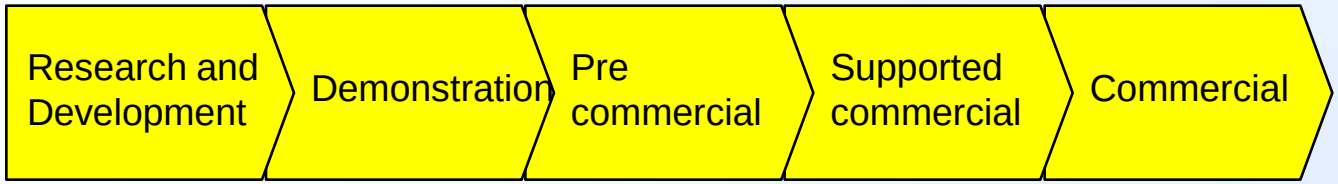
- Global cumulative capacity
- 90% mass dependence, i.e $C\%_0 = 10\%$

R&D – substitute or complement for strategic deployment?

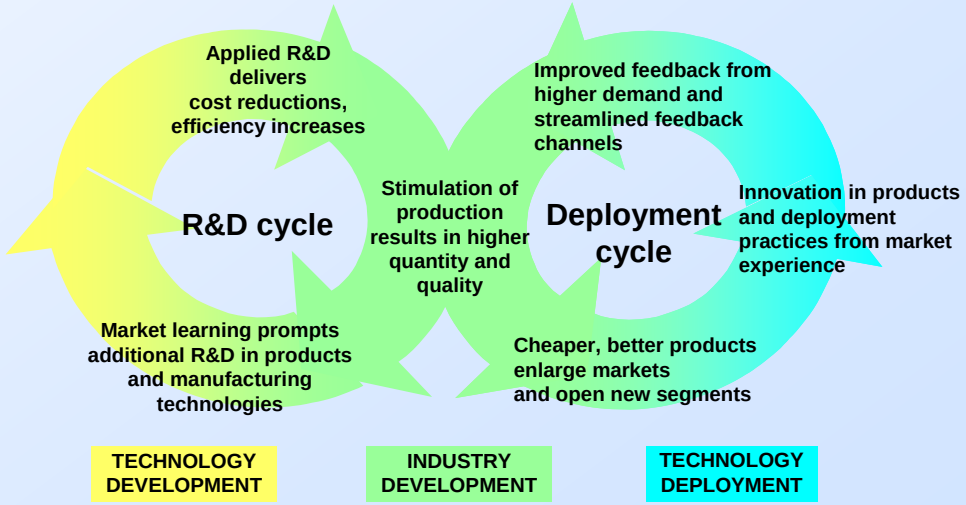


Source: IEA

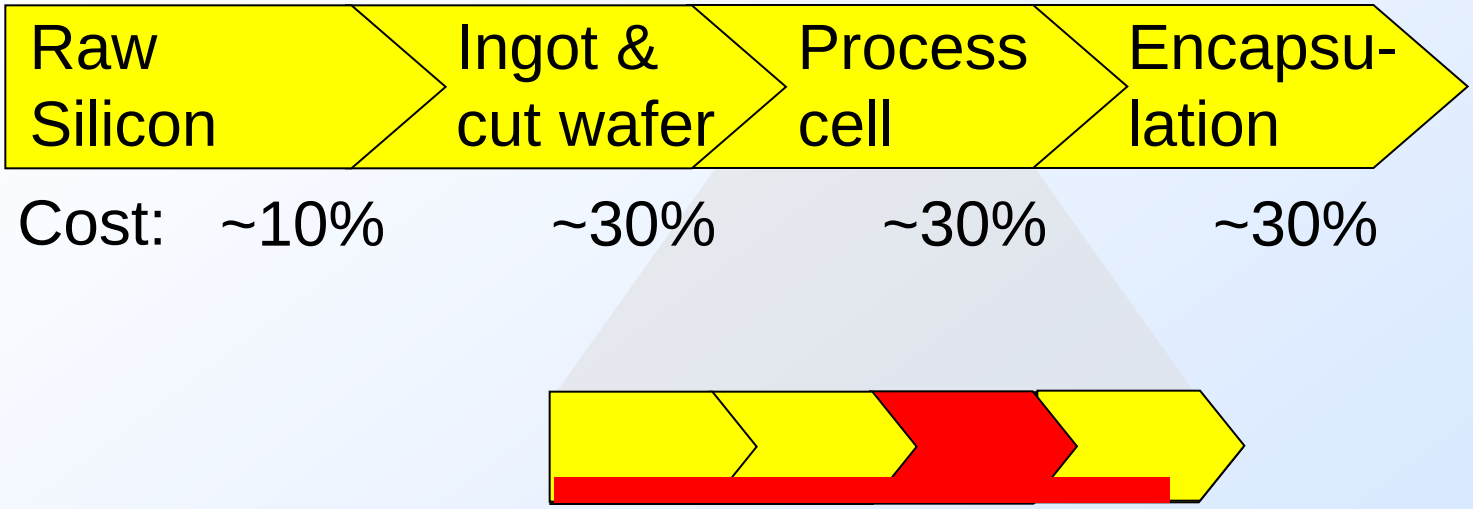
R&D – substitute or complement?



Or is there more interaction?



Example: Solar PV production

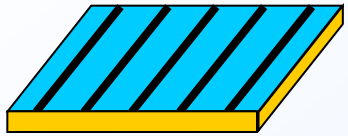


Product innovation: Coating: TiO_2 -> SiN_x

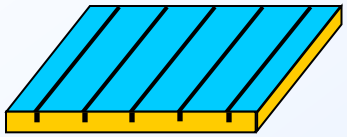
Process innovation: Wafer: 400um -> 200um

Interaction between growth and learning rate

Illustrative



Too much shadowing

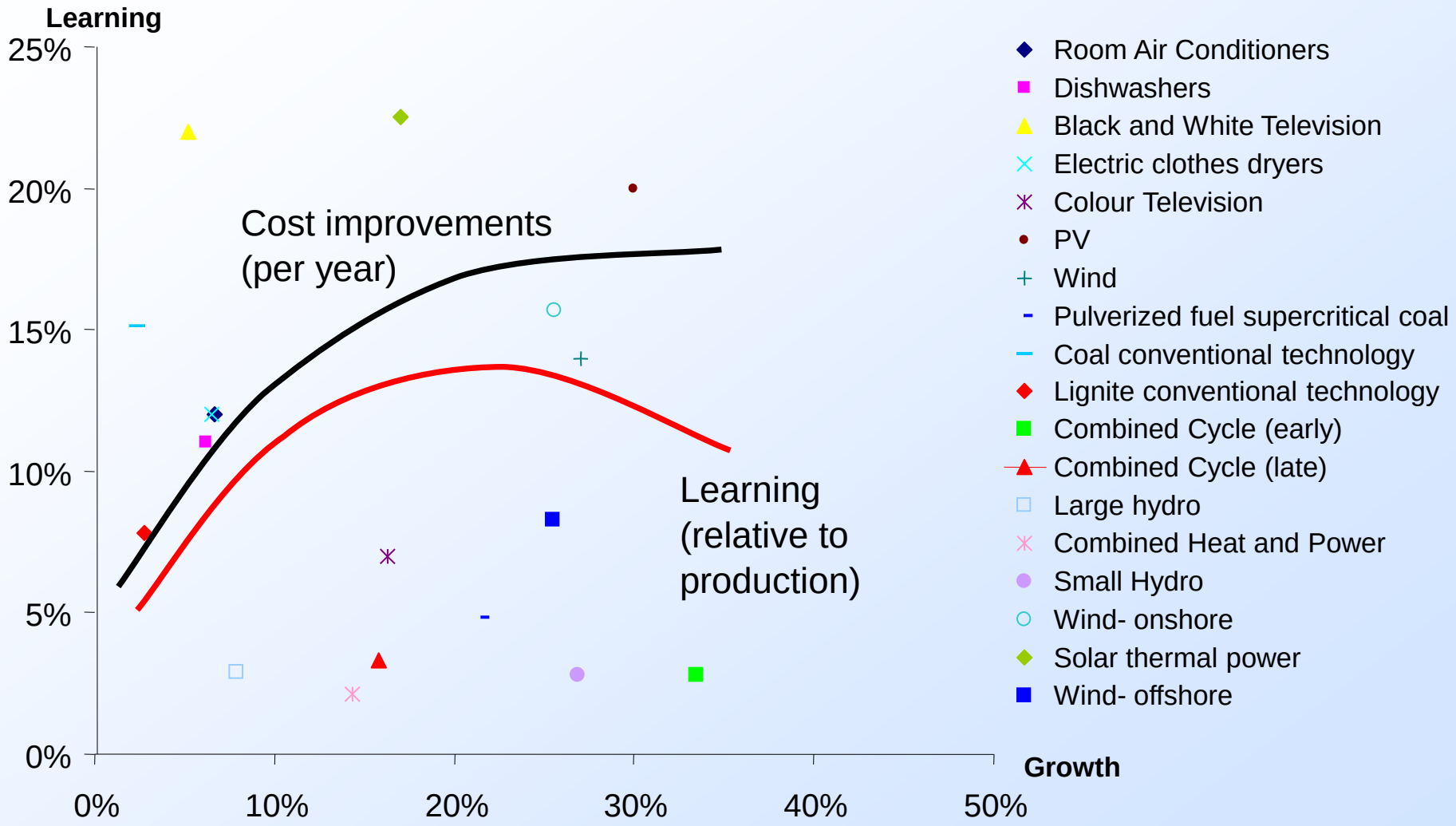


Saturn (BP)

Backjunction (Sunpower)

Market growth			
0%	X %	2X %	3X %
Year of first utilisation			
5	1	1	1
7	2	1	1
Learning over time			
slow	medium	fast	fast

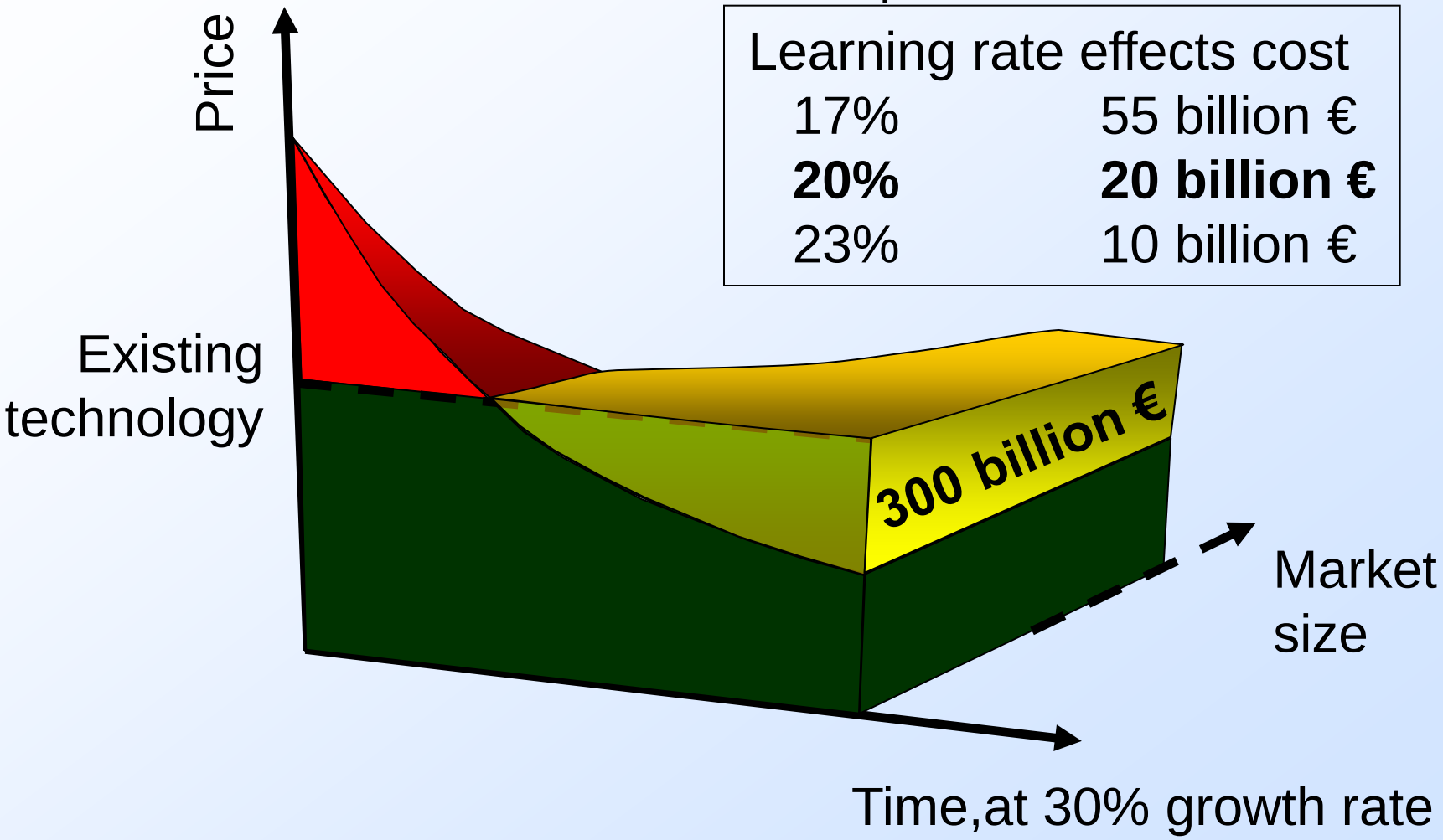
Implications for learning rate



How to make tech

Example Solar PV:

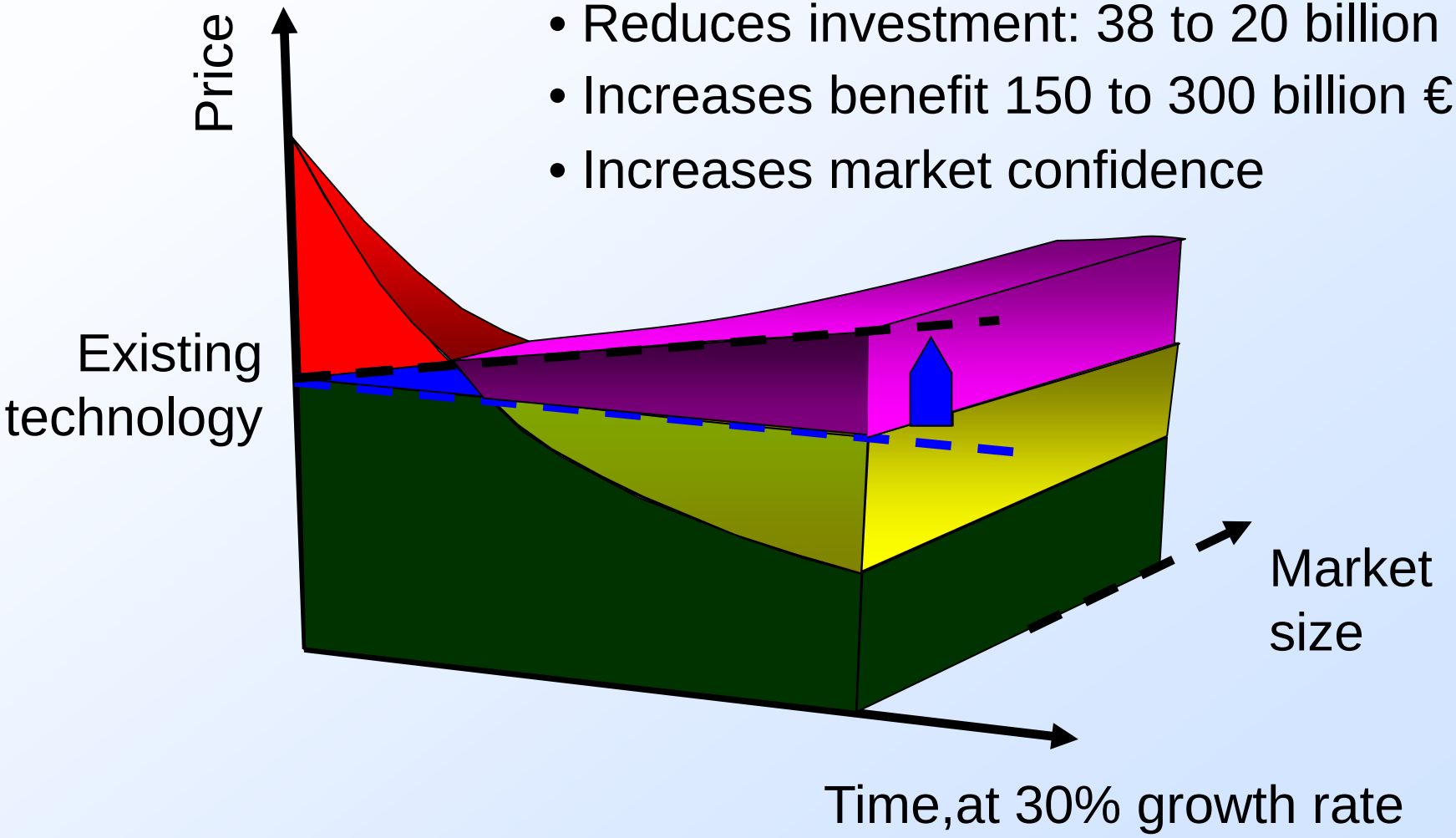
Learning rate	effects cost
17%	55 billion €
20%	**20 billion €**
23%	10 billion €



5% discount rate

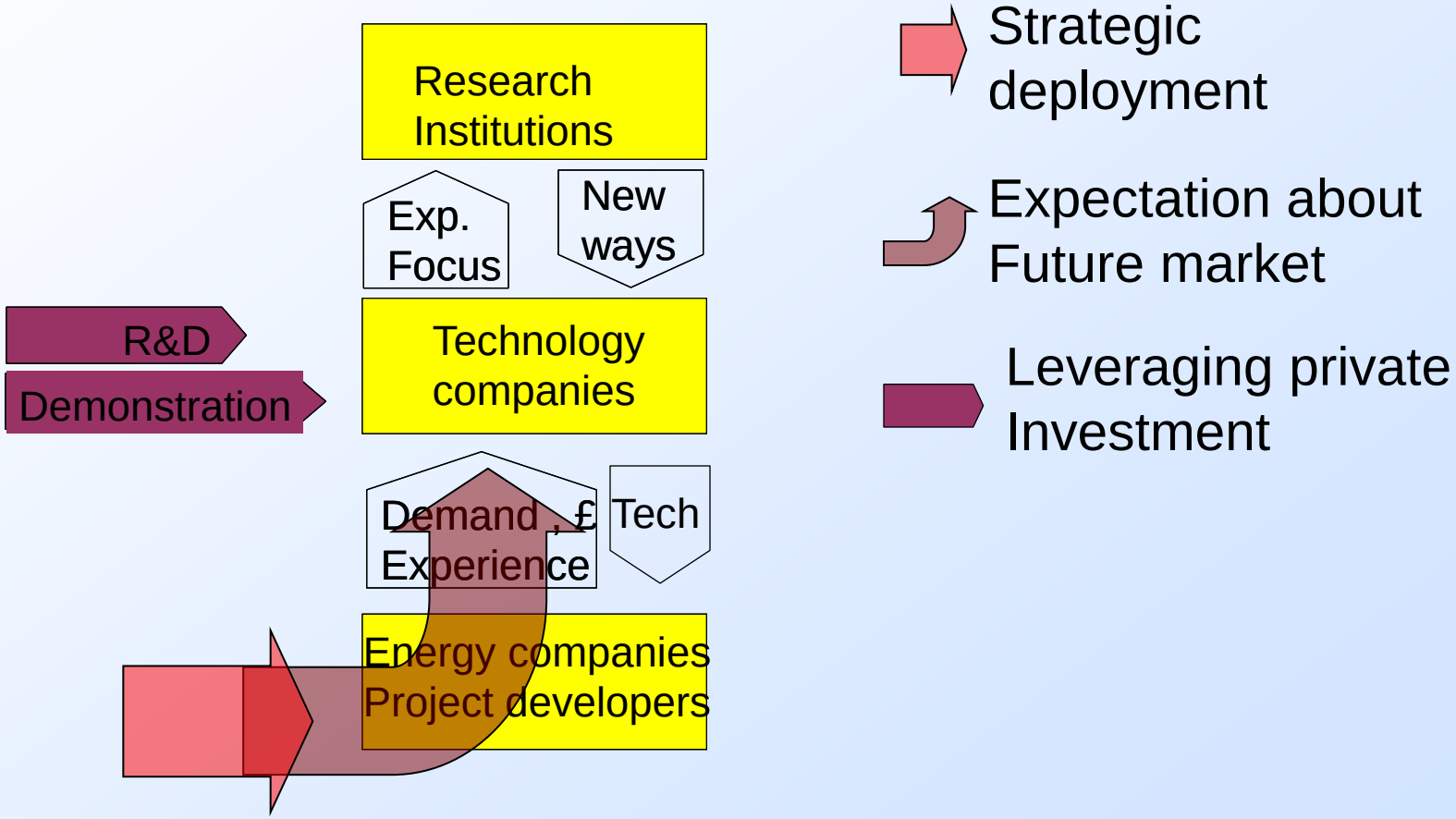
Internalisation of CO2 benefits new technologies

- Reduces investment: 38 to 20 billion €*
- Increases benefit 150 to 300 billion €
- Increases market confidence



* Break even price moves €40/MWh to €50/MWh, 5% discount, 2005-2040

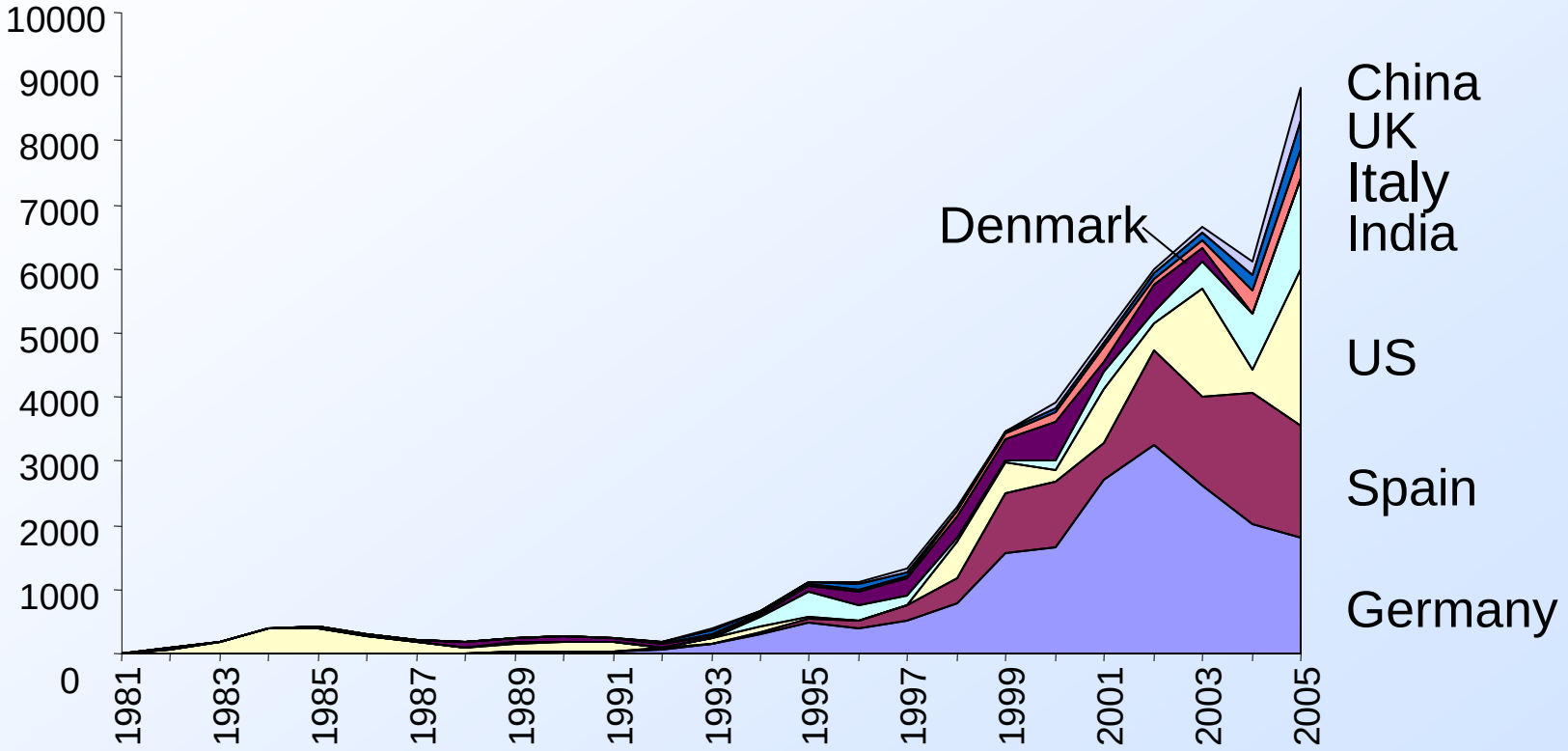
How does strategic deployment work?



Source: Neuhoff/Sellers EPRG 2006

Future demand difficult to predict

Installed wind power per year (MW)

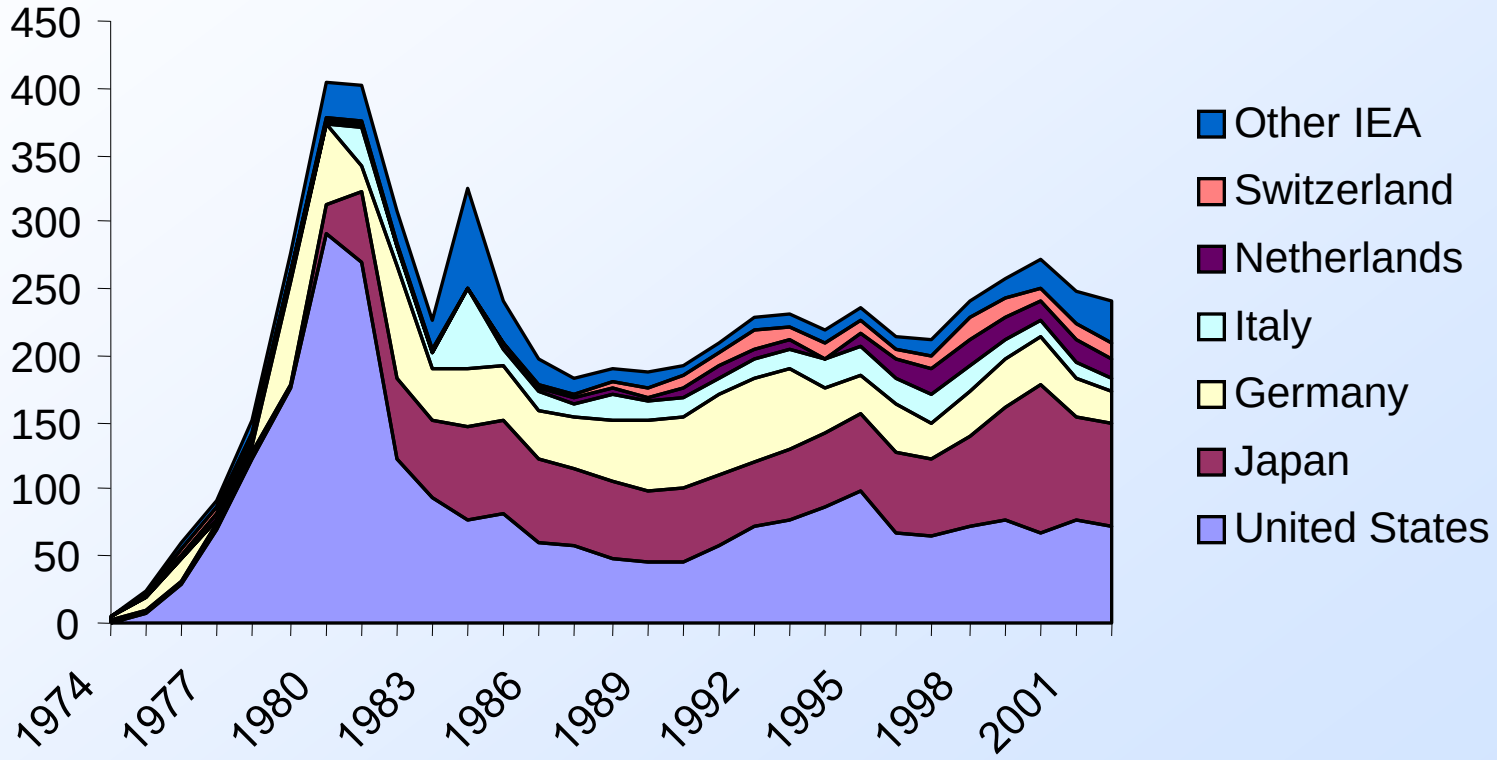


… international markets average over some of national volatility

Source BTM consult, GWEC

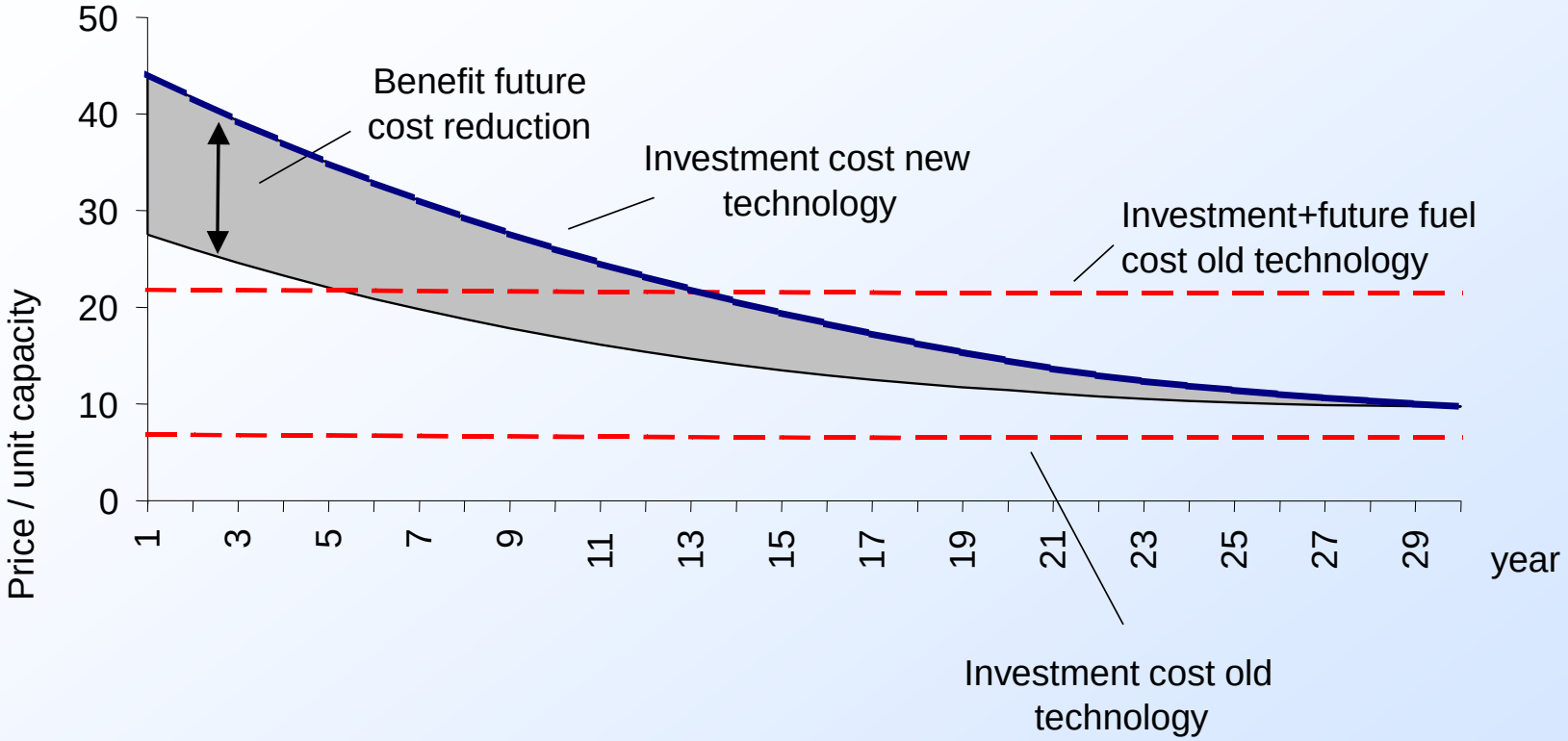
Global aggregation reduces volatility

RD&D expenditure on Photo Voltaic (Mio. $ 2002)



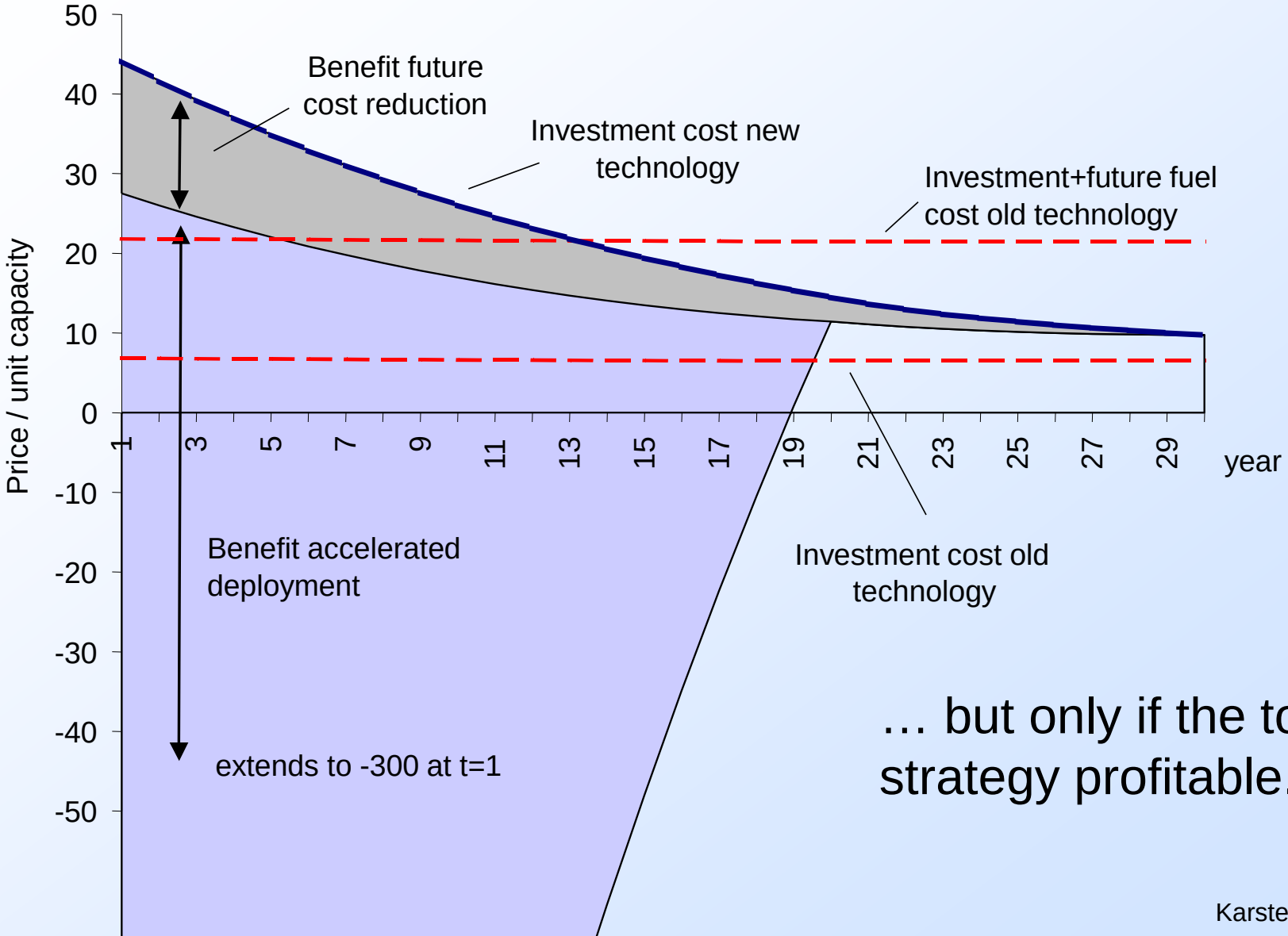
Source IEA

Marginal Learning Externalities



Additional investment brings additional experience
-> this reduces future investment costs
-> but not sufficient to justify technology in early years

… adding the benefit from accelerated future deployment adds value to early deployment



… but only if the total strategy profitable.

Conclusion

- Resources available
- Learning by doing could drive down costs
- RD&D complement not substitute for market experience
- Use time effectively that is required for new technologies
- Strategic deployment
  - Creates market experience
  - Provides well defined interface with government
- Parallel implementation of strategic deployment
  - Increases scale and reduces volatility
  - Increases political support