



# Energy Technologies of the Future and R&D priorities

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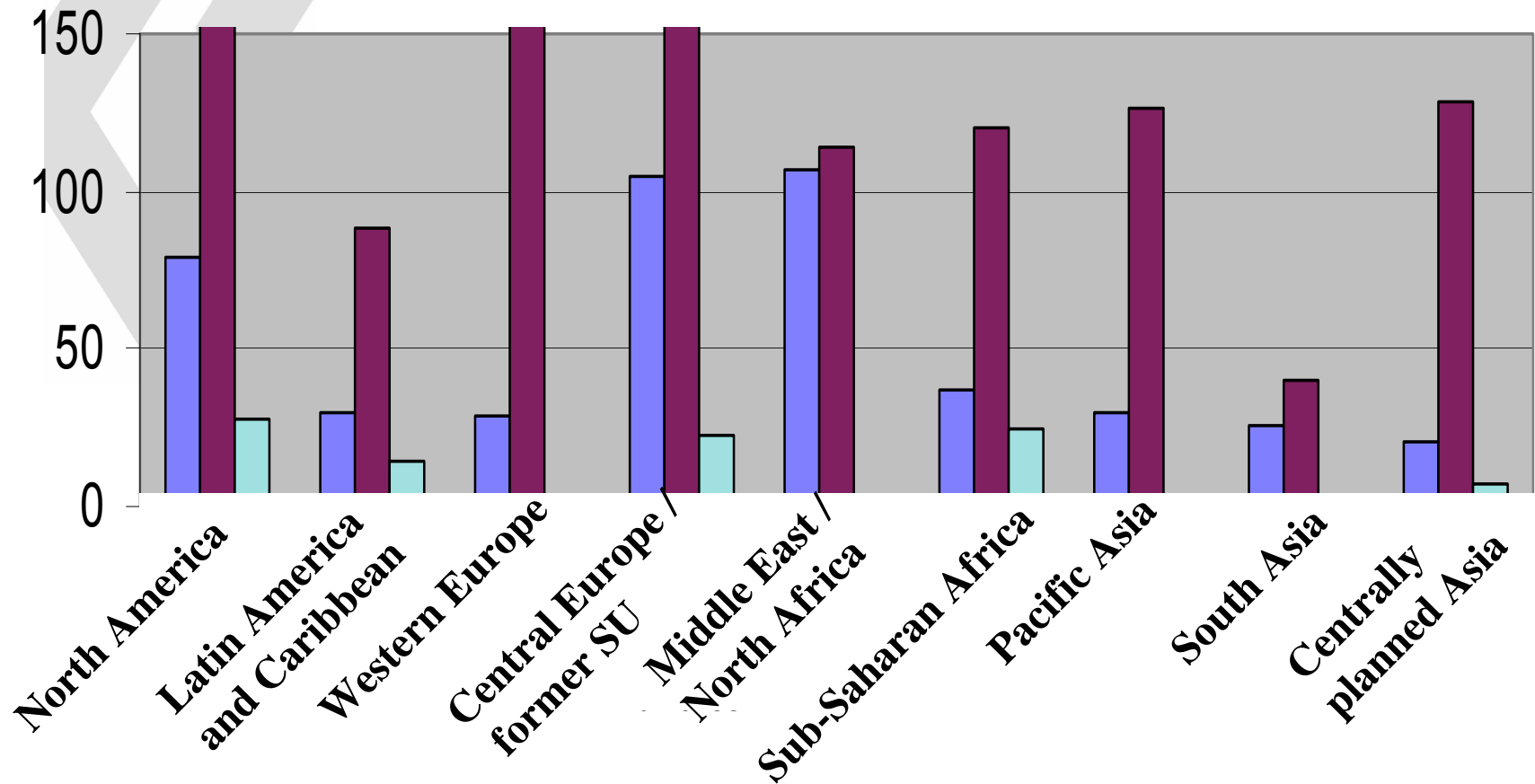
OECD Round Table on Sustainable Development  
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## Energy 2050: two myths

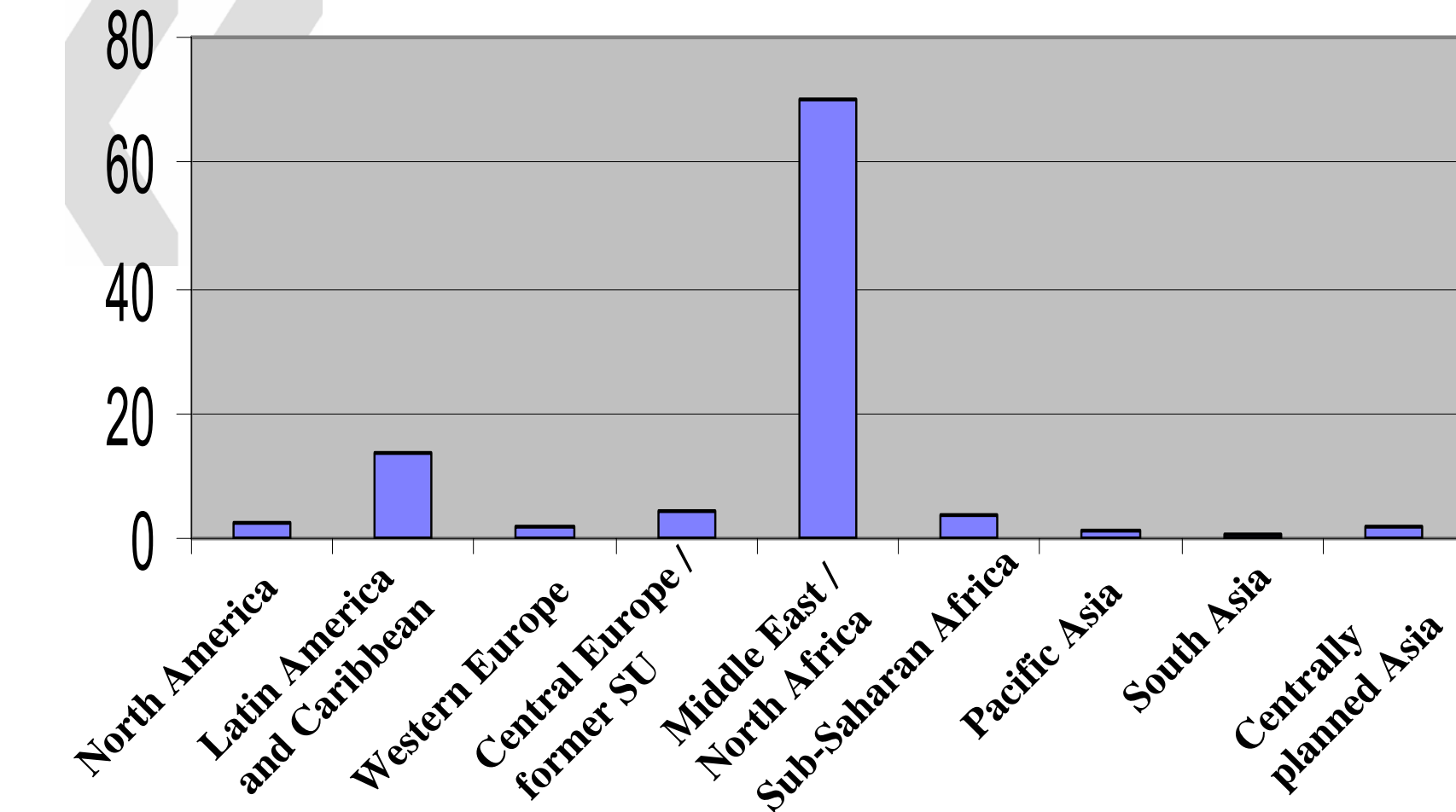
- The world depends on oil from the Middle East
- Technology will come to the rescue to save the planet

# Fossil fuel resources



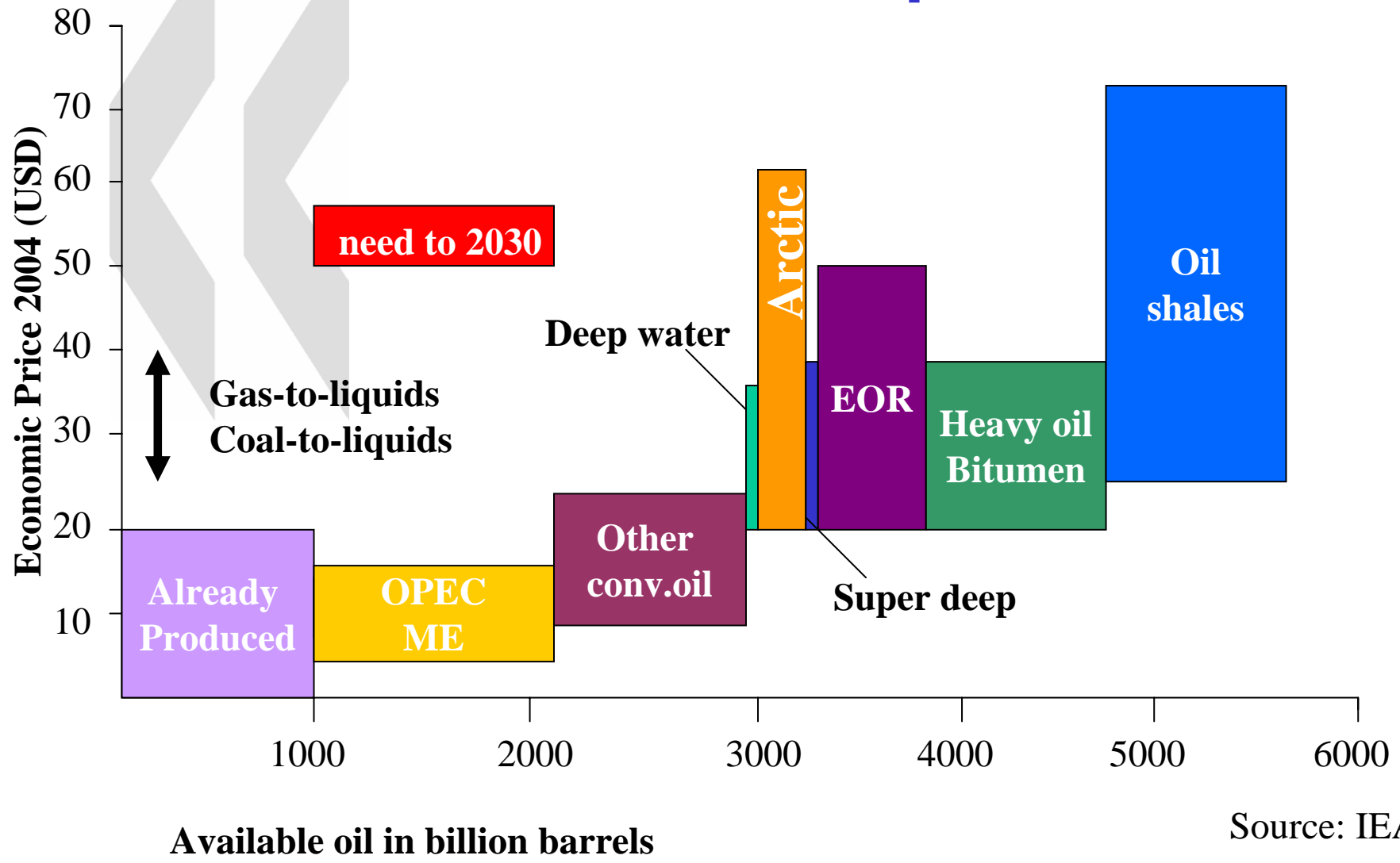
■ Years conventional fossil fuels      ■ Years uranium  
■ Years unconventional fossil fuels

# Oil resources



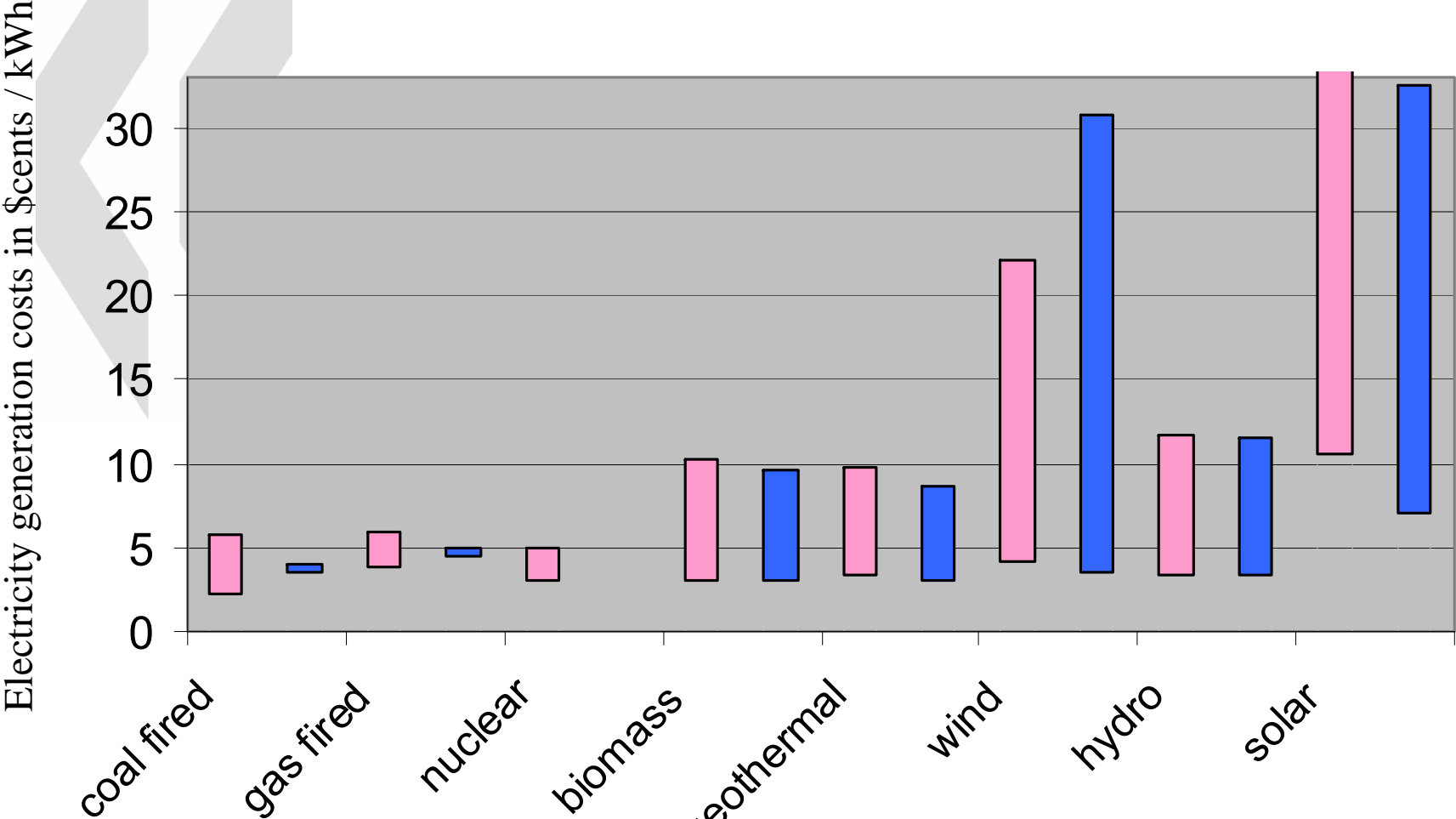
 Years conventional and unconventional oil

# Costs alternative transportation fuels



Source: IEA

# Electricity generation costs



Source: IEA



'Potential / future costs'



'Present costs'

OECD



OCDE

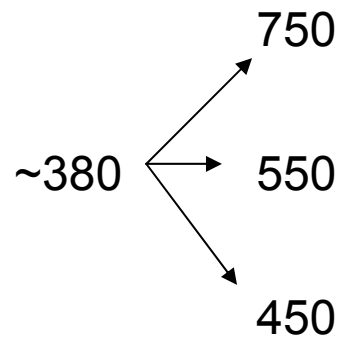
# Security of Supply

- Cheap oil in OPEC countries
- But 'alternative' fossil fuel resources widely distributed and abundant against 'reasonable' costs
- Fungibility of fossil fuels likely to bind producers
- Interconnectedness, market power, smoothen cost curves of backstop technologies

# Carbon free energy

In 2050 the world needs ~ 15 TW additional

In TW	2003	2050	2100
Demand	14.2	29	46
CO2 Concentration levels			
Carbon-			
Free	2.8	~ 11	~ 29
Supply		~ 15	~ 38
		~ 21	~ 42



Source: Hoffert et al (1998) and IEA



# Global carbon free alternatives

## Bio-energy

~ 3 TW (total additional potential)

## Wind

~2-7 TW

## Nuclear

~ 2 TW is 18 new plants a year until 2050



## CCS

~ ?

(15 TW = roughly two Sleipner plants a day until 2050)

## Geothermal

~ 1 TW (2003: 0.06 TW and not much room for improvement)

## Hydro

~ 1 TW (total potential)

## Solar

~ ? TW  
(2003: 0.006 TW)

## 2050: Fossil fuels dominate energy mix

- IEA scenario's: fossil fuels 85% energy mix
- Because (1) path dependency and (2) competitiveness
- Technology fix, if any, should come from solar or fusion
- In both cases → too late for global warming

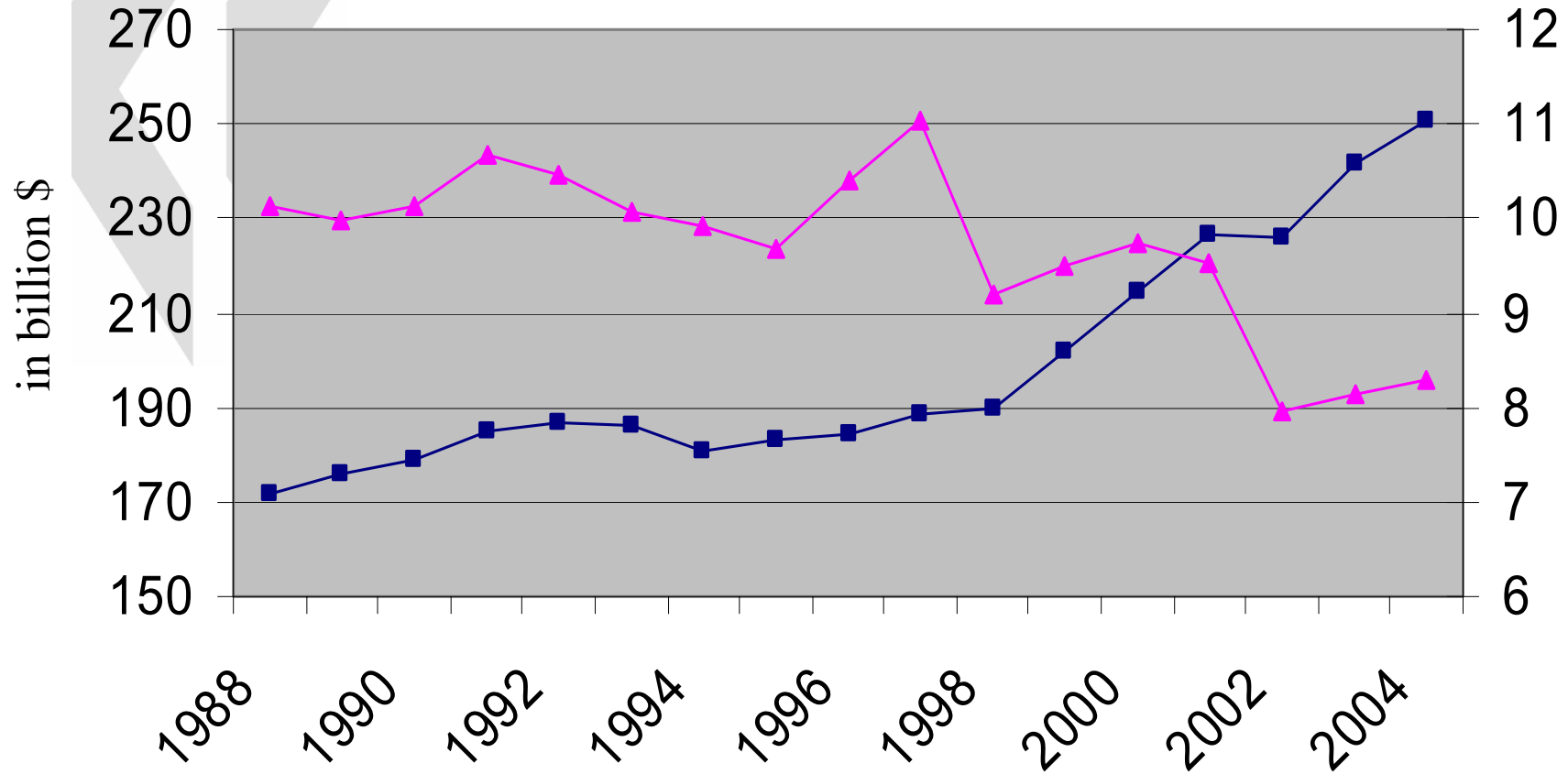
# R&D priorities and programmes

## - not up to the task -

- Trend is declining, challenge is increasing
  - Public [expenditure](#)
  - Private [expenditure](#)
- [R&D intensity](#) in comparison with other sectors of the economy is low
- [Energy R&D portfolio](#) is not well focused (Solar, CCS seem under funded)



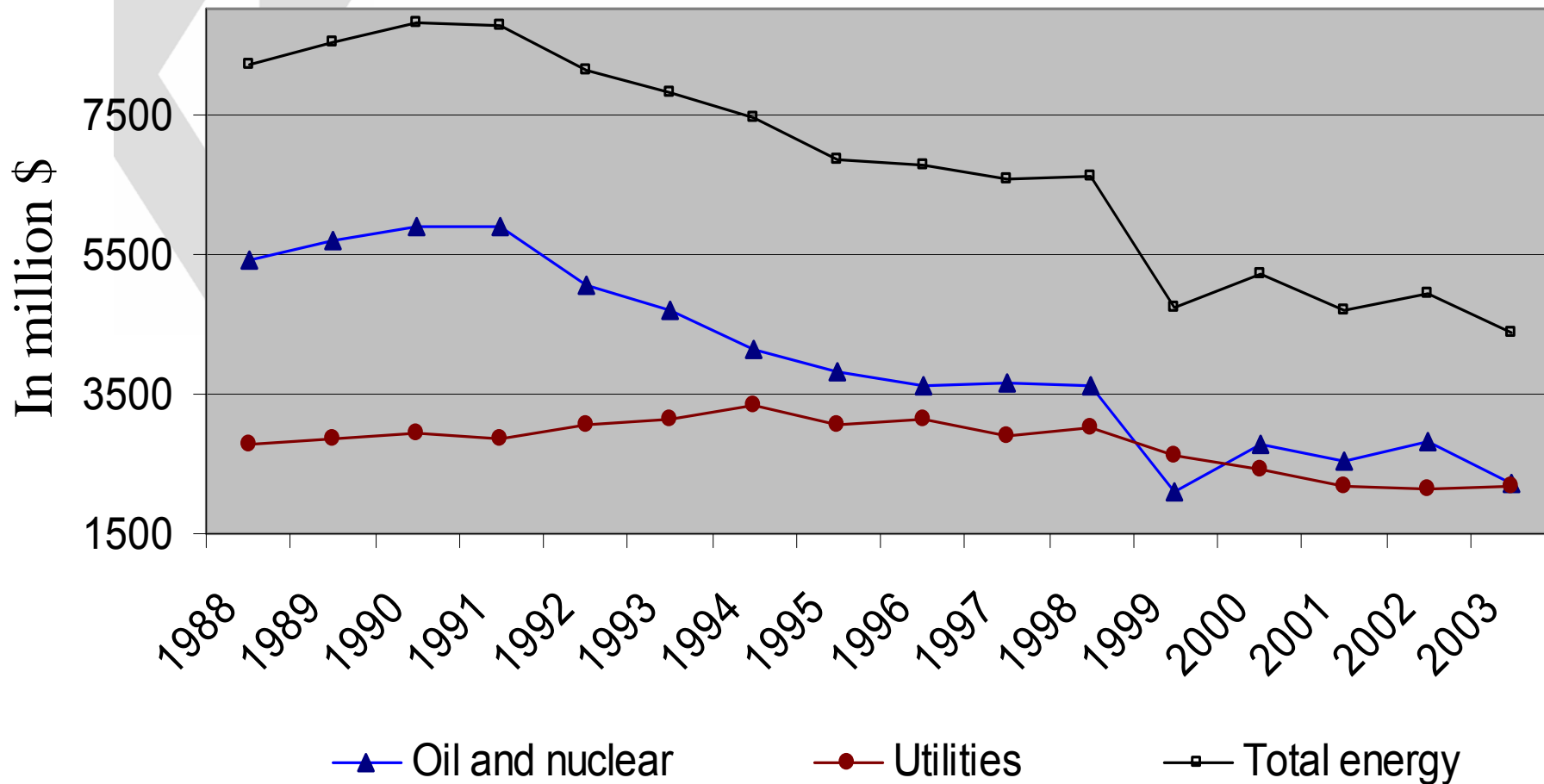
# Development public R&D expenditure (in OECD)



■ Total R&D (left axis) ▲ Energy R&D (right axis)

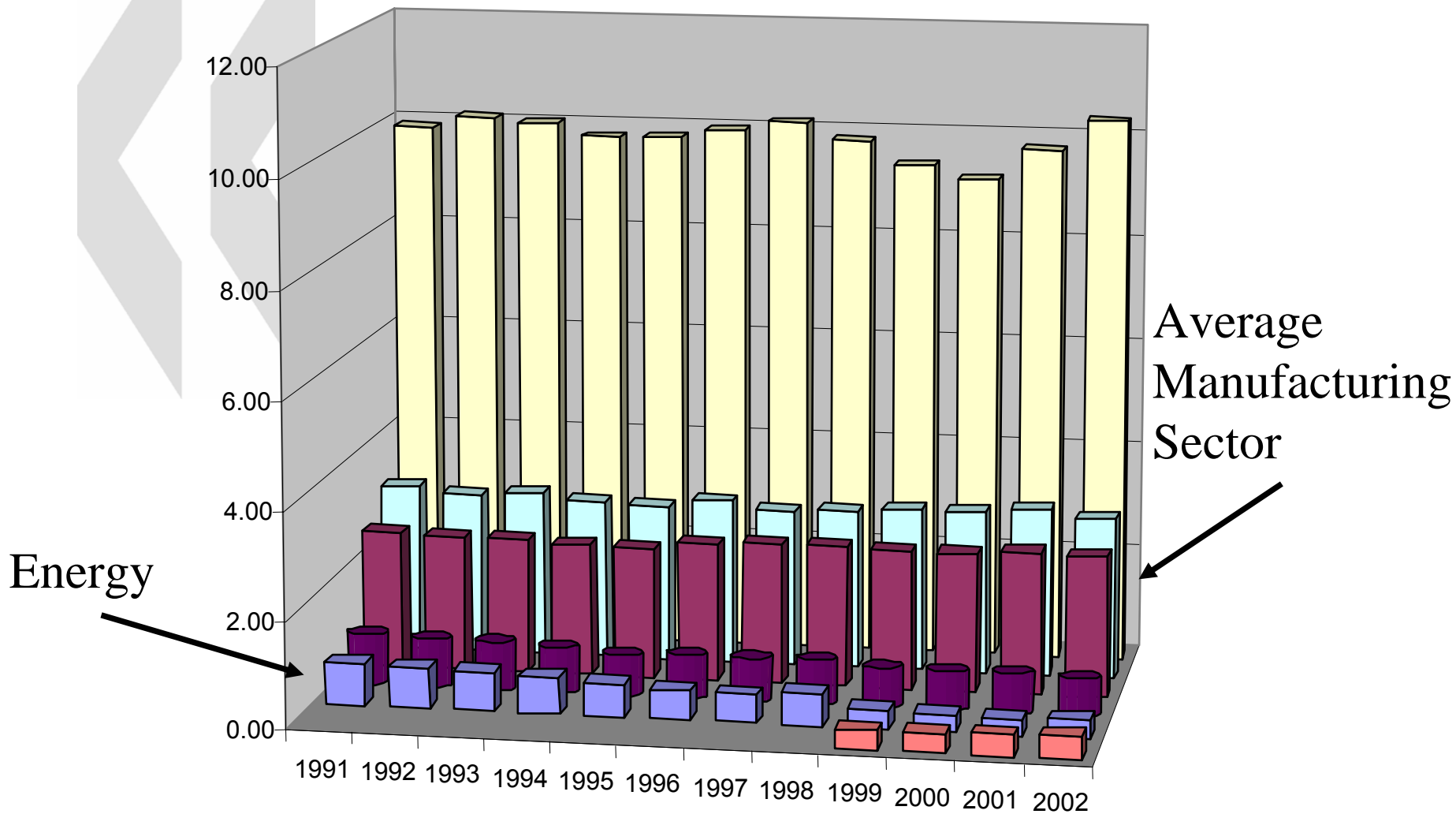


# Development private R&D expenditure (in OECD)



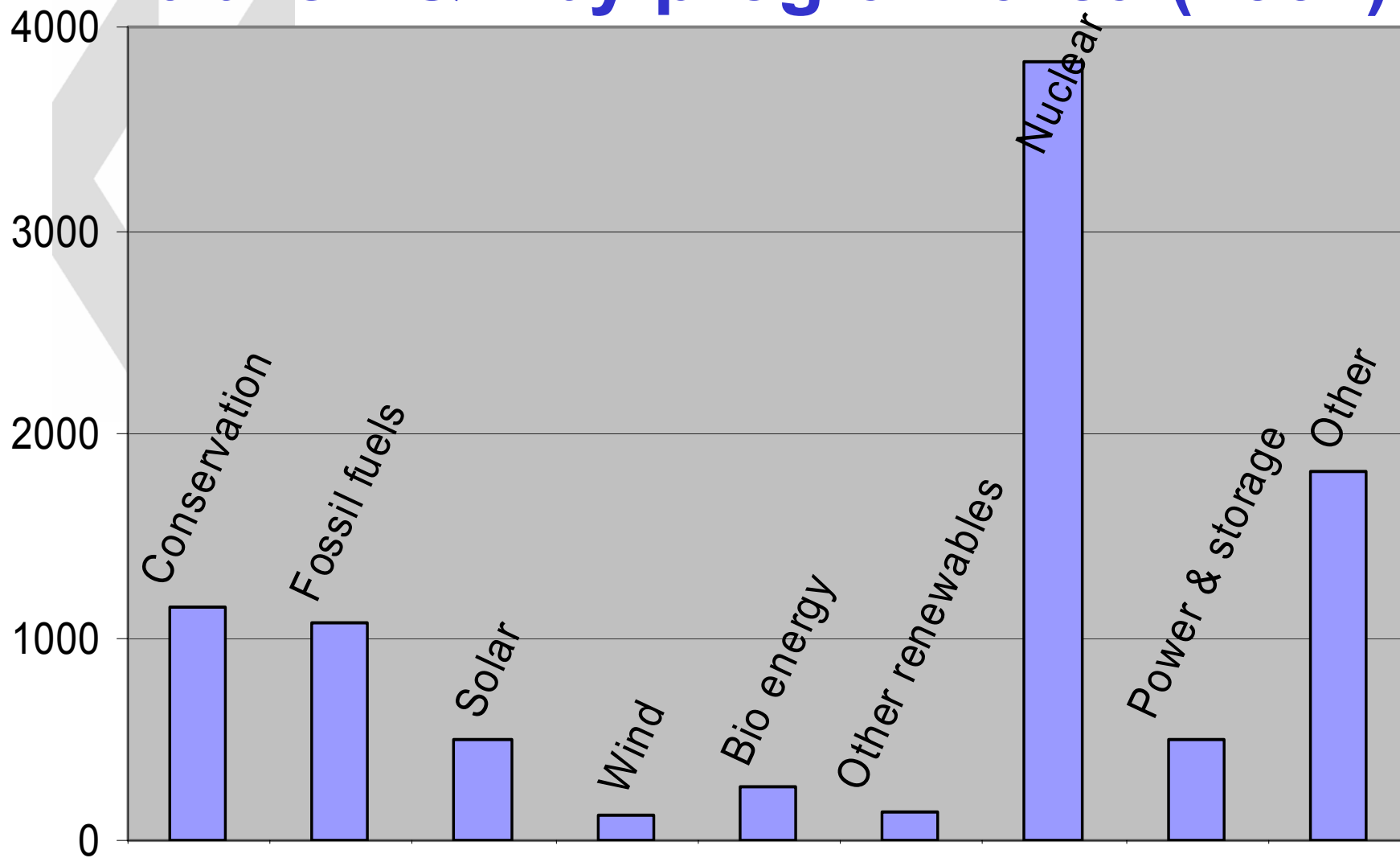


# R&D intensity





# Public R&D by program area (2004)



Source: IEA

## Catch 22?

- Treaty, only if the technology is there at low cost
- Technology becomes available at low cost, only if there is a treaty
- Is the technology there? At what costs?
  - Pacala and Socolow's Stabilisation Wedges (2004)
  - IEA Technology perspectives (2006)
  - Annual increase in real energy price  $\leq 1\%$ ?



# Energy 2050: carbon price now!

- Real challenge, not security of supply but 'clean' technology
  - in time
  - on a sufficient scale
- Global R&D
  - insufficient
  - important to reduce cost 'clean' technology
  - not crucial for mitigation
  - window of opportunity next 10-20 years
- Global carbon price only way!

# References

- **Doornbosch, R.A. and S. Upton (2006)**, *Do we have the Right R&D Priorities and Programmes to Support the Energy Technologies of the Future*, OECD Round Table on Sustainable Development, Paris, France
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