

# How Much (Energy) RD&D is Enough?

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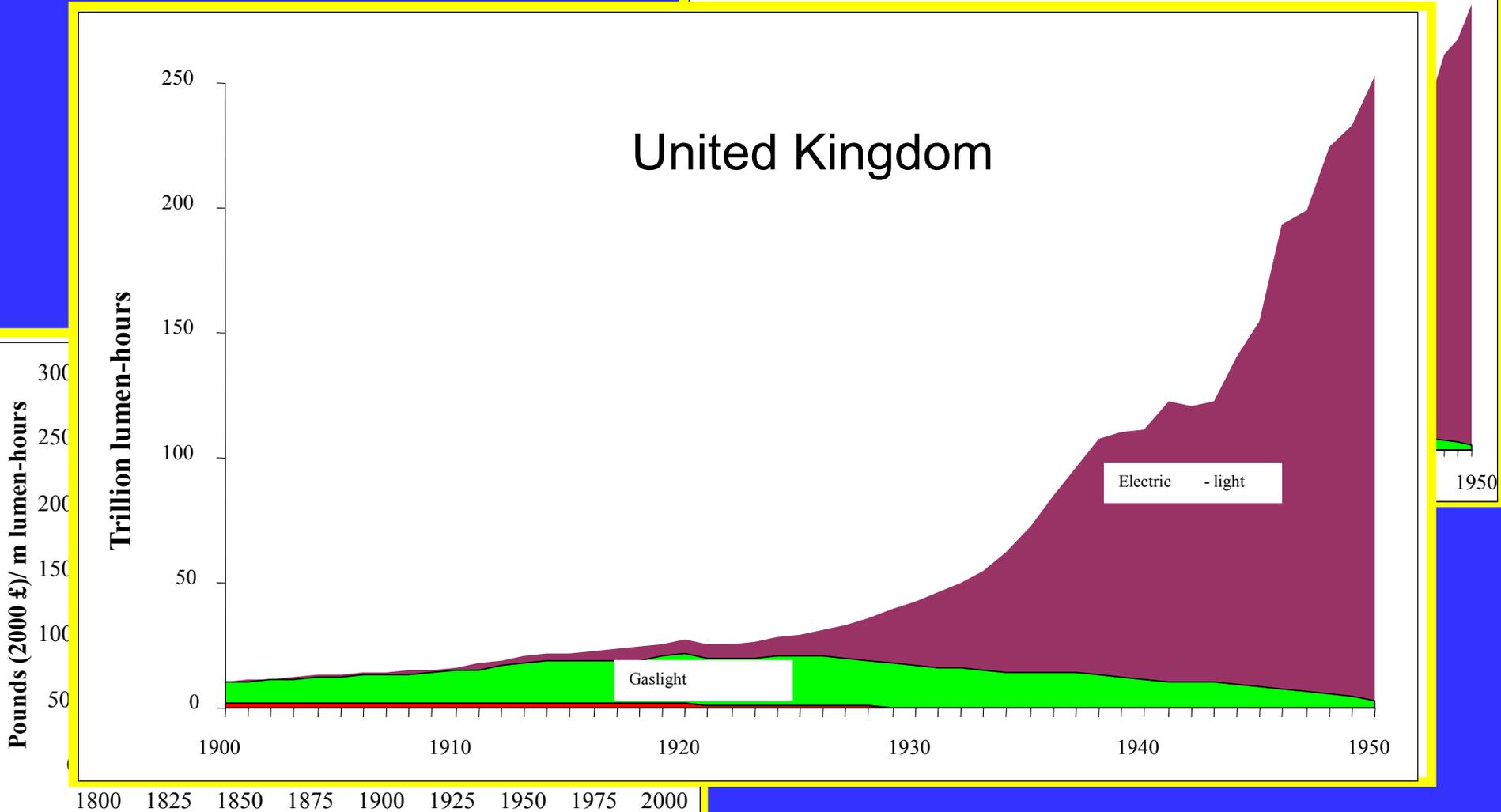
Technische Universität Wien



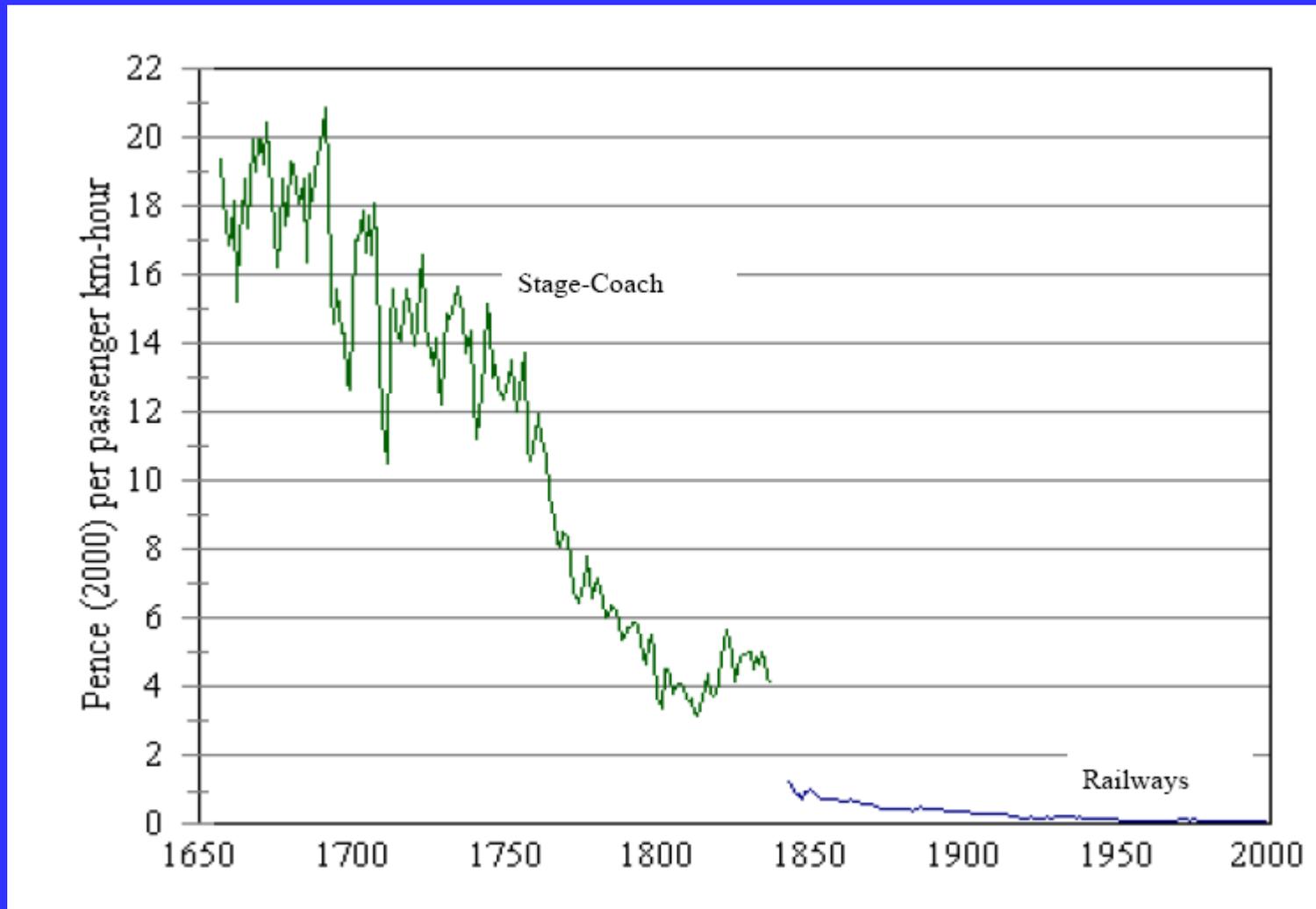
[naki@iiasa.ac.at](mailto:naki@iiasa.ac.at)

Snowmass, Colorado – 3-4 August 2009

# The Example of Lighting



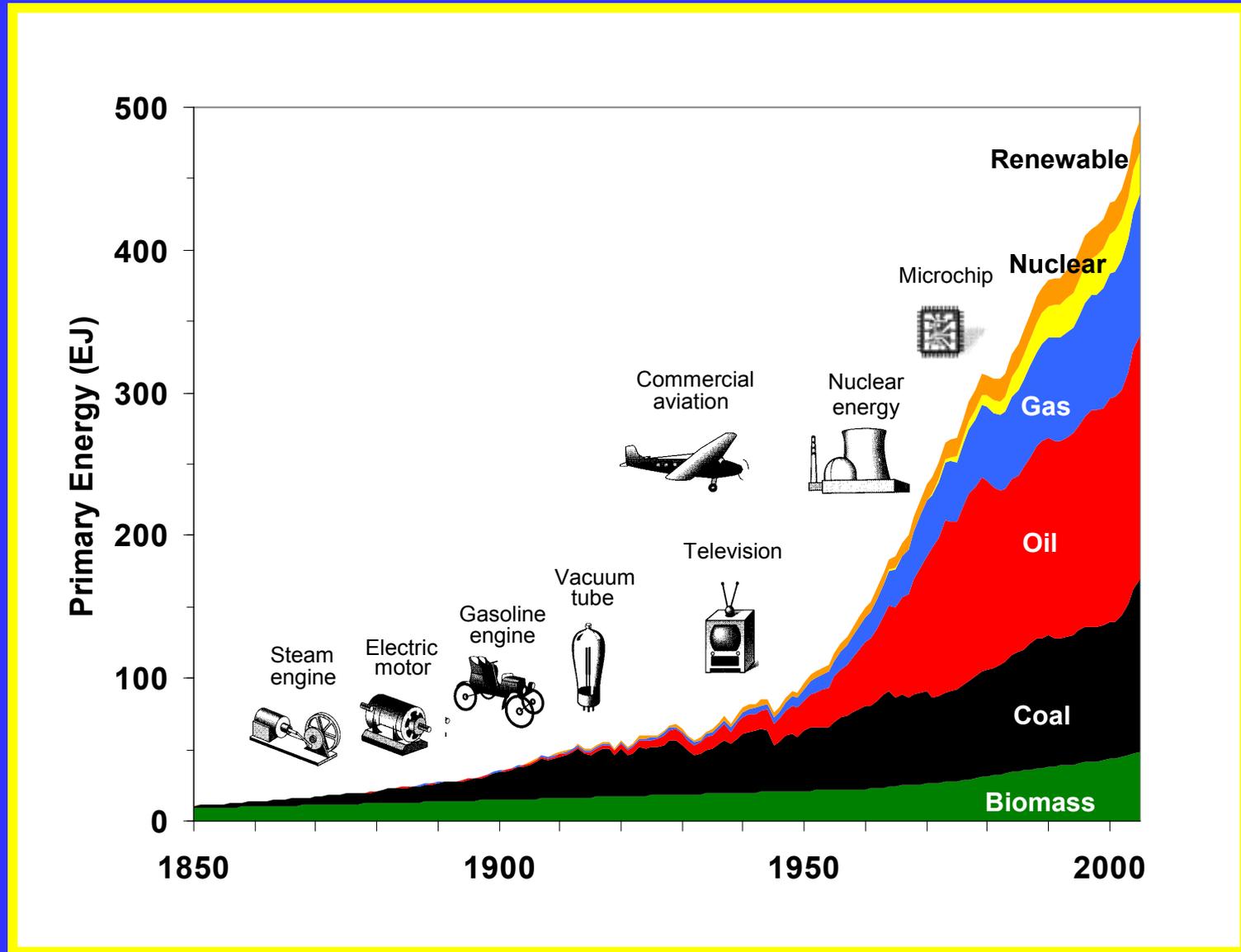
# Price of Passenger Transport (per passenger-kilometer-hour)



# Technological Change: Dynamic, Cumulative, Systemic and Uncertain

- Incremental – gradual (continuous) and cumulative improvements
- Abrupt – radical, discontinuous and disruptive as “gales of creative destruction”

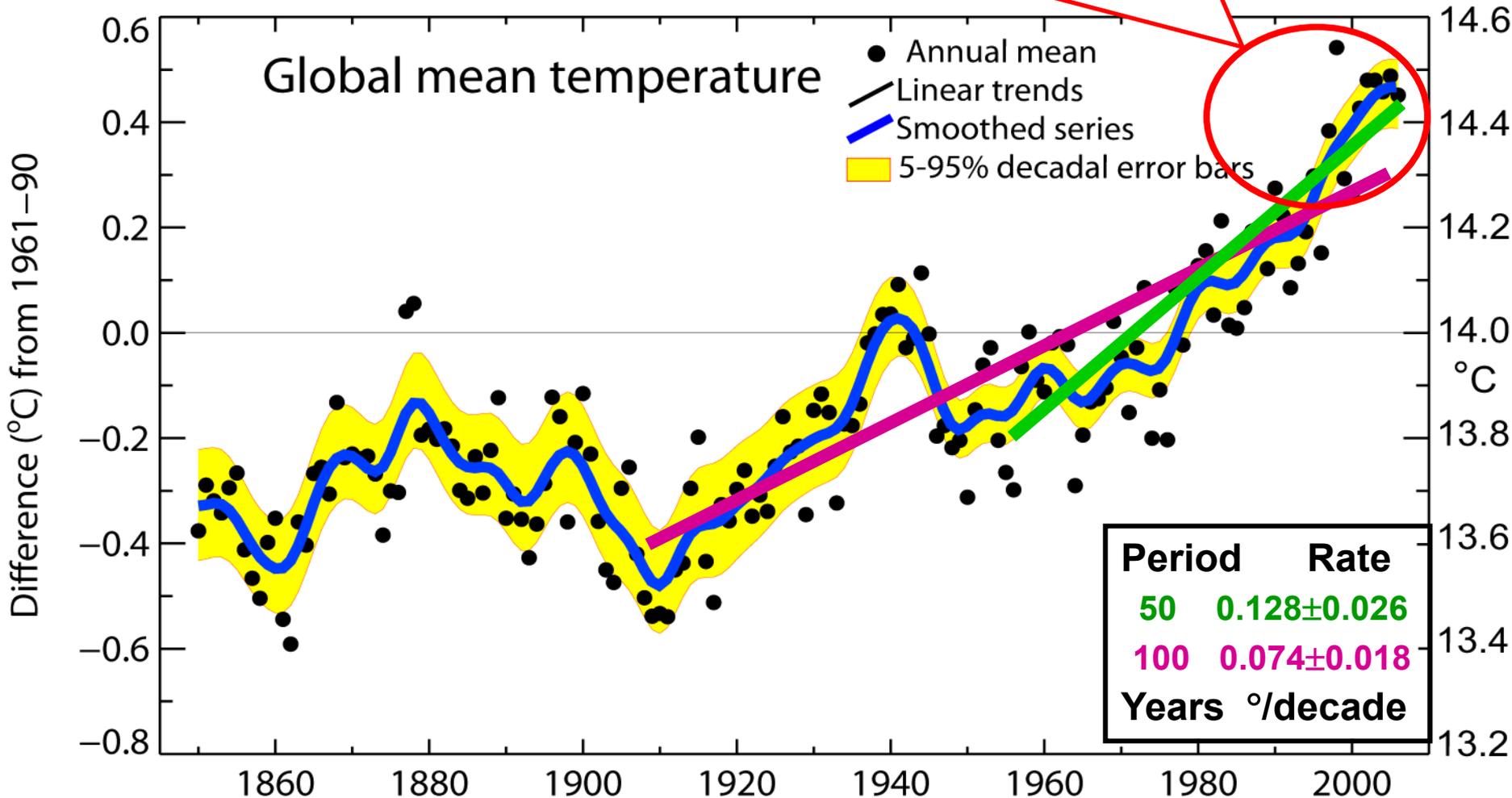
# World Primary Energy



# Global Mean

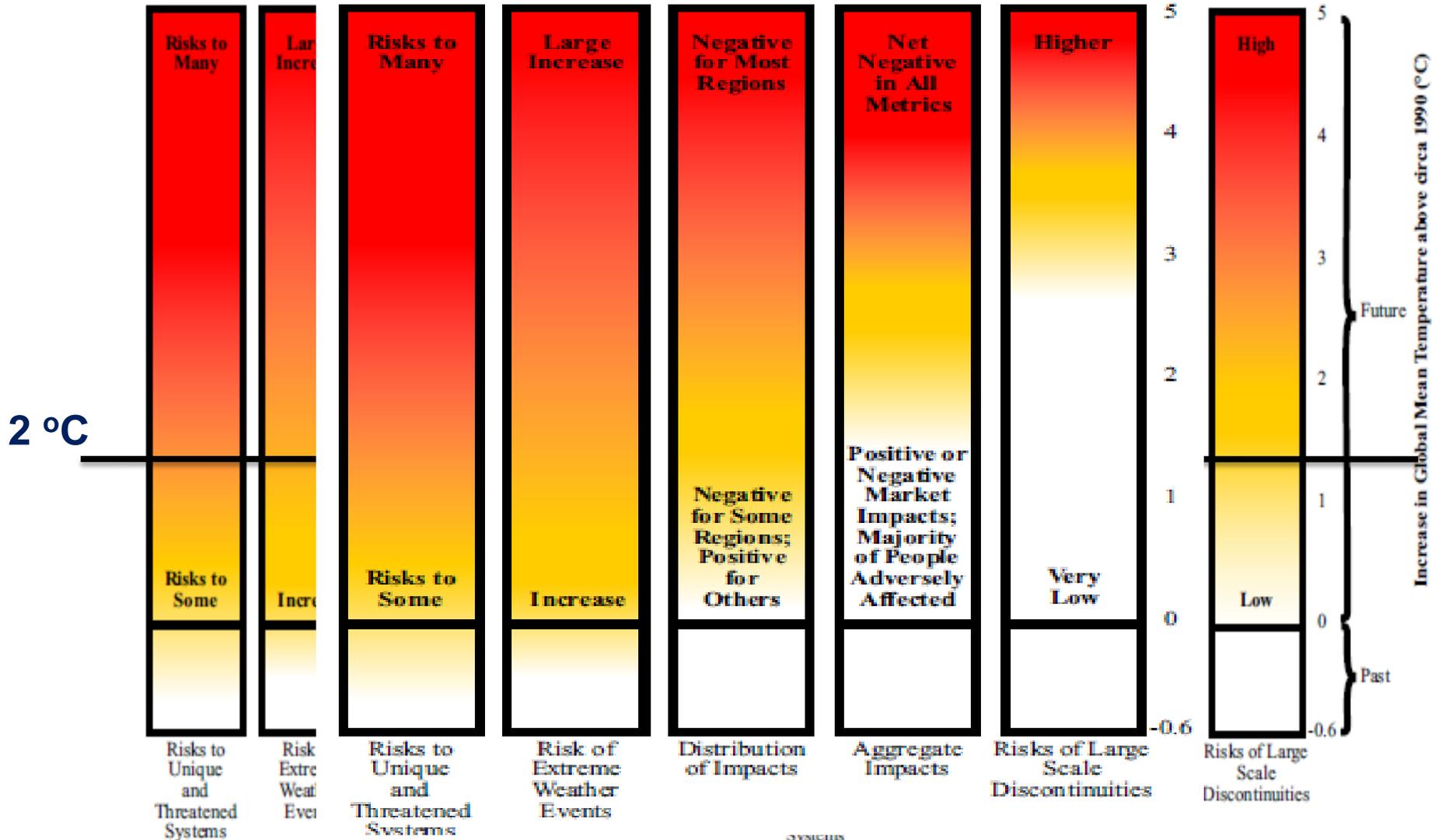
**Warmest 12 years:**  
1998, 2005, 2003, 2002, 2004, 2006,  
2001, 1997, 1995, 1999, 1990, 2000

# ing



# Reasons for Concern – “Red Amber”

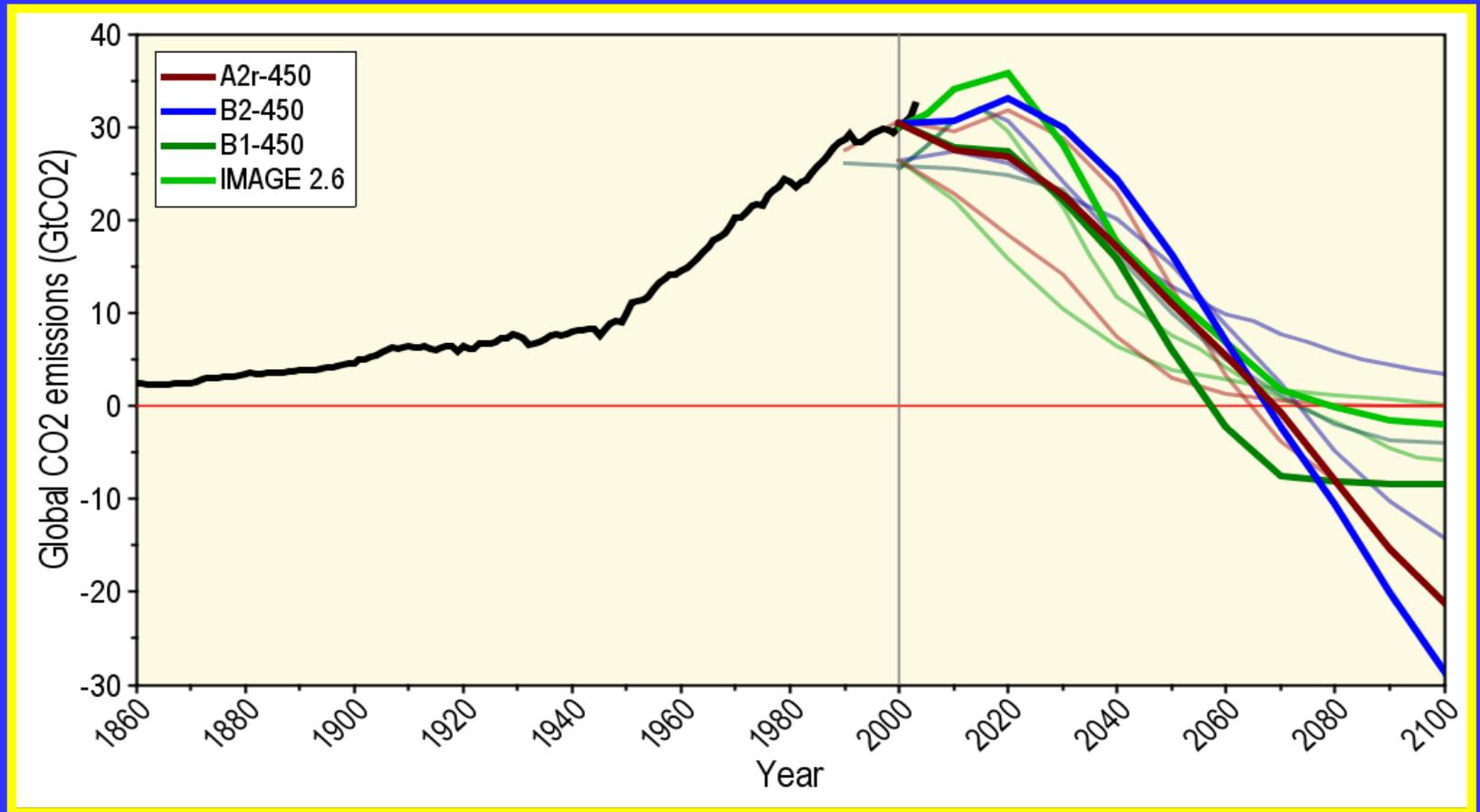
TA TAR (2001) Reasons For Concern



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Source: IPCC TAR, 2001

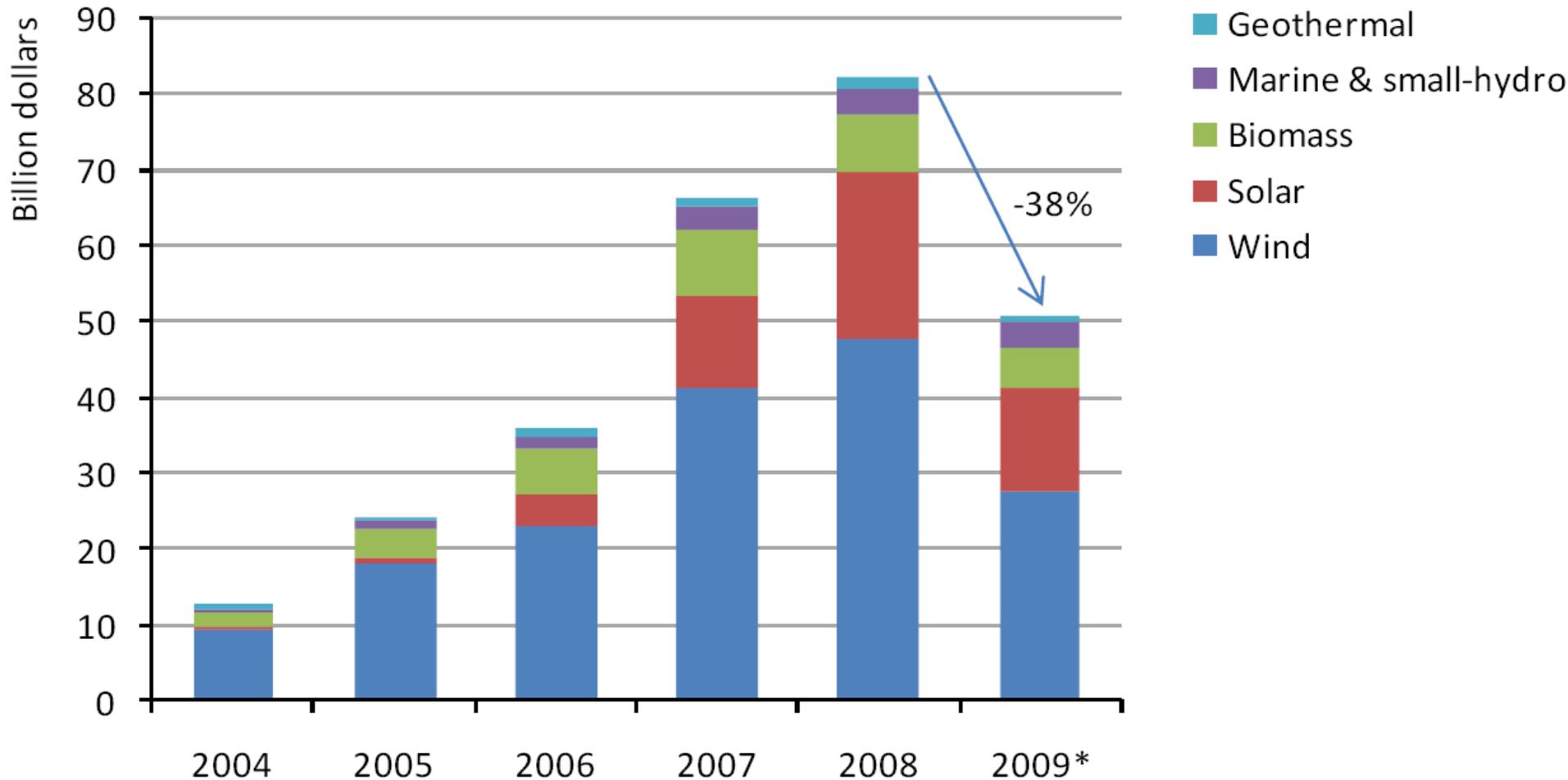
# Global Carbon Emissions



# New Worlds: What's Needed

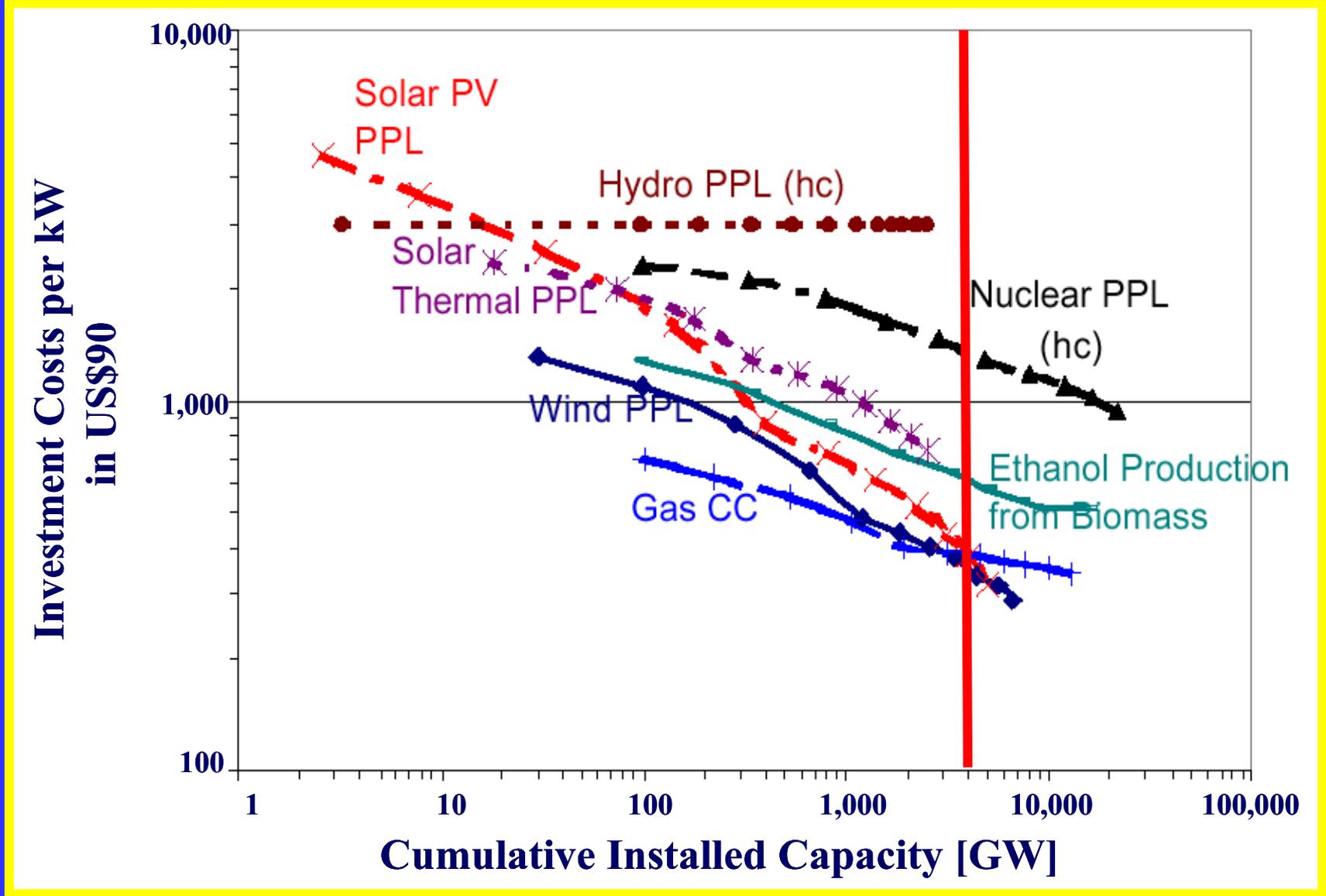
- Knowledge capital (including R&D)
- Investments into niche markets
- Technology deployment & diffusion  
(=investments, overcoming capital constraints, new combinations)

# Global Investments in New Renewables



Source: IEA, 2009

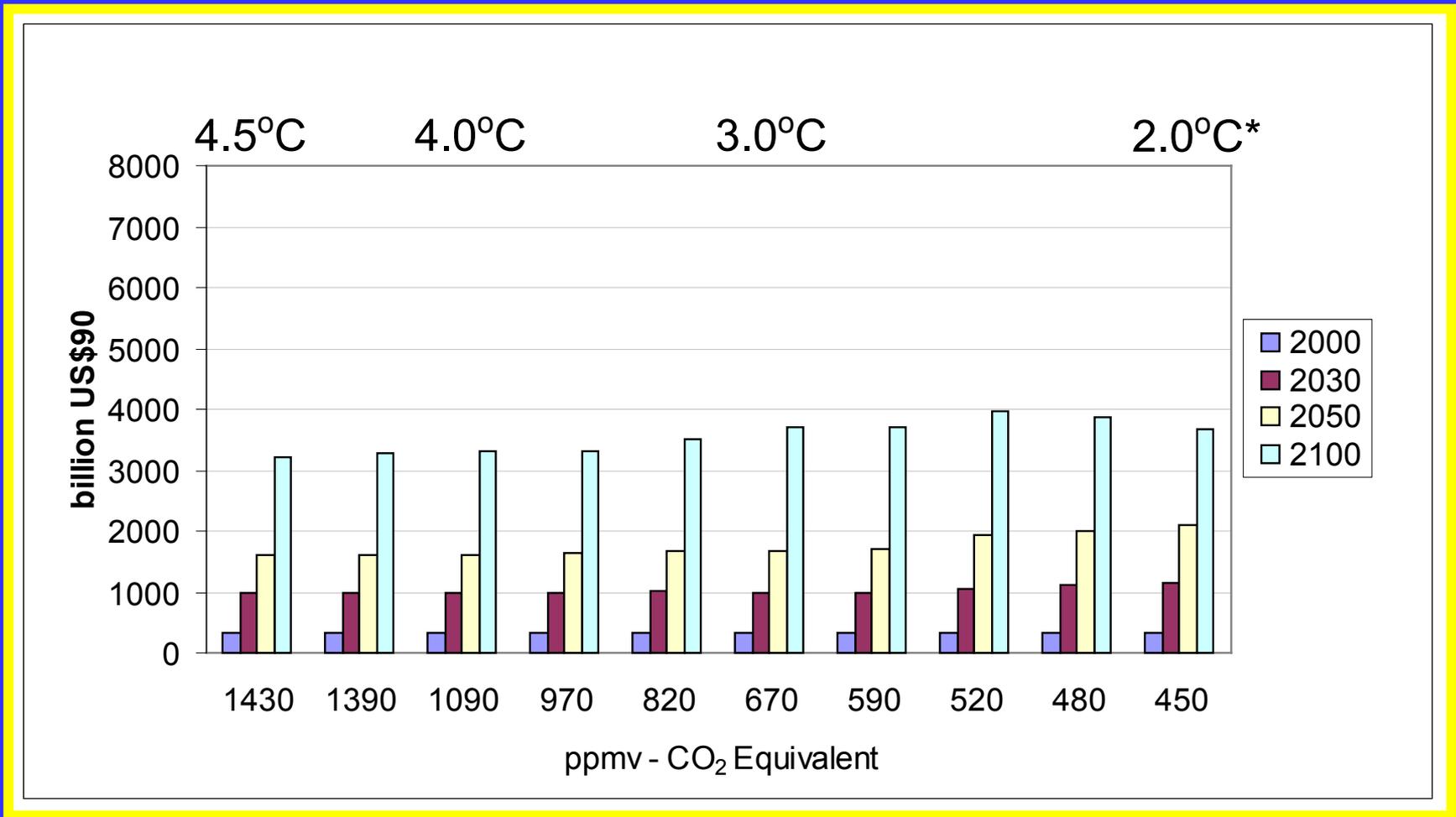
# Technology Learning in SRES





# Energy Supply Investments

## Global – Supply Side Only

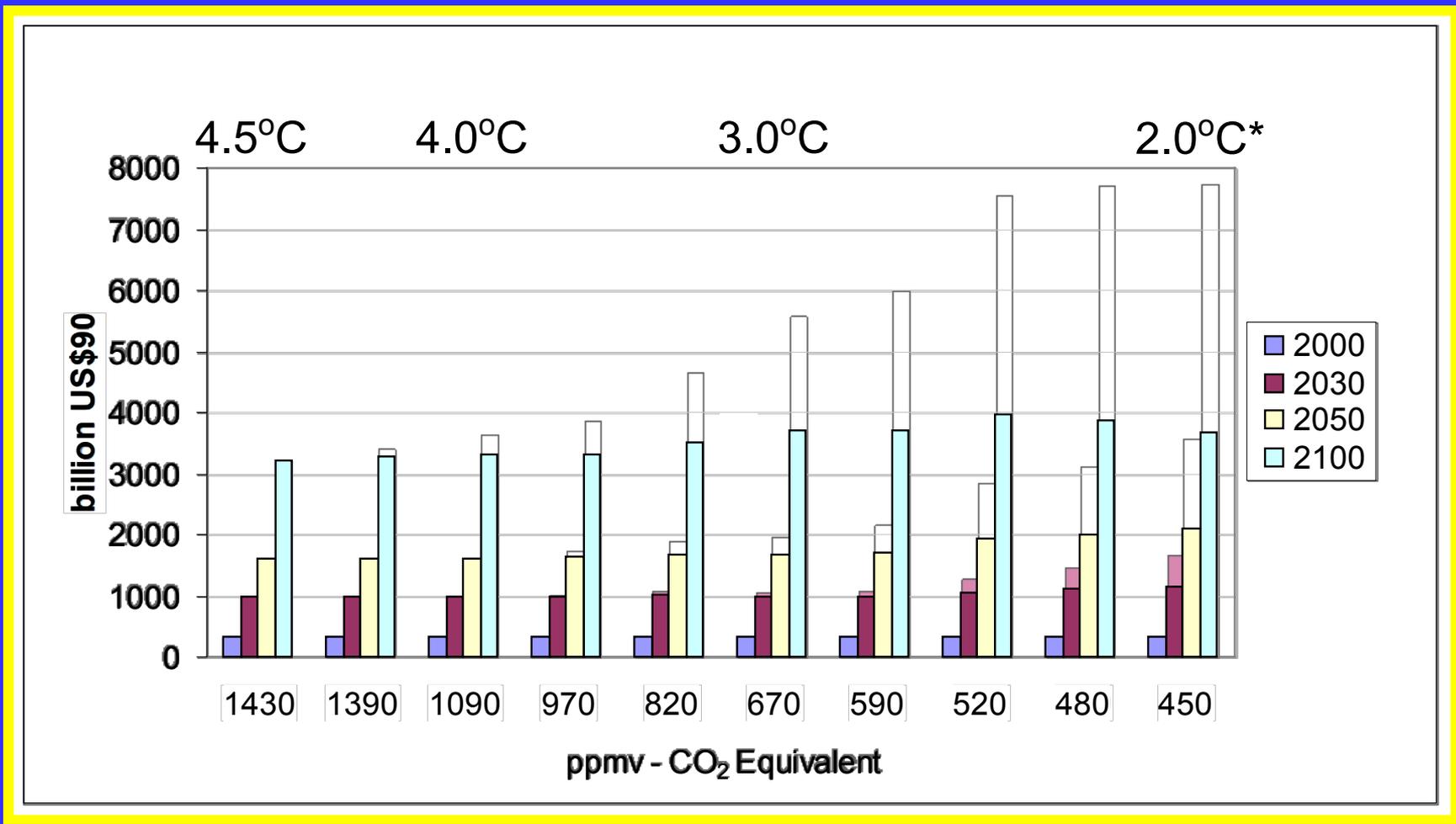


\*) maximum temperature change over the 21<sup>st</sup> century assuming 3C climate sensitivity



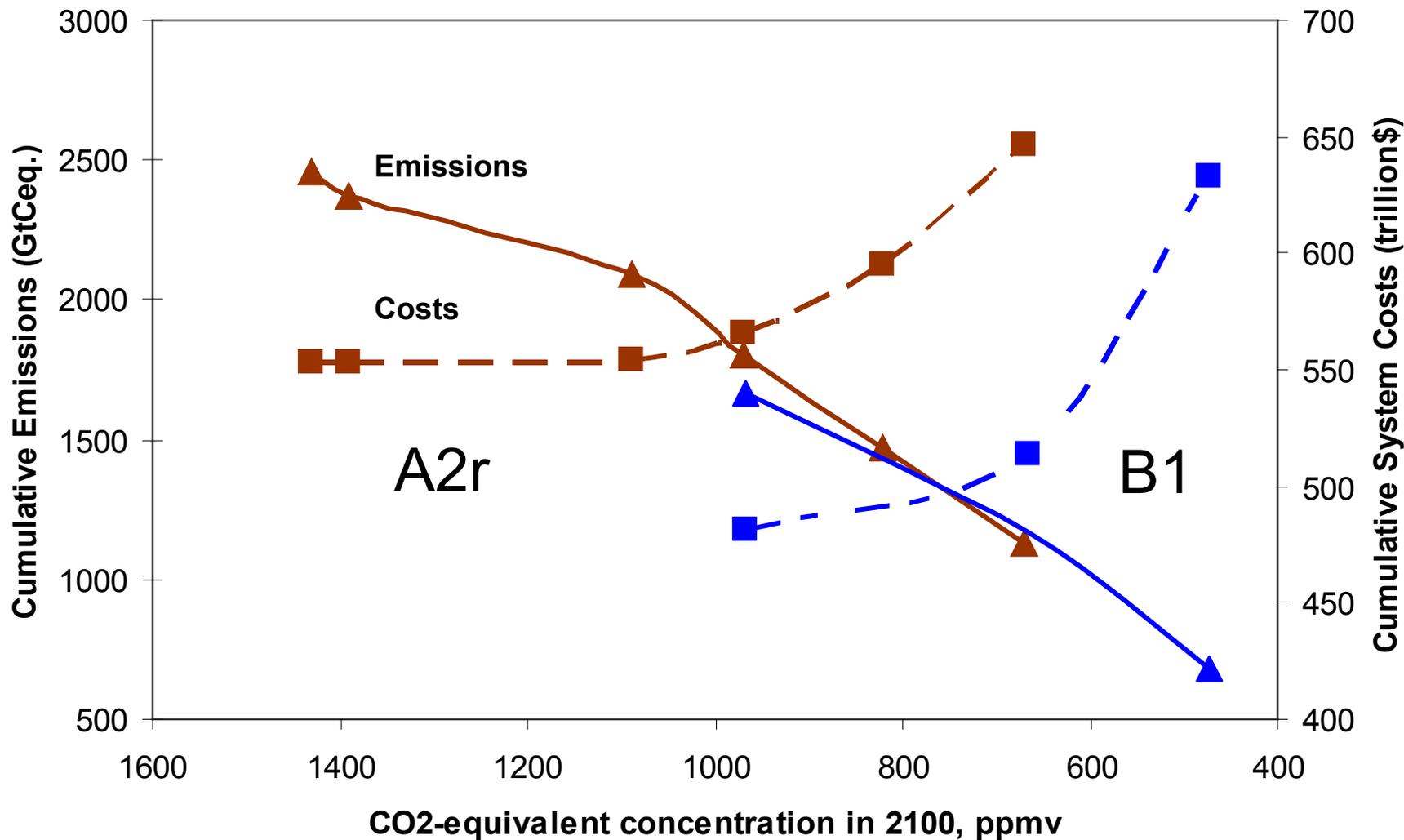
# Energy Systems Investments

## Global – Supply Side and End Use

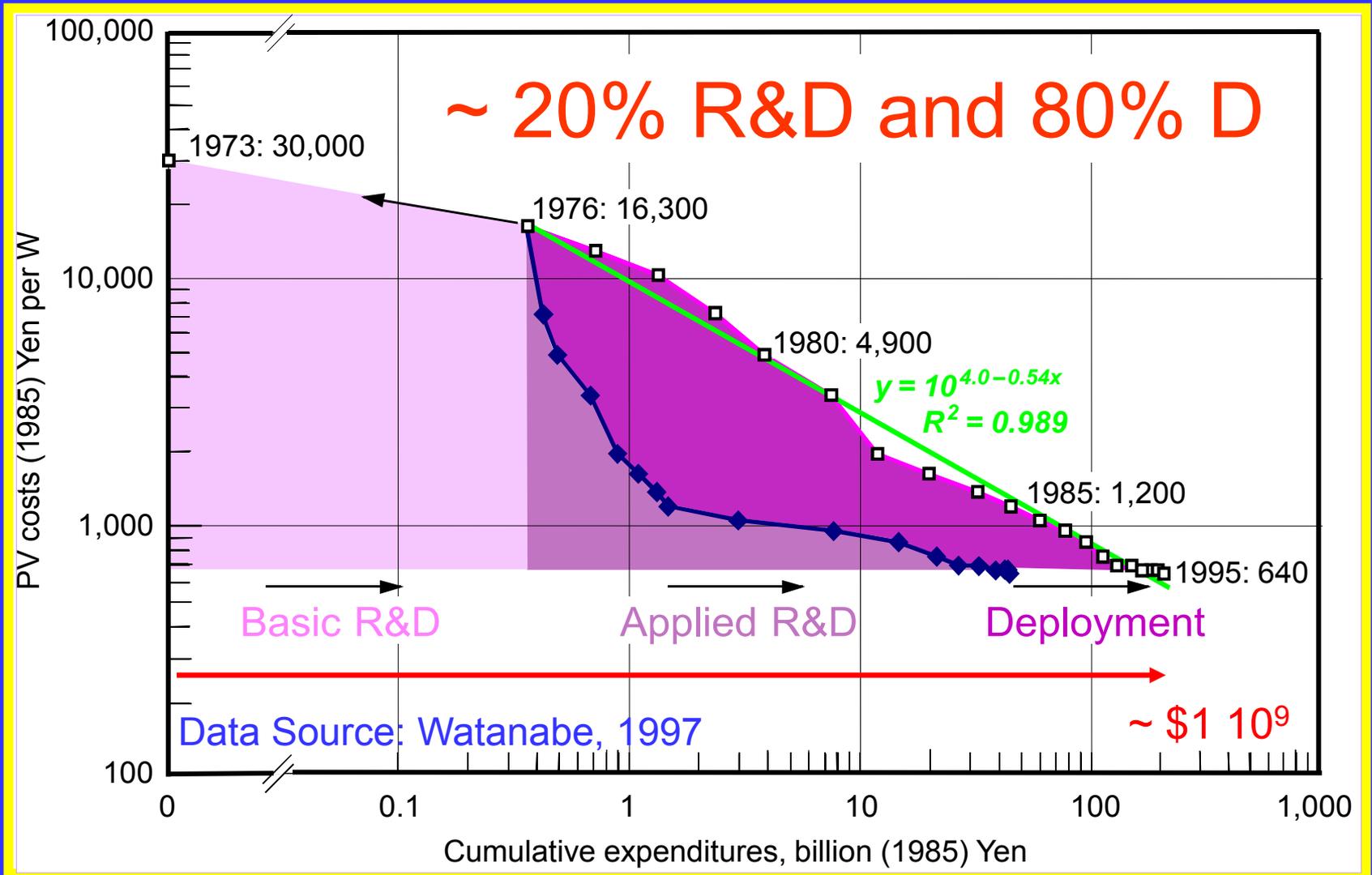


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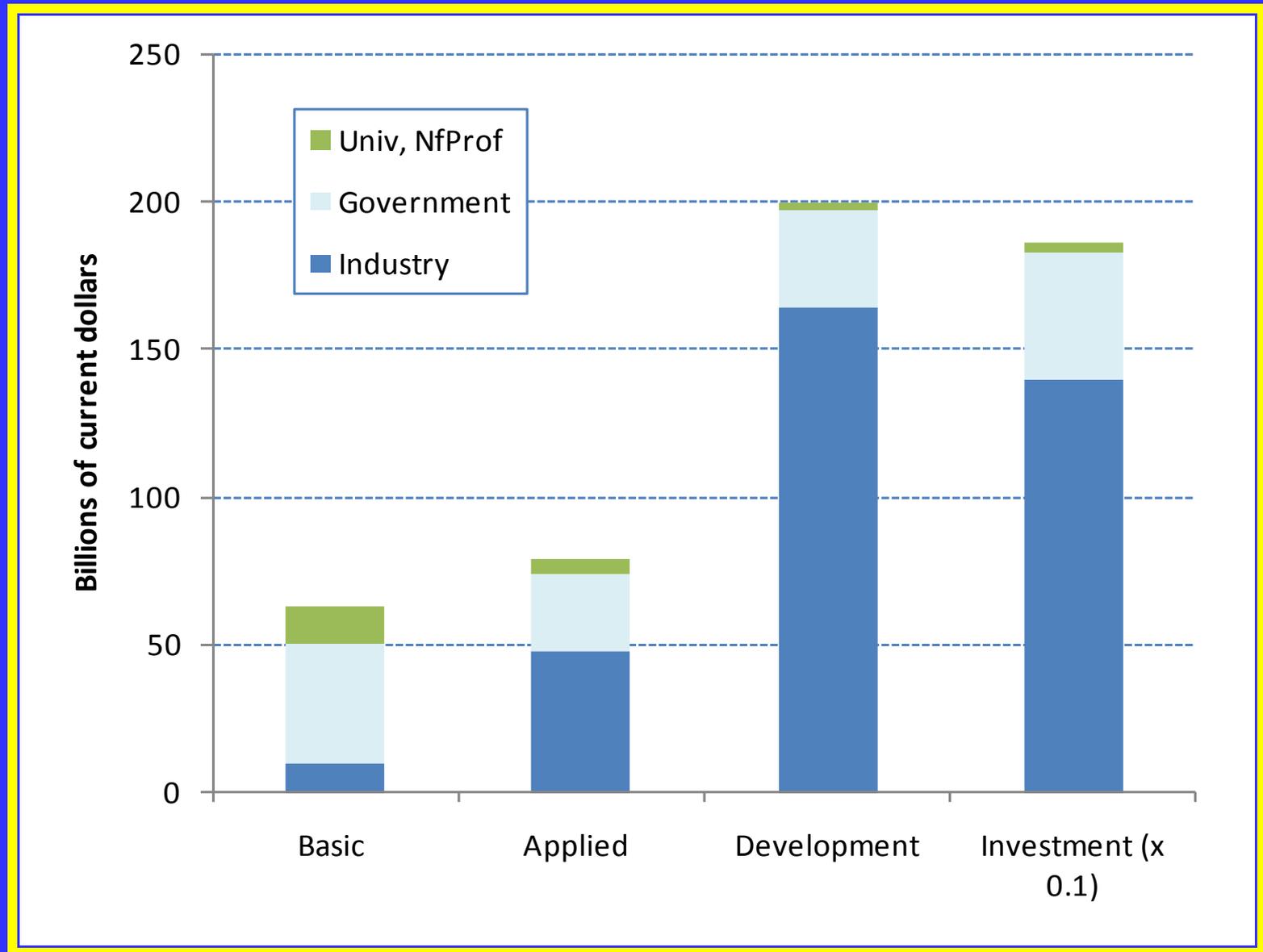
# Emissions and Costs 2000-2100



# Japan - PV Costs vs. Expenditures



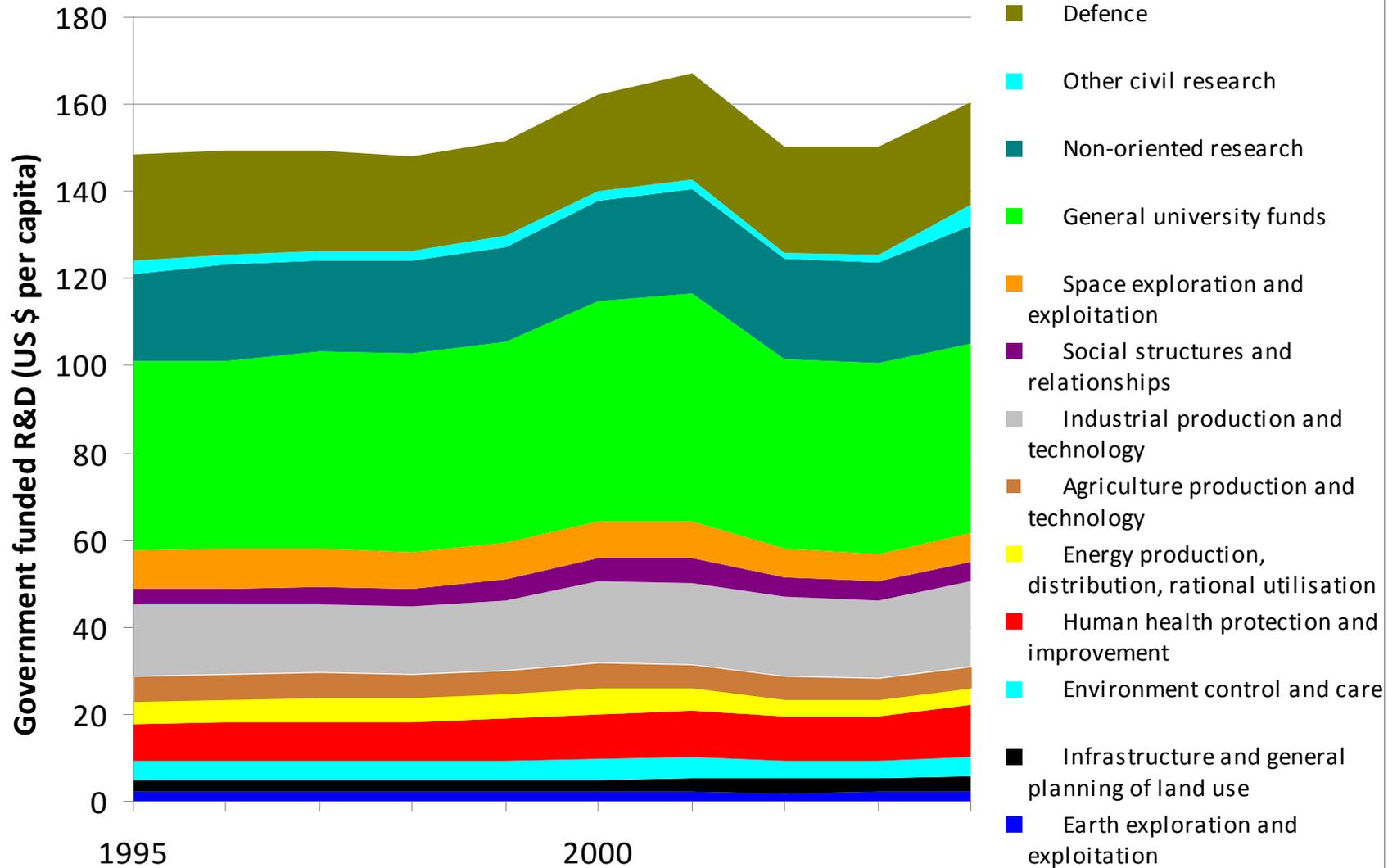
# Innovational spending by sector and type



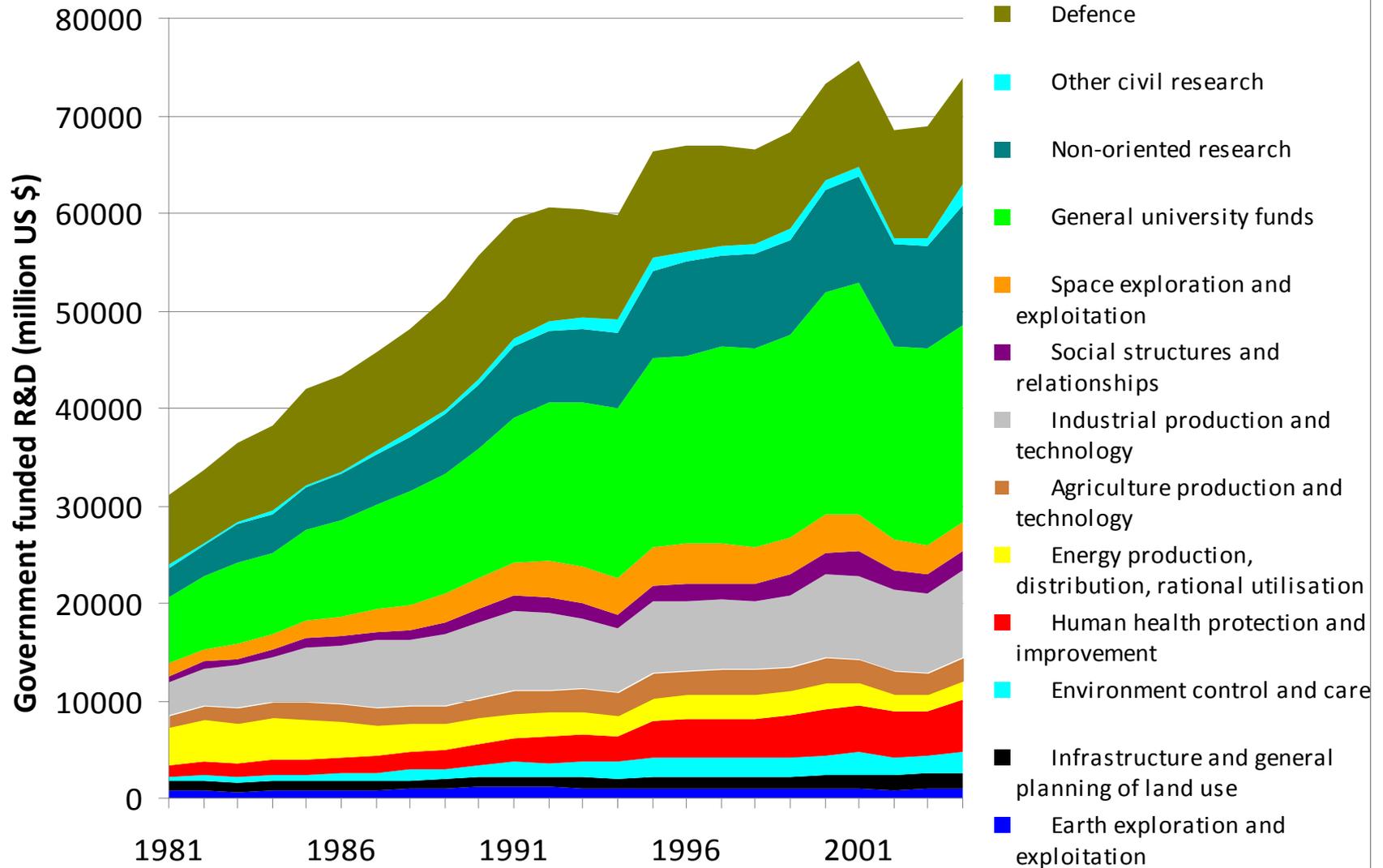
# How Much Energy RD&D is Enough?

- \$10bn public & ~ \$40bn private
- Investments ~ \$350-500bn
- 20:80 Rule → R&D \$70-100bn
- Required investments ~ \$1000bn  
→ R&D \$70-100bn

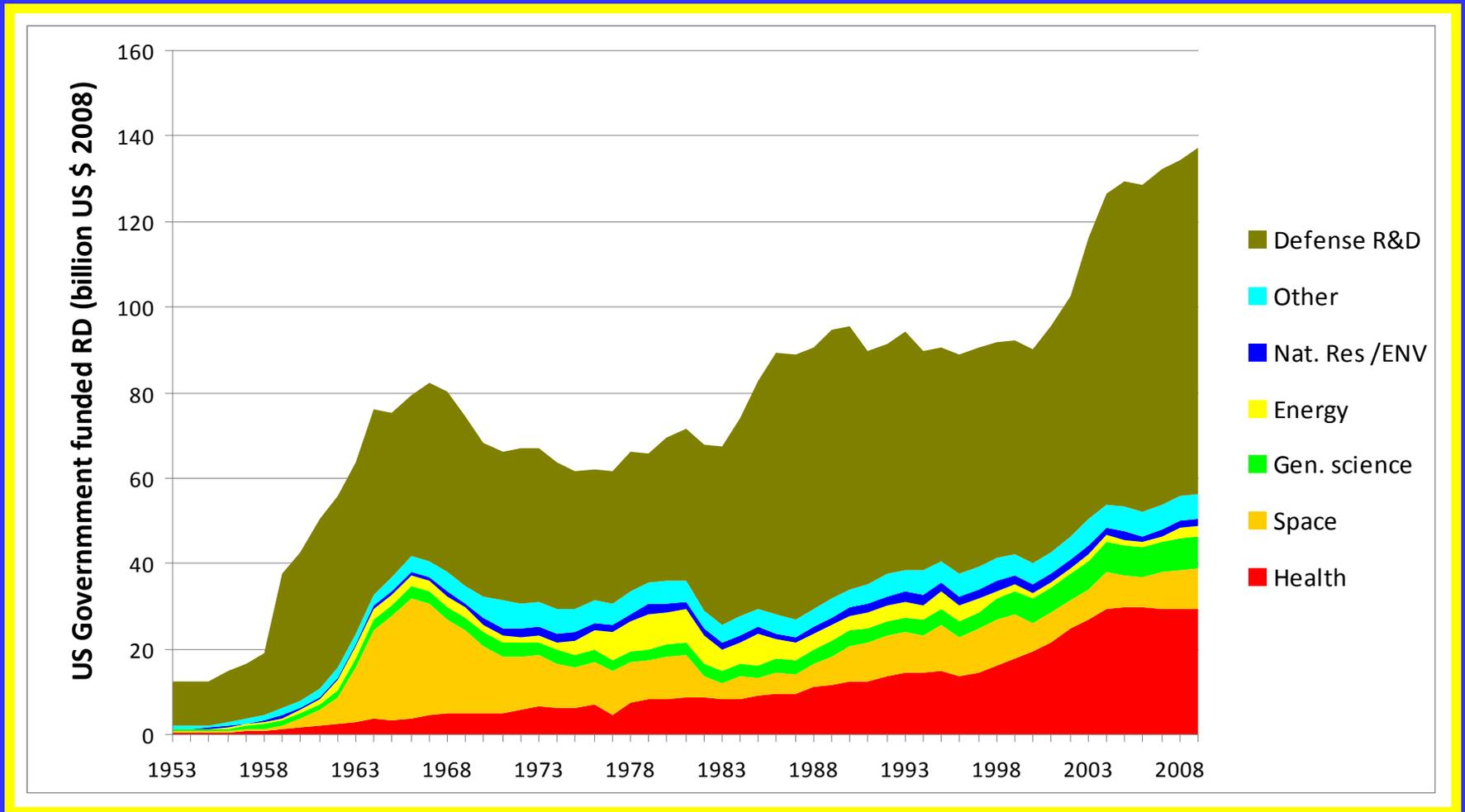
# EUROPEAN UNION 25



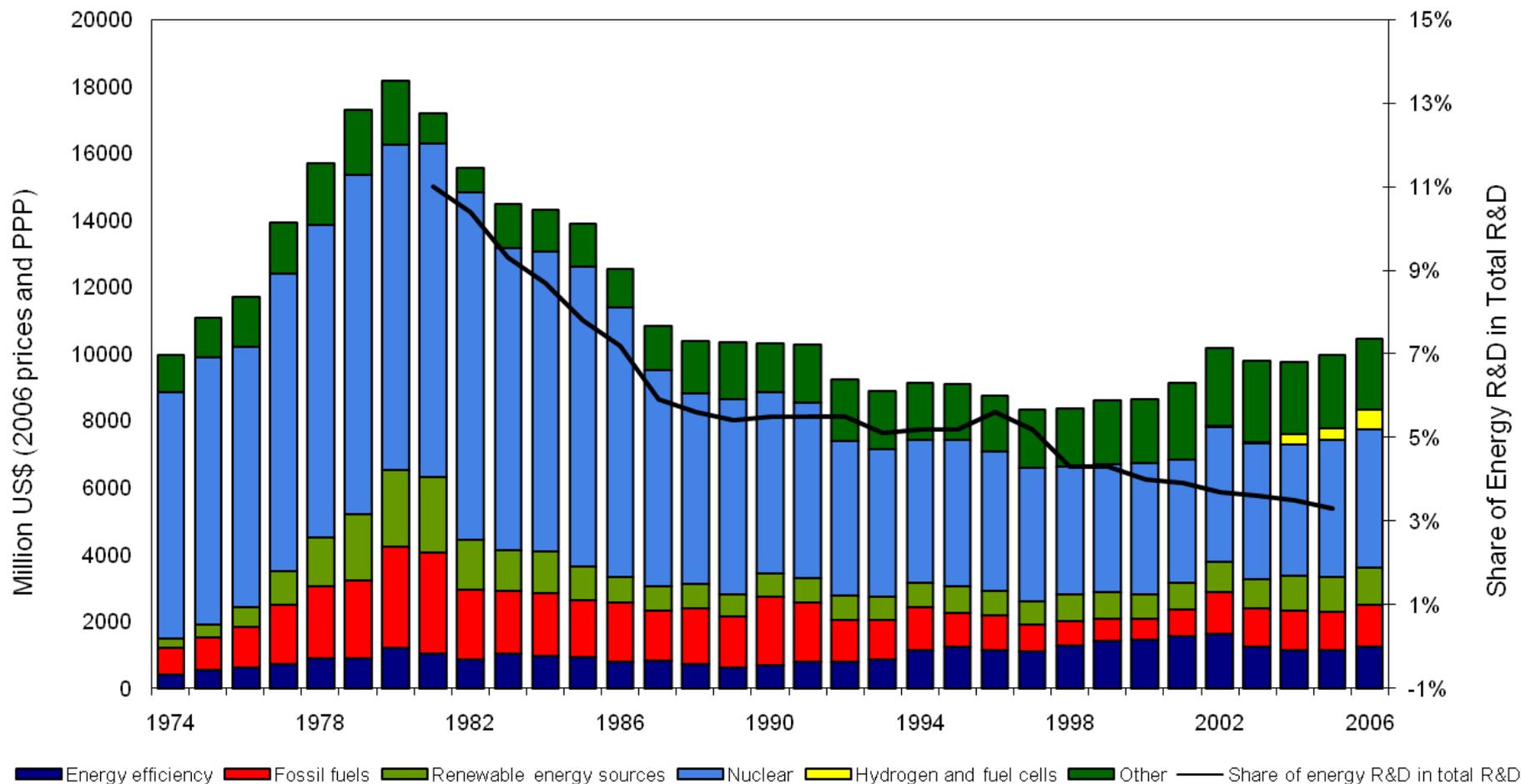
# EUROPEAN UNION 25



# UNITED STATES

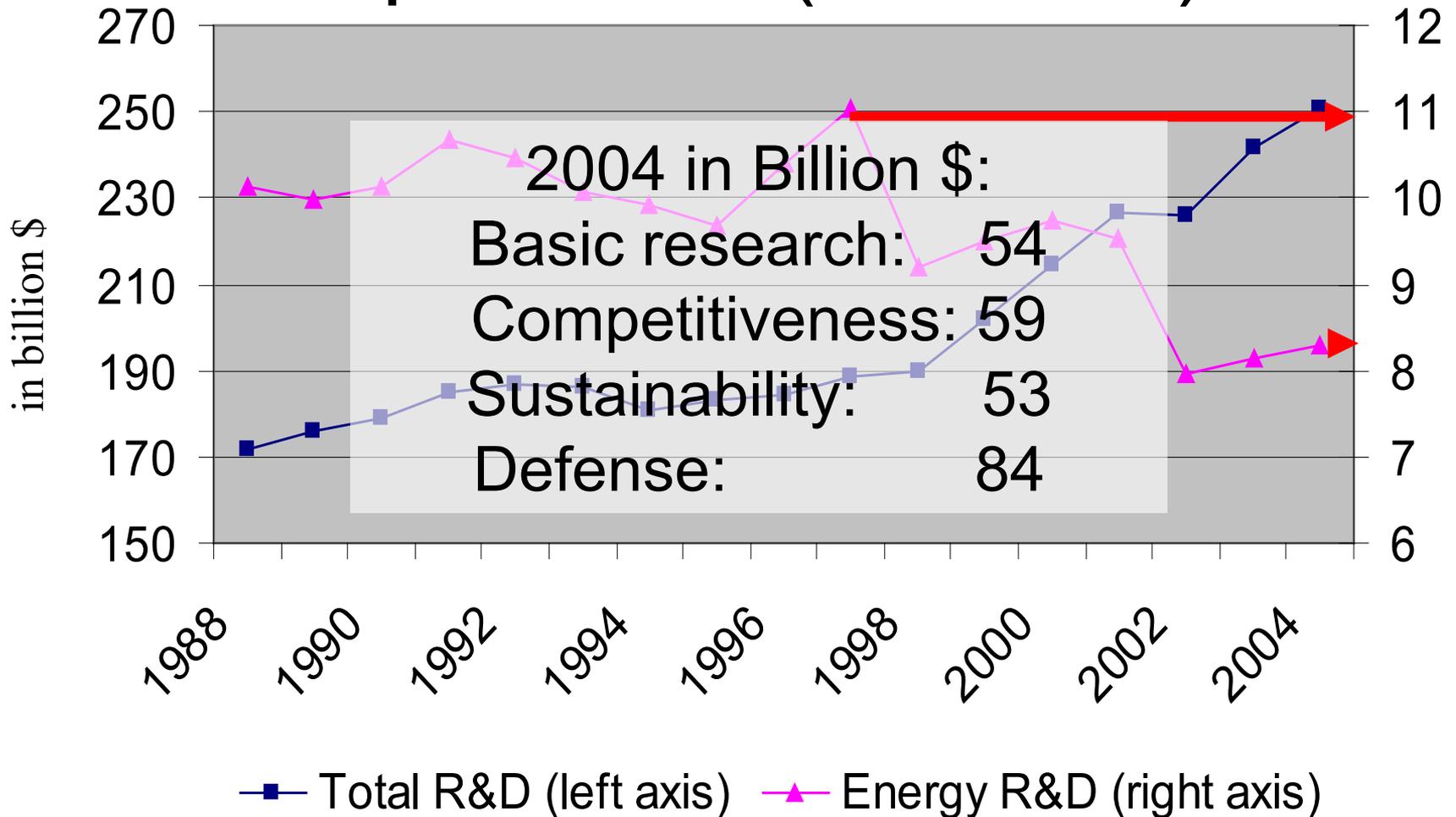


# Public Energy R&D in IEA Countries



Private-sector R&D is increasingly focused on projects with short-term payoffs.  
 Source: IEA Databases, Doornbosch, et al., 2008

# Development public R&D expenditure (in OECD)



Source: Doornbosch, 2006

“Energy RD&D programs are not commensurate in scope and scale with the energy challenges & opportunities the 21<sup>st</sup> century will present.”

# Investments Themes in Stimulus Packages

Green New Deals? Climate Change Investment Themes in 2008 Stimulus Packages (USD bn)

Country	Stimulus Package	Total Package	Low Carbon Power (Renewables, CCS)	Energy Efficiency, R&D, Modal Shift	Waste, Water Treatment & Pollution Control	Green Investments (%)	Other Infra	Period	Status
Chile	Anti-crisis stimulus package	4.0	-	-	-	-	0.7	2009	Pending
China	NDRC Stimulus Package	581.2	-	147.6	50.9	34%	239.9	2009-2010	Passed
EU	Recovery Plan	253.6	19.0	15.5	-	14%	8.0	2009-2010	Passed
France	Revival Plan	32.9	0.8	2.0	-	8%	18.7	2009-2010	Pending
Germany	Stimulus Plan	63.4	-	11.9	-	19%	-	2009-2010	Pending
India	Stimulus Package	6.8	-	-	-	-	2.0	2009	Passed
Israel	Stimulus Plan	5.0	-	0.1	-	2%	2.3	2010 onwards	Passed
Italy	Emergency Package	101.4	-	1.2	-	1%	-	2009 onwards	Passed
Japan	Stimulus Package	476.0	-	11.0	-	2%	2.2	2009 onwards	Pending
Poland	Stimulus Package	30.0	-	-	-	-	-	2009 onwards	Pending
South Korea	Green New Deal	38.1	-	8.5	17.8	69%	-	2009-2012	Passed
Spain	Stimulus Package	13.9	0.8	0.6	-	10%	11.2	2009	Passed
Thailand	Stimulus Package	8.7	-	-	-	-	-	2009	Pending
United Kingdom	Pre-budget report 2008	29.7	0.6	1.4	-	7%	26.5	2009	Pending
United States	Emergency Economic Stabilization Act	700.0	12.0	1.7	-	2%	0.9	Next 10 years	Passed
	Economic Stimulus Package	825.0	10.4	85.9	32.3	16%	9.2	2009-2010	Pending
<b>Total Funds Unveiled</b>		<b>3170</b>	<b>43.5</b>	<b>287.4</b>	<b>101.0</b>	<b>14%</b>	<b>321.5</b>	<b>Available from 2 to 10 yrs</b>	

Source: HSBC

Source: HSBC 2009

# Towards a more Sustainable Future

- The *magnitude of the change* required will be huge
- The challenge is to find a way forward that addresses *simultaneously* multiple challenges ... climate change, security and equity issues.
- *Paradigm change is needed* radical increase in R&D efforts, both public and private, capacity building and technology deployment and diffusion
- Needs to be *globally integrated* but with maximum support of countries and local levels.

Need Good  
Entrepreneurships