The World Nuclear Industry in 2009

Renaissance or Decline?

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International Lessons and Transparency in Decision-Making/State Policies »,
Review Sub-committee of the 2007 Power Development Programme
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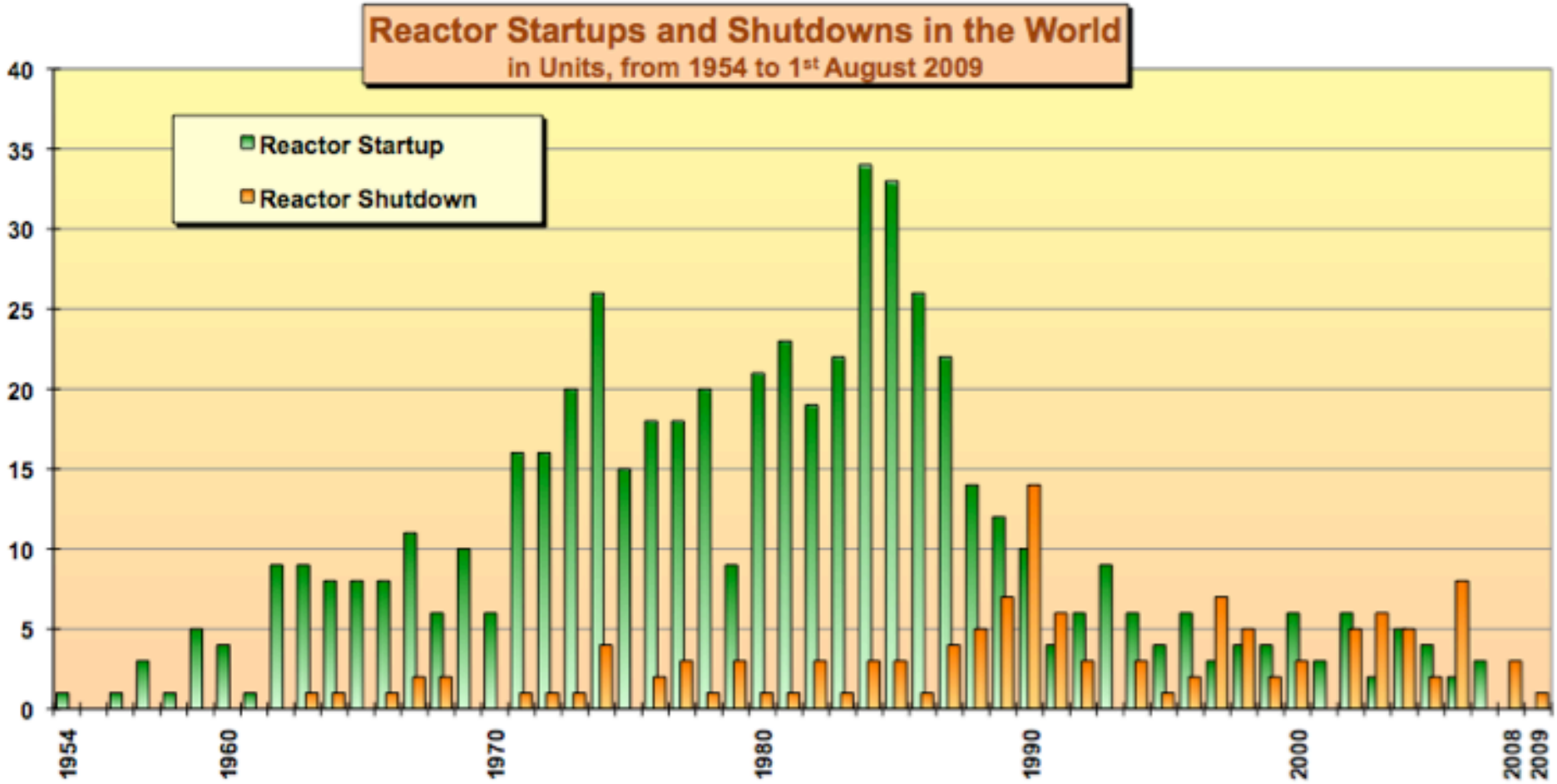
National Parliament, Bangkok, Thailand, 20 October 2009

1. Status and Trends of the International Nuclear Industry
2. New-build in China, EU, USA
3. Key Barriers
    - Financial Risks/Credit Rating
    - Workforce Problem/Skills Gap
    - Public Opinion
    - Climate Mitigation/Time Factor

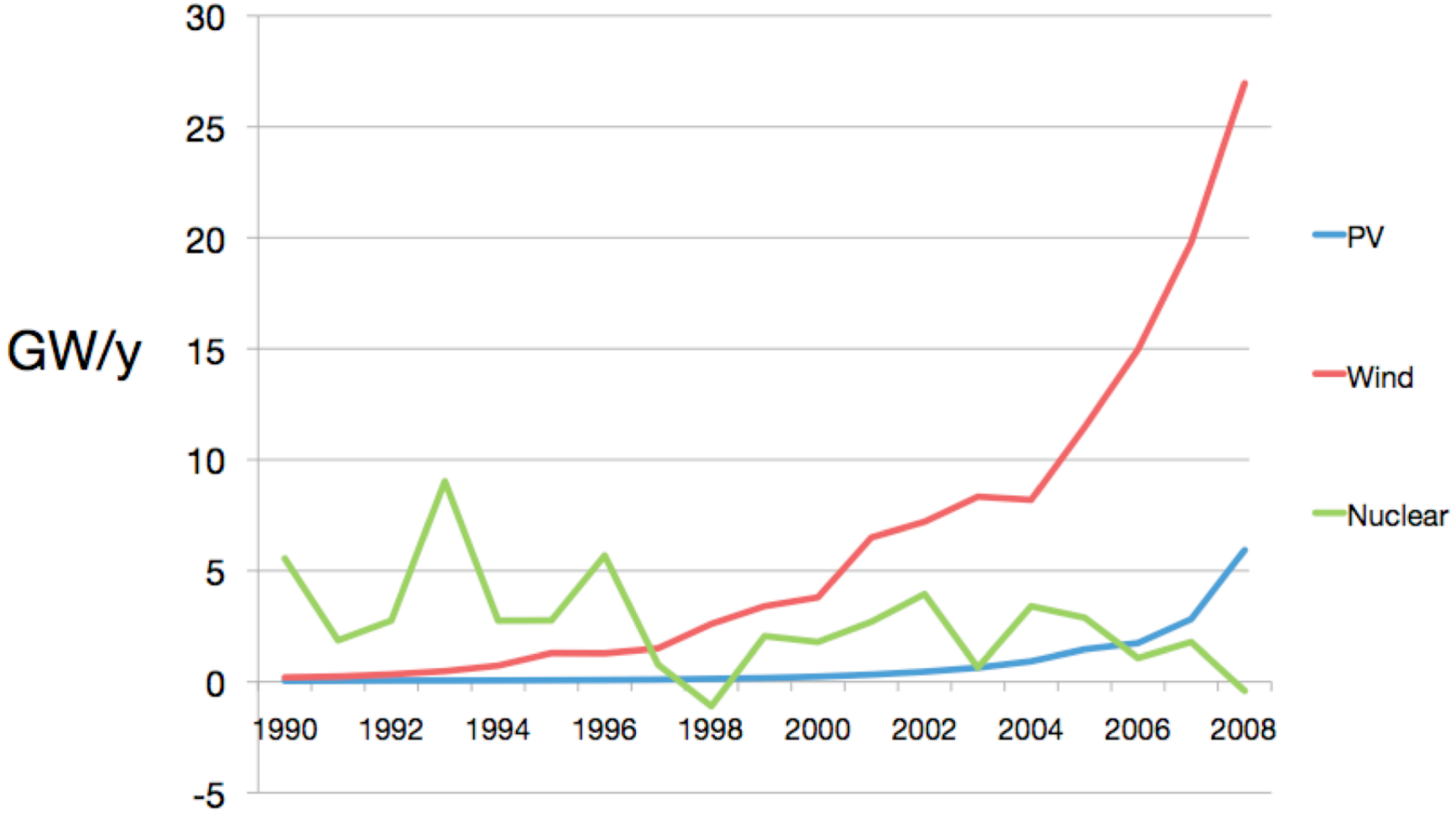
« The IAEA has revised upwards its nuclear power generation projections to 2030, while at the same time it reported that nuclear's share of global electricity generation dropped another percentage point in 2007 to 14%. »

IAEA Press Release, 11 September 2008

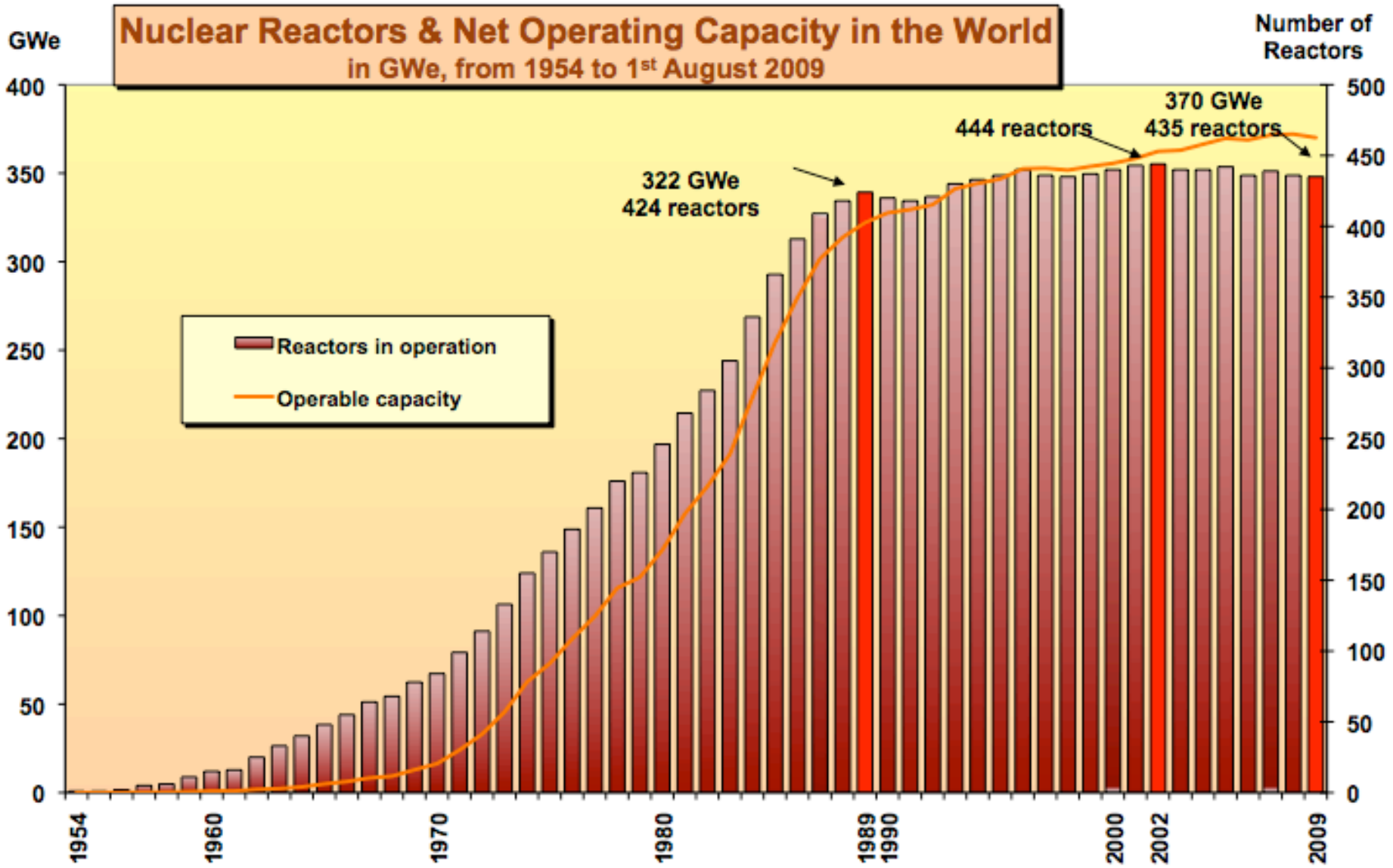


Source: IAEA, PRIS, 2009

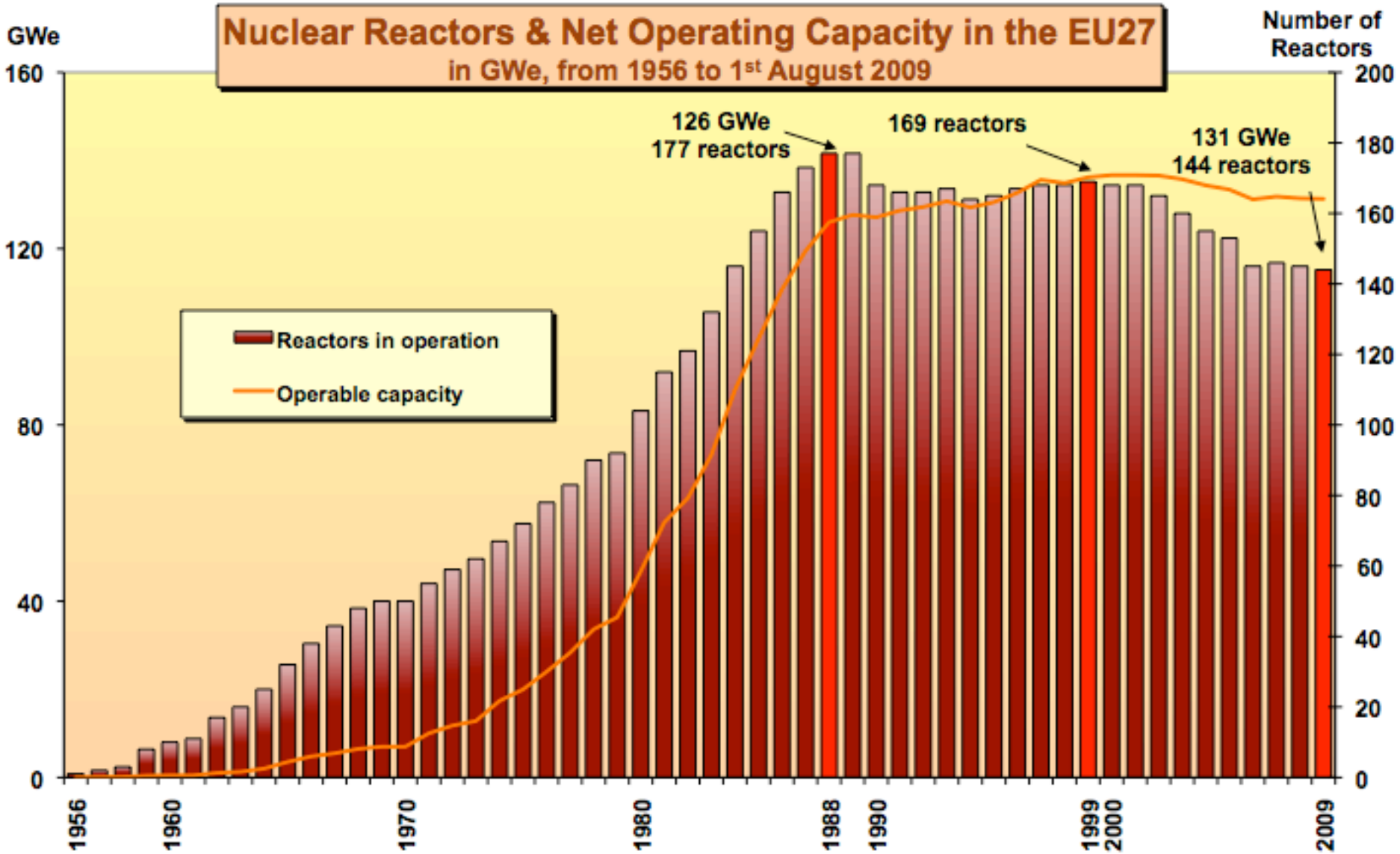
New Grid Connections in the World 1990-2008



Source: Amory Lovins, "Four Myths About Nuclear Power", October 2009



Source: IAEA, PRIS, 2009

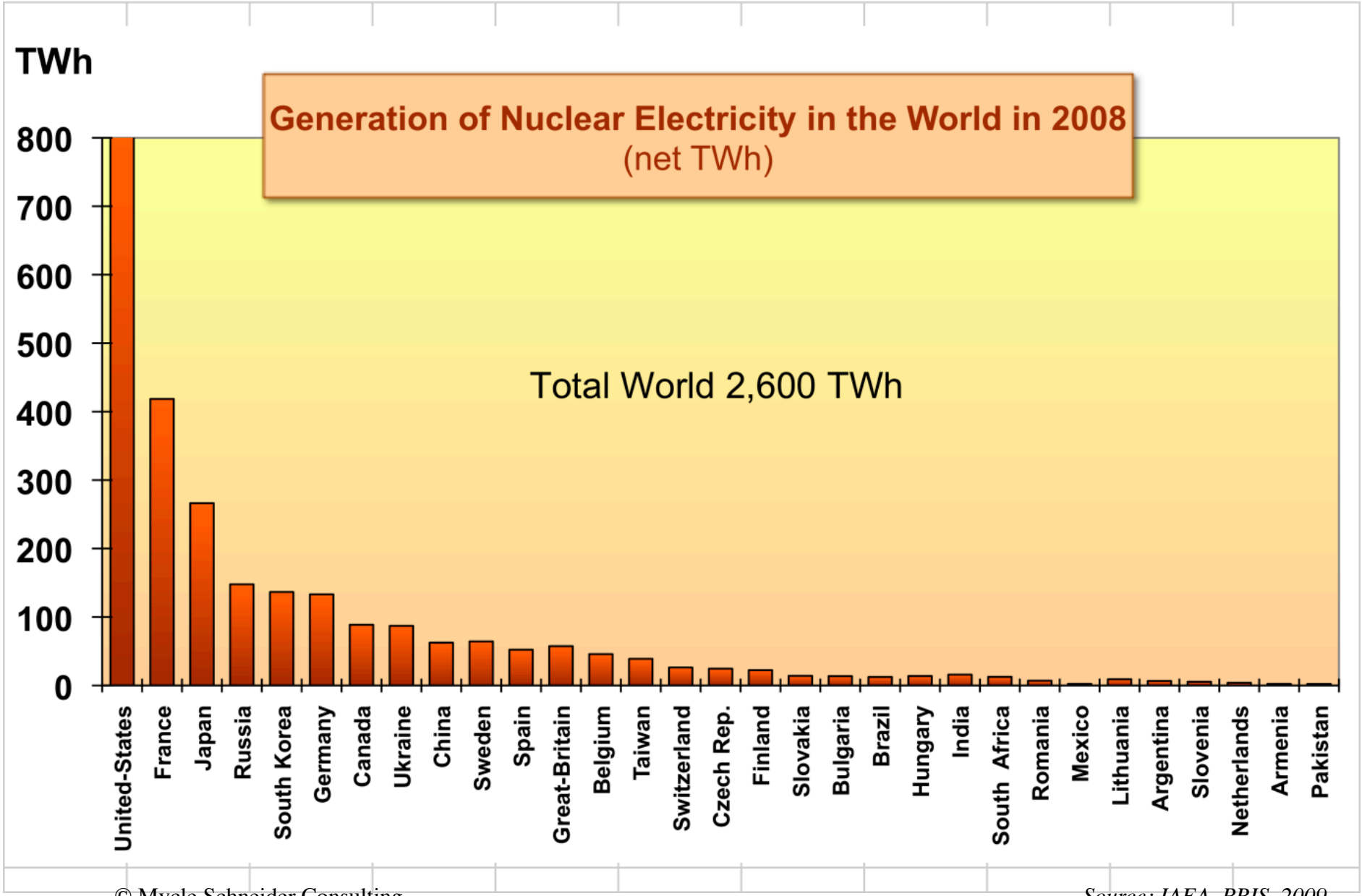


Source: IAEA, PRIS, 2009

17 reactors « in operation » did not generate *any* power in 2008

Country	StationName	Production
Germany	Brunsbüttel (KKB)	no production in 2008
	Krümmel (KKK)	no production in 2008
	2	
India	Narora-2	no production in 2008
	Rajasthan-1	no production after 2004
	Rajasthan-2	no production in 2008
	Rajasthan-3	no production in 2008
	4	
Japan	Hamaoka-1	no production after 2001
	Hamaoka-2	no production after 2004
	Kashiwazaki Kariwa-1	no production after earthquake in July 2007
	Kashiwazaki Kariwa -2	no production after earthquake in July 2007
	Kashiwazaki Kariwa -3	no production after earthquake in July 2007
	Kashiwazaki Kariwa -4	no production after earthquake in July 2007
	Kashiwazaki Kariwa -5	no production after earthquake in July 2007
	Kashiwazaki Kariwa -6	no production after earthquake in July 2007
	Kashiwazaki Kariwa -7	no production after earthquake in July 2007
	Shika-1	no production in 2008
	10	
UK	Oldbury-A	no production after 2006
	1	
Total	**17**	

 Source: Nucleonics Week, 12 Feb 2009, IAEA-PRIS 2009



Source: IAEA, PRIS, 2009

Nuclear Power in the World

By Country

(as of 1 August 2009)

Trend Nuclear Share 2008/2007

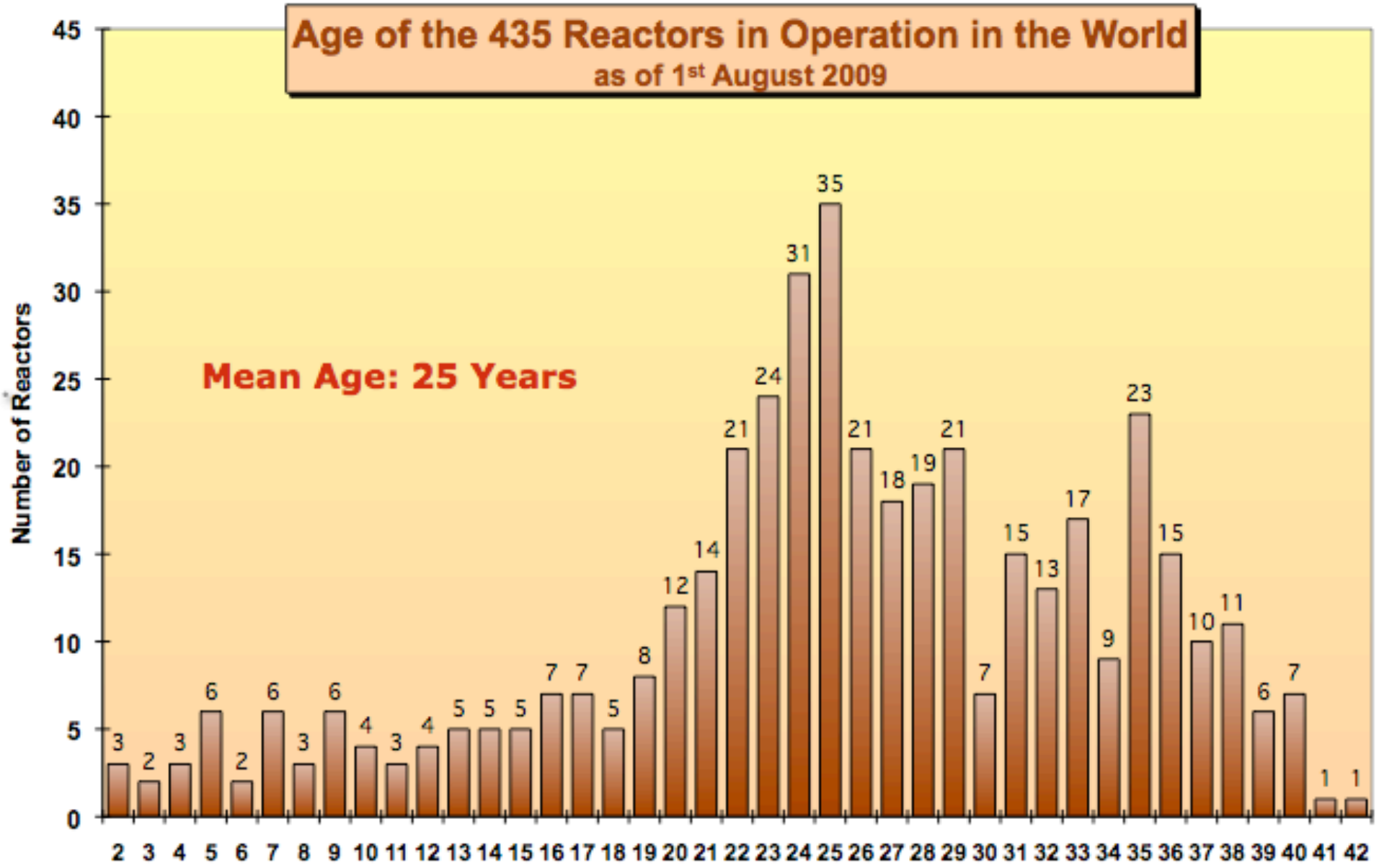
+ : 4 countries (13 units)

= : 23 countries stable

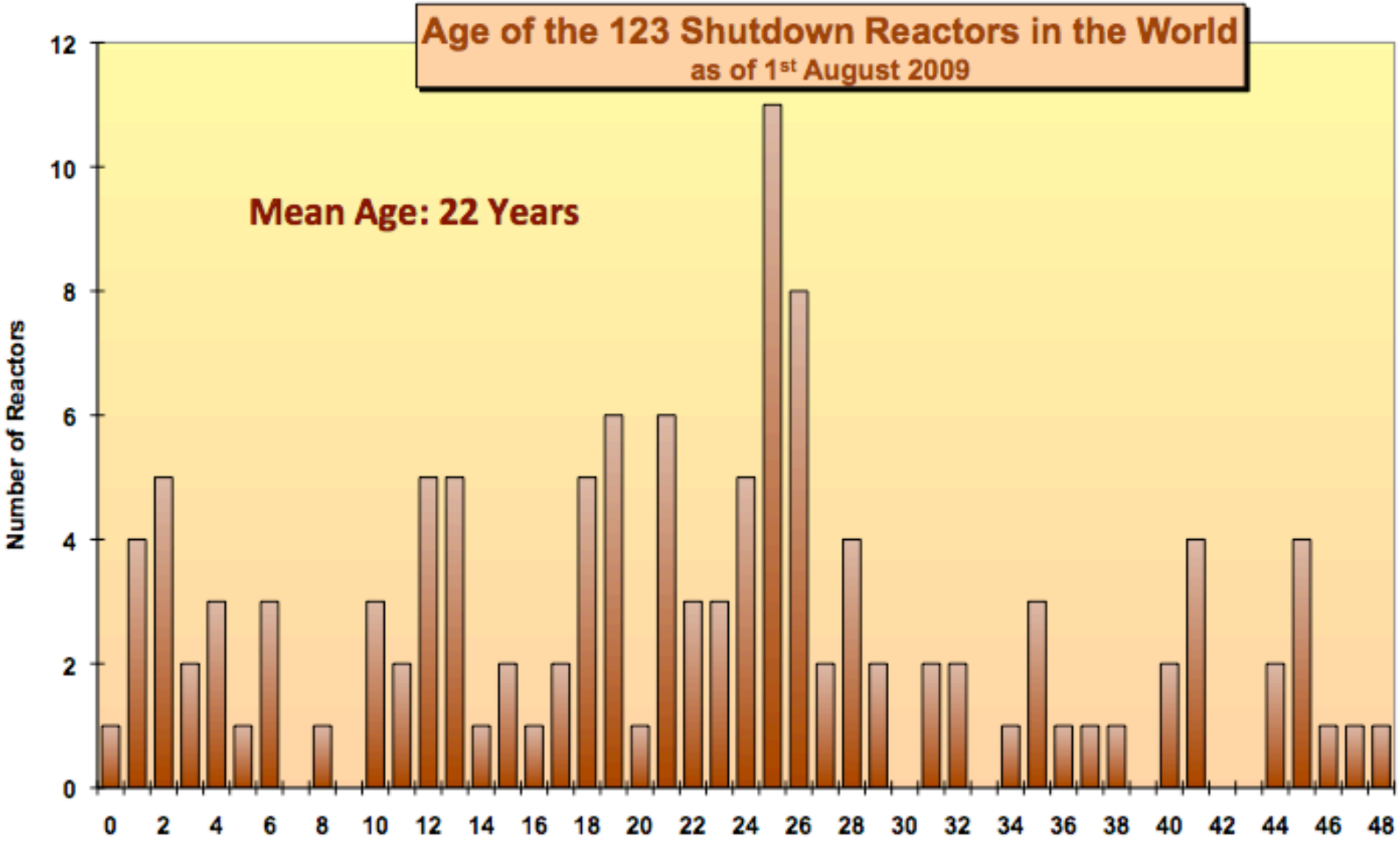
— : 4 countries

Sources: IAEA-PRIS 2009, BP 2009, WNA 2009, MSC 2009

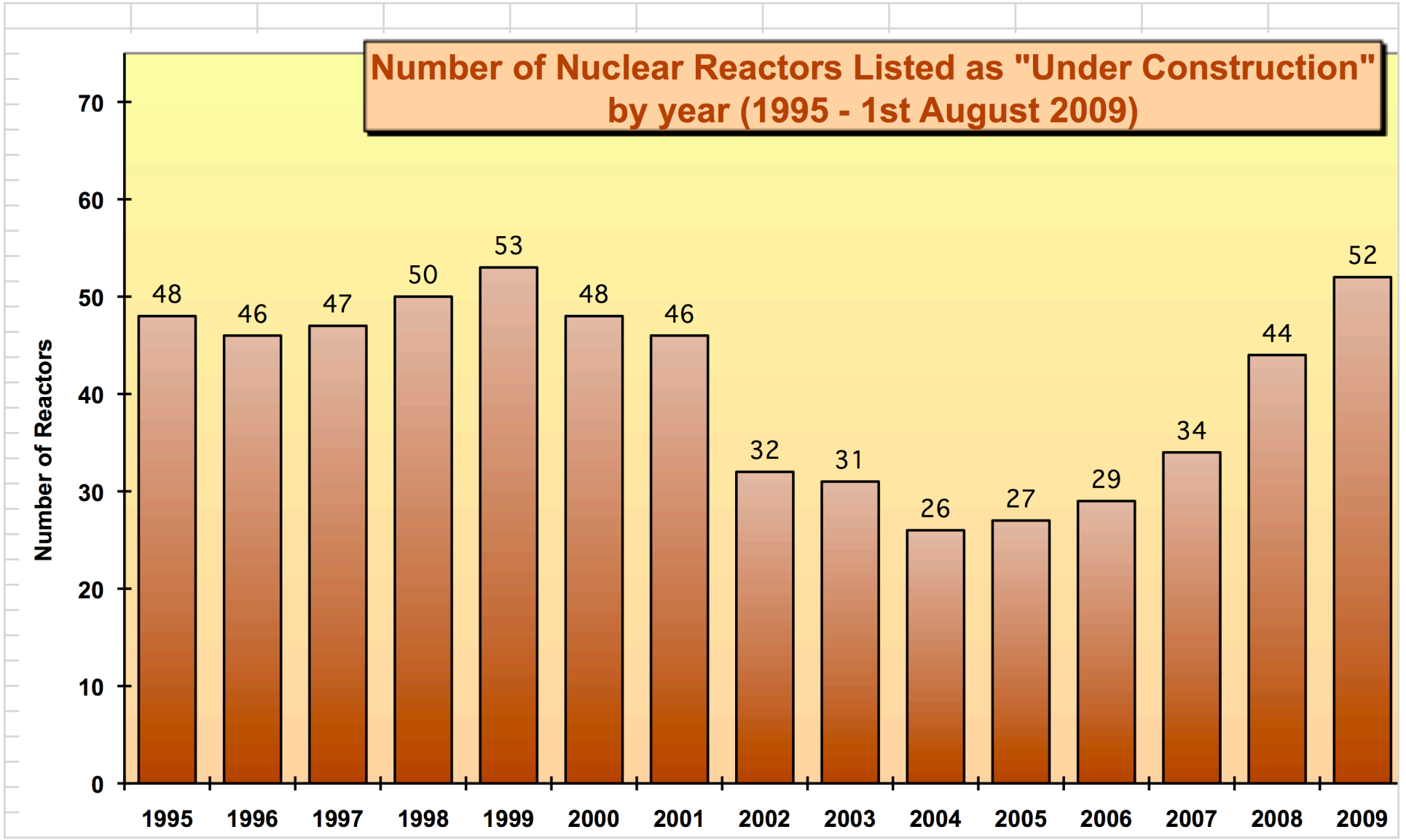
Countries	Nuclear Reactors[1]				Power[2]	Energy[3]
	Operate	Average Age	Under Construction[4]	Planned[5]	Share of Electricity[6]	Share of Commercial Primary Energy
Argentina	2	31	1	1	6%(=)	2%
Armenia	1	30	0	0	39%(–)	?%
Belgium	7	29	0	0	54%(=)	14%
Brazil	2	18	0	1	3%(=)	1%
Bulgaria	2	20	2	0	33%(=)	18%
Canada	18	26	0	3	15%(=)	6%
China	11	8	16	29	2%(=)	<1%
Czech Republic	6	18	0	0	32%(+)	14%
Finland	4	30	1	0	30%(=)	20%
France	58	24	1	1	76%(=)	39%
Germany	17	28	0	0	28%(=)[7]	11%
Hungary	4	24	0	0	37%(=)	14%
India	17	18	6	10	2%(=)	<1%
Iran	0	0	1	2	0%(=)	0%
Japan	53	24	2	13	25%(–)	11%
Lithuania	1	22	0	0	73%(+)	26%
Mexico	2	18	0	0	4%(=)	1%
Netherlands	1	36	0	0	4%(=)	1%
Pakistan	2	24	1	2	2%(=)	<1%
Romania	2	8	0	2	18%(+)	7%
Russia	31	27	9	7	17%(=)	5%
Slovakia	4	19	2	0	56%(+)	21%
Slovenia	1	28	0	0	42%(=)	?%
South Africa	2	25	0	3	5%(=)	2%
South Korea	20	17	5	7	36%(=)	14%
Spain	8	26	0	0	18%(=)	9%
Sweden	10	31	0	0	42%(–)	31%
Switzerland	5	34	0	0	39%(=)	21%
Taiwan	6	28	2	0	19%(=)	8%
Ukraine	15	21	2	0	47%(=)	16%
United Kingdom	19	28	0	0	13%(–)	6%
USA	104	30	1	11	20%(=)	8%
EU27	**144**	**25**	**6**	**3**	**28%(=)**	**12%**
Total	**435**	**25**	**52**	**93**	**ca. 14%**	**5.5%**



Source: IAEA-PRIS, MSC, 2009

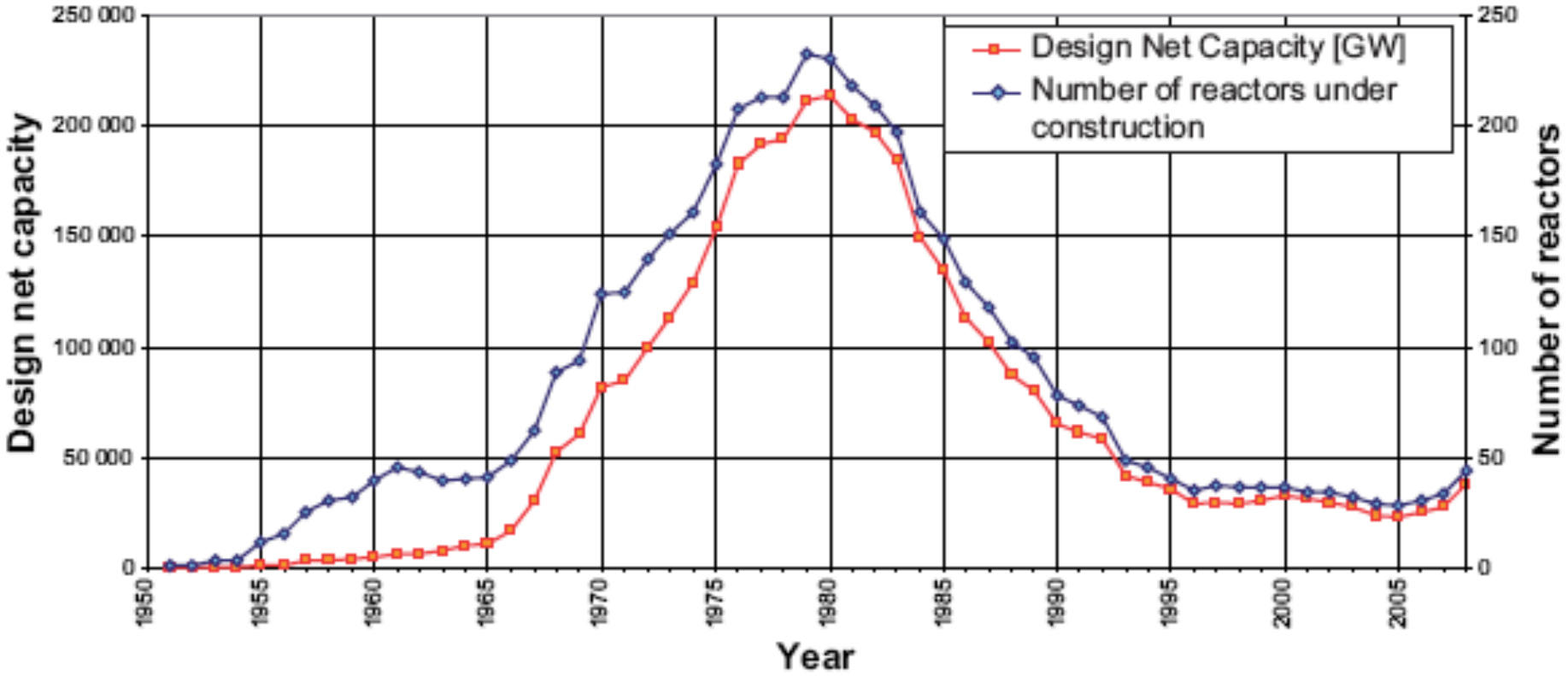


Source: IAEA-PRIS, MSC, 2009



Sources: CEA, IAEA-PRIS, MSC 2009

Number of units and total nominal capacity in MW (!) 1951-2008



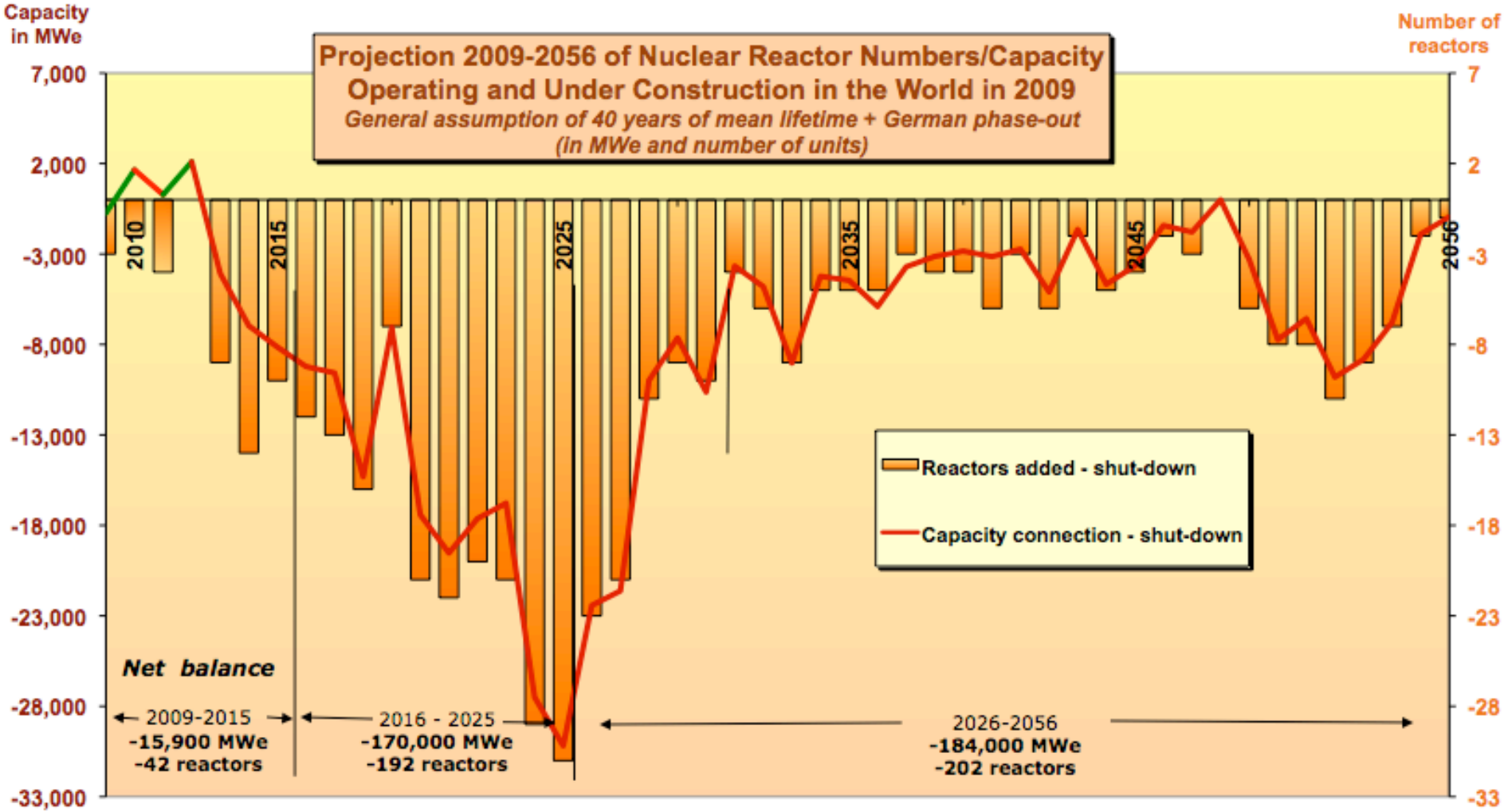
Source: IAEA, International Status and Prospects of Nuclear Power, 2008

Nuclear Reactors Listed as "Under Construction"

By Country

Country	Units	MWe (net)	Construction Start	Planned Grid Connection
China	16	15,220	2005-2009	2010-2014
Russia	9	6,894	1983-2008	2010-2014
India	6	2,910	2002-2004	2009-2011
South-Korea	5	5,180	2006-2008	2010-2013
Bulgaria	2	1,906	1987	2014-2015
Japan	2	2,191	2004-2007	2009-2011
Slovakia	2	810	1985	2012-2013
Taiwan	2	2,600	1999	2010-2011
Ukraine	2	1,900	1986-1987	2015-2016
Argentina	1	692	1981	2010
Finland	1	1,600	2005	2012
France	1	1,600	2007	2012
Iran	1	915	1975	2009
Pakistan	1	300	2005	2011/05/31
USA	1	1,165	1972	2012
Total	52	45,883	1972-2009	2009-2016

Sources: IAEA-PRIS, MSC 2009



Sources: IAEA-PRIS, WNA, MSC 2009

New Build Issues

- China
- European Union
- USA

Chinese Fantasies

Chinese Forecasting	Capacity Planned	Capacity Installed	Share Realised
in 1985 for 2000	20,000 MW	2,168 (in 15 Years)	11%
in 1996 for 2010	20,000 MW	max.10,282 (in 25 Years)	51%
in 2006 for 2020	40,000 MW to 60,000 MW	+30,000 to + 50,000? (in 10 Years?)	?

Source: Mycle Schneider Consulting

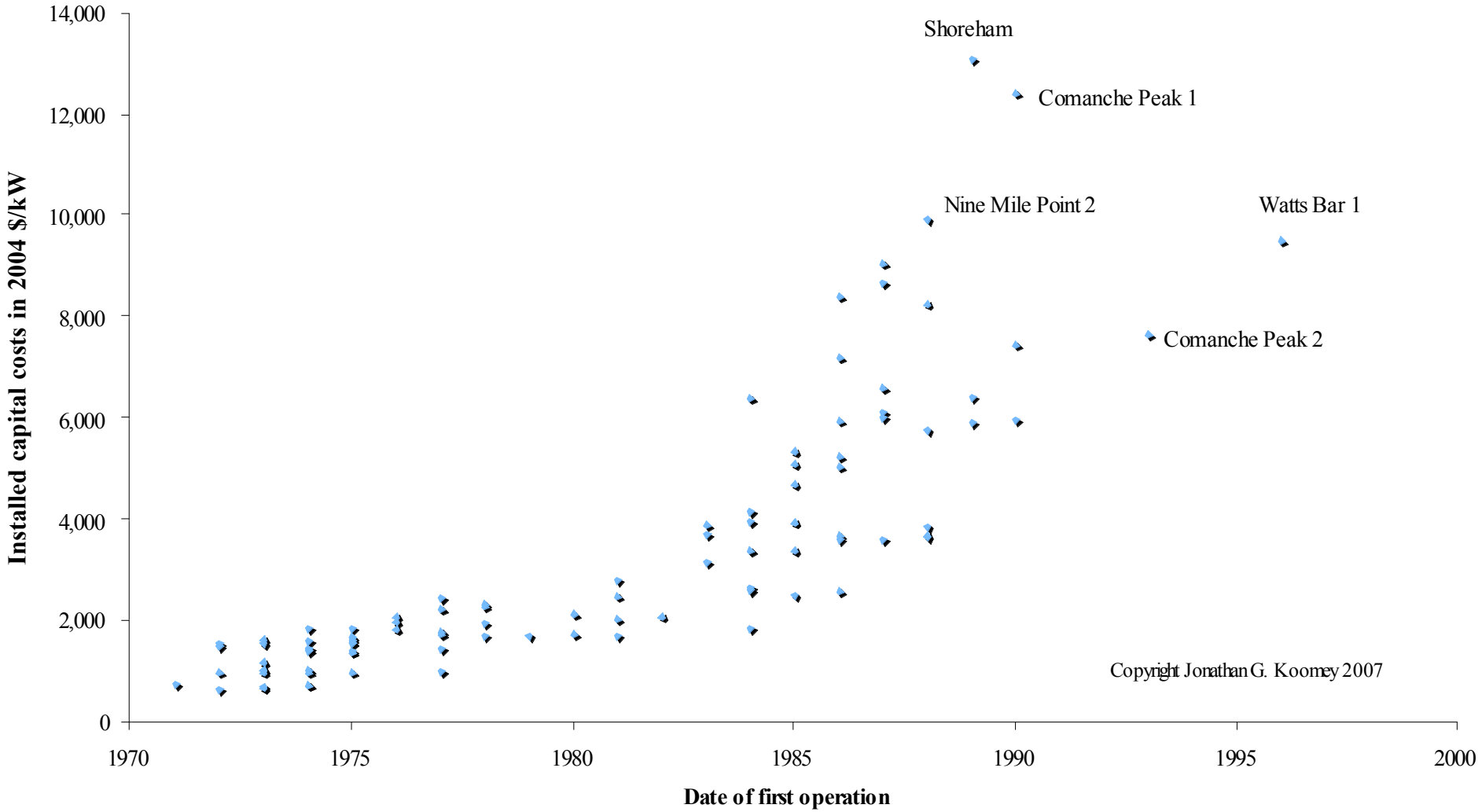
Excessive Lead Times/Cost Overruns: Example Olkiluoto-3, Finland

1998-1999	TVO submits environmental impact assessment report.
2005	First concrete in August.
2006	Project running 18 months late.
2007	Project running 24 months late.
2008	Project running at least 36 months late.
2009	October: Safety Authority halts welding.
2012	Start-up?

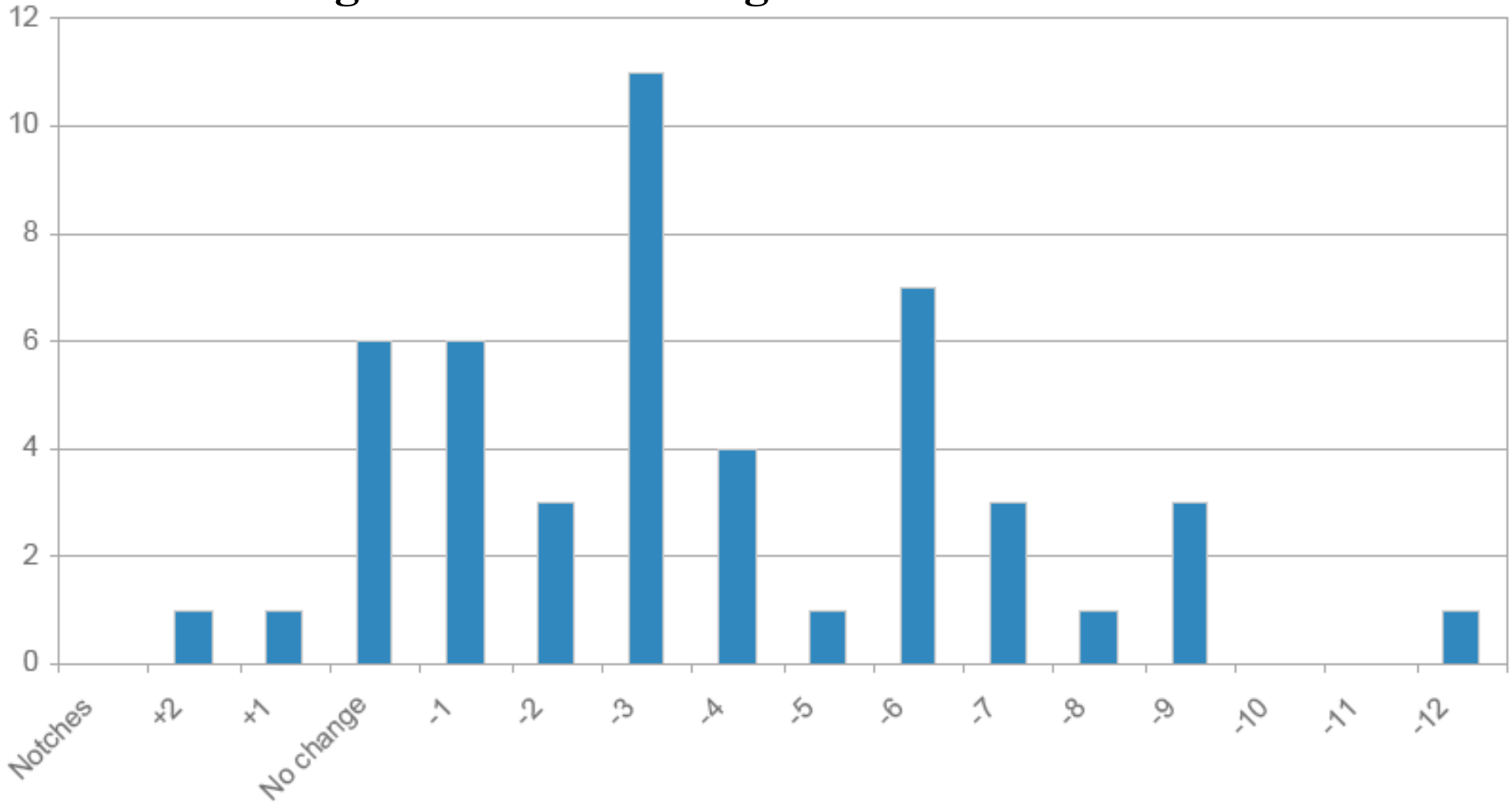
Lead Time: at least 13-14 years since EIA
Official Price: ca. €3 Billion (Guaranteed Fix Price)
Cost Overrun 4 Years after Construction Start: €2.3 Billion

Sources: Various, compiled by MSC

“Learning Curve” of US Nuclear Projects



Changes in Credit Rating of 48 US Nuclear Utilities



"Moody's is considering applying a more negative view for issuers that are actively pursuing new nuclear generation"

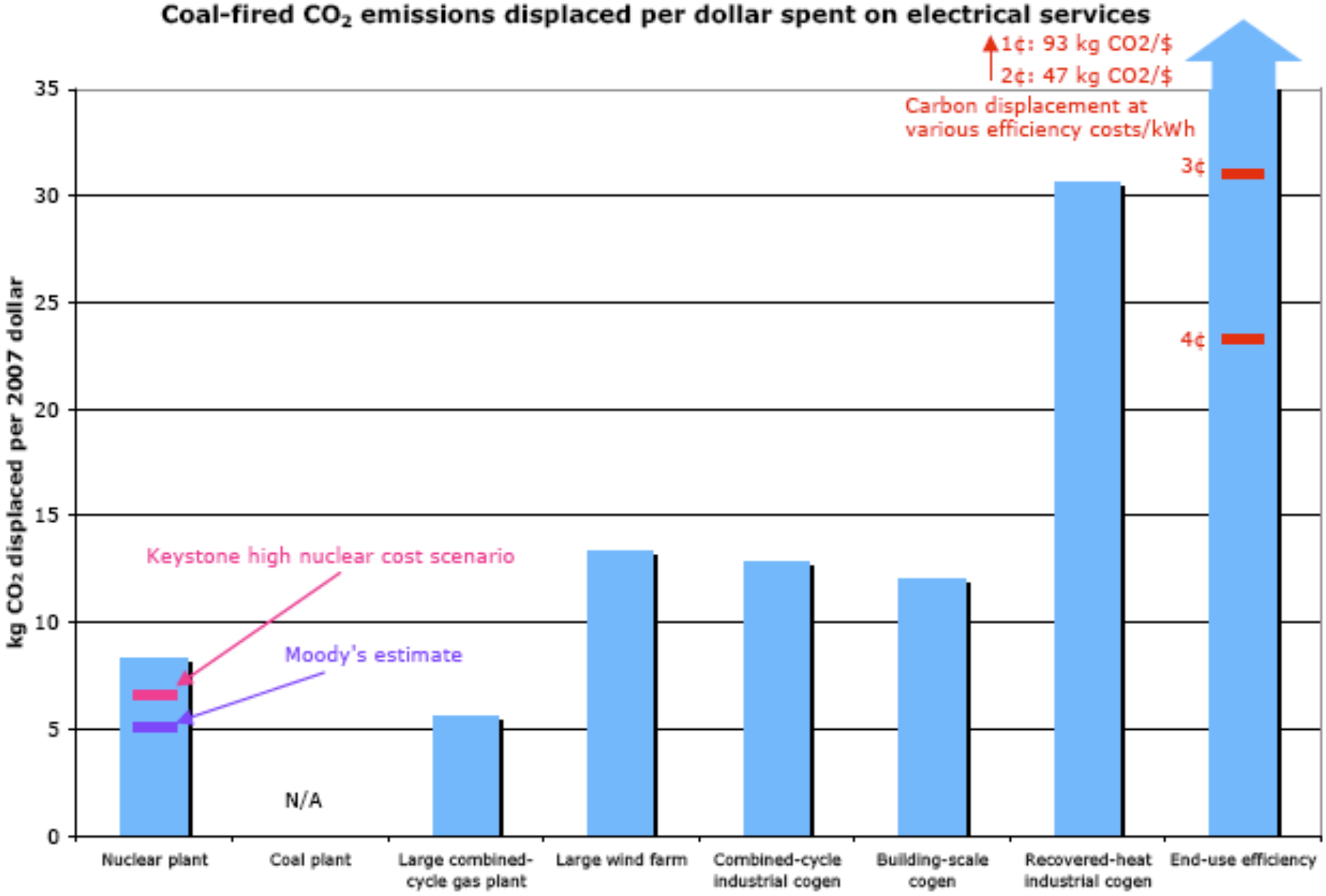
Source: Moody's, "New Nuclear Generation: Ratings Pressure Increasing", 2009

Excessive Lead Times: Example US New Build

2002 Launch of Nuclear Power 2010 programme.
2003 DOE invites proposals, NRC receives 3 ESP applications.
2005 Energy Policy Act passed in summer.
2006 By mid-2006, ten firms had "announced their intention" to submit a Construction and Operating License (COL) request.
2007 March Exelon receives first ESP for Clinton site (Illinois).
2007 NRG submits first COL application to the NRC.
2009? Final decision to proceed with construction.
2014-2020 Expected commissioning of the first 6 GW, most likely on existing sites.

Lead Time: 11-17 Years Since Early Site Permit Application (ESP)

Sources: OECD-IEA, WEO 2006; NRC Web 2007



Source: Amory Lovins, "Nuclear Power Climate Fix or Folly", February 2009

Significant Manufacturing Bottlenecks

Whether or not the nuclear renaissance will come to fruition is also dependant in large part on the success or failure of the industrial infrastructure that provides the necessary parts and equipment for construction of a nuclear power plant.

Kristine L. Svinicki
Commissioner, NRC
May 2009

Massive Nuclear Skills Gap

OECD Nuclear Energy Agency on Finland, Germany, South Korea, UK, USA…

"These national surveys show that employers require more engineers and scientists having a nuclear component to their education than those graduating."

Source: OECD NEA, *Nuclear Competence Building,* 2004

No Change in Sight

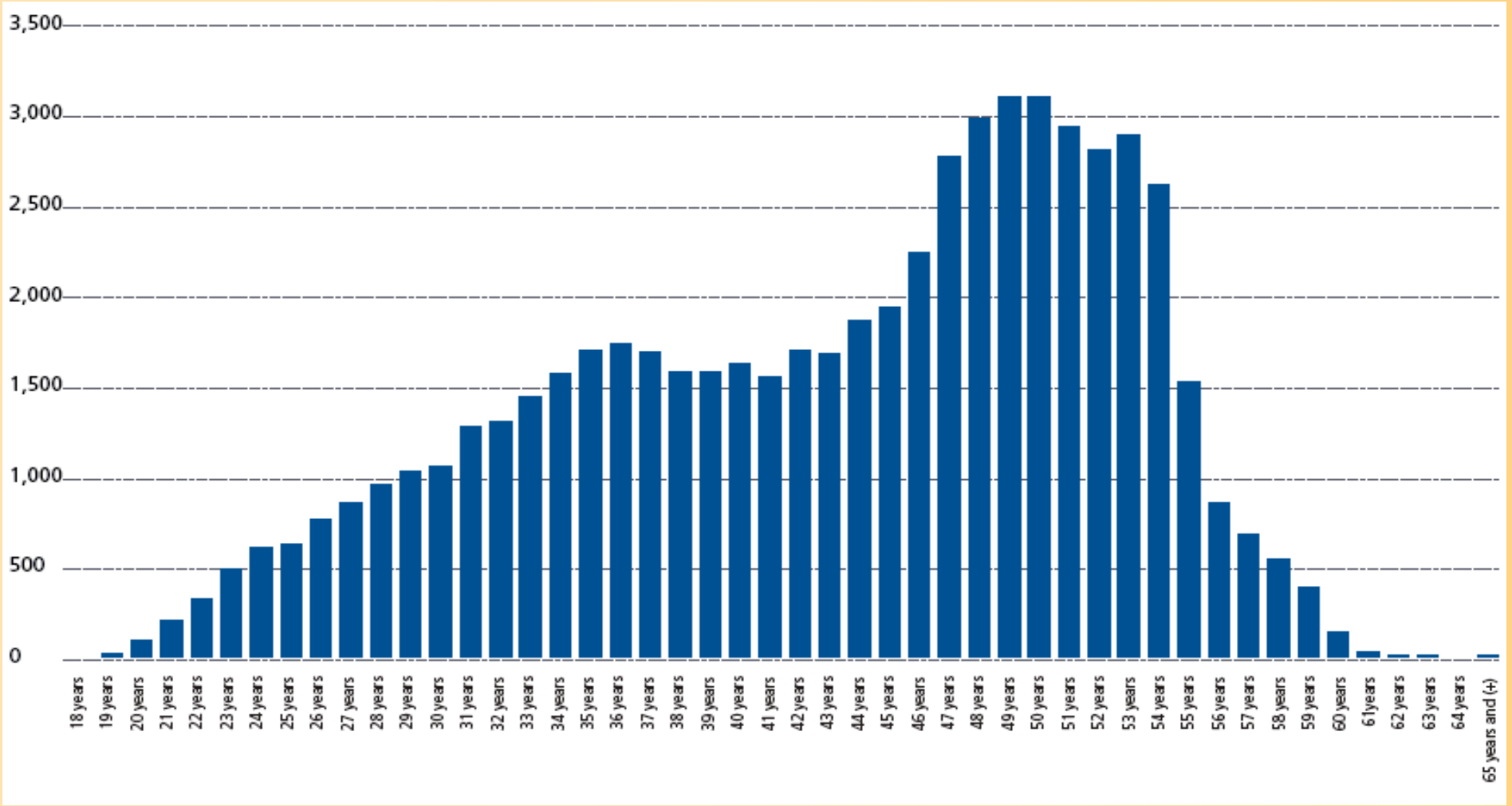
« The “aging workforce” issue is keeping countless CEOs awake at night. (…)

The U.S. Department of Labor indicates that a third of the workers in the nuclear industry are eligible to retire in the next five years. (…)

The U.S. nuclear power industry will need to attract about 26,000 new employees over the next 10 years for existing facilities. These estimates do not include additional resources necessary to support new plants. »

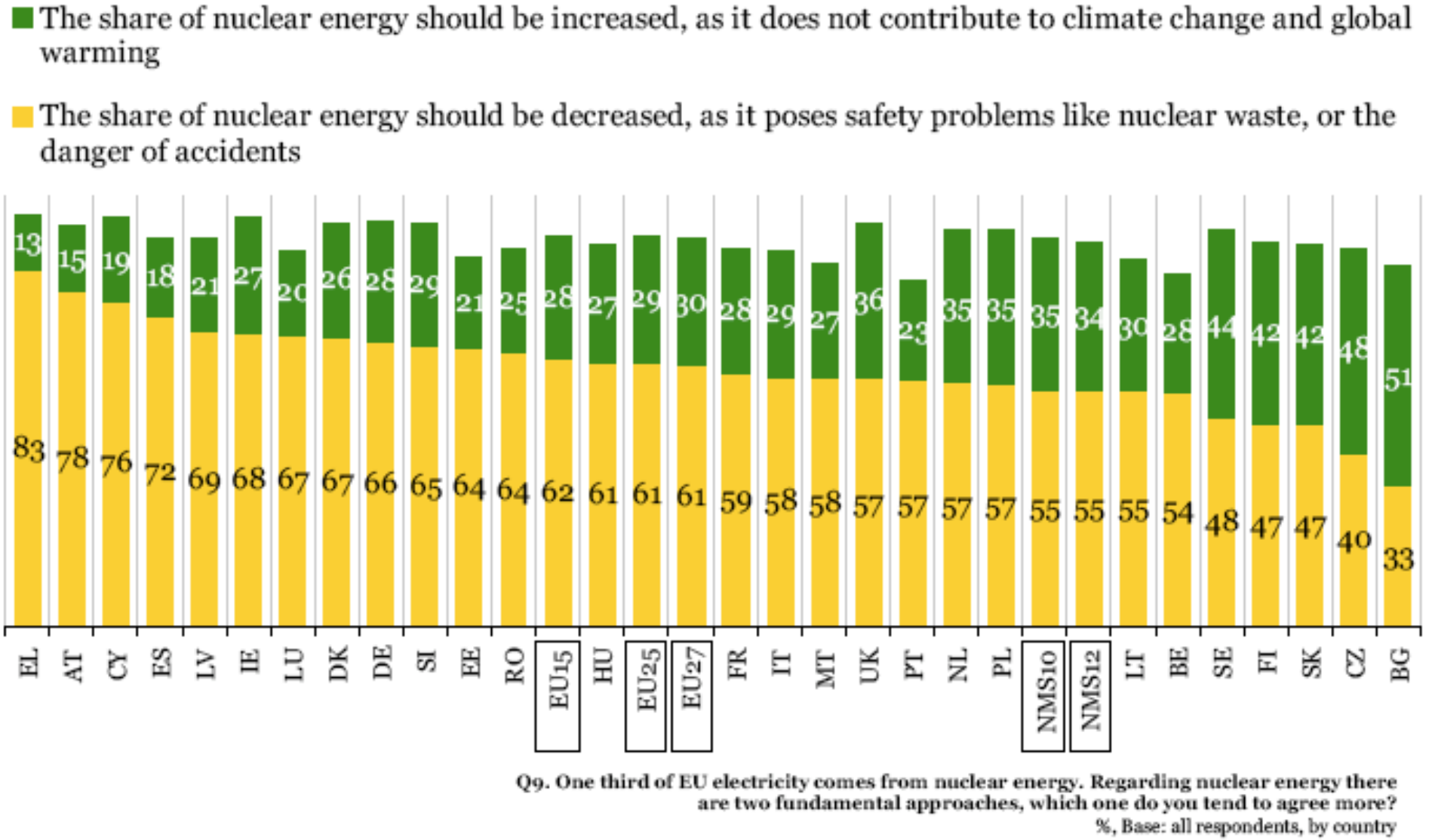
Source: Capgemini, « Preparing for the Nuclear Renaissance », March 2008

Workforce Age Structure at EDF
(as of the end of 2008)



Source: RTE, Document de Référence 2008", April 2008

Barrier Public Opinion: Example EU



Q9. One third of EU electricity comes from nuclear energy. Regarding nuclear energy there are two fundamental approaches, which one do you tend to agree more?
%, Base: all respondents, by country

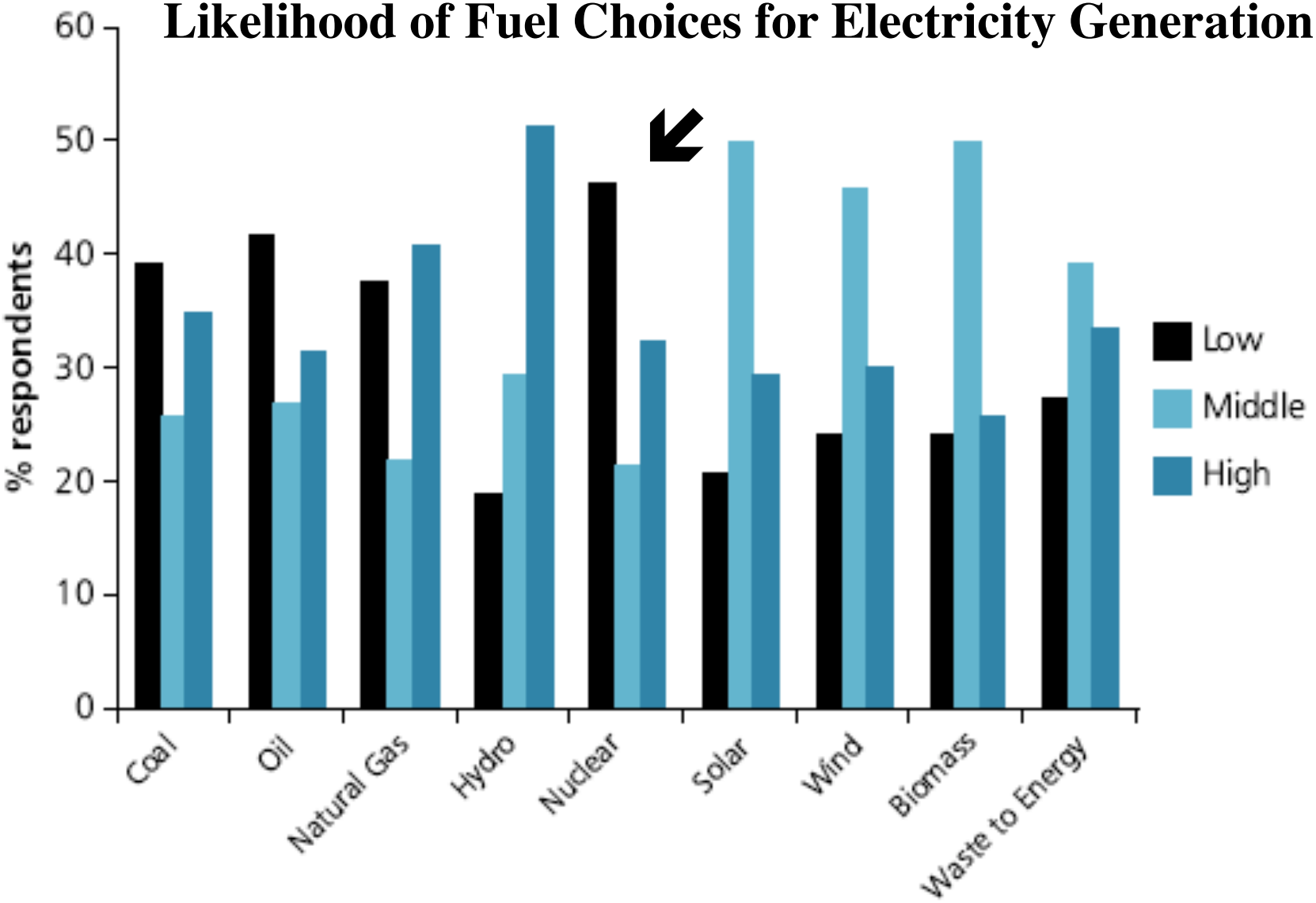
Gallup, *Attitudes on issues related to EU Energy Policy,* European Commission, DG TREN, April 2007

"The European public is still strongly opposed to the use of nuclear power; those who are worried about climate change are even more fiercely opposed."

Gallup, *Attitudes on issues related to EU Energy Policy,* European Commission, DG TREN, April 2007

Asian Development Bank Expert Survey 2009

Likelihood of Fuel Choices for Electricity Generation



Source: ADB, « Improving Energy Security and Reducing Carbon Intensity », October 2009

Nuclear Irrelevant To Climate Change Mitigation

"Nuclear power is unlikely to play a critical role in limiting CO_2 equivalent concentrations in the atmosphere until mid-century at the earliest…
No realistic plan foresees a reactor build rate that allows nuclear power to help stay below 550 ppme CO_2 within the next ~30-40 years."*

Robert Rosner
Director, Argonne National Laboratory
April 2009

*The term ppme CO_2 refers to parts per million equivalent CO_2 concentration of greenhouse gases in the atmosphere.

Conclusions on Status and Role of Nuclear Power

• Nuclear power plays a limited role in the international energy sector: 14% of electricity, 5.5% of primary energy, ≈2% of final energy in the world. Further decline is highly likely.

• The industry has a long term workforce problem and will struggle to maintain competence levels for existing facilities.

• Public opinion in the EU and in many other countries remains opposed to nuclear power; strong preference for other energy forms.

• The nuclear industry has failed to deliver in the past. Large budget overruns, construction delays and excessive overall lead times. Much of this had to be covered by the tax-payer.

• Problems with recent new build projects – Olkiluoto 3 years late, ≈80% over budget – indicate that there is no change to be expected.

• $1 spent on nuclear will save ≈3–20 times *less* carbon ≈20–40 times *slower* (per year) than efficiency and micro-power.

The energy future lies in affordable, distributed, superefficient technologies, smart grids and sustainable urbanism. Nuclear policy – centralized, inflexible and generally autocratic – symbolizes the opposite.

Nuclear energy will likely rather hinder than favour the urgent implementation of reliable, sustainable energy policies.