Energy Security: Could Nuclear Power Deliver?

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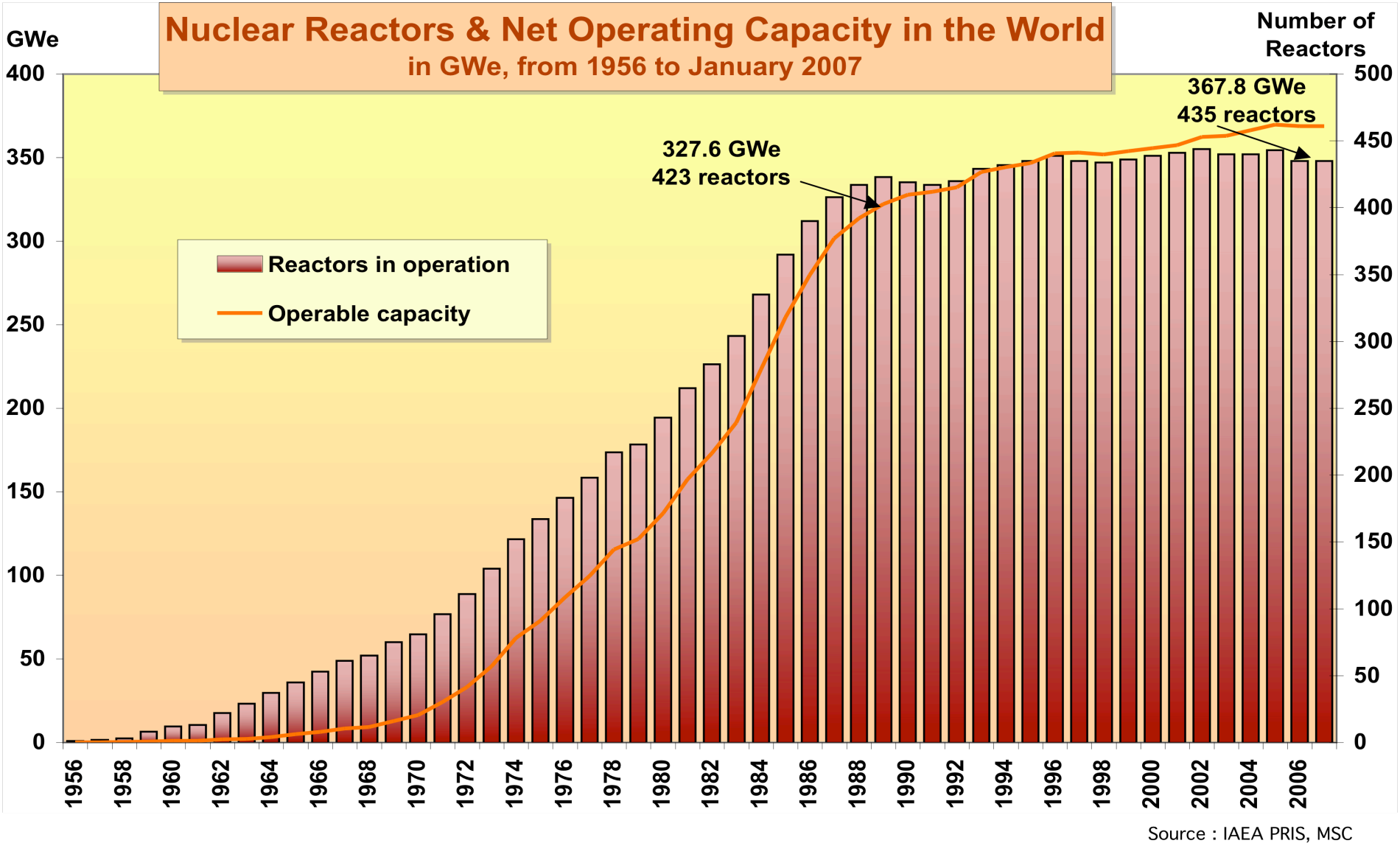
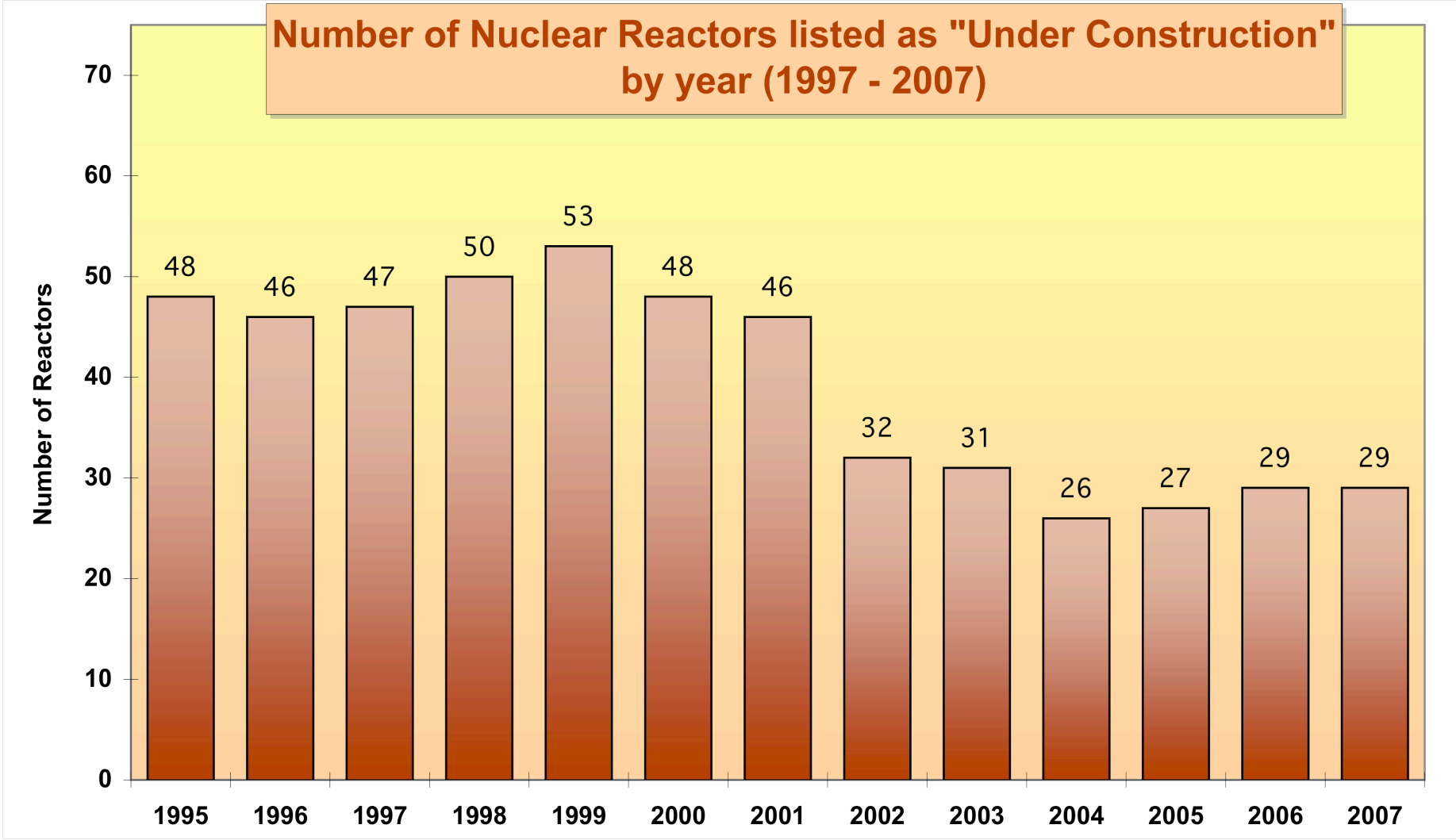
1. Status/Trends of the Nuclear Power Industry
2. New Build Issues in the EU, the US, China
3. Key Barriers
    - Financial Risks
    - Workforce Issues
    - Public Opinion
4. French Case Study



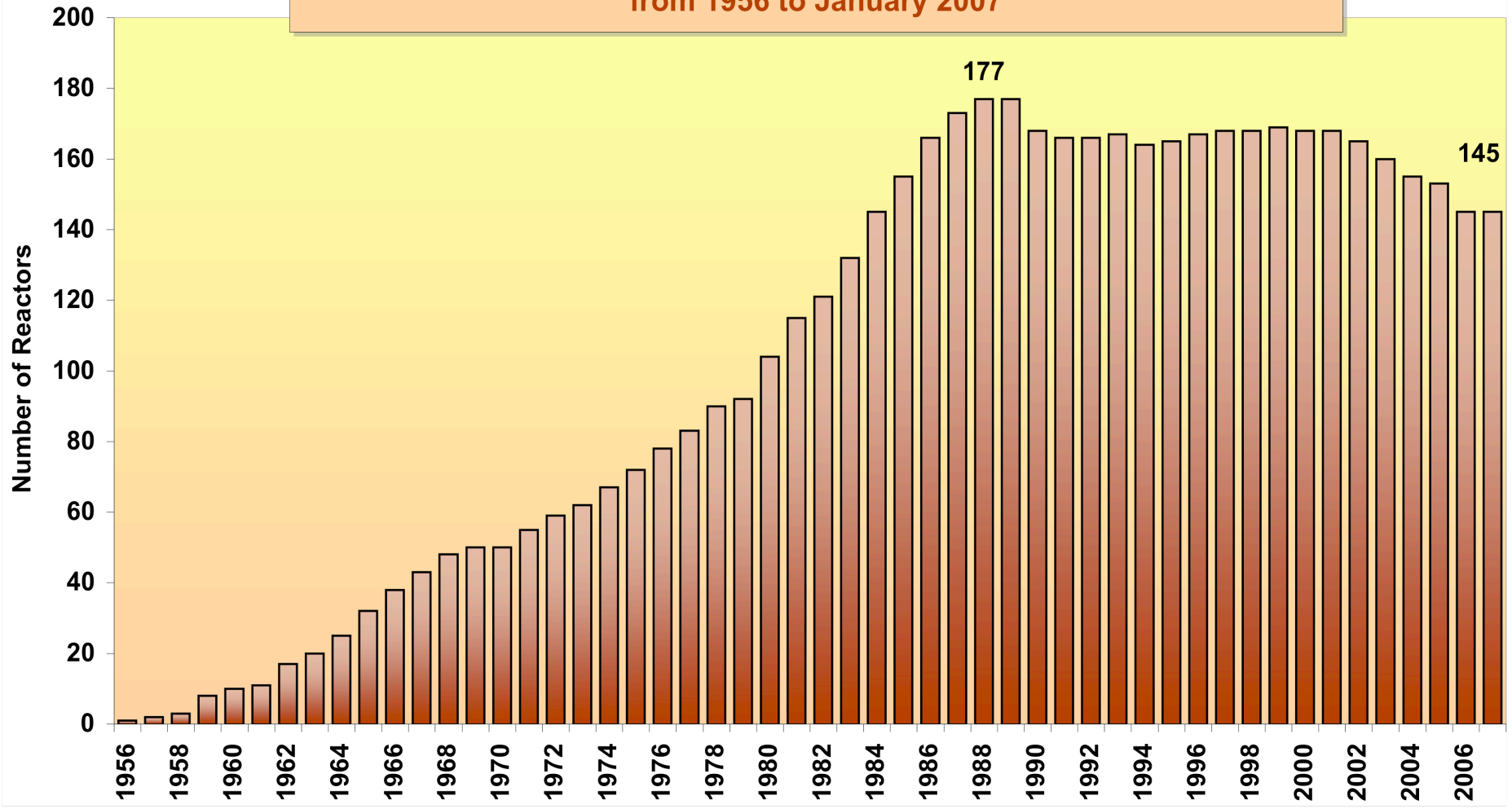
Source : IAEA PRIS, MSC



Source: CEA 1997 - 2006, IAEA 2007

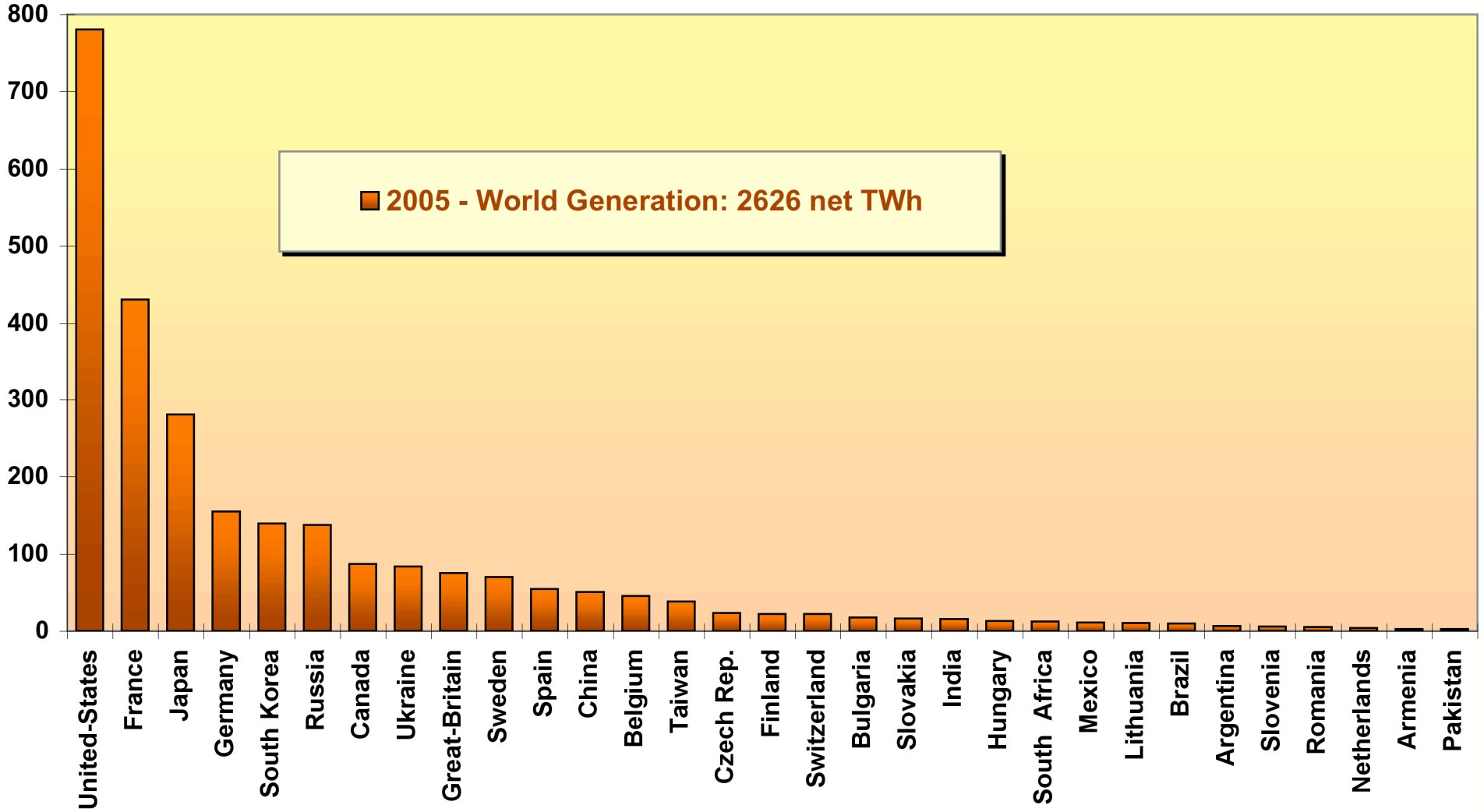
Nuclear Reactors in Operation in the EU 27

from 1956 to January 2007



Source: IAEA PRIS

Generation of Nuclear Electricity in the World in 2005 (net TWh)



Source: IAEA/PRIS 2006

Nuclear Power in the World

by Operational Reactors

(as of 15 January 2007)

Countries	Nuclear Reactors				Power	Energy
	Operate	Average Age	Under Construc-tion	Planned	Share of Electricity	Share of Com.Primary Energy
USA	103	25	0	2	20%	8%
France	59	20	0	1	78%	38%
Japan	55	20	1	12	25%	10%
Russia	31	23	5	6	17%	5%
Korea RO (South)	20	12	1	7	40%	14%
United Kingdom	19	26	0	0	24%	9%
Canada	18	20	0	2	13%	6%
Germany	17	23	0	0	28%	11%
India	16	17	7	4	3%	1%
Ukraine	15	17	2	0	46%	14%
Sweden	10	26	0	0	50%	33%
China	10	4	4	14	2%	1%
Spain	8	23	0	0	24%	10%
Belgium	7	24	0	0	56%	19%
Czech Republic	6	13	0	0	31%	13%
Taiwan	6	23	2	0	22%	9%
Slovakia	5	17	0	2	57%	21%
Switzerland	5	29	0	0	40%	21%
Hungary	4	19	0	0	33%	10%
Finland	4	25	1	0	27%	19%
Bulgaria	2	19	2	0	38%	20%
Argentina	2	26	1	1	9%	3%
South Africa	2	20	0	1	6%	2%
Mexico	2	13	0	0	5%	2%
Brazil	2	13	0	1	4%	2%
Pakistan	2	19	1	2	2%	1%
Lithuania	1	19	0	0	80%	38%
Slovenia	1	23	0	0	40%	21%
Armenia	1	24	0	0	36%	23%
Romania	1	8	1	0	9%	3%
Netherlands	1	31	0	0	5%	1%
Iran	0	0	1	2	0%	0%
Turkey	0	0	0	1	0%	0%
Korea DPR (North)	0	0	0	1	0%	0%
EU27	145	22	4	3	30%	15%
Total	435	22	29	59	16%	6%

Sources: IAEA-PRIS 2007, BP 2006, WNA 2006

Nuclear Power in the World

by Share of Nuclear Electricity

(in 2005)

Countries	Nuclear Reactors				Power	Energy
	Operate	Average Age	Under Construc-tion	Planned	Share of Electricity	Share of Com.Primary Energy
France	59	20	0	1	78%	40%
Lithuania	1	19	0	0	70%	38%
Slovakia	5	17	0	2	56%	21%
Belgium	7	24	0	0	56%	19%
Ukraine	15	17	2	0	50%	14%
Sweden	10	26	0	0	45%	33%
Korea RO (South)	20	12	1	7	45%	14%
Bulgaria	2	19	2	0	44%	20%
Armenia	1	24	0	0	43%	23%
Slovenia	1	23	0	0	42%	21%
Hungary	4	19	0	0	37%	10%
Finland	4	25	1	0	33%	19%
Switzerland	5	29	0	0	32%	21%
Germany	17	23	0	0	31%	11%
Czech Republic	6	13	0	0	31%	13%
Japan	55	20	1	12	29%	10%
United Kingdom	19	26	0	0	20%	9%
Spain	8	23	0	0	20%	10%
Taiwan	6	23	2	0	20%	9%
USA	103	25	0	2	19%	8%
Russia	31	23	5	6	16%	5%
Canada	18	20	0	2	15%	6%
Romania	1	8	1	0	8%	3%
Argentina	2	26	1	1	7%	3%
South Africa	2	20	0	1	6%	2%
Mexico	2	13	0	0	5%	2%
Netherlands	1	31	0	0	4%	1%
India	16	17	7	4	3%	1%
Pakistan	2	19	1	2	3%	1%
Brazil	2	13	0	1	3%	2%
China	10	4	4	14	2%	1%
Iran	0	0	1	2	0%	0%
Turkey	0	0	0	1	0%	0%
Korea DPR (North)	0	0	0	1	0%	0%
EU27	145	22	4	3	30%	15%
Total	435	22	29	59	16%	6%

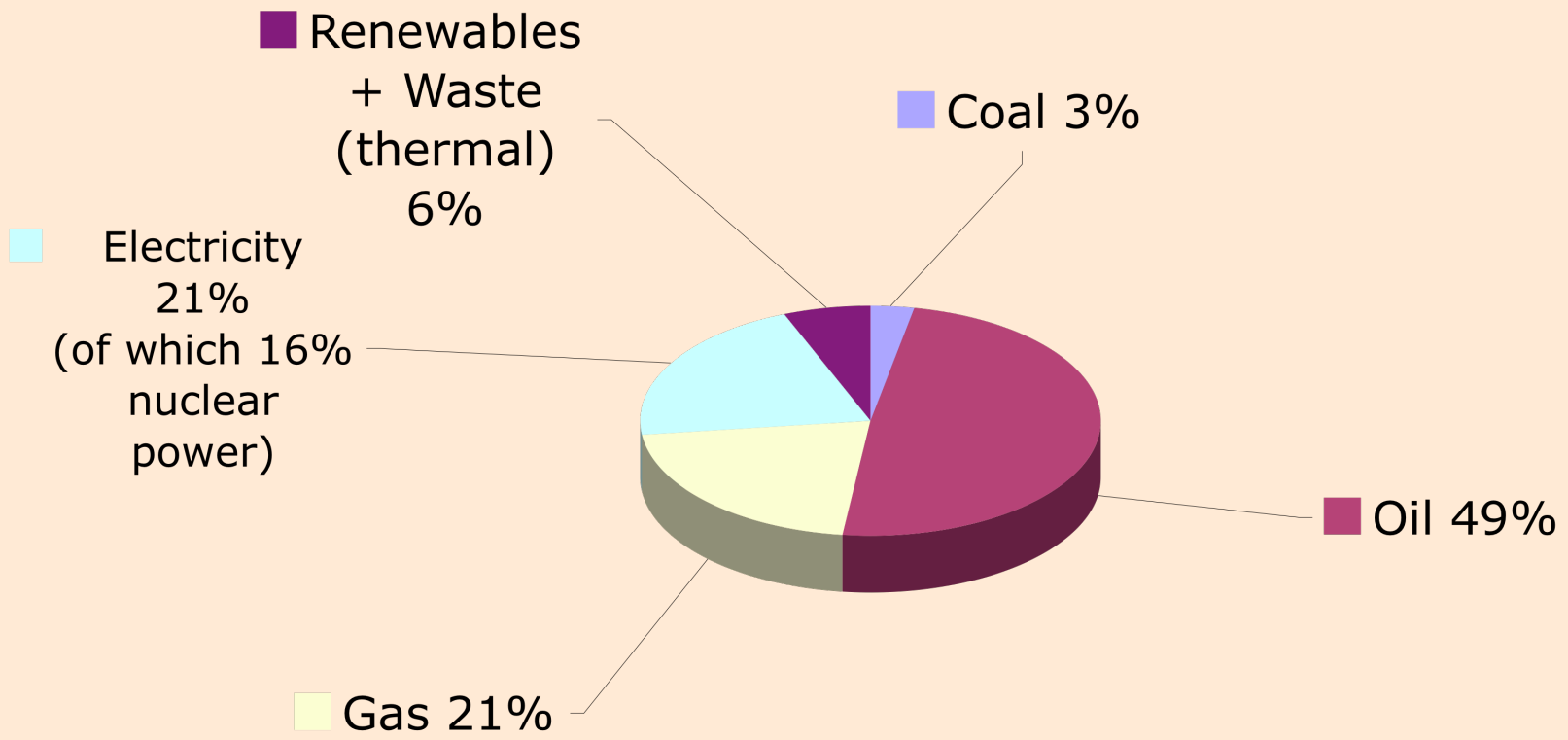
Sources: IAEA-PRIS 2007, BP 2006, WNA 2006

The Role of Nuclear Power in the Final Energy Supply of the Six Largest Nuclear Electricity Producers (status 2002, France 2005)

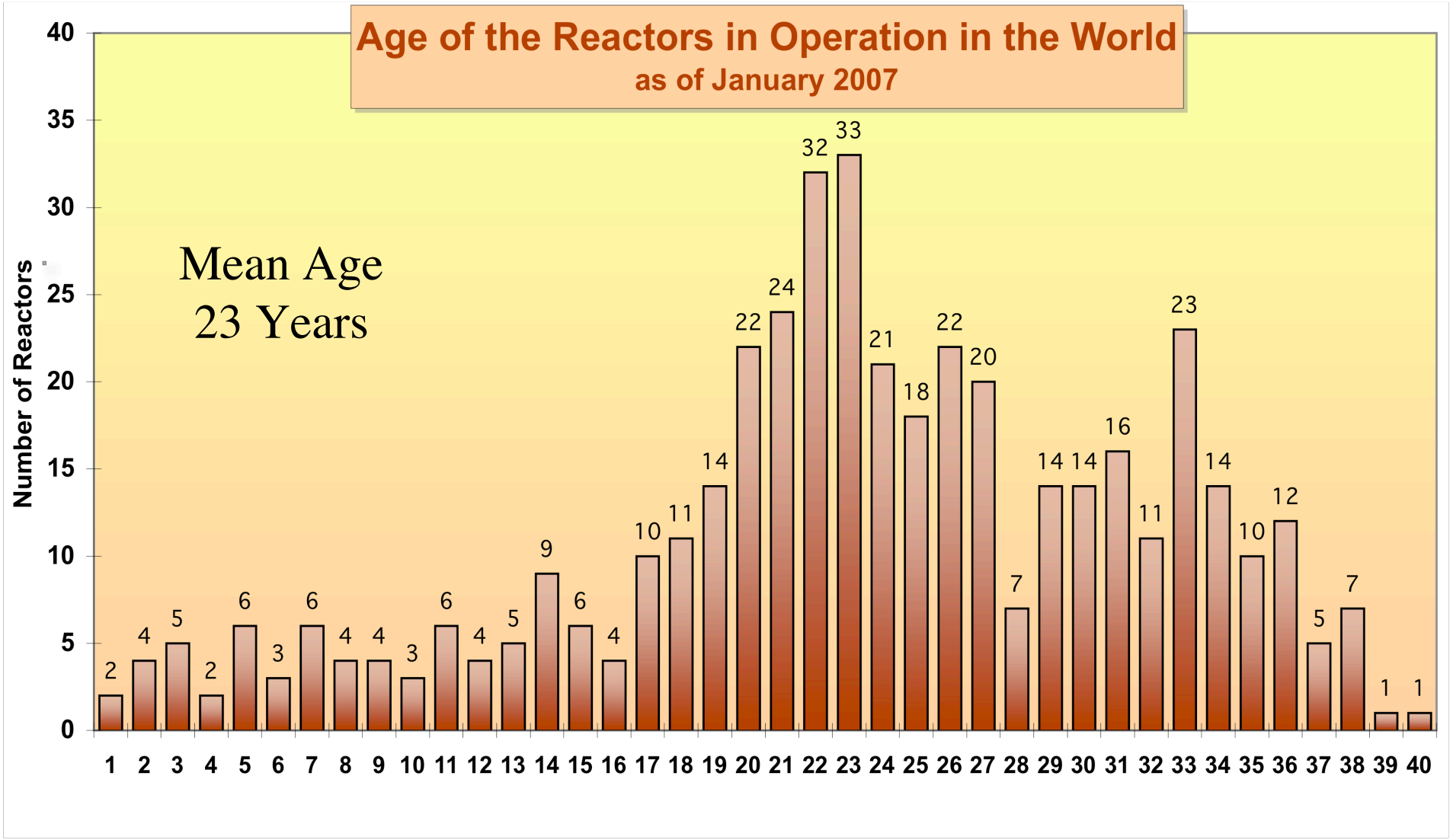
Country	Total Primary Energy (in Mtoe)	Total Final Energy *(in Mtoe)*	Nuclear Final Energy Supply *(in Mtoe)*	Nuclear Share in Final Energy *(in %)*
France	284	176	29	**16,3**
Japan	515	359	23	**6.4**
South Korea	217	138	9	**6,7**
Germany	330	241	15	**6,4**
USA	2332	1557	61	**3,9**
Russia	671	418	13	**3,1**

Sources: various; France MINEFI 2006

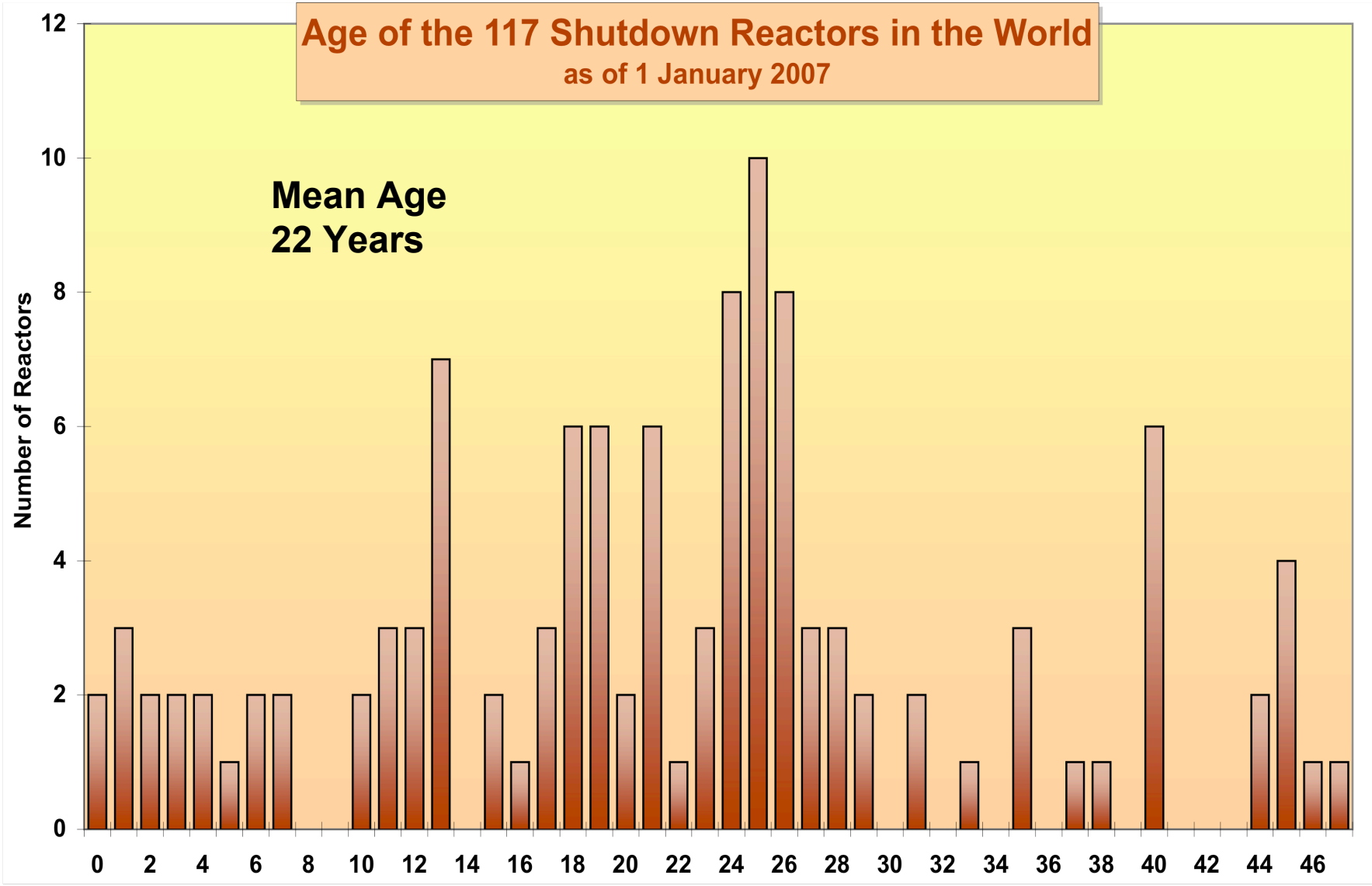
Final Energy Consumption in France in 2005
>73% fossil fuels, 16% nuclear



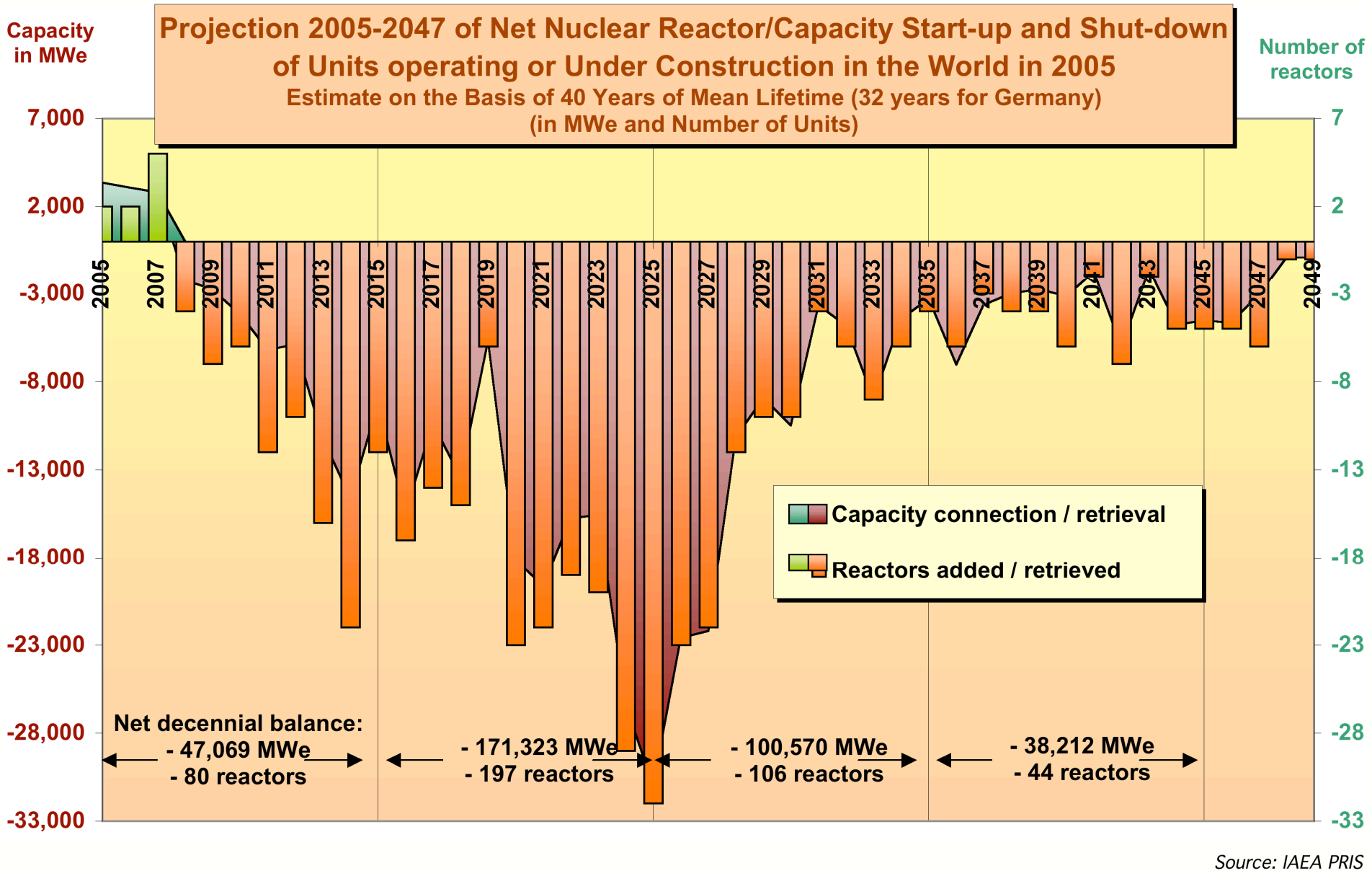
Source: French Ministry of Economics, Finances and Industry, *L'Energie en France - Repères,* Edition 2006



Source: IAEA PRIS, 01/200



Source: IAEA PRIS



Source: IAEA PRIS

New Build Issues

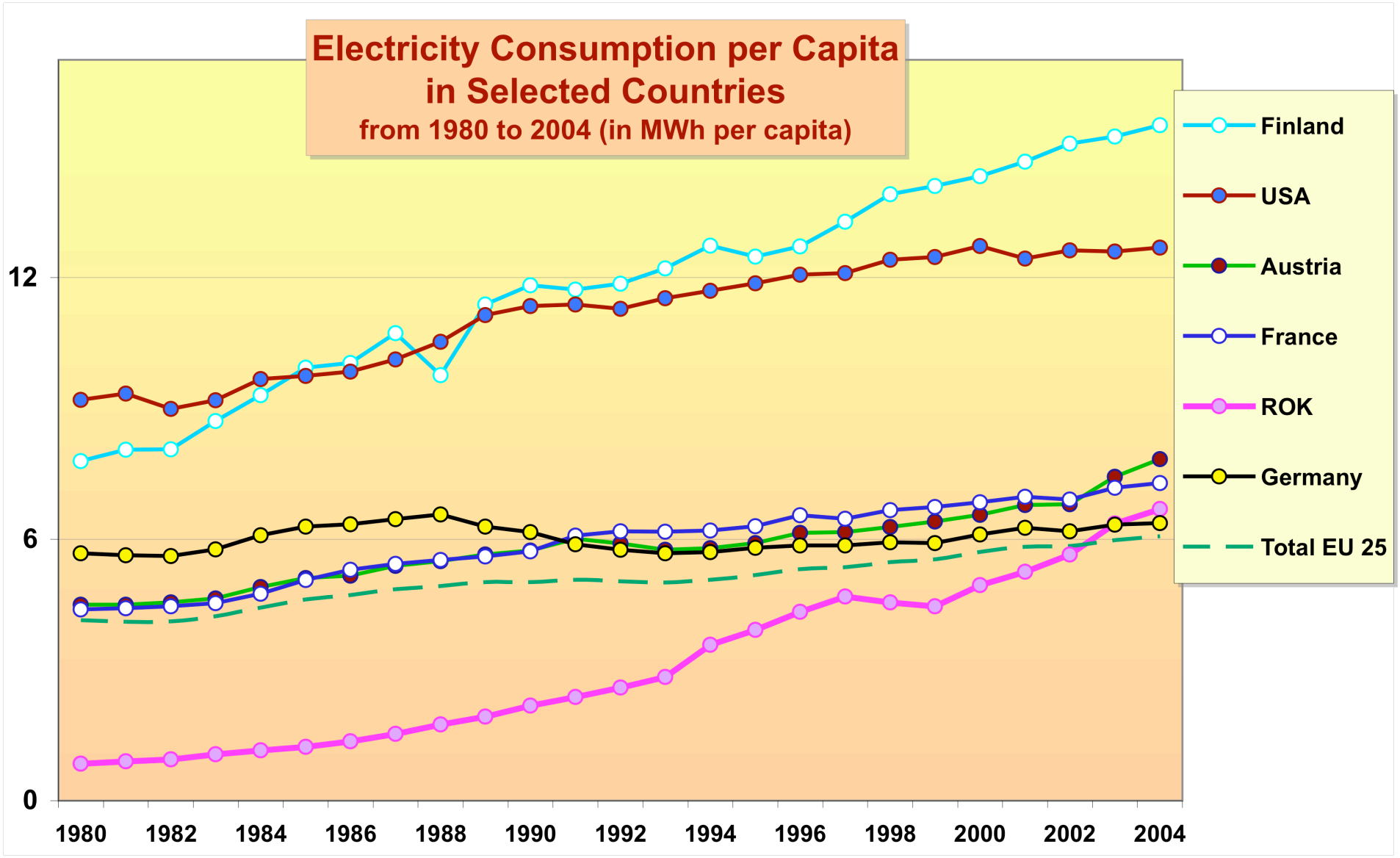
- Western Europe
- USA
- China

"As to actively replacing plants now, the technology is on life support." (Platts, 22 March 2006)

Grid Connections in Western Europe in 2004
- 10,900 MW of combined cycle gas turbines
- 5,800 MW of wind
- 0 MW of nuclear.

Grid Connections in Western Europe in 2005
- 12,900 MW of combined cycle gas turbines
- 6,183 MW of wind power
- 0 MW of nuclear.

Under Construction in Western Europe in 2006
- > 20,000 MW of combined cycle gas turbines
- 1,600 MW of nuclear (Finland)



Source: DOE Energy Information Administration, 2006

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

1998-1999	TVO submits environmental impact assessment report.
2000	TVO submits application for decision-in-principle.
2001	Preliminary safety assessment. Public hearings.
2002	Government and Parliament approve decision.
2003	TVO selects its Olkiluoto site to build a third reactor.
2004	TVO applies for construction licence.
2005	MTI grants licence. First concrete in August.
2006	Project running 18 months late.
2010	Expected start-up.

Lead Time: 12 years since EIA

Official Price: ca. €3 billion (Guaranteed Fix Price)

Cost Overrun 18 Months after Construction Start: €700 million

Sources: OECD-IEA, WEO 2006; AREVA 2006, French Ministry of Finances 2006

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.

2007-2008 Expected time for the submission of COL to the NRC.
After 2007-2008 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

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

US Department of Energy Outlook for 2030

- EIA 2007 Reference Case for 2030
  - + 3 GW of uprates of existing plants
  - + 9 GW of new plants stimulated by federal financial incentives (shared)
  - + 3.5 GW in later years without financial subsidies
  - - 2.6 GW of retirements of older plants
  - Nuclear generation share falls from 19% to 15%
  - Lower construction costs required to stimulate more nuclear investment absent CO_2 emissions prices
- Some of the most attractive economics are in states where new nuclear plants will be opposed by local authorities (California, New England, New York)
- Realistic best case scenario would have first new nuclear plant in operation in 2015 on an existing site

Source: Paul L. Joskow, MIT
January 2007

Average Estimated and Realised Investment Costs of Nuclear Power Plants by Year of Construction Start

1966-1977 ($2005/kW)

Construction Start	Number of Reactors	Initial Estimate	Real Costs	Cost Increase
1966-1967	11	530	1 109	+109%
1968-1969	26	643	1 062	+65%
1970-1971	12	719	1 407	+96%
1972-1973	7	1057	1 891	+144%
1974-1975	14	1095	2 346	+114%
1976-1977	5	1413	2 132	+51%

Sources: OECD-IEA, WEO 2006; MSC 2007

Large Cost Overrun at AREVA's MOX Plant Project in the US

"The original estimated cost of the DOE's MOX-fuel facility presented to Congress in 2002 was $1 billion.
By July 2005, three years later, the estimated cost had ballooned to $3.5 billion and the project was 2.5 years behind schedule.
Such cost overruns and delays are typical for U.S. Department of Energy projects."

Source: Frank von Hippel, Princeton, January 2007