

Status and Trends of the World Nuclear Industry

An Update to *The World Nuclear Industry Status Report 2010-2011*

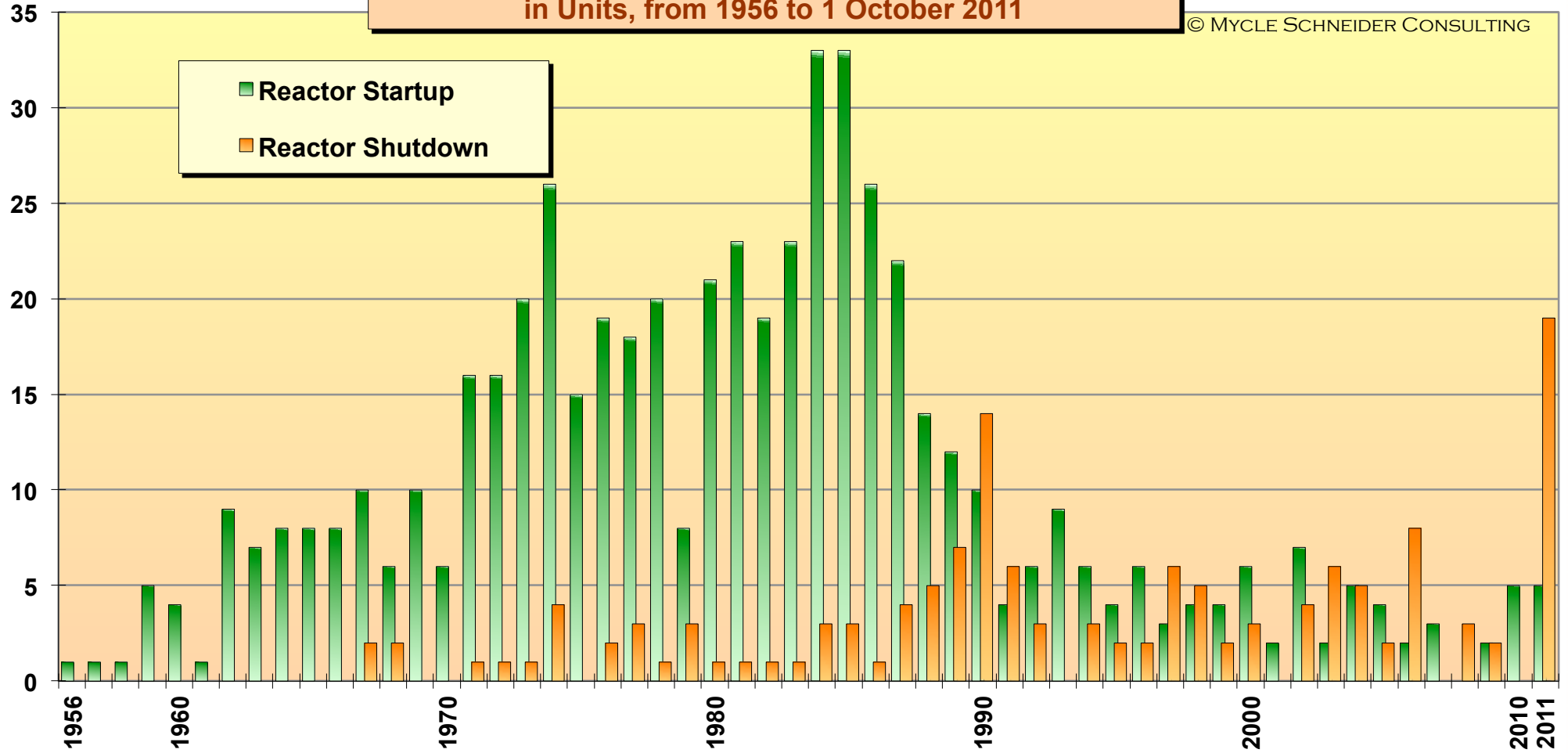
Mycle Schneider

International Consultant on Energy and Nuclear Policy, Paris, France

8th UCTEA Energy Symposium – Global Energy Politics and Turkey, 17-19 November 2011

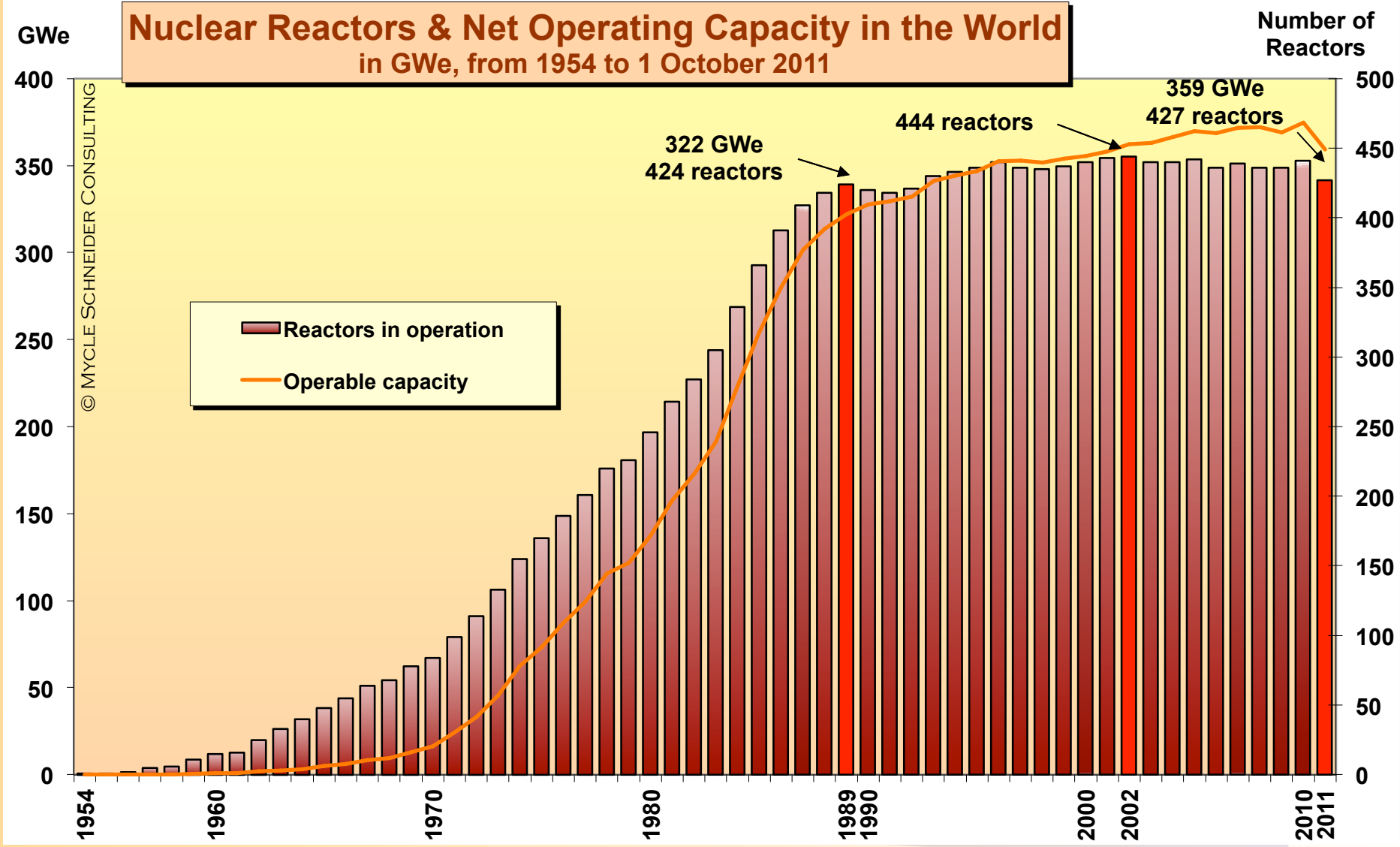
Reactor Startups and Shutdowns in the World in Units, from 1956 to 1 October 2011

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Source: IAEA-PRIS, MSC, 2011

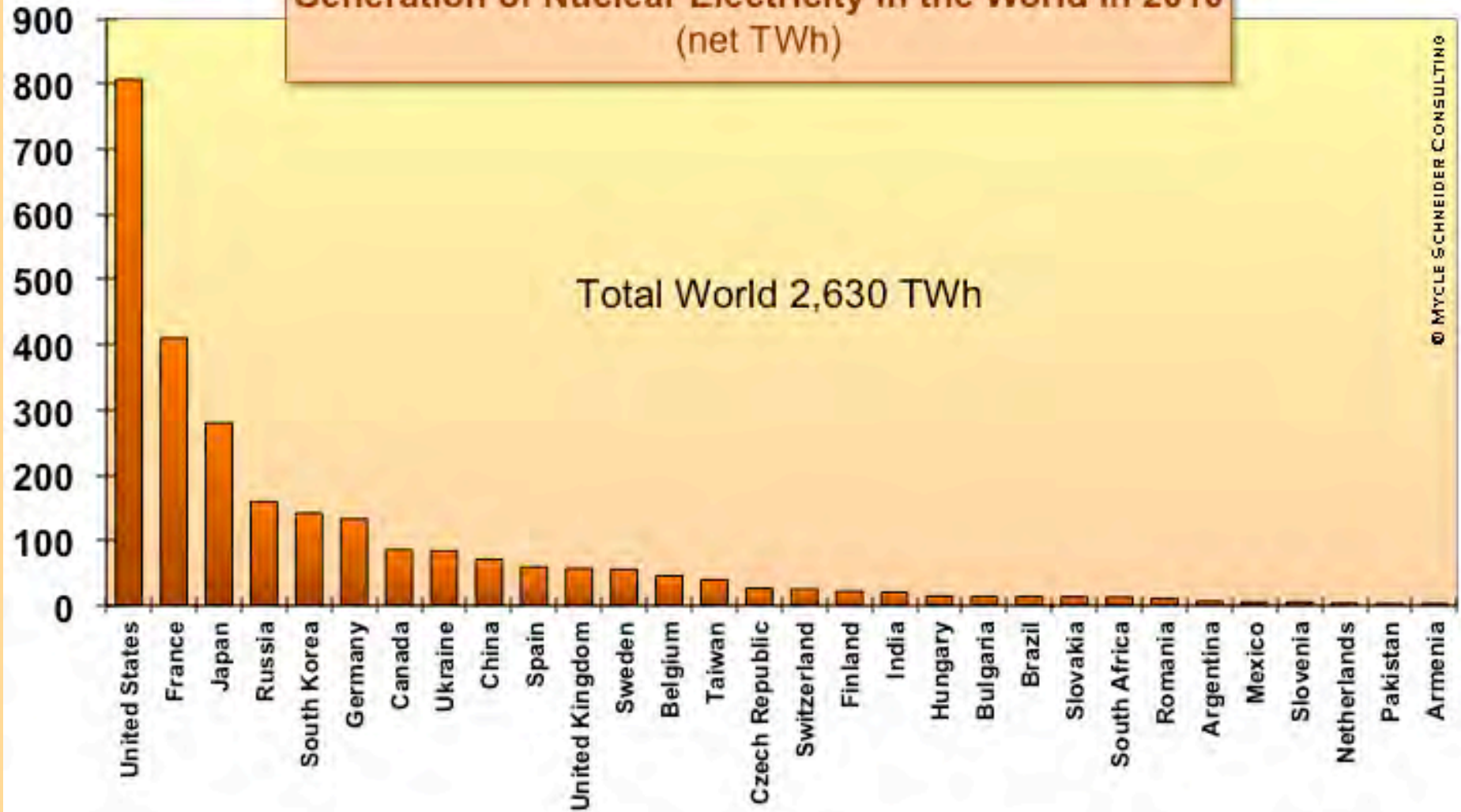
Nuclear Reactors & Net Operating Capacity in the World in GWe, from 1954 to 1 October 2011



Source: IAEA-PRIS, MSC, 2011

TWh

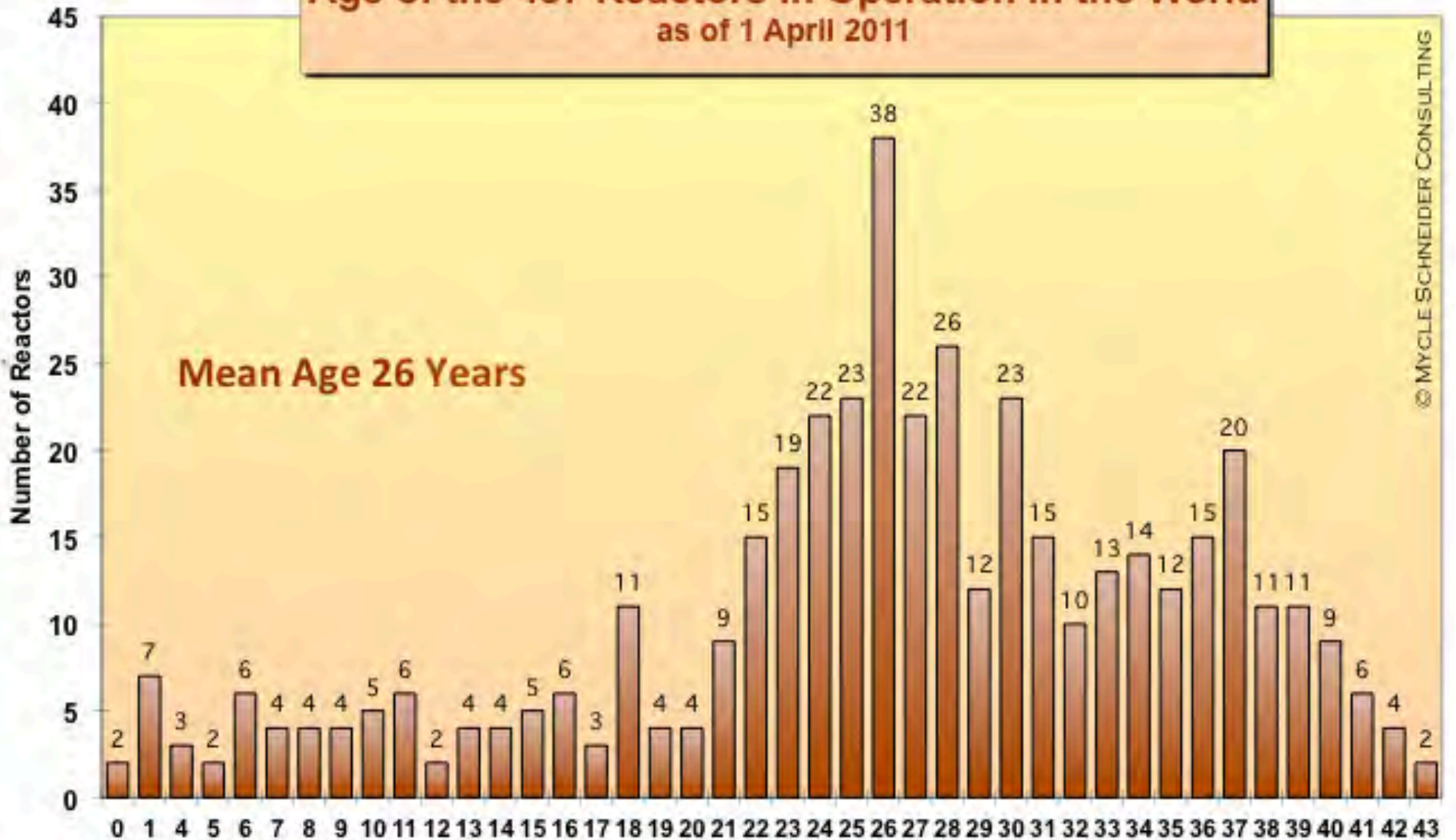
Generation of Nuclear Electricity in the World in 2010 (net TWh)



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Source: IAEA-PRIS, 2011

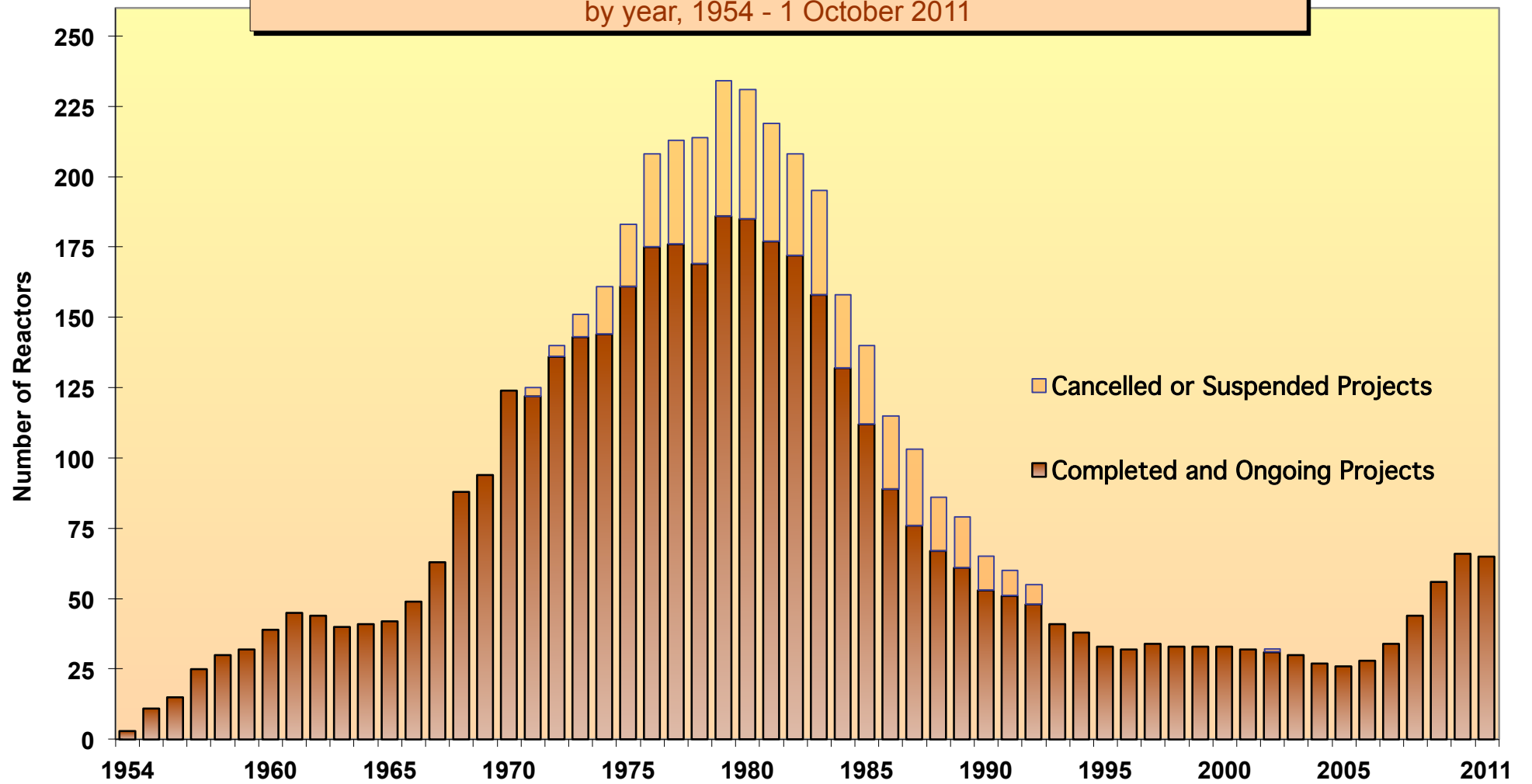
Age of the 437 Reactors in Operation in the World as of 1 April 2011



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Source: IAEA-PRIS, MSC, 2011

Number of Nuclear Reactors Listed as "Under Construction" by year, 1954 - 1 October 2011



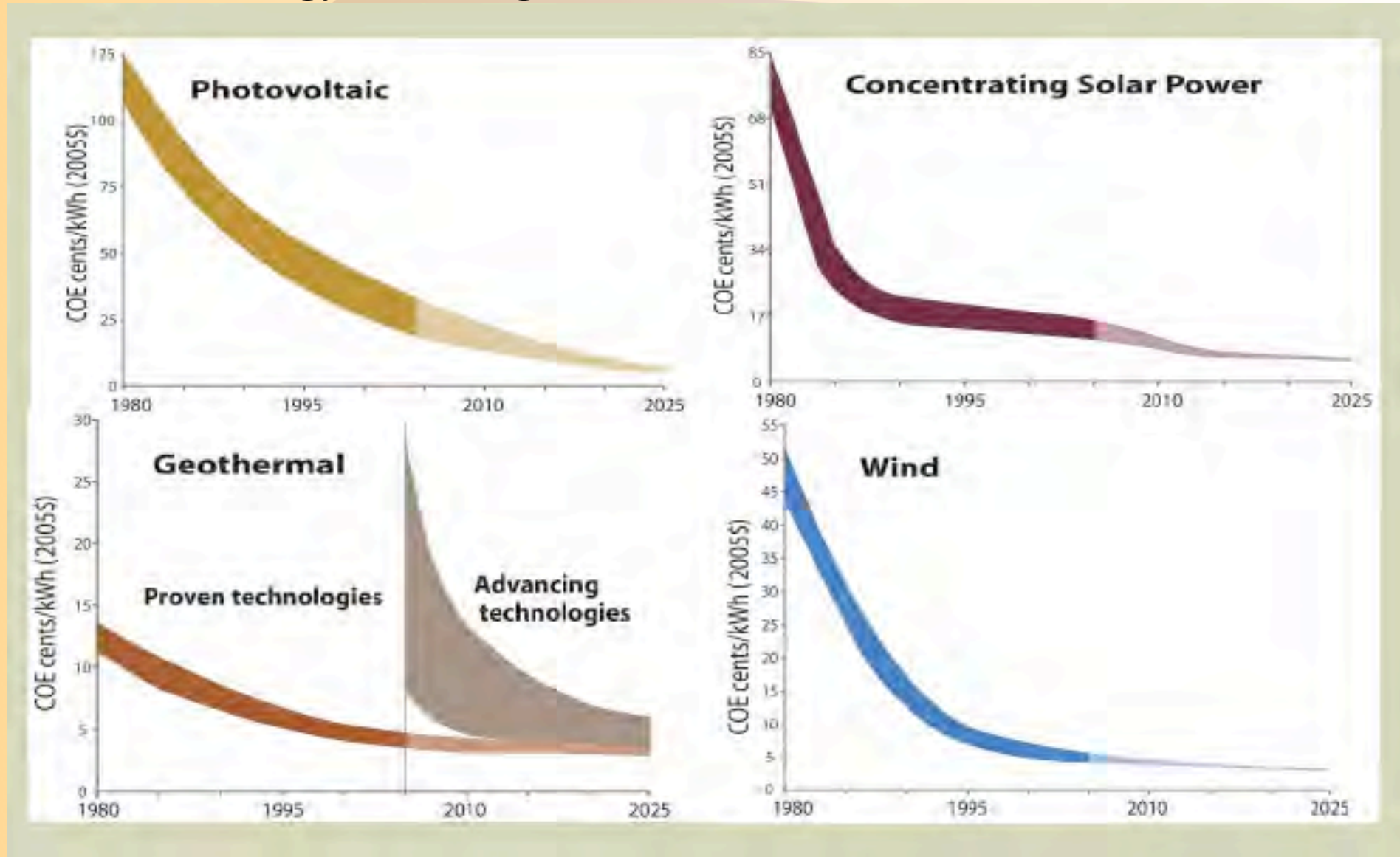
Source: IAEA-PRIS, MSC, 2011

Reactors « Under Construction » in the World (15 November 2011)

Country	Units	MWe (net)	Construction Start	Grid Connection
China	27	27,230	2005-2010	2011-?
Russia	11	9,153	1985-2010	2011-?
India	6	4,194	2002-2004	2011-2015
South-Korea	5	5,560	2006-2008	2011-2013
Bulgaria	2	1,906	1987	2014-2015
Japan	2	2,650	2004-2010	2011-2014
Slovakia	2	782	1985	2012-2013
Taiwan	2	2,600	1999	2011-2012
Ukraine	2	1,900	1986-1987	2015-2016
Argentina	1	692	1981	2012
Brazil	1	1,245	2010	2018
Finland	1	1,600	2005	2014?
France	1	1,600	2007	2014?
Pakistan	1	315	2011	2016
USA	1	1,165	1972	2012
Total	65	62,592	1972-2011	2011-2018

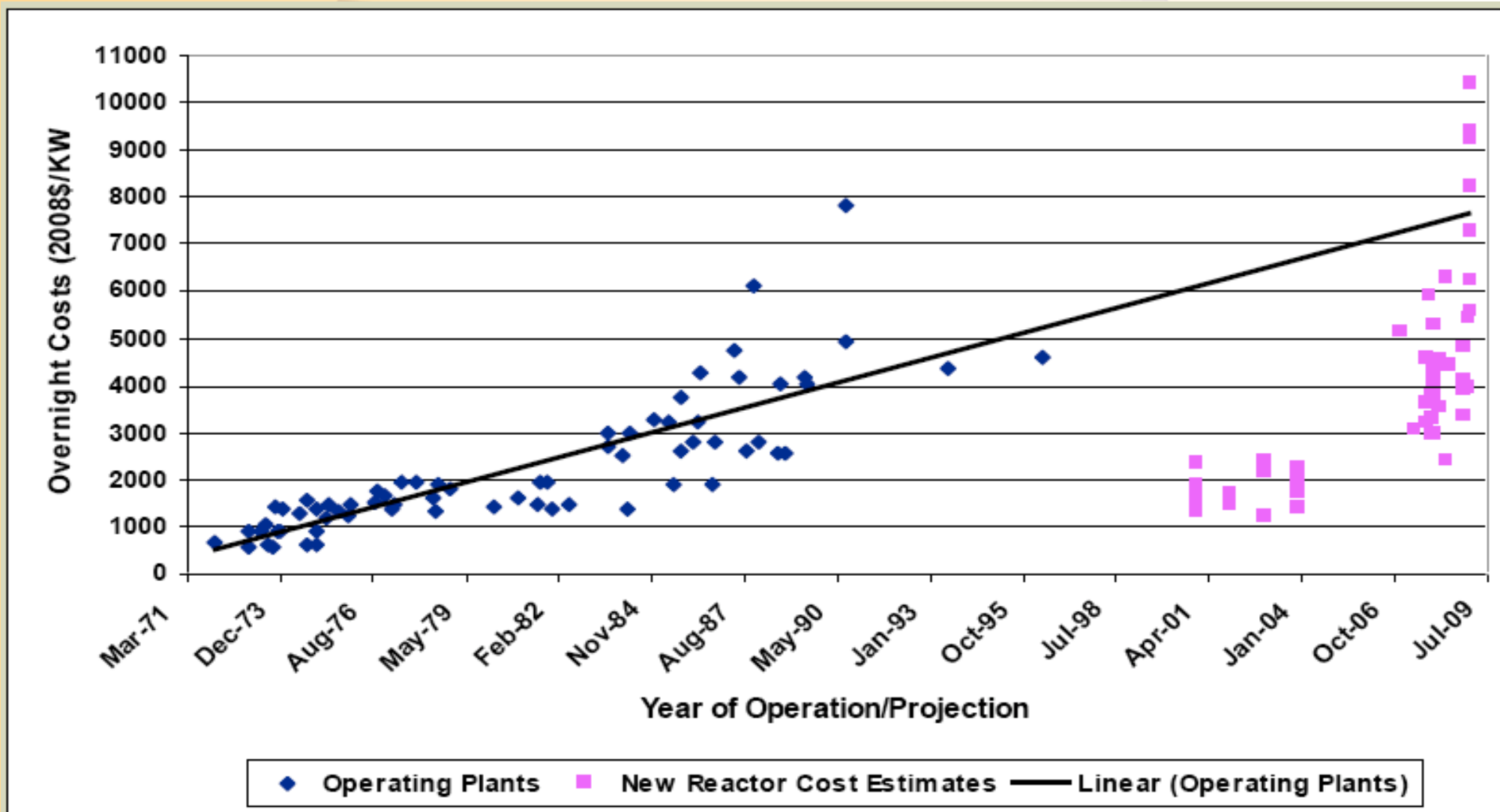
Source: IAEA-PRIS, MSC, 2011

Technology Learning Curves



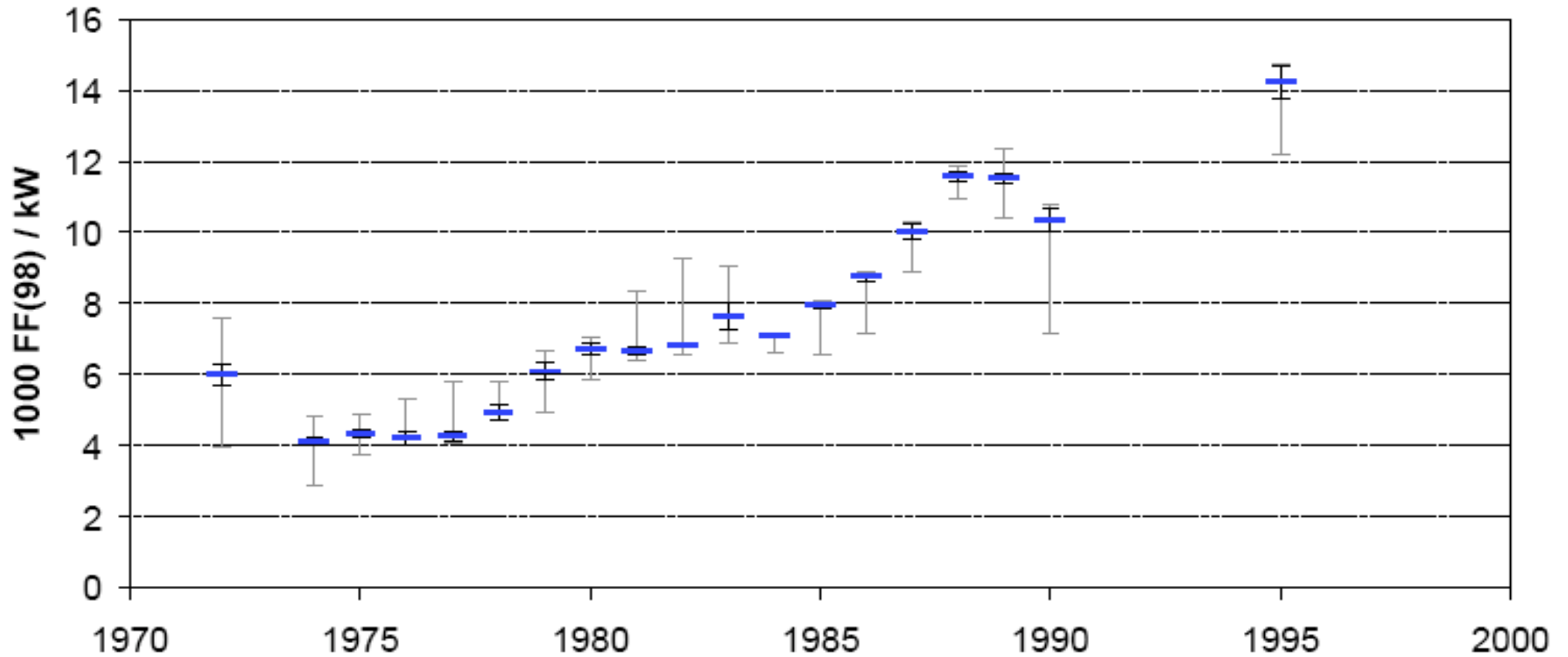
Source: Cooper 2010

Negative Learning Curve US Nuclear Reactors



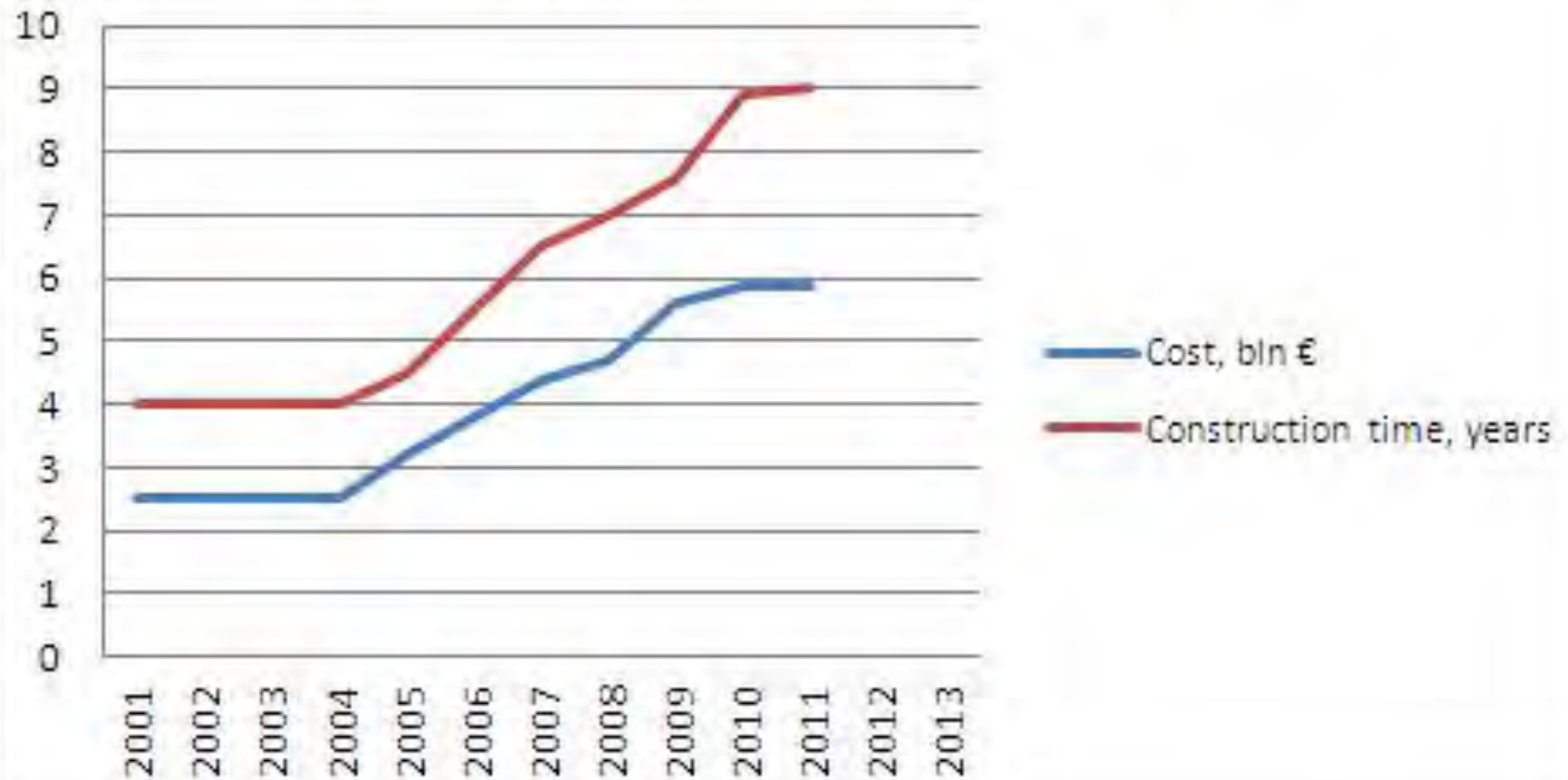
Source: Cooper 2010

Negative Learning Curve of French PWRs



Source: Arnulf Grübler, «An assessment of the costs of the French nuclear PWR program 1970–2000 », 6 October 2009

Olkiluoto 3 cost & lead time



Source: Greenpeace Finland 2011

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.
2010	Project running at least 42 months late
2011	Project running about 54 months late
2014	Start-up?

Lead Time: at least 15-16 years since EIA

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

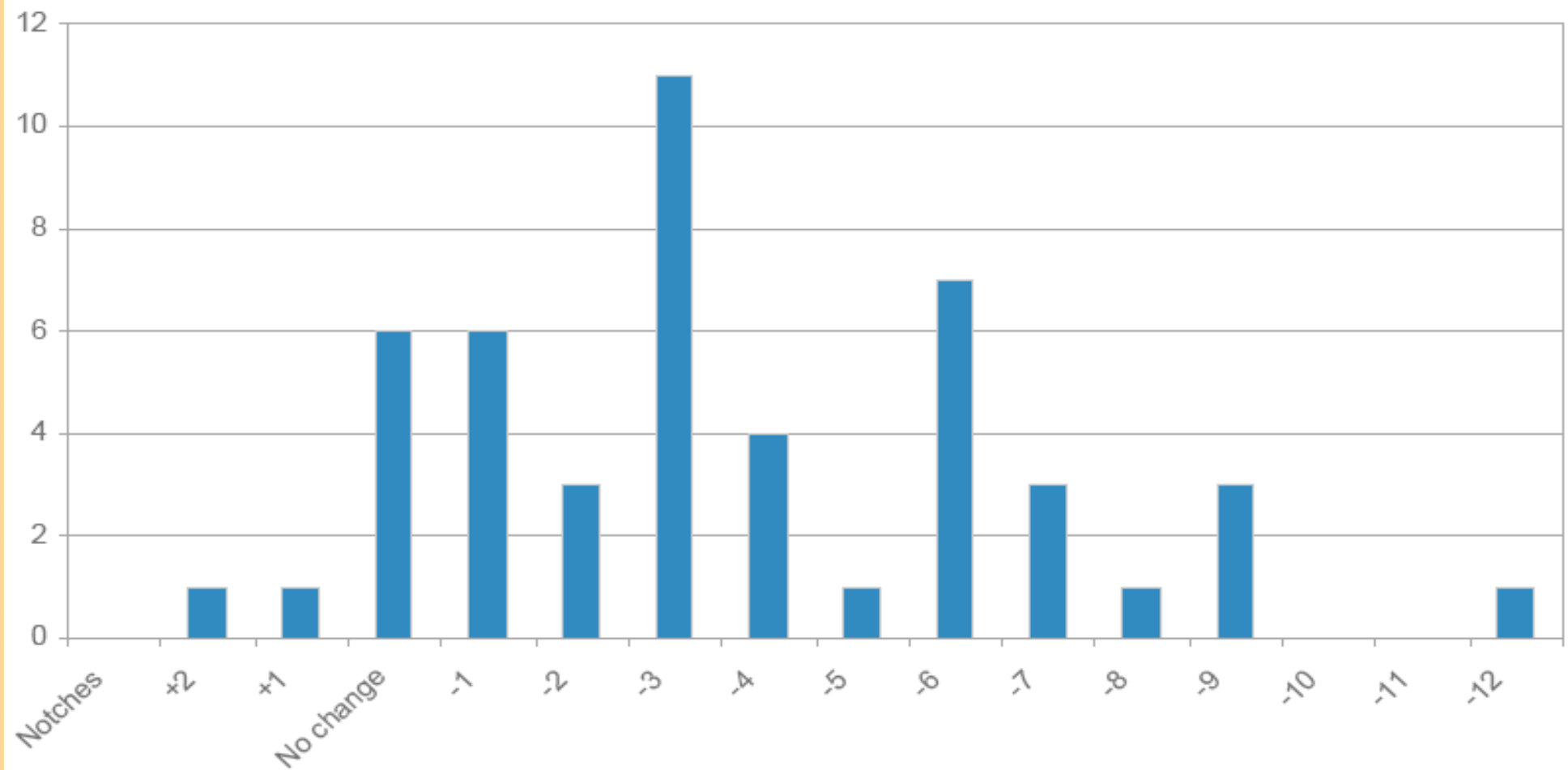
Cost Overrun at 6 Years after Construction Start: €2.7 Billion (90%)

New provisions likely (October 2011)

Estimated Total: >€5.7 Billion or \$8.3 Billion

Sources: Various, compiled by MSC

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

French State Companies in Trouble

EDF

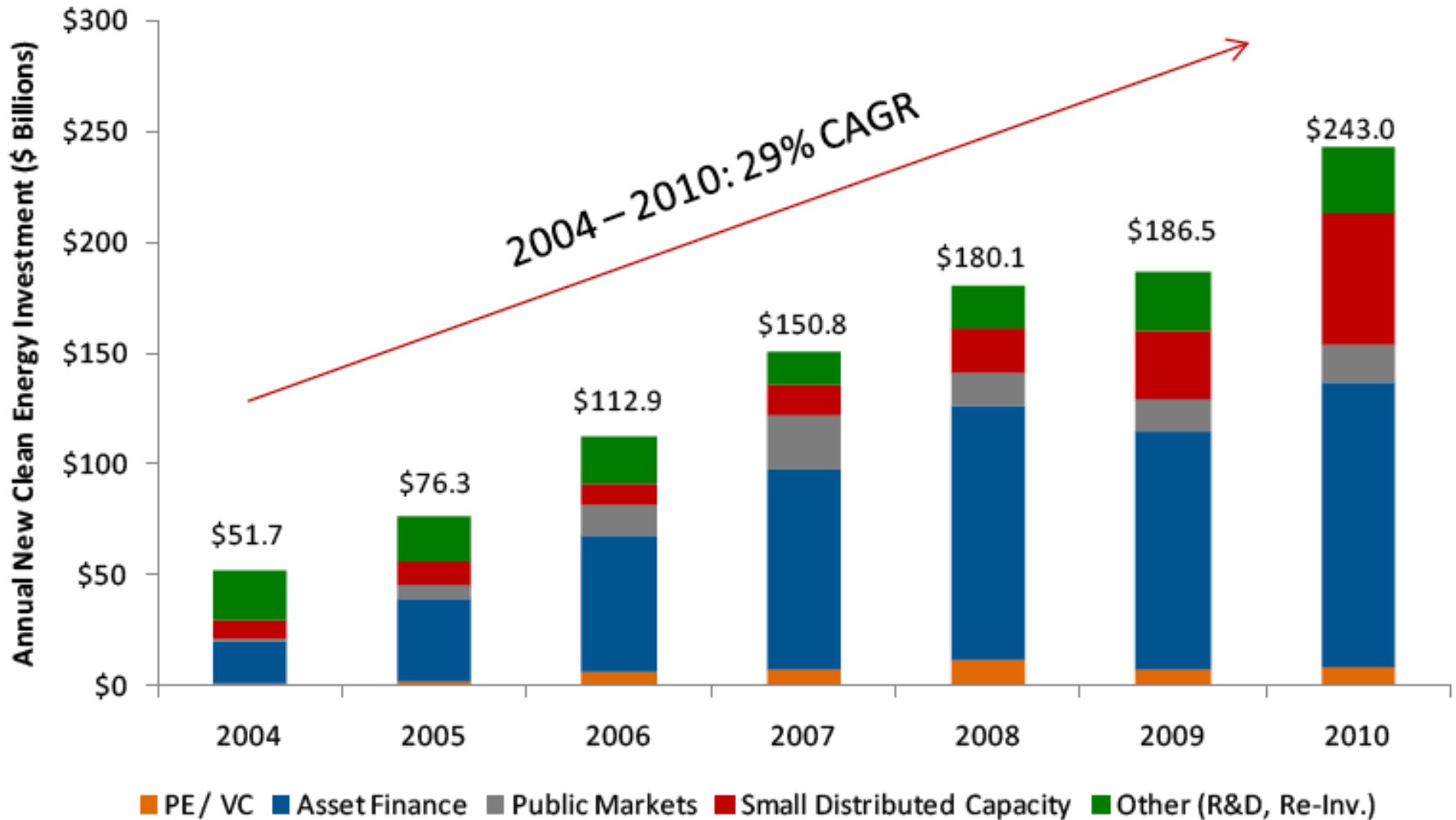
- lost 78% of share value since 2007
- large debt burden

AREVA

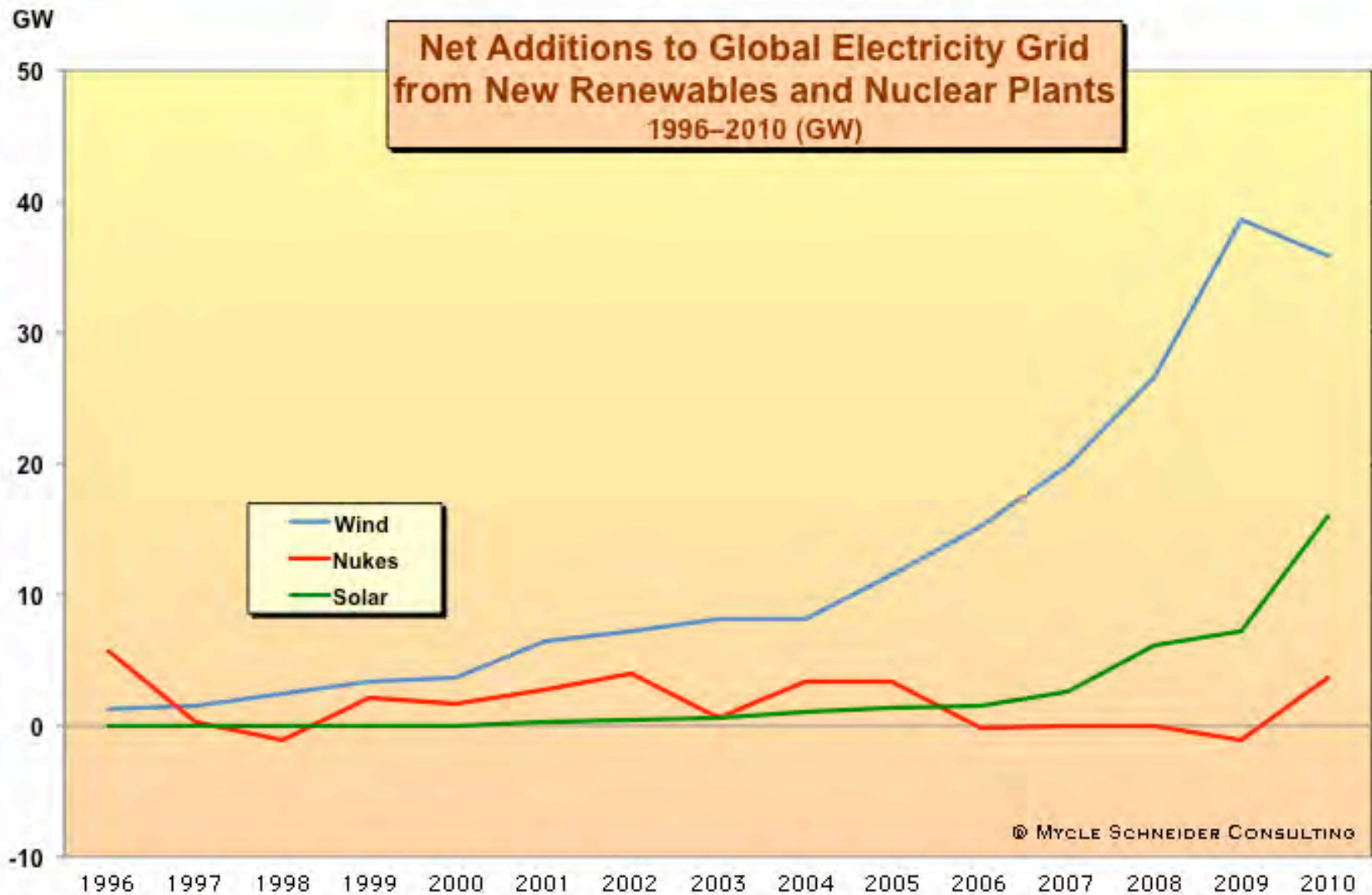
- lost 72% of share value since 2007
- in April 2011 Standard & Poor's downrated Stand Alone Credit Profile (SACP) to BB+ (« junk bond »)

Sources: Company websites; Standard & Poor's, 15 April 2011

Annual New Clean Energy Investment by Asset Class 2004-2010

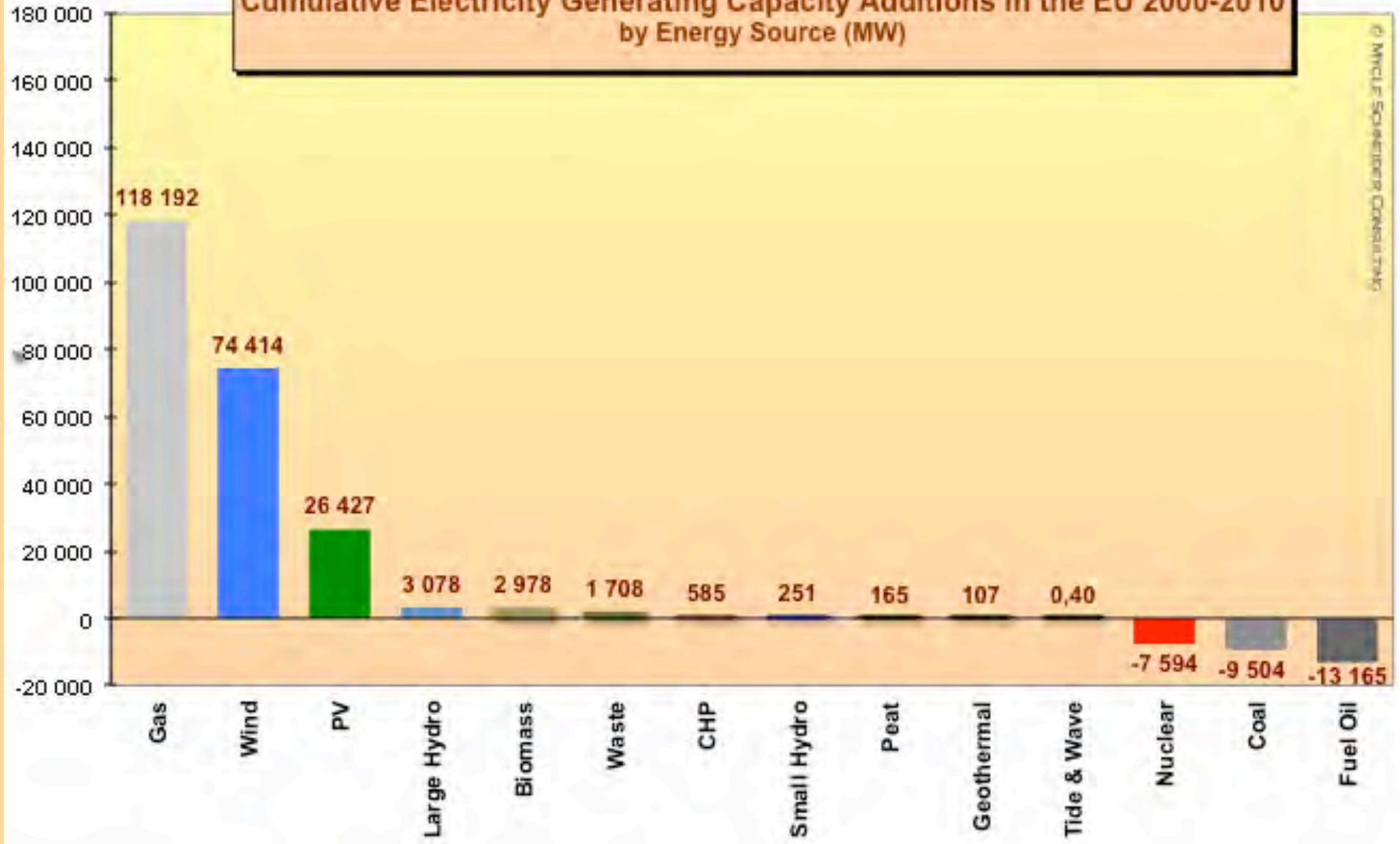


Source: Bloomberg/Deutsche Bank, 2 May 2011



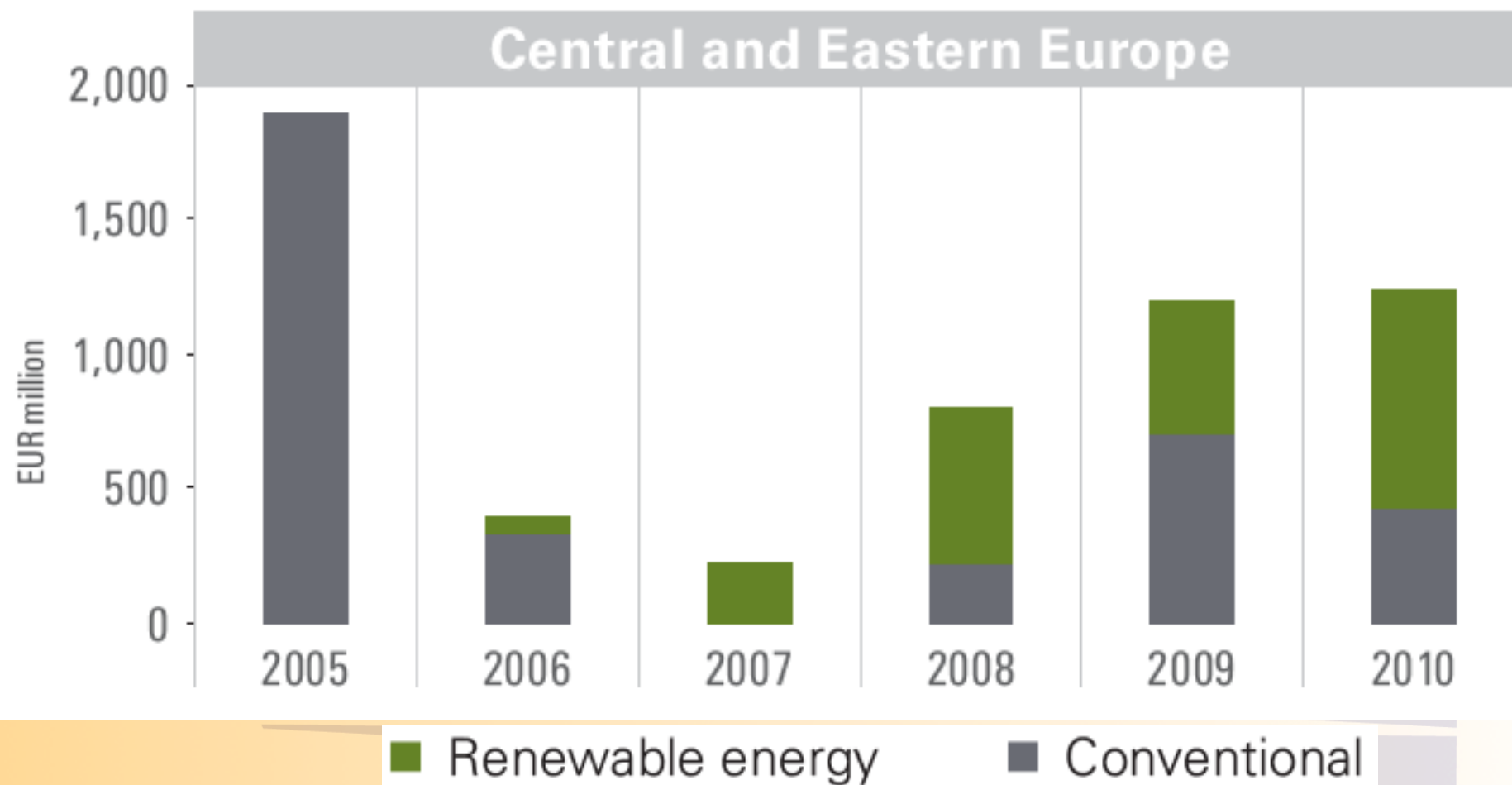
Sources: Amory Lovins, 2010; Global Wind Energy Council (GWEC), Global Wind Energy Report 2010 (Brussels: 2001); IAEA, PRIS database; European Photovoltaic Industry Association, "Global Market Outlook for Photovoltaics until 2014" (Brussels: May 2010)

**Cumulative Electricity Generating Capacity Additions in the EU 2000-2010
by Energy Source (MW)**



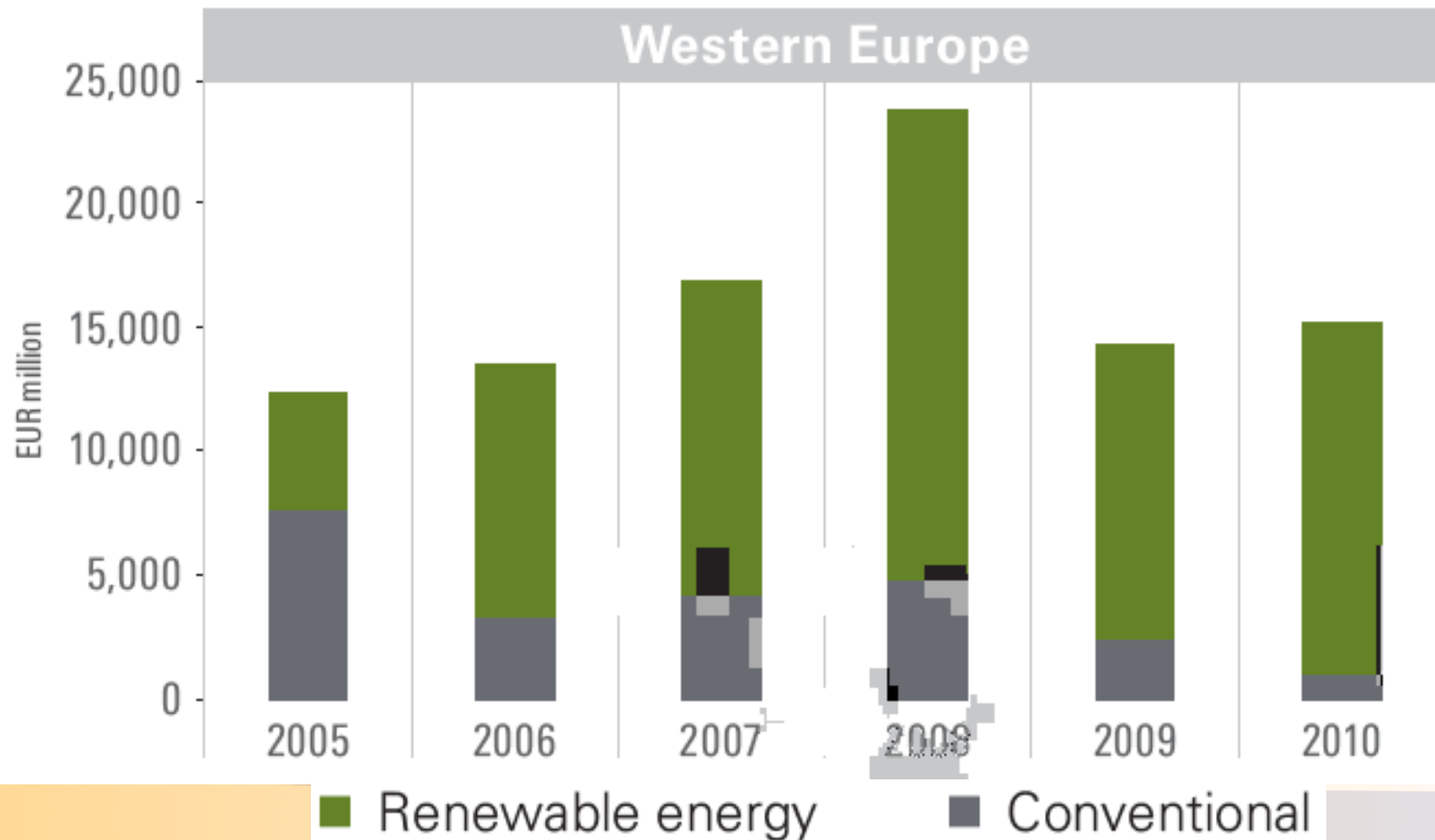
Source: EWEA 2011

Renewable vs. Conventional Power Project Investments in Europe (1)



Source: KPMG, « Power Sector Development in Europe - Lenders' Perspectives 2011 », September 2011

Renewable vs. Conventional Power Project Investments in Europe (2)



Source: KPMG, « Power Sector Development in Europe - Lenders' Perspectives 2011 », September 2011

Estimated Investment Needs in European Power Sector 2011-2025

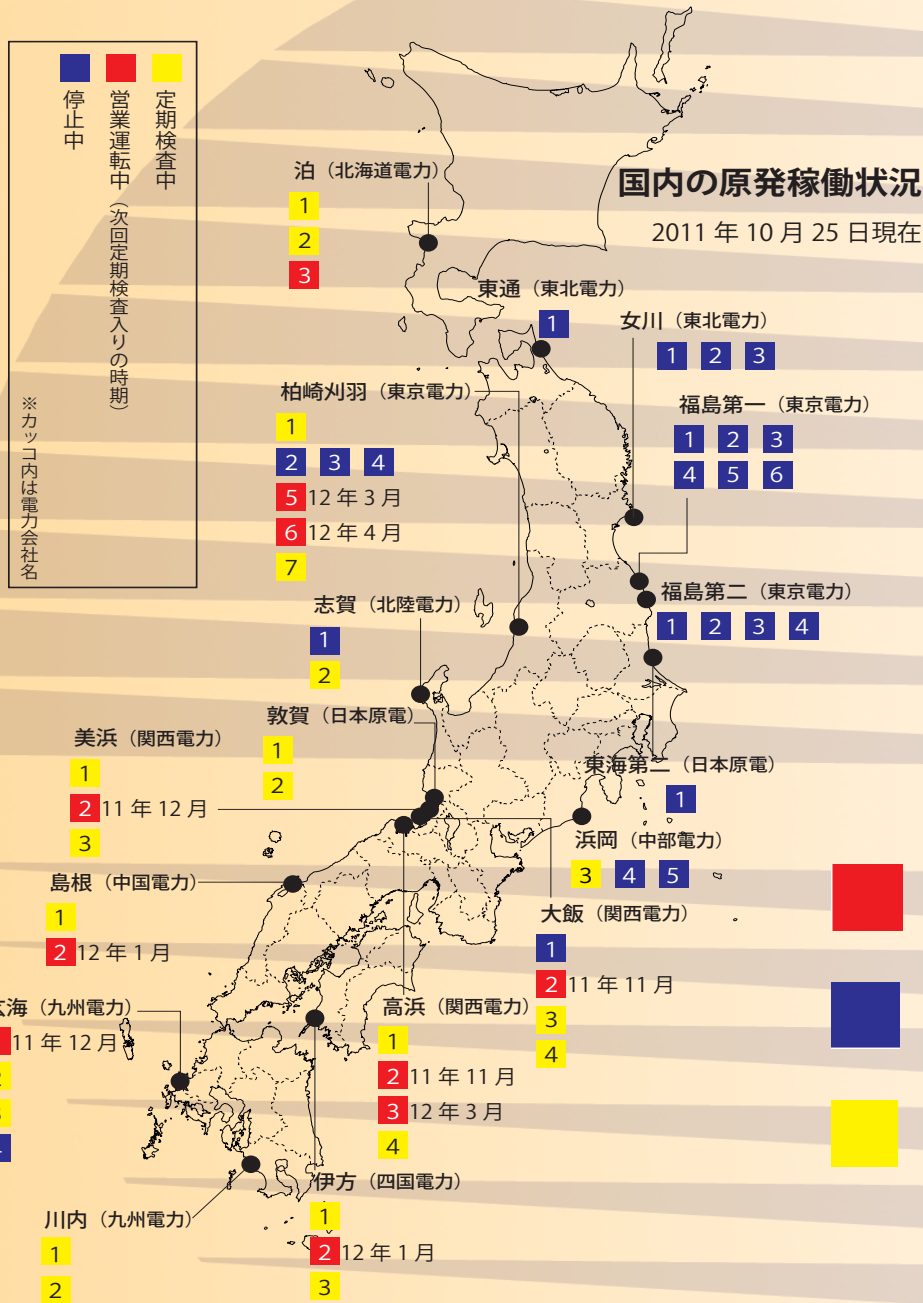
Technology	CAPEX (EUR/kW)	Conservative Estimate		Best Estimate	
		Capacity (GW)	Investment (EUR million)	Capacity (GW)	Investment (EUR million)
Nuclear	3,500	-	-	5	16,100
Coal	1,600	126	201,044	147	235,343
Gas	800	122	97,775	178	142,678
Oil	800	2	1,735	2	1,735
Wind	1,400	107	149,576	170	237,622
Solar	5,000	24	121,200	36	180,050
Other renewables	3,500	21	73,558	25	87,838
Hydro	2,500	35	88,568	46	116,243
Total		437	733,455	609	1,017,608

Source: KPMG, « Power Sector Development in Europe - Lenders' Perspectives 2011 », September 2011

Post-Fukushima in Selected Countries (1)

Japan

- Profound collective traumatism.
- Shutdown of 3 reactors at Hamaoka (one started up in 2005).
- Abandoning of Fukushima-Daini (4 reactors).
- Abandoning of all new construction.
- Reorganization of the nuclear sector (ex. NISA separated from METI).
- Vote of Renewable Energy Law (26 August 2011).
- Launch of the Japan Renewable Energy Foundation (September 2011) by Masayoshi SON, CEO of SoftBank.
- *“The coming energy policy reform could be as important as or even more important than a reform that followed the first and second oil crises.”*
(Ken Koyama, Managing Director, Japan Institute of Energy Economics, on 3 October 2011)



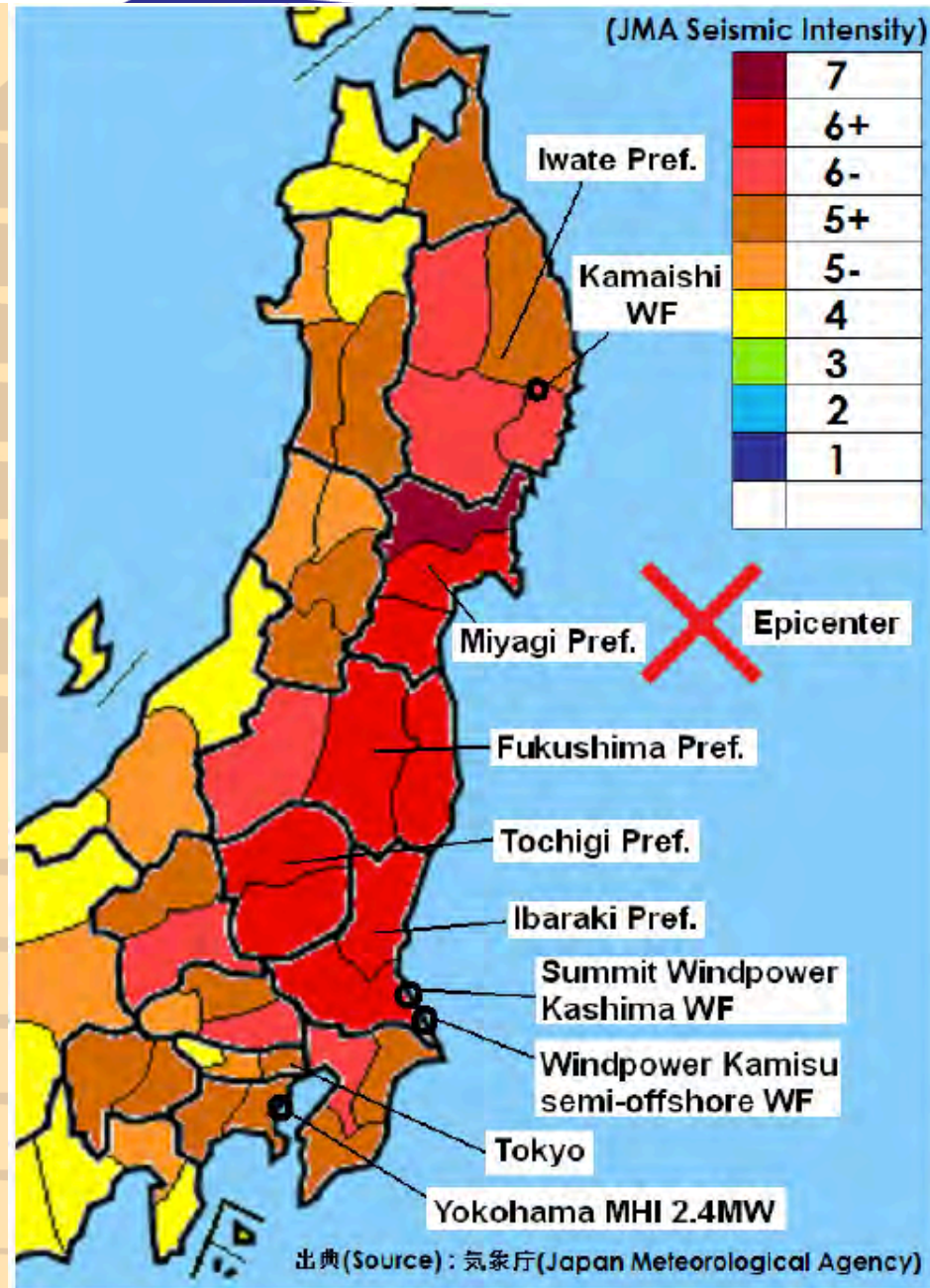
Japan Post-Fukushima

- Only 11 of 54 pre-Fukushima reactors operating.
- Key role of local authorities/citizens.

	Operating
	Shut Down After Earthquakes
	Shut Down For Refueling/Maintenance

Sources: Mainichi, CNIC, Green-Action November 2011

Windpower Plants in Earthquake-Affected Areas



- 35 Sites
190 Turbines
270 MW
in 5 Prefectures

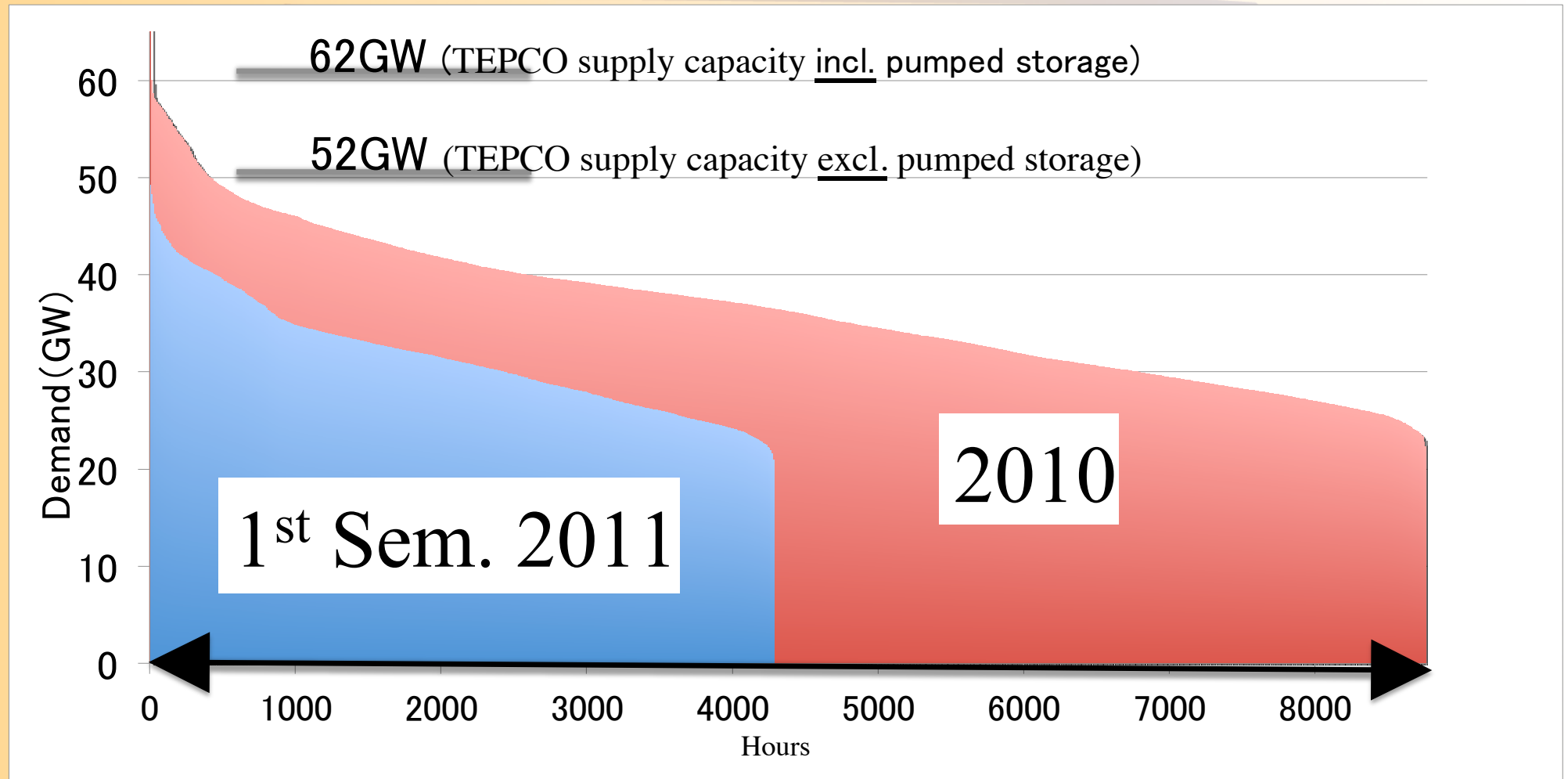
- 2 Sites
37 Turbines
<30 km Fukushima

Damage

Serious Impact on Power Lines but only 1 Slightly Leaning Turbine

Sources: JWEA, JWPA, 12 August 2011

Spectacular Demand Reduction: TEPCO 1st Semester 2011 vs. 2010



Source: TEPCO, ISEP 2011

Post-Fukushima Reactions in Selected Countries (2)

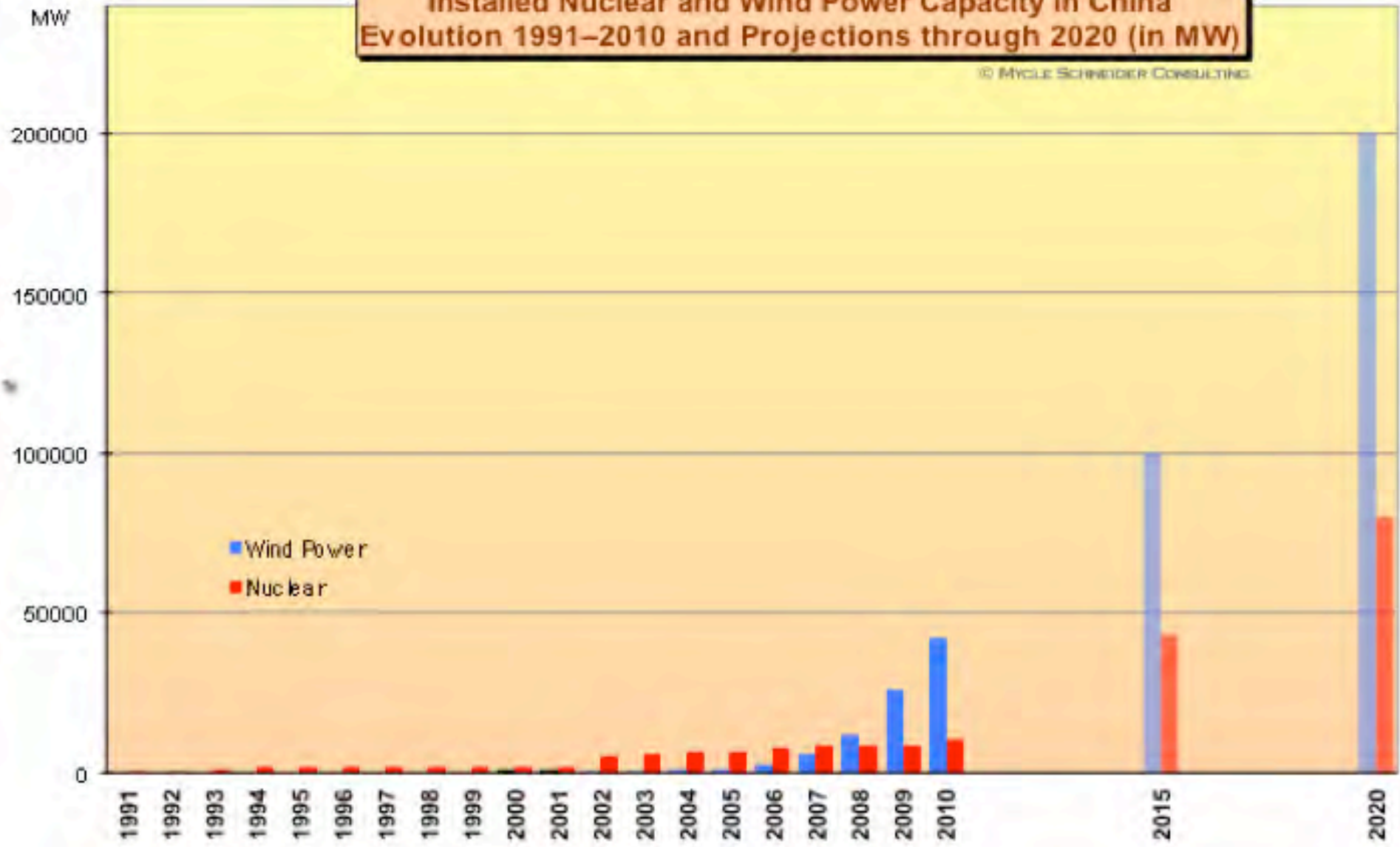
China

- Freeze authorization of new projects. (Limiting units per site?)
- Safety audit of reactors in operation and under construction.
- Startup of new reactor on 3 May 2011.
- Abandoning of CPR1000 series (summer 2011).
- Acceleration of renewable energy programs.

May double target for installed PV from 5 GW to 10 GW by 2015.

**Installed Nuclear and Wind Power Capacity in China
Evolution 1991–2010 and Projections through 2020 (in MW)**

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Sources: IAEA-PRIS, 2011; GWEC 2011; Chinese 12th Five-Year Plan; media reports

Post-Fukushima Reactions in Selected Countries (3)

United States

- President Obama / Minister Chu “*nuclear has an important role to play in our energy mix*”.
- Senator Lieberman: “*kind of quietly, quickly put the brakes on*” until we can absorb what happened in Japan.
- NRG, main shareholder of South Texas Project (2 new reactors), has abandoned project (loss \$481 million).
- HSBC (London): “*US public may find it difficult to support major nuclear new build and we expect that no new plant extensions will be granted either*”.

Example US Military

- Off-Grid and Micro-Grid power “*next Big Thing for US military*” (todaydefense.com)
- On 8 August 2011 Boeing and Siemens (entirely abandoning nuclear) announced “strategic alliance” to develop micro-grid systems that “reduce costs and increase efficiency”.
“The alliance’s micro-grid management solution will be designed to:
 - *implement economical energy-efficiency tools that allow for analysis, control and automation of energy processes*
 - *use smart energy controls to provide real-time data to manage energy use*
 - *integrate renewable energy sources and storage.”*
- In 2009 General Electric launched smart grid at Twentynine Palms Base, California, the world’s largest Marine Corps Base, to optimize power generation and storage and to enhance capacities to use renewables.

Sources: Siemens, Press Release, 8 August 2011, INTECH, 14 July 2009

Post-Fukushima Reactions in Selected Countries (4)

France

- Continued support by government of nuclear policy.
- Safety Chief: "Nobody can ever guarantee that there will never be a severe nuclear accident in France." (OECD, Paris, 8 June 2011)
- Major safety upgrading requested (November 2011)
- Political party consensus gone. Nuclear election issue 2012.
- Public opinion in favor of phase-out.

Germany

- Immediate halt of 7+1 reactors (30+ years old).
- Definitive shutdown of 7+1 reactors. Progressive phase-out of remaining 9 reactors until 2022 at the latest.

Post-Fukushima Reactions in Selected Countries (5)

Italy

- First, one-year moratorium (23 March 2011), then draft bill to abandon legal framework for relaunch of nuclear program, objective : defining “*a new national energy strategy*”. Presidency of the Council of Ministers, 20 April 2011
- Then referendum (94% against nuclear): “*Following a decision that the Italian people is currently taking, we will have to say goodbye to the option of nuclear power stations and commit ourselves to renewable energies.*”

Silvio Berlusconi, 13 June 2011

Switzerland

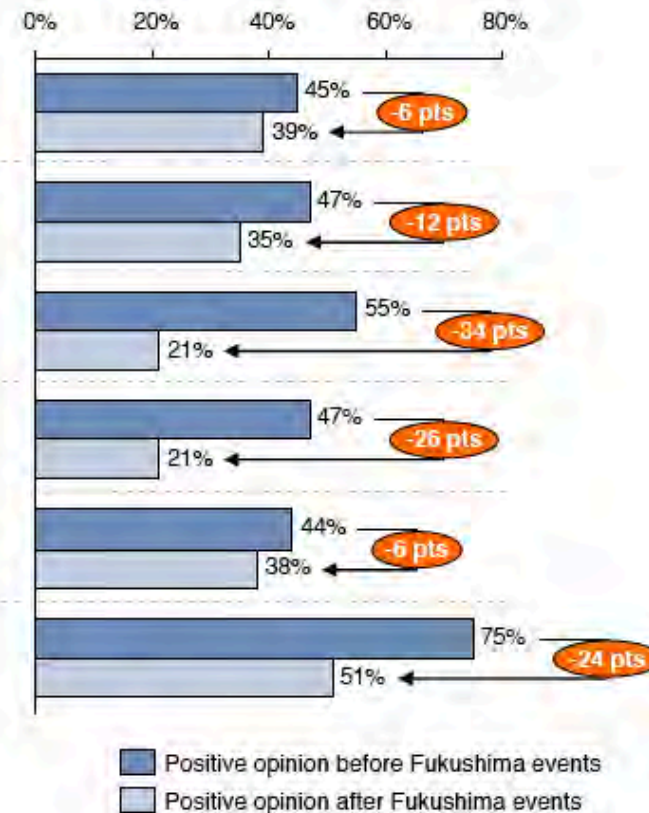
- First, suspension of licensing procedures for replacement reactors.
- Elaboration of “*new energy scenarios and corresponding action plans and measures*” (Federal Energy Office).
- Then, vote of prohibition of all new construction (28 September 2011).

Public opinion

Whereas polls have been done right after Fukushima event, international public opinion showed a certain resilience

Poll question and references

US	▶ Would you favor or oppose the government promoting the increase use of nuclear power? (<i>the Pew Research Center, October 2010 & March 20th 2011</i>)
UK	▶ Are in favor or opposed to new nuclear build in the UK? (<i>BBC News, November 2010 & March 22nd 2011</i>)
Switzerland	▶ Are you in favor or opposed to the construction of new nuclear plants in Switzerland? (<i>Demoscope, January 2010 & Matin Dimanche, March 20th 2011</i>)
Sweden	▶ Are you in favor or opposed to further developing the nuclear capacity in Sweden? (<i>AFP, November 2010 & March 22nd 2011</i>)
Finland	▶ Do you have a positive general outlook towards nuclear energy before and after? (<i>MTV3, March 23rd, 2011</i>)
Bulgaria	▶ Are you in favor of nuclear power, and, the expanding of the nation's nuclear capability? (<i>Alpha research, 2007 & March 23rd 2011</i>)



Note: Results cannot be compared across countries as poll questions are different

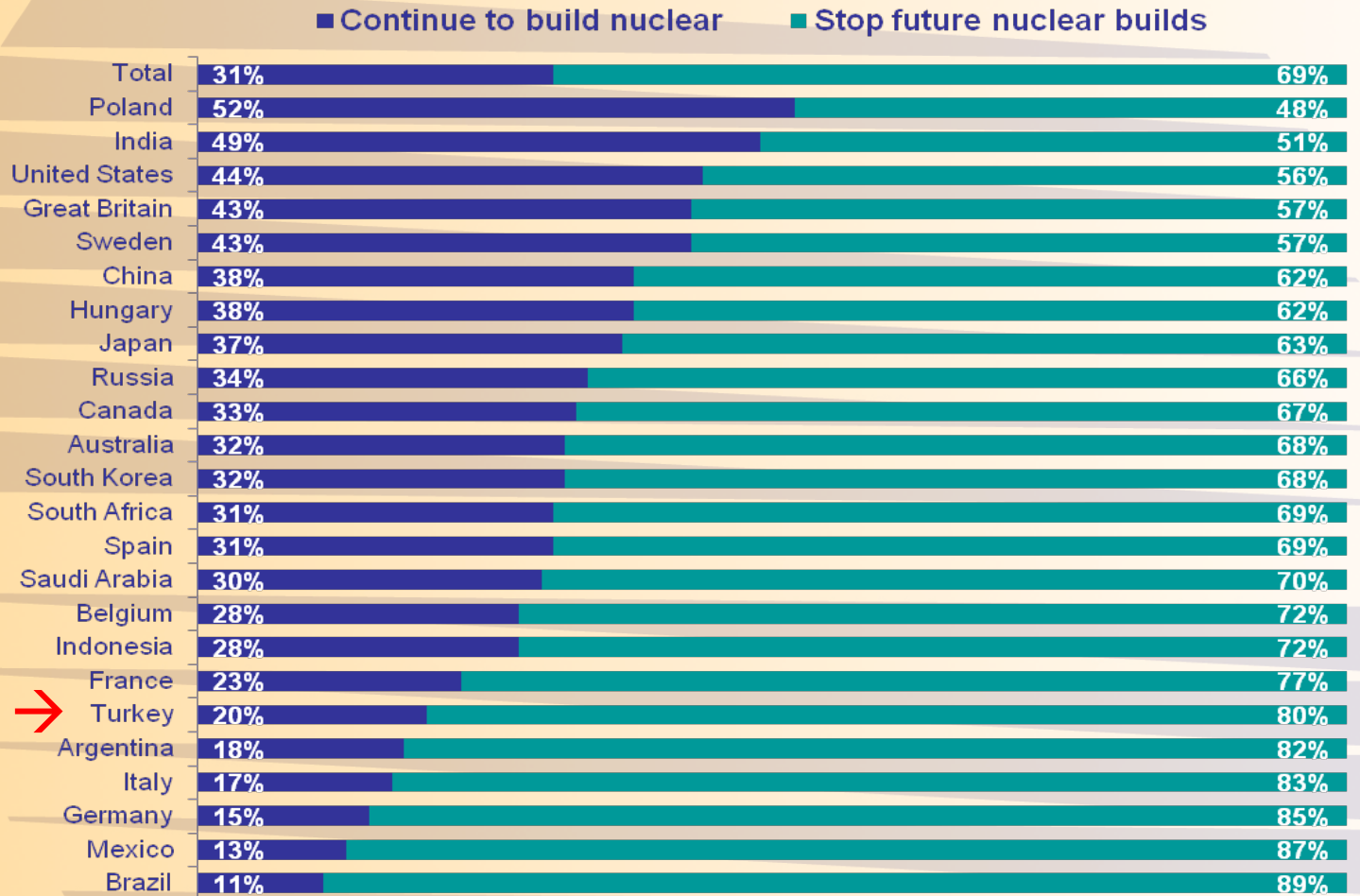
Only Three In Ten (31%) Globally Support Continuation of Nuclear Builds, With Only Poland Showing Majority Support...

CONTINUE TO BUILD NUCLEAR

Some/other people say that what happened in Japan was an unforeseeable and isolated event so that there really is nothing that should stop the nuclear industry from continuing to build and operate nuclear plants to produce electricity in other parts of the world..

STOP FUTURE NUCLEAR BUILDS

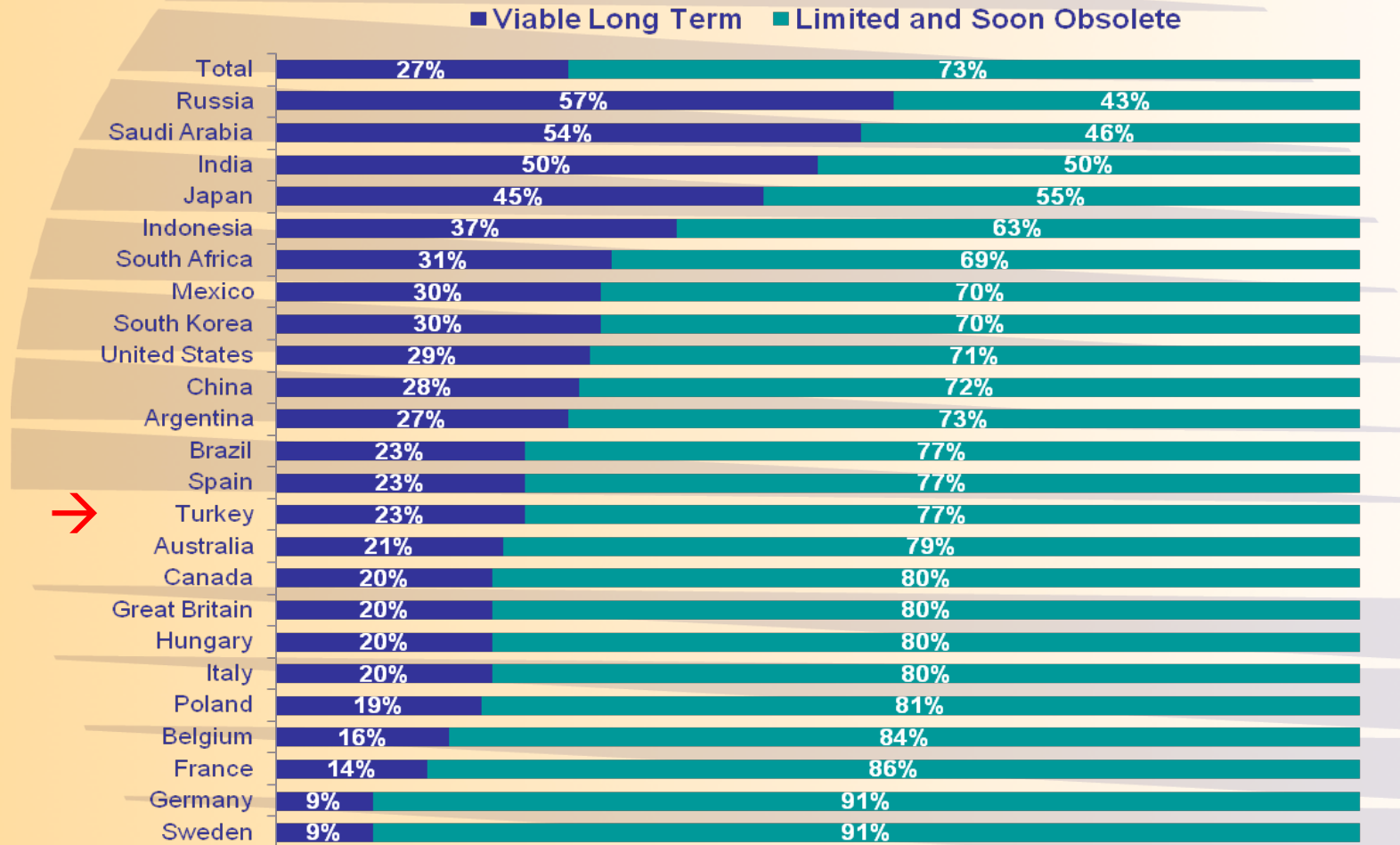
Other/some people say that what happened at the nuclear plant in Japan demonstrates that all nuclear facilities are vulnerable to unforeseen events that could have a deadly impact on those who live in and around them. As a result we should stop all further plans to build nuclear plants anywhere.



Which is closer to your point of view? Base: Have seen, read or heard in Q8 n= 17969

Source: IPSOS, June 2011

The World View: Nuclear Not A Viable Long Term Option...



Overall, do you think that electricity produced from nuclear energy will be a viable long term option for countries who need to produce it in that way or do you think it is only a limited and soon obsolete form of producing energy for the future? Base: All Respondents n = 18787

Source: IPSOS, June 2011

“Even” the French Public Increasingly in Favor of a Nuclear Phase-out

Do you wish that France...	March 2011	June 2011
• <i>rapidly stops its nuclear program and the operation of its reactors</i>	19%	15%
• <i>phases-out its nuclear program and the operation of its reactors progressively over 25 or 30 years</i>	51%	62%
• <i>continues its nuclear program and the building of new plants</i>	30%	22%
• <i>don't know</i>		1%
Total in favor of phase-out	70%	77%

Source: IFOP, June 2011

Conclusions

- Nuclear power plays a limited role in the international energy sector: $\approx 13\%$ of electricity, $\approx 5\%$ of primary energy, $\approx 2\%$ of final energy in the world. Further decline is to be expected.
- Nuclear power is expensive and slow. Fukushima further increases costs (safety, insurance, financing...) and problems (public opinion, political parties, competence...).
- After Fukushima and following spectacular reactions in the world's leading economies, at this point, there are no identifiable prospects for nuclear power as a major energy technology for the future.
- Renewables penetration will accelerate with storage and grid developments.
- The energy future lies in affordable, distributed, superefficient technologies, smart grids and sustainable urbanism. Nuclear policy – centralized, inflexible and generally autocratic – symbolizes the opposite.

“We know the country that harnesses the power of clean, renewable energy will lead the 21st century.”

President Barack Obama
State of the Union Address
27 January 2010

“Germany's shift towards renewable energies is the project of the century.”

Peter Löscher
CEO, Siemens
September 2011

Thank You!

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