The World Nuclear Industry Status Report 2012

An Independent Assessment 15 Months After Fukushima
(see www.WorldNuclearReport.org)

Mycle Schneider

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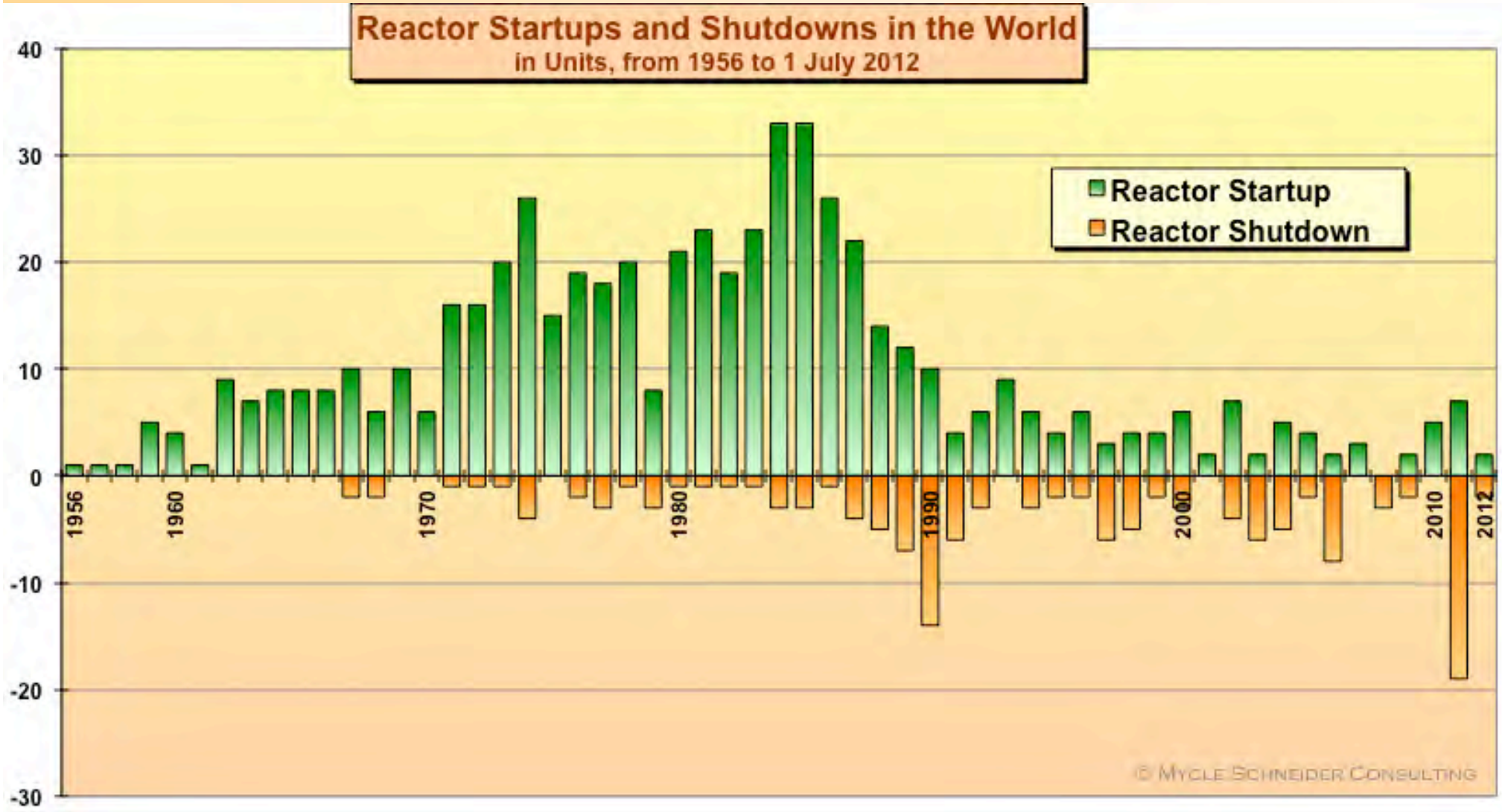
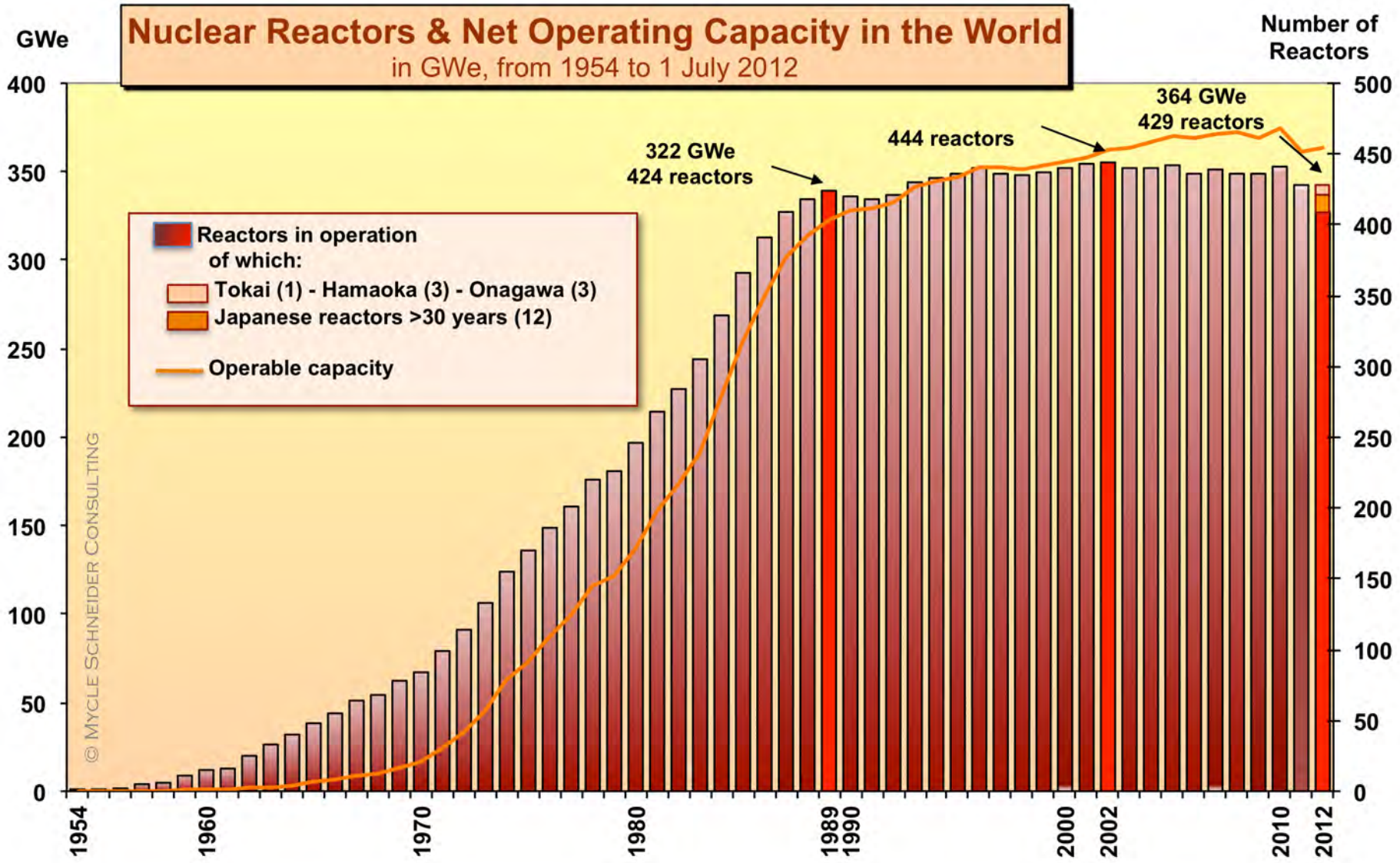
Paris, France

Université de Genève, 16 November 2012



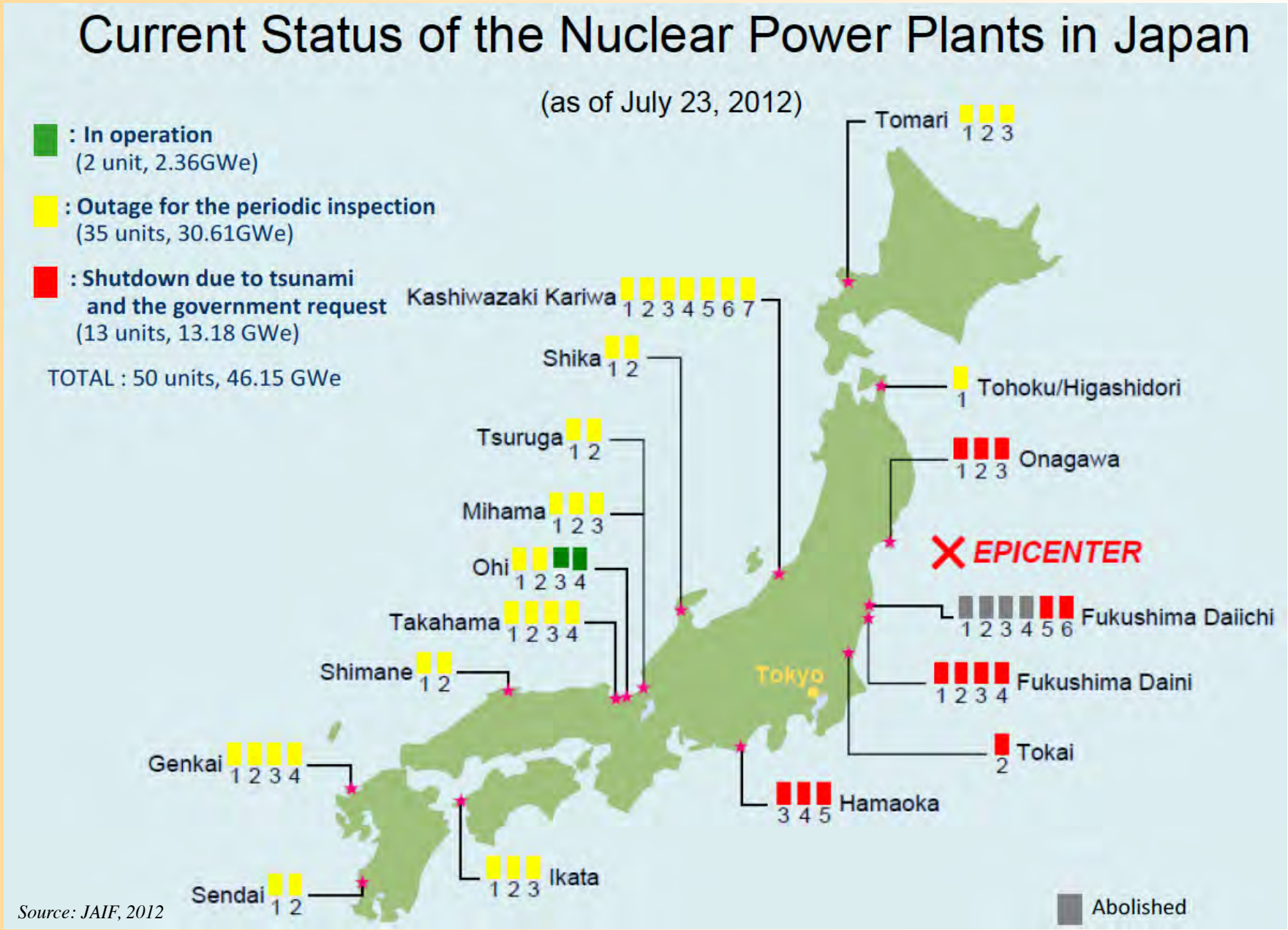
Source: IAEA-PRIS, MSC, 2012



Source: IAEA-PRIS, MSC, 2012

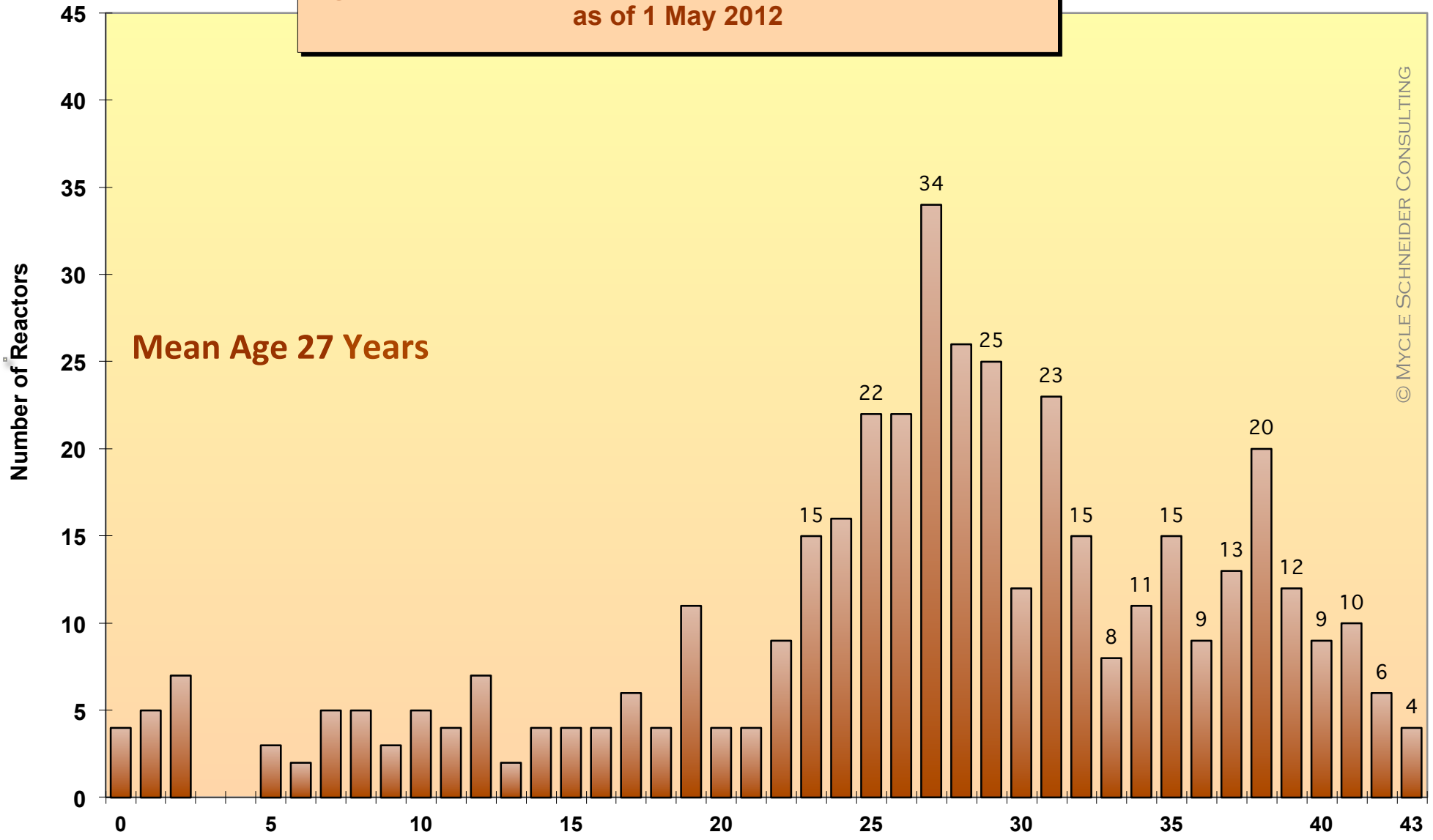
Current Status of the Nuclear Power Plants in Japan

(as of July 23, 2012)

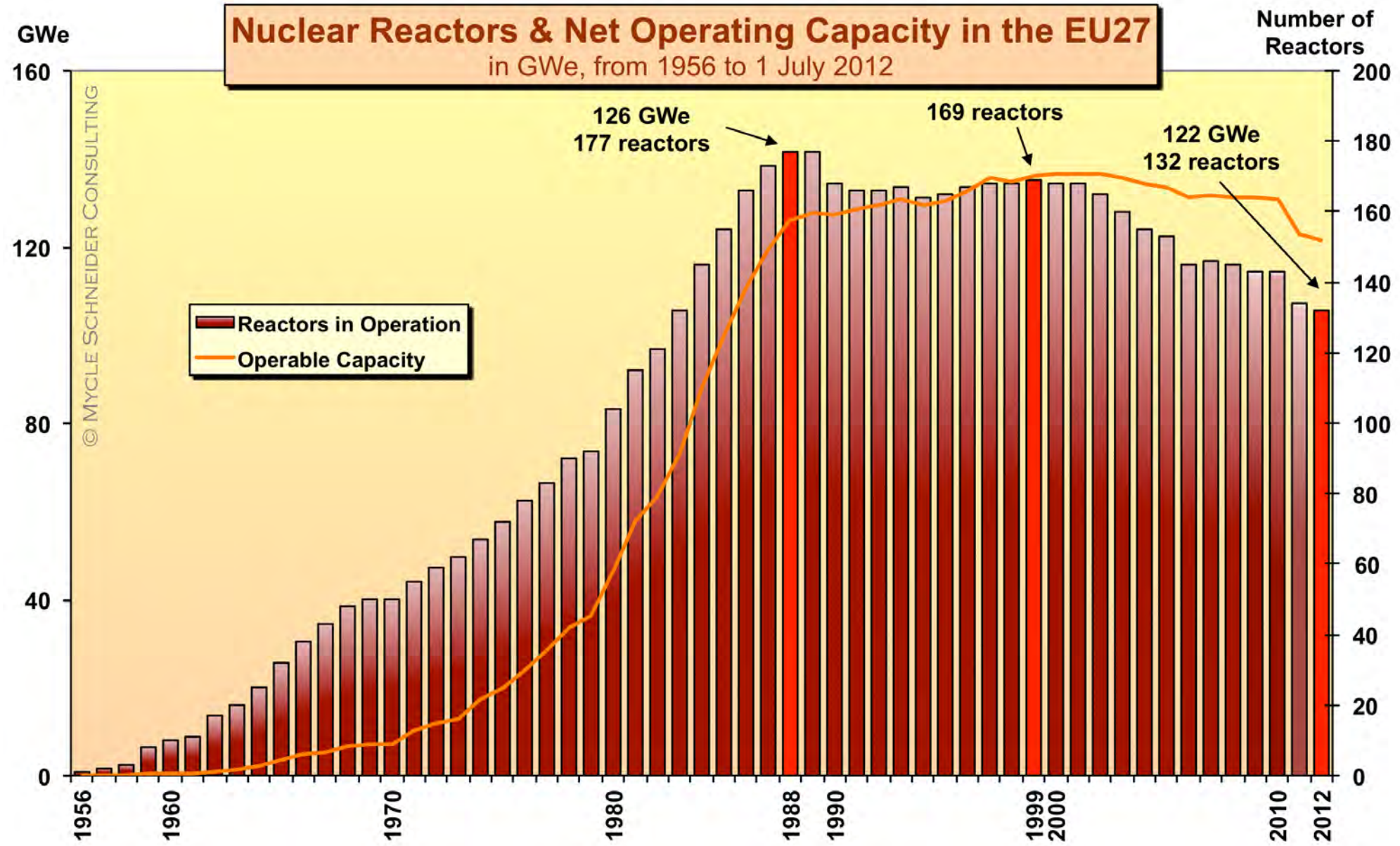


Source: JAIF, 2012

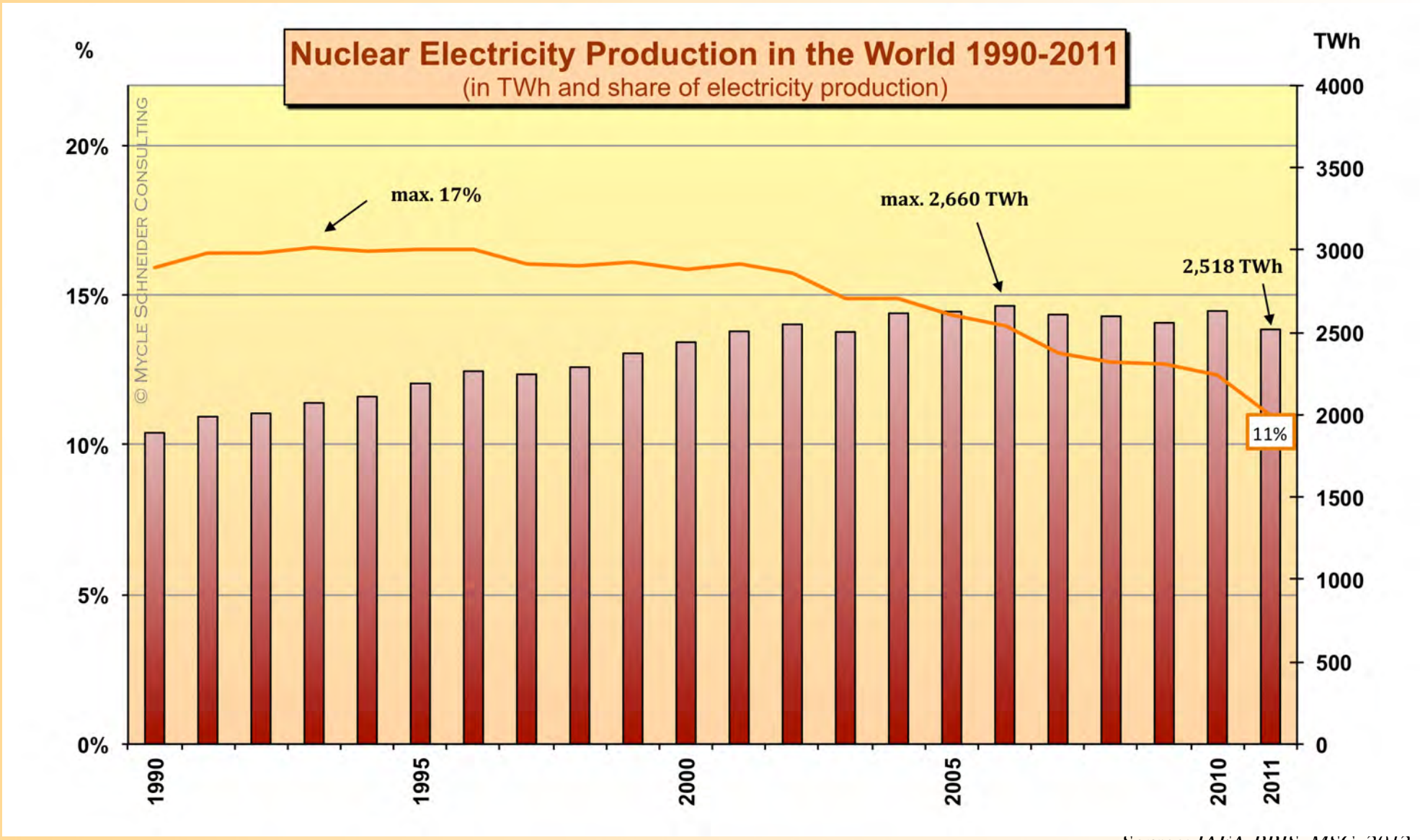
Age of 429 Reactors in Operation in the World
as of 1 May 2012



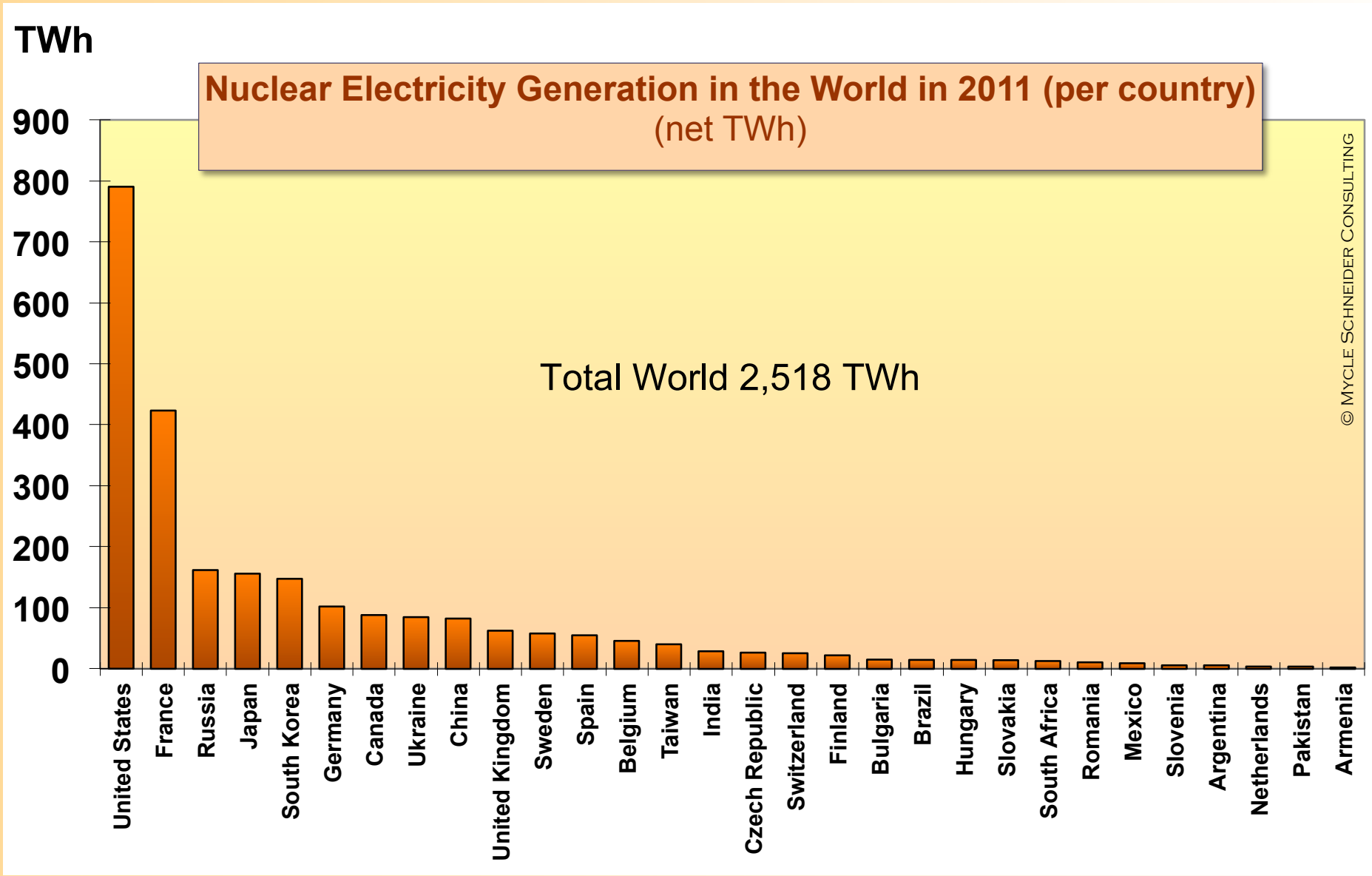
Source: IAEA-PRIS, MSC, 2012



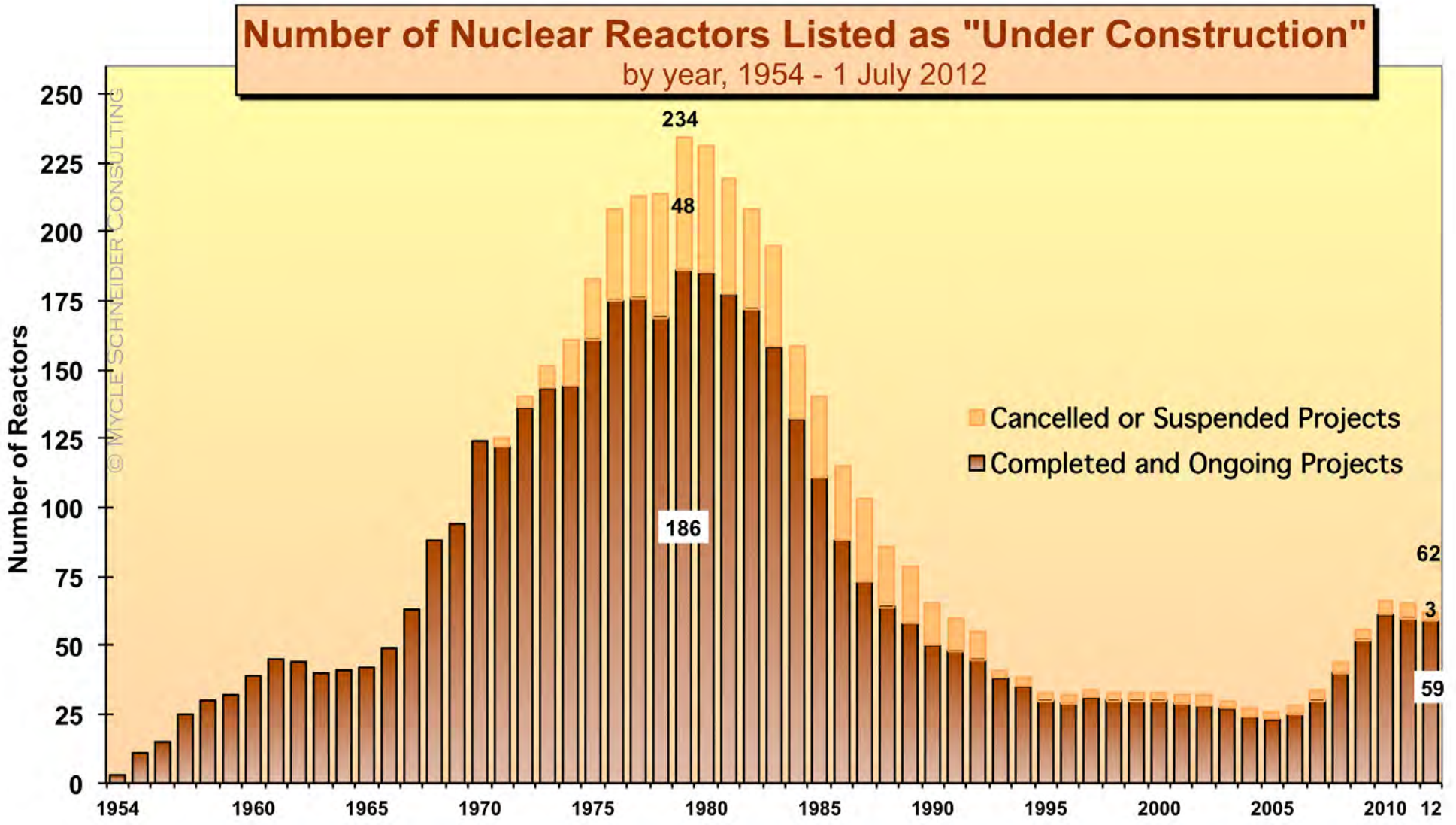
Source: IAEA-PRIS, MSC, 2012



Source: IAEA-PRIS, MSC, 2012



Source: IAEA-PRIS, 2012



Source: IAEA-PRIS, MSC, 2012

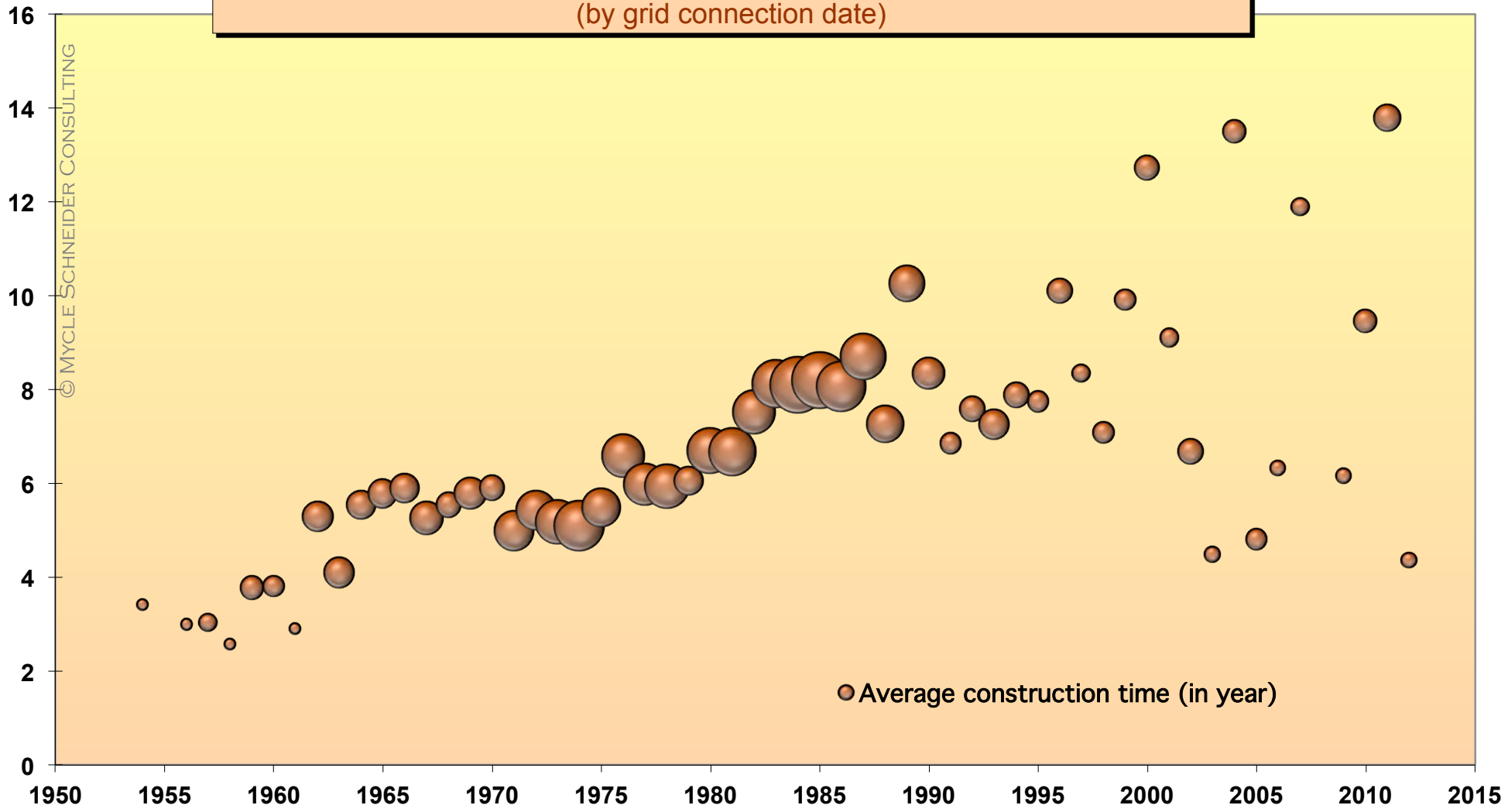
Reactors « Under Construction » in the World (1 July 2012)

Country	Units	MWe (net)	Construction Start	Grid Connection
China	26	27,230	2005-2010	2012-?
Russia	10	8,203	1985-2010	2012-?
India	7	4,824	2002-2011	2012-2015
South-Korea	3	3,640	2006-2008	2012-2013
Pakistan	2	630	2011	2016
Slovakia	2	782	1985	2012-2013
Taiwan	2	2,600	1999	2016
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	2016
USA	1	1,165	1972	2013
Total	59	55,427	1972-2011	2012-2018

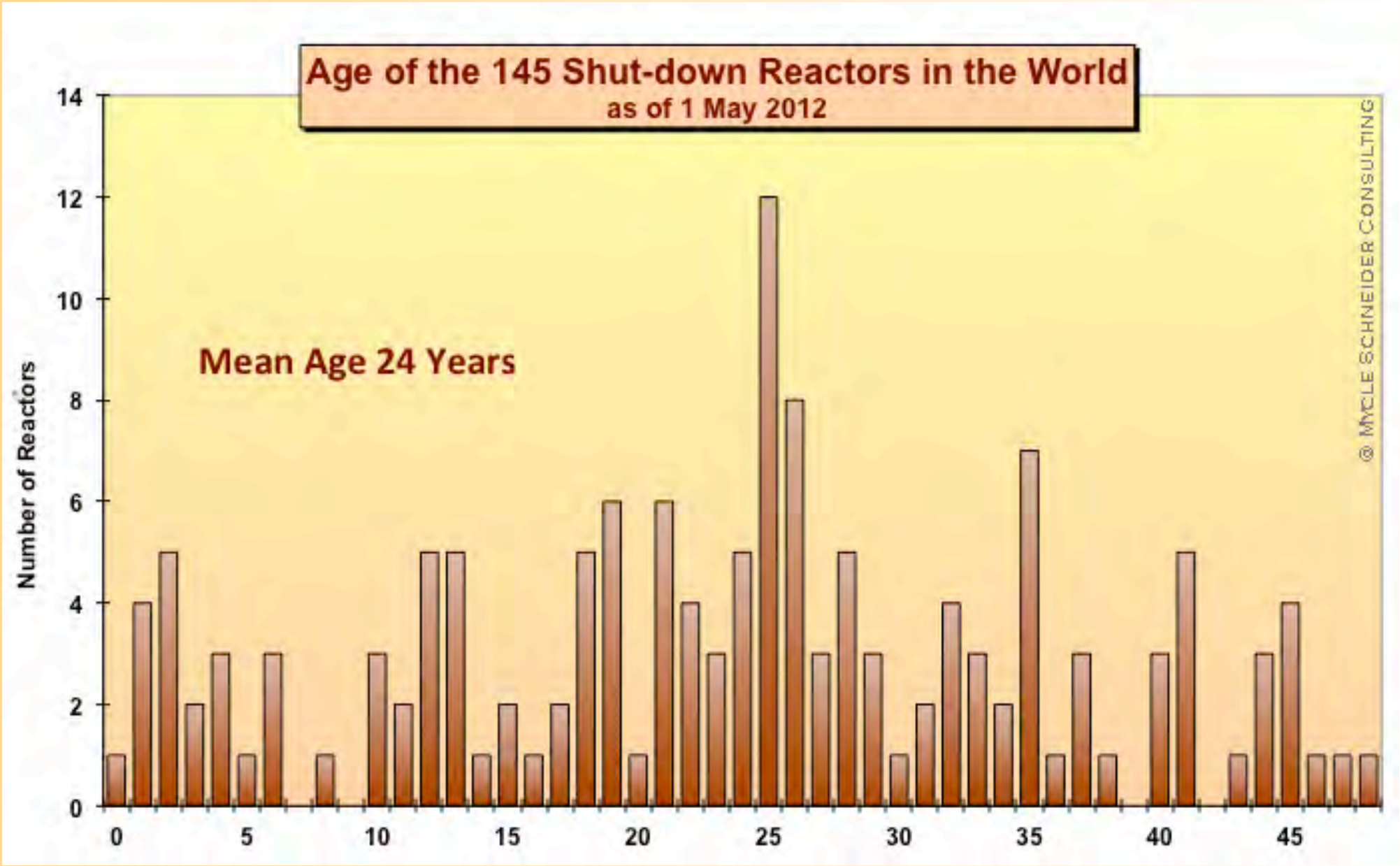
Source: IAEA-PRIS, MSC, 2012

Average Annual Construction Times in the World 1954-2012

(by grid connection date)

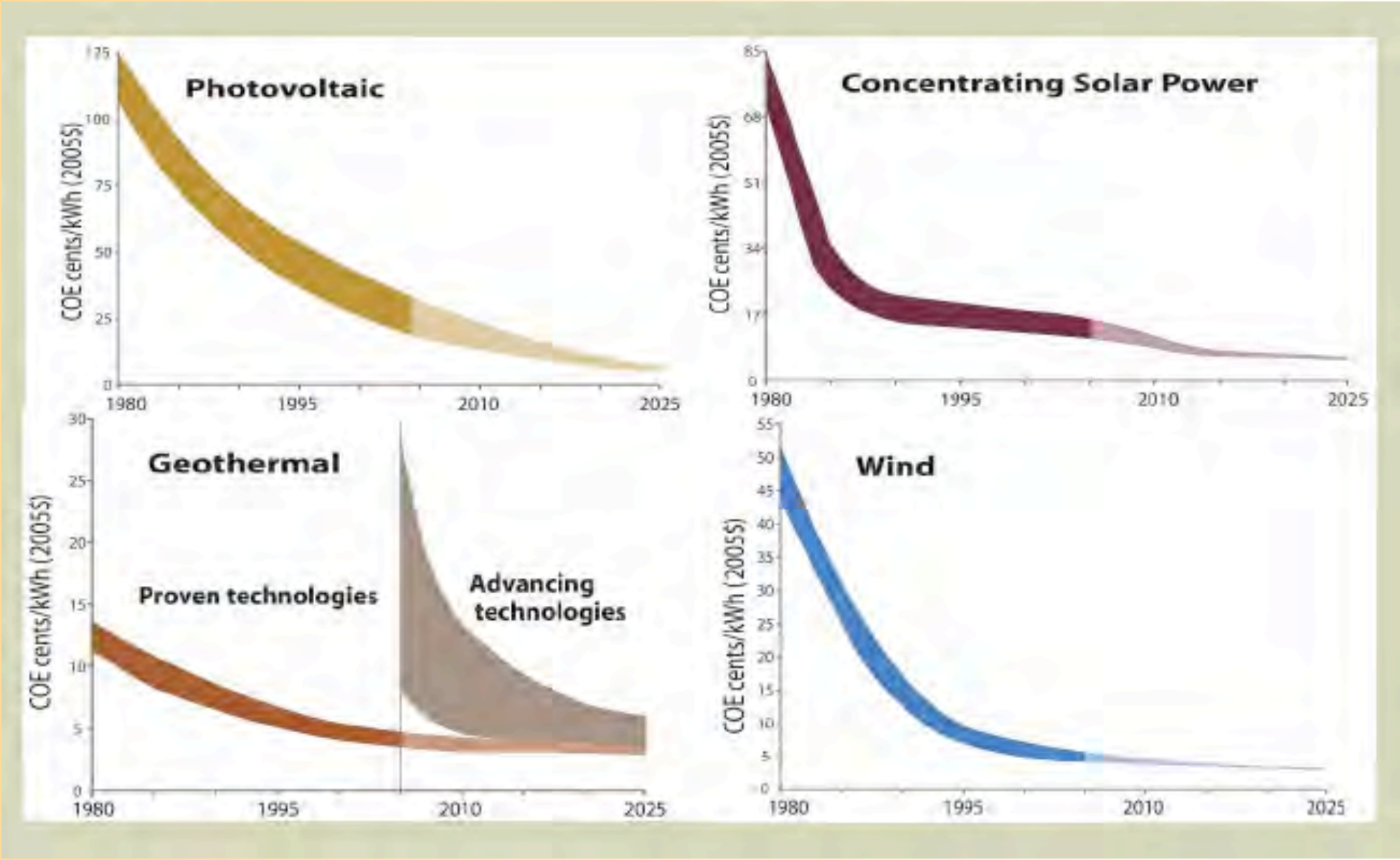


Source: IAEA-PRIS, MSC, 2012



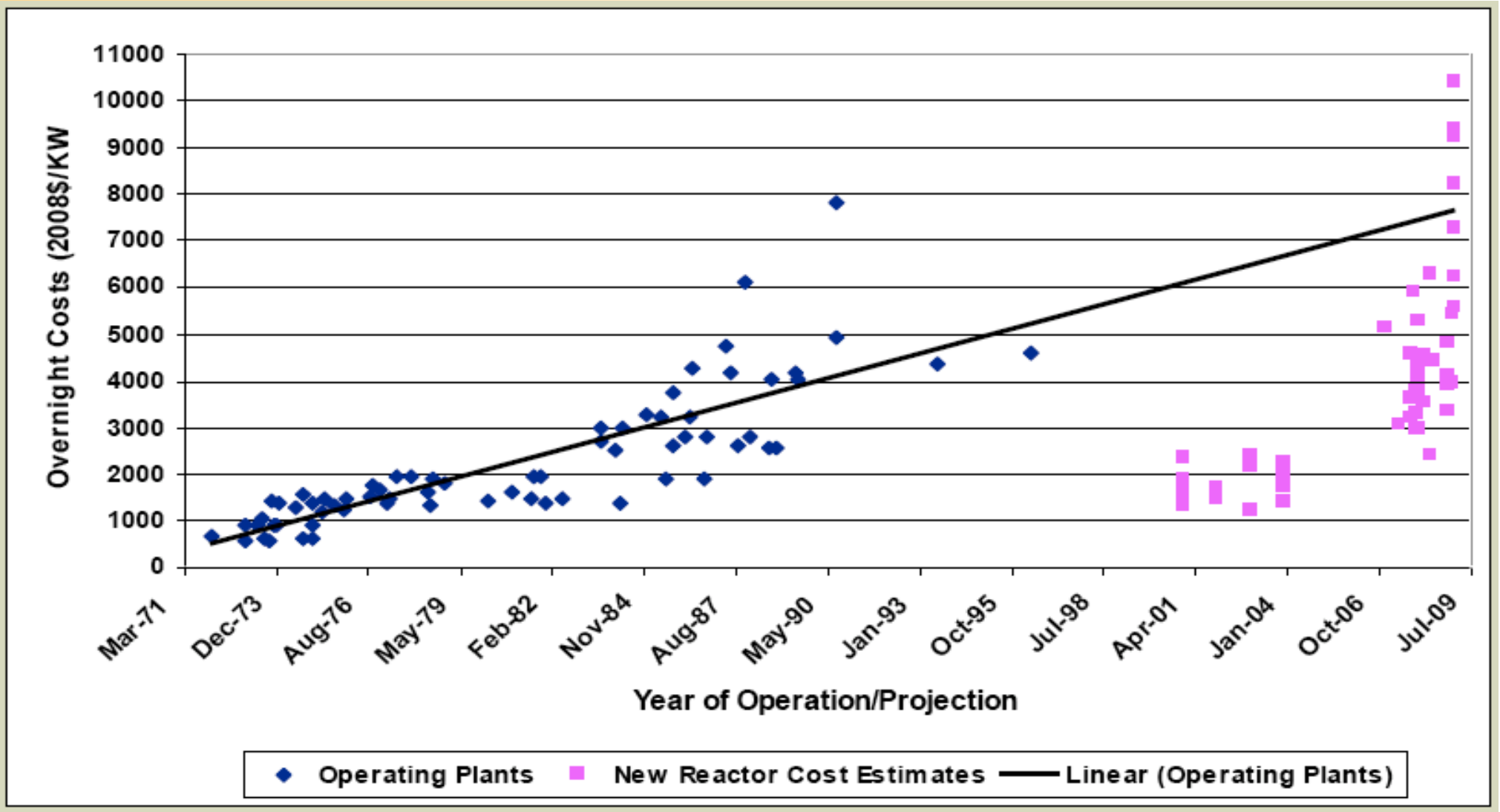
Source: IAEA-PRIS, MSC, 2012

Technology Learning Curves



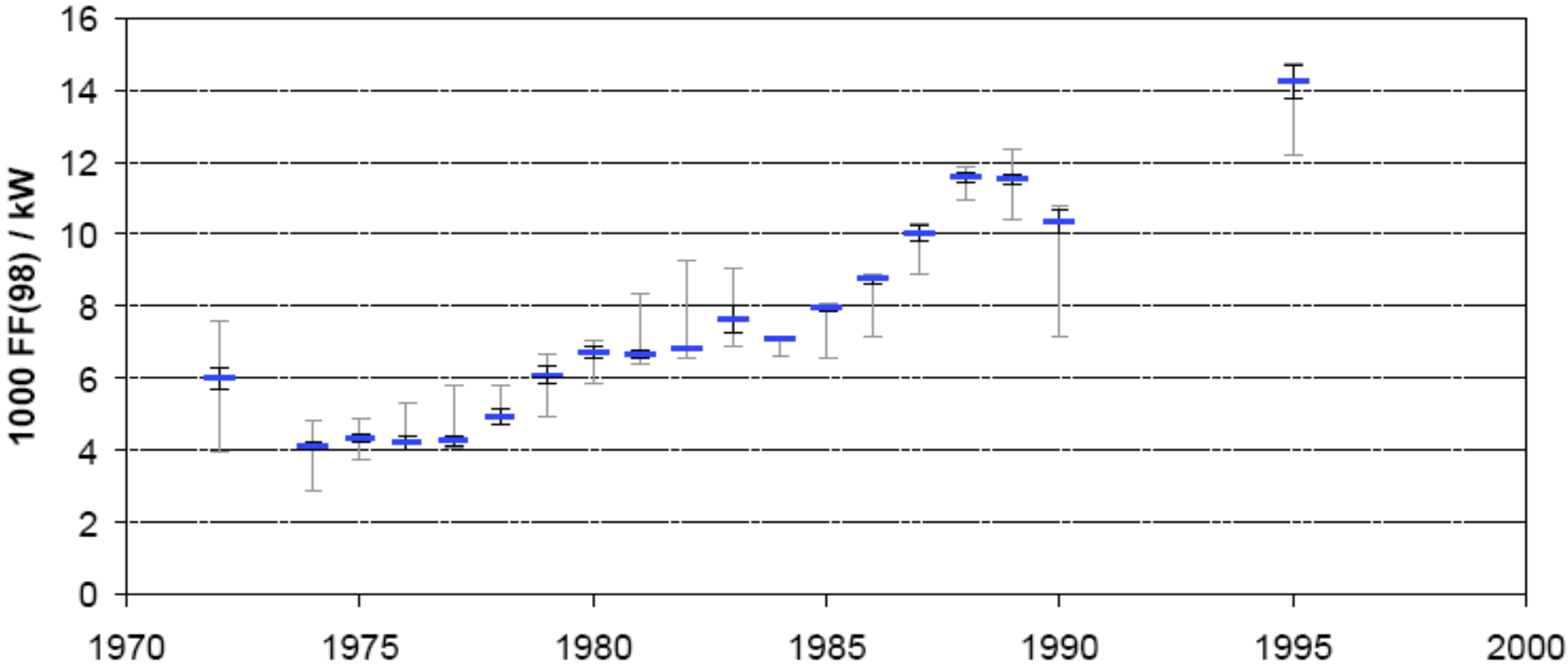
Source: Cooper 2010

Negative Learning Curve US Nuclear Power Plants



Source: Cooper 2010

Negative Learning Curve French Nuclear Power Plants

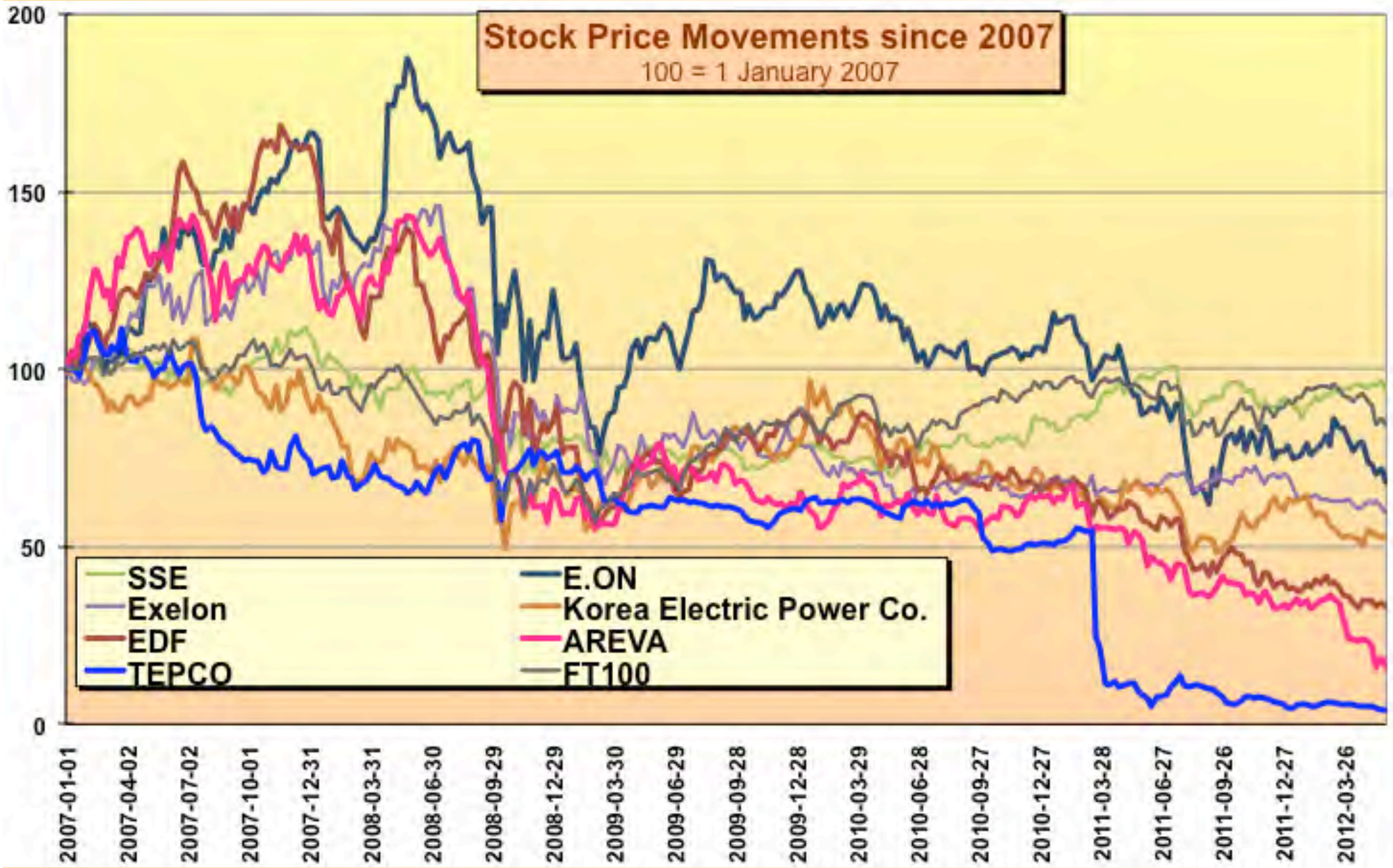


Source: Arnulf Grübler, «An assessment of the costs of the French nuclear PWR program 1970–2000 », IIASA, 6 October 2009

Evolution of EPR Cost Estimates 2003-2012

Origin of Estimate	Construction Costs (€/kW)[110]	Production Costs (€/MWh)
DGEMP 2003[111]	1,043 (1,274 $€_{2012}$)	28.4[112] $€uro_{2001}$
EDF 2005[113]	?	(33-)41[114] $€uro_{2004}$
EDF 2005[115]	?	(35-)43[116] $€uro_{2004}$
EDF 2006[117]	2,063 (2,331 $€_{2012}$)	46 $€uro_{2005}$
AREVA 2007[118]	1,300–1,800 (1,498–2,074 $€_{2012}$)	29.9[119] $€uro_{2004}$
DGEC 2007[120]	?	44.9 $€uro_{2007}$
EDF 2008[121]	2,500 (2,677 $€_{2012}$)	54-60[122] $€uro_{2008}$
Cour des Comptes 2012[123]	3,700 (3,874 $€_{2012}$)	70-90 $€uro_{2010}$
EDF 2012[124]	5,400	110-166[125] $€uro_{2012}$

Source: WNISR 2012



Source: WNISR 2012

French BNP-Paribas Bank Conclusions on Nuclear New Build

- ”Most nuclear projects are financed either by Governments or by very large utilities.”

- ”They are at high risk of being completed late and significantly over budget.”

- ”Nuclear projects face heightened political risk relative to other energy assets.”

- ”Public acceptance is not assured and this brings reputational risk.”

- ”No clear idea about the economics.”

Source: BNP-Paribas 2012, “How will financing be secured in the future?”, Mark Muldowney, Presented at the European Nuclear Forum, Brussels, 19 March 2012

Long Term Credit Ratings of Nuclear Related Companies

Standard and Poor's Long-Term Credit Rating (year end or as noted)							
Company	**2012** June	**2011** June	**2011** April	**2010**	**2009**	**2008**	**2007**
EDF	A+	AA-	AA-	A+	A+	AA-	AA-
KEPCO	A	A	A	A	A	A	A
E.ON	A	A	A	A	A	A	A
CEZ	A-	A-	A-	A-	A-	A-	A-
Iberdrola	A-	A-	A-	A-	A-	A-	A-
RWE	A-	A-	A-	A	A	A	A+
ENEL	BBB+	A-	A-	A-	A-	A-	A-
Exelon	BBB	BBB	BBB	BBB	BBB	BBB	BBB+
TVO	BBB	-	-	-	-	-	-
AREVA	BBB-	BBB+	BBB+	BBB+	A	-	-
TEPCO	B+	B+	BBB+	AA	AA	AA	AA

Source: WNISR 2012

Rating Agency *Moody's* and Nuclear Power

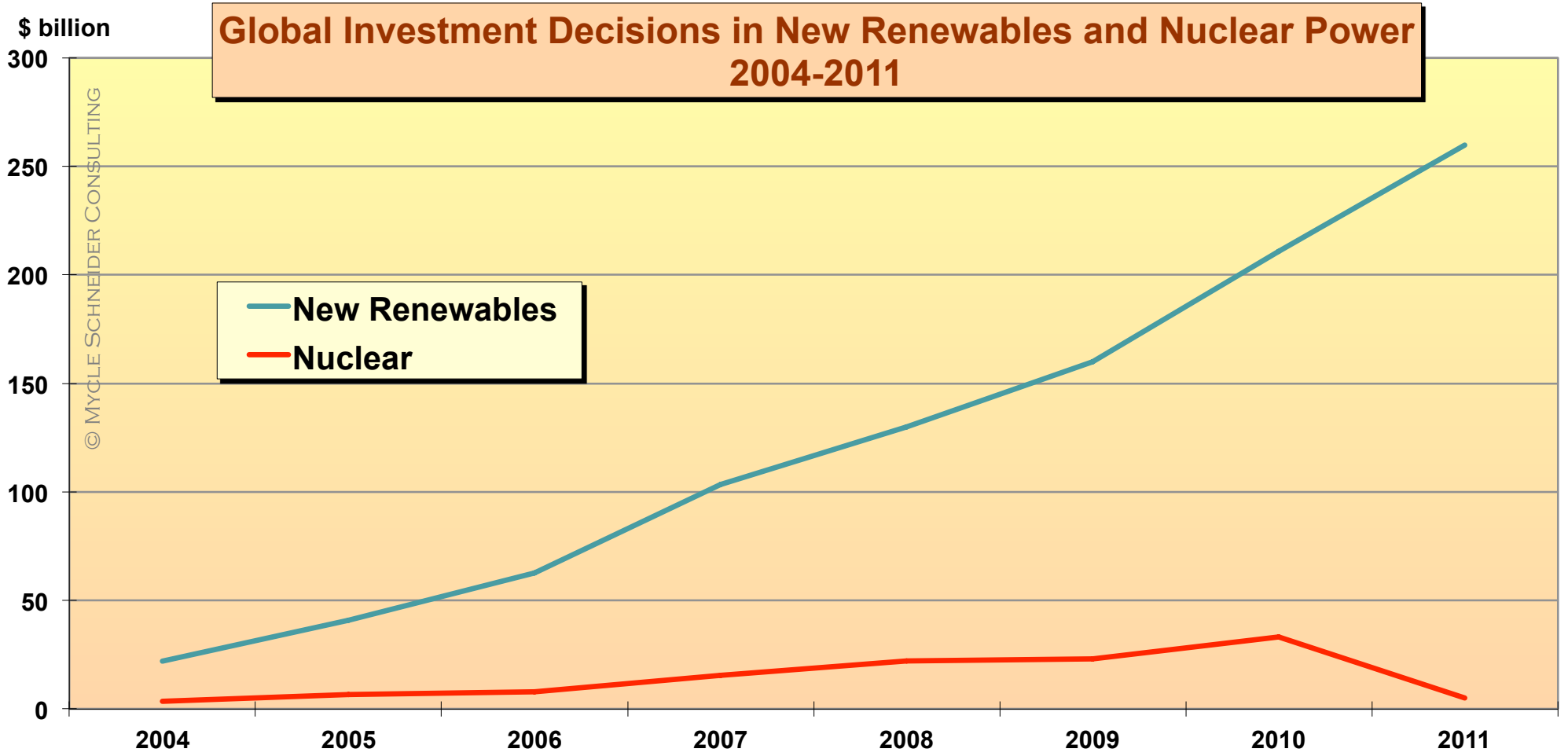
"…a nuclear project could be the thing that pushes [the utility] over the edge—it's just another negative factor."

Decisions considered "credit positive":

• German utilities E.ON and RWE pullout of UK new-build market is considered positive because they "can instead focus on investment in less risky projects".

• German electronics company Siemens announcement to entirely withdraw from nuclear power "frees up funds that Siemens can redeploy in businesses with better visibility".

Sources: see WNISR 2012

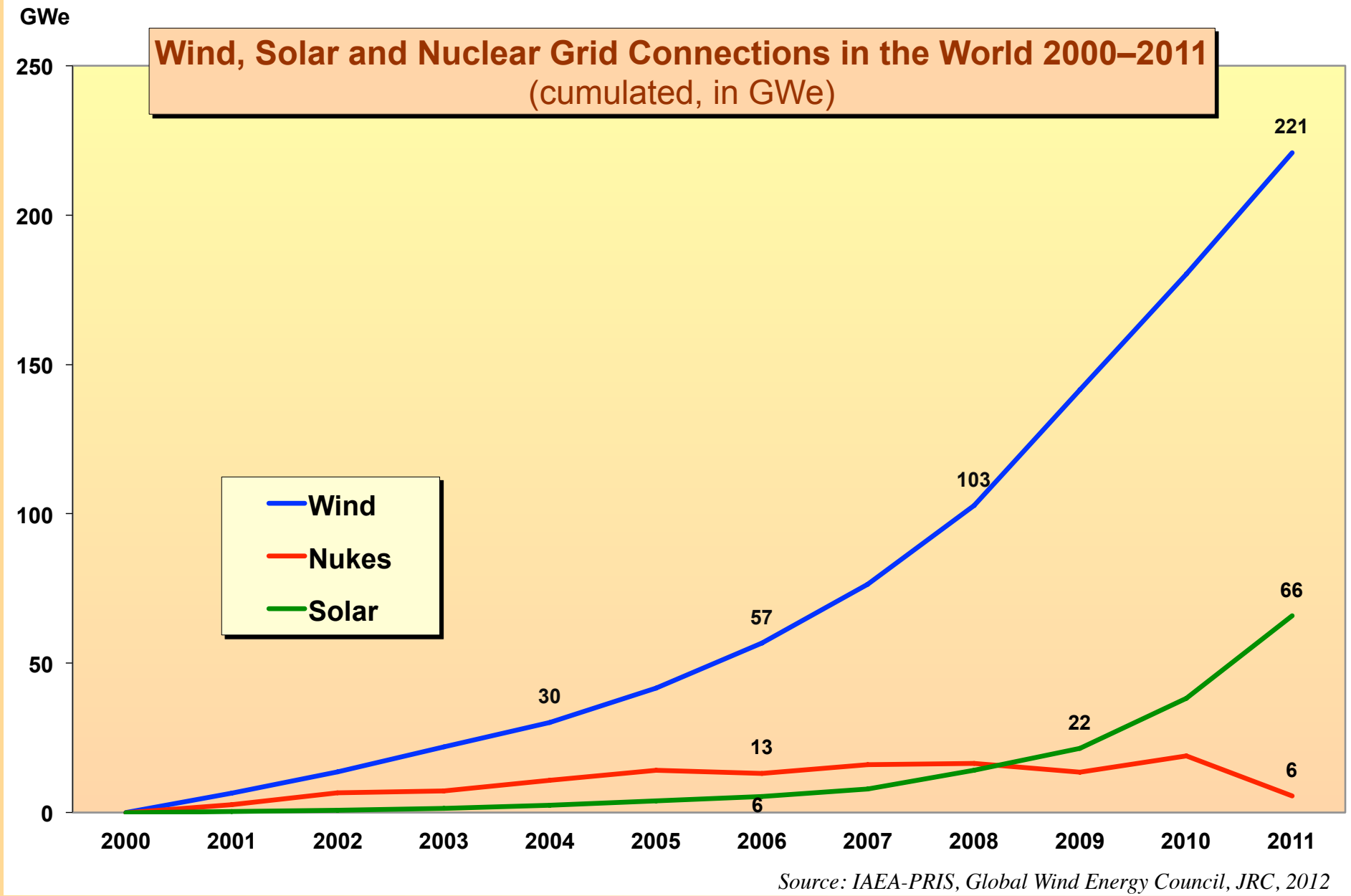


Sources: BNEF 2012; WNISR 2012

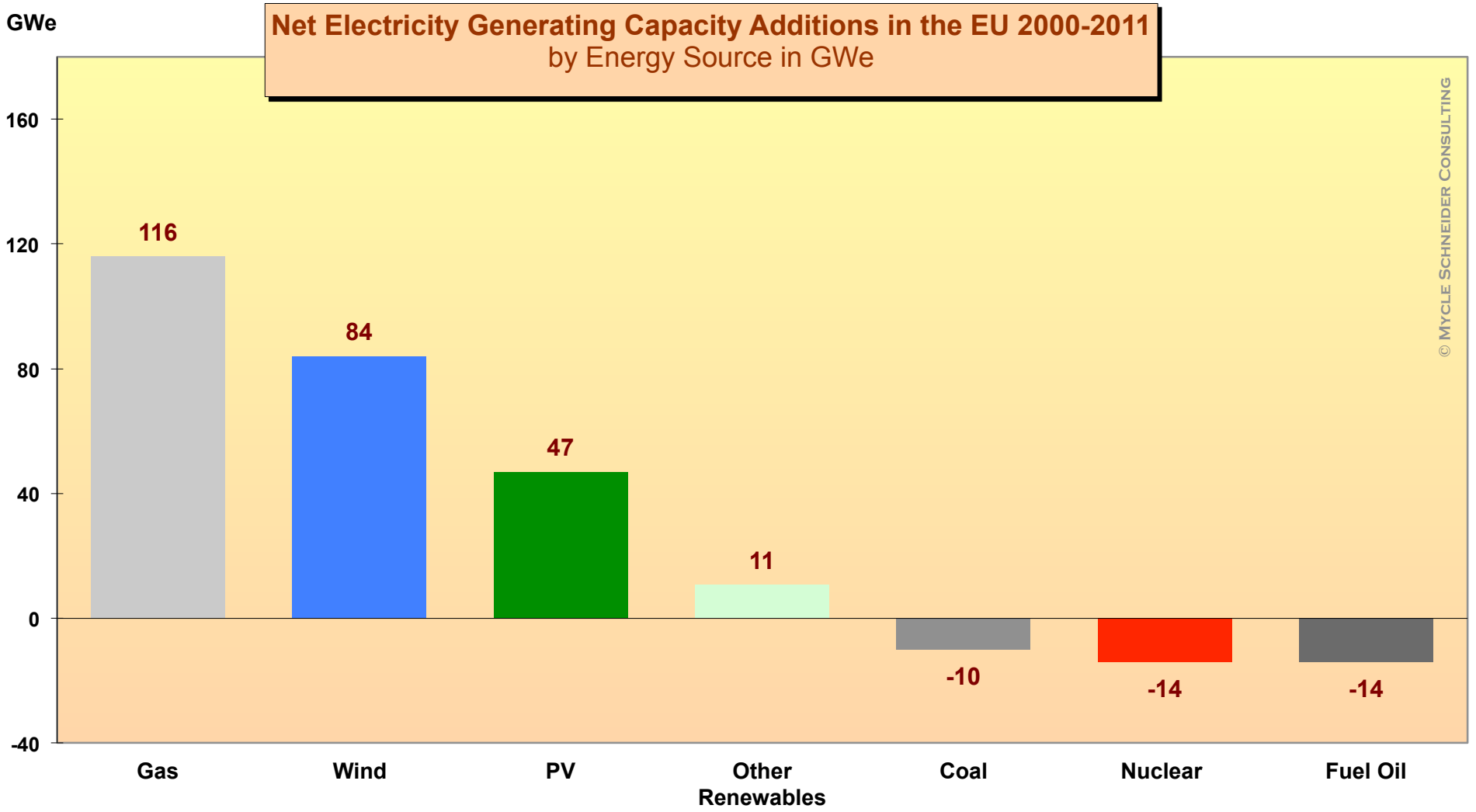
Renewable Energy Investment in Top 10 Countries 2009-2011
(in billion US$)

	2011	2010	2009
United States	48.1	34.0	22.5
China	45.5	54.4	39.1
Germany	30.6	41.2	20.6
Italy	28.0	13.9	6.2
India	10.2	4.0	3.2
UK	9.4	7.0	N/A
Japan	8.6	7.0	N/A
Spain	8.6	4.9	10.5
Brazil	8.0	7.6	7.7
Canada	5.5	5.6	3.5

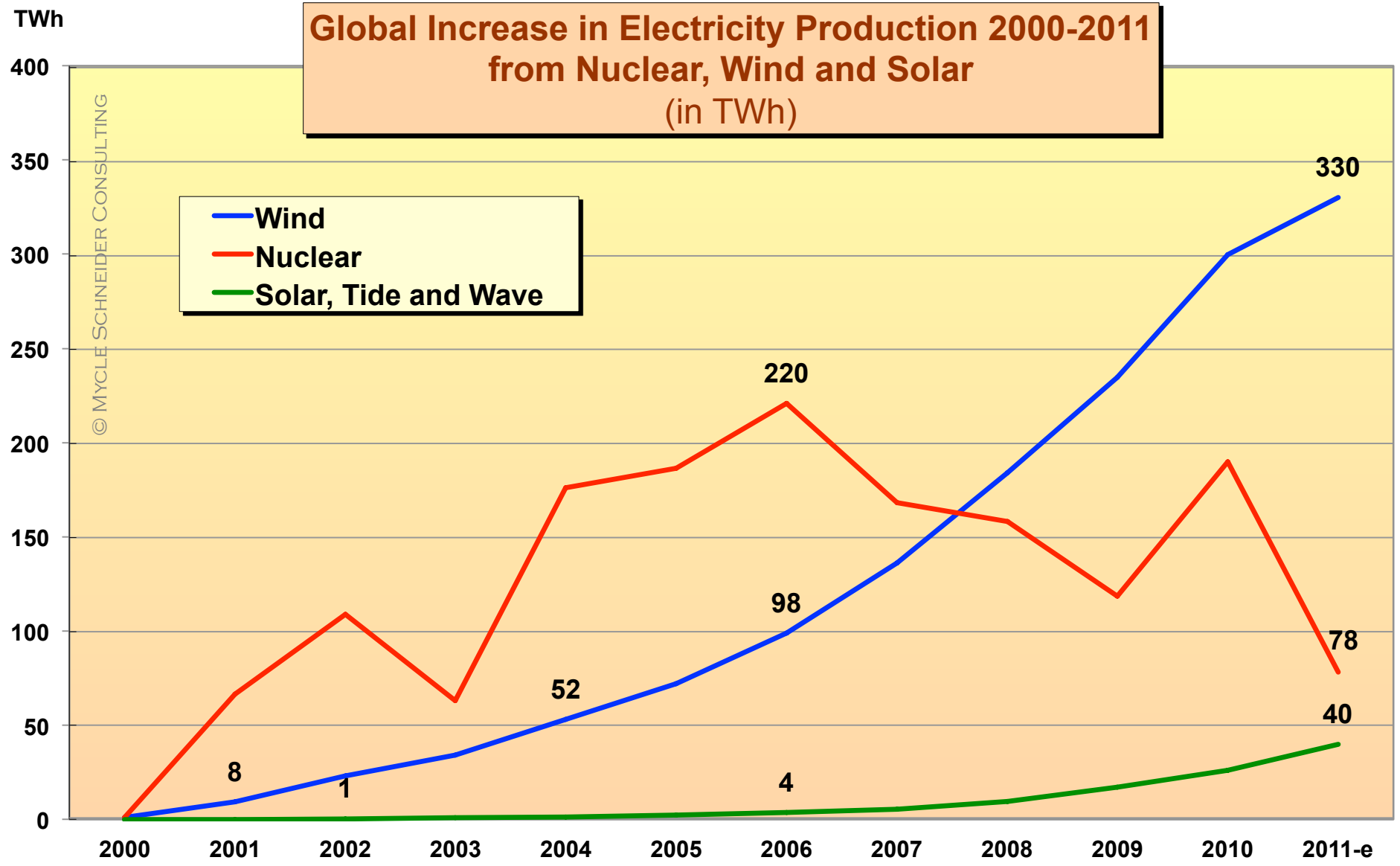
Sources: BNEF 2012; WNISR 2012



Source: IAEA-PRIS, Global Wind Energy Council, JRC, 2012



Source: EWEA 2012


Global Increase in Electricity Production 2000-2011
from Nuclear, Wind and Solar
(in TWh)
TWh
© Mycle Schneider Consulting
Wind
Nuclear
Solar, Tide and Wave
400
350
300
250
200
150
100
50
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011-e
330
220
98
78
52
40
8
1
4

Post-Fukushima Reactions in Selected Countries (1)

Belgium

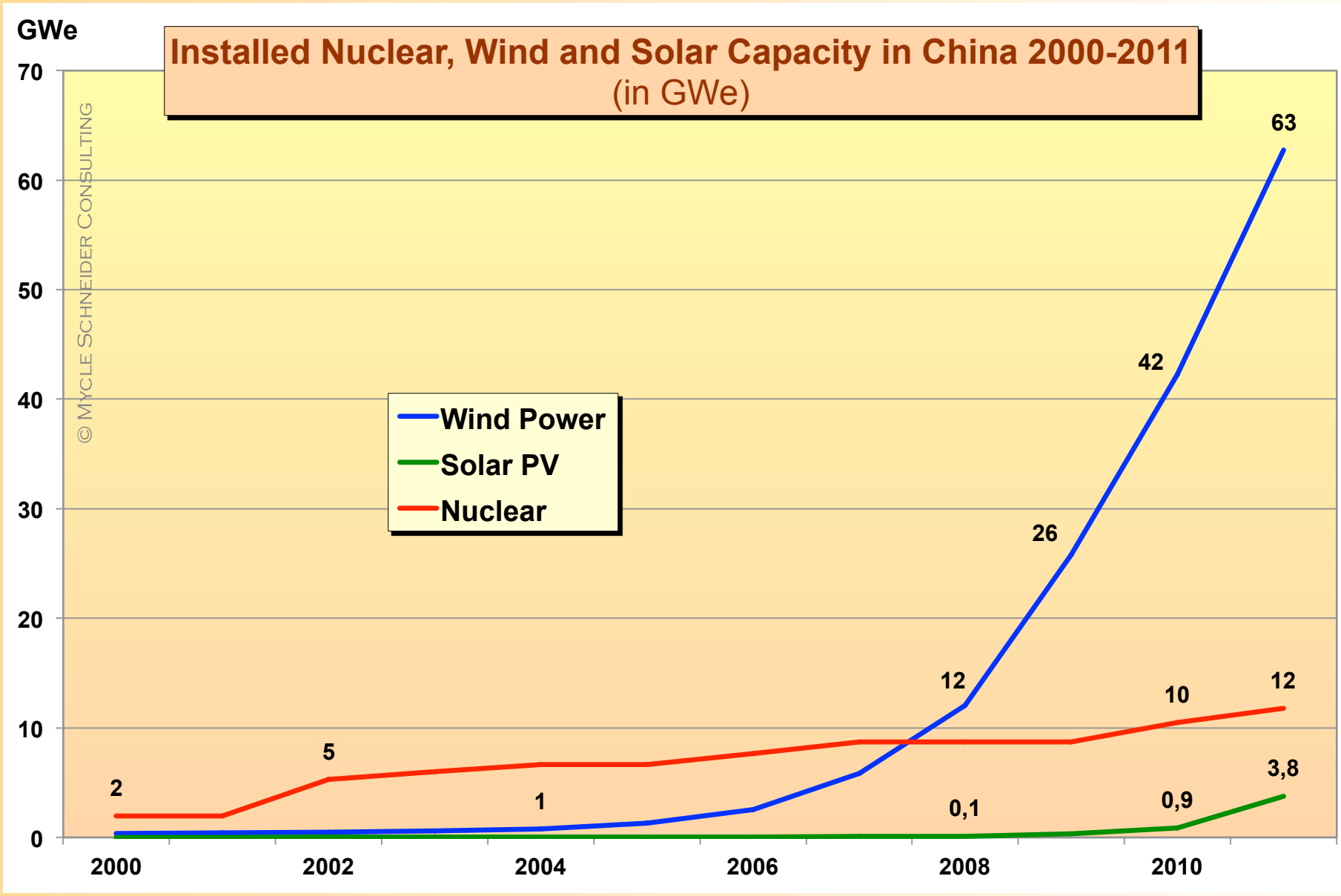
- October 2011: Confirmation of phase-out between 2015 and 2025.
- August 2012: Discovery of severe pressure vessel cracking Doel-3/Tihange-2.

Bulgaria

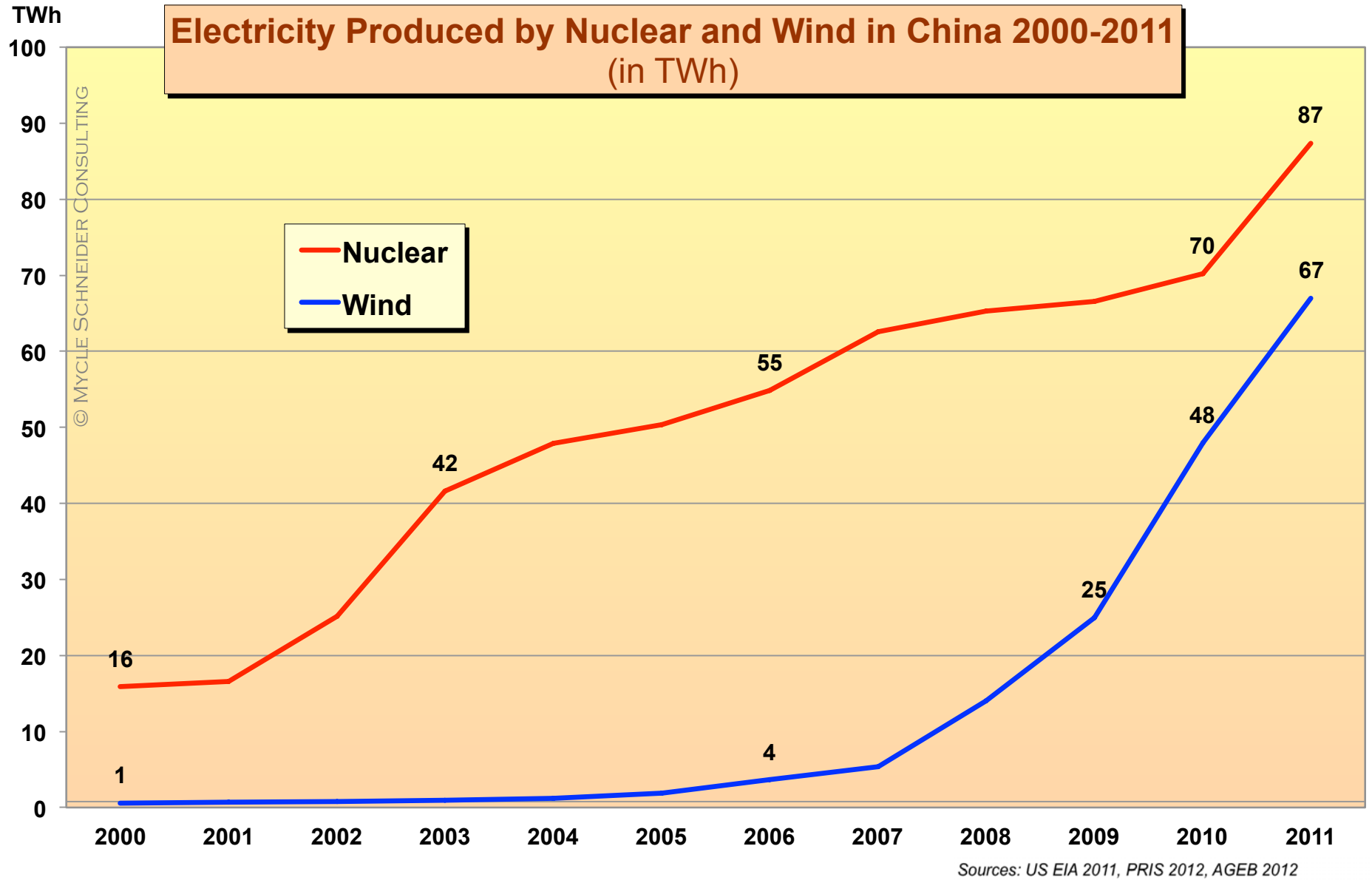
- Belene project with two reactors abandoned (construction since 1987).

China

- No construction initiation in 2011. • Limiting units per site?
- Safety audits. Startup of 2 new commercial reactors in 2011 (1,600 MW).
- Abandoning of CPR1000 series?
- Acceleration of renewable energy programs in 2011:
  +18,000 MW wind (11 x nuclear) → 63,000 MW installed (= French nuclear)
  +3,000 MW solar (2 x nuclear, 5 x addition 2010) → Target quadrupled to 20 GW by 2015



Sources: GWEC, IAEA PRIS, BP Statitical Review, Solar PV Investor, 2012


Electricity Produced by Nuclear and Wind in China 2000-2011
(in TWh)
TWh
100
90
80
70
60
50
40
30
20
10
0
Nuclear
Wind
16
42
55
70
87
1
4
25
48
67
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Sources: US EIA 2011, PRIS 2012, AGEB 2012
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Post-Fukushima Reactions in Selected Countries (2)

France

- Rupture with Sarkozy- and all other Governments of the post-WW2-era: 75%→50% nuclear power share; Fessenheim, Penly.
- Safety Chief: ”Nobody can ever guarantee that there will never be a severe nuclear accident in France.” (OECD, Paris, 8 June 2011)
- Extensive backfitting requested (>10 billion €); maintenance costs double.
- Political party consensus gone.
- Public opinion strongly in favor of phase-out (>75%).
- *Conseil de Politique Nucléaire (28 Sep 12):* continue repro, MOX, exports

French State Companies in Trouble

EDF

- lost up to 82% of share value since 2007
- large debt burden (€33.3 billion)

AREVA

- lost up to 88% of share value since 2007
- lost new build markets in Italy, Switzerland, USA…
- record loss of €2.4 billion for 2011
- in December 2011 Standard & Poor's downrates AREVA:
  - global to BBB-, one notch off "junk bond";
  - Stand Alone Credit Profile (SACP) to BB-, one notch off "highly speculative"

Sources: MSC; Company websites; Standard & Poor's, 20 December 2011

Post-Fukushima Reactions in Selected Countries (3)

Germany

- Immediate shut-down of 8 of 17 reactors after 3/11.
- Complete nuclear phase-out until 2022 at the latest.
- Radical redesign of energy landscape.
- >20,000 MW PV installed 2010-2012.
- Peter Terium, incoming CEO of RWE:

"We are exiting from nuclear power with conviction – and not just here in Germany. The cluster risk this technology presents is not an option in the long run."

Official Statement, Press Conference, 14 August 2012

Siemens and the US Military

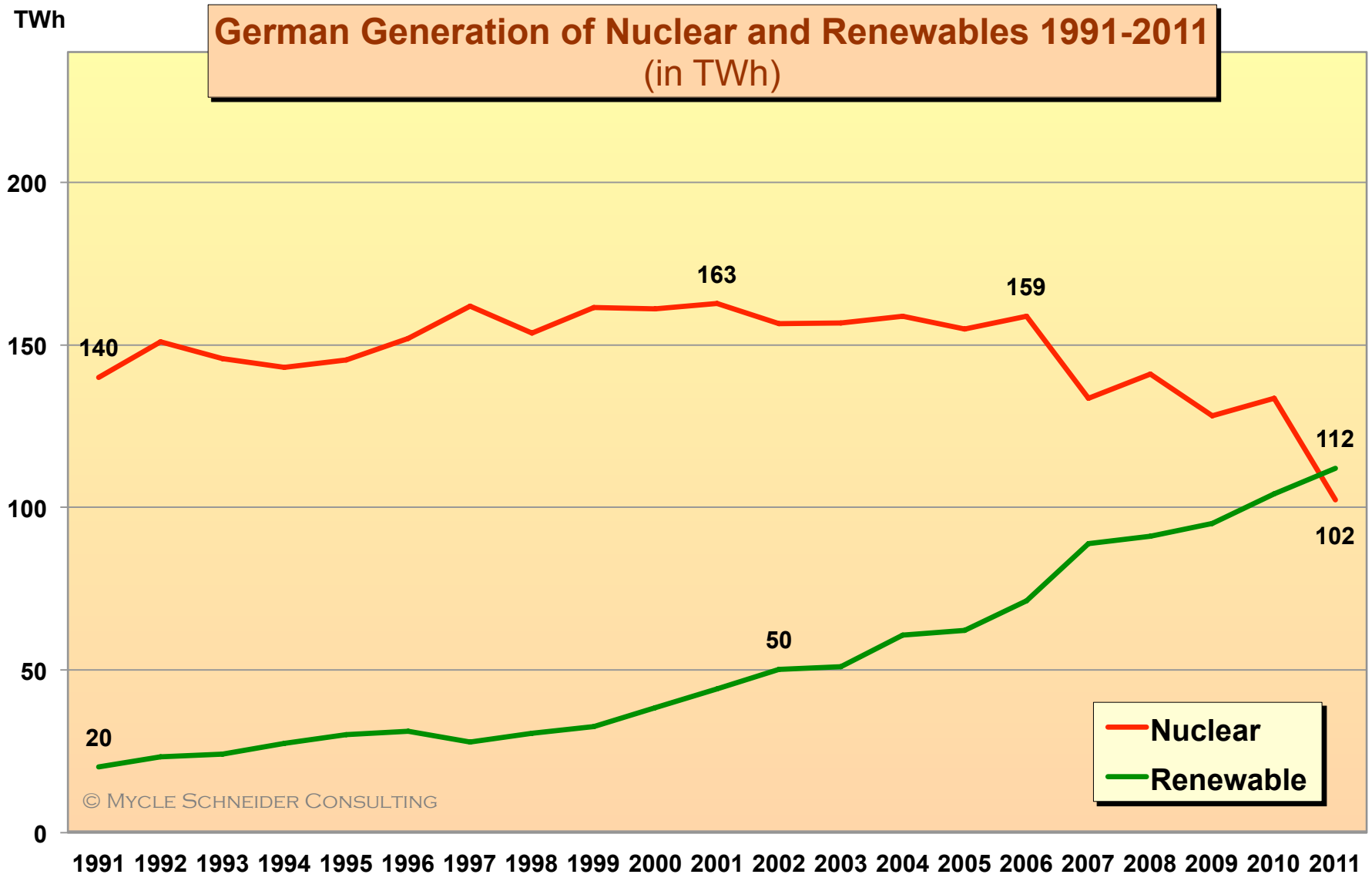
• Off-Grid and Micro-Grid power "next *Big Thing* for US military" (todaysdefense.com)

• 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:

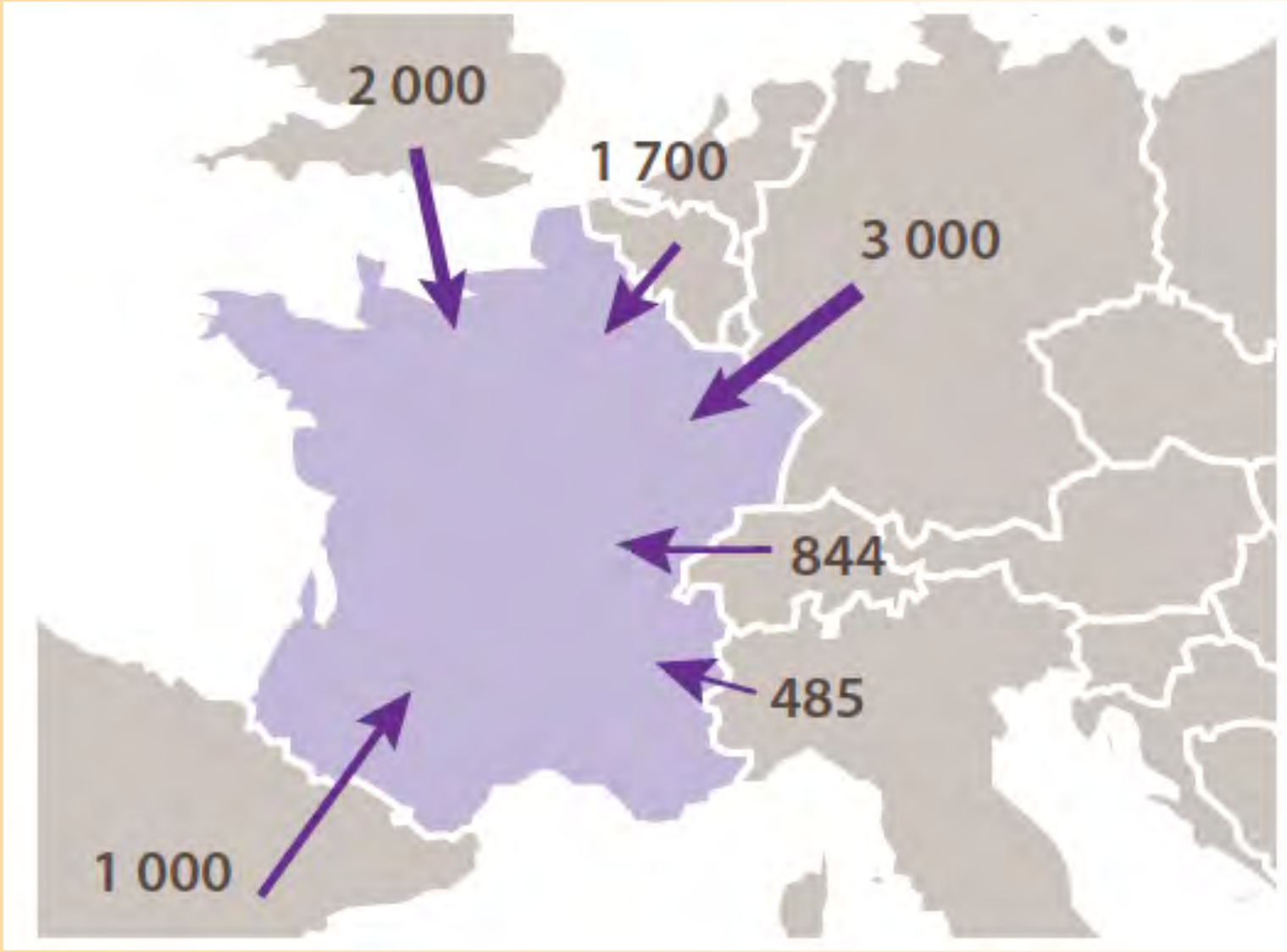
- implement economical energy-efficiency tools that allow for analysis, control and automation of energy processes
- use smart energy controls to provide real-time data to manage energy use
- integrate renewable energy sources and storage."

Source: Siemens, Press Release, 8 August 2011



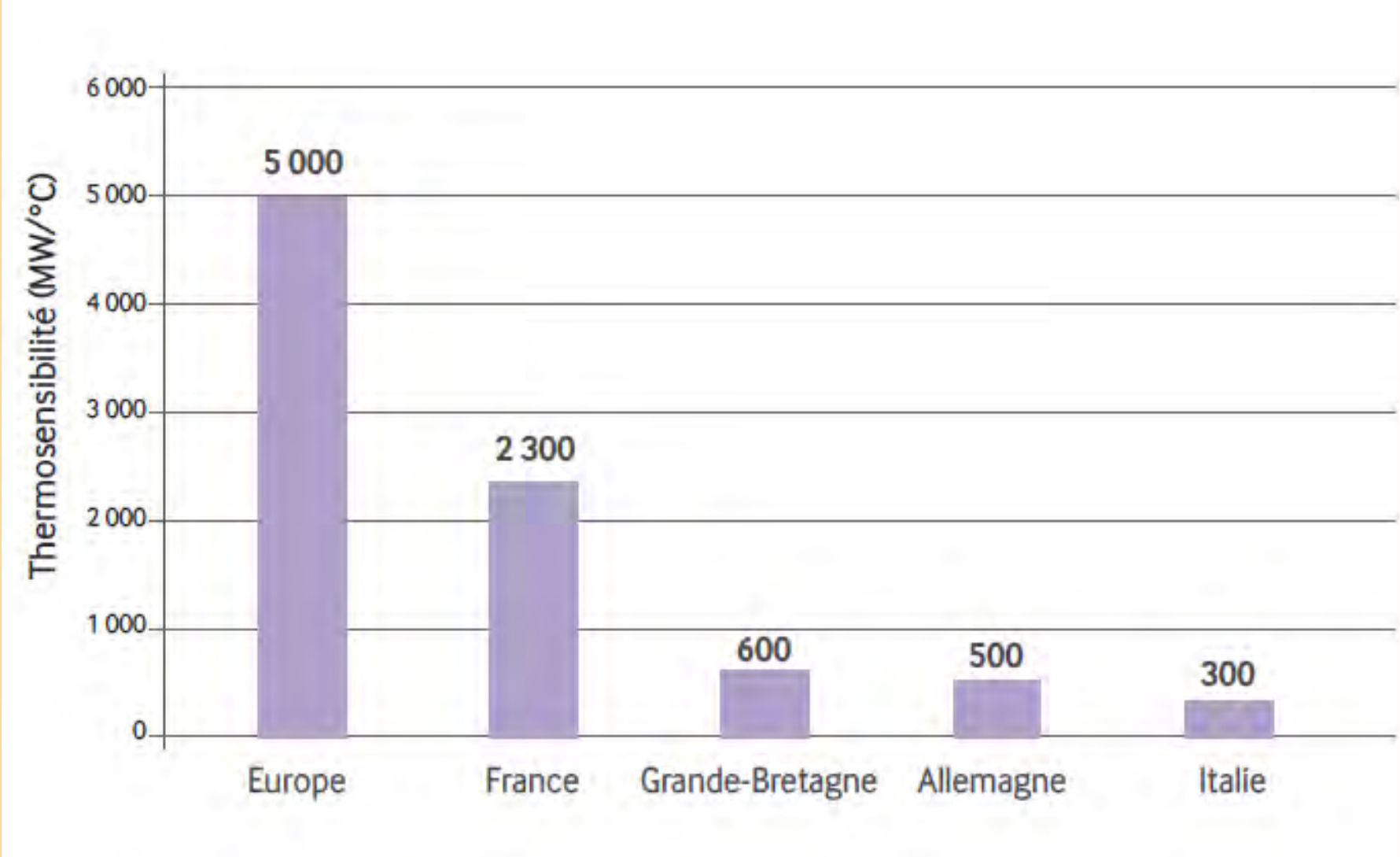
Sources: US EIA 2011, PRIS 2012, AGEB 2012

Neighbors Save French Electricity Grid, 9 February 2012 (in MW)



Source: RTE, "La vague de froid de février 2012", April 2012

Temperature Sensitivity of Power Systems in Europe (MW/°C)



Source: RTE, "La vague de froid de février 2012",

Post-Fukushima Reactions in Selected Countries (4)

Italy

- National referendum: 94% against new nuclear program.

Japan

- Deep societal trauma. Society split.
- Large majority in favor of abandoning nuclear. Demonstrations >100,000.
- RE Law voted in August 2011; Feed-in Tariff July 2012.
- Launch *Japan Renewable Energy Foundation* (September 2011) by Masayoshi Son, CEO SoftBank.
- Massive renewables and smart system expansion expected.

Lithuania

- National referendum 14 Oct 2012: two thirds against new build.

Post-Fukushima Reactions in Selected Countries (5)

Netherlands

- New build project abandoned.
- German utility RWE pulled out.

Switzerland

- Elaboration of “new energy scenarios and corresponding action plans and measures” (Federal Energy Office) after Fukushima.
- Vote of prohibition of all new reactor construction (28 September 2011).

Taiwan

- No plant life extension.
- Policy objective MOEA: ”Gradually move towards a nuclear-free homeland”

Post-Fukushima Reactions in Selected Countries (6)

United Kingdom

- Government strongly in favor of nuclear new build, under condition that no public subsidies.
- 29 March 2012: German RWE and E.ON abandon all new build project — Horizon consortium for sale.
- 16 April 2012: GDF-Suez pushes back investment decision to 2015.
- 20 April 2012: Centrica (EDF ally) “threatens nuclear pull-out” (Guardian).
- 23 July 2012: UK Parliament Committee slams proposed Energy Bill.
- September 2012: Iberdrola (GDF-Suez ally) pulls out.
- October 2012: Chinese utilities drop interest in taking over Horizon.

Post-Fukushima Reactions in Selected Countries (7)

United States

- President Obama / Minister Chu: “nuclear has an important role”.
- NRG, main shareholder of South Texas Project (2 new reactors), abandoned project (loss $481 million).
- In February and April 2012 first licenses for new reactors since 1978 (Vogtle, Summer), but chairman of NRC voted against. Vogtle license already challenged in court.
- Opinion survey March 2012: 77% in favor of transferring federal loan guarantees from nuclear to wind and solar.
- Now officially (IAEA-PRIS) only 1 reactor under construction… since 1972 (Watts Bar 2).

Conclusions

• Nuclear power plays a decreasing role in the international energy sector: ≈11% of electricity, <5% of primary energy, <2% of final energy in the world. Further decline is to be expected.

• Fukushima increases costs (safety, insurance, financing…) and problems (public opinion, political parties, competence…). Nuclear companies are in deep financial trouble.

• 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.

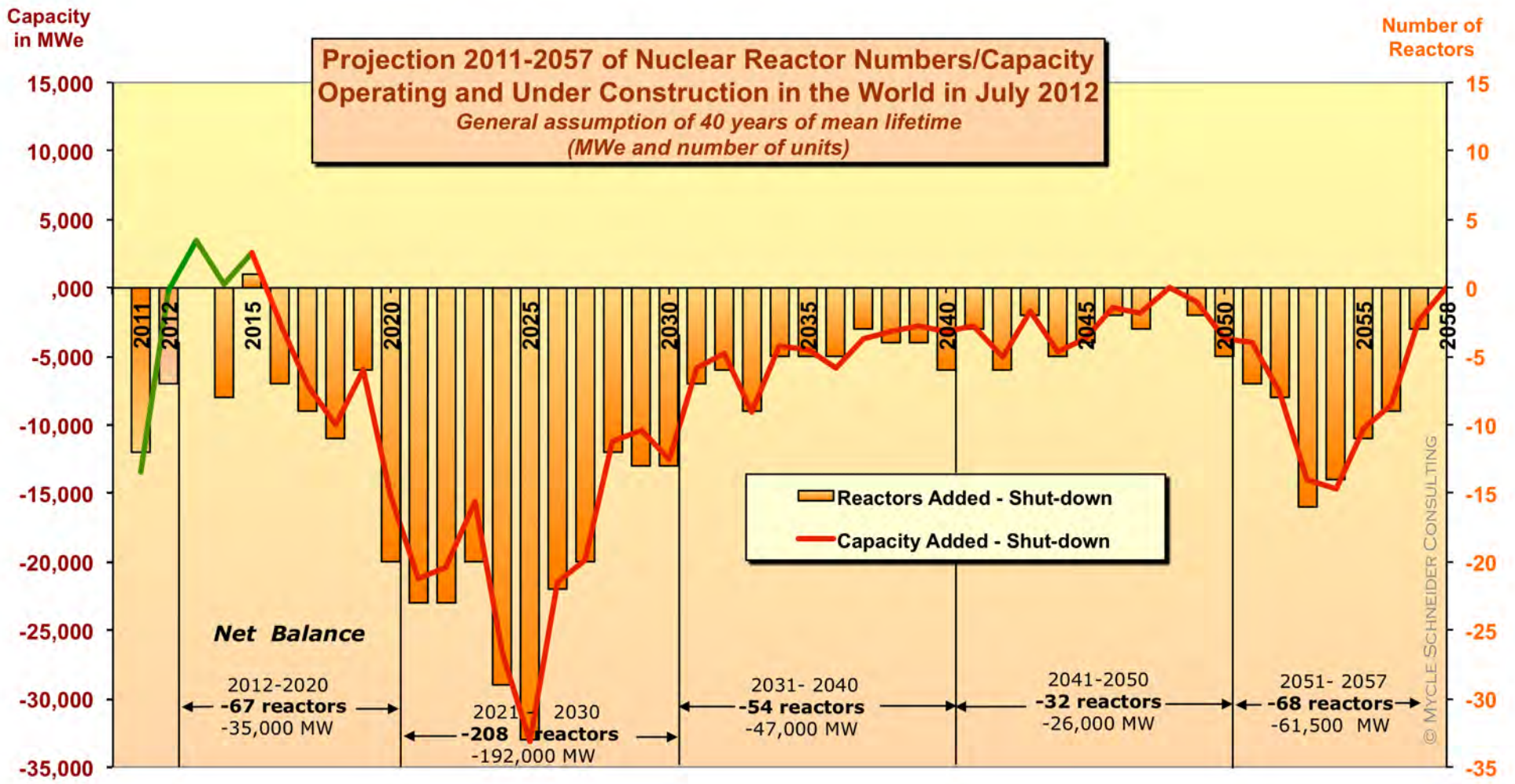
"We know the country that harnesses the power of clean, renewable energy will lead the 21st century."

President Barack Obama
State of the Union Address
27 January 2010

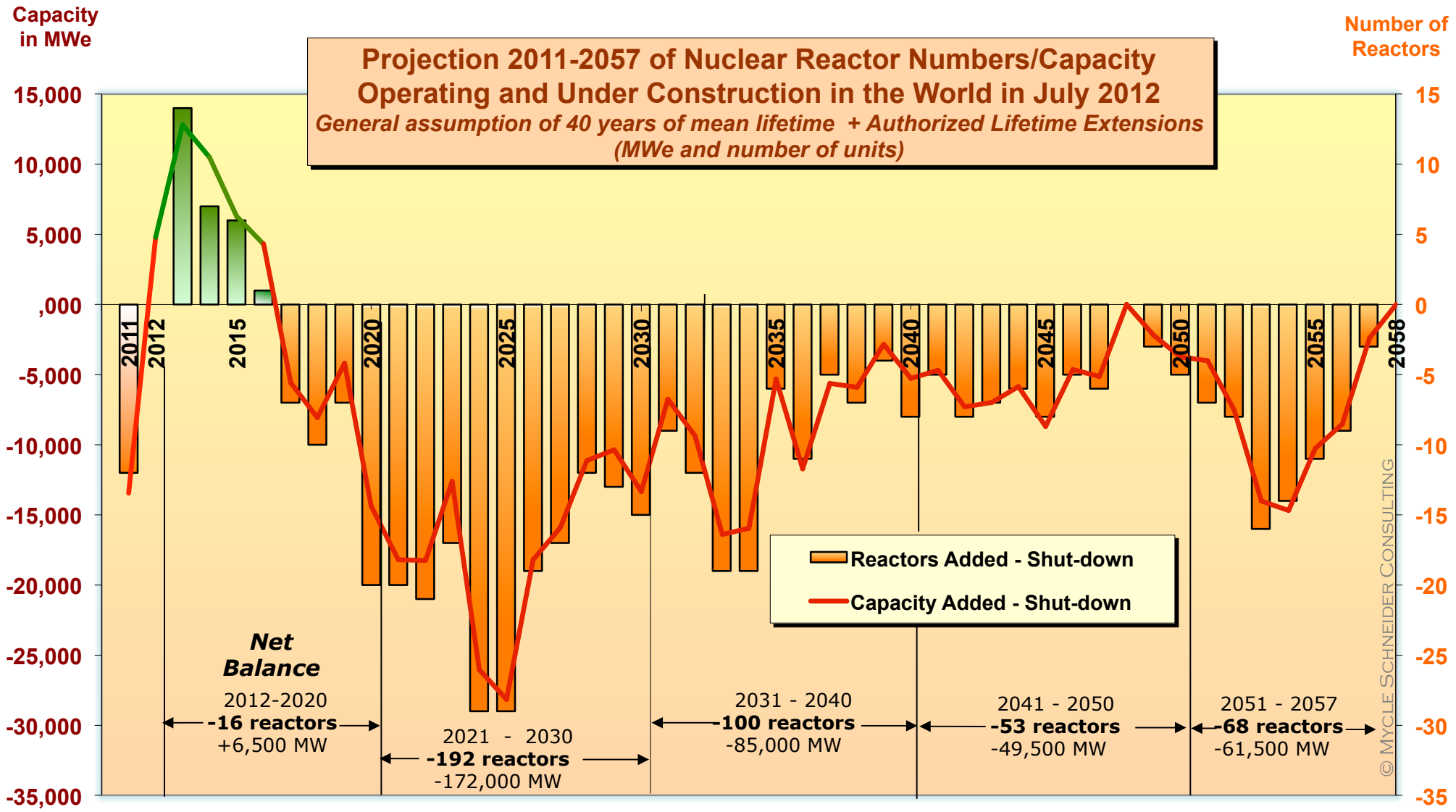
Thank You!

Contact: mycle@orange.fr
Phone: +33-1-69 83 23 79

www.WorldNuclearReport.org - online now!



Source: IAEA-PRIS, MSC, 2012



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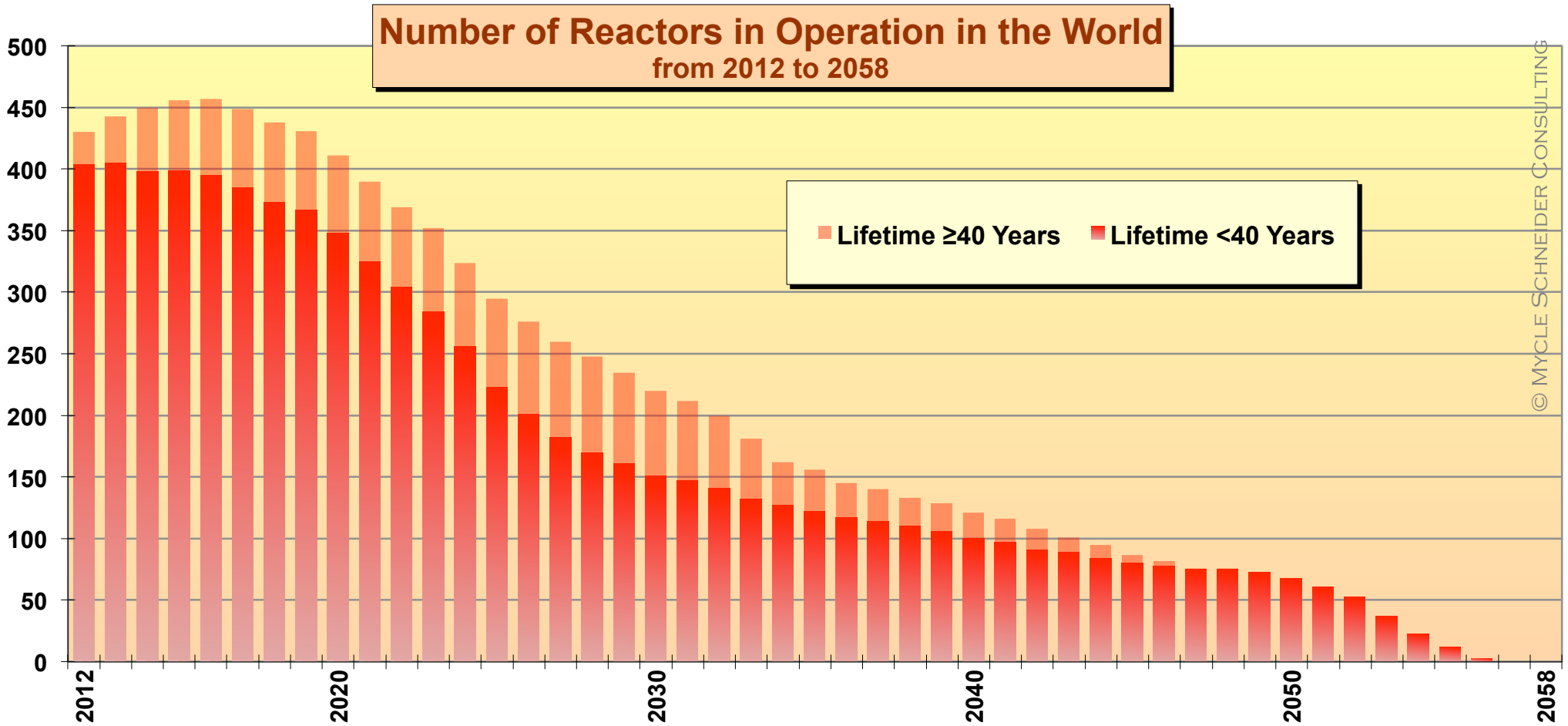

Source: IAEA-PRIS, MSC, 2012