NUCLEAR POWER IN DEVELOPING COUNTRIES

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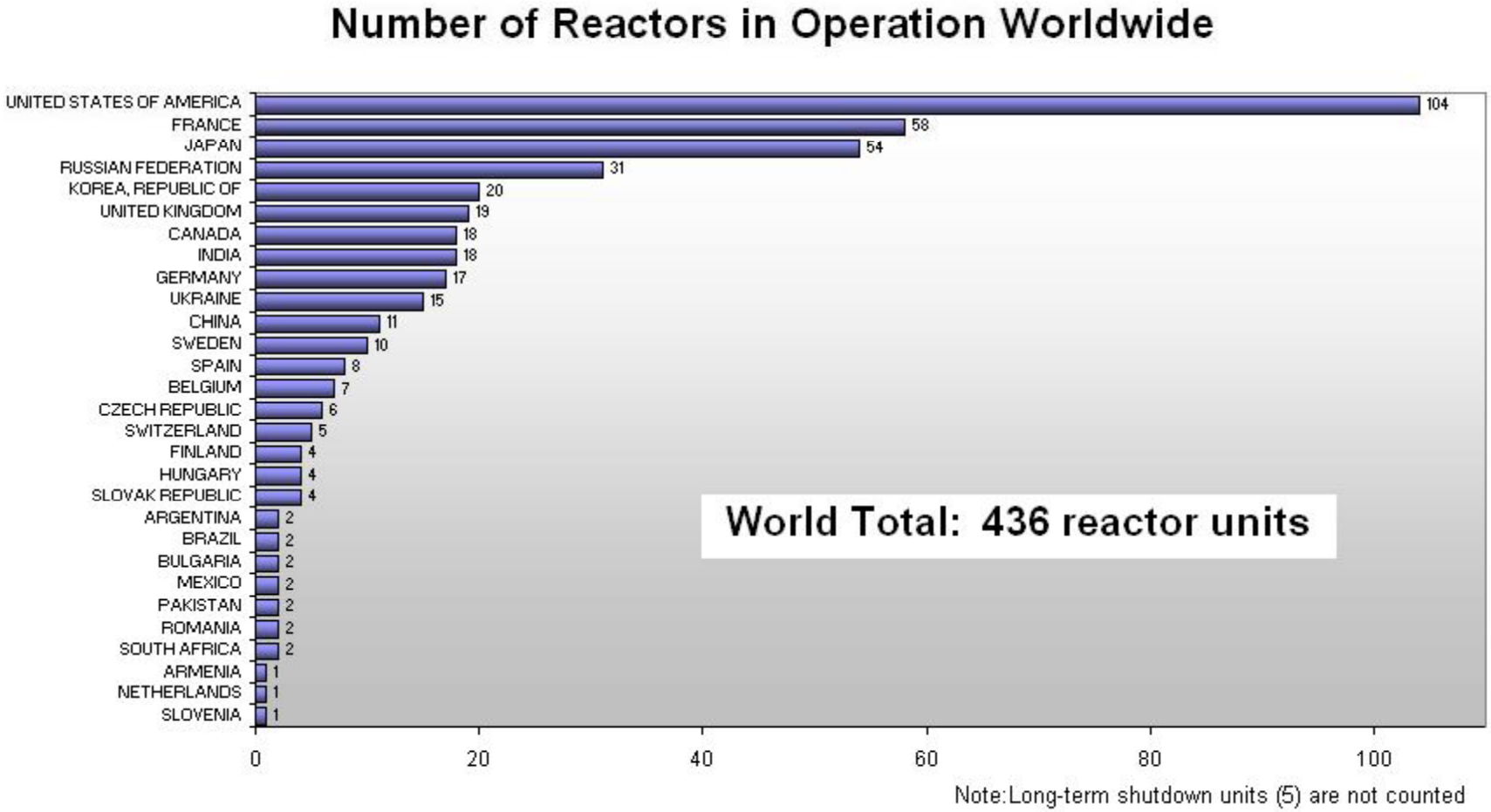
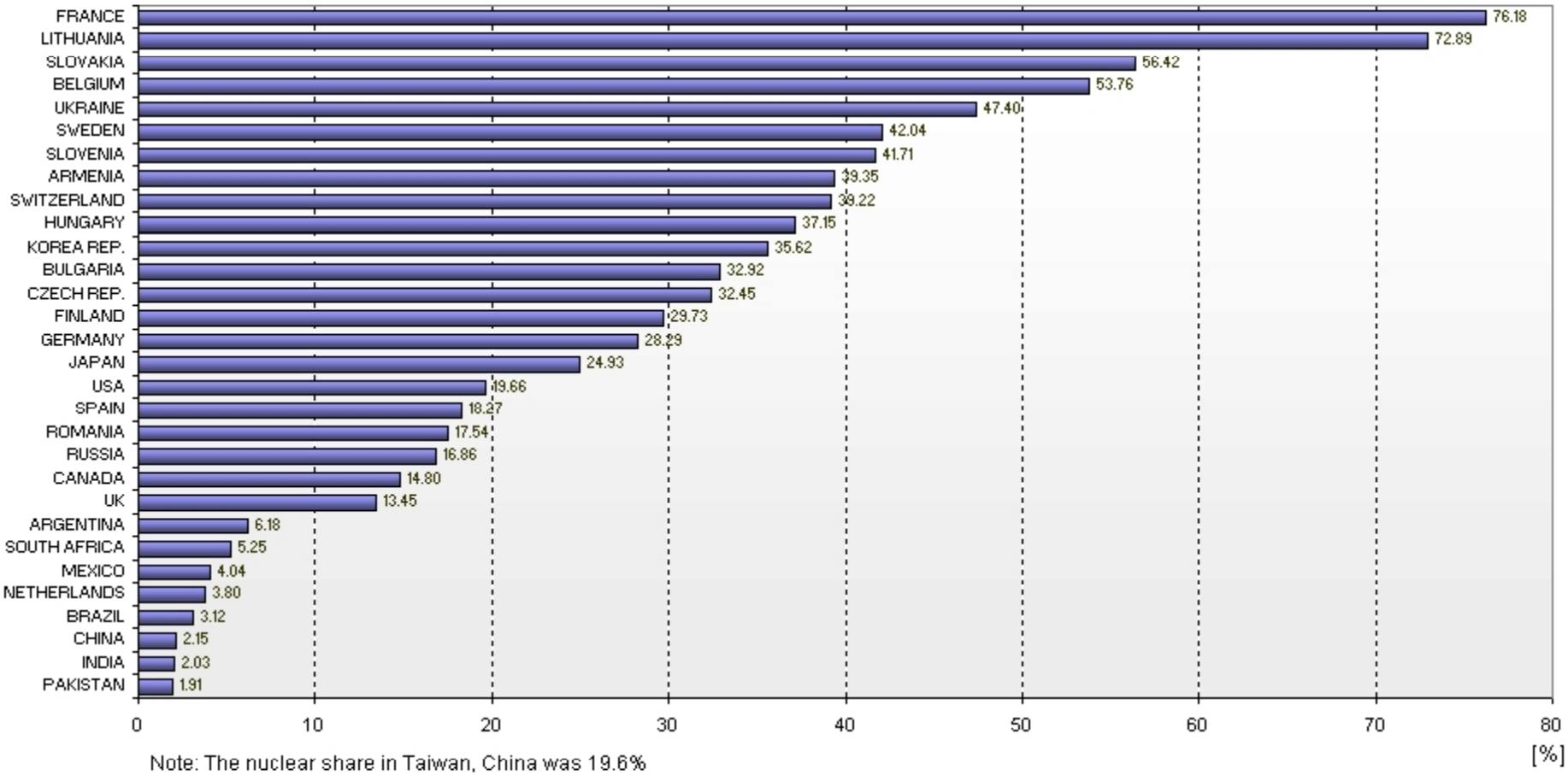


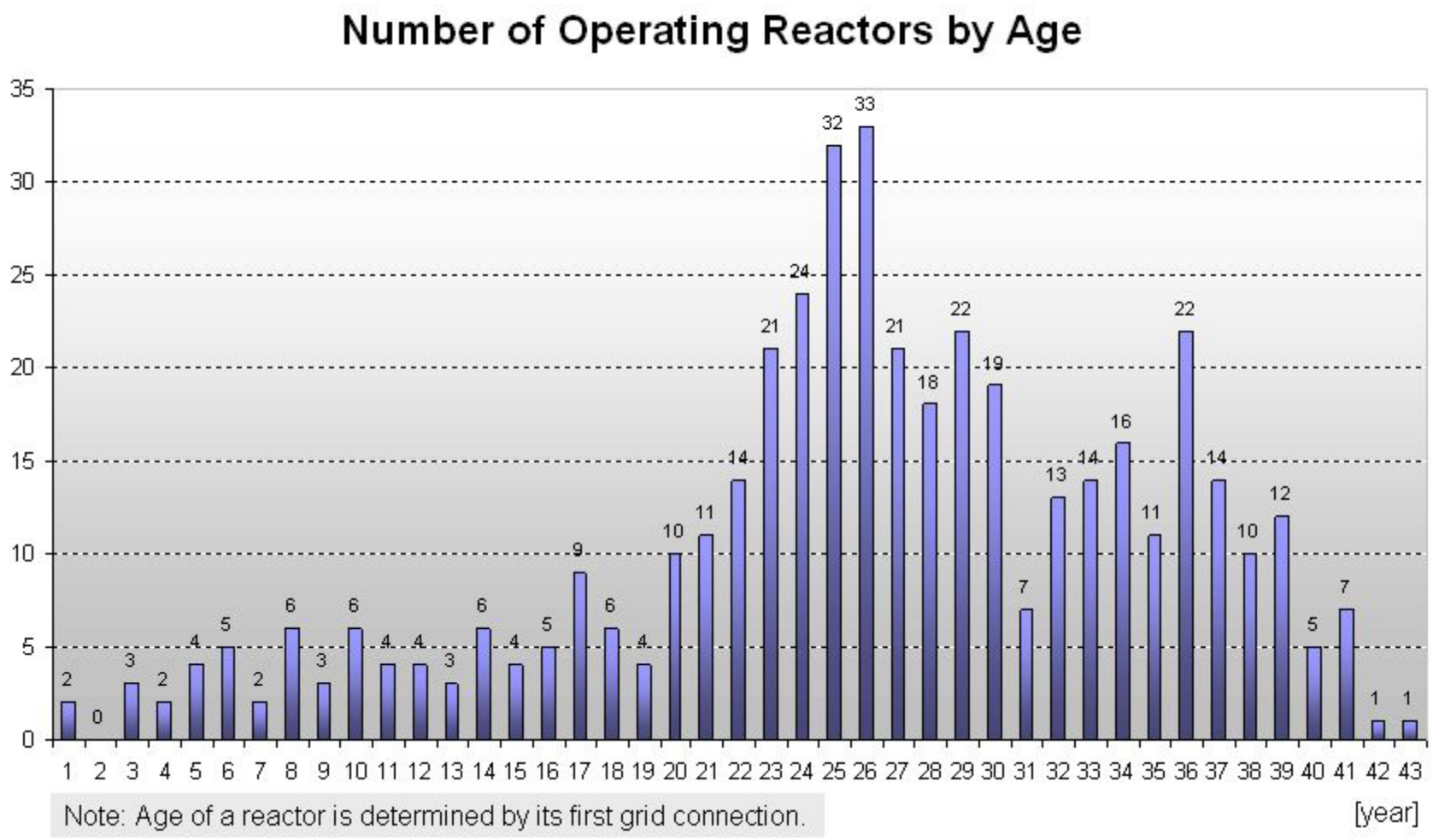
Source: IAEA February 2010

Nuclear Share in Electricity Generation in 2008



Note: The nuclear share in Taiwan, China was 19.6%

Source: IAEA February 2010



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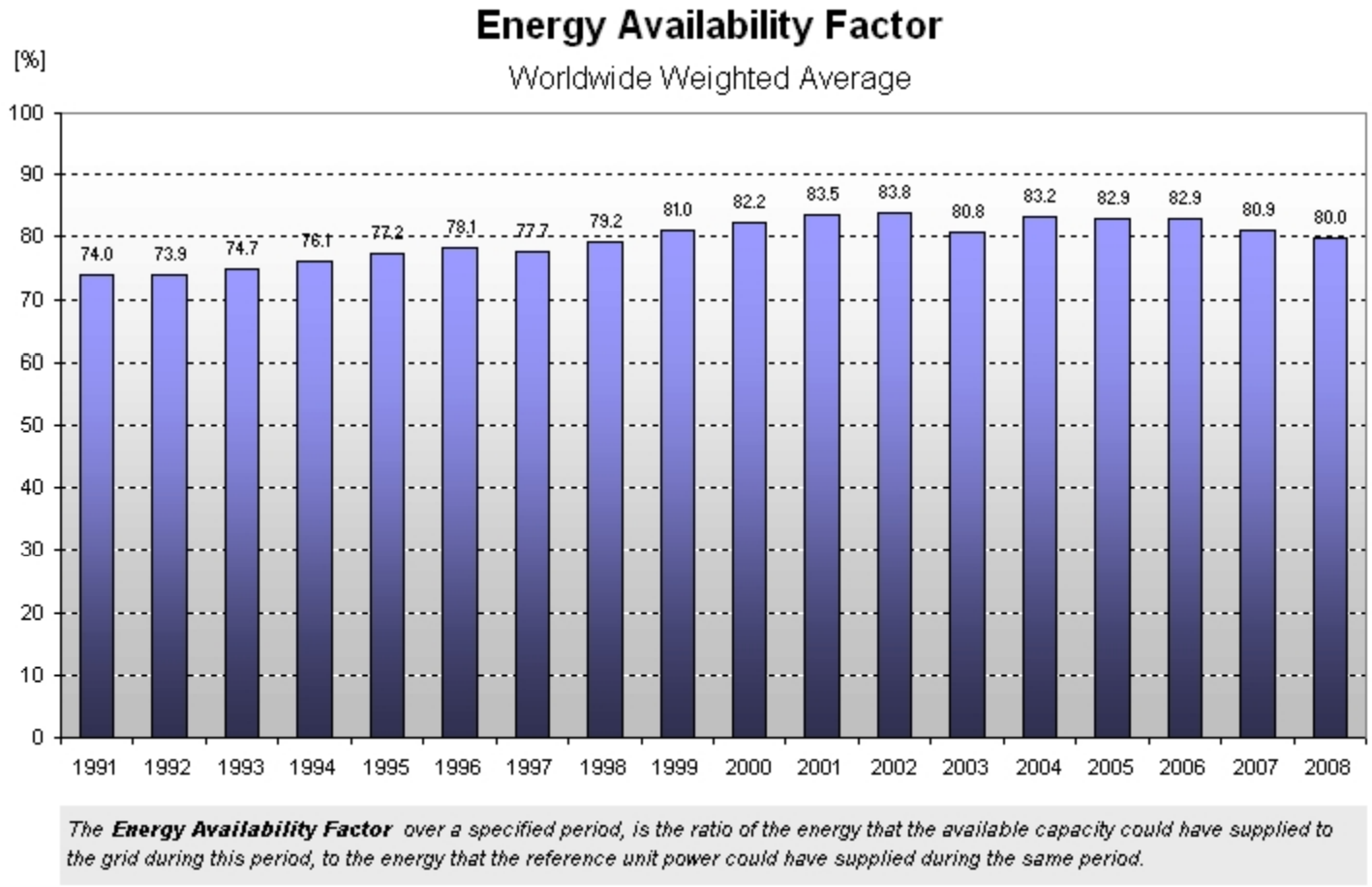

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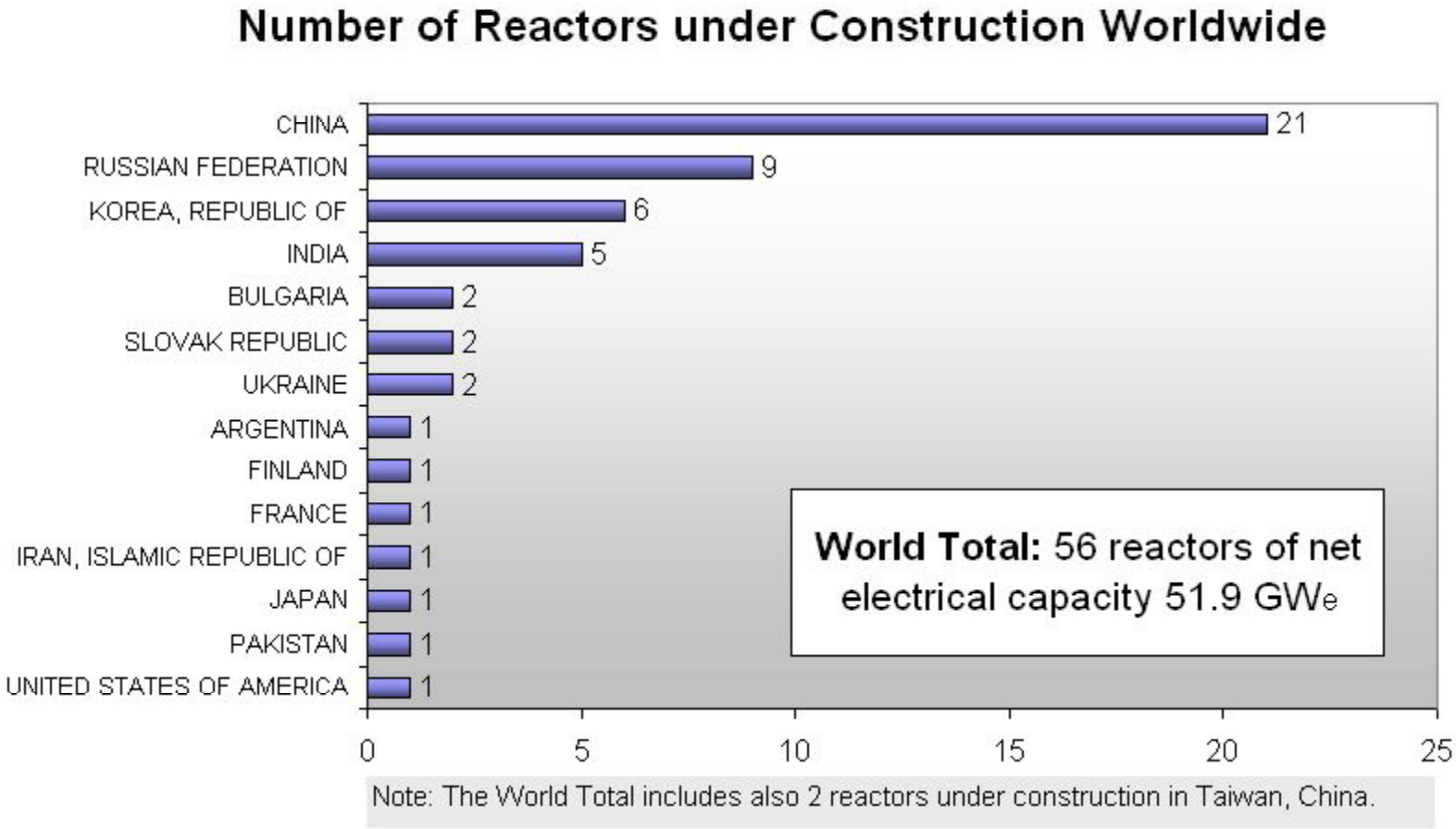
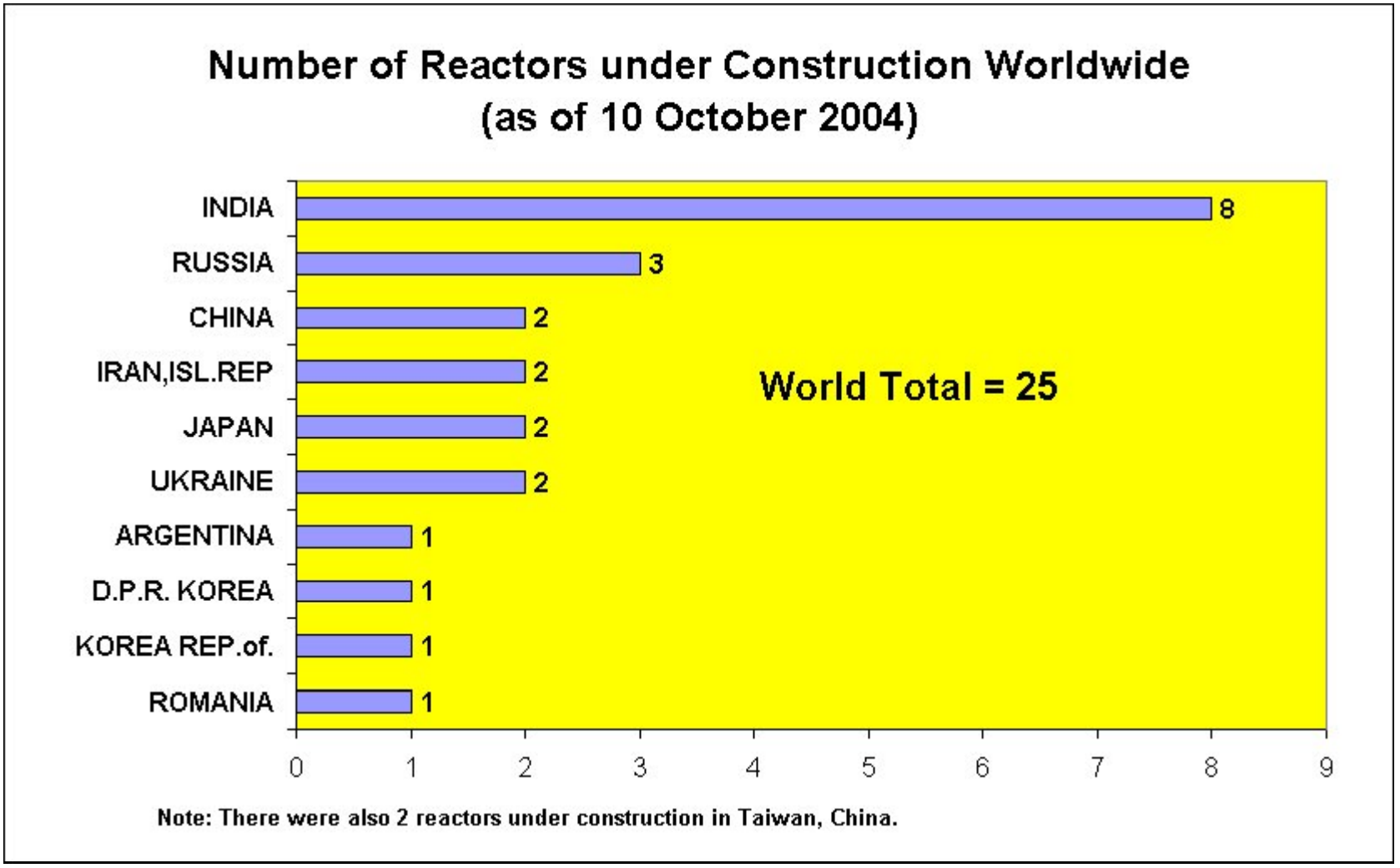


Source: IAEA February 2010



Source: IAEA October 2004

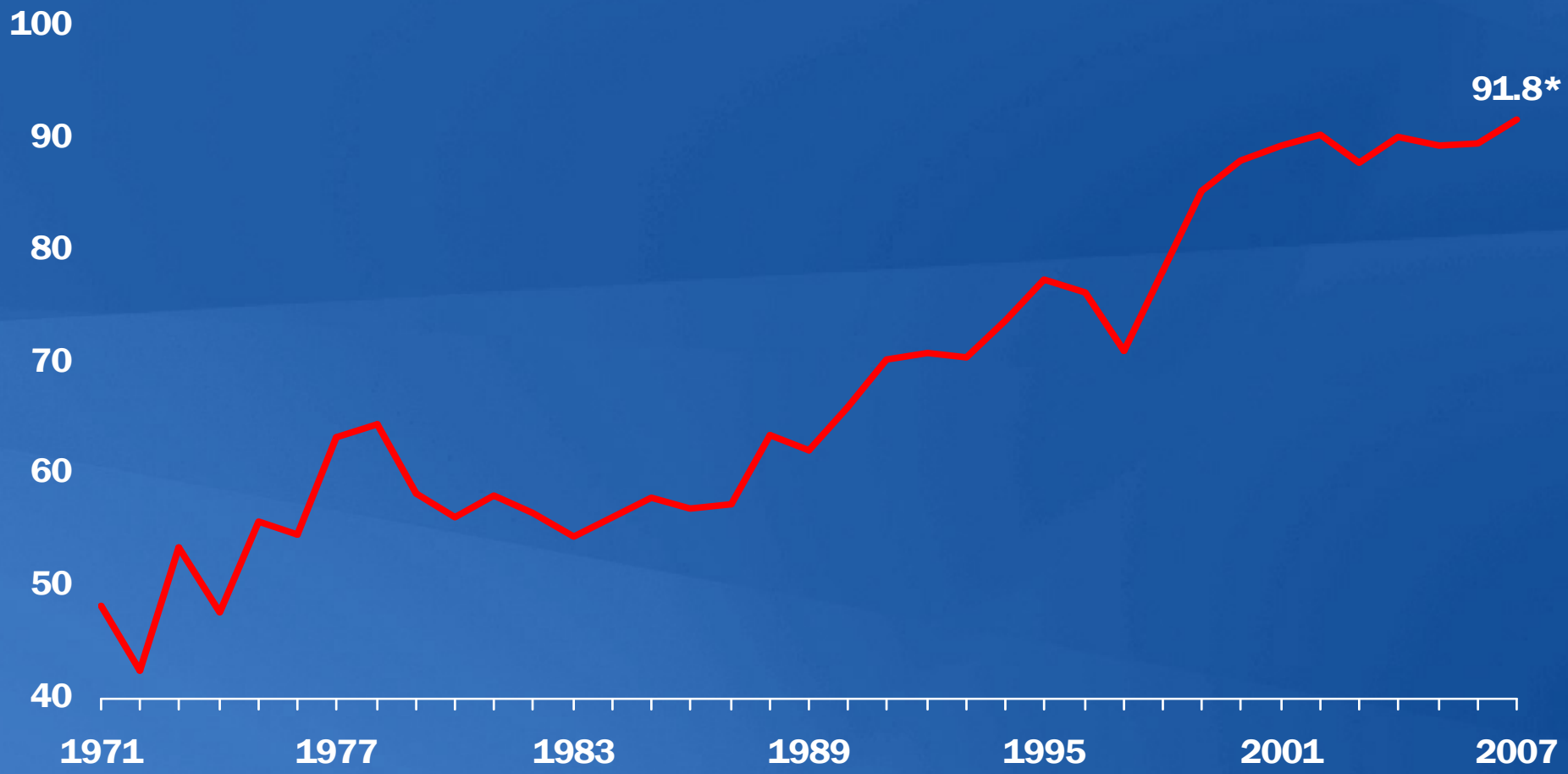
U.S. LICENSE EXTENSIONS (20 Years)

APPROVED:	59 units
IN-PROCESS:	19 units
EXPECTED:	16 units

U.S. NRC February 2010

U.S. Nuclear Industry Capacity Factors

1971 - 2007



* Preliminary

Source: Global Energy Decisions / Energy Information Administration

Updated: 4/08

U.S. Nuclear Refueling Outage Days

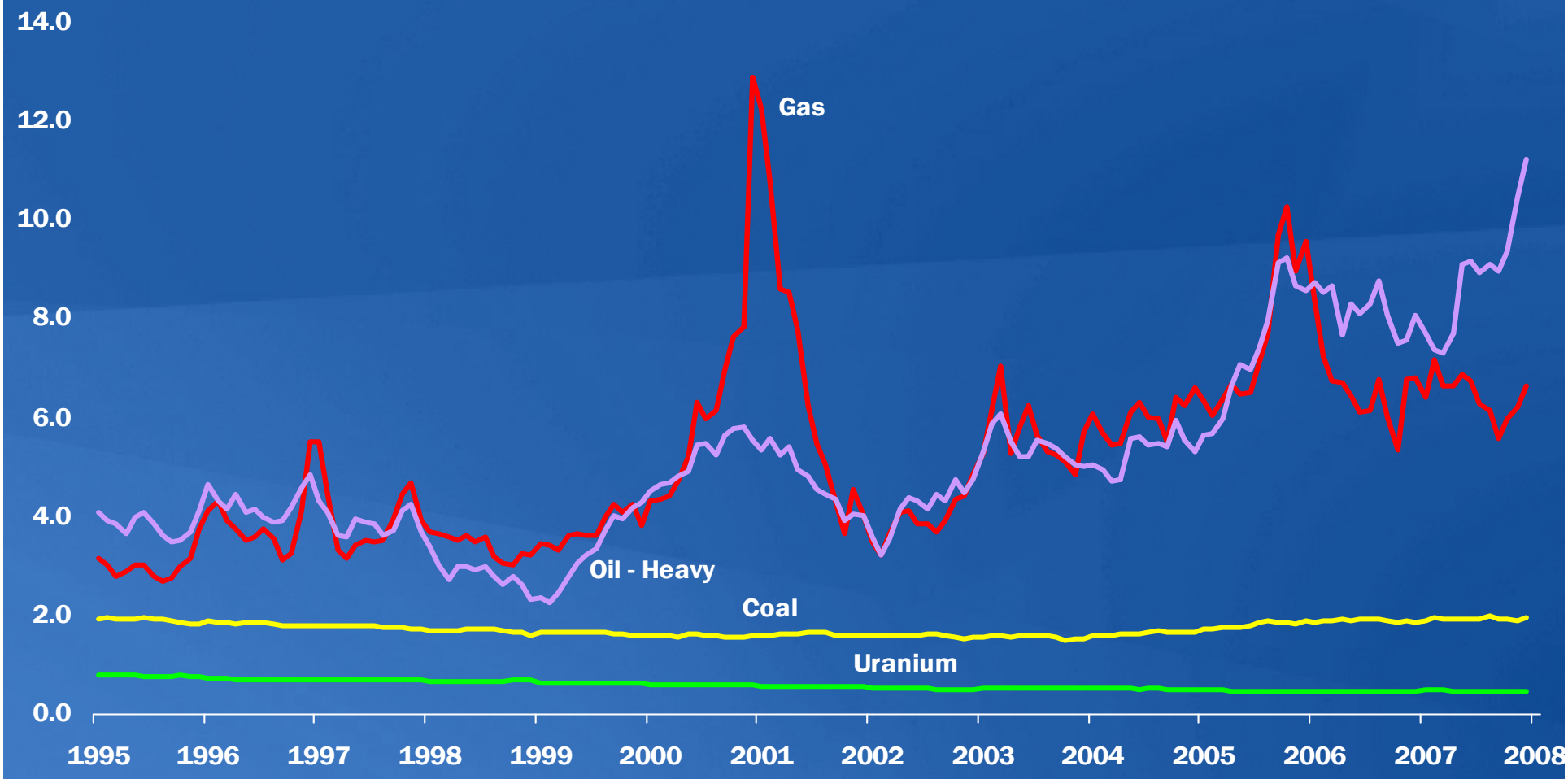
Average

Source: 1990-98 EUCG, 1999-2008 Ventyx Velocity Suite / Nuclear Regulatory Commission

Updated: 1/09

Monthly Fuel Cost to U.S. Electric Utilities

1995 – 2007, *In 2007 cents per kilowatt-hour*

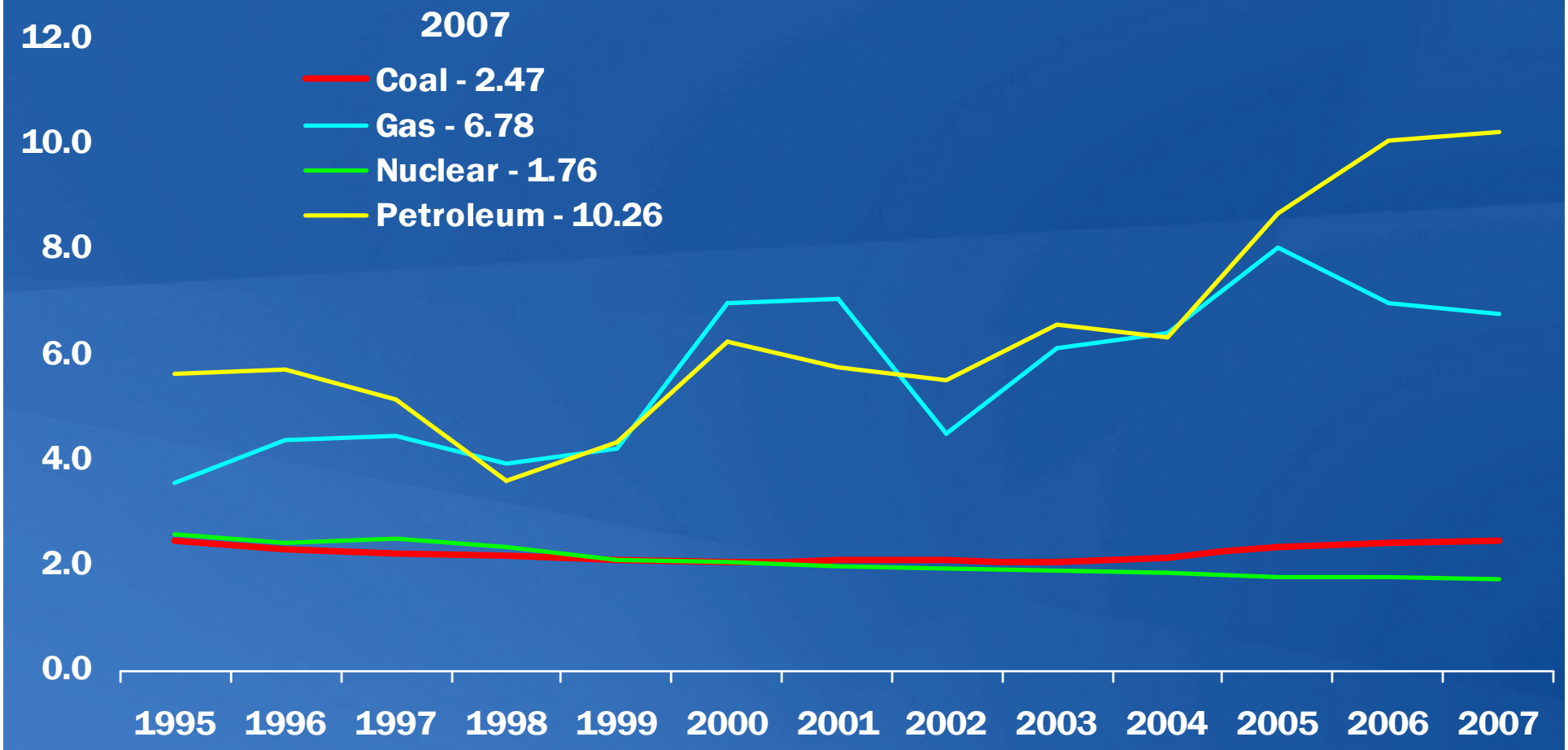


Source: Global Energy Decisions

Updated: 5/08

U.S. Electricity Production Costs

1995-2007, *In 2007 cents per kilowatt-hour*



Production Costs = Operations and Maintenance Costs + Fuel Costs

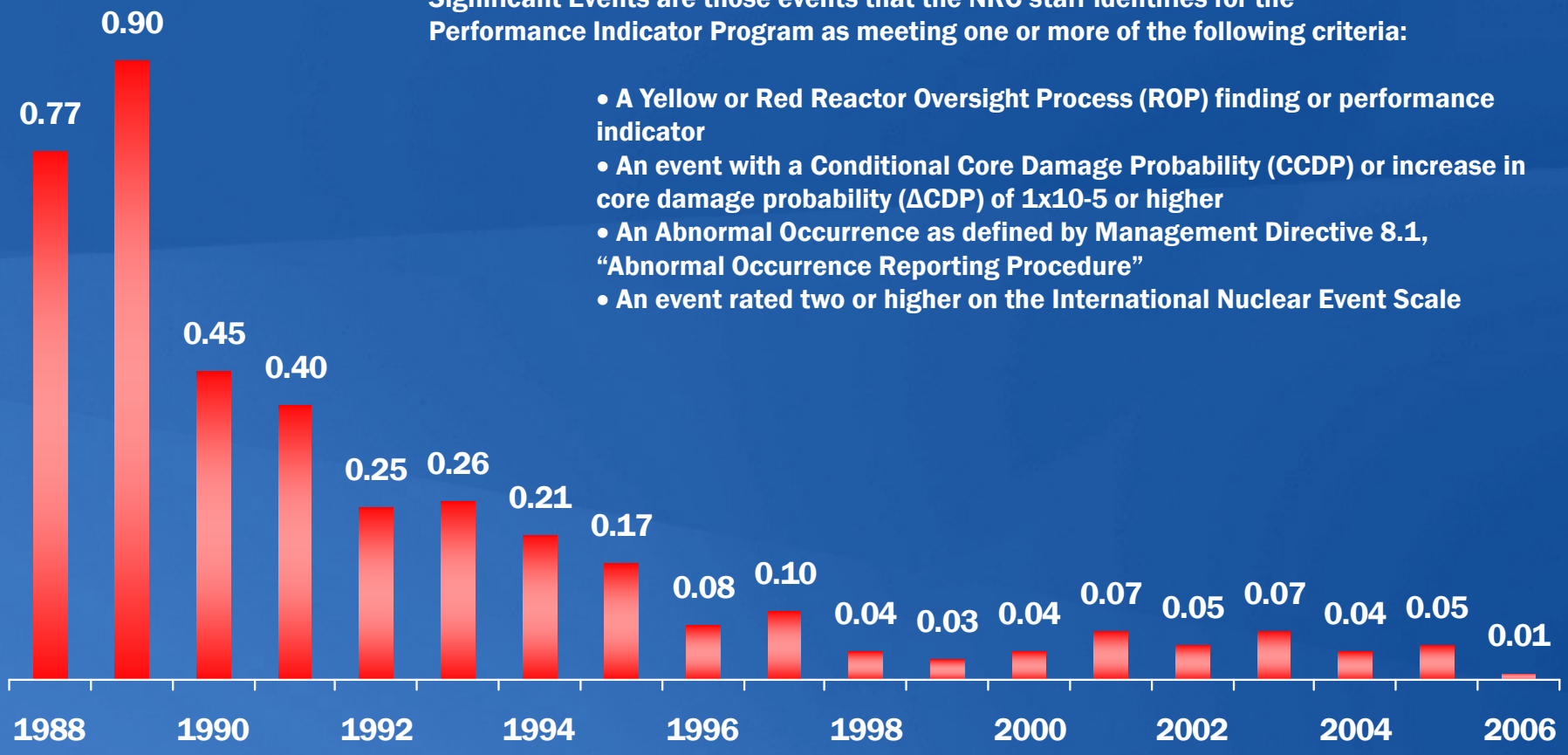
Source: Global Energy Decisions
Updated: 5/08

Significant Events at U.S. Nuclear Plants:

Annual Industry Average, Fiscal Year 1988-2006

Significant Events are those events that the NRC staff identifies for the Performance Indicator Program as meeting one or more of the following criteria:

- **A Yellow or Red Reactor Oversight Process (ROP) finding or performance indicator**
- **An event with a Conditional Core Damage Probability (CCDP) or increase in core damage probability (ΔCDP) of 1x10-5 or higher**
- **An Abnormal Occurrence as defined by Management Directive 8.1, "Abnormal Occurrence Reporting Procedure"**
- **An event rated two or higher on the International Nuclear Event Scale**

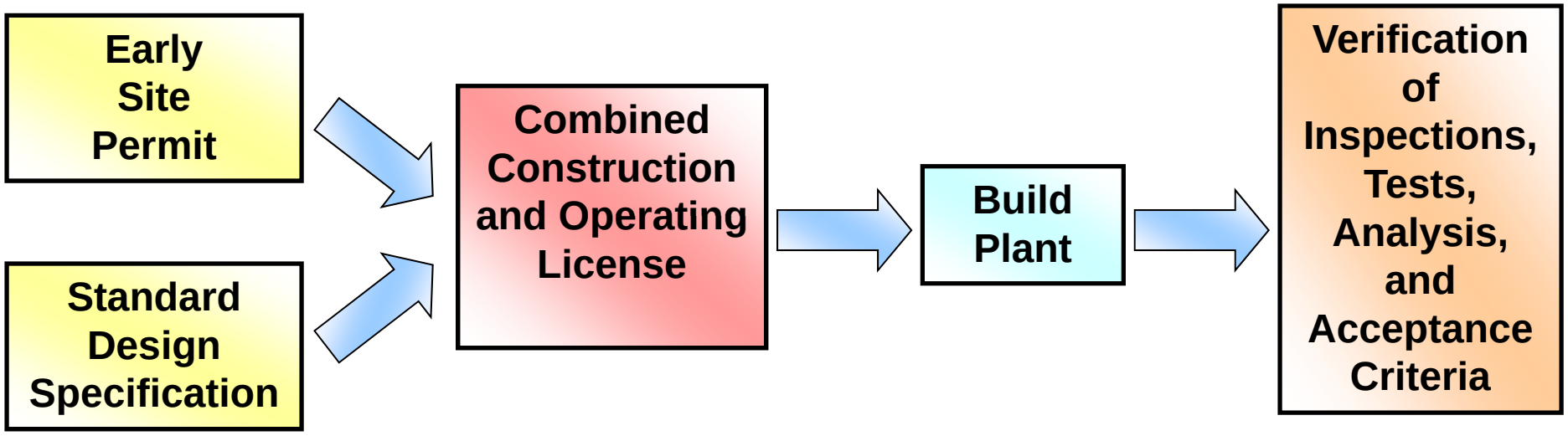


Source: NRC Information Digest, 1988 is the earliest year data is available.
Updated: 11/07

New U.S. Reactor Licensing Process

Old Process: The two-step licensing process (10 CFR 50)

New Process: Combined licensing process (10 CFR 52)



Source: Berger and Parsons (MIT CEEPR 2005)

Issued Design Certifications

Source: NRC Feb 2010

The NRC staff has issued the following design certifications:

Design	Applicant
Advanced Boiling Water Reactor (ABWR)	General Electric (GE) Nuclear Energy
System 80+	Westinghouse Electric Company
Advanced Passive 600 (AP600)	Westinghouse Electric Company
Advanced Passive 1000 (AP1000)	Westinghouse Electric Company

Design Certification Applications Currently Under Review

The staff is currently reviewing the following design certification applications:

Design	Applicant
AP1000 Amendment	Westinghouse Electric Company
ABWR Design Certification Rule (DCR) Amendment	South Texas Project Nuclear Operating Company
Economic Simplified Boiling-Water Reactor (ESBWR)	GE-Hitachi Nuclear Energy
U.S. Evolutionary Power Reactor (U.S. EPR)	AREVA Nuclear Power
U.S. Advanced Pressurized-Water Reactor (US-APWR)	Mitsubishi Heavy Industries, Ltd.

Advanced Reactors

Reactor designers are developing a number of small light-water reactor (LWR) and non-LWR designs employing innovative solutions to technical nuclear power issues. These designs could be used for generating electricity in isolated areas or producing high-temperature process heat for industrial purposes. The U.S. Nuclear Regulatory Commission (NRC) expects to receive applications for staff review and approval of some of these designs as early as Fiscal Year 2011.

Design	Applicant
International Reactor Innovative and Secure (IRIS)	Westinghouse Electric Company
NuScale	NuScale Power, Inc.
Pebble Bed Modular Reactor (PBMR)	PBMR (Pty.), Ltd.
Super-Safe, Small and Simple (4S)	Toshiba Corporation
Hyperion	Hyperion Power Generation, Inc.
Power Reactor Innovative Small Module (PRISM)	GE Hitachi Nuclear Energy
mPower	Babcock and Wilcox Company

Source: U.S. NRC February 2010

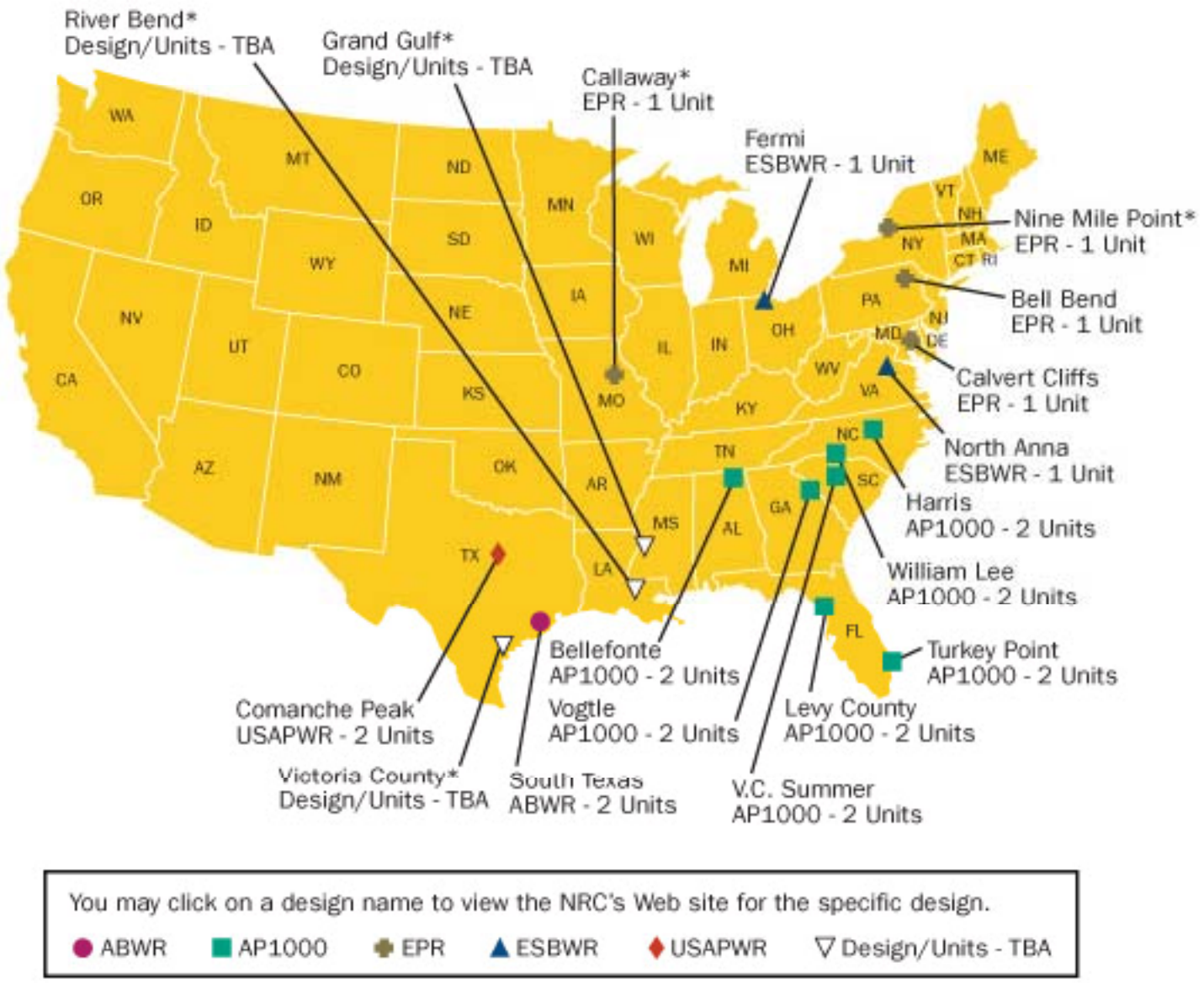
Expected New Nuclear Power Plant Applications Updated September 28, 2009						
Company*	Date of Application	Design	Date Accepted	Site Under Consideration	State	Existing Operating Plant
Calendar Year (CY) 2007 Applications						
NRG Energy (52-012/013)***	09/20/2007	ABWR	11/29/2007	South Texas Project (2 units)	TX	Y
NuStart Energy (52-014/015)***	10/30/2007	AP1000	01/18/2008	Bellefonte (2 units)	AL	N
UNISTAR (52-016)***	07/13/2007 (Envir.) 03/13/2008 (Safety)	EPR	01/25/2008 06/03/2008	Calvert Cliffs (1 unit)	MD	Y
Dominion (52-017)***	11/27/2007	ESBWR	01/28/2008	North Anna (1 unit)	VA	Y
Duke (52-018/019)***	12/13/2007	AP1000	02/25/2008	William Lee Nuclear Station (2 units)	SC	N
2007 TOTAL NUMBER OF APPLICATIONS = 5 TOTAL NUMBER OF UNITS = 8						
Calendar Year (CY) 2008 Applications						
Progress Energy (52-022/023)***	02/19/2008	AP1000	04/17/2008	Harris (2 units)	NC	Y
NuStart Energy (52-024)***	02/27/2008	ESBWR	04/17/2008	Grand Gulf (1 units)	MS	Y
Southern Nuclear Operating Co. (52-025/026)***	03/31/2008	AP1000	05/30/2008	Vogtle (2 units)	GA	Y
South Carolina Electric & Gas (52-027/028)***	03/31/2008	AP1000	07/31/2008	Summer (2 units)	SC	Y
Progress Energy (52-029/030) ***	07/30/2008	AP1000	10/06/2008	Levy County (2 units)	FL	N
Detroit Edison (52-033)***	09/18/2008	ESBWR	11/25/2008	Fermi (1 unit)	MI	Y
Luminant Power (52-034/035)***	09/19/2008	USAPWR	12/2/2008	Comanche Peak (2 units)	TX	Y
Entergy (52-036)***	09/25/2008	ESBWR	12/4/2008	River Bend (1 unit)	LA	Y
AmerenUE (52-037)***	07/24/2008	EPR	12/12/2008	Callaway (1 unit)	MO	Y
UNISTAR (52-038)***	09/30/2008	EPR	12/12/2008	Nine Mile Point (1 unit)	NY	Y
PPL Generation (52-039)***	10/10/2008	EPR	12/19/2008	Bell Bend (1 unit)	PA	Y
2008 TOTAL NUMBER OF APPLICATIONS = 11 TOTAL NUMBER OF UNITS = 16						
Calendar Year (CY) 2009 Applications						
Florida Power and Light (763)***	6/30/2009	AP1000	09/04/2009	Turkey Point (2 units)	FL	Y
Amarillo Power (752)		EPR		Vicinity of Amarillo (2 units)	TX	UNK
Alternate Energy Holdings (765)		EPR		Hammett (1 unit)	ID	N
2009 TOTAL NUMBER OF APPLICATIONS = 3 TOTAL NUMBER OF UNITS = 5						
Calendar Year (CY) 2010 Applications						
Blue Castle Project		TBD		Utah	UT	N
Unannounced		TBD		TBD	TBD	UNK
2010 TOTAL NUMBER OF APPLICATIONS = 2 TOTAL NUMBER OF UNITS = 2						
Calendar Year (CY) 2011 Applications						
No Letters of Intent have been received from applicants expressing their plans to submit new COL applications in CY 2011.						
2007 – 2011 Total Number of Applications = 21 Total Number of Units = 31						

*Project Numbers/Docket Numbers **Yellow – Acceptance Review Ongoing ***Blue – Accepted/Docketed

Recent Applications for COLs for 31 New Nuclear Units in US

Many have applied for Federal loan guarantees and other subsidies

U.S. NRC February 2010



*Review Suspended

Source: U.S. NTC February 2010

Table 1: Costs of Electric Generation Alternatives

	Overnight Cost	Fuel Cost	Levelized Cost of Electricity
	$/kW	$/MMBtu	¢/kWh
Nuclear	4,000	0.67	8.4
Coal (low)	2,300	1.60	5.2
Coal (moderate)	2,300	2.60	6.2
Coal (high)	2,300	3.60	7.2
Gas (low)	850	4.00	4.2
Gas (moderate)	850	7.00	6.5
Gas (high)	850	10.00	8.7

Notes: The low, moderate, and high fuel costs for coal correspond to a $40, $65, and $90/short ton delivered price of Central Appalachian coal (12,500 Btu), respectively. Costs are measured in 2007 dollars.

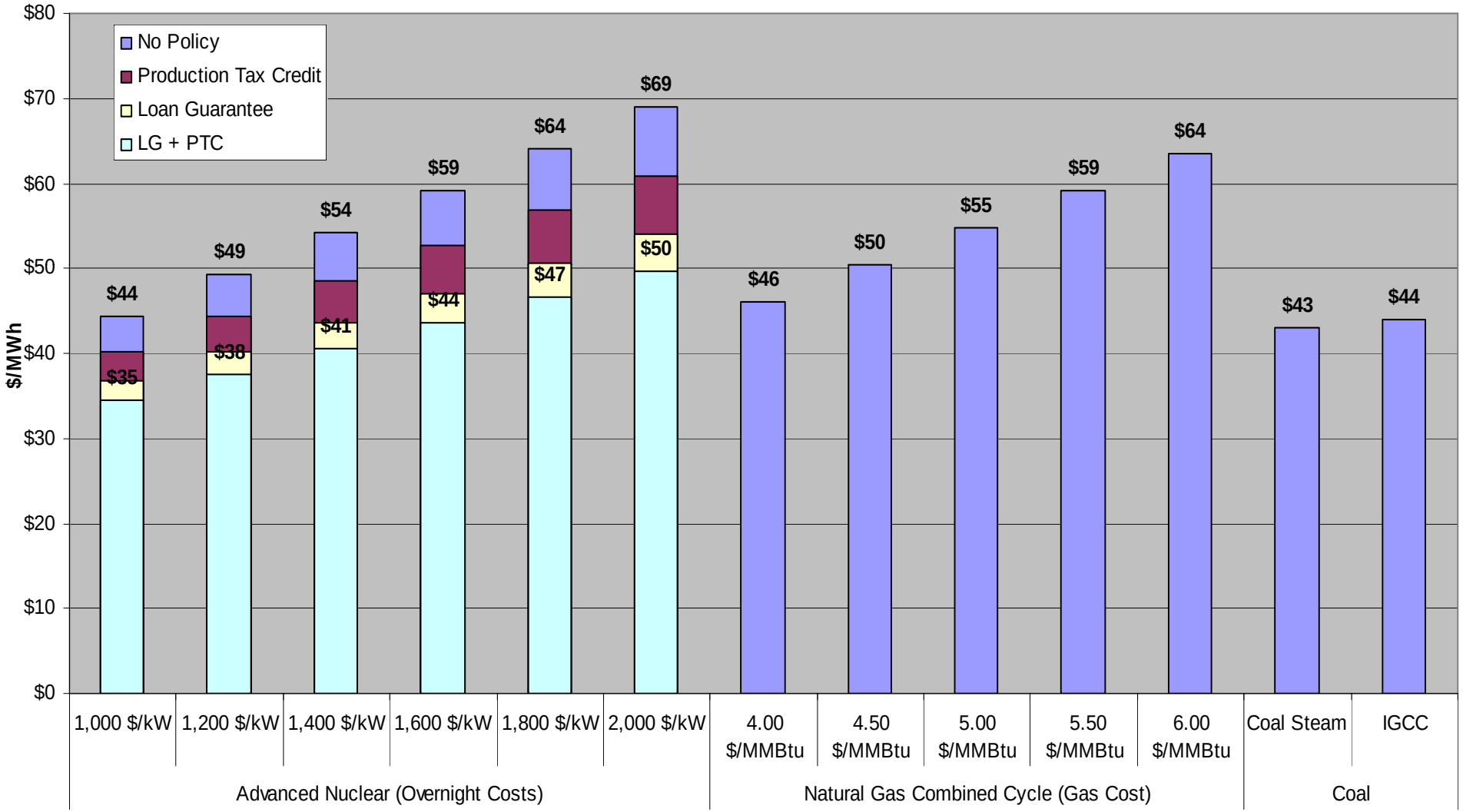
Joskow and Parsons (2009) as reported by Du and Parsons (2009)

Table 2: Costs of Electric Generation Alternatives, Inclusive of Carbon Charge

	Overnight Cost	Fuel Cost	Levelized Cost of Electricity w/carbon charge $25/tCO$_2$	w/carbon charge $50/tCO$_2$
	$/kW	$/MMBtu	¢/kWh	¢/kWh
Nuclear	4,000	0.67	8.4	8.4
Coal (low)	2,300	1.60	7.3	9.4
Coal (moderate)	2,300	2.60	8.3	10.4
Coal (high)	2,300	3.60	9.3	11.4
Gas (low)	850	4.00	5.1	6.0
Gas (moderate)	850	7.00	7.4	8.3
Gas (high)	850	10.00	9.6	10.5

Joskow and Parsons (2009) as reported by Du and Parsons (2009)

The Energy Policy Act of 2005 Reduces Costs for First Movers



Source: Berger and Parsons (MIT CEEPR 2005)

Loan Guarantees: $8.5 ➔ $34 billion

Current Nuclear Programmes*	2008	2030 Low	2030 High	2060 Low	2060 High	2100 Low	2100 High
Click Countries for further information	*Capacity in GWe*						
Argentina	1	4	11	5	30	10	90
Armenia	0	1	0	1	1	2	4
Belarus	0	2	5	5	8	5	10
Belgium	6	6	8	8	10	8	22
Brazil	2	10	30	40	100	70	330
Bulgaria	2	4	7	5	7	5	7
Canada	13	20	30	25	40	30	85
China	9	50	200	150	750	500	2800
Czech Republic	3	5	7	5	12	5	15
Finland	3	5	7	8	10	8	11
France	63	65	75	80	110	80	130
Germany	20	20	50	40	80	80	175
Hungary	2	4	5	4	8	5	12
India	4	20	70	60	500	200	2750
Iran	0	3	10	5	30	10	140
Japan	48	55	70	80	140	80	200
Lithuania/ Latvia/ Estonia	1	4	6	5	8	5	8
Mexico	1	2	20	3	75	20	225
Netherlands	1	1	5	7	20	10	35
Pakistan	0	10	20	20	65	30	180
Romania	1	4	10	5	20	10	25
Russia	22	45	80	75	180	100	200
Slovenia	1	1	1	1	2	1	2
South Africa	2	8	25	30	50	30	55
South Korea (& North Korea)	18	25	50	45	80	70	145
Spain	7	8	20	20	50	25	60
Sweden	9	10	15	10	18	10	18
Switzerland	3	4	6	5	10	5	11
Ukraine	13	20	30	20	40	20	45
United Kingdom	11	20	30	30	80	40	140
United States	99	120	180	150	400	250	1200
SUBTOTAL	367	559	1087	951	2939	1729	9137

WNA 2010

Nations Planning Nuclear	2008	2030 Low	2030 High	2060 Low	2060 High	2100 Low	2100 High
Click Countries for further information	*Capacity in GWe*						
Egypt	0	3	10	6	40	10	90
Gulf Cooperation Council*	0	12	50	30	80	40	175
Indonesia	0	2	6	3	35	5	175
Kazakhstan	0	0	2	3	5	5	20
Nigeria	0	2	15	10	40	20	120
Poland	0	4	10	12	40	20	50
Turkey	0	5	15	10	50	20	160
Vietnam	0	2	4	4	30	6	120
SUBTOTAL	0	30	112	78	300	126	910

**Gulf Cooperation Council members are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates*

WNA 2010

Potential Entrants	2008	2030 Low	2030 High	2060 Low	2060 High	2100 Low	2100 High
Click Countries for further information	*Capacity in GWe*						
Albania	0	0	2	1	4	2	5
Algeria	0	0	5	2	15	5	40
Australia	0	0	10	15	25	20	60
Austria	0	0	3	2	5	4	7
Bangladesh	0	0	10	5	40	20	90
Chile	0	0	5	5	15	10	38
Croatia	0	0	2	2	5	2	5
Denmark	0	0	2	2	4	2	7
Iraq	0	0	2	5	15	6	60
Ireland	0	0	5	2	5	3	10
Israel	0	0	3	2	5	3	20
Italy	0	7	20	10	40	25	70
Jordan	0	3	7	3	8	5	12
Kenya	0	0	2	2	8	4	24
Malaysia and Singapore	0	0	10	5	15	5	30
Morocco	0	0	5	2	15	5	40
New Zealand	0	0	2	2	5	3	8
Norway	0	0	2	2	5	3	10
Philippines	0	1	10	10	60	20	95
Portugal	0	0	5	5	10	5	14
Serbia	0	0	2	5	8	5	14
Syria	0	0	3	2	7	5	25
Thailand	0	2	10	10	40	15	50
Venezuela	0	0	3	4	25	8	60
Other	0	0	8	4	40	20	200
SUBTOTAL	0	13	140	111	429	207	999
WORLD TOTAL	367	602	1339	1140	3688	2062	11046

Source: WNA 2010

WHY INTEREST IN NUCLEAR?

- Forecasts of high fossil fuel prices
- Energy (primarily natural gas) security concerns
- Respond to expected future CO2 emission constraints and other air pollution problems
- Acquire modern technological expertise for peaceful uses of nuclear power
- Acquire capabilities to produce nuclear weapons in the future

ISSUES FOR DEVELOPING COUNTRIES

- Big ticket items. Construction (capital) costs with interest during construction on the order $9 billion (nominal with IDC) for a 1,600 Mw unit, though the costs may be lower in developing countries
- All major pieces of equipment will (at least initially) be imported from a limited number of suppliers
- Regulatory and management expertise to ensure quality, safety and security over the life-cycle from construction through operations
- Alternative sources of electricity (and desalinization) may be less costly, require less capital, less construction and operating expertise, and are more compatible with grid infrastructure and other sector problems
- Nuclear weapons proliferation concerns
- Long term waste management and storage

NUCLEAR POWER PLANTS INFORMATION

Last three years Energy Availability Factor

(Includes only operational reactors from 2006 up to 2008)

Country	2006		2007		2008		2006-2008	
	No. of Reactors	EAF (%)	No. of Reactors	EAF (%)	No. of Reactors	EAF (%)	No. of Reactors	EA (%
ARGENTINA	2	87.6	2	82.7	2	83.7	2	84.
ARMENIA	1	76.1	1	73.8	1	69	1	7
BELGIUM	7	87.7	7	90.5	7	84.6	7	87.
BRAZIL	2	81	2	78.4	2	86.2	2	81.
BULGARIA	4	79.9	2	82.5	2	87.5	4	82.
CANADA	18	84.6	18	80.7	18	80	18	81.
CHINA	9	87.3	11	86.5	11	86.5	11	86.
CZECH REPUBLIC	6	79.4	6	78.3	6	78	6	78.
FINLAND	4	92.8	4	94.7	4	92.5	4	93.
FRANCE	59	81.6	59	78.5	59	77.6	59	79.
GERMANY	17	89.6	17	75.7	17	79.9	17	81.
HUNGARY	4	81.5	4	87.1	4	86.1	4	8
INDIA	16	55	17	51.6	17	43.6	17	49.
JAPAN	55	69.1	55	63.2	55	57	55	63.
KOREA, REPUBLIC OF	20	92.3	20	90.2	20	93.2	20	91.
LITHUANIA, REPUBLIC OF	1	73.5	1	83.8	1	84.5	1	80.
MEXICO	2	93.9	2	89.7	2	83.1	2	8
NETHERLANDS	1	84.6	1	95.1	1	92.6	1	90.
PAKISTAN	2	70.7	2	68.1	2	55.5	2	64.
ROMANIA	1	90.3	2	96	2	90.3	2	91.
RUSSIAN FEDERATION	31	75.1	31	76.9	31	80.6	31	77.
SLOVAK REPUBLIC	6	82.5	5	82.1	5	87.8	6	8
SLOVENIA	1	89.9	1	90.9	1	98.6	1	93.
SOUTH AFRICA	2	65.6	2	80.4	2	81.3	2	75.
SPAIN	9	87.7	8	81.1	8	86.4	9	85.
SWEDEN	10	82.7	10	80.9	10	77.8	10	80.
SWITZERLAND	5	92.8	5	93.5	5	92	5	92.
UKRAINE	15	77.8	15	77.3	15	77.1	15	77.
UNITED KINGDOM	23	67.1	19	63.3	19	54.3	23	61.
UNITED STATES OF AMERICA	103	91	104	92.1	104	91.1	104	91.
World Wide	**442**	**82.9**	**439**	**80.9**	**439**	**80**	**447**	**81.**

Source: IAEA 2-10

Abu Dhabi Deal with Korean Consortium as a Model

- December 2009 Abu Dhabi announces contract to purchase 4 nuclear units (5,600 Mw) from a Korean consortium to be completed by 2020
- $20 billion for construction (rumored that competing bids 25% to 50% higher with less favorable allocation of risks of cost increases)
- $20 billion 60-year operating contract with KEPCO
- Beat out GE-Japanese consortium and AREVA
- First export sale of nuclear plants by Korea

Abu Dhabi Nuclear Fuel Supply and Regulation

- Forgoes enrichment of uranium
- Plans to source fuel, enrichment and fabrication externally under long term contracts or leases
- Will seek third party storage of nuclear waste
- Reaffirmed NPT commitments in 2009
- Established Federal Authority of Nuclear Regulation and has begun to hire experts from other countries to lead it

Rationale

- Domestic gas supplies will run out over the next couple of decades
- Imports from Qatar already are used to produce 60% of electricity
- Imports will be costly and raise energy security concerns
- Prepare infrastructure for a large future commitment to nuclear power for electricity generation
- Better than solar and wind as a carbon free source of electricity

Other Countries Close

- Turkey (Korean Consortium)
- Vietnam (Russia)
- A new generation of smaller reactors may be better suited to developing countries
- But they are far from being a reality
- There has been big talk about a nuclear “renaissance,” but so far the real action has been limited to a few countries