The Abdus Salam International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

IAEA International Atomic Energy Agency

2473-8

Joint ICTP-IAEA School on Nuclear Energy Management

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Lecture Notes

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International Atomic Energy Agency

Introduction to Power Reactor Information System (PRIS)

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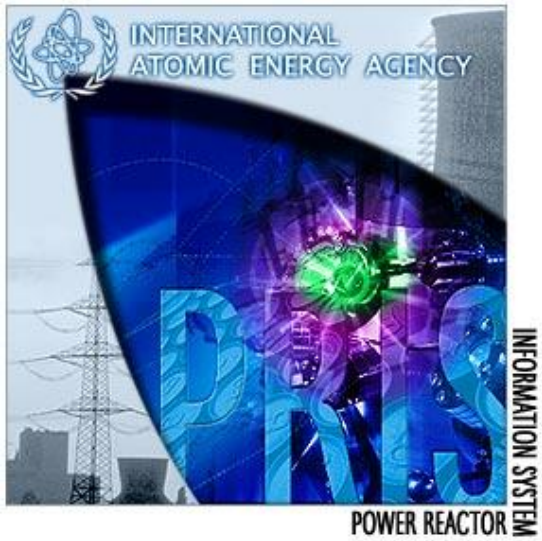
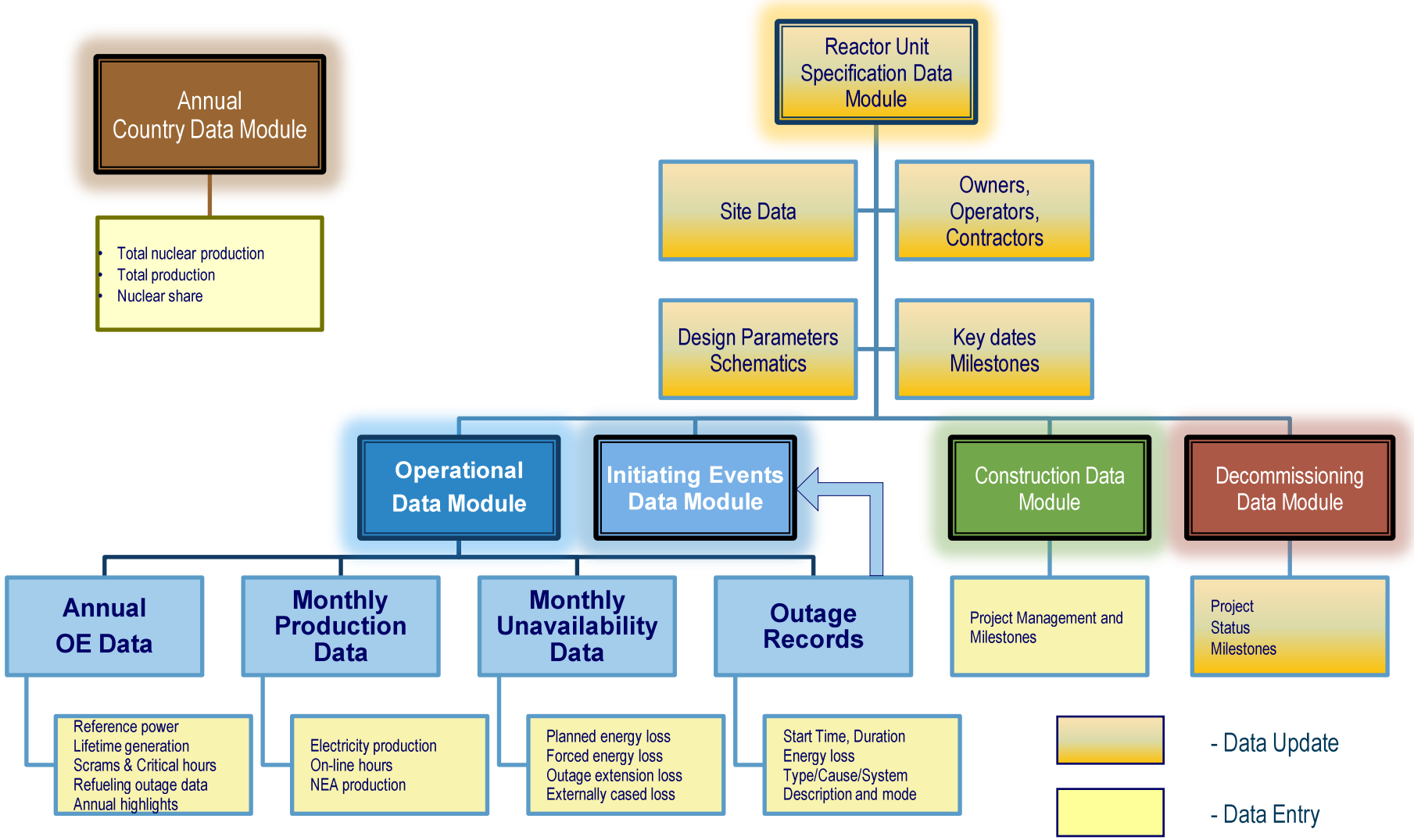
Presented: Bismark Tyobeka
NPTDS, Division of Nuclear Power

What is PRIS?

- The most complete databank on nuclear power reactors in the Word
- Reference data source used worldwide
- 40 years experience in data collection on nuclear power status and performance
- Publications and analyses
- Comprehensive reporting system
- Modern on-line communication
- Team of collaborators



PRIS Data Modules

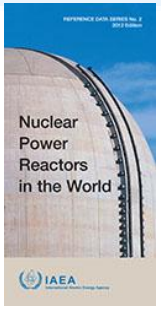


What PRIS provides?

- Monitoring of reactor status and its changes
- Historical development of nuclear power
- NPP specification and design characteristics
- NPP performance analyses using well defined and internationally accepted indicators
- Trend analyses
- Industrial standards – average, median, quartiles
- Process of reactor decommissioning

PRIS Outputs

Publications



NPR in the World

since 1981

~2000 pageviews/month

Operating Experience with NPP

since 1970

(now on CD)

~1000 pageviews/month

WEB Applications

WEDAS

Data Entry

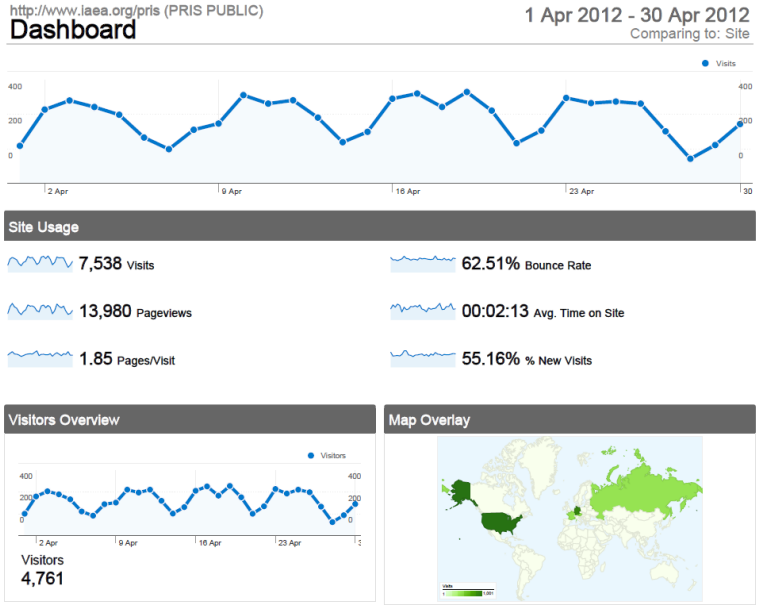
prisweb.iaea.org

PRIS

Public website

http://pris.iaea.org/pris

~ 5000 visits /month



PRISTA

Statistical Reports

prisweb.iaea.org/statistics

~ 1000 visits /month

International Atomic Energy Agency

Status on Nuclear Power illustrated by PRIS outputs

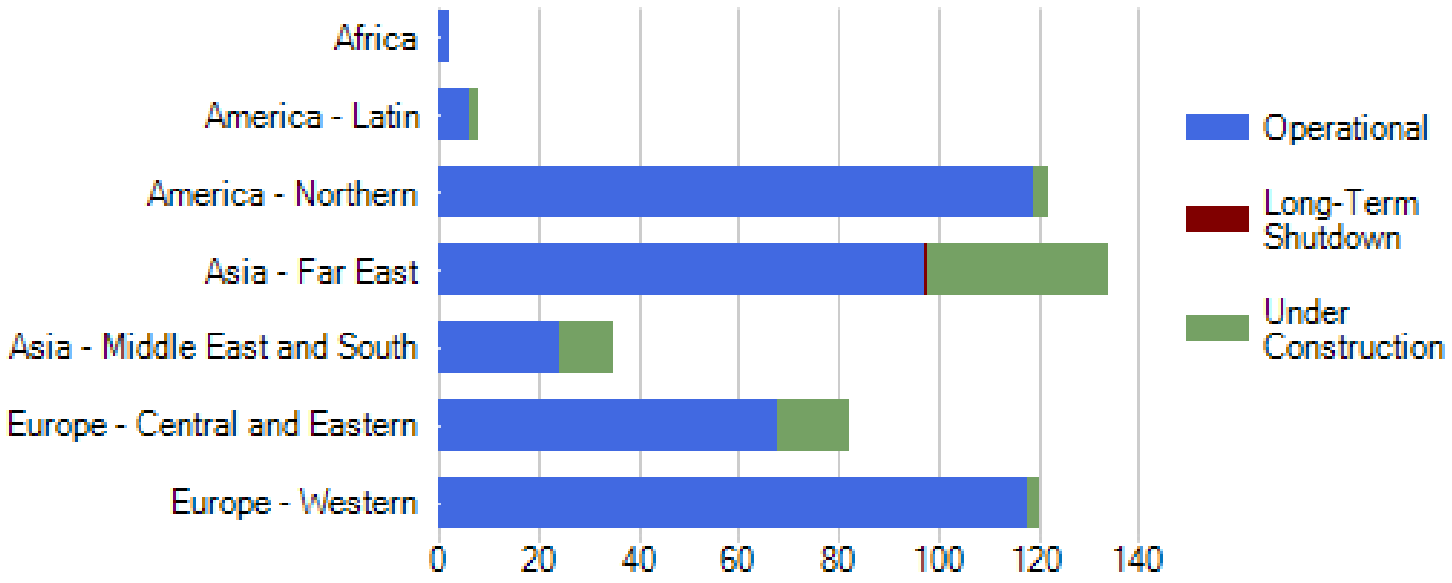
Nuclear Power

- Nuclear energy since 1954
- Fast development in 1970s to 1980s
- An important part of a global energy mix – 11.3%
- 15 000 reactor-years of operating experience
- World energy demand is expected to more than double by 2050, and expansion of nuclear energy is a key to meeting this demand while reducing pollution and greenhouse gases
- A number of countries are expressing interest in introducing nuclear power
- In 2013, nuclear energy continued to play an important role in global electricity production despite the accident at the Fukushima Daiichi nuclear power plant.

Reference: IAEA-PRIS

Current status

- 434 reactors in operation (371 GW_e)
- 1 reactors in long-term shutdown (0.2 GW_e)
- 68 reactors under construction (66 GW_e)



Reference: IAEA-PRIS

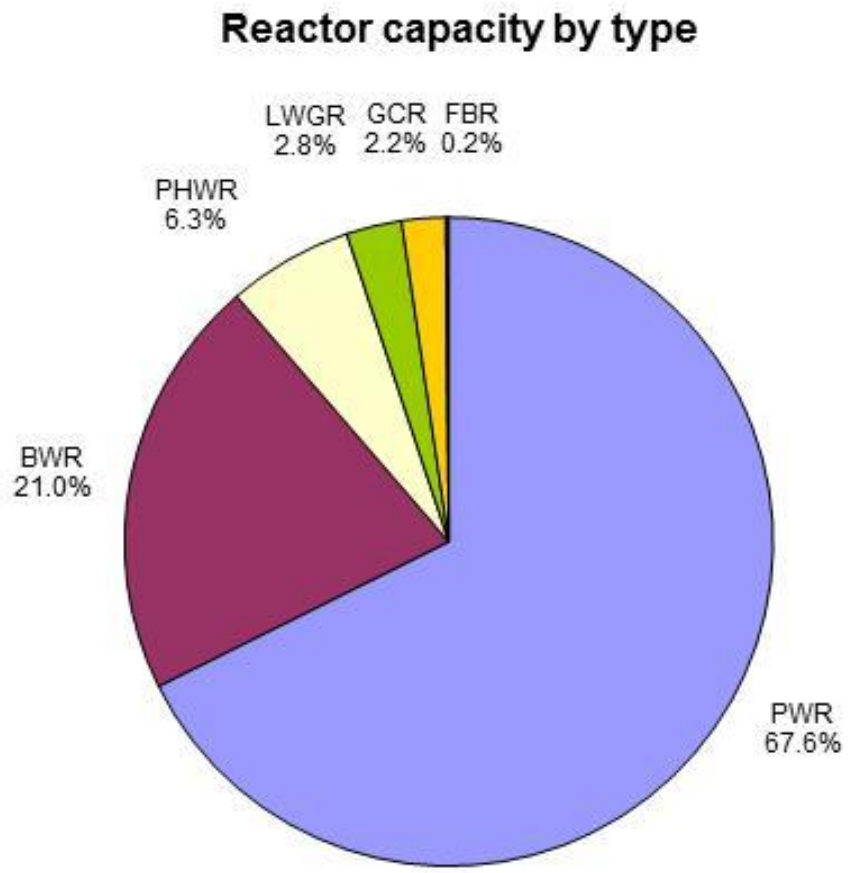
Nuclear Reactors in the World

Reference: IAEA-PRIS

International Atomic Energy Agency

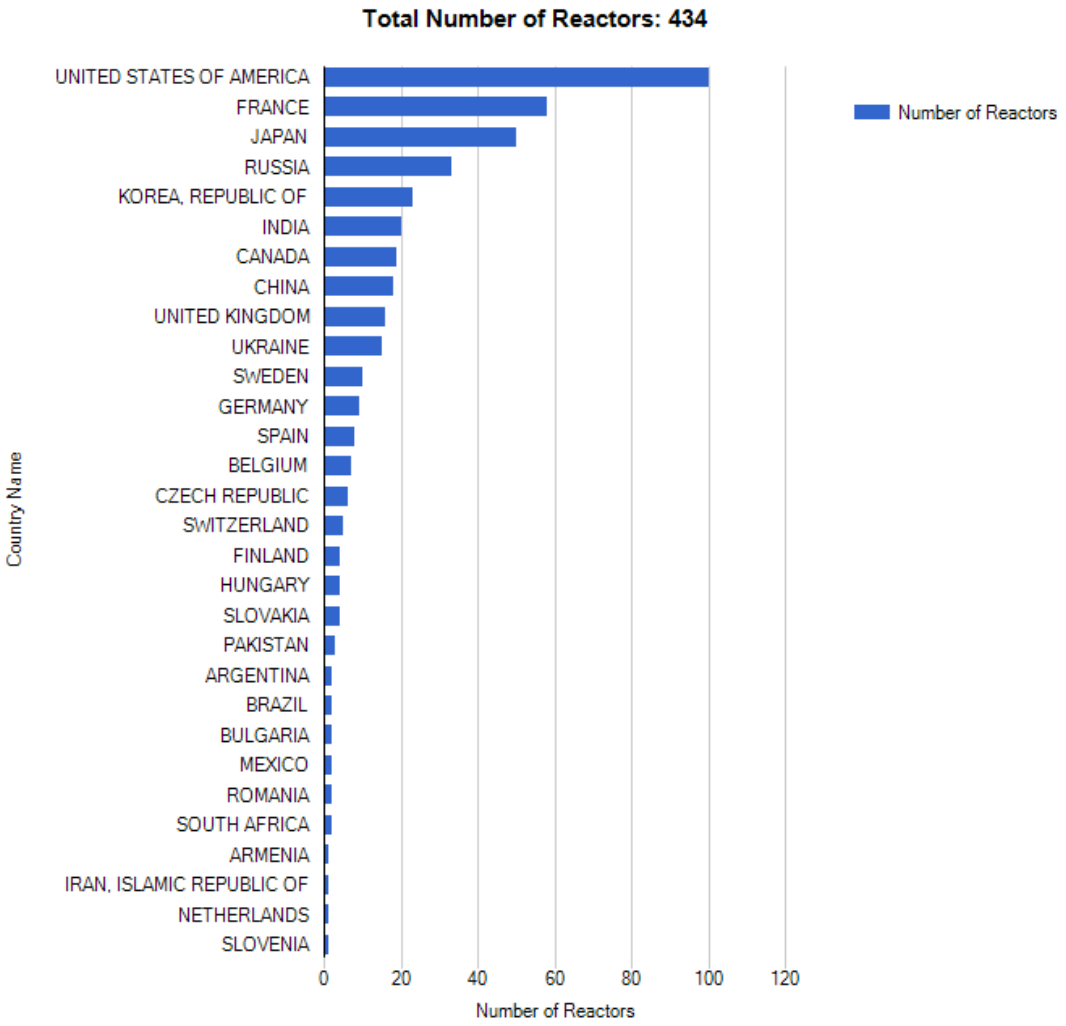
Reactor types

- BWR: Boiling light water cooled and moderated reactor
- FBR: Fast breeder reactor
- GCR: Gas cooled graphite moderated reactor
- LWGR: Light water cooled graphite moderated reactor
- PHWR: Pressurized heavy water moderated and cooled reactor
- PWR: Pressurized light water moderated and cooled reactor



Reference: IAEA-PRIS

Nuclear reactors by country



Reference: IAEA-PRIS

2012 status changes

3 new connections to the grid (7 in 2011):

- SHIN-WOLSONG-1 (997 MW(e), PWR, KOREA REP.) on 27 January
- SHIN-KORI-2 (960 MW(e), PWR, KOREA REP.) on 28 January
- NINGDE 1 (1000 MW(e), PWR, CHINA) on 28 December

2 restarts after long-term shutdown

- BRUCE-1 (772 MW(e), PHWR, CANADA) on 19 September
- BRUCE-2 (772 MW(e), PHWR, CANADA) on 16 October

3 final shutdowns (13 in 2011):

- OLDBURY-A1 (217 MW(e), GCR, UK) on 29 February
- WYLFA 2 (490 MW(e), GCR, UK) on 25 April
- GENTILLY-2 (635 MW(e), PHWR, CANADA) on 28 December

7 construction initiations (4 in 2011):

- BALTIC-1 (1082 MW(e), PWR, RUSSIA) on 22 February
- SHIN-HANUL-1 (1340 MW(e), PWR, KOREA REP.) on 10 July
- BARAKAH 1 (1345 MW(e), PWR, UAE) on 18 July
- FUQING 4 (1000 MW(e), PWR, CHINA) on 17 November
- YANGJIANG 4 (1000 MW(e), PWR, CHINA) on 17 November
- SHIDAO BAY 1 (200 MW(e), HTGR, CHINA) on 9 December
- TIANWAN 3 (933 MW(e), PWR, CHINA) on 27 December

3 cancelled construction

- BELENE-1 (953 MW(e), PWR, BULGARIA) on 28 March
- BELENE-2 (953 MW(e), PWR, BULGARIA) on 28 March
- KURSK-5 (915 MW(e), LWGR, RUSSIA) on 15 August

Reference: IAEA-PRIS

2013 status changes

1 new connections to the grid:

- HONGYANHE 1 (1000 MW(e), PWR, CHINA) on 18 February

4 final shutdowns:

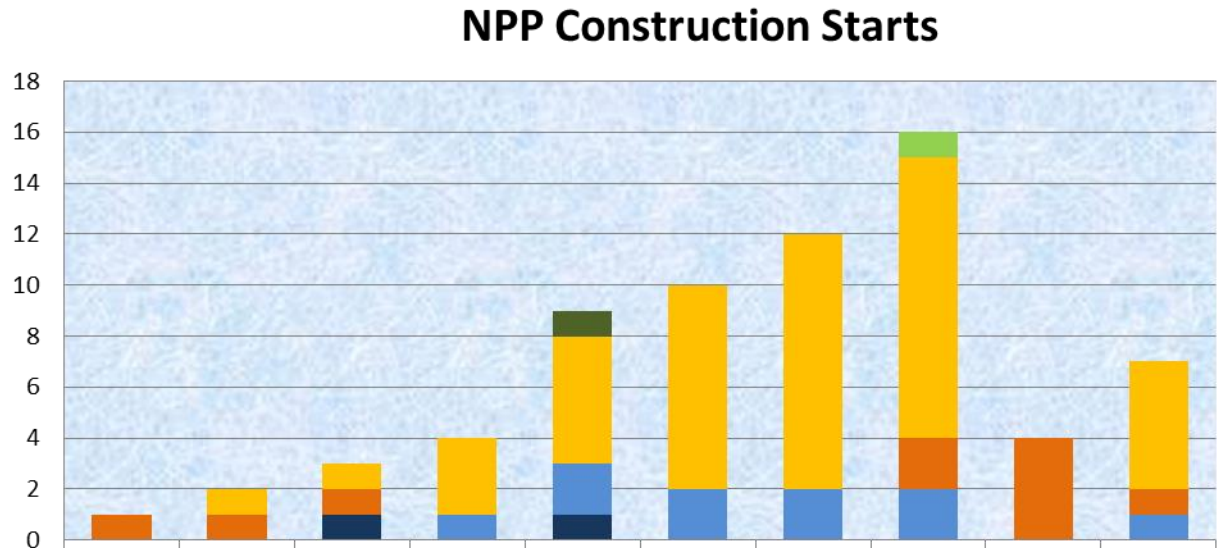
- CRYSTAL RIVER-3 (860 MW(e), PWR, USA) on 5 February
- KEWAUNEE (566 MW(e), PWR, USA) on 7 May
- SAN ONOFRE-2 (1070 MW(e), PWR, USA) on 7 June
- SAN ONOFRE-3 (1080 MW(e), PWR, USA) on 7 June

3 construction start :

- VIRGIL C. SUMMER-2 (1117 MW(e), PWR, USA) on 9 March
- VOGTLE-3 (1117 MW(e), PWR, USA) on 12 March
- BARAKAH 2 (1345 MW(e), PWR, UAE) on 28 May

Reference: IAEA-PRIS

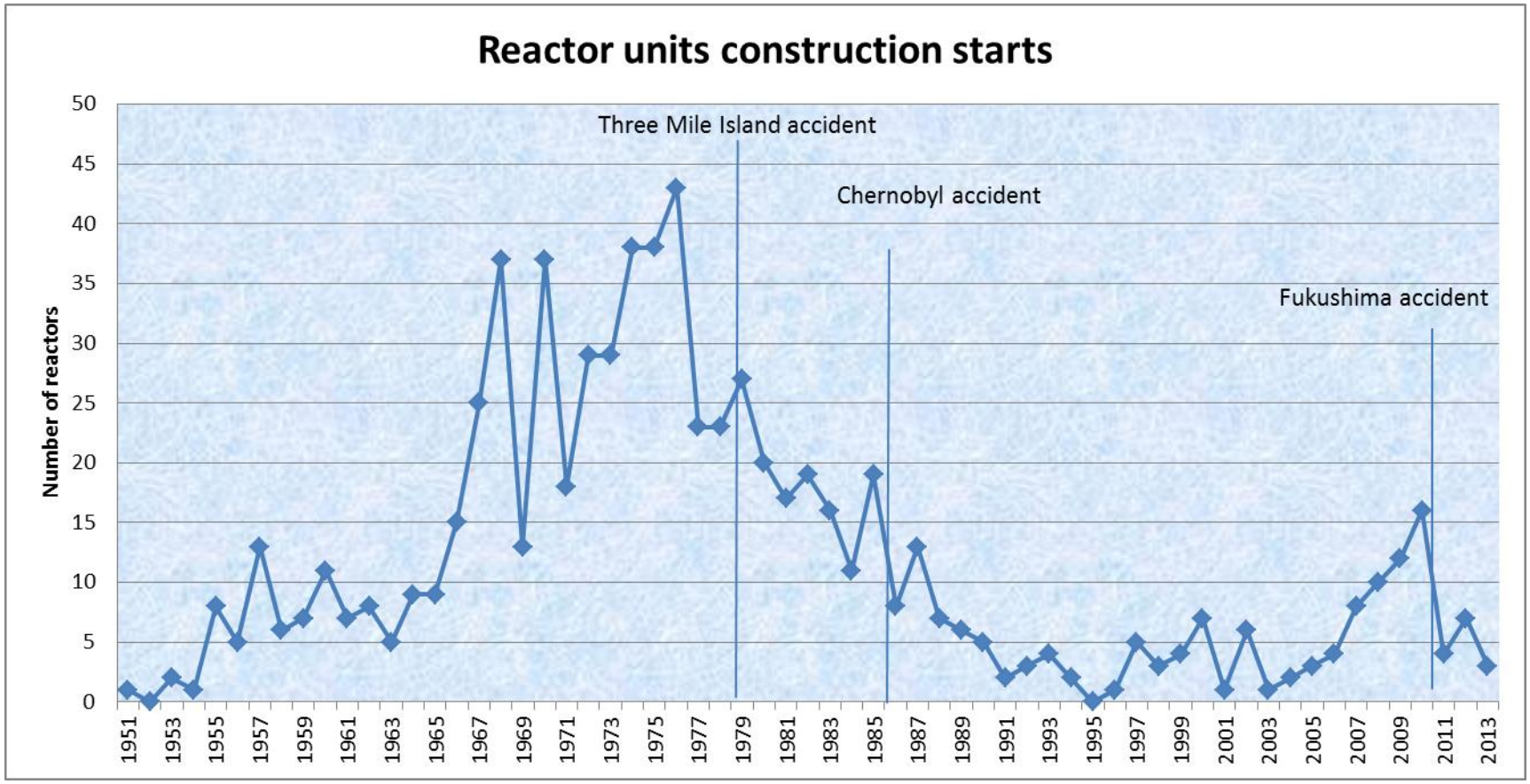
Trend in construction starts



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
America - Latin								1		
America - Northern					1					
Asia - Far East		1	1	3	5	8	10	11		5
Asia - Middle East and South	1	1	1					2	4	1
Europe - Central and Eastern				1	2	2	2	2		1
Europe - Western			1		1					

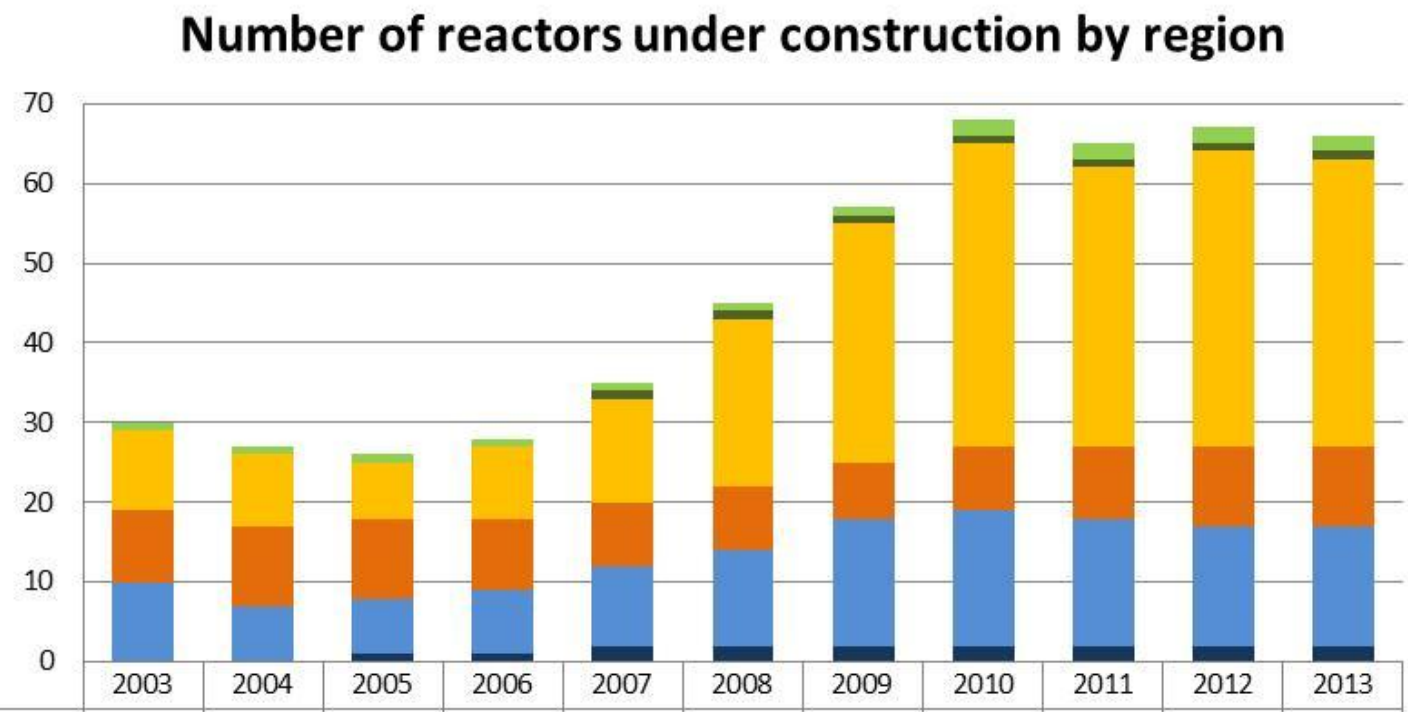
Reference: IAEA-PRIS

Impact of accidents on construction starts



Reference: IAEA-PRIS

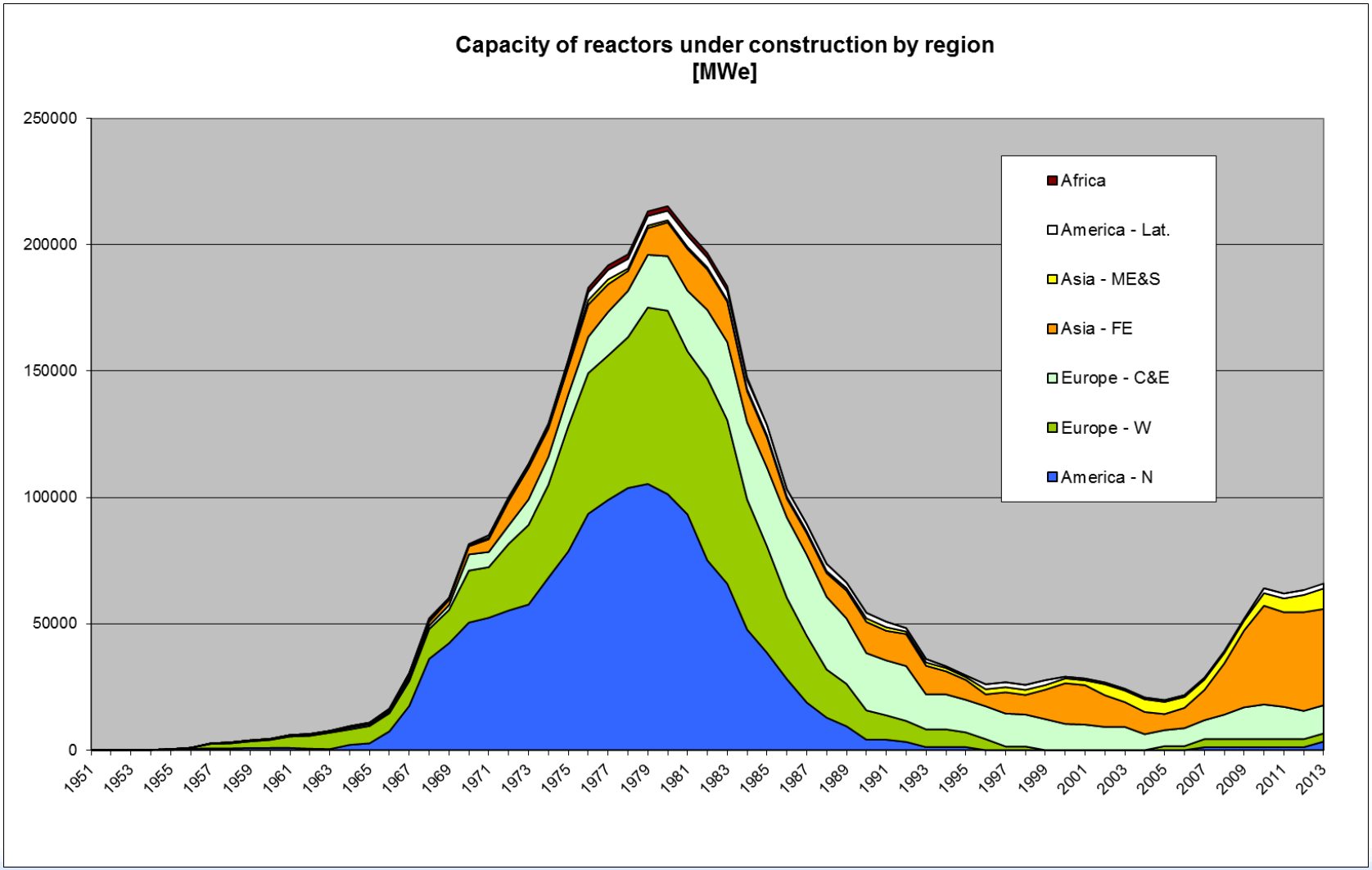
History of NPP construction



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
America - Latin	1	1	1	1	1	1	1	2	2	2	2
America - Northern	0	0	0	0	1	1	1	1	1	1	1
Asia - Far East	10	9	7	9	13	21	30	38	35	37	36
Asia - Middle East and South	9	10	10	9	8	8	7	8	9	10	10
Europe - Central and Eastern	10	7	7	8	10	12	16	17	16	15	15
Europe - Western	0	0	1	1	2	2	2	2	2	2	2

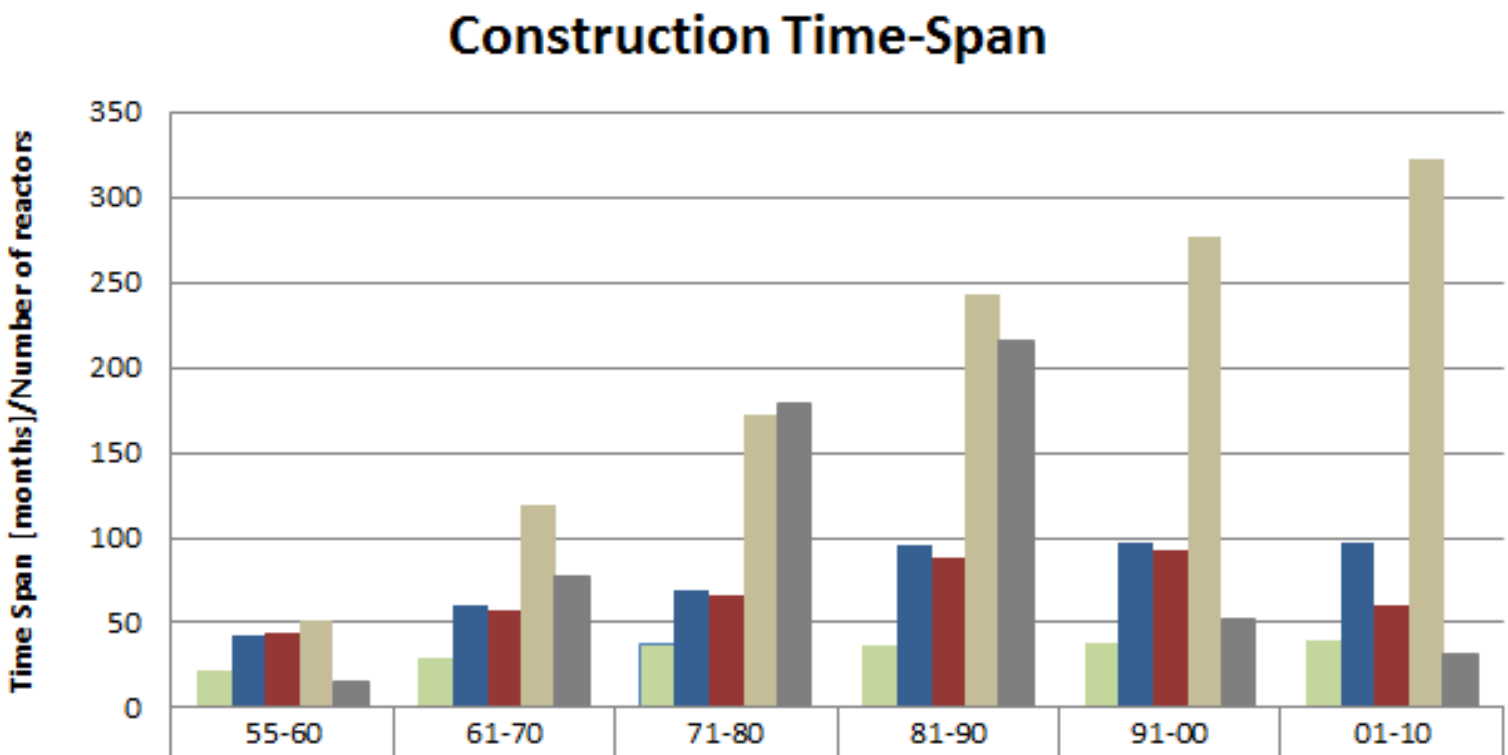
Reference: IAEA-PRIS

Full history of NPP construction



Reference: IAEA-PRIS

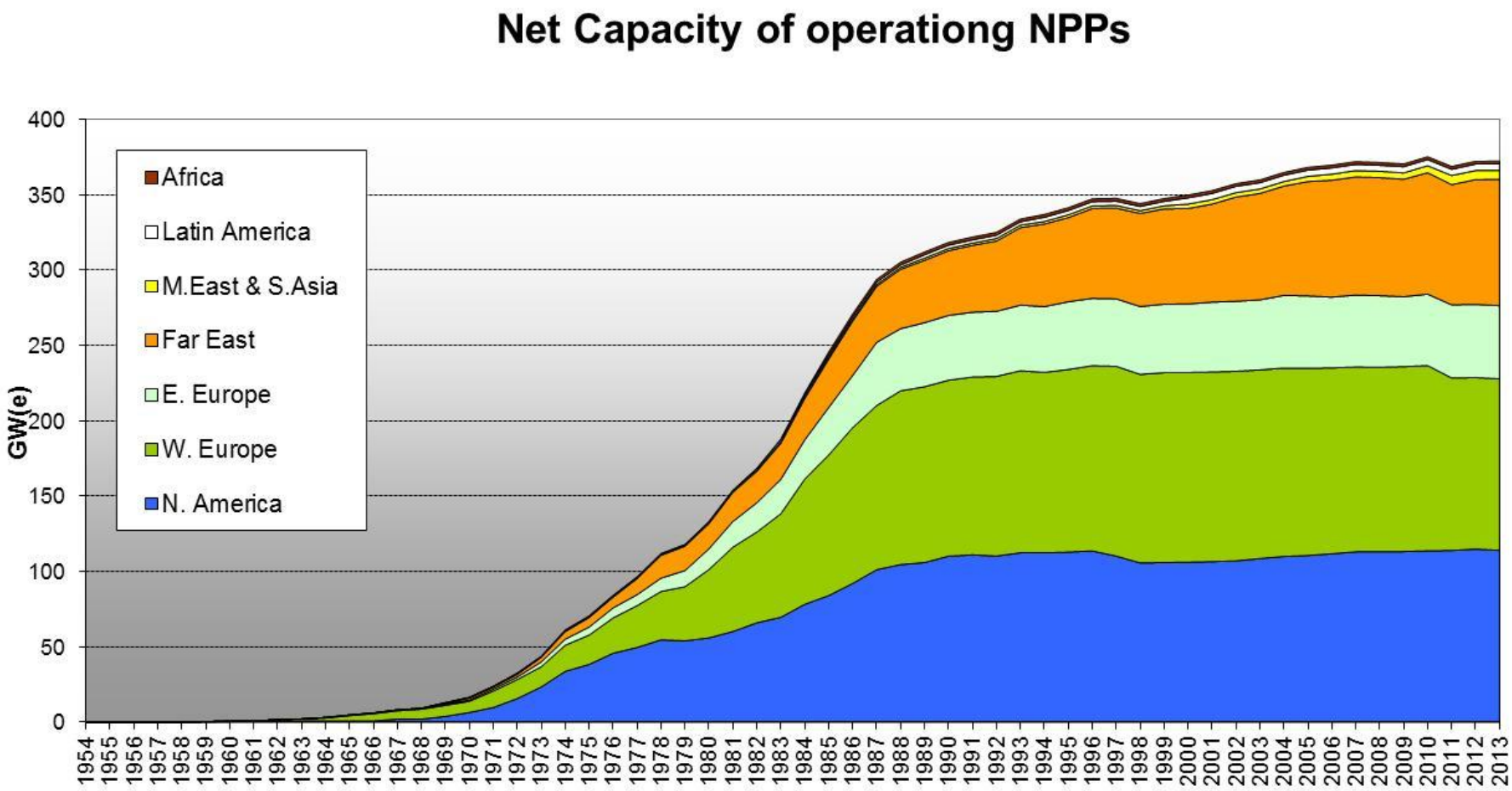
Construction duration statistics



	55-60	61-70	71-80	81-90	91-00	01-10
Min	22	29	38	37	39	40
Average	42	60	70	96	98	97
Median	44	58	66	89	93	60
Max	51	120	172	242	276	322
Number	15	77	179	216	52	32

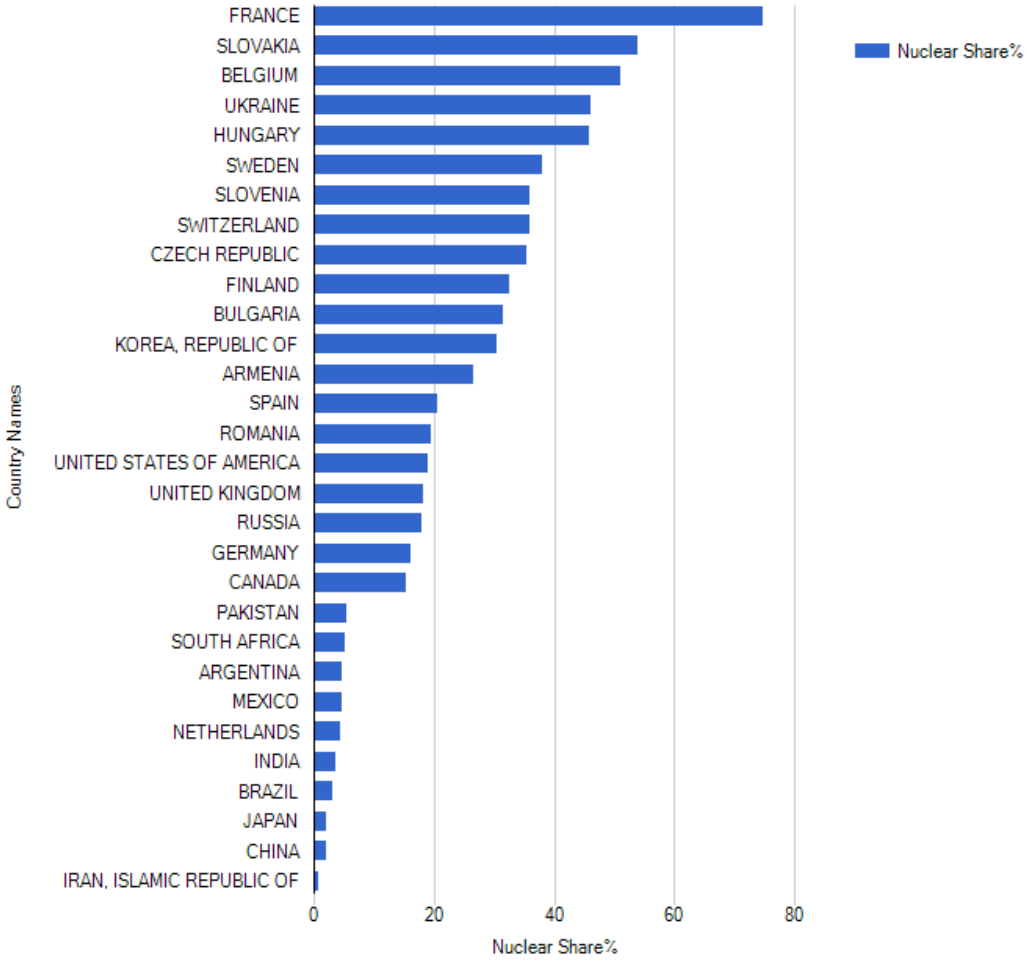
Reference: IAEA-PRIS

Net Capacity by region

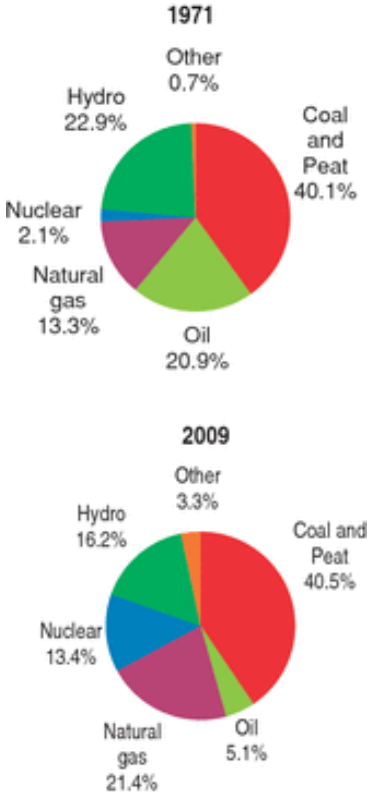


Reference: IAEA-PRIS

Nuclear share in 2012



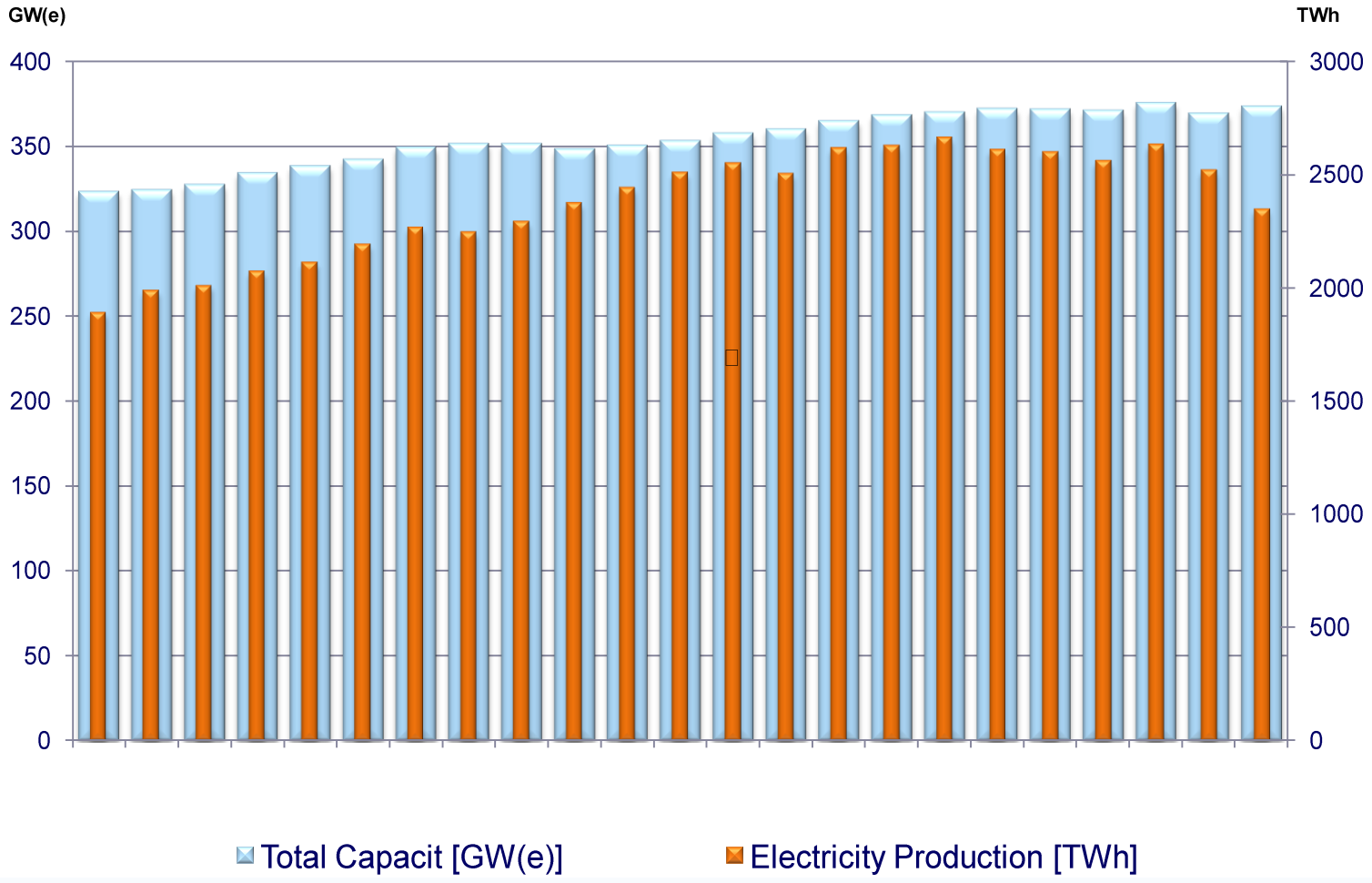
World electricity generation by source of energy



Source: OECD Factbook 2011-2012

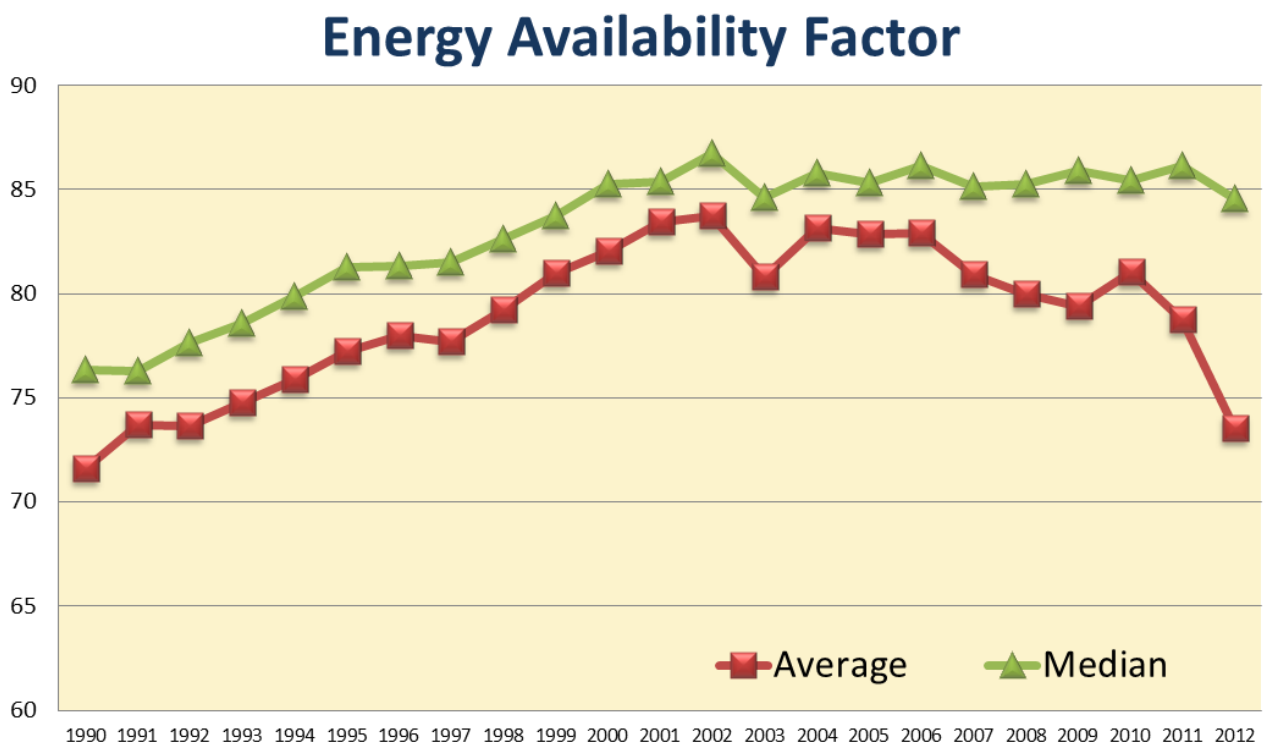
Reference: IAEA-PRIS

Trend in electricity production



Reference: IAEA-PRIS

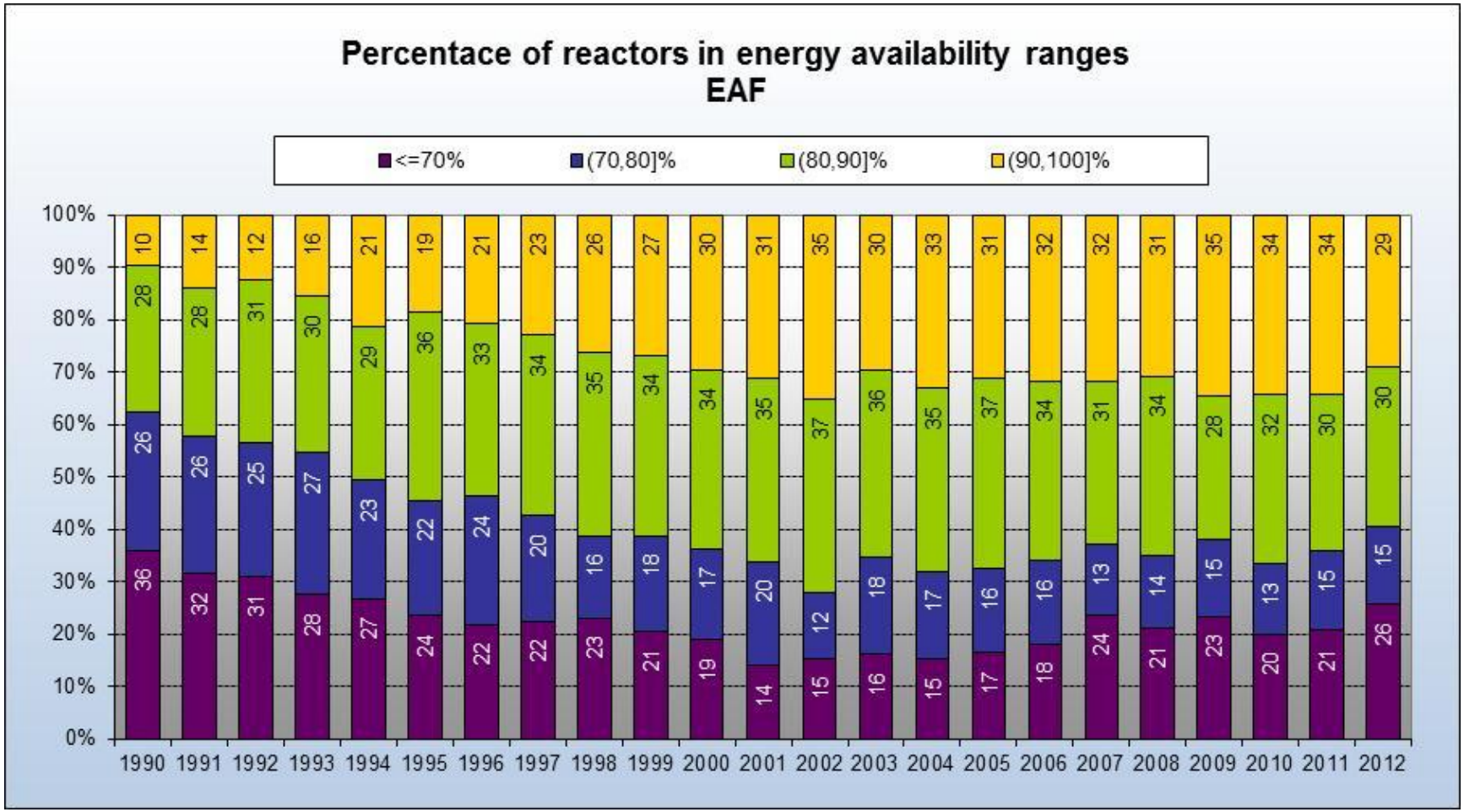
Installed Capacity Utilization



- Continuous increasing trend during 1990s has reversed in last years
- In 2012 the Energy Availability Factor (EAF) dropped to 73.5% on average.
- Half of nuclear reactors operated with EAF above 84%.

Reference: IAEA-PRIS

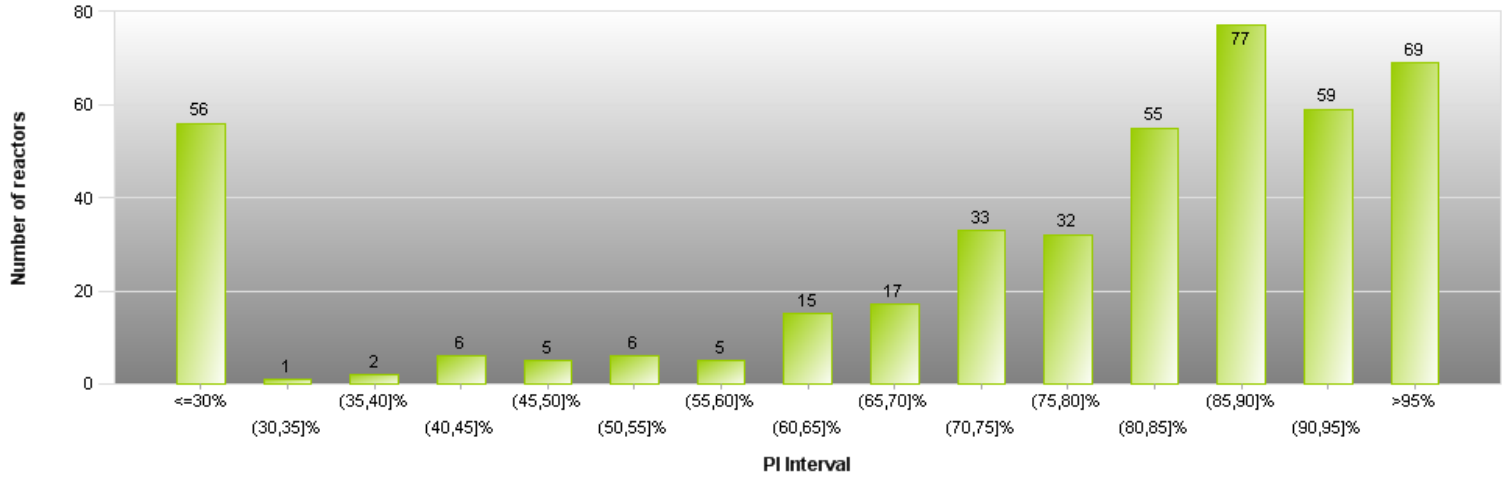
EAF in intervals



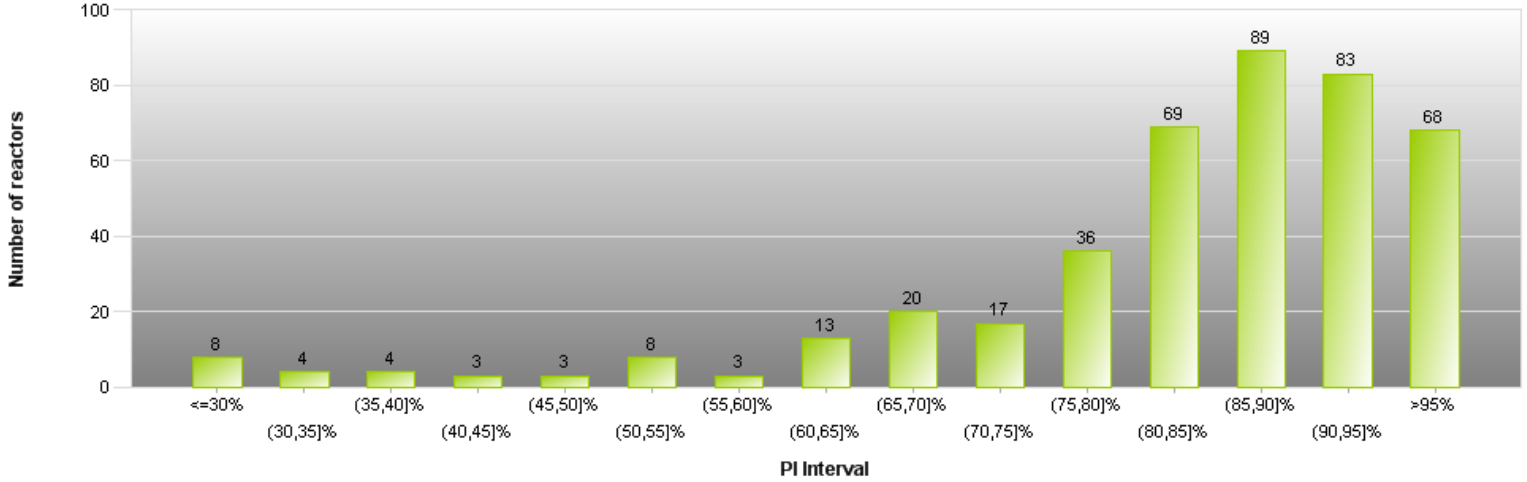
Reference: IAEA-PRIS

EAF histograms

2012

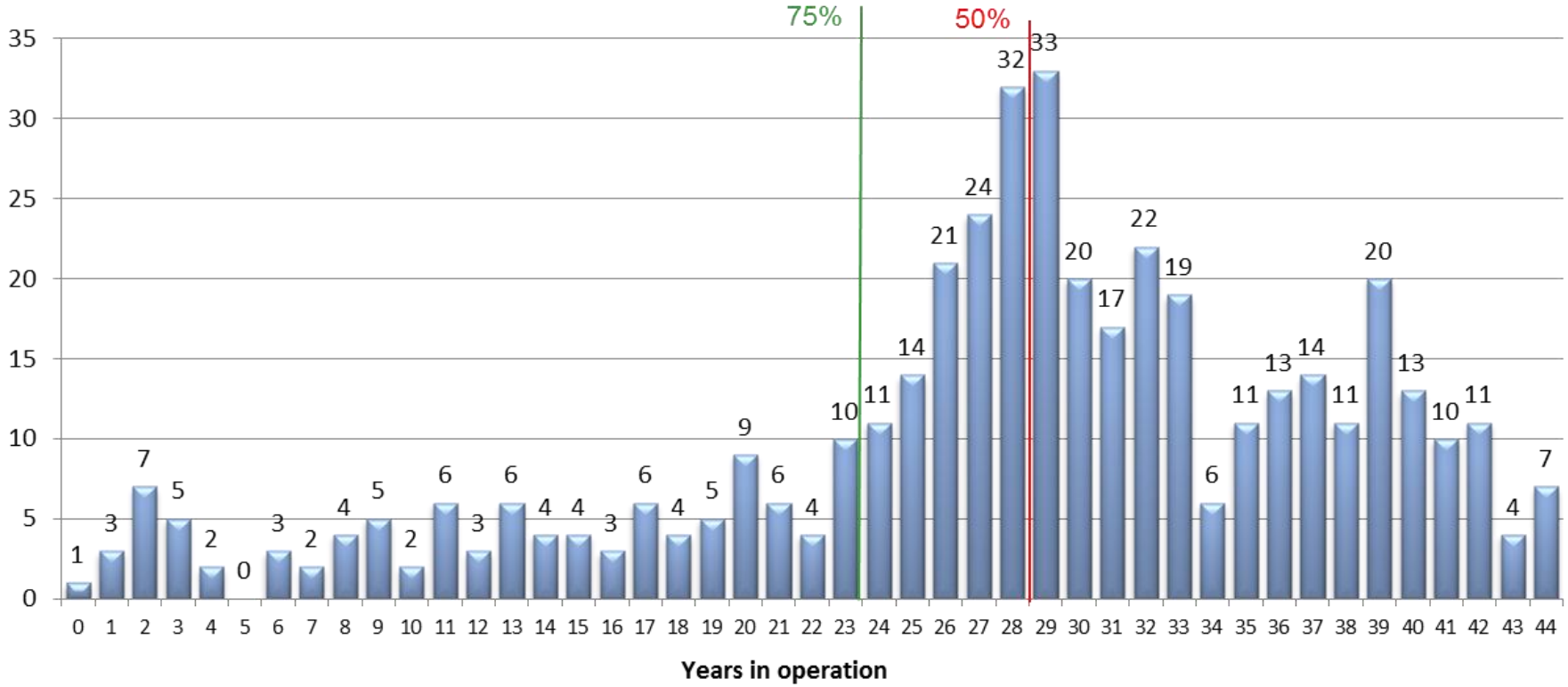


2002



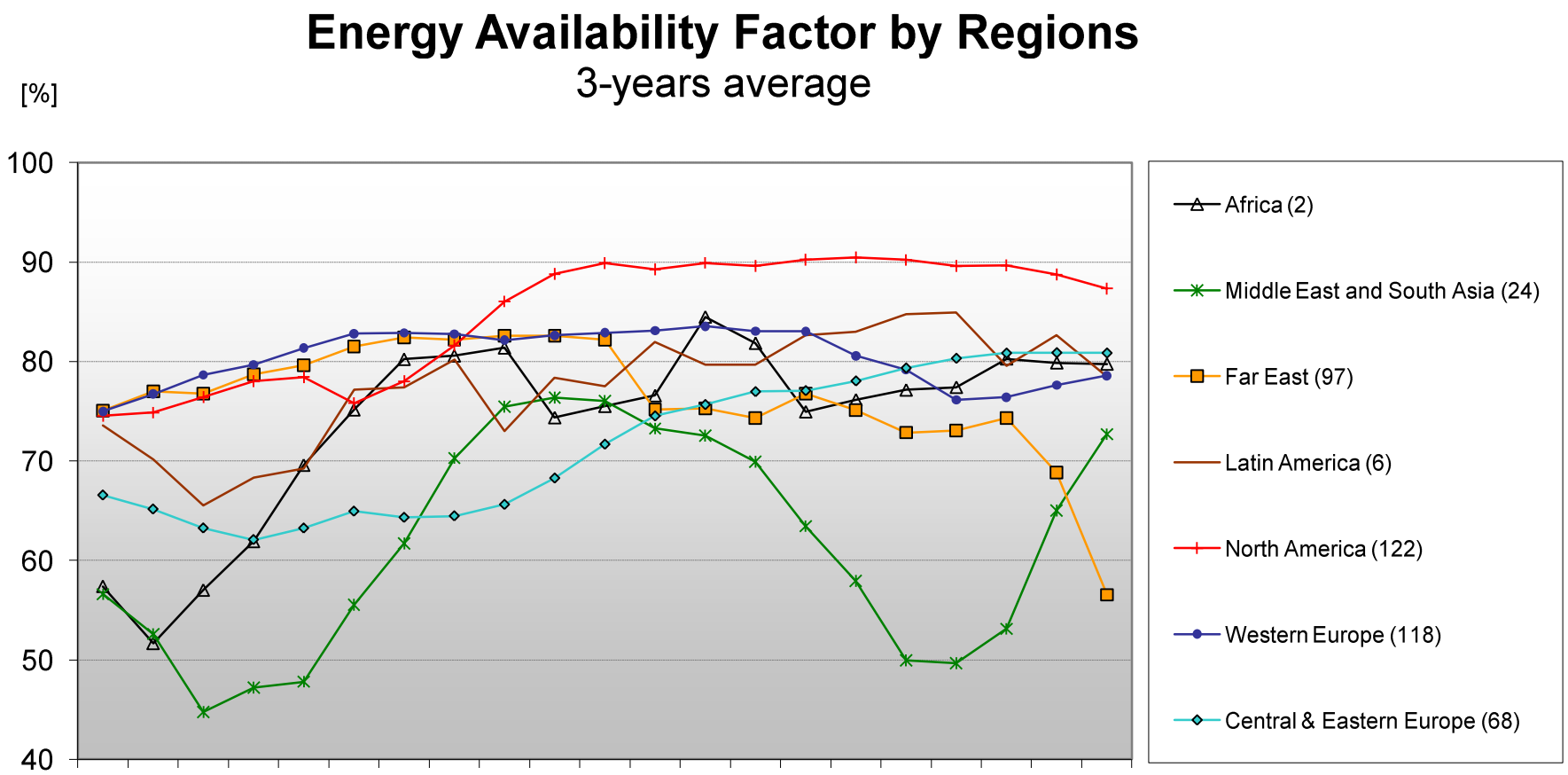
Reference: IAEA-PRIS

Age of operating reactors



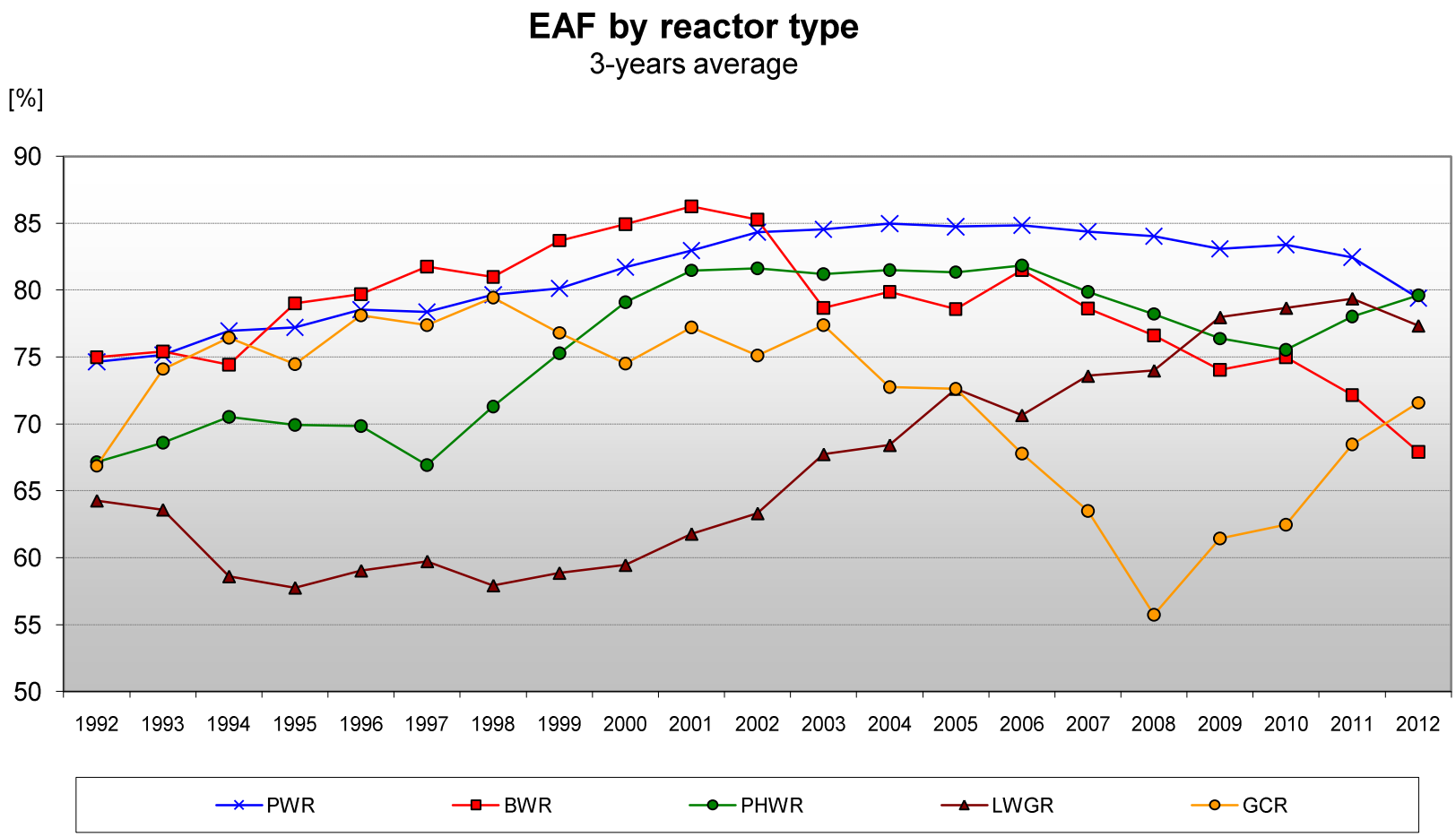
Reference: IAEA-PRIS

Regional trends



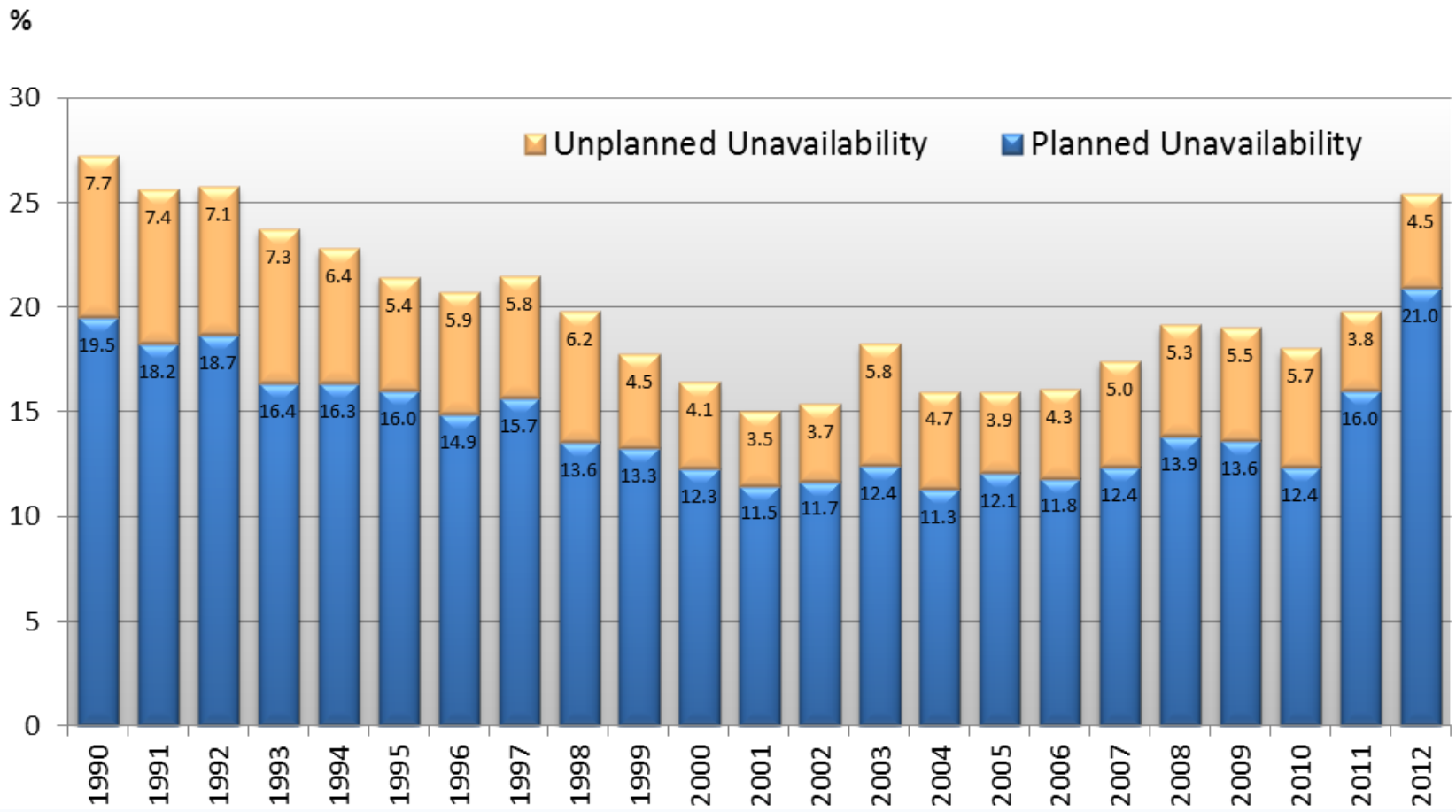
Reference: IAEA-PRIS

Performance by technology



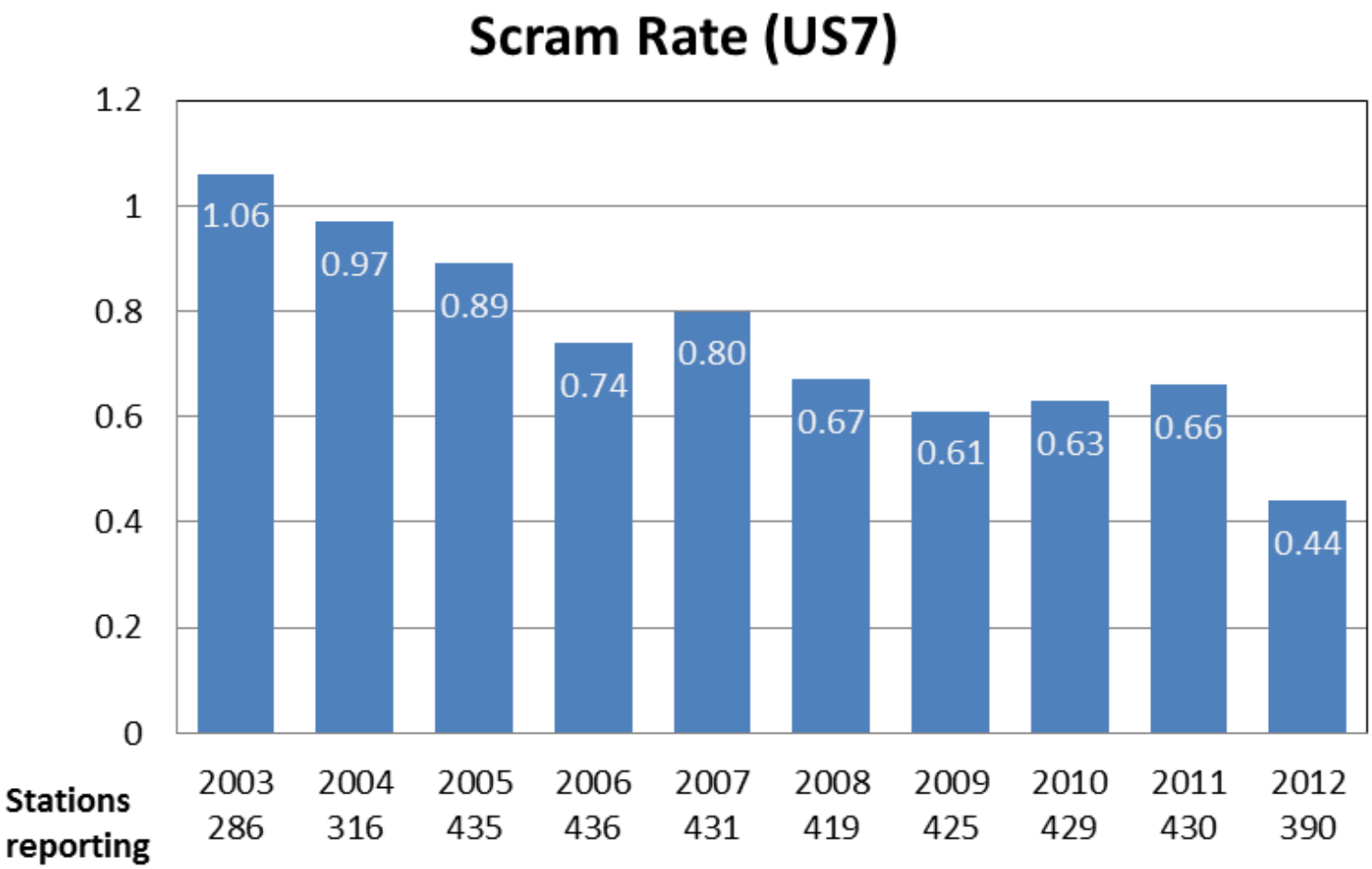
Reference: IAEA-PRIS

Energy Unavailability



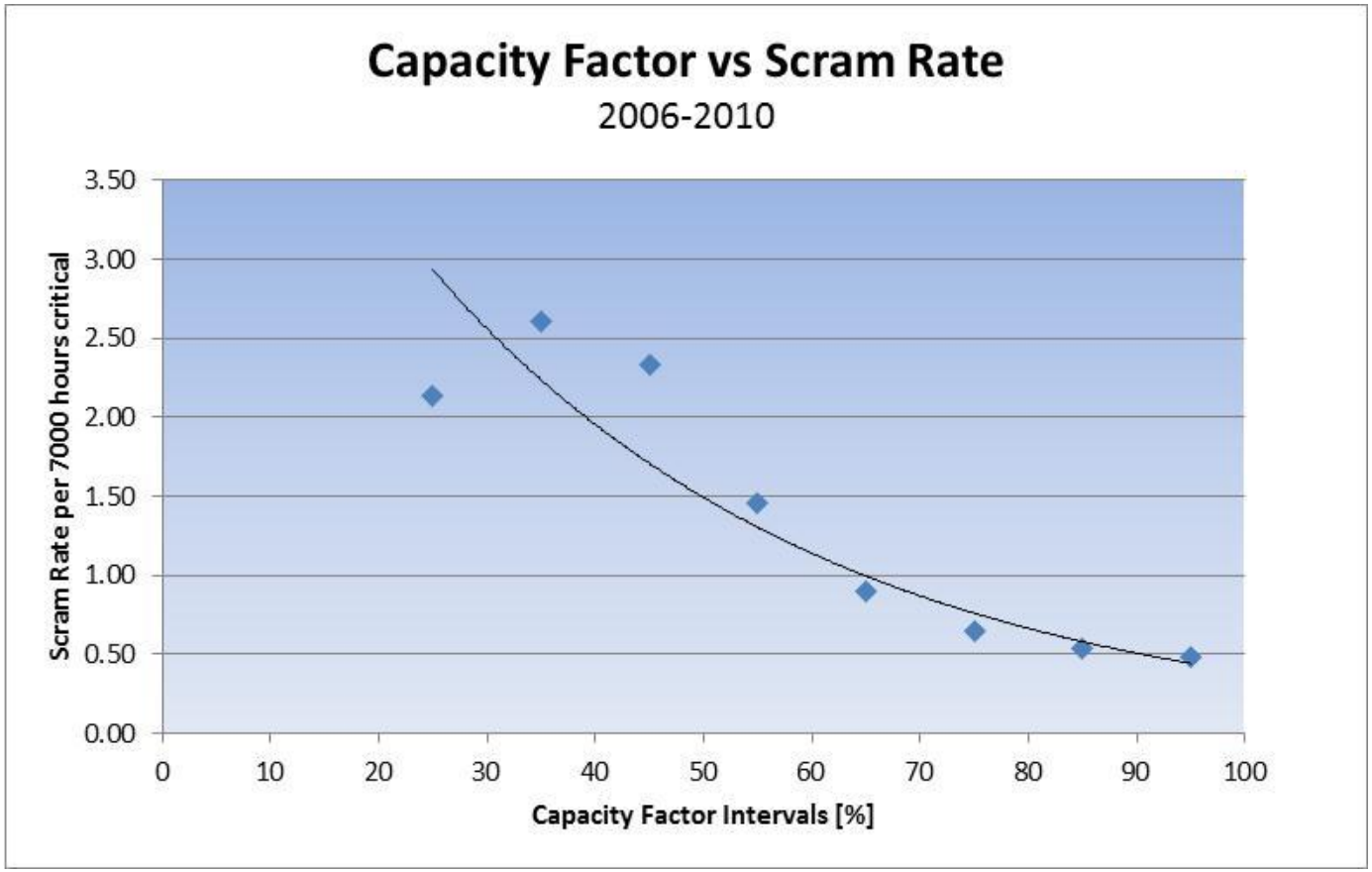
Reference: IAEA-PRIS

Scram statistics



Reference: IAEA-PRIS

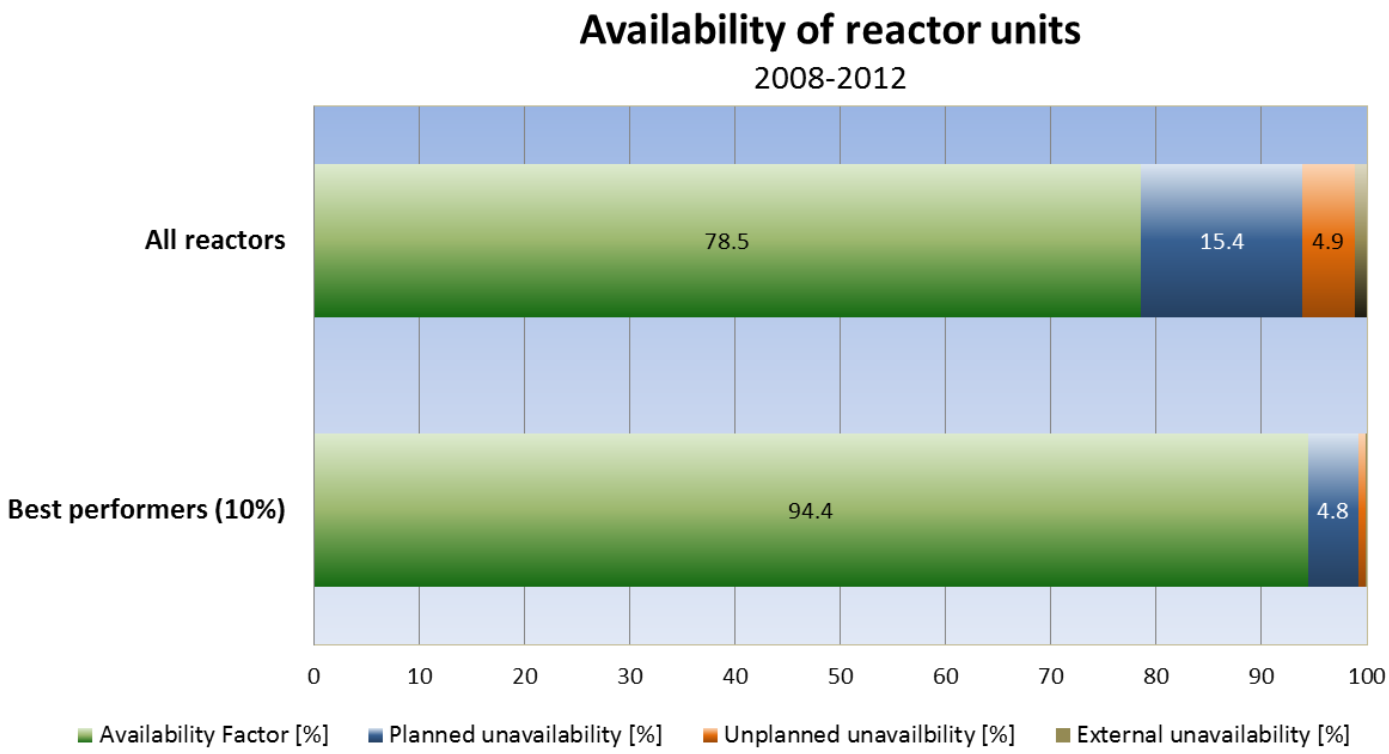
Operational and Safety Performance



Better operating performance improves competitiveness and safety performance

Reference: IAEA-PRIS

Benchmarking



- Who are world-class performance leaders?
- Identification of gaps in performance
- Learning by sharing information and experience

Reference: IAEA-PRIS

Summary of NE Trends

- Extensive development in 1970s and 1980s was changed to intensive development in 1990s
- Performance in last 10 years influenced by refurbishments related to lifetime management and license renewal and by particular cases
- Nuclear energy production growth:
  - Capacity increase
    - New units – large capacity, shutdown units – small capacity
    - Existing capacity modification (uprating, derating)
  - Availability increase
    - Planned outage optimization
    - Minimization of forced energy losses
- Maintenance optimization is a key for improvement
- Regional factors – public acceptance, competitiveness
- Significant impact of Fukushima I accident

How to get information?

- Annual publications:
  - Nuclear Power Reactors in the World
  - Operating Experience with NPP
  - Country Nuclear Power Profiles
- Public website

  www.iaea.org/pris
- Web-based on-line system “PRIS-Statistics” for registered users

  prisweb.iaea.org/statistics