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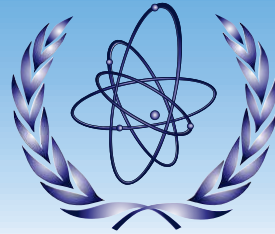
Joint ICTP-IAEA School of Nuclear Energy Management

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Current Status of Active Nuclear Power Programmes in Member States

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International Atomic Energy Agency

Current Status of Active Nuclear Power Programmes in Member States

**Jiri Mandula,
IAEA, Division of Nuclear Power**

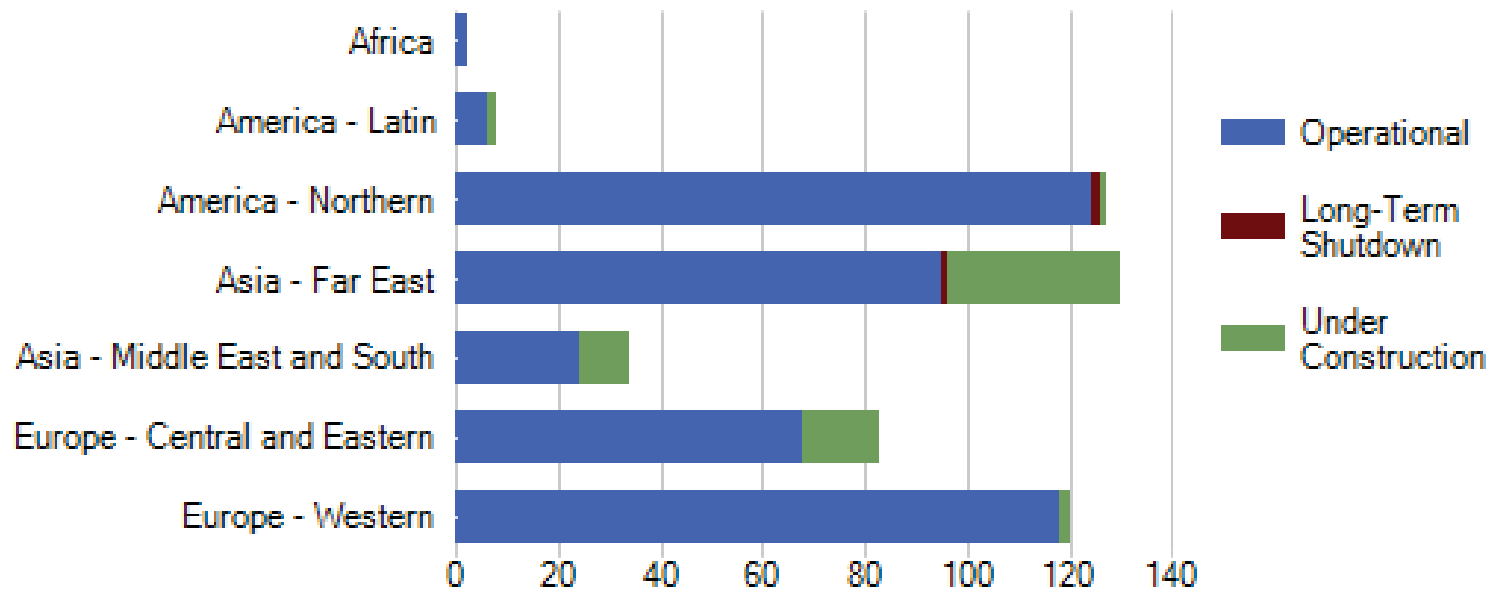
Nuclear Power

- ❑ Nuclear energy since 1954
- ❑ Fast development in 1970s to 1980s
- ❑ An important part of a global energy mix – 13%
- ❑ 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 2012, nuclear energy continued to play an important role in global electricity production despite the accident at the Fukushima Daiichi nuclear power plant.



Current status

- ❑ 437 reactors in operation (372 GWe)
- ❑ 3 reactors in long-term shutdown (1.3 GWe)
- ❑ 64 reactors under construction (62 GWe)



Sites with operational reactors

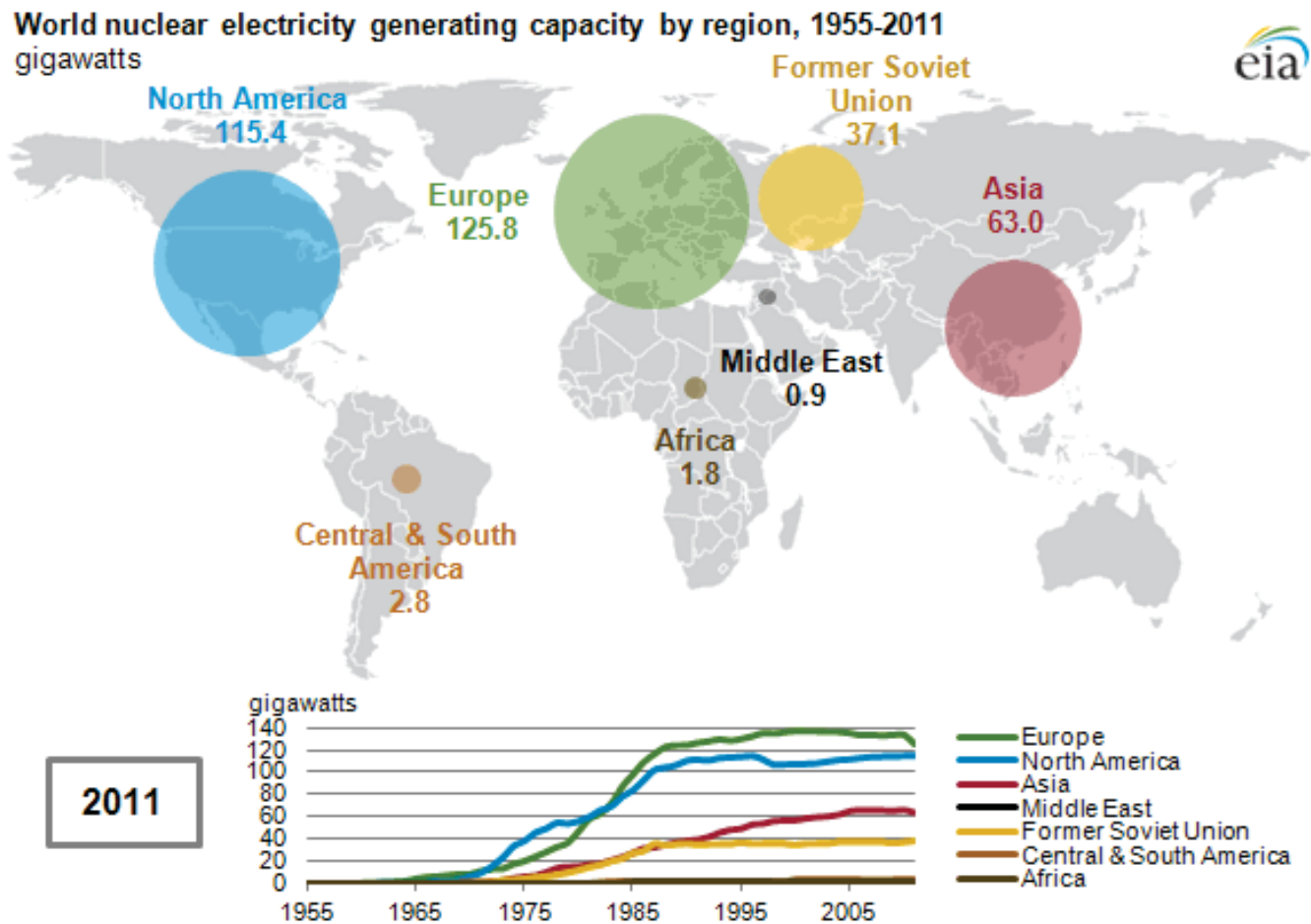


Reference: IAEA-PRIS

International Atomic Energy Agency



Nuclear capacity by regions

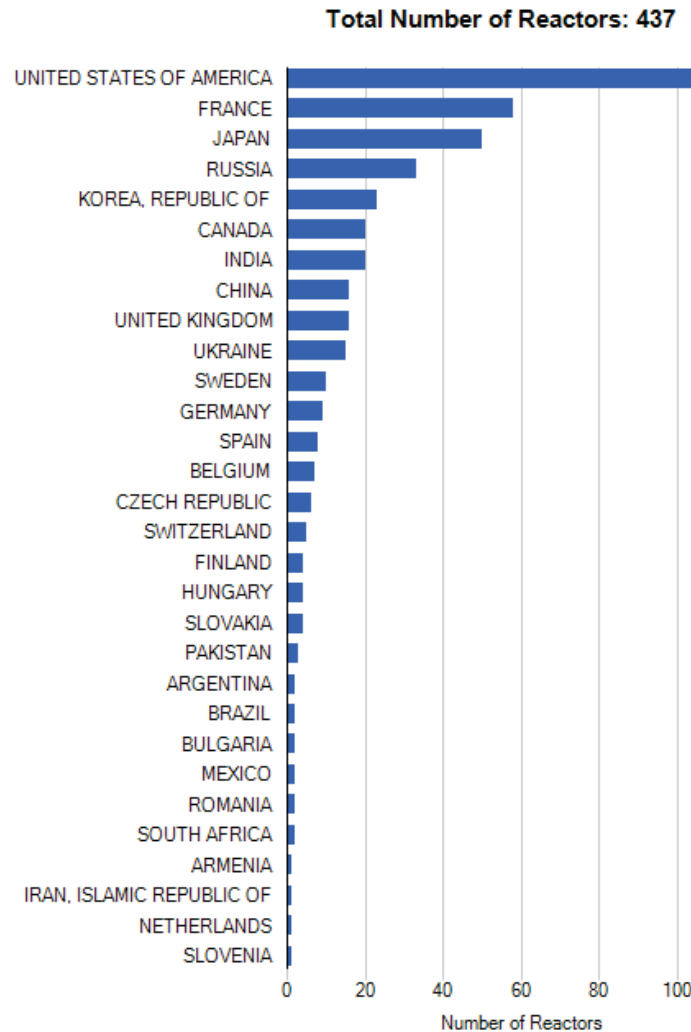


Source: EIA
<http://www.eia.gov/todayinenergy/detail.cfm?id=6310>

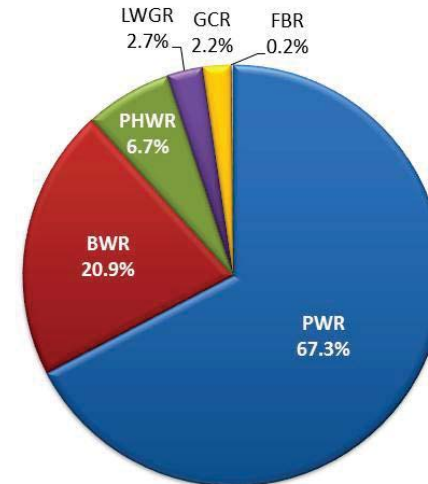
International Atomic Energy Agency



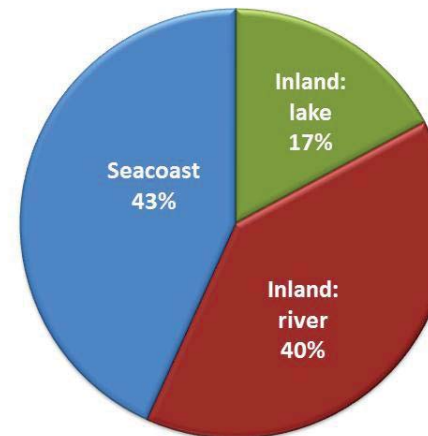
Operational reactors



Reactor capacity by type



Location of NPPs



2011 status changes

7 new connections to the grid (5 in 2010):

- KAIGA 4 (202 MW(e), PHWR, India), 19 January
- CHASNUPP 2 (300 MW(e), PWR, Pakistan), 14 March
- LINGAO 4 (1000 MW(e), PWR, China), 3 May
- CEFR - China Experimental Fast Reactor (20 MW(e), FBR, China), 21 July
- BUSHEHR 1 (915 MW(e), PWR-VVER, Iran), 3 September
- KALININ-4 (950 MW(e), PWR, RUSSIA) on 24 November
- QINSHAN 2-4 (610 MW(e), PWR, CHINA) on 25 November

13 final shutdowns (1 in 2010):

- FUKUSHIMA-DAIICHI 1,2,3,4 (439/760/760/760 MW(e), BWR, Japan), 20 May
- OLDBURY A2 (217 MW(e), GCR-Magnox, UK), 30 June
- BIBLIS A and B (1167/1240 MW(e), PWR, Germany), 6 August
- BRUNSBUETTEL (771 MW(e), BWR, Germany), 6 August
- ISAR 1 (878 MW(e), BWR, Germany), 6 August
- KRUEMMEL (1346 MW(e), BWR, Germany), 6 August
- NECKARWESTHEIM 1 (785 MW(e), PWR, Germany), 6 August
- PHILIPPSBURG 1 (890 MW(e), BWR, Germany), 6 August
- UNTERWESER (1345 MW(e), PWR, Germany), 6 August

4 construction initiations (16 in 2010):

- CHASNUPP 3 (315 MW(e), PWR, Pakistan), 28 May
- RAJASTHAN 7 (630 MW(e), PHWR, India), 18 July
- RAJASTHAN-8 (630 MW(e), PHWR, India) on 30 September
- CHASNUPP 4 (315 MW(e), PWR, PAKISTAN) on 18 December



2012 status changes

2 new connections to the grid:

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

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

2 final shutdowns:

- OLDBURY-A1 (217 MW(e), GCR, UK) on 29 February
- WYLFA 2 (490 MW(e), GCR, UK) on 25 April

3 construction start :

- BALTIISK-1 (1082 MW(e), PWR-VVER, Russia), 22 February
- SHIN-ULCHIN-1 (1340 MW(e), PWR, KOREA REP.) on 10 July
- BARAKAH 1 (1340 MW(e), PWR, UAE) on 18 July

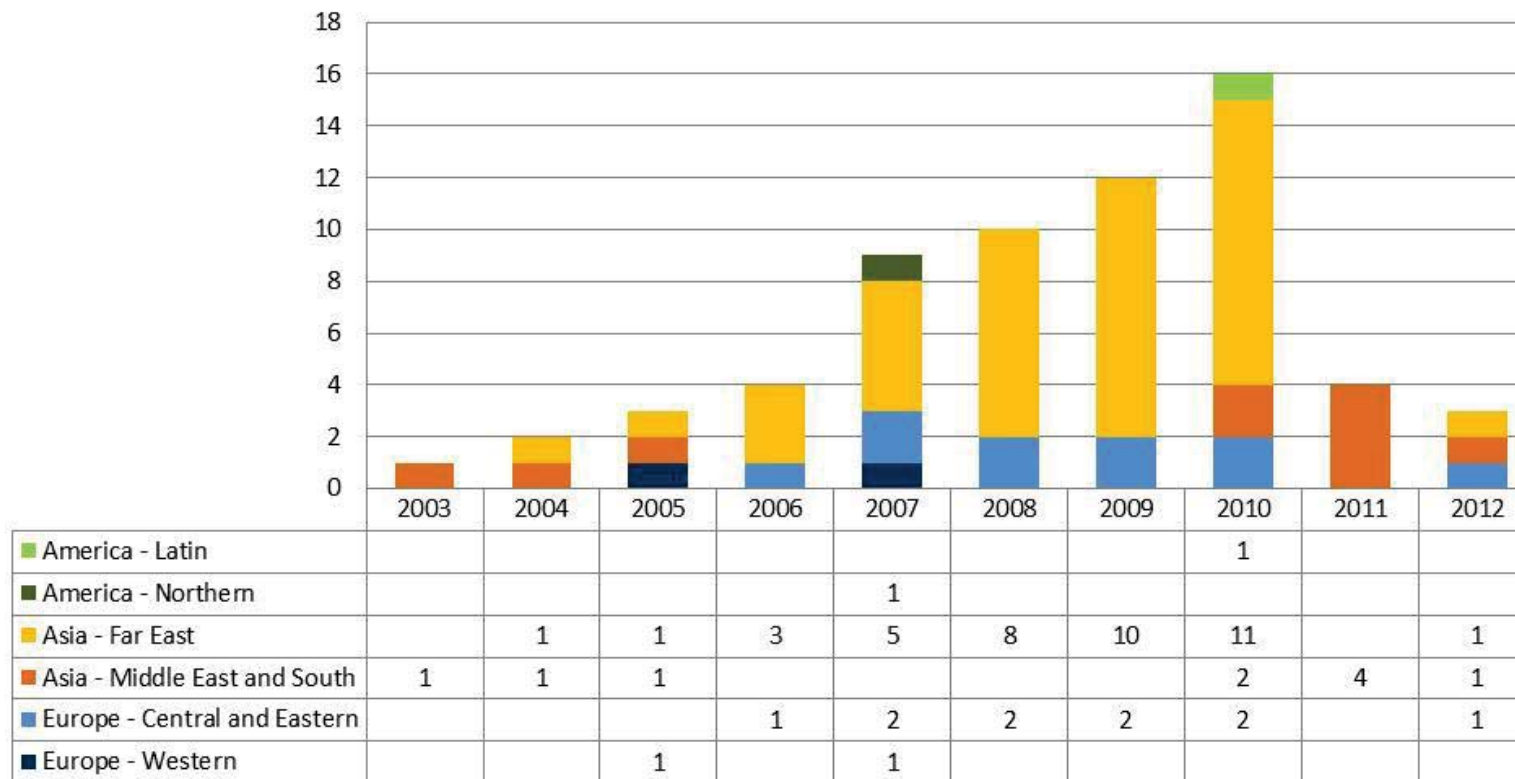
2 cancelled constructions:

- BELENE 1 & 2 (953 MW(e), PWR-VVER V-466, BULGARIA) on 28 March



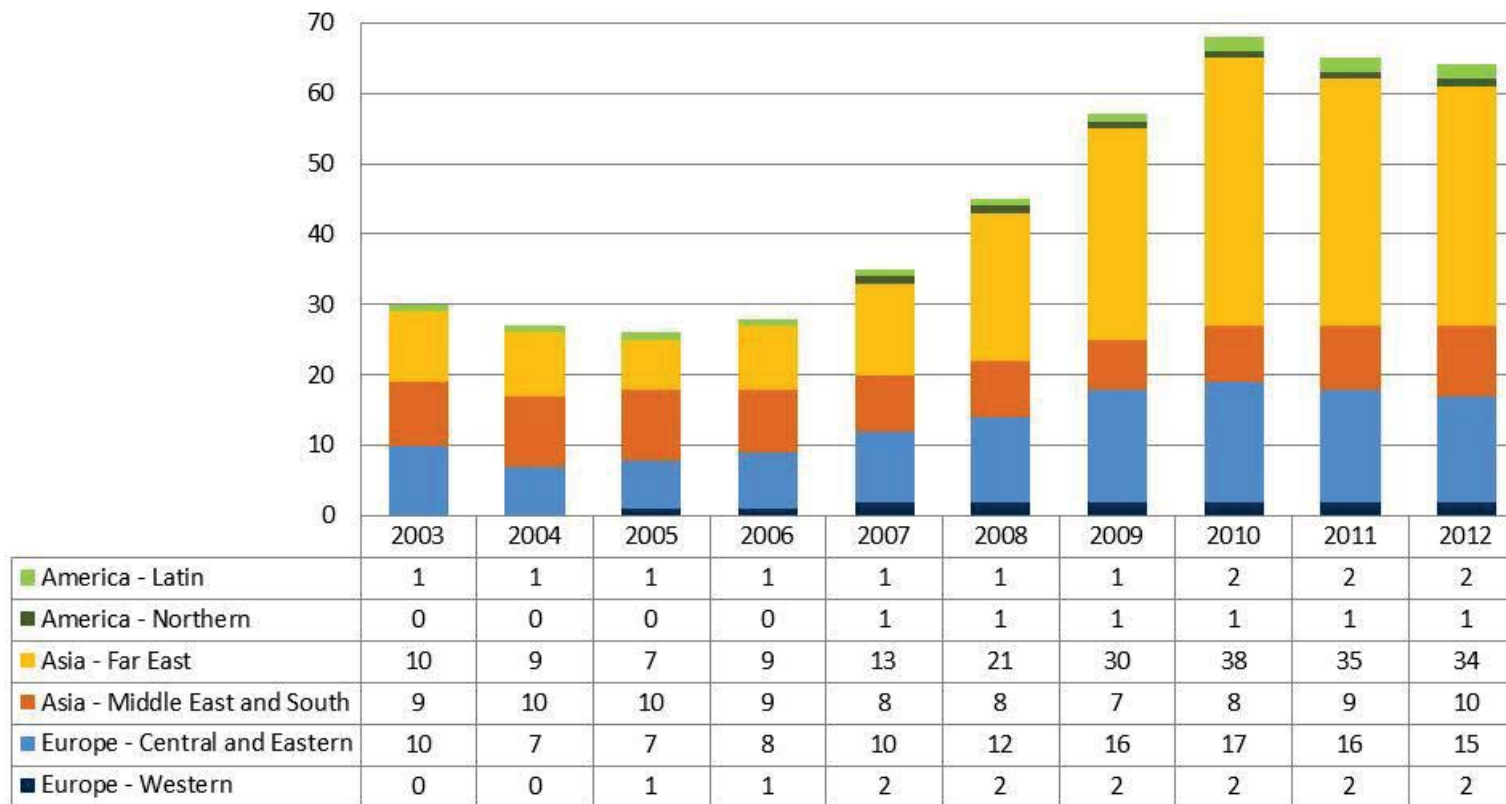
Trend in construction starts

NPP Construction Starts

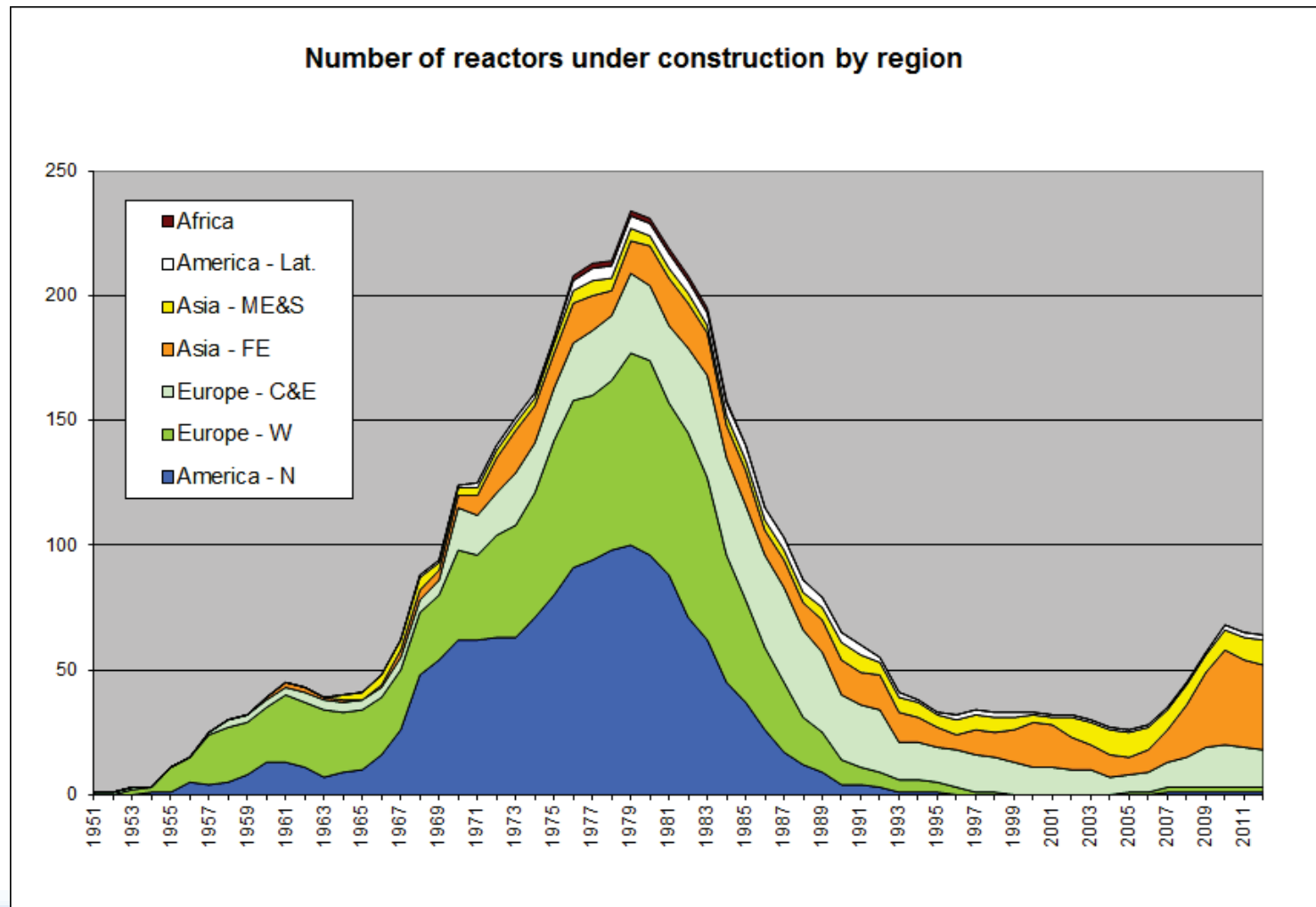


History of NPP construction

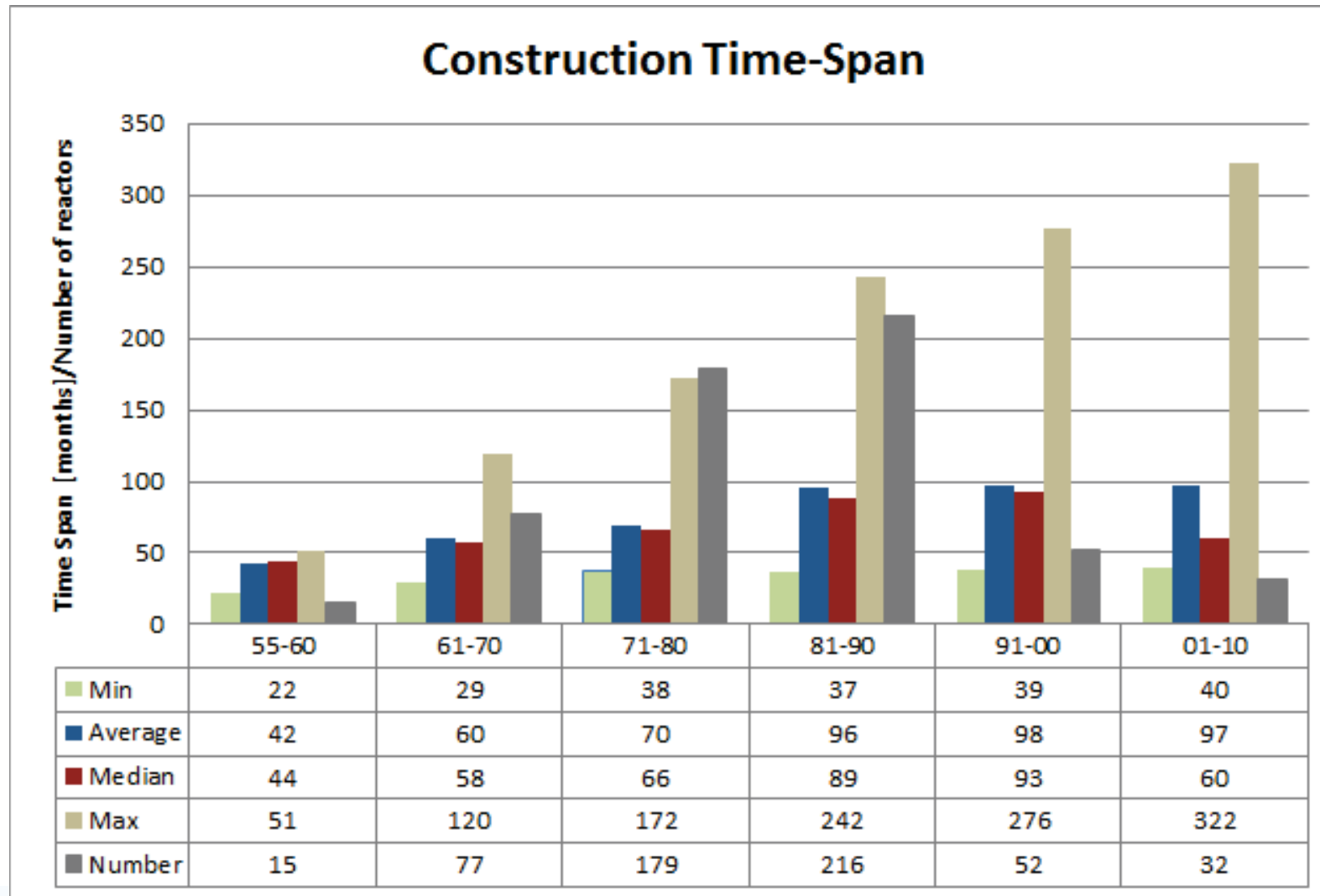
Number of reactors under construction by region



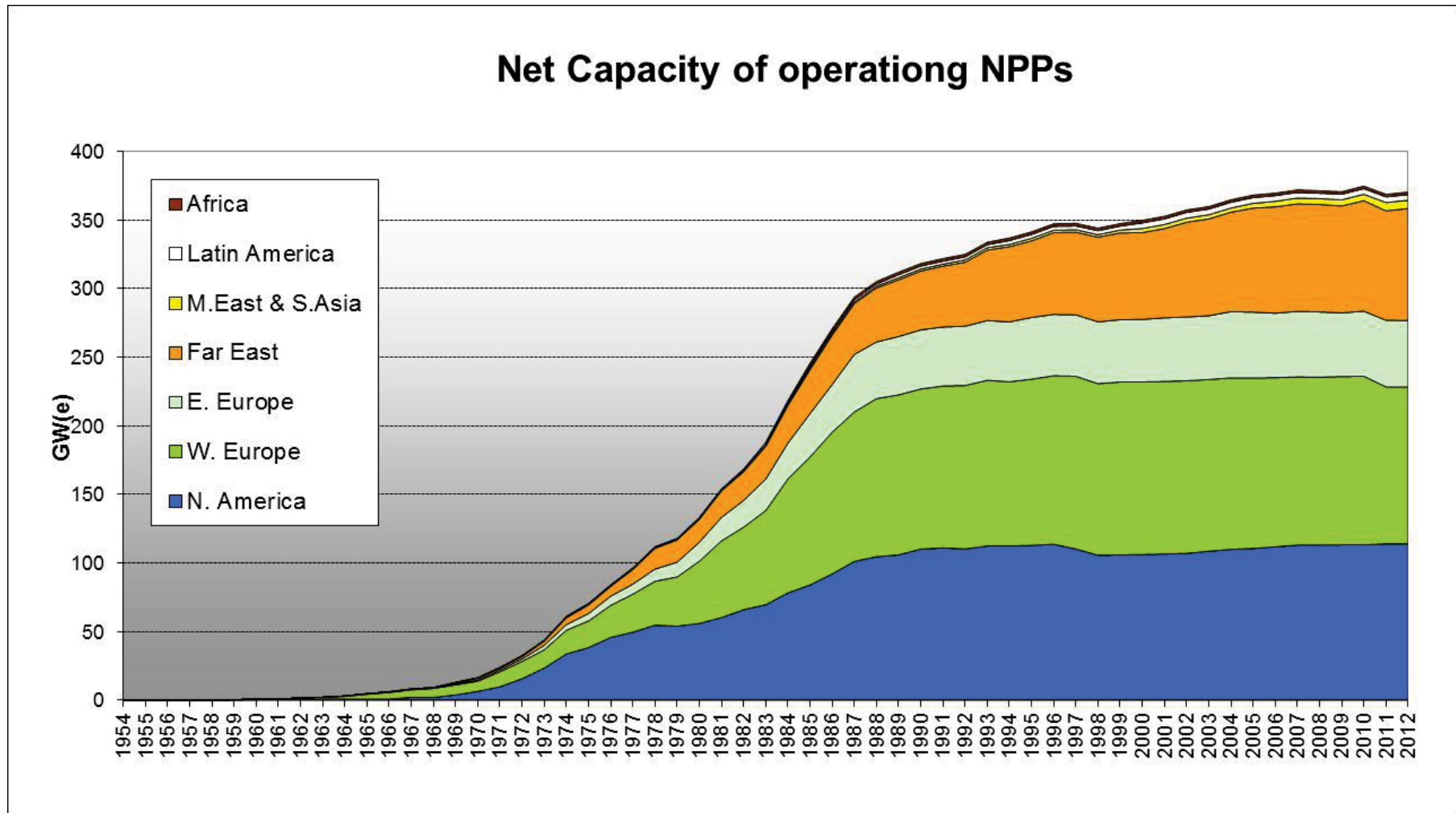
Full history of NPP construction



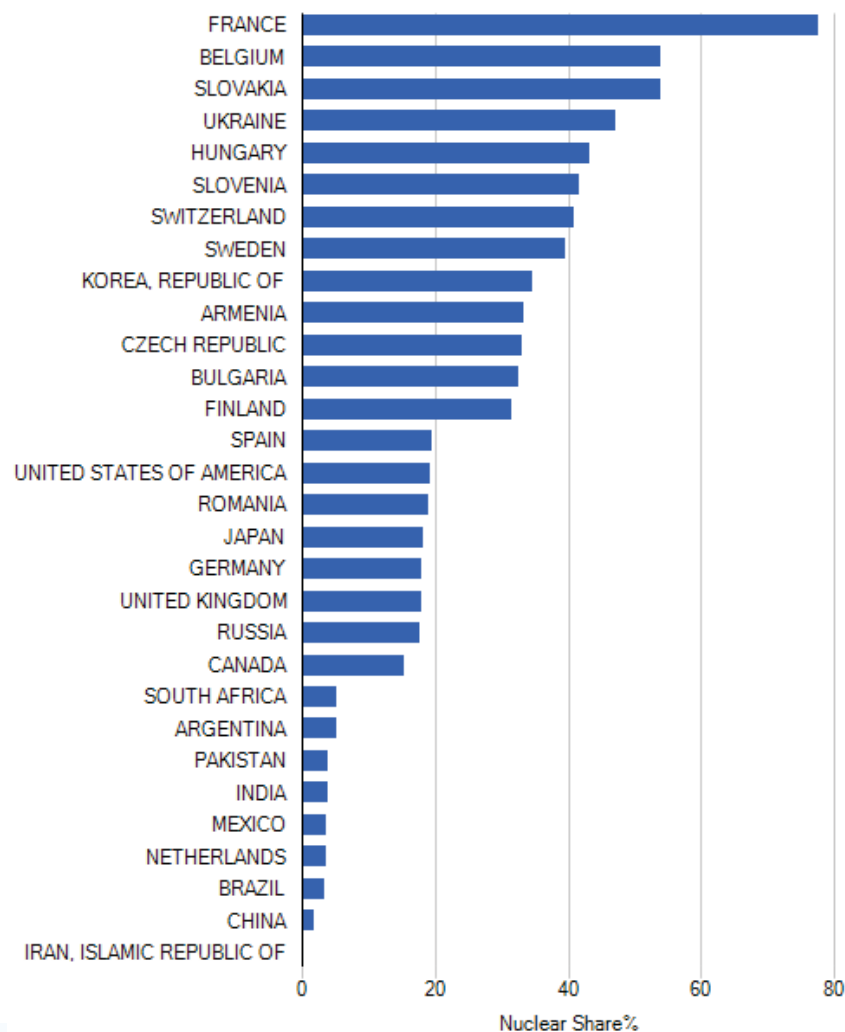
Construction duration statistics



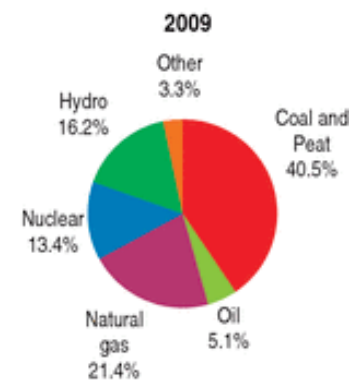
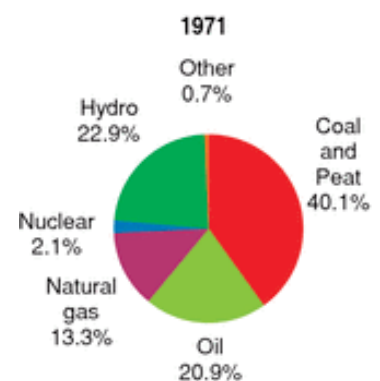
Year-end capacity by region



Nuclear share in 2011



World electricity generation by source of energy

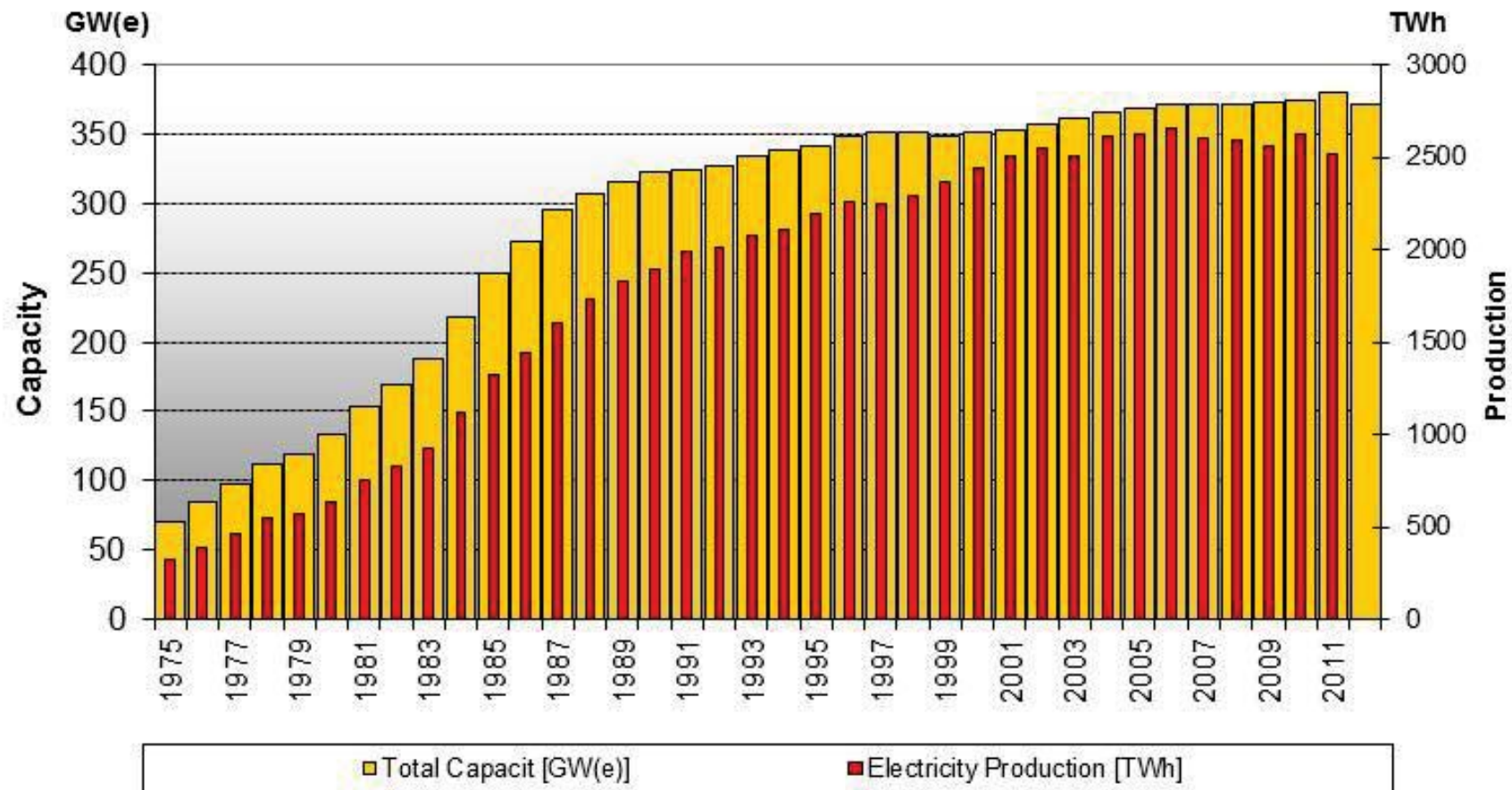


Source: OECD Factbook 2011-2012

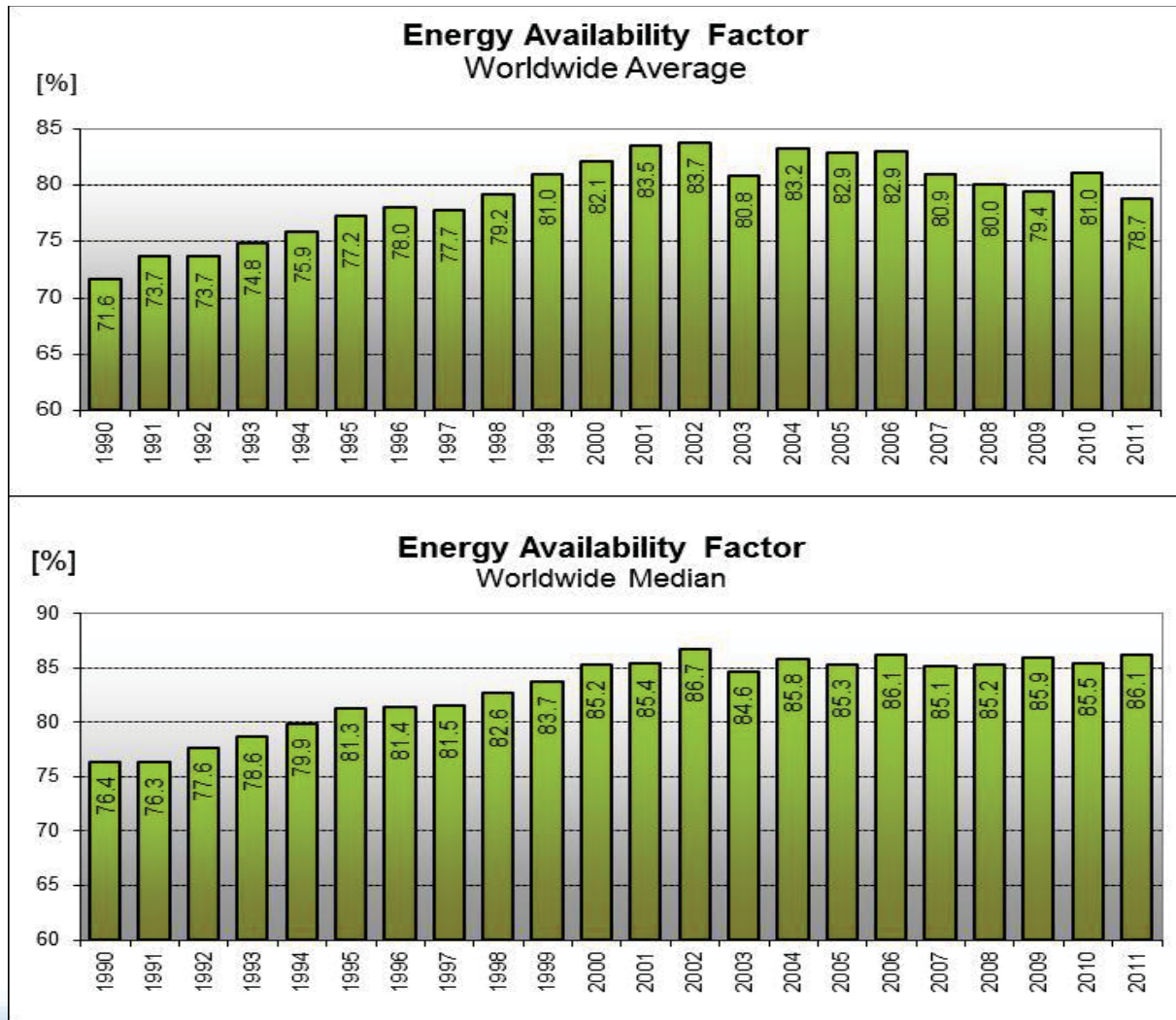


Trend in electricity production

Trend of available capacity and electricity production



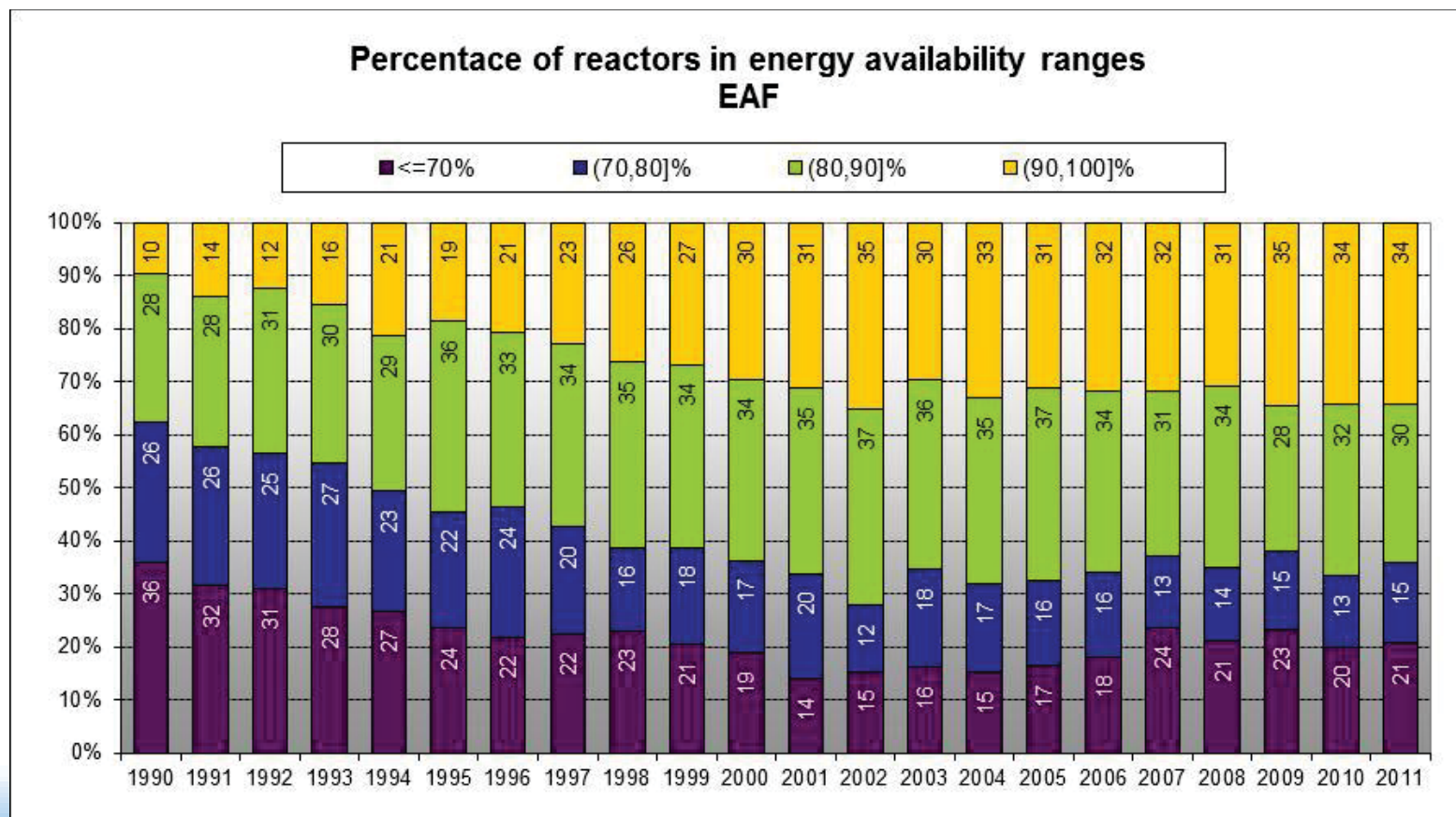
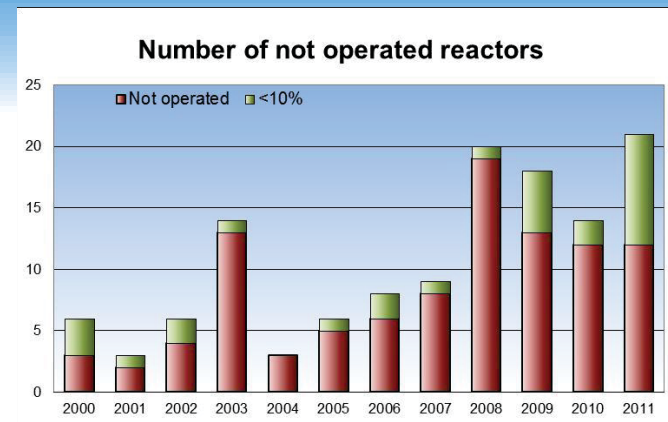
Installed Capacity Utilization



- ❑ Continuous increasing trend during 1990s has reversed in last years
- ❑ In 2011 the Energy Availability Factor (EAF) dropped to 79% on average.
- ❑ Half of nuclear reactors operated with EAF above 86%.

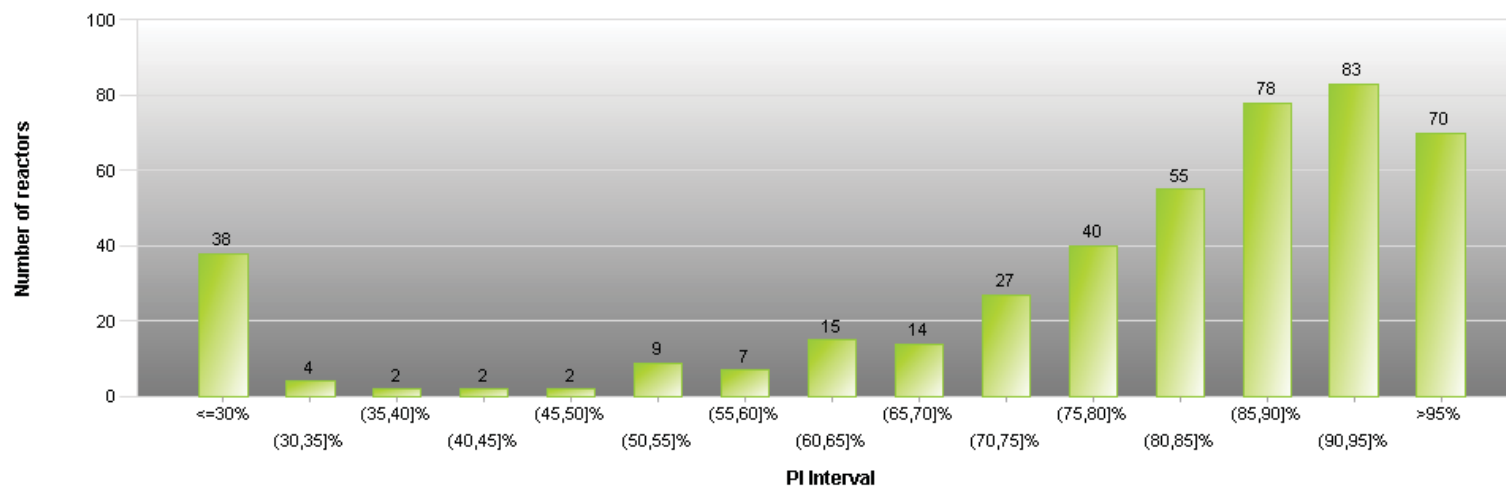


EAF in intervals

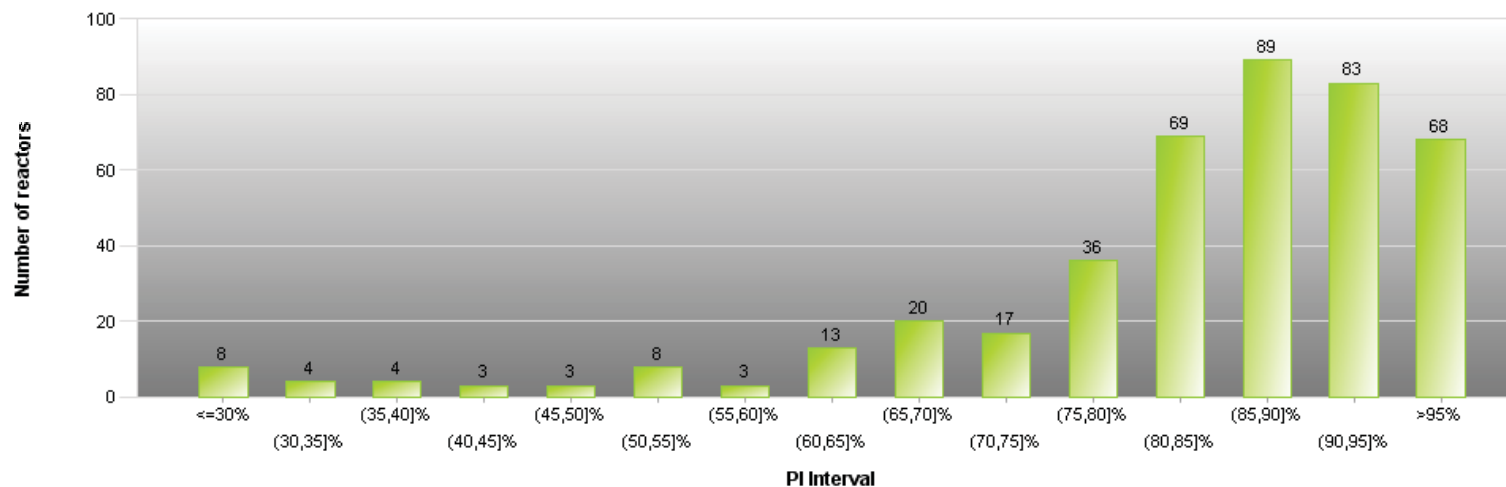


EAF histograms

2011



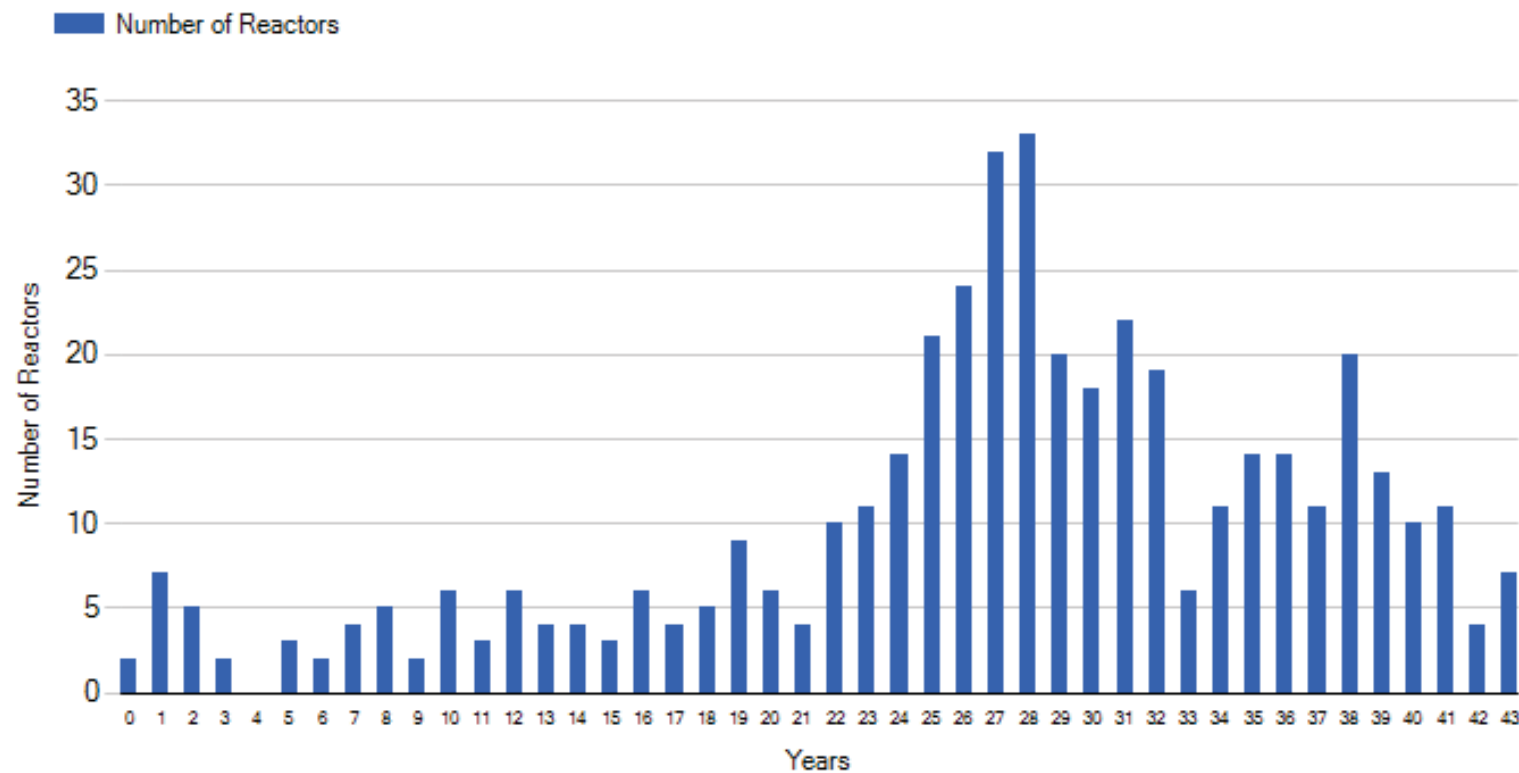
2002



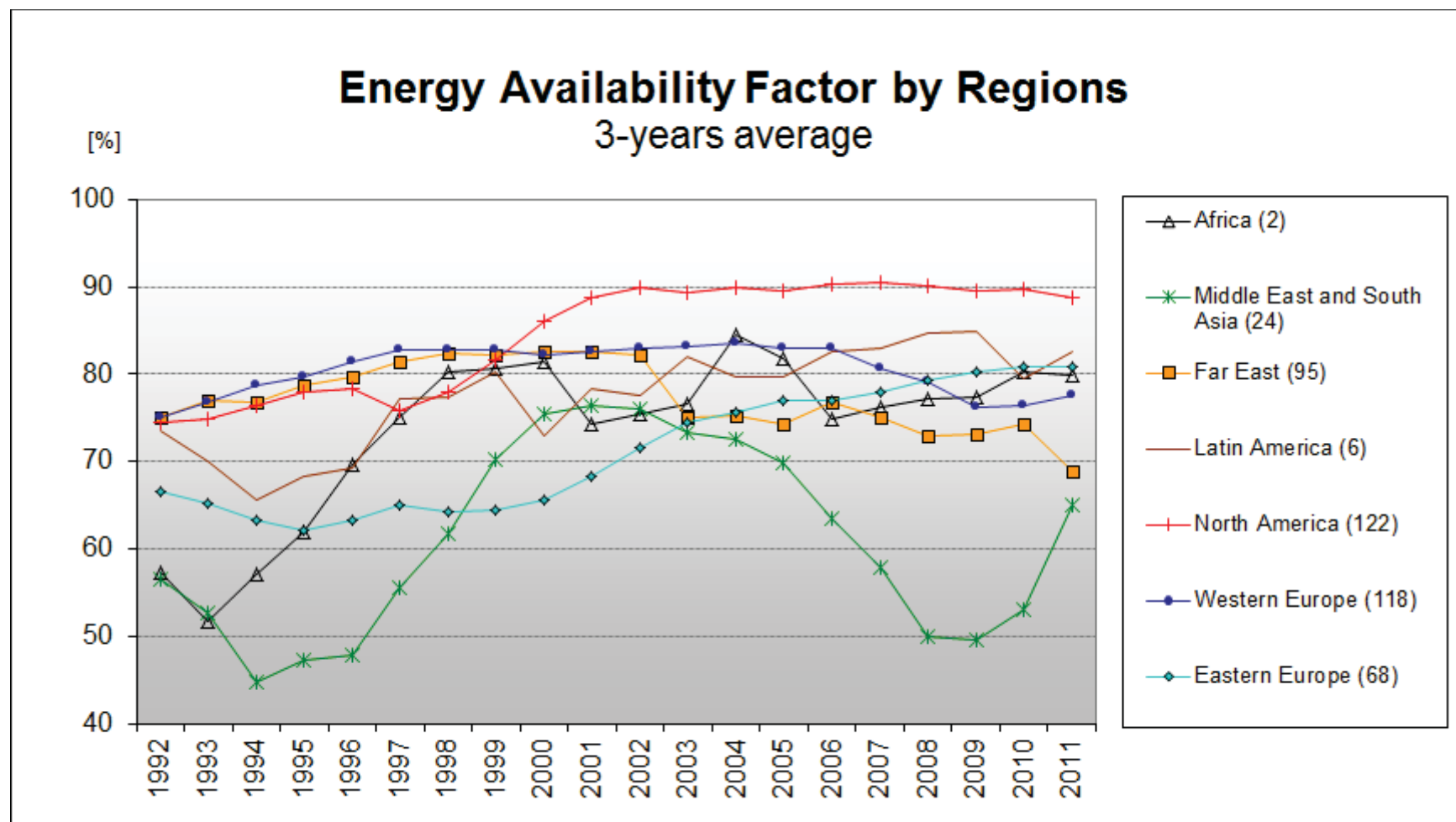
Age of operating reactors

75% of reactors older than 23 years
50% of reactors older than 27 years

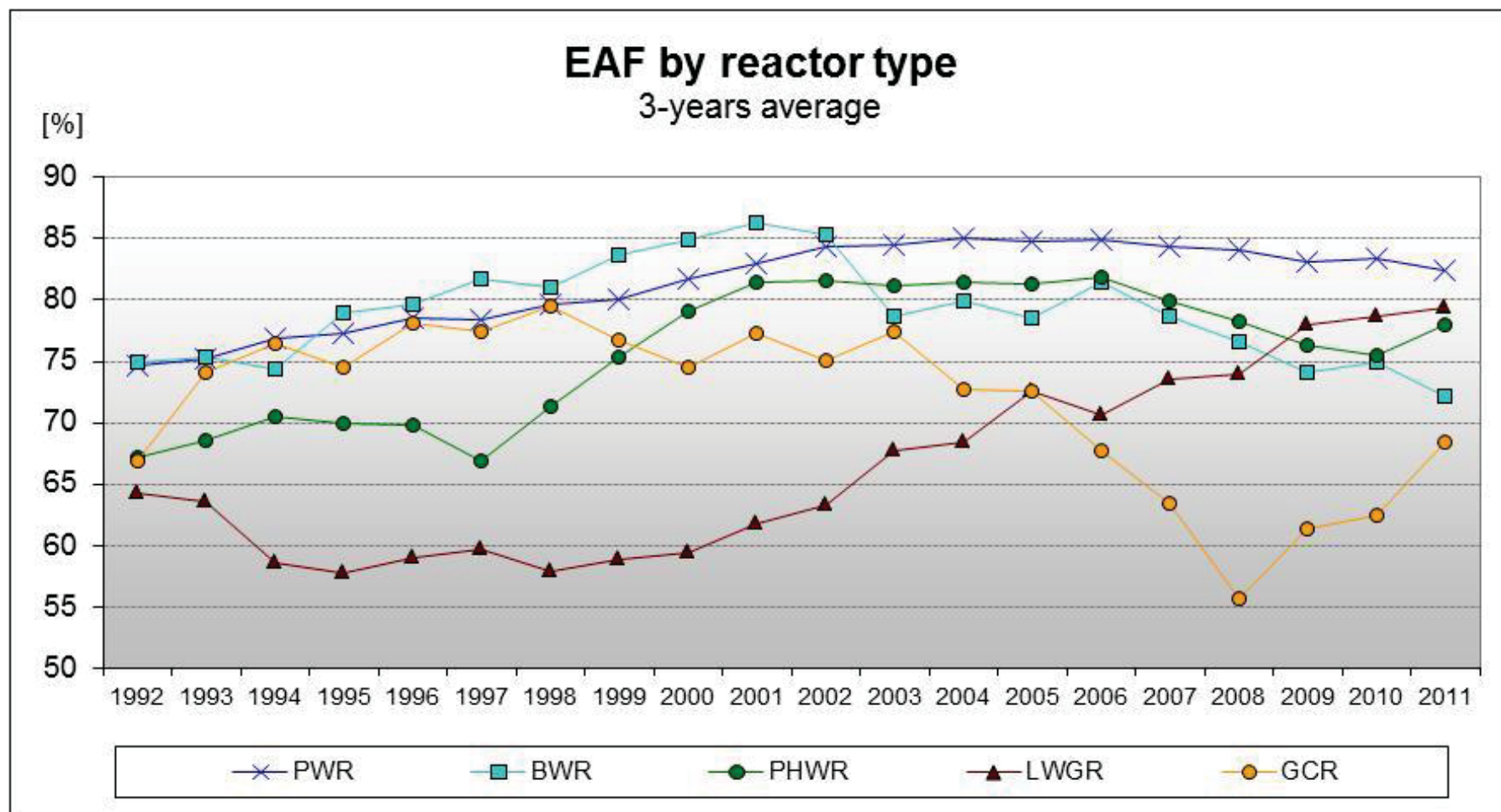
Total Number of Reactors: 437



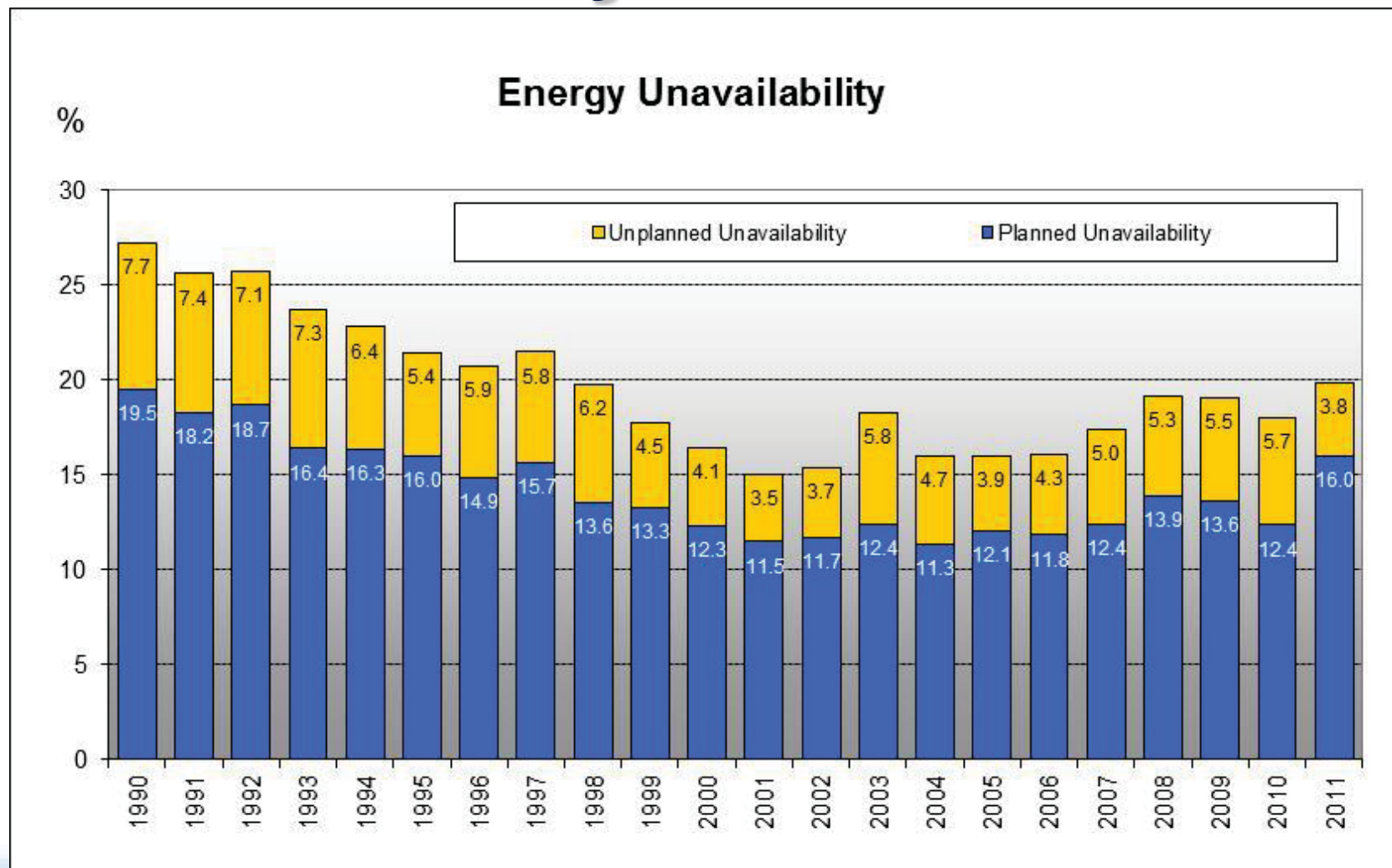
Regional trends



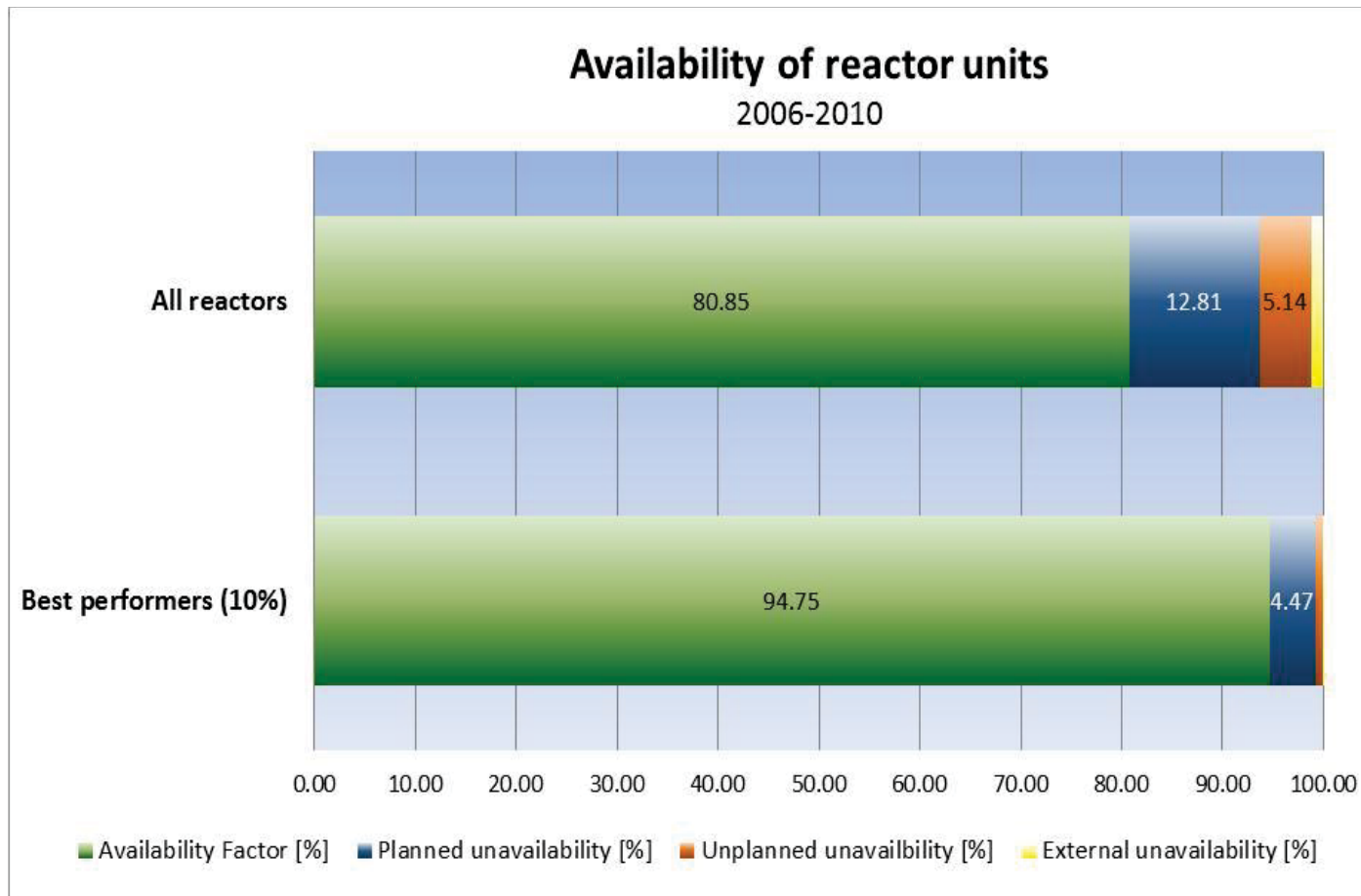
Performance by technology



Unavailability



Benchmarking



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



Summary of NE Trends

- ❑ Extensive development in 1870s 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

