



International Atomic Energy Agency

NPP in operation Worldwide

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

Nuclear Reactors in the World



Reference: IAEA-PRIS

International Atomic Energy Agency



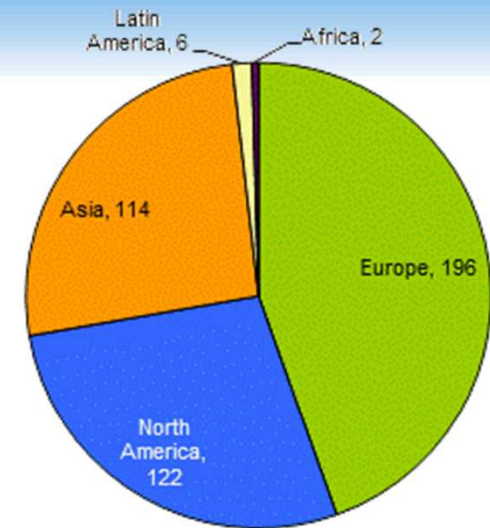
Nuclear Power

- ❑ Nuclear energy since 1954
- ❑ Fast development from 1960s to 1980s
- ❑ An important part of a global energy mix – 14%
- ❑ >14 000 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 growing number of countries are expressing interest in introducing nuclear power

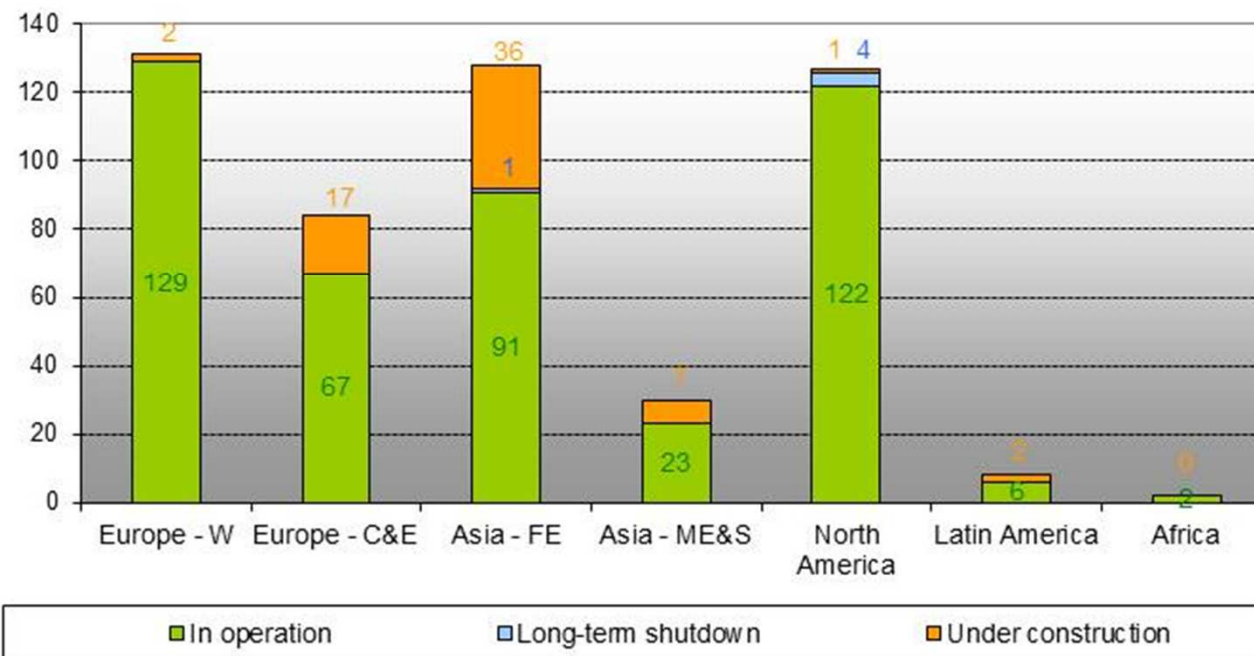


Reactors overview

- ❑ 440 reactors in operation (374 GWe)
- ❑ 5 reactors in long-term shutdown (3 GWe)
- ❑ 65 reactors under construction (63 GWe)

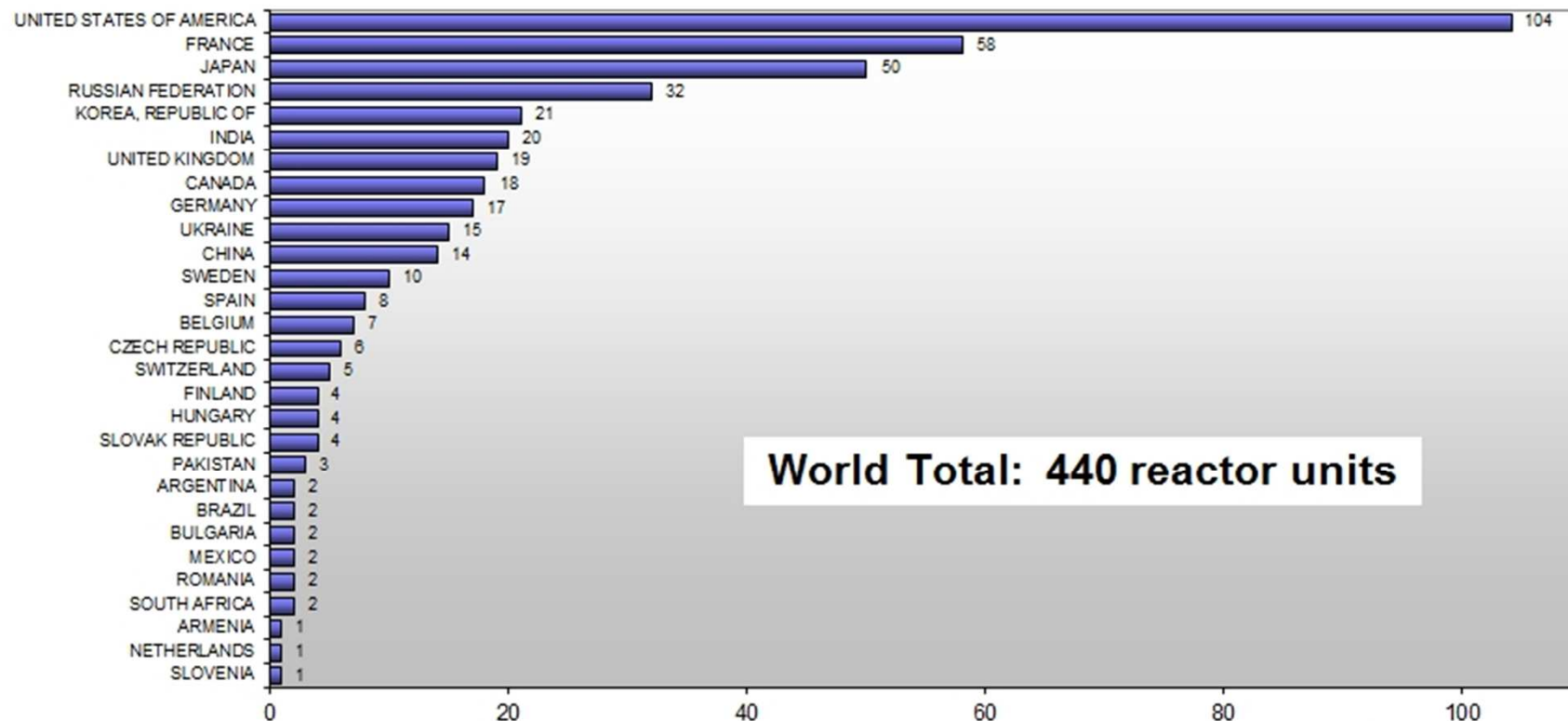


Reactors by region



Nuclear reactors by country

Number of Reactors in Operation Worldwide

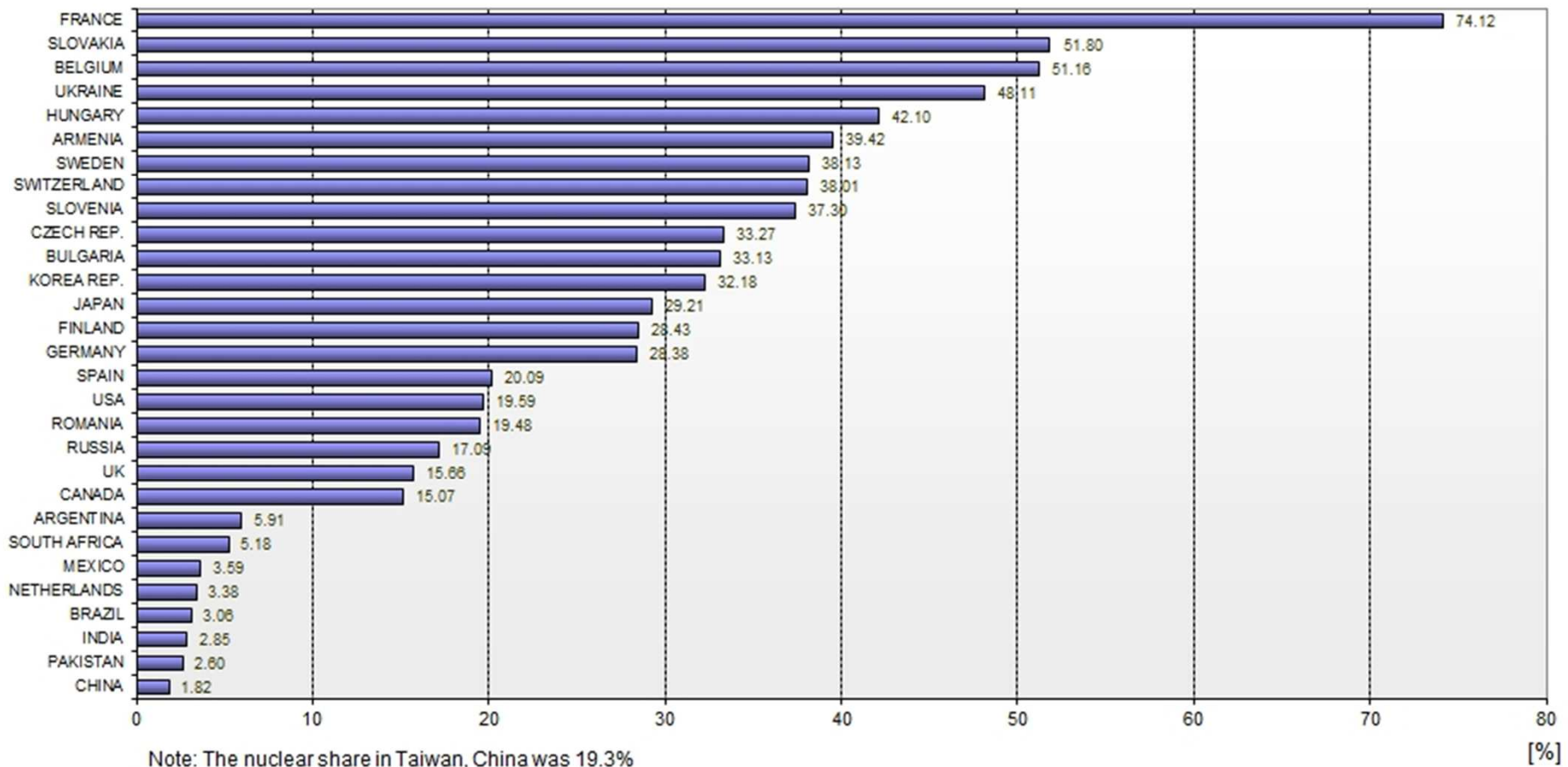


Note: Long-term shutdown units (5) are not counted



Nuclear share

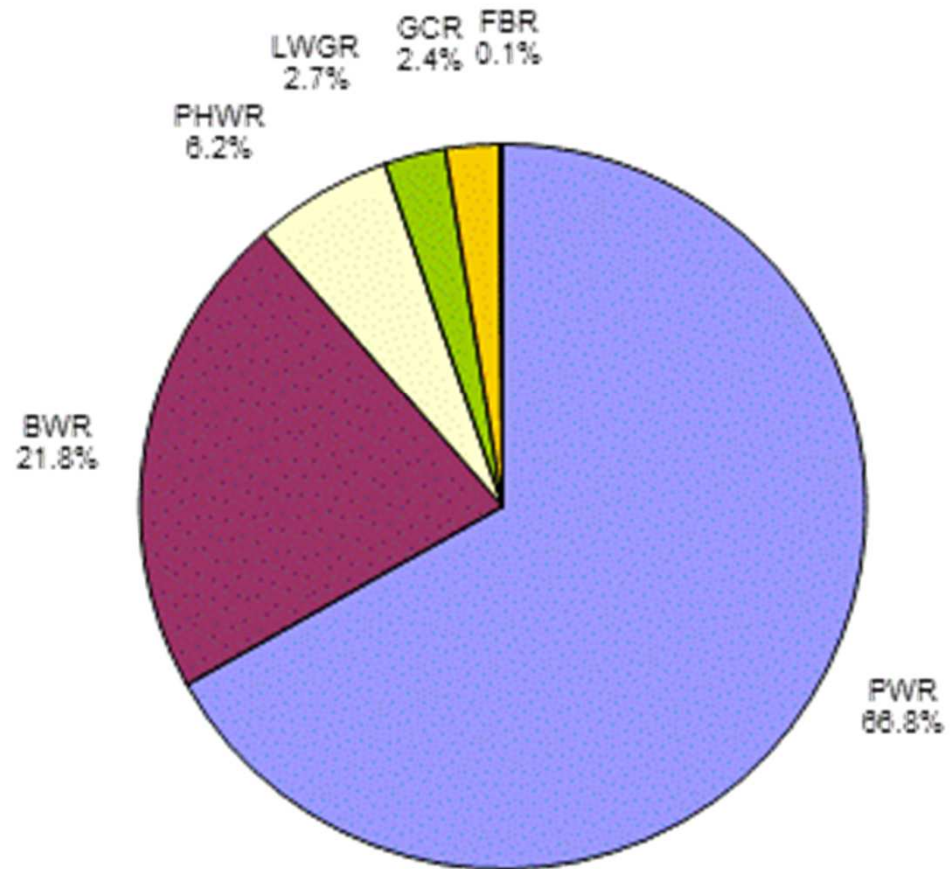
Nuclear Share in Electricity Generation in 2010



Reactor types

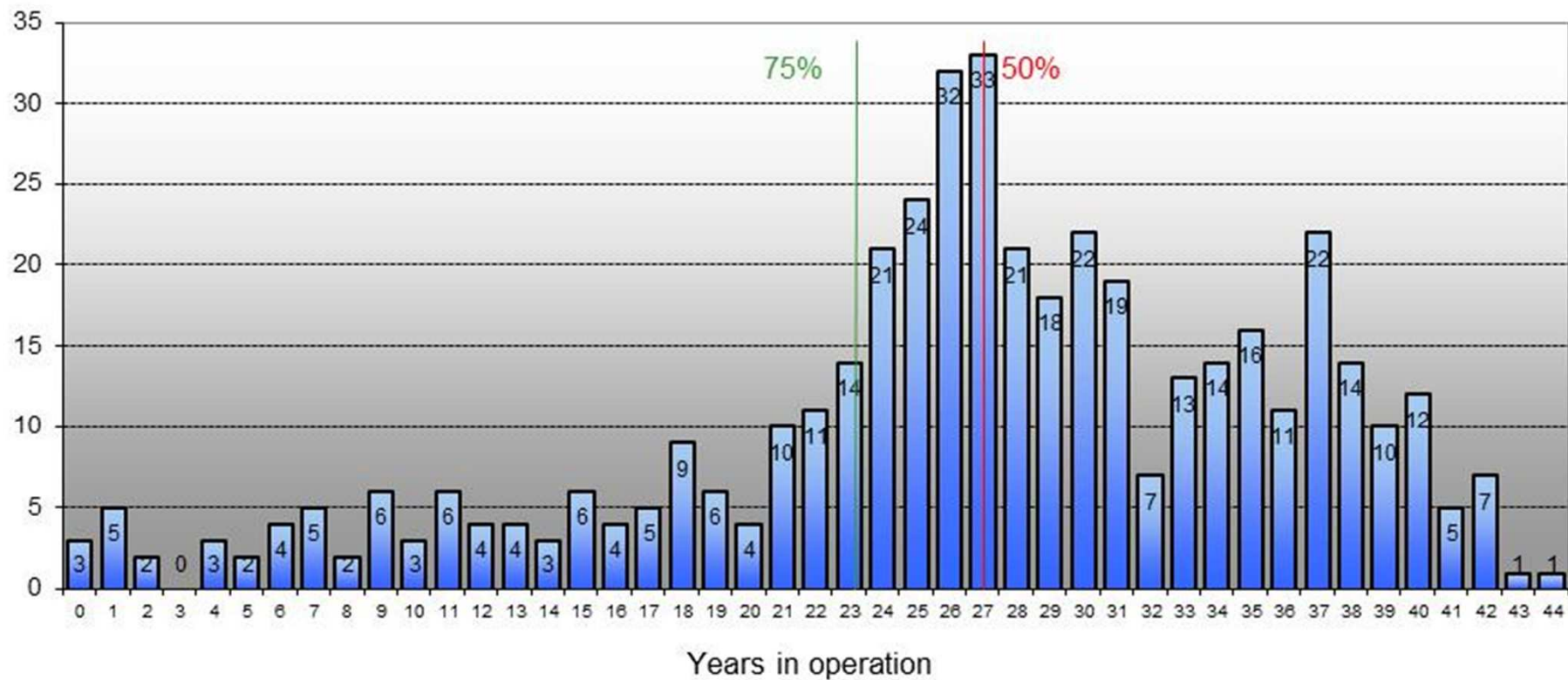
- **BWR:** Boiling light water cooled and moderated reactor
- **FBR:** Fast breeder reactor
- **GCR:** Gas cooled graphite moderated reactor
- **LWGR:** Light water cooled graphite moderated reactor
- **PHWR:** Pressurized heavy water moderated and cooled reactor
- **PWR:** Pressurized light water moderated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

Reactor capacity by type



Age of operating reactors

Number of operational reactors by age



2010 status changes

5 new units:

- Rostov 2 (950 MW(e), PWR-VVER, Russia) - first grid connection on 18 March
- Rajasthan 6 (202 MW(e), PHWR, India) - first grid connection on 28 March
- Lingao 3 (1000 MW(e), PWR, China) - first grid connection on 15 July
- Qinshan 2-3 (610 MW(e), PWR, China) - first grid connection on 1 August
- Shin Kori 1 (960 MW(e), PWR, S. Korea) - first grid connection on 4 August

1 final shutdowns:

- Phenix (130 MW(e), FBR, France) was officially closed on 1 February

16 construction initiation:

- Ningde 3 (1000 MW(e), PWR, China) - construction officially started on 8 January
- Taishan 2 (1700 MW(e), PWR-EPR, China) - construction officially started on 15 April
- Leningrad 2-2 (1085 MW(e), PWR-VVER, Russia) - construction officially started on 15 April
- Changjiang 1 (610 MW(e), PWR, China) - construction officially started on 25 April
- Ohma (1325 MW(e), ABWR, Japan) - construction officially started on 7 May
- Angra 3 (1245 MW(e), PWR, Brazil) - construction officially started on 1 June
- Rostov 4 (1011 MW(e), PWR-VVER, Russia) - construction officially started on 16 June
- Haiyang 2 (1000 MW(e), PWR-AP1000, China) - construction officially started on 21 June
- Fangchenggang 1 (1000 MW(e), PWR, China) - construction officially started on 30 July
- Ningde 4 (1000 MW(e), PWR, China) - construction officially started on 29 September
- Yangjiang 3 (1000 MW(e), PWR, China) - construction officially started on 15 November
- Changjiang 2 (610 MW(e), PWR, China) - construction officially started on 21 November
- Kakrapar 3&4 (2x 640 MW(e), PHWR, India) - construction officially started on 22 November
- Fangchenggang 2 (1000 MW(e), PWR, China) - construction officially started on 23 December
- Fuqing 3 (1000 MW(e), PWR, China) - construction officially started on 31 December



2011 status changes

New connection to the grid:

- Kaiga 4 (202 MW(e), PHWR, India) - first grid connection on 19 January
- Chasnupp 2 (300 MW(e), PWR, Pakistan) - first grid connection on 14 March
- Lingao 4 (1000 MW(e), PWR, China) - first grid connection on 3 May

Final shutdowns:

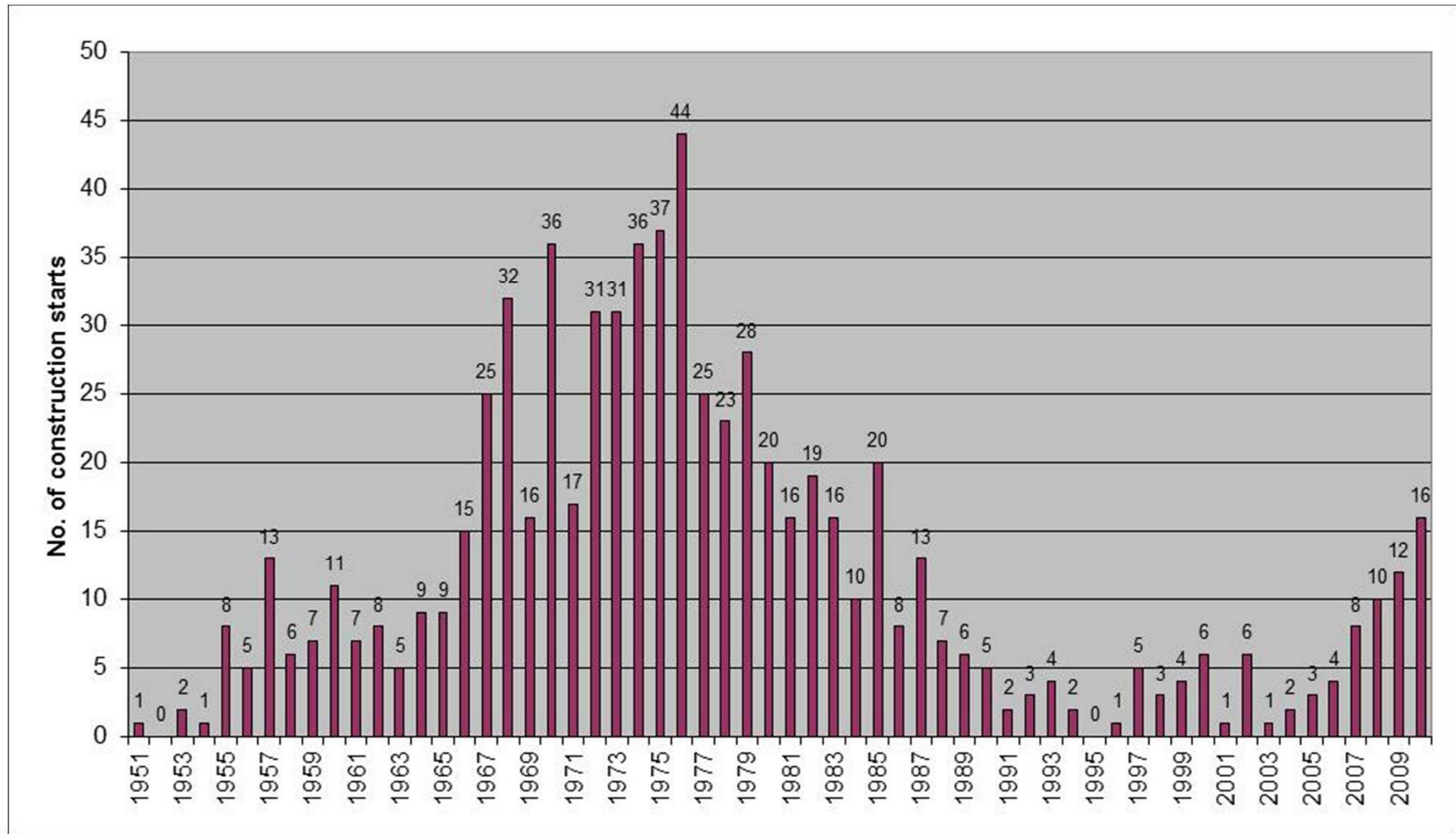
- Fukushima-Daiichi 1,2,3,4 (439/760/760/760 MW(e), BWR, Japan) were officially declared as permanently shutdown on 20 May

Construction initiation:

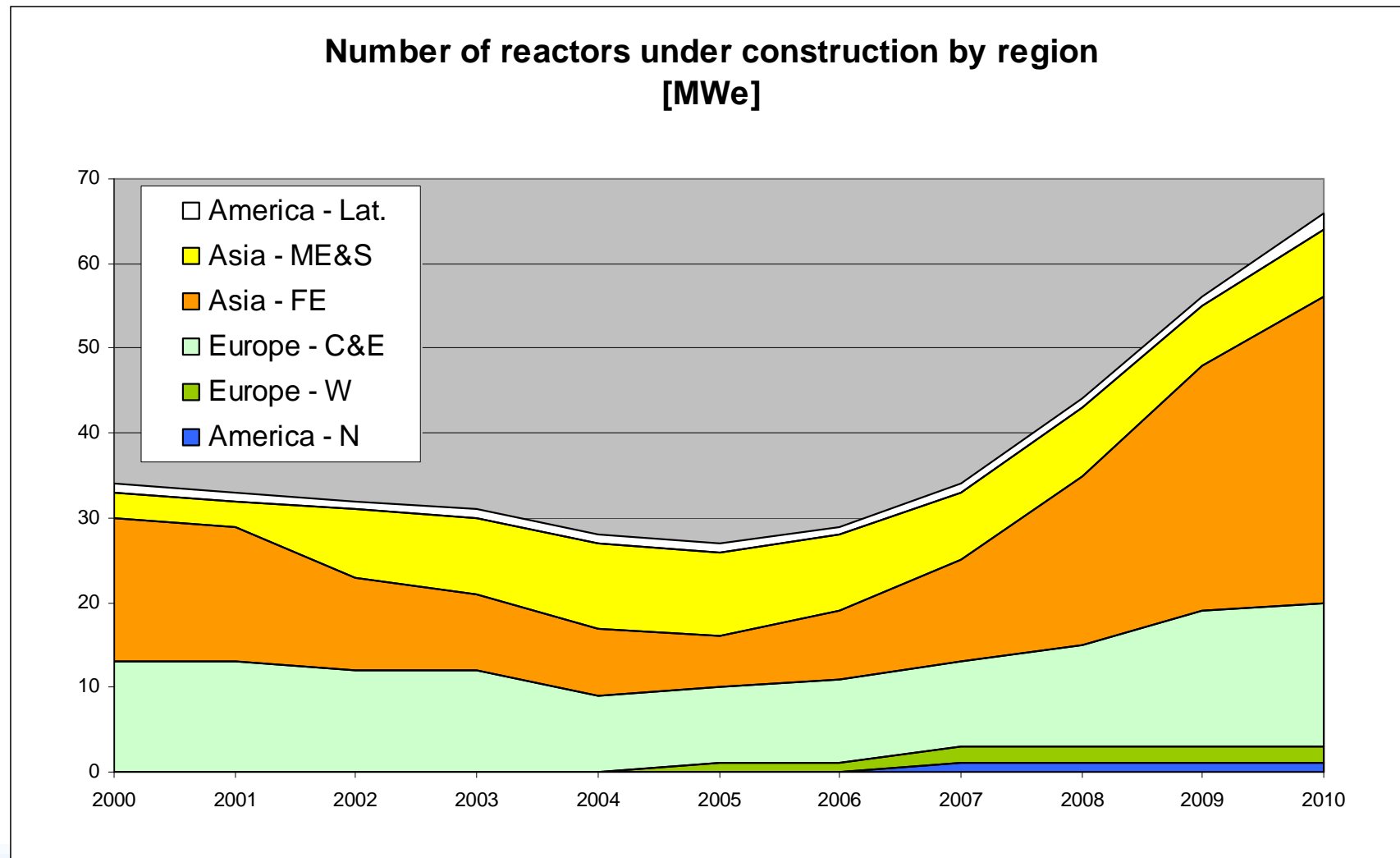
- Chasnupp 3 (315 MW(e), PWR, Pakistan) - construction officially started on 28 May



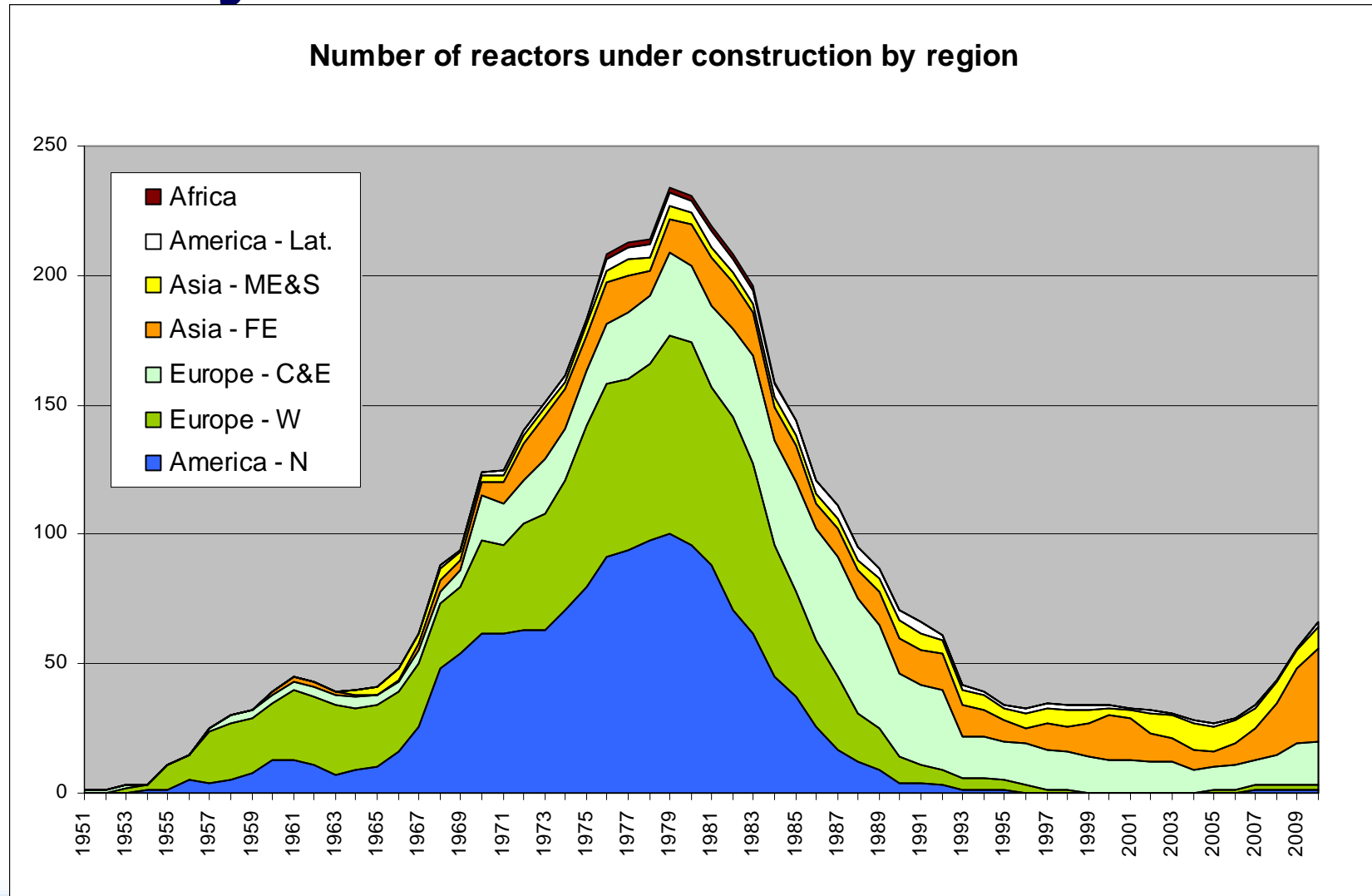
History of NPP construction Starts



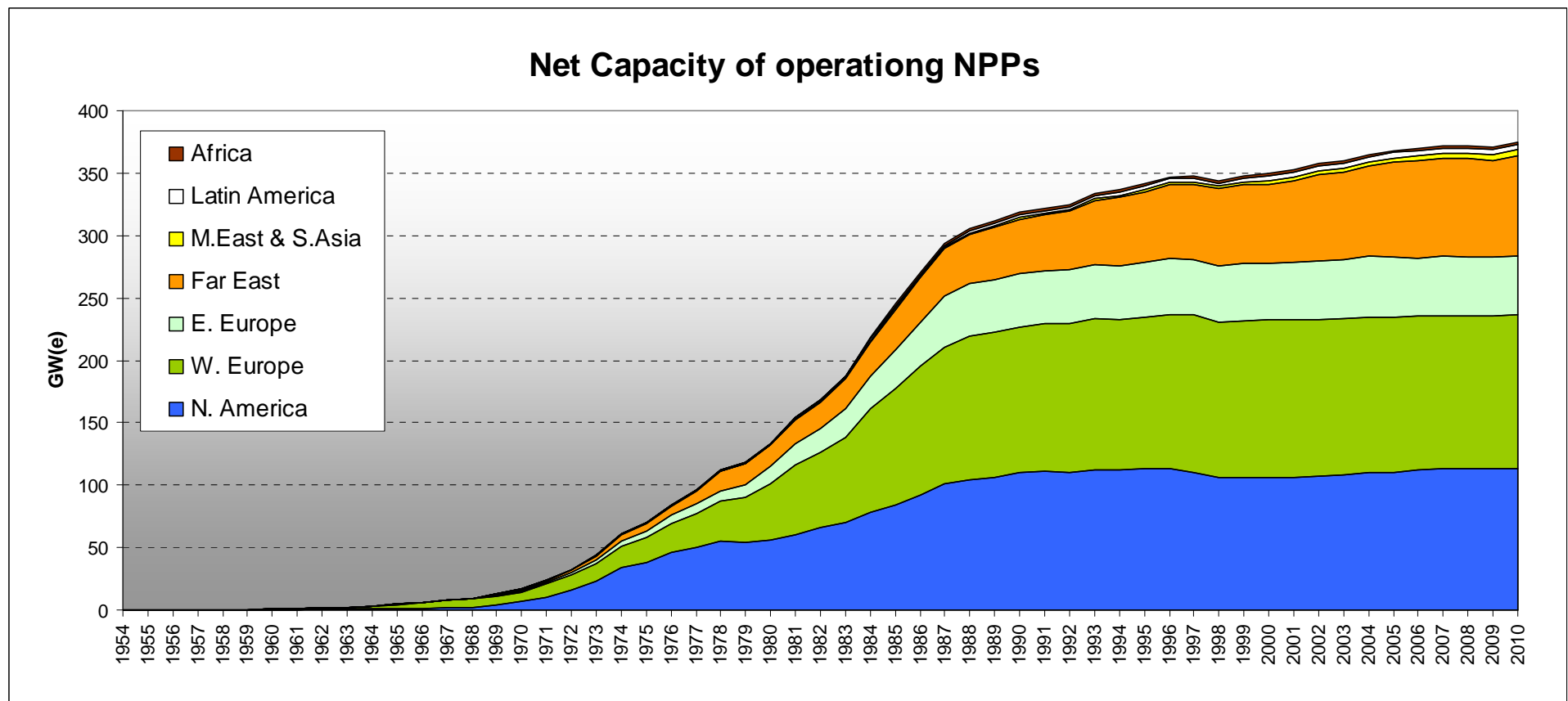
Nuclear power renaissance ?



History of NPP construction

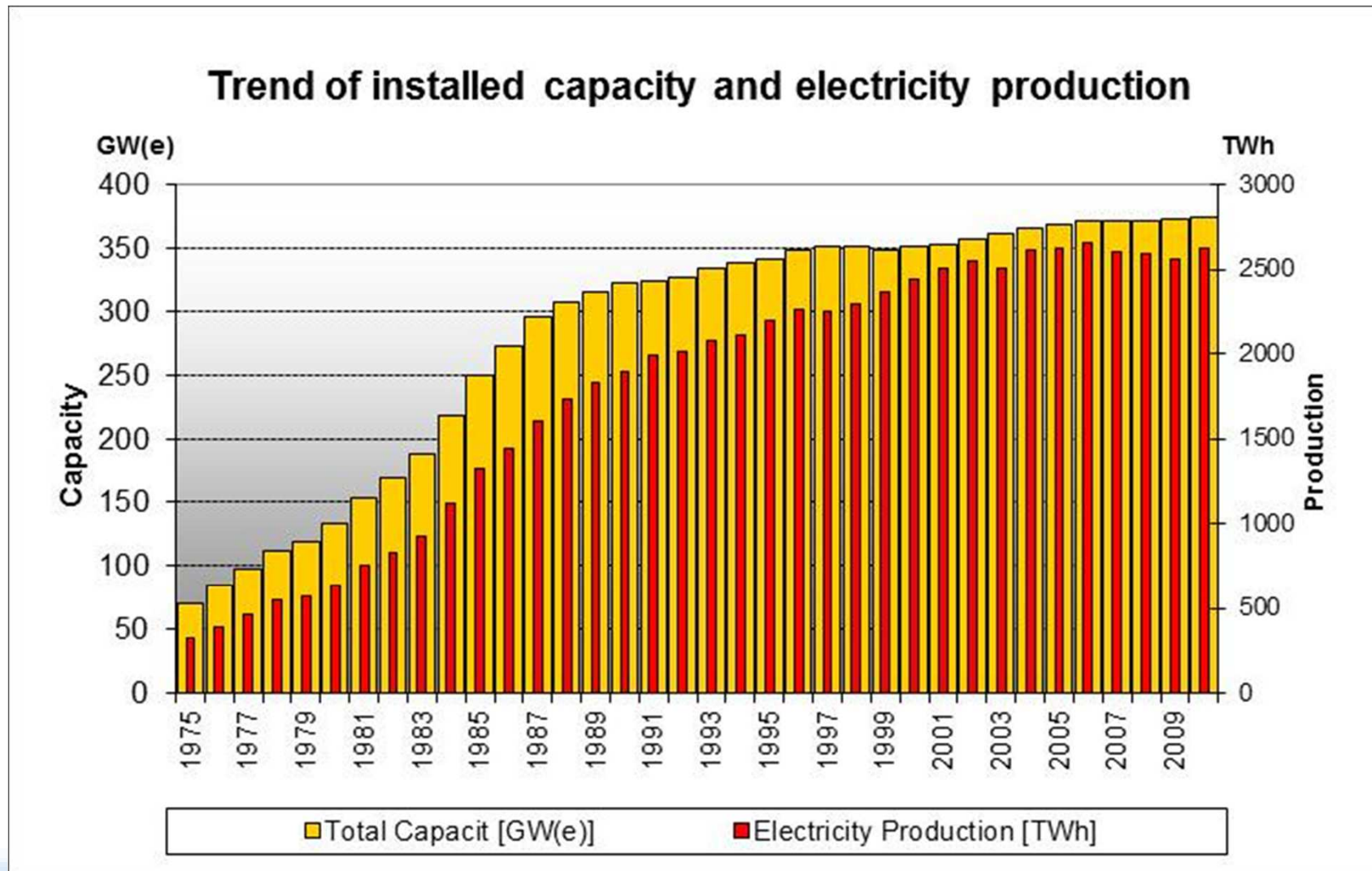


Net Capacity by region

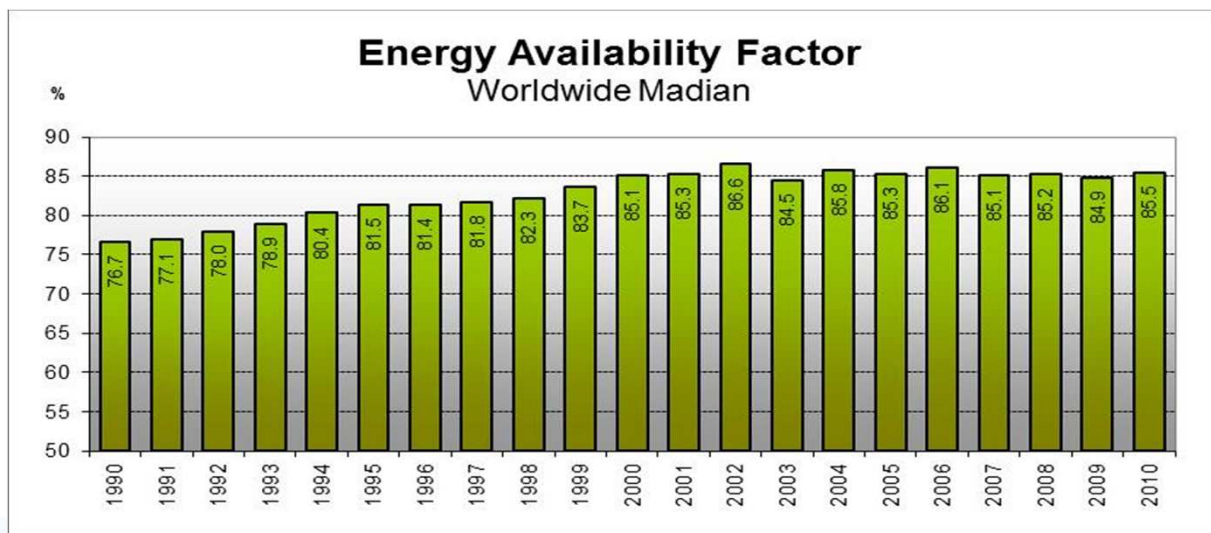
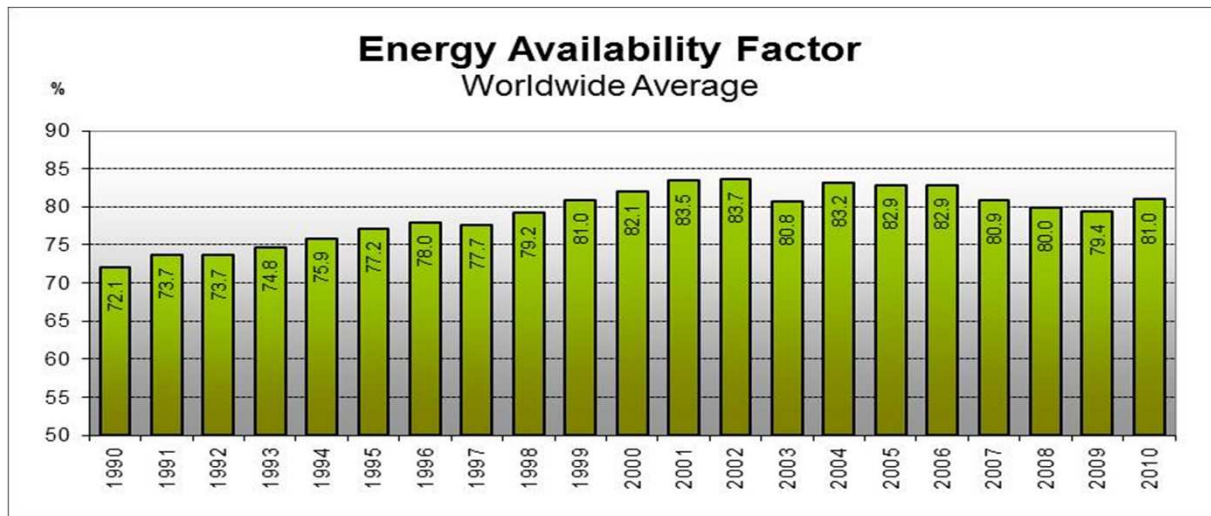


Nuclear energy production

2630 TWh in 2010



Installed Capacity Utilization

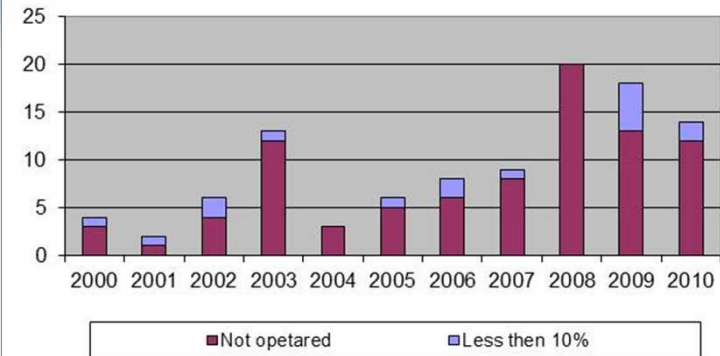


- Continuous increasing trend during 1990s has reversed in last years
- In 2010 the Energy Availability Factor (EAF) was 81% on average.
- Half of nuclear reactors operated with EAF above 85%.

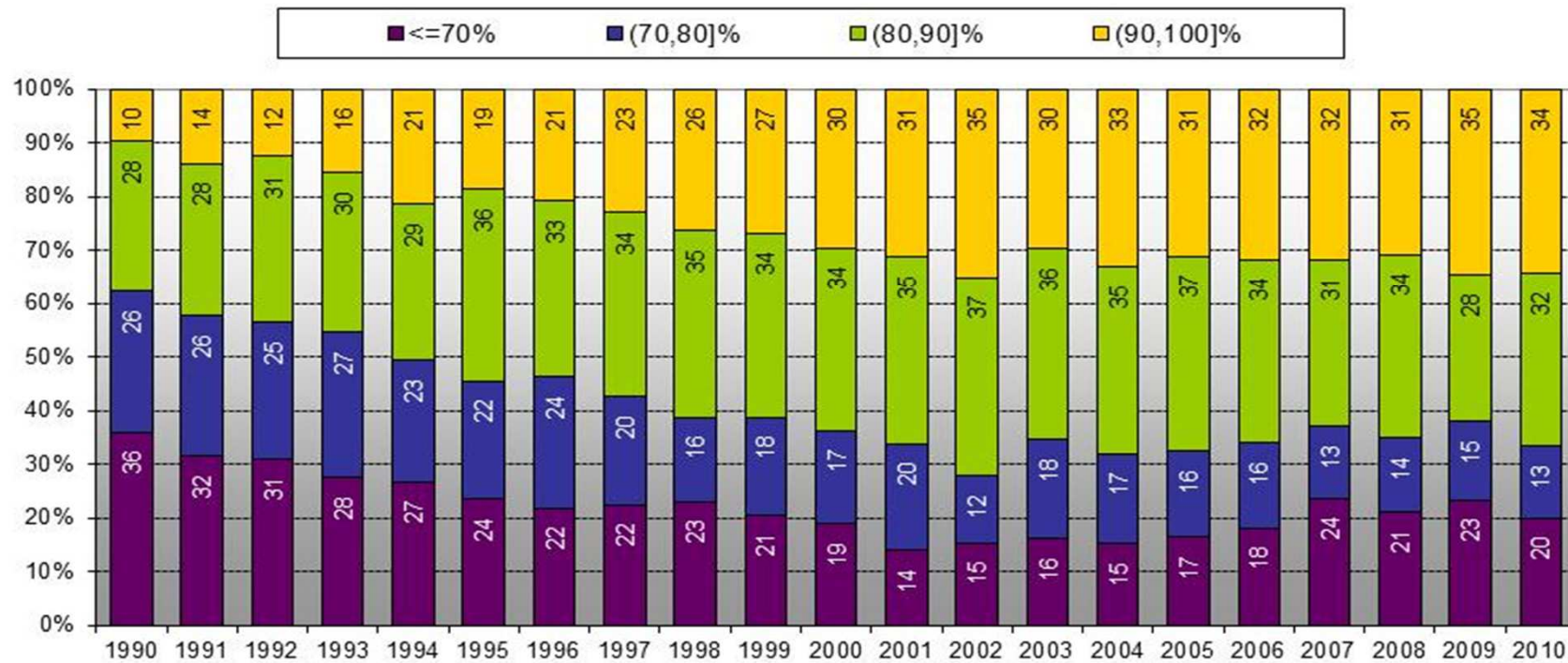


EAF in intervals

Number of not operated reactors

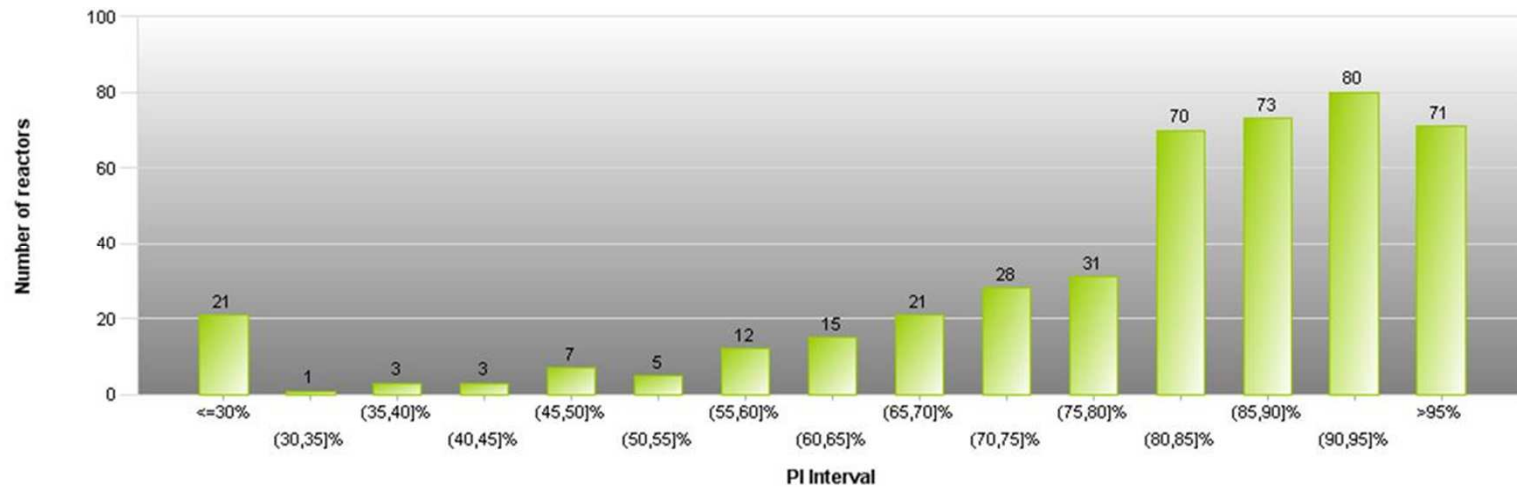


Percentage of reactors in energy availability ranges
EAF

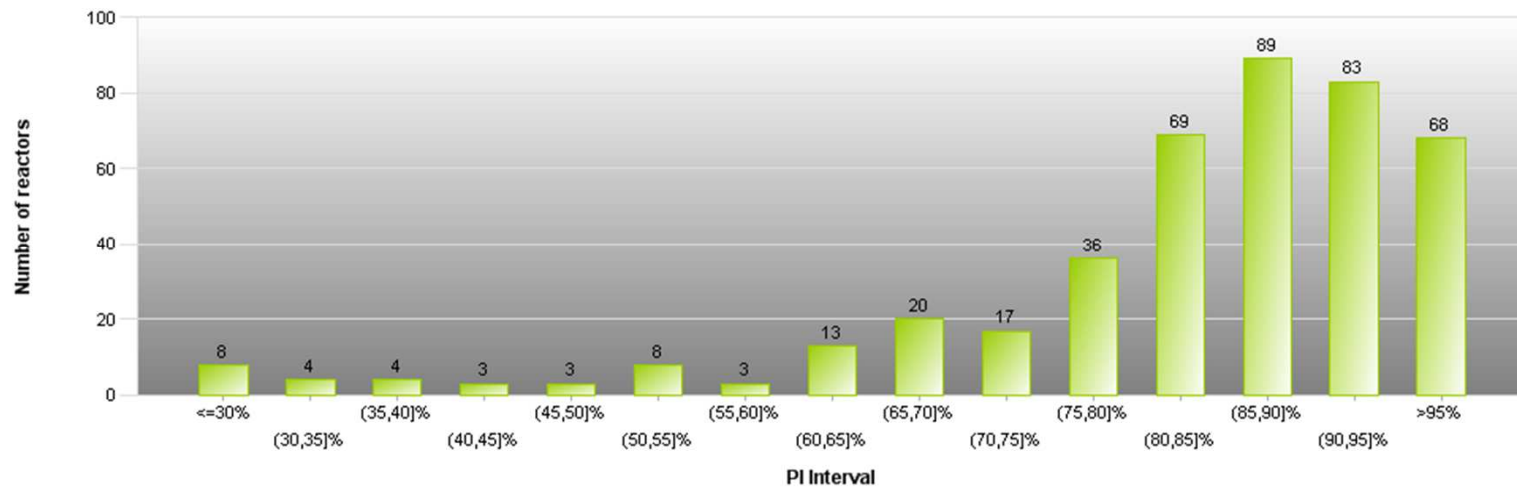


EAF histograms

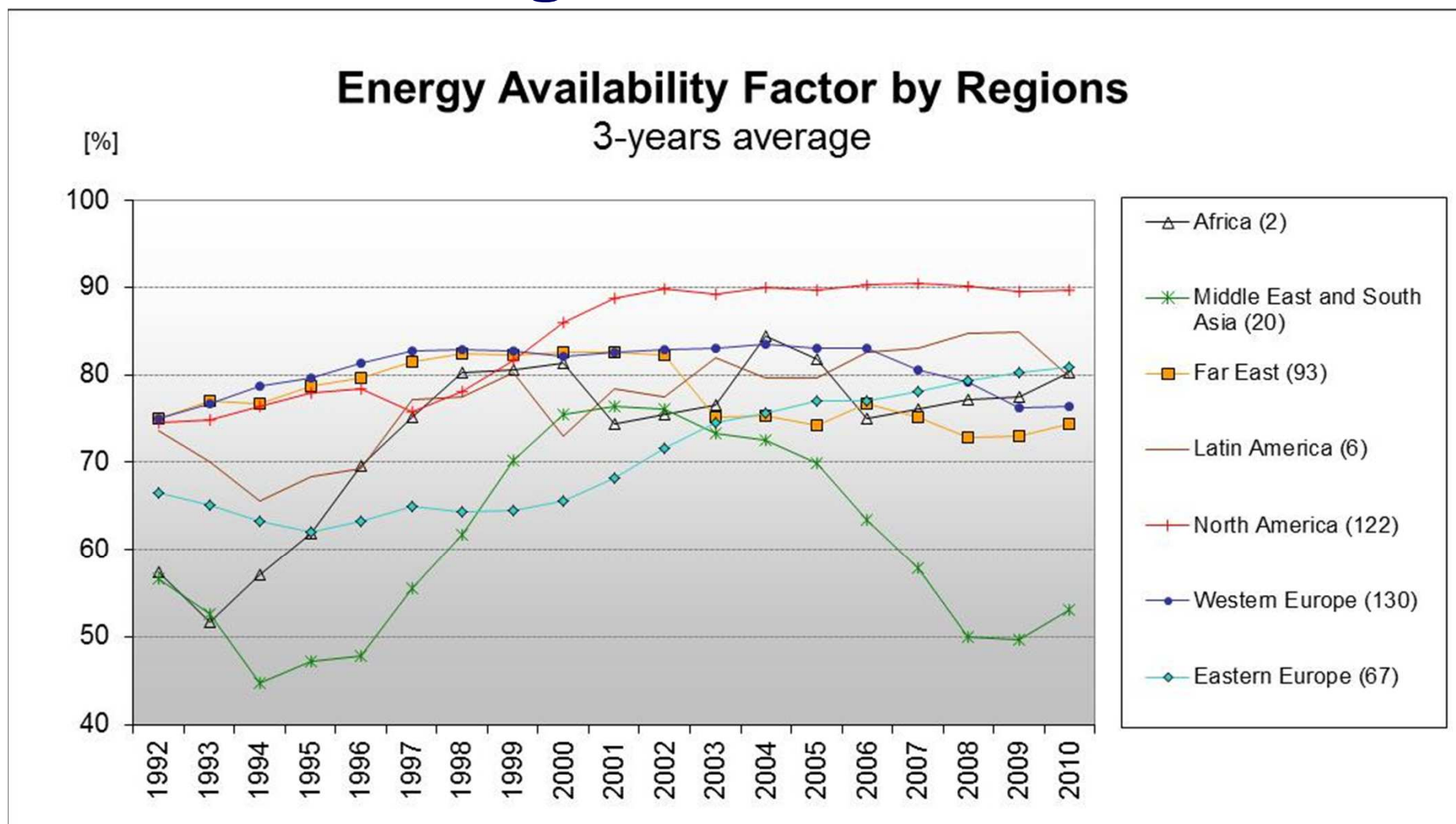
2010



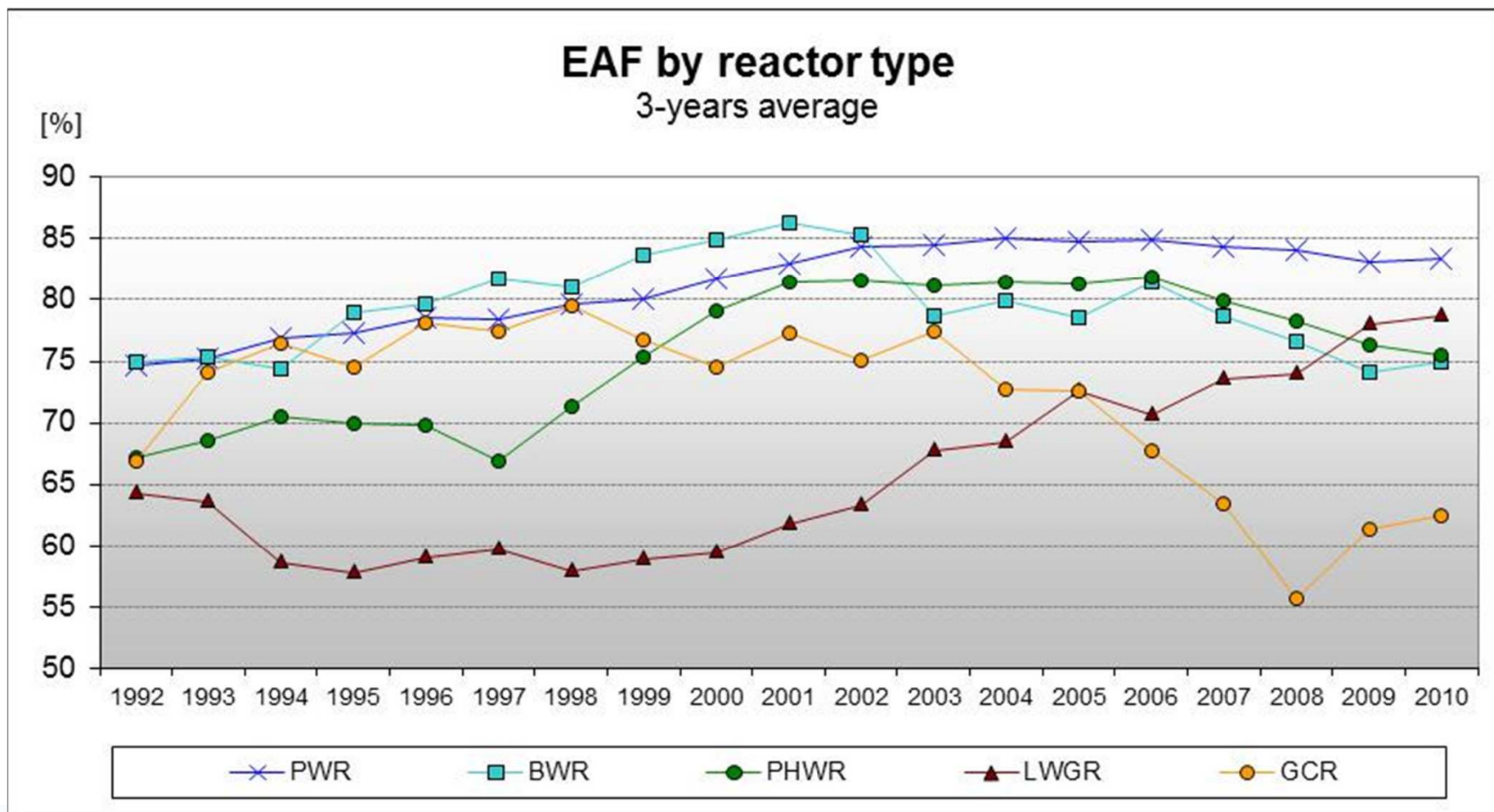
2002



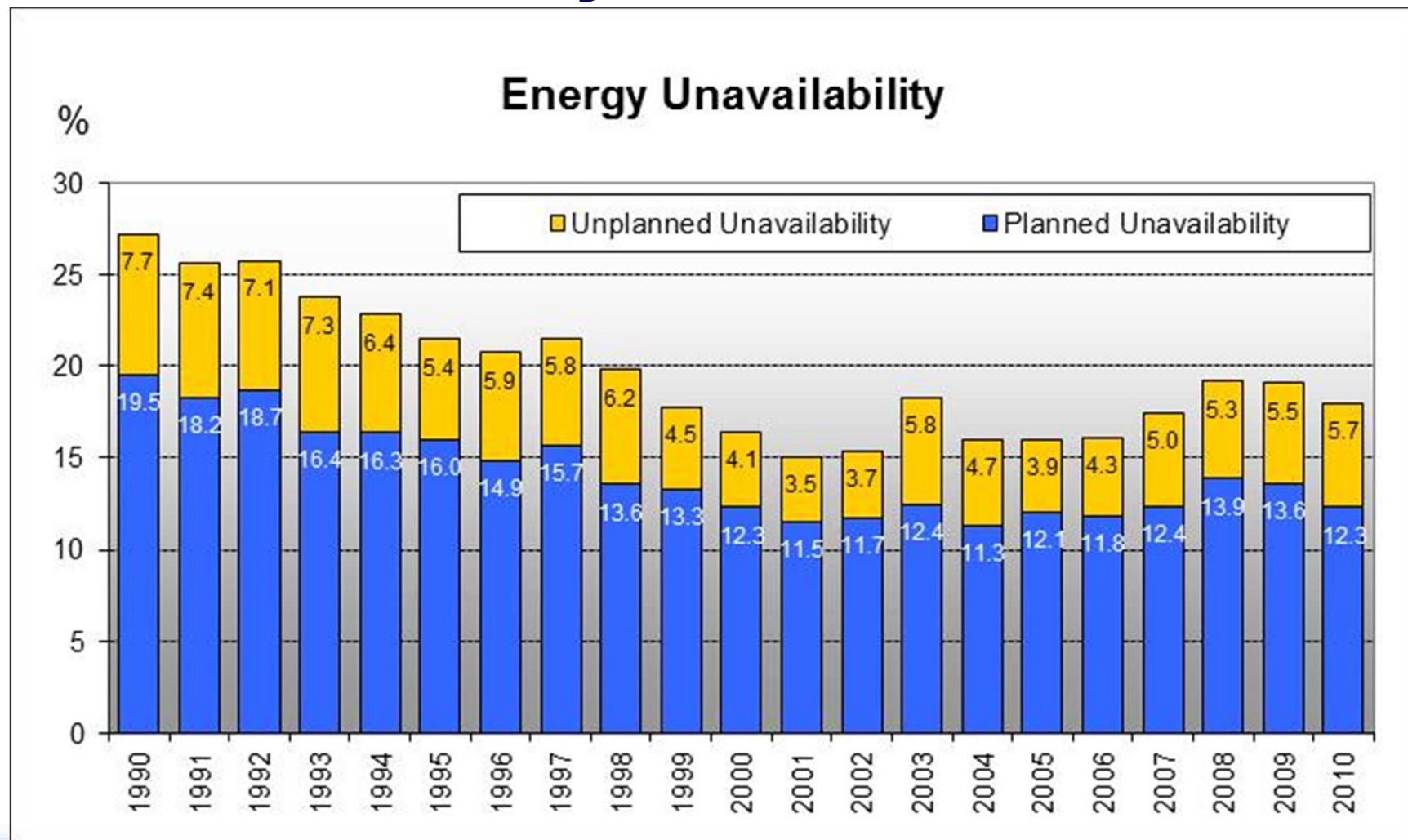
Regional trends



Performance by technology

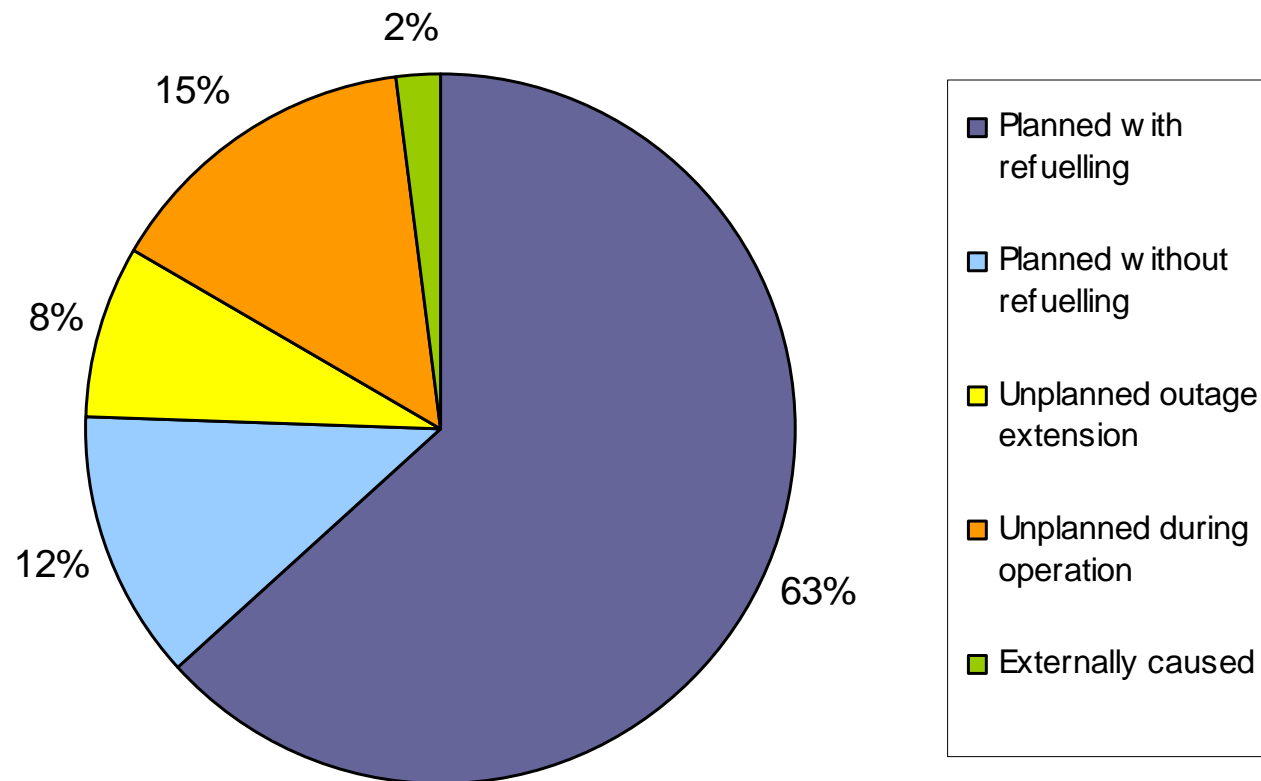


Unavailability

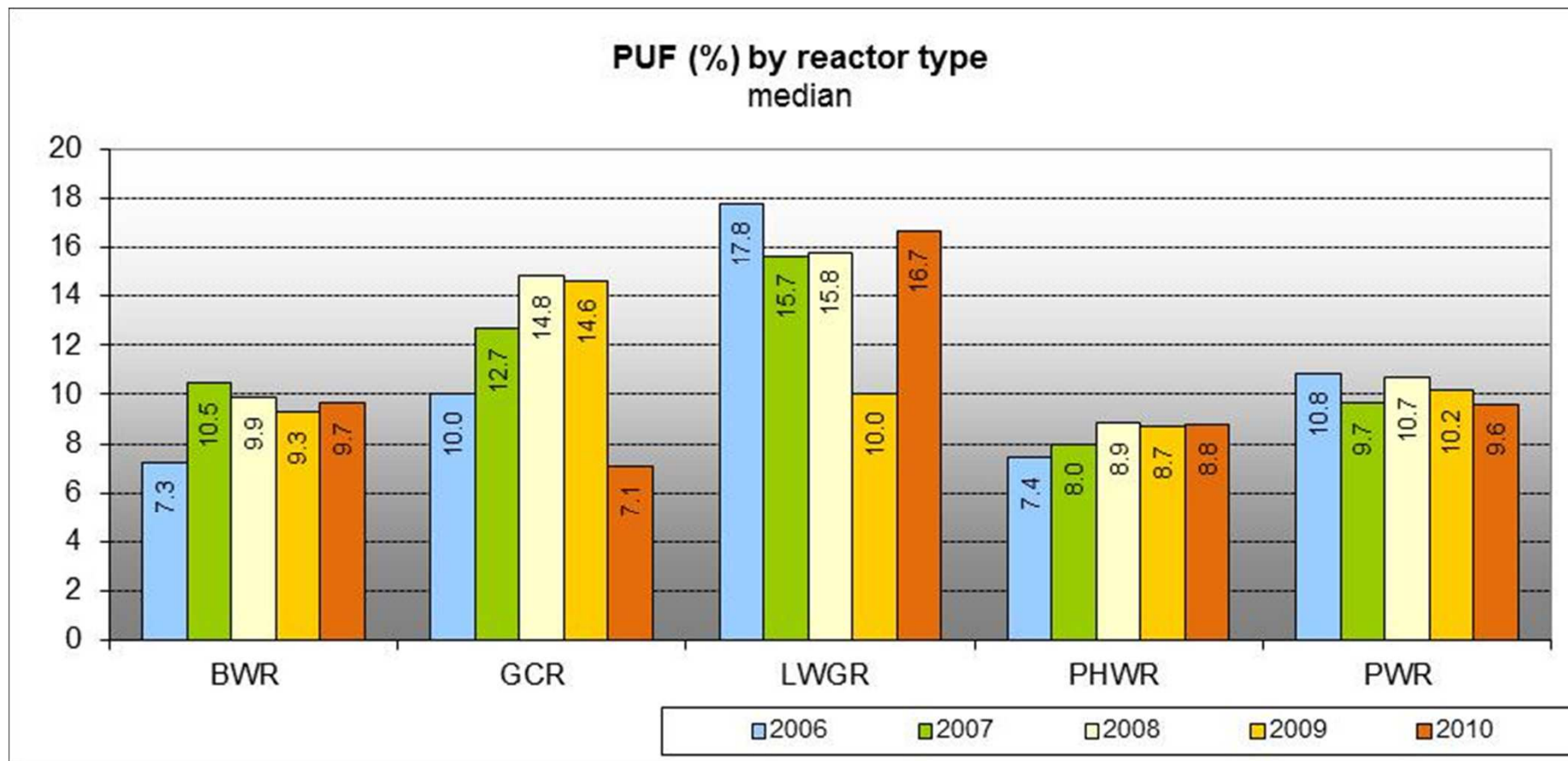


Outages by type

Grid disconnection break-down World



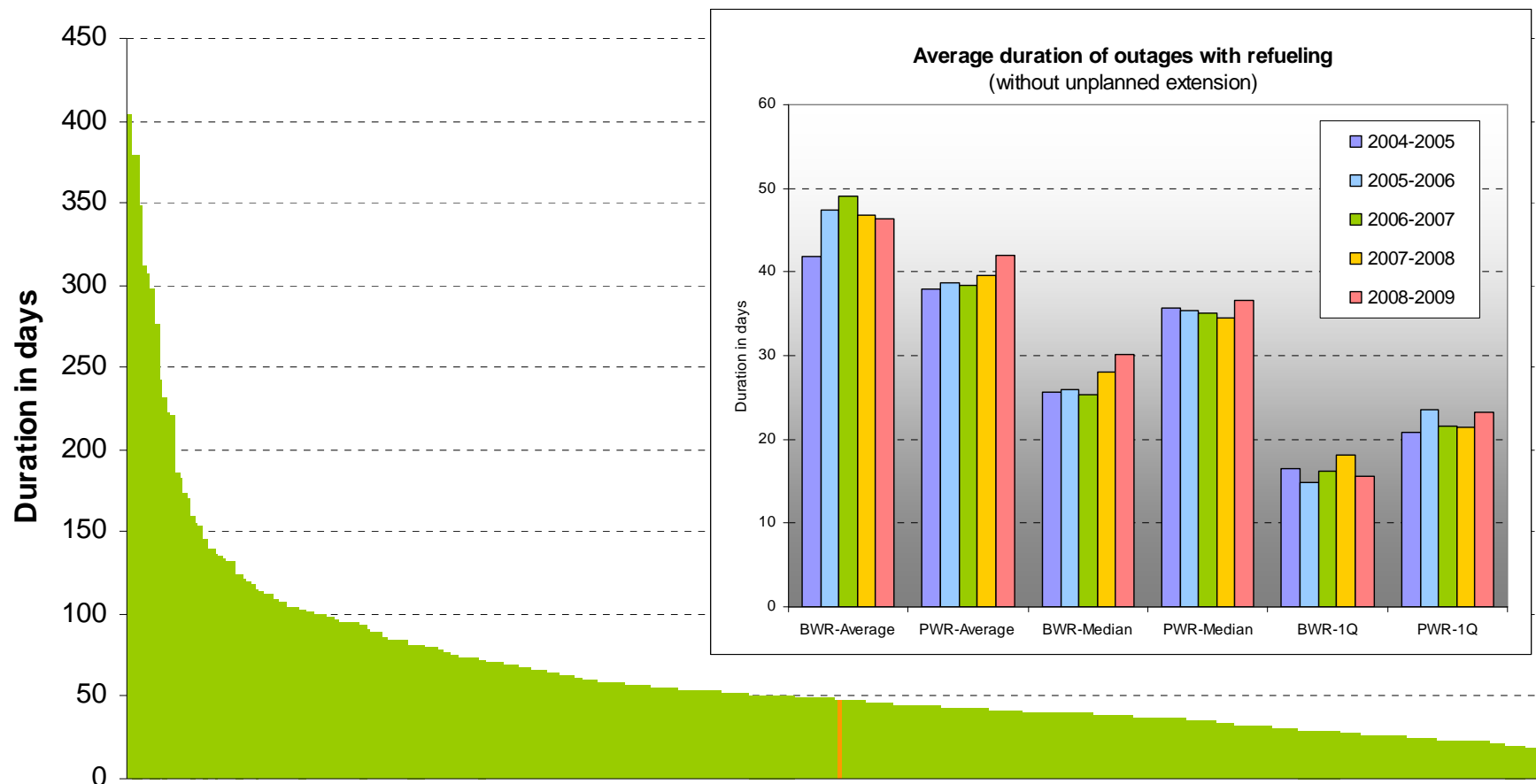
Planned Unavailability



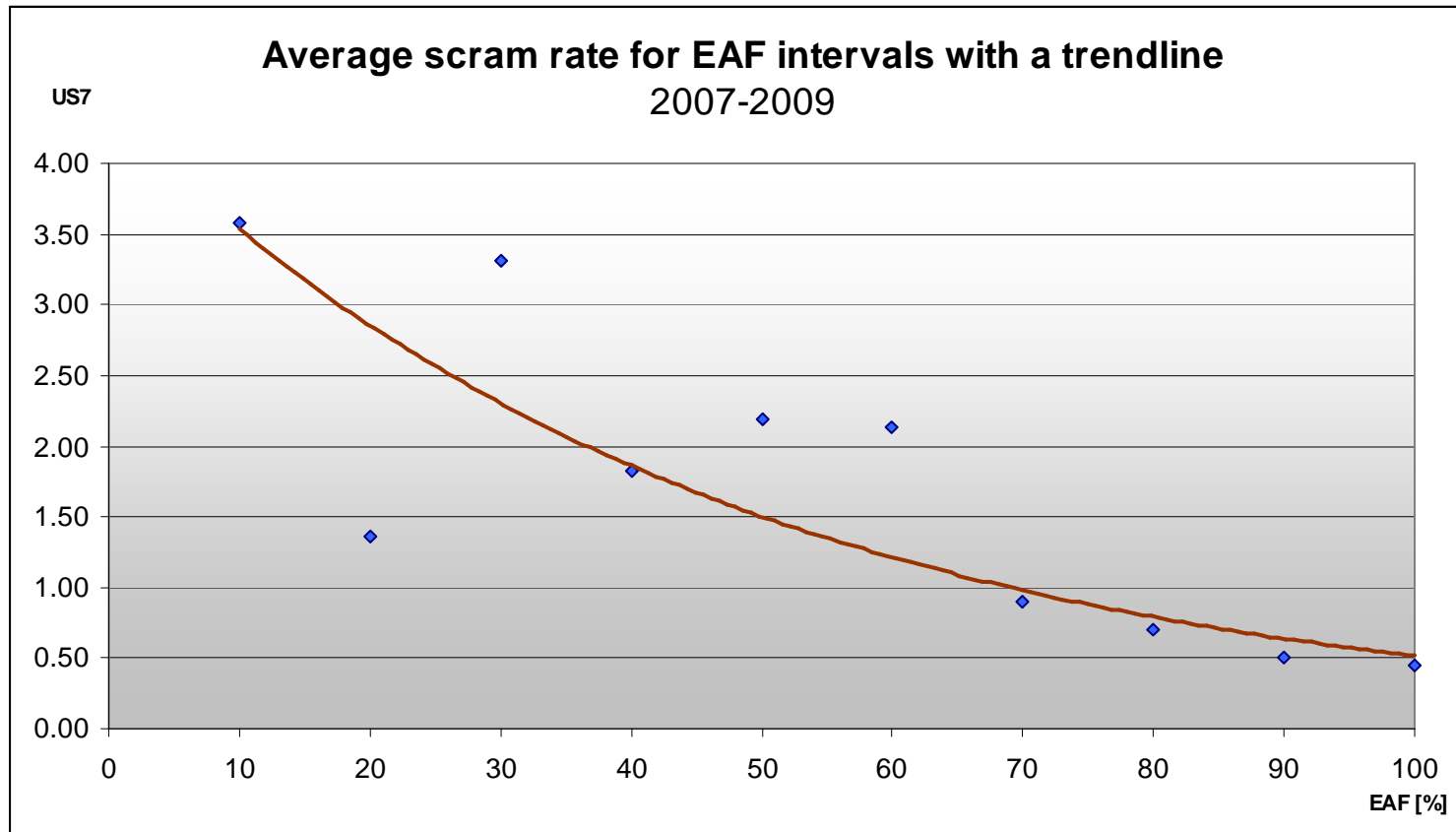
Refuelling outages for PWR and BWR

Average duration of refuelling

2007-2009



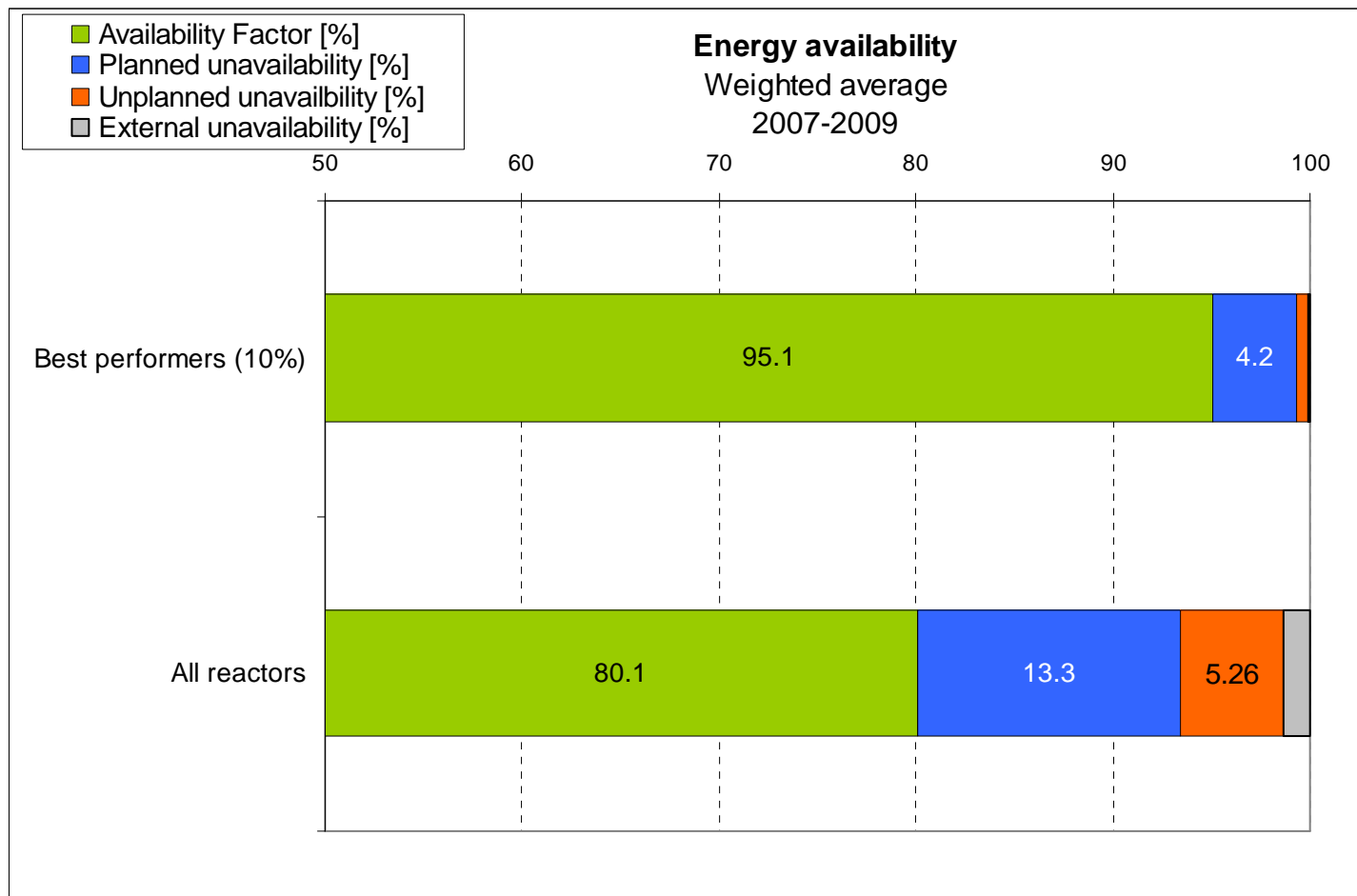
Operational and Safety Performance



Better operating performance improves competitiveness
and safety performance



Benchmarking



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



How to get information?

- Annual publications:
 - Nuclear Power Reactors in the World (since 1981)
 - Operating Experience with NPP (since 1970)
- Public website
www.iaea.org/pris
- Web-based on-line system “PRIS-Statistics” for registered users
prisweb.iaea.org/statistics

