



IAEA activities in the field of nuclear I&C engineering

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Dallas, Texas, USA, 8 October 2018



IAEA

International Atomic Energy Agency

Outline

- Introduction to the IAEA and a global nuclear power outlook
- Most significant issues in the nuclear instrumentation and control area today
- Current projects, IAEA publications in the I&C field

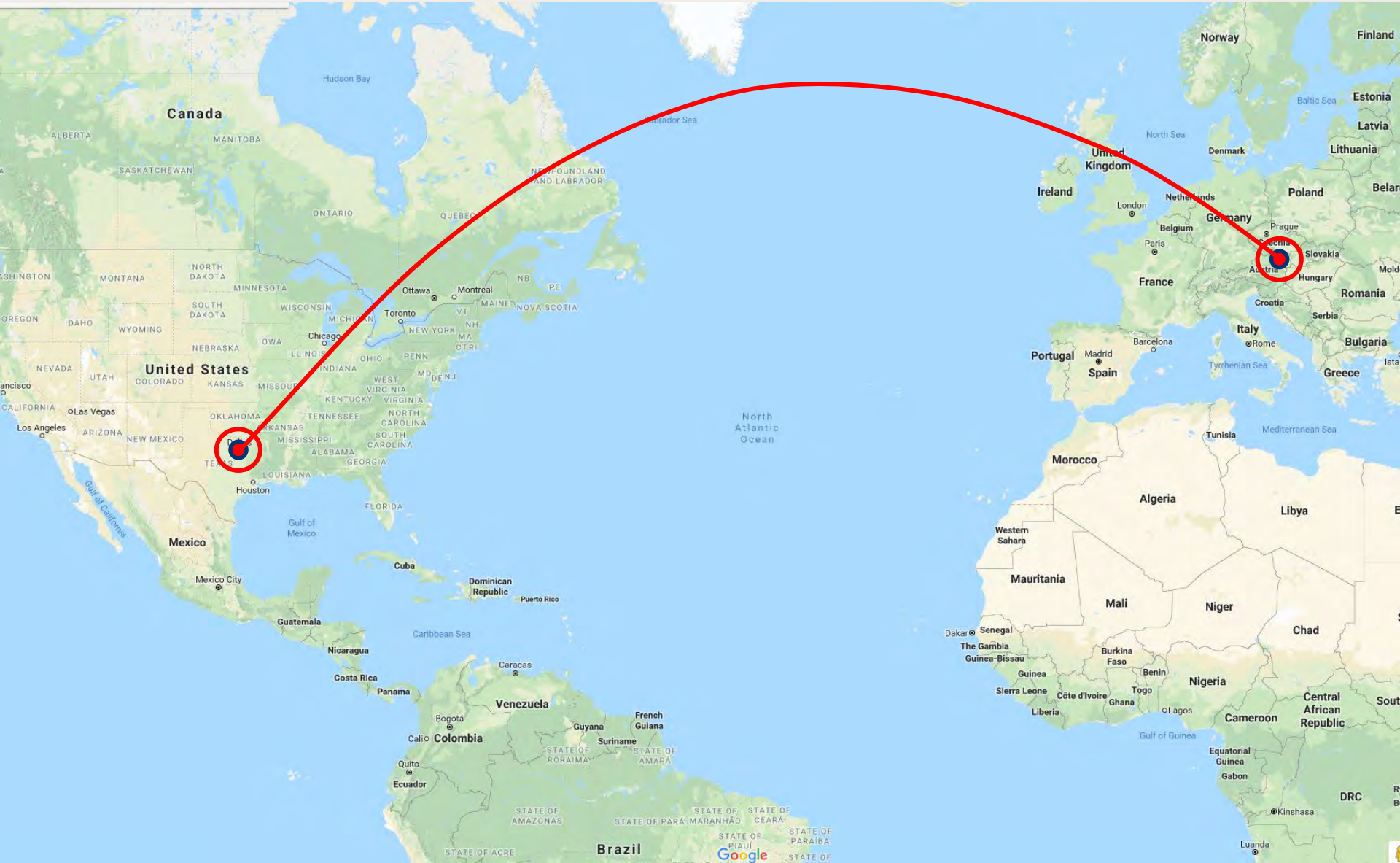
The IAEA in a nutshell and a global nuclear power outlook



IAEA

International Atomic Energy Agency

Vienna – Dallas



IAEA at a glance

- Founded in 1957



U.S. Pres. Dwight D. Eisenhower delivering his Atoms for Peace speech to the United Nations, 8 December 1953

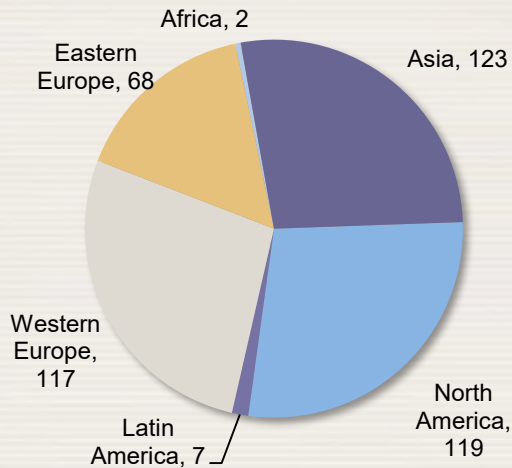
IAEA at a glance

- Founded in 1957
- 170 member states
- New member in 2018
 - Grenada
- 2453 staff
- Nobel Peace Prize



Global nuclear power status

Geographical distribution

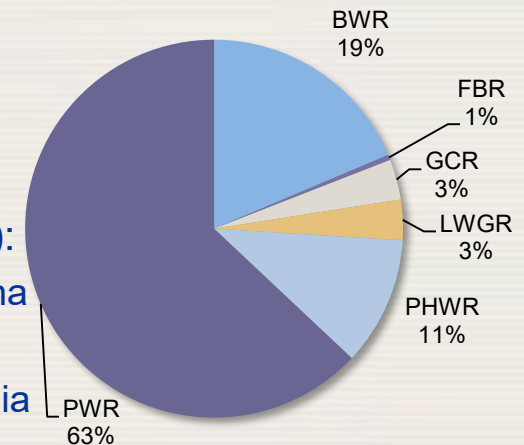


455 reactors in operation (400 GW_e)
 166 reactors in permanent shutdown
 55 reactors under construction
As of Sept 2018

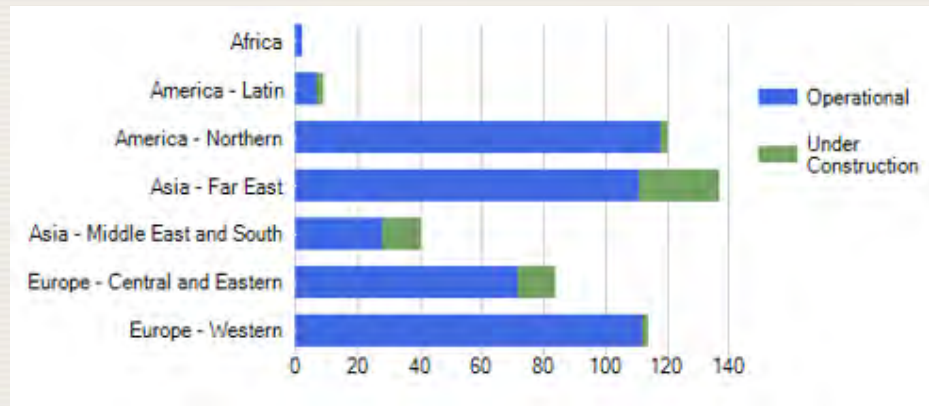
Latest connections to the grid (7 in 2018):

- ❖ SANMEN-1 and 2, 1000 MW(e) PWR, China
- ❖ TAISHAN-1, 1660 MW(e) PWR, China
- ❖ LENINGRAD 2-1, 1085 MW(e) PWR, Russia

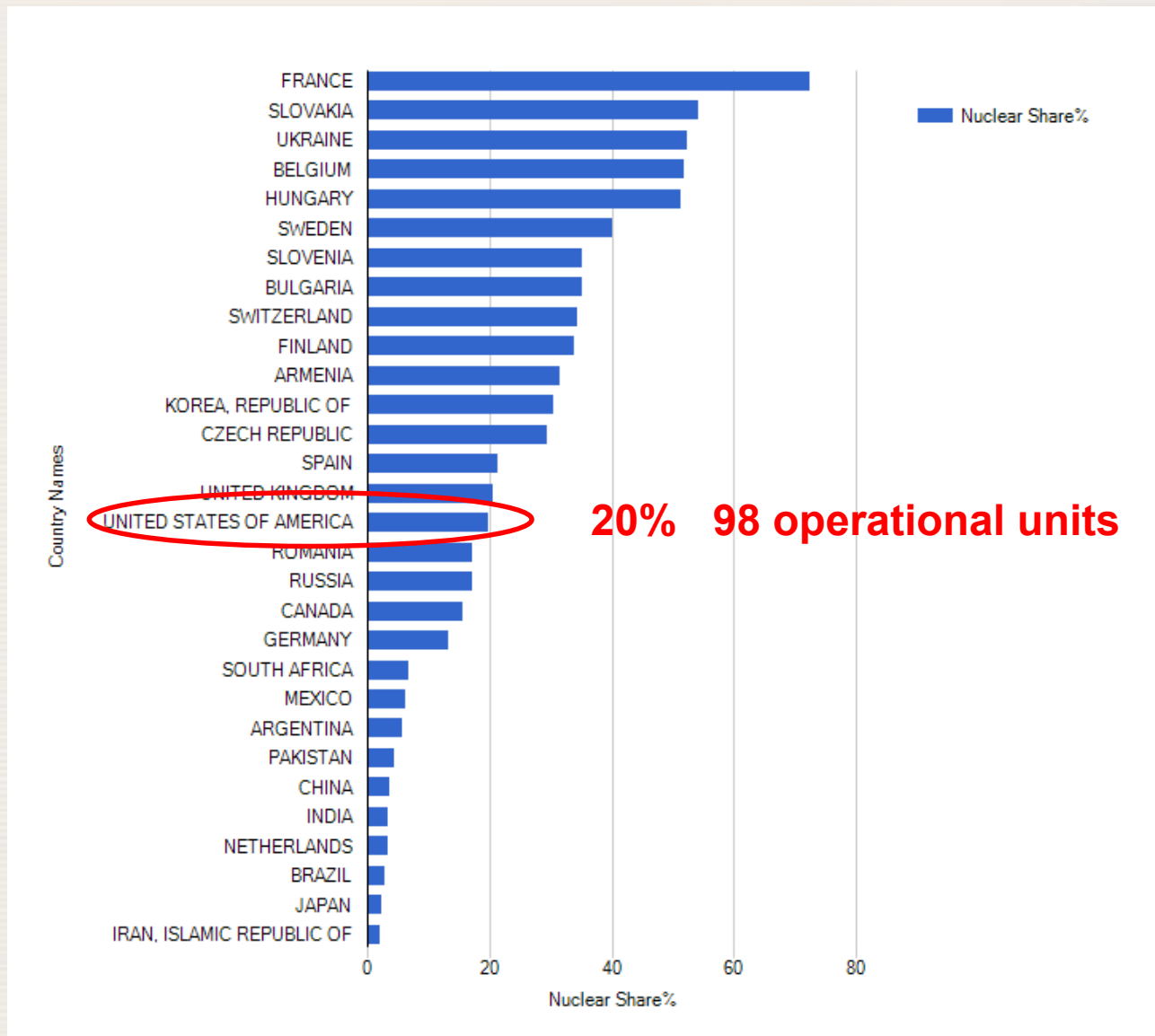
Reactor capacity by type



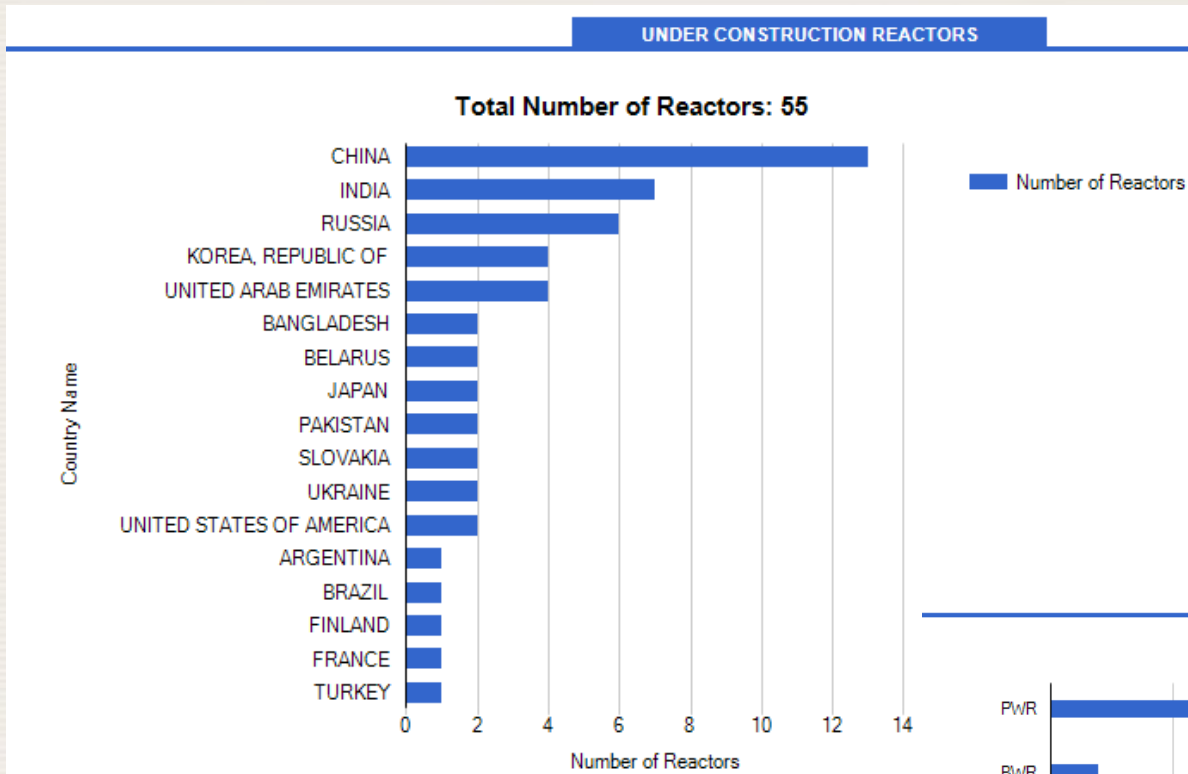
Website: <http://www.iaea.org/pris/>



Nuclear share of electricity generation in 2017

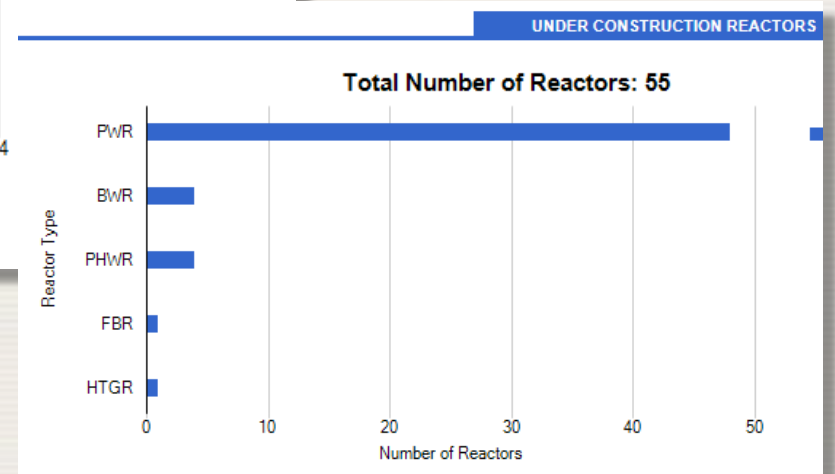


Reactors under construction in the world

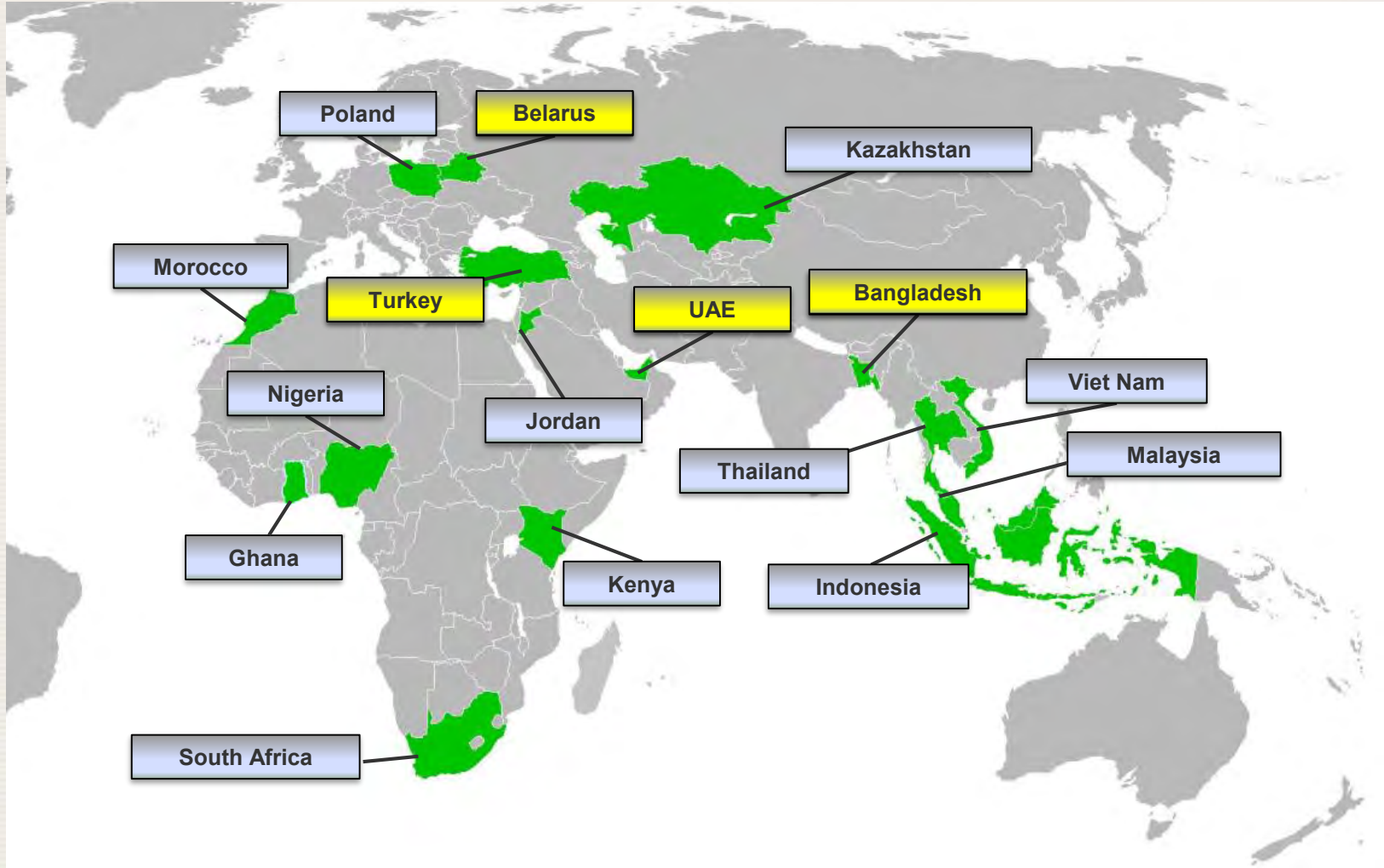


The total Number of Reactors includes also 2 reactors in Taiwan, China

As of Sept 2018



Who are the newcomers?



Newcomers with 1st NPP under construction

UAE, Barakah, July 2012



Belarus, Belarussian, Nov 2013



Bangladesh, Rooppur, Nov 2017

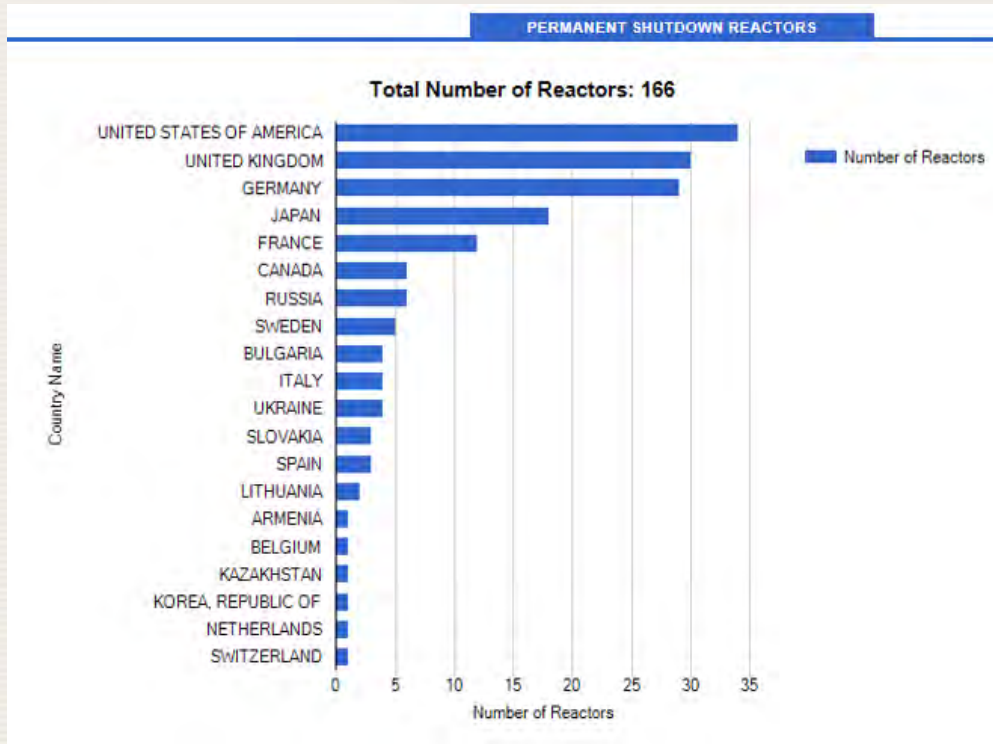


Turkey, Akkuyu, Apr 2018



Permanent shutdowns

7 reactors announced early shutdown in 2015,
4 reactors in 2016,
and 5 reactors in 2017



As of Sept 2018

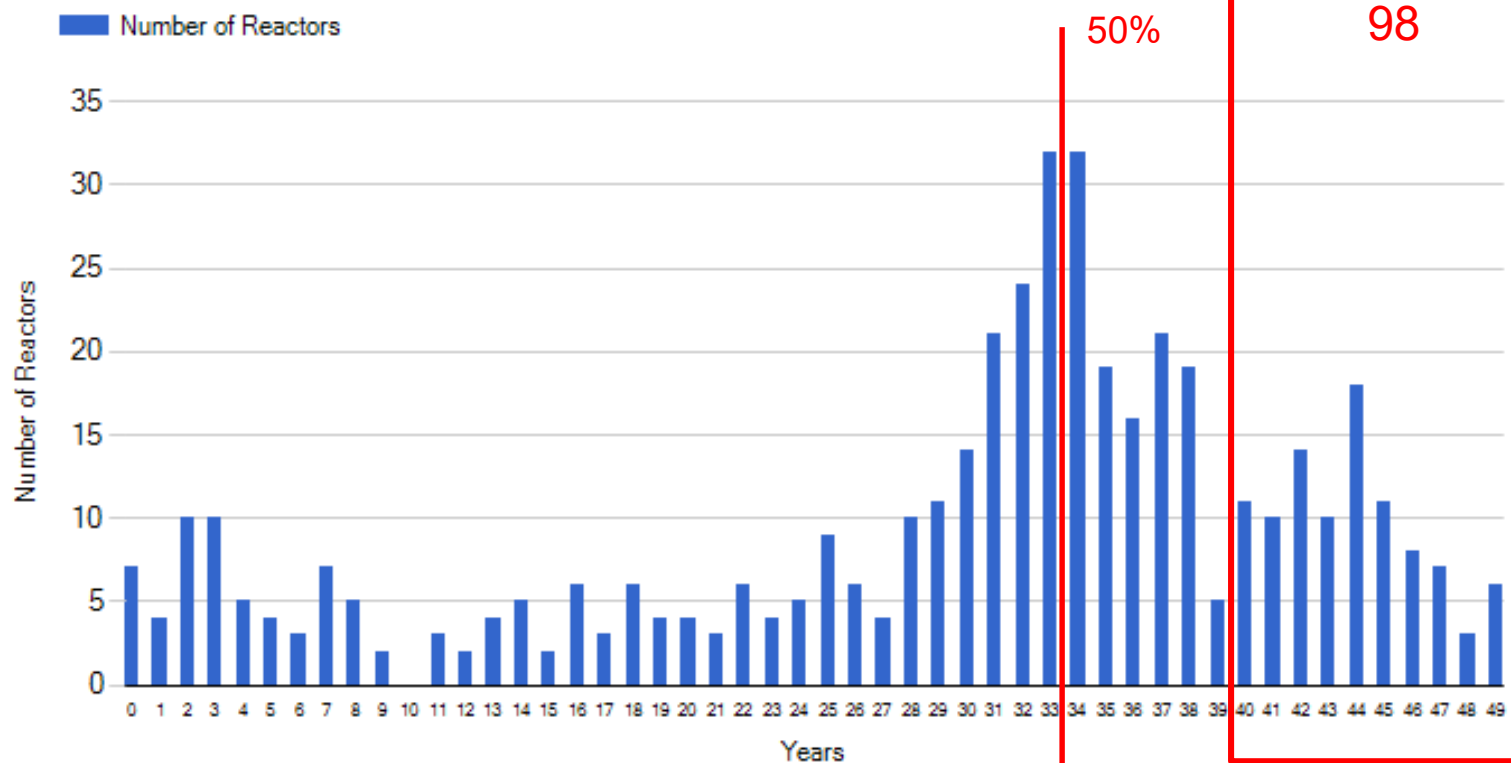


Mainly economic reasons
Decommissioning & dismantling

Age of operating reactors

OPERATIONAL REACTORS BY AGE

Total Number of Reactors: 455



Most significant issues in the nuclear instrumentation and control area today



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TWG group photo from 2017

- The program for 2018 - 2021 was compiled in the last biennial meeting in 2017



Current challenges in the nuclear I&C field

- **Safety, security and licensing**-driven issues
 - Enhancement of safety through improved systems and processes
 - Implementation of all necessary post-Fukushima improvements
 - Harmonization of standards, licensing practices, and safety classification schemes
 - Issues with software dependability (common cause failure)
 - Digital communications, independence, computer security
- **Economic** driven issues
 - Improvement of plant efficiency, increase of plant and personnel productivity for cost-effective operation -> competitiveness
 - Long term operation -> ageing management
 - Rapid evolution of digital technologies -> obsolescence management

Current challenges in the nuclear I&C field (2)

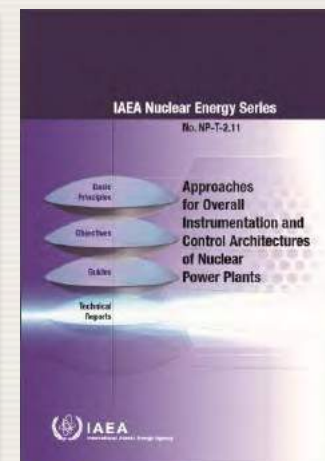
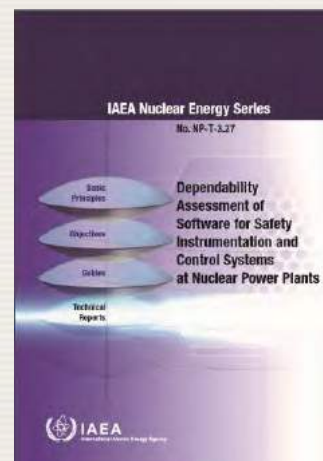
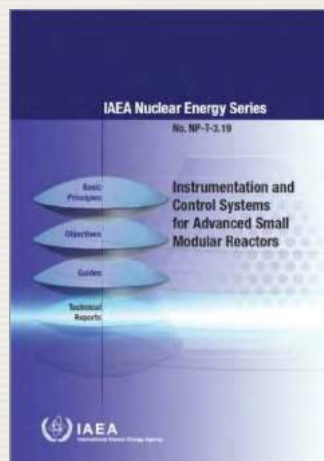
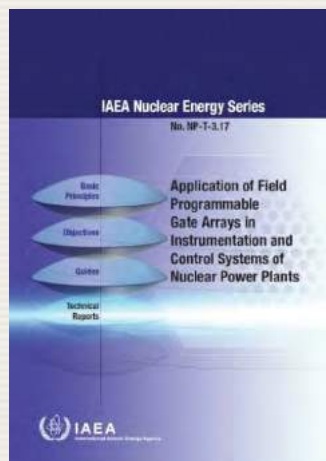
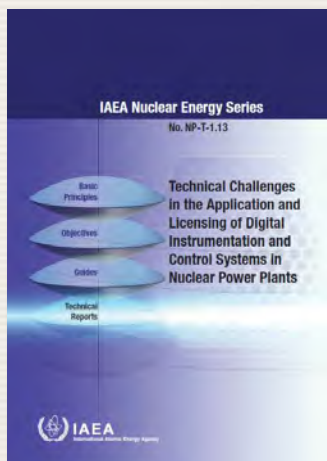
- Issues related to **new technologies**
 - Use of wireless technologies
 - Use of new information and communications technologies
 - Use of new Human Factors Engineering technologies
 - New reactor designs such as small modular reactors (SMRs)

Priority list of topics from the TWG to the IAEA

- I&C **architectural** approaches
- Engineering and design aspects of **computer security** in NPP I&C systems
- The application of **wireless technologies** in NPP I&C systems
- Justification of **commercial industrial I&C equipment** for NPP application
- I&C aspects of **human factors engineering** / HFE design and analysis
 - Computer screen (VDU) based **control room technologies**
- **Aging management** of I&C and electrical equipment and components
- Harmonization of **codes, standards, and safety** classifications
- I&C support for plant process **performance optimization** and **improvement**
- **Configuration management** of I&C systems
- Application of **smart field devices**

Recent Nuclear Energy Series publications

- Technical **Challenges** in the **Application and Licensing** of Digital I&C Systems in NPPs
- Application of **FPGAs** in I&C Systems of NPPs
- I&C Systems for Advanced **Small Modular Reactors**
- Dependability **assessment of software** for safety I&C systems at NPPs
- Approaches for overall **I&C architectures** of nuclear power plants



The IAEA report

- Nuclear Energy Series
 - NP-T-3.17
- Chairman: Joe Naser
- 79 pages
- 6 main chapters

IAEA Nuclear Energy Series

No. NP-T-3.17

Basic
Principles

Objectives

Guides

Technical
Reports

**Application of Field
Programmable
Gate Arrays in
Instrumentation and
Control Systems of
Nuclear Power Plants**

List of participants at the 1st CS meeting

- Andrashov, A. Radiy, Ukraine
- Naser, J. EPRI, United States of America
- Arndt, S. US NRC, United States of America
- Seaman, S. Westinghouse, United States of America
- Eiler, J. International Atomic Energy Agency
- Glockler, O. SunPort SA, Switzerland
- Thuy, N. EDF R&D STEP, France
- Zeng, H. SNPAS, China



List of participants at the last CS meeting

- Eiler, J. International Atomic Energy Agency
- Russomanno, S. Global Nuclear Solutions Inc., Canada
- Thuy, N. EdF R&D STEP, France
- Gassino, J. IRSN, France
- Arndt, S. US NRC, United States of America
- Naser, J. EPRI, United States of America
- Glockler, O. SunPort SA, Switzerland





Structure

- Foreword
- 1. Introduction
- 2. Introduction to FPGA technology
- 3. Methods and tools for development and verification
- 4. Licensing
- 5. Replacement systems and new NPP designs
- 6. Summary
- References
- Annex I: Specific application examples and experience
- Annex II: Typical life cycle for an FPGA platform
- Glossary



Links to access IAEA publications on I&C

- For Nuclear Energy I&C webpage and publications
 - <https://www.iaea.org/topics/operation-and-maintenance/instrumentation-and-control-systems-for-nuclear-power-plants>
- For all Nuclear Energy Series publications
 - <https://www-pub.iaea.org/books/IAEABooks/Series/134/IAEA-Nuclear-Energy-Series>
- IAEA publications in general
 - <https://www.iaea.org/publications>

Major meetings planned for 2019

- 27th Meeting of the **Technical Working Group** on Nuclear Power Plant Instrumentation and Control, 22-24 May 2019, Vienna, Austria
 - Technical meeting on “Critical **Challenges with Digital** Instrumentation and Control Systems at Nuclear Power Plants”, 8-11 October 2019, Budapest, Hungary
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- 11th International Topical Meeting on Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (**NPIC & HMIT 2019**), 9-14 February, 2019, Orlando, FL, USA

Thank you for your attention!



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