Efemeral Nuclear Power Plants…

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Nuclear energetics: 70 years history (1954-)

626 units were put into operation worldwide until now

416 units: in operation

210 units: permanent shutdown

59 units under construction

criteria of a successful nuclear power plant lifecycle

- the nuclear energetics and the project was accepted by public
- builds without significant delay
- put into operation
- operating without major incidents and unplanned shutdowns
- completes its planned lifetime (typically several decades)
- after shutdown the plant is successfully decommissioned
- economically cost-effective, cost meets with the calculations

Examples on successful Nuclear Power Plant projects

Obninsk APS-1

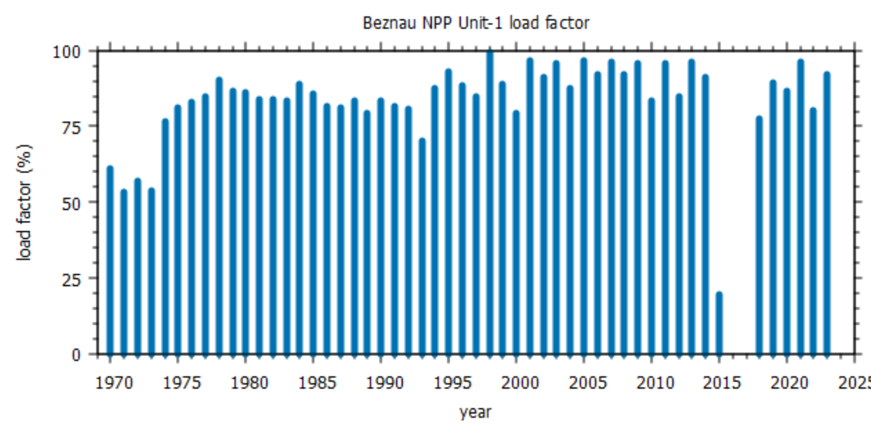
5 MWe since December 1, 1954

operational until 2002 (48 yrs)

KKW Beznau

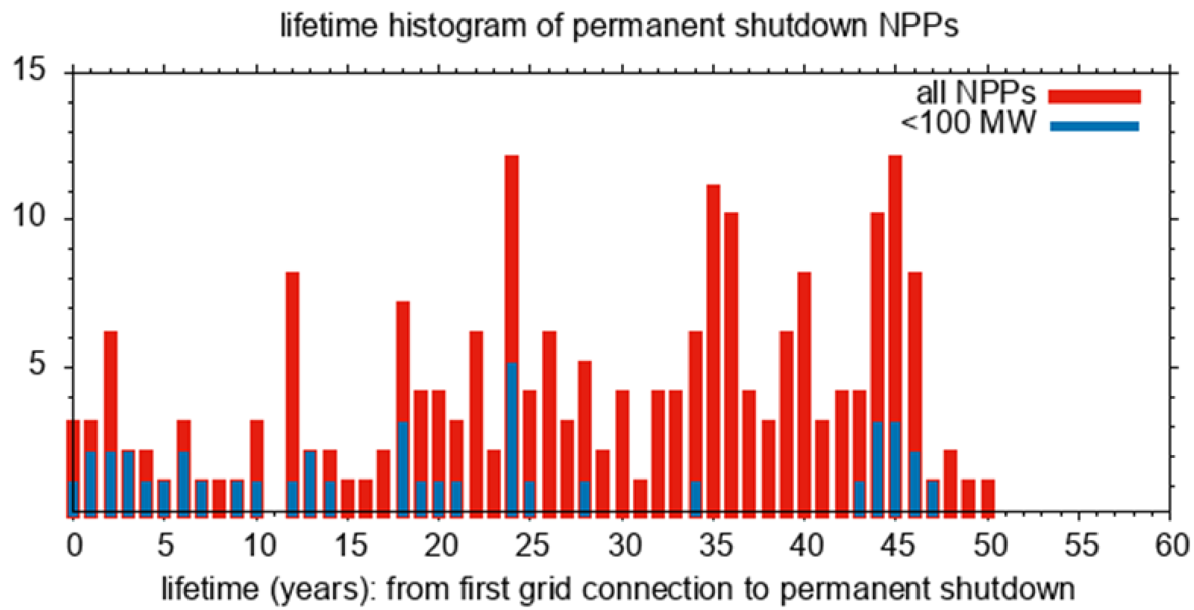
Unit 1: 365 MWe

operational since 1969 (55 yrs)



However many Nuclear Power Plant projects were not so successful

- construction works were suspended, the project was abandoned
- construction was completed but never put into operation
- operation suspended or permanent shutdown after relatively short operation time
- economical issues are not discussed here



The diagram is based on 207 permanently shutdown NPP units. The majority of NPP units were in operation for 20 – 50 years, but a significant number of units had been operated definitely shorter time: 53 NPP units of the a 207 (26%) had been in operation for less than 20 years, while 23 NPP units (11%) for less than 10 years.
The histogram shows separately the NPP units with less than 100 MW electric power. Some of them are experimental constructions, tests for new concepts. In this category short operation time is more common, since these units were stopped if the construction was not successful in practice.

However considering the > 100 MW power reactors, 10 of them had been operating for less than 10 years, while additonal 21 units had been operating for less than 20 years. This is a significant number of shortly operating NPPs probably significant economically as well, mainly for the concerned countries.

Greifswald NPP

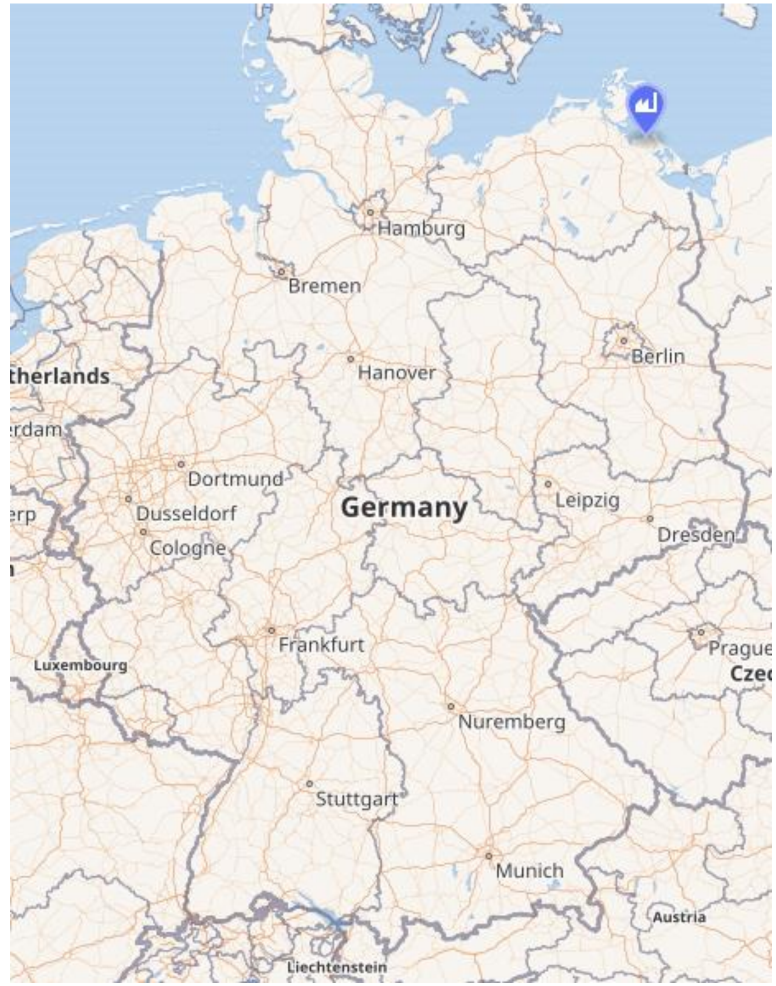
Units 1-4: VVER-440 / 230 (1973,1974, 1977,1979 - 1990)

Units 5-8: VVER 440 / 230

Unit 5: in operation: April to November 1989 (6 months)

Unit 6: finished but never operated (1989/90)

Units 7-8: not finished, project cancelled (1990)



Unfinished nuclear power plants in Europe

CIRENE NPP

CIRENE (CISE Reattore a Nebbia) uses heavy water as its neutron moderator and normal "light" boiling water as the coolant. This reduces the amount of heavy water required for operations compared to CANDU, still using natural uranium as fuel.

The plant was completed in 1988. It was then abandoned, never loaded with fuel. After the Chernobyl-disaster a referendum in 1987 ended the development of nuclear power in Italy and since then all existing power-reactors have been shut down.

Montalto di Castro NPP

Two Mark III type BWR units from General Electric , each of 982 MWe, was approaching completion in 1988 when the Italian government decided to close all nuclear plants as a result of the 1987 referendum. In February 1988 the two units were 80% complete.

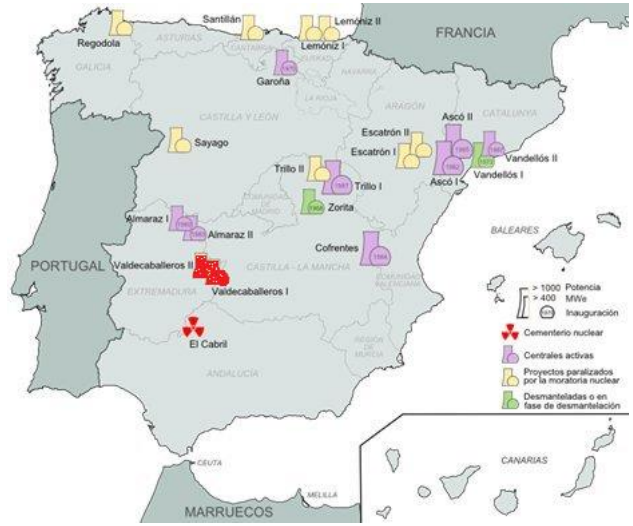
Lemoniz NPP

Basque province of Bizkaia

Its construction stopped in 1983 when the Spanish nuclear power expansion program was cancelled following a change of government. Its two PWRs, each of 900 MWe, were almost complete but were never operated.

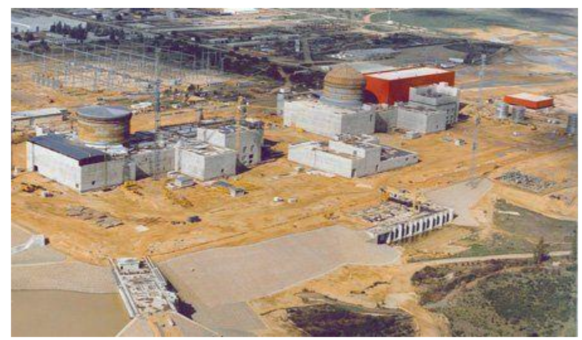
Conflict concerning the Lemóniz Nuclear Power Plant was one of the major anti-nuclear issues in the 1970s and 1980s in Spain. It faced major opposition from the Basque anti-nuclear movement and the Basque armed separatist organization ETA.

Valdecaballeros NPP

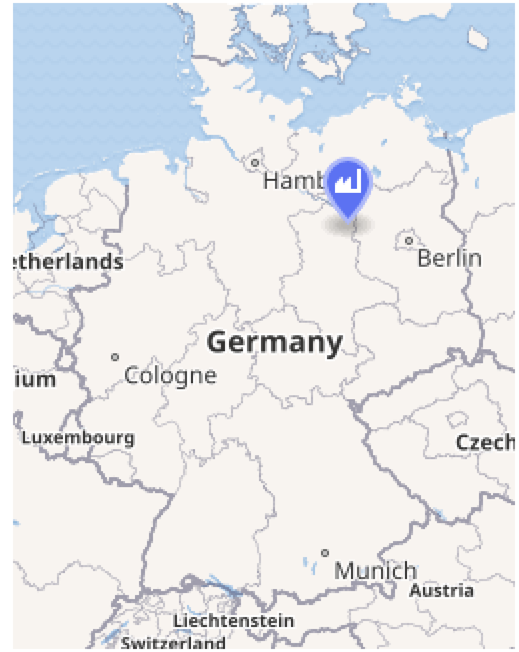


Badajoz Province, Extremadura

It was under construction in 1983 when the Spanish nuclear power expansion program was cancelled following a change of government.
Its two General Electric BWR-6 reactors, each of 975 MWe, were mothballed, one 60% complete and the other 70% complete. In 1994, the decision was taken that the plant would not be completed.



Stendal-1,2



2 * VVER-1000 / 320 (more two were planned)

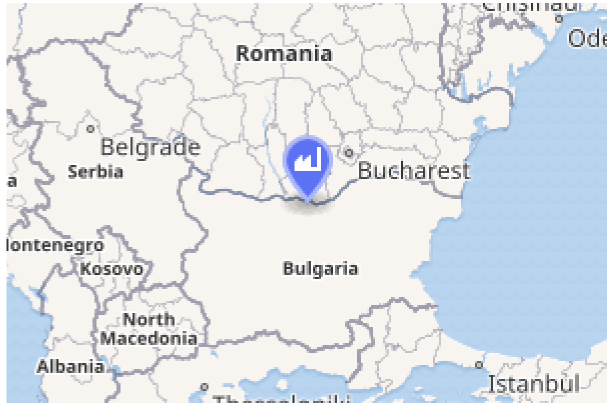
The construction works were discontinued after the German re-unification. Unit 1 was about 85% finished and unit 2 was about 15% finished, while and units 3 and 4 remained in planning.

Belene

VVER-1000/320 – 4 units were planned, construction of unit 1 was started

It was intended to substitute the Kozloduy Nuclear Power Plant (4*VVER-440) that were decommissioned as a prerequisite for Bulgaria to join the European Union.

On June 11, 2010, the Bulgarian government announced an indefinite freeze on the planned construction of the Belene nuclear power plant because it was uncertain on the duration of the return on investment.



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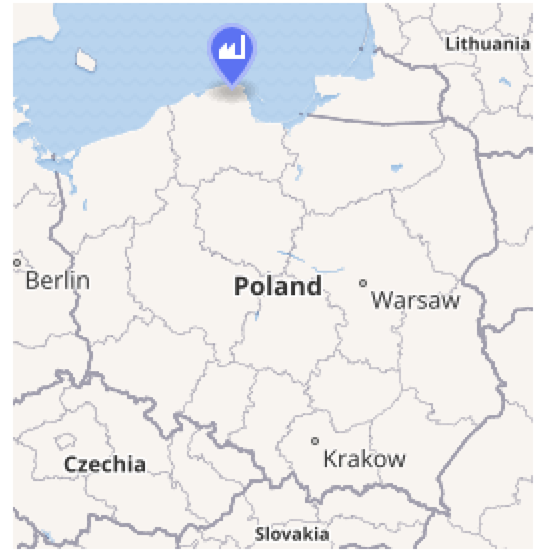


4 * VVER-440/231

It was to be the first nuclear power plant in Poland. The construction was cancelled in 1990 due to changes in the economic and political situation in Poland, in the Soviet Union and in the Eastern Bloc and due to the Chernobyl disaster in 1986 and the following years.

Marviken NPP

PHWR: 130MWe

dual use: power generation & plutonium production

central role in the Swedish nuclear weapon programme. During the mid 1960s, the social democratic government officially abandoned the project of designing Swedish nuclear weapons and the Marviken plant became derelict. It was never loaded with fuel, and the project was cancelled in 1970.

It soon became clear that heavy water technology had to be improved if it was to remain competitive. Nuclear technology was commercialised in the early 1960s and several foreign manufacturers sold turnkey light water reactors. These had a significantly lower cost for each generated kWh compared to Marviken-T. A decision was taken in 1971 to convert the plant for oil burning and an oil furnace was built adjacent to the existing turbine hall.

The reactor was used for experiments simulating various aspects of accident scenarios in nuclear power plants.

Nuclear power plants completed but never operated

Bataan NPP, Philippines

Westinghouse PWR 621 MWe

In response to the 1973 oil crisis, the Philippines began construction of a nuclear power plant. The Bataan Nuclear Power Plant was a focal point for anti-nuclear protests in the late 1970s and 1980s. The project was criticized for being a potential threat to public health, especially since the plant was located in an earthquake zone.

The plant at Bataan was completed in 1984 but never commissioned. The project was suspended due to safety concerns motivated by the Chernobyl disaster.

Zwentendorf NPP, Austria

Siemens BWR 723 MWe

The Zwentendorf Nuclear Power Plant was the first commercial nuclear plant for electric power generation built in Austria, of 3 nuclear plants originally envisioned (St. Pantaleon-Erla, St. Andrä in Kärnten). Construction of the plant was finished but the plant never entered service.

The start-up of the Zwentendorf plant, as well as the construction of the other 2 plants, was prevented by a referendum on 5 November 1978, in which a narrow majority of 50.47% voted against the start-up.

Following the 1978 referendum, no commercial nuclear power plant (built for the purpose of producing electricity) ever went into operation in Austria. In 1978, Austria enacted a law prohibiting the construction and operation of fission reactors for electrical power generation.

SNR-300, Kalkar, Germany

SNR-300 was a fast breeder sodium-cooled nuclear reactor built near the town of Kalkar, North Rhine-Westphalia, Germany.
The reactor was completed but never taken online.

In late 1972, Germany, Belgium and the Netherlands charged the Siemens subsidiary Interatom to build a fast breeder. The German government wanted to limit energy import, and a breeder facility was required to use the limited resources efficiently as the uranium supply in Germany was limited. The building commenced at the end of the same year.

In 1979 motivated by the Three Mile Island accident local anti-nuclear movements caused open questioning about the project. The construction was interrupted for 4 years with conclusion that the safety of the facility needs to be upgraded.

Before the elections in 1987 the German government unofficially decides not to take SNR-300 into operation just yet. The official cancellation of the SNR-300 is offered on March 21, 1991.

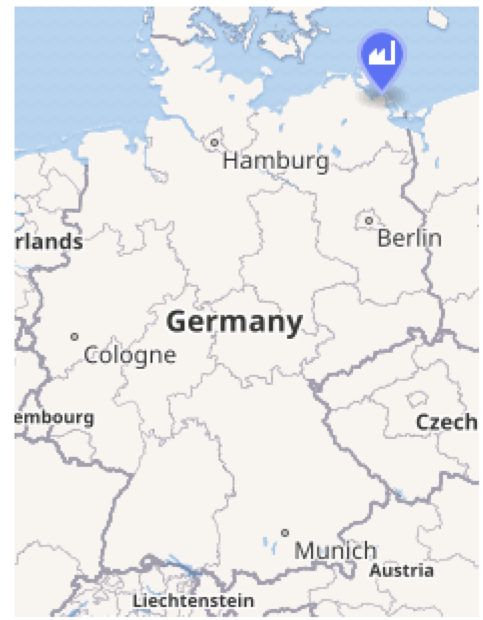
Greifswald-6, Germany (former GDR)

VVER-440/213.

Finished but never commissioned and operated.

Twin-block structure with unit 5.

All East German power-reactors were shutdown soon after the German reunification, due to the non-compliance with the West European safety standards. Convinced that upgrading to the new safety standards was not economically feasible, the operating units are stopped, units under construction are abandoned.



Greifswald NPP: Units 1-4: VVER 440/230 (without hermetic box and localisation tower)
Units 5-6: VVER 440/213 (upgraded version, with hermetic box and loc. tower)
Unit 5 was under test operation, unit 6 was finished but never commisioned.

Short lived nuclear power plants

power reactors $\geq$ 100 MWe

Greifswald NPP unit-5, Germany (former GDR)

VVER-440/213, 440 MWe

first grid connection: Apr 24, 1989
permanent shutdown: Nov 24, 1989
lifetime: **0.59 years**

Shuthdown at the German reunification due to non-compilance to West European safety standards.

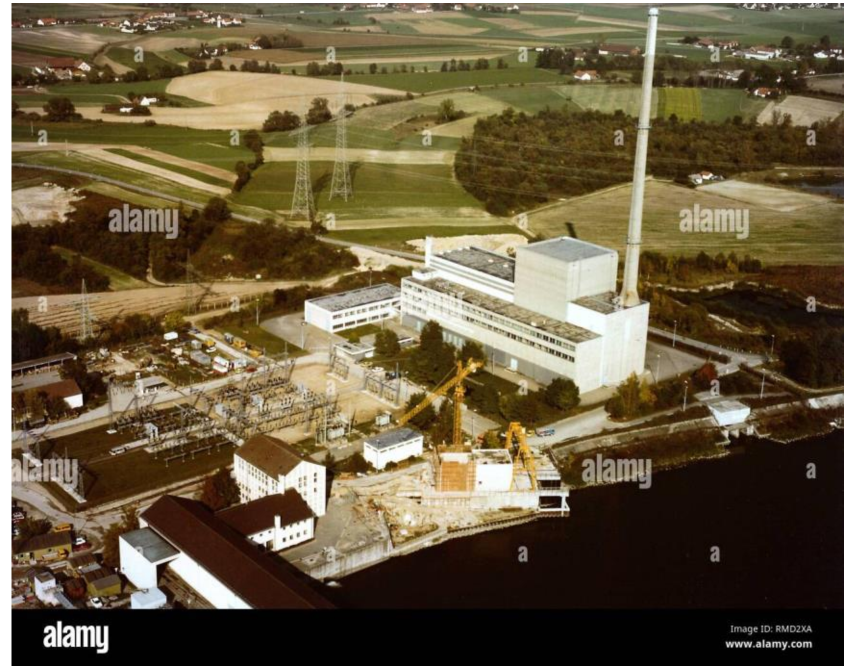
Three Mile Island, unit 2
United States

Babcock & Wilcox, 906 MWe

first grid connection: Apr 21, 1978
permanent shutdown: Mar 28, 1979
lifetime: **0.93 years**

Lost-of-cooling-agent (LOCA) and core meltdown happened as of March 28, 1979, rated INES level 5.

KKN Niederaichbach, Germany



heavy water moderated - gas cooled reactor (HWGC), 100 MWe

first grid connection: Jan 1, 1973
permanent shutdown: July 21, 1974
lifetime: **1.5 years**

Safety and maintenance issues caused the reactor to be decommissioned after only a year and a half in operation. It was the first nuclear plant in Europe to be completely decommissioned. After its decommissioning, German development of heavy water reactors was halted.

Chernobyl NPP Unit-4

RBMK, light water-cooled,
graphite moderated reactor,
925 MWe

first grid connection:	Dec 22, 1983
permanent shutdown:	Apr 26, 1986
lifetime:	**2.34 years**

Destroyed due to INES level 7 accident (core meltdown and steam explosion) as of April 26, 1986.

KKW Mülheim-Kärlich

Babcock-Brown Boveri Reaktor GmbH (BBR) /ABB

PWR, 1219 MWe

first grid connection: Mar 14, 1986
permanent shutdown: aug 18, 1987
lifetime: **2.49 years**

Revealed that the construction site lay in an earthquake-prone basin, the Neuwieder Becken. Due to earthquake concerns, the location was moved 70 meters from where it had been originally planned. After just three years of operation it had to be taken out of operation indefinitely, with resumption of operations contingent on a judicial decision.

THTR-300,
Hamm-Uentrop, Germany

thorium cycle high-temperature nuclear reactor

300 MWe

first grid connection: Nov 16, 1985
permanent shutdown: Sep 29, 1988
lifetime: **2.87 years**

Technical difficulties with fuel elements occured more often than anticipated

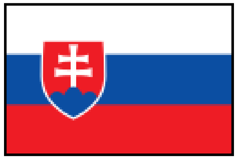
Shoreham NPP
United States

General Electric BWR, 820 MWe

first grid connection: Aug 1, 1986
permanent shutdown: Jun 28, 1989
lifetime: **2.91 years**

Faced considerable public opposition after the 1979 TMI accident and the 1986 Chernobyl disaster, since the nearby Suffolk county could not be safely evacuated in the event of an accident at Shoreham.

There were large protests and two dozen local groups opposed the plant.



Bohunice A-1, Slovakia

Heavy Water Gas-Cooled Reactor (HWGCR)
KS-150 150 MWe

first grid connection: Dec 25, 1972
permanent shutdown: Feb 22, 1977
lifetime: **4.16 years**

Experimental designed in Czechoslovakia.
Used non-enriched uranium as a fuel, refuelling was carried out with the reactor in operation. There were many problems with the operation of the reactor related to the reactor's experimental design. Number of accidents, including two serious accidents occurred. Two people lost their lives during fuel replacement 1n 1976. INES level 4 accident occurred during refuelling in1977.
After the second major accident, a decision was made to shut down the reactor because it was expensive to repair it after the accident, and the operation of the reactor was inefficient.

Gentilly NPP, Canada

CANDU-BWR prototype, 250 MWe

first grid connection: Apr 5, 1971
permanent shutdown: Jun 1, 1977
lifetime: **6.16 years**

Steam Generating Heavy Water Reactor (SGHWR) was a United Kingdom design for commercial nuclear reactors. It uses heavy water as the neutron moderator and normal "light" water as the coolant. The coolant boils in the reactor, like a boiling water reactor, and drives the steam turbines. The reactor had several features unique amongst CANDU reactors intended to reduce the cost and complexity of the unit. However the design was not successful.

KKW Lingen, Germany

BWR with fossil fuel-fired superheater

268 MWe

first grid connection: July 1, 1968
permanent shutdown: Jan 5, 1977
lifetime: **8.51 years**

Constructed in the years 1964 to 1968 as demonstration power plant to test the possibility of using nuclear energy for safe and reliable power generation. With a building time of 48 months, construction of the plant was completed in due time.

In 1977 the nuclear part of the power plant was shut down after damage of the the steam converter system.

Risk factors which can led to fail of the project

problem ➔ delay ➔ unforeseen factors and increased uncertainty

General

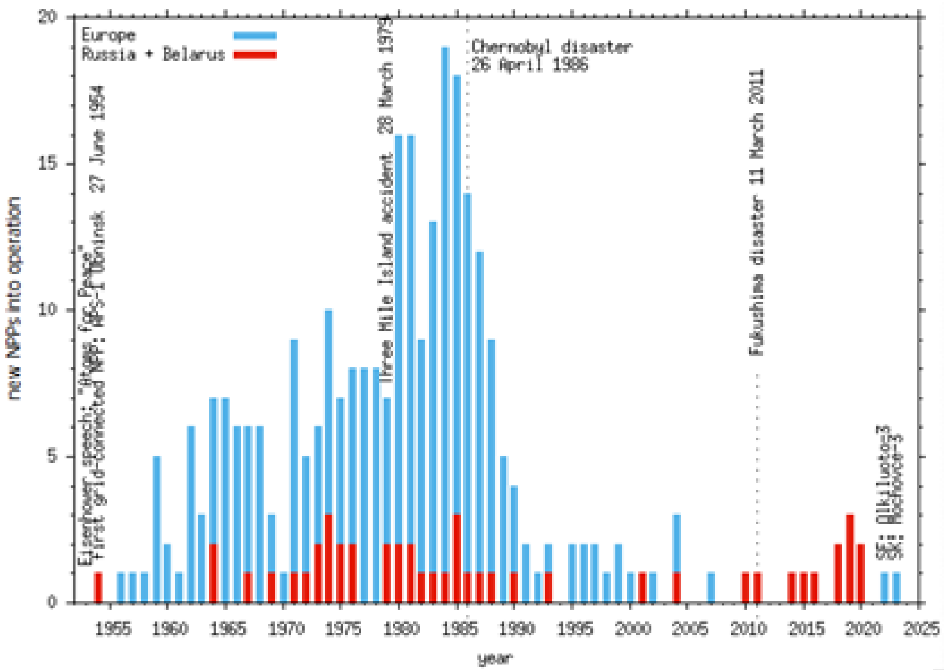
- opposite trends in Europe, mainly in the European Union
- long-term storage of spent fuel
- competing alternative energy sources
- safety concerns, risk of terrorist attack

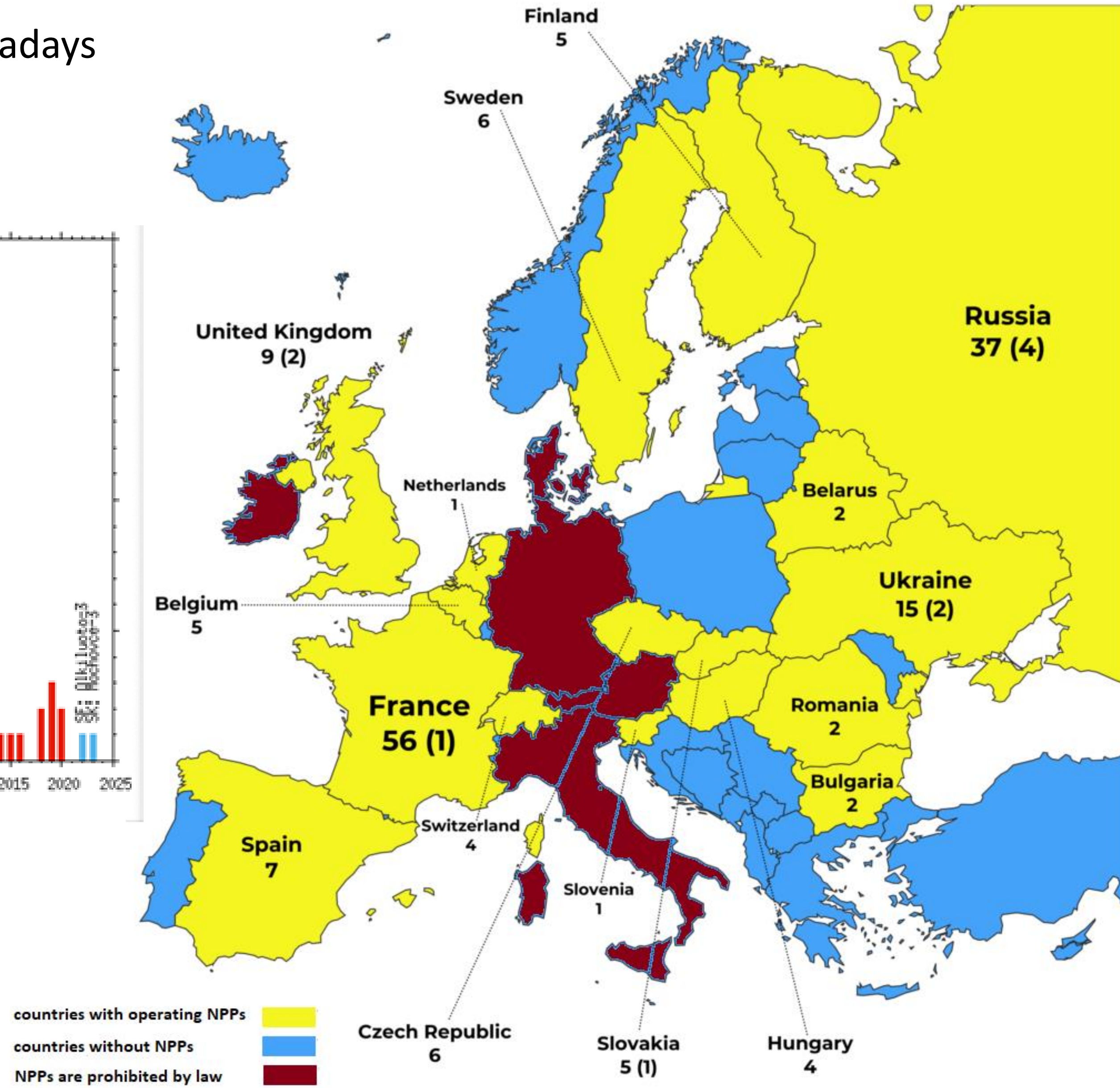
Paks II specific

- selection of the contractor – without open international tender
- Russian – Ukrainian war and international sanctions against Russia
- Paks I: additional lifetime extension -> simultaneous operation with Paks II
- introduction of new or additional contractors to the project
- geological trench near to the NPP site
- limited cooling capactity of river Danube

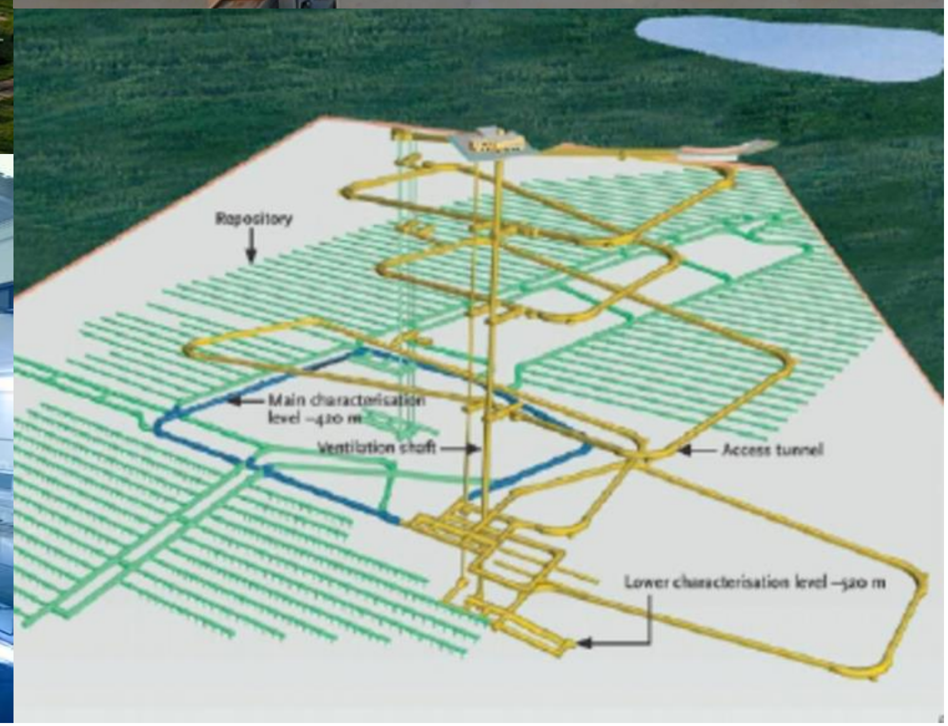
Opposite trends in Europe

nuclear energetics is not favoured nowadays

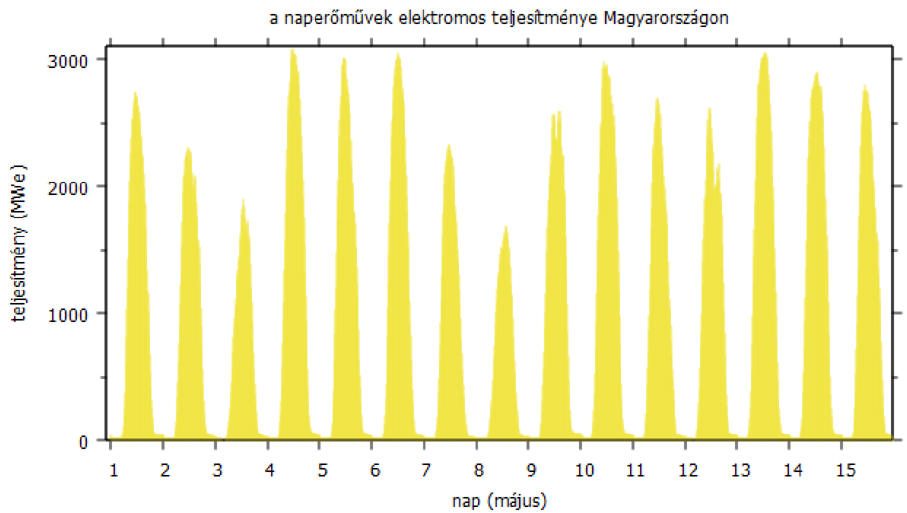




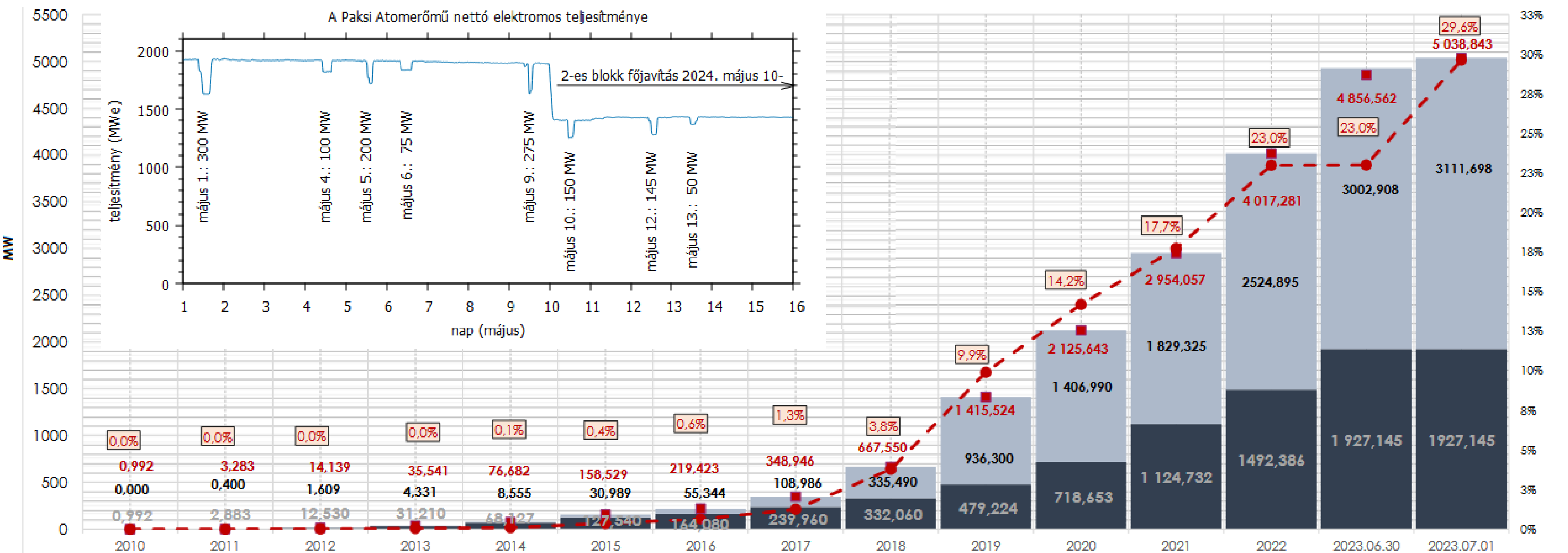
long-term storage of spent fuel



Competitive alternative energy sources

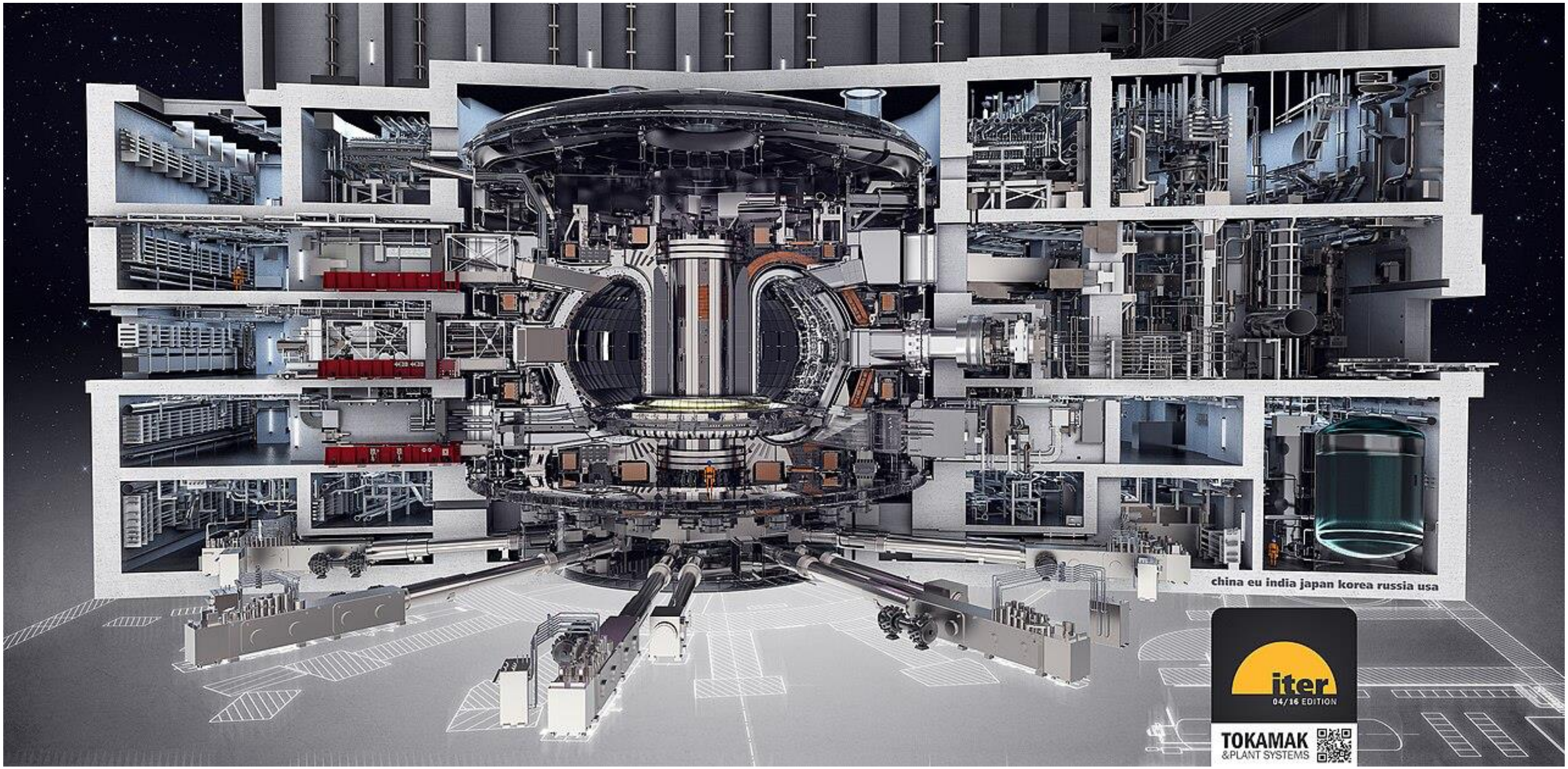


Increment of installed photovoltaic capacities (2010 - 2023)

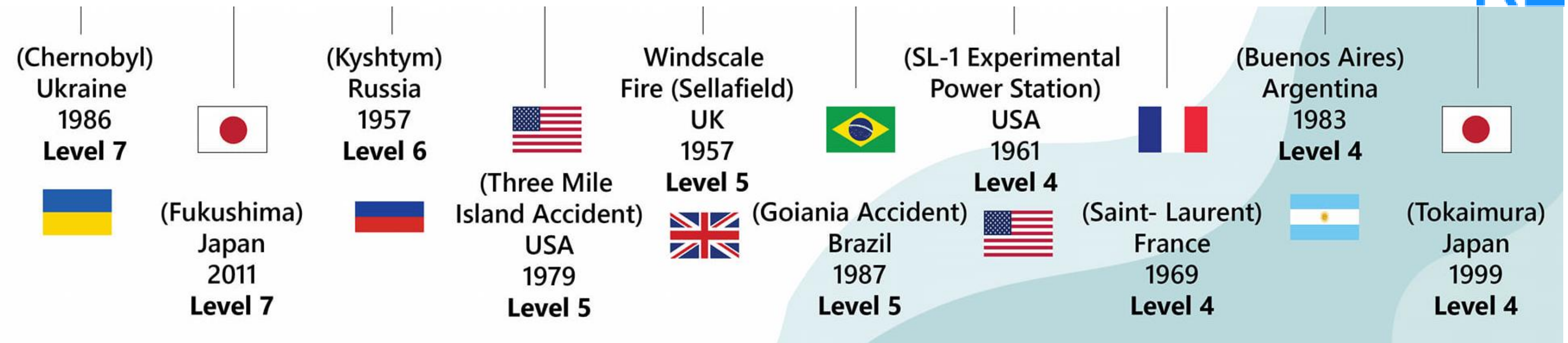


Competitive alternative energy sources

fusion energy -- maybe realized in the future…



Safety concerns, risk of terrorist attack



Risk of accidents: serious accident in each ~30 years

- 1957: Kyshtym disaster – Mayak
- 1986: Chernobyl disaster
- 2011: Fukushima

Terrorist Theft of Spent Fuel Storage facilities for use in a Radiological Dispersal Device (RDD)

Prvo srečanje jedrskih strokovnjakov Slovenije
First Meeting of the Nuclear Society of Slovenia
Bovec, 11.-12.6.1992

Vulnerability of the Nuclear Power Plant in War Conditions

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ABSTRACT - *In the summer 1991 the Nuclear Power Plant Krško in Slovenia found itself in the area of military operations. This was probably the first commercial nuclear power plant, to which it was threatened with the air jet attack. A number of never before asked questions had to be answered by the operating staff and supporting organizations. In this paper some aspects of the nuclear power plant safety in war condition are described: the selection of the best plant operating state before the attack and the determination of plant system vulnerability. It was concluded, that the best operating mode, into which the plant should be brought before the attack, is the cold shutdown mode. The problem of Nuclear Power Plant safety in war conditions should be addressed in more detail in the future.*

Concerns specific to Paks II nuclear power plant

Selection of the contractor without open international tender

AES-2006

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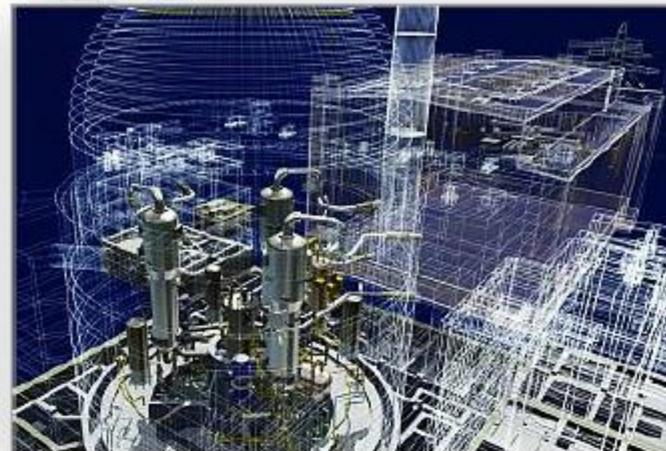

APR1400

EPR

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Russian – Ukrainian war -- international sanctions against Russia

HUN REN

REGULATIONS

COUNCIL REGULATION (EU) 2022/259

of 23 February 2022

amending Regulation (EU) No 269/2014 concerning restrictive measures in respect of actions undermining or threatening the territorial integrity, sovereignty and independence of Ukraine

Exemptions

… humanitarian purposes, medical applications, software updates …
execution of contracts entered into prior the sanctions coming into effects.

An Roinn Fiontar,
Trádála agus Fostaíochta
Department of Enterprise,
Trade and Employment

Guidance Note:

EU Trade Sanctions in response to Russia's aggression against Ukraine

17 January 2024

Paks I: additional lifetime extension
-> simultaneous operation with Paks II

Paks II: EU approval for capacity maintenance -- Paks I should be shutdown
at the end of operating license (2032-2037)
Paks I announced the additinal lifetime extension programme: + 20 years operation up to 70 years
(2032-37 + 20 years)

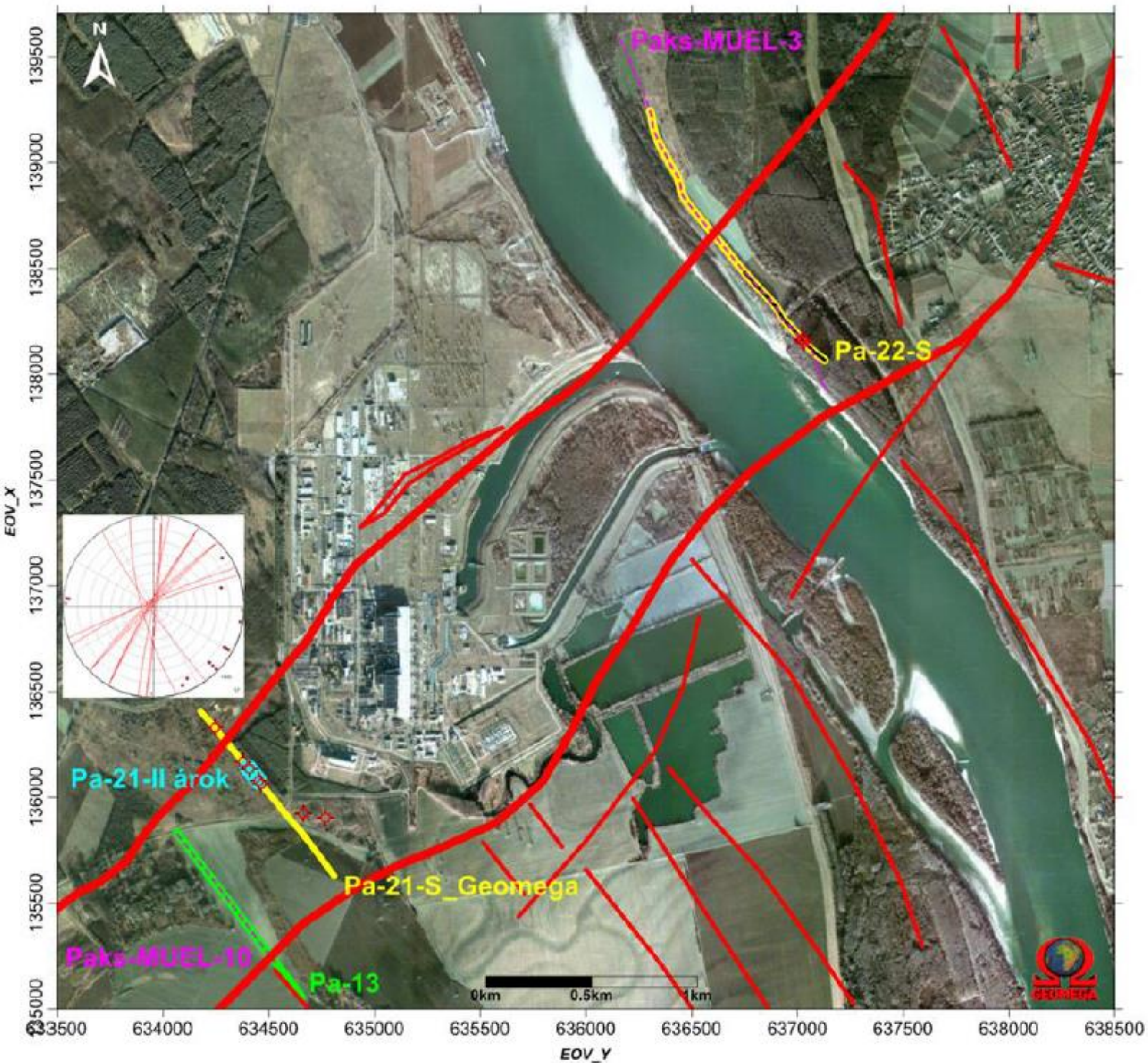
If the two power plants will be in operation for longer time,
it means capacity increment instead of capacity maintenance.

As the four nuclear power plant units MVM PA Zrt. operates in Paks are scheduled to gradually shut down in the 2032-2037 period, Developer plans to implement 2 new nuclear power plant units as specified in section I/3 of the licence in order to maintain the existing commercial electricity generation capacity in Hungary.

Introduction of new or additional contractors to the project

- licenses, certificates, approvals should be obtained according to EU and local regulations
- technical issue: system integration
- modification of plans may needed
- effects of multicultural environment

Geological trench near to the NPP site



Geological trench near to the NPP site

HUN REN

umweltbundesamt

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

NPP PAKS II

Paleoseismological assessment of the Siting Report and the Site License with respect to fault capability

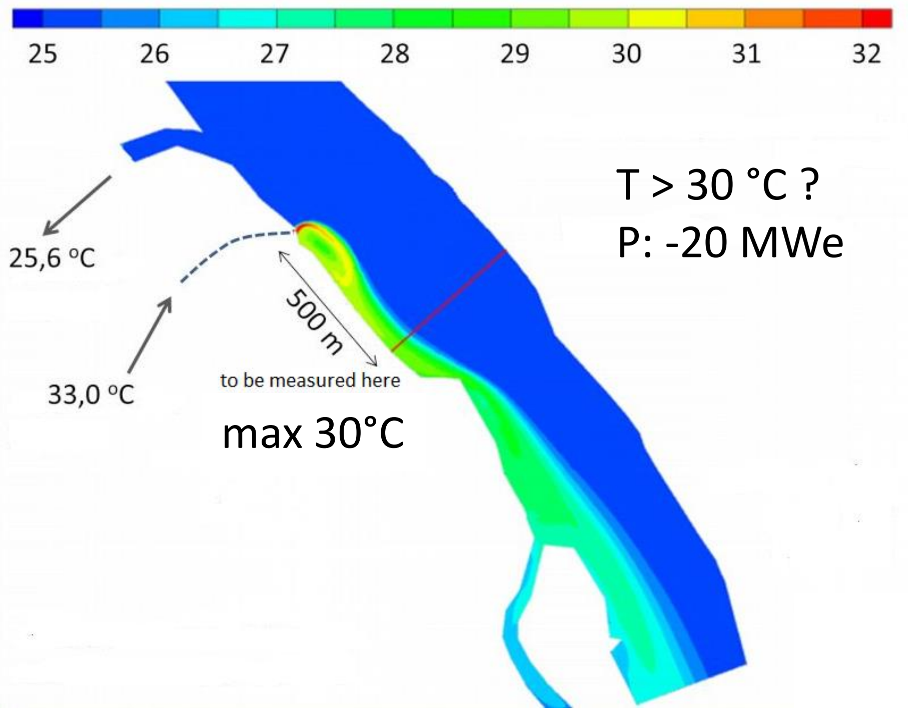
Kurt Decker & Esther Hintersberger

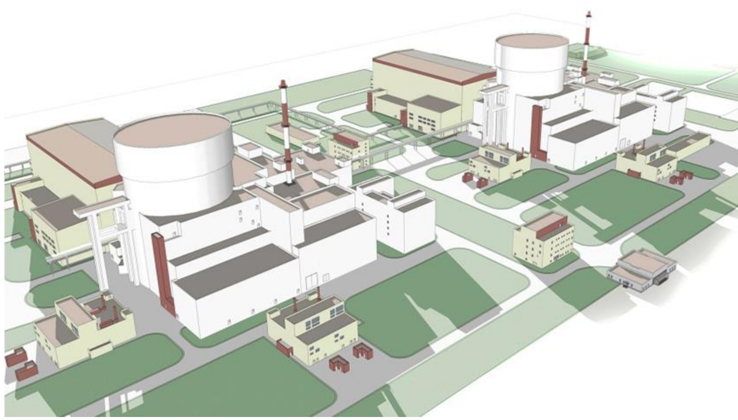
REPORT REP-0759 VIENNA 2021

The authors conclude that, on the contrary, the paleoseismological data derived from the trench Pa-21-II next to the site confirm the existence of capable faults in the site vicinity of Paks II. These capable faults are part of the Dunaszentgyörgy-Harta fault zone, strike into the site and show evidence of repeated and significant surface displacements that occurred during the last circa 20,000 years.

This study therefore concludes that the Hungarian Governmental Decree No. 118 of 2011 on nuclear safety requirements, requirement 7.3.1.1100, is apparently not met. The potential occurrence of a permanent surface displacement on the site cannot be reliably excluded by scientific evidences. The Paks II site should therefore be deemed unsuitable.

limited cooling capactity of river Danube





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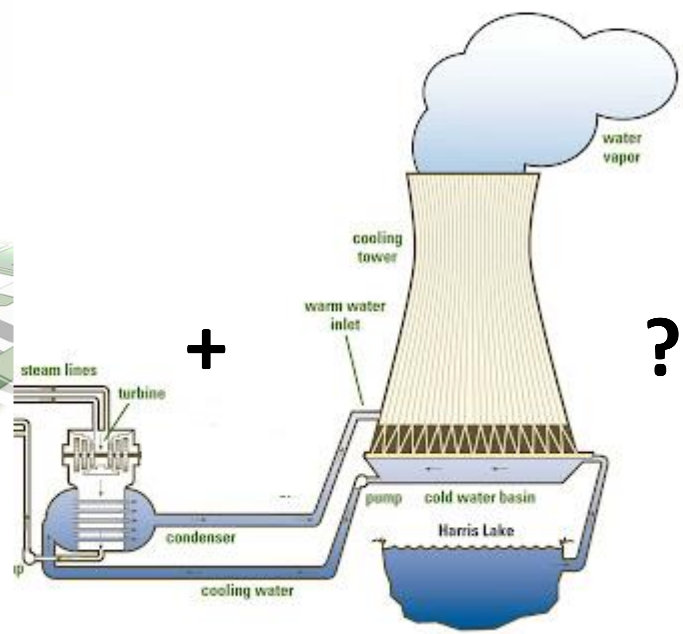

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Conclusions

Paks II CEO: construction of a nuclear power plant is an extra-long project

If a NPP project is abandoned due to the changed conditions,
what is the optimal escape route'?

- cancel in the planning phase – moderate costs
- during the constructions works – increasing costs
  some main components can be sold
- after put into operation – low return rate
  + high costs of decommissioning (spent fuel + radioactive waste).

Concorde effect?

Thank you for your attention!

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