POLITECHNIKA GDAŃSKA
WYDZIAŁ ELEKTROTECHNIKI I AUTOMATYKI

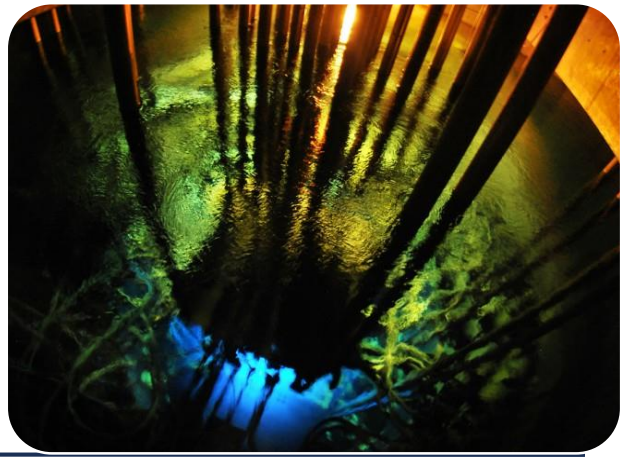
NUCLEAR POWER

LECTURE 5

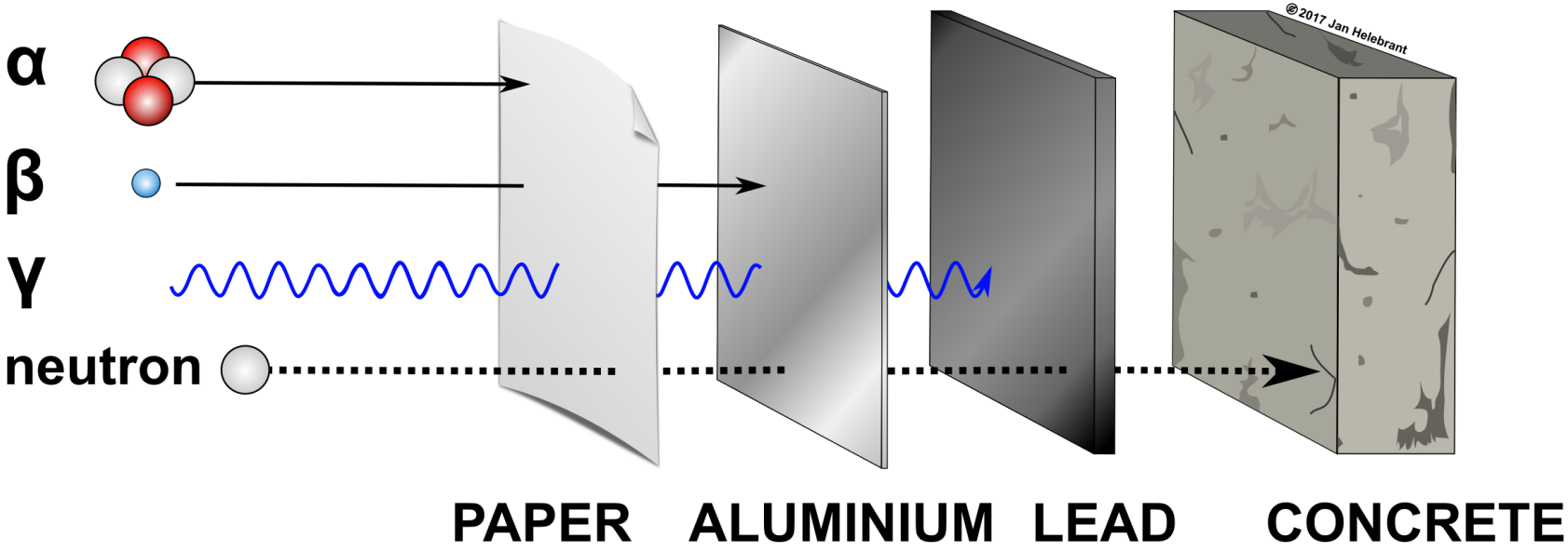
Gdańsk 2018

1. Radioactivity and nuclear energy
2. The fuel cycle
3. National experiences, and nuclear energy
4. Polish nuclear power plant
5. CPP vs NPP

RADIOACTIVITY AND NUCLEAR ENERGY



The radioactivity means the ability of some atomic nuclei to emit ionizing radiation.



Rys. Penetrating power of different types of radiation

RADIOACTIVITY

Type of radiation emitted & symbol	Nature of the radiation (higher only)	Nuclear Symbol (higher only)	Penetrating power, and what will block it (more dense material, more radiation is absorbed BUT smaller mass or charge of particle, more penetrating)	Ionising power - the ability to remove electrons from atoms to form positive ions
α Alpha	a helium nucleus of 2 protons and 2 neutrons, mass = 4, charge = +2	$^{4}_{2}He$	Low penetration, biggest mass and charge, stopped by a few cm of air or thin sheet of paper	Very high ionising power, the biggest mass and charge of the three radiation's, the biggest 'punch'!
β Beta	high kinetic energy electrons, mass = 1/1850, charge = -1	$^{0}_{-1}e$	Moderate penetration, 'middle' values of charge and mass, most stopped by a few mm of metals like aluminium	Moderate ionising power, with a smaller mass and charge than the alpha particle
γ Gamma	very high frequency electromagnetic radiation, mass = 0, charge = 0	$^{0}_{0}\gamma$	Very highly penetrating, smallest mass and charge, most stopped by a thick layer of steel or concrete, but even a few cm of dense lead doesn't stop all of it!	The lowest ionising power of the three, gamma radiation carries no electric charge and has virtually no mass, so not much of a 'punch' when colliding with an atom

UNITS OF MEASURE FOR RADIOACTIVITY

The numer of falling apples can be compared to the **Becquerel** (number of disintegrations per second)

The numer of apples that hit the sleeper can be compared to the **Gray** (absorber dose)

The effect on the body, bassed on the size or weight of the apples, can be compared to the **Sievert** (effective dose)

NATURAL RADIOACTIVITY

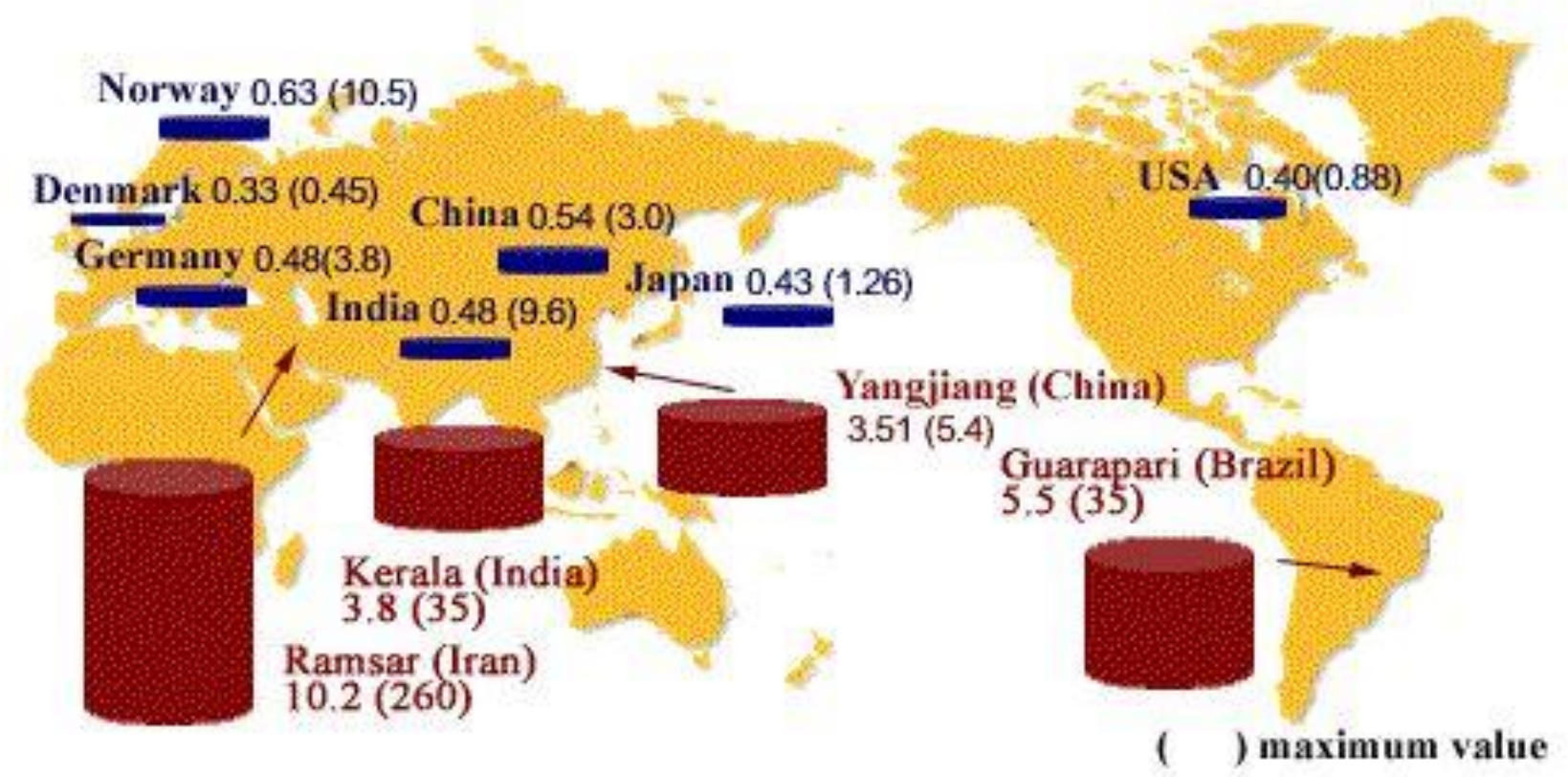


Fig. High Background Radiation Areas Around the World.
Numbers given are in mSv/year

natural radiation

man-made radiation

radiation levels in Guarapari, Brazil 10
(yearly, from the earth)

natural radiation absorbed per person 2.4
(yearly) (world average)

- from cosmic rays 0.4
- from the earth 0.5
- from food 0.3
- inhaled (mostly radon) 1.2

difference in natural radiation levels between prefectures 0.4
(yearly)
(the largest difference between average levels)

Gifu ⇦ Kanagawa

Tokyo-New York travel by airplane 0.19
(round trip)
(cosmic rays may increase depending on flight speed)

10

1

0.1

0.01

6.9 CT-scanner
(one time)

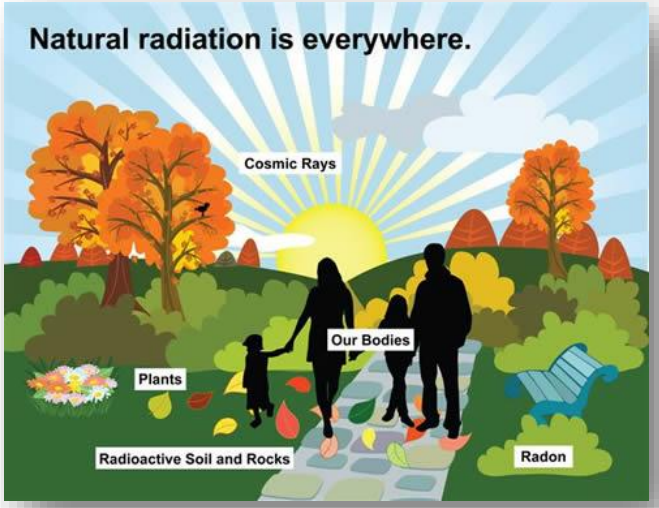
1.0 dose limits for the general public (yearly)
(not including medical treatments)

0.6 complete series of stomach X-rays
(one time)

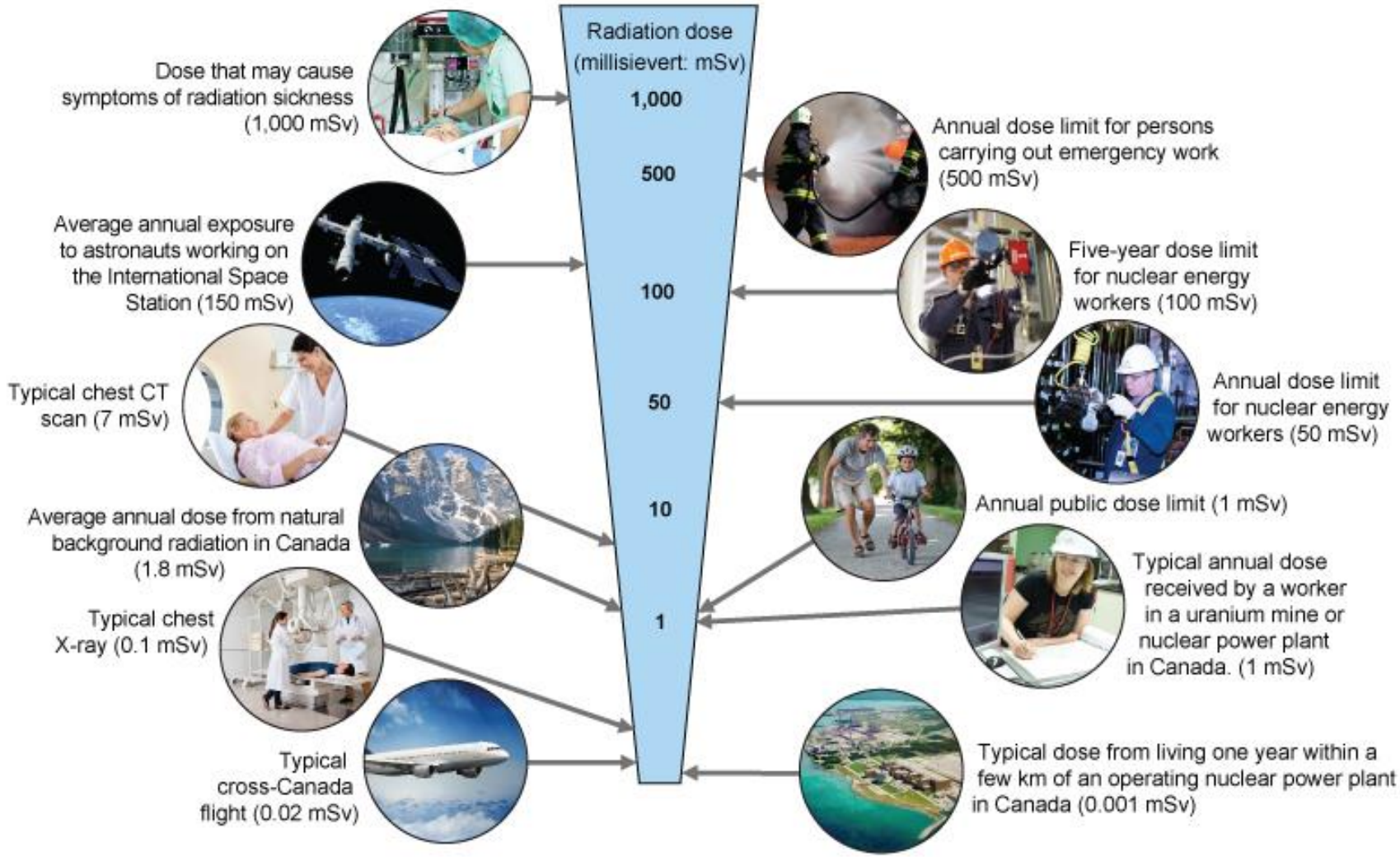
0.05 complete series of X-rays
(one time)

0.05 target range for radiation around a nuclear power plant
(light water reactor) (yearly)
(as results are under 0.001mSv, these are far below the target range)

radiation dose (mSv)



Radiation dose examples



Fot. Canadian Nuclear Safety Commission

HOW IS RADIOACTIVITY DETECTED?

Control gate ARGOS (alpha, beta, gamma).
Copyright AREVA

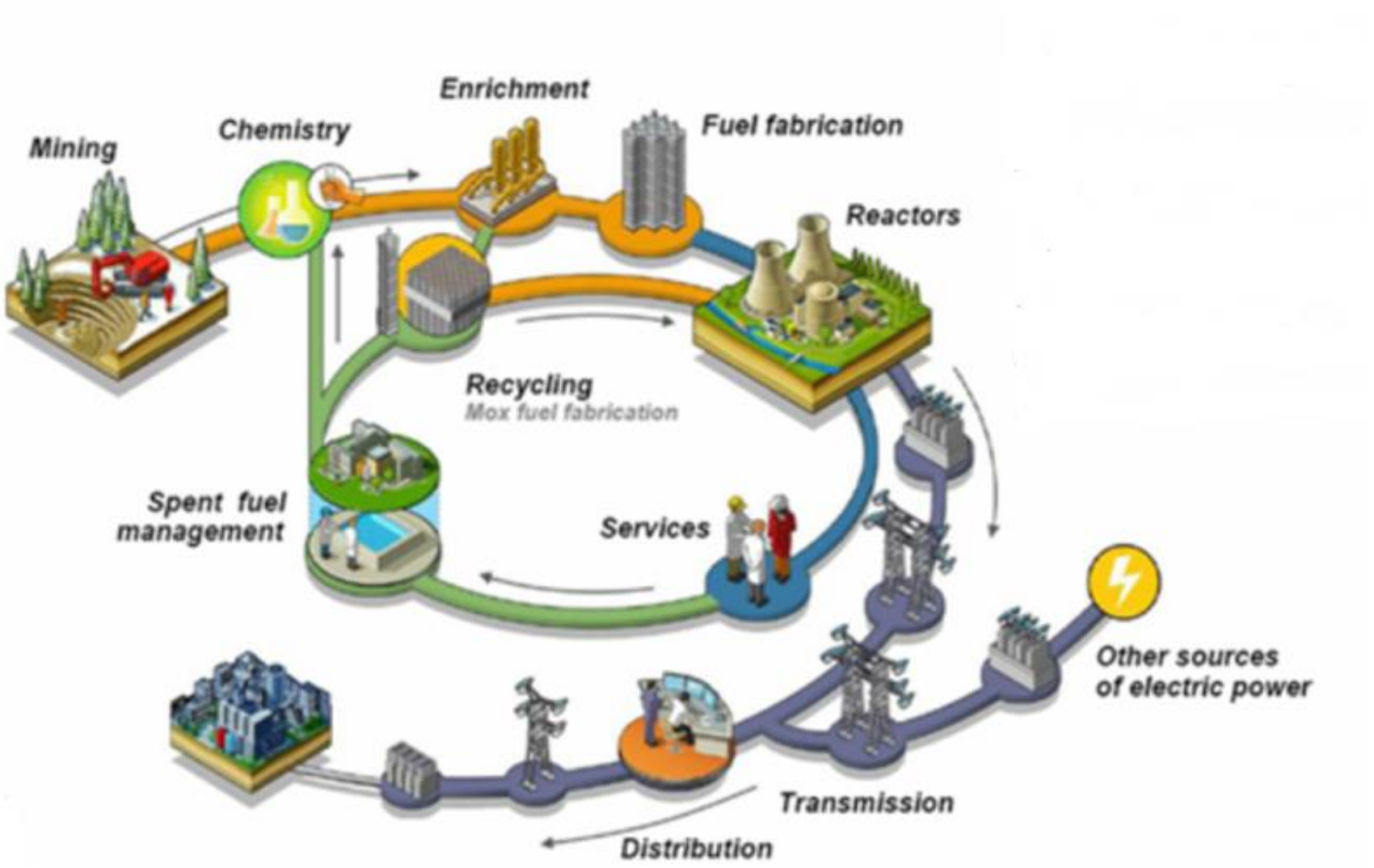
Personal dosimeter Dosicard. Copyright AREVA

Radiation measurer and detector alpha, beta, gamma.
Copyright AREVA

RADIATION EFFECTS

FUEL CYCLE

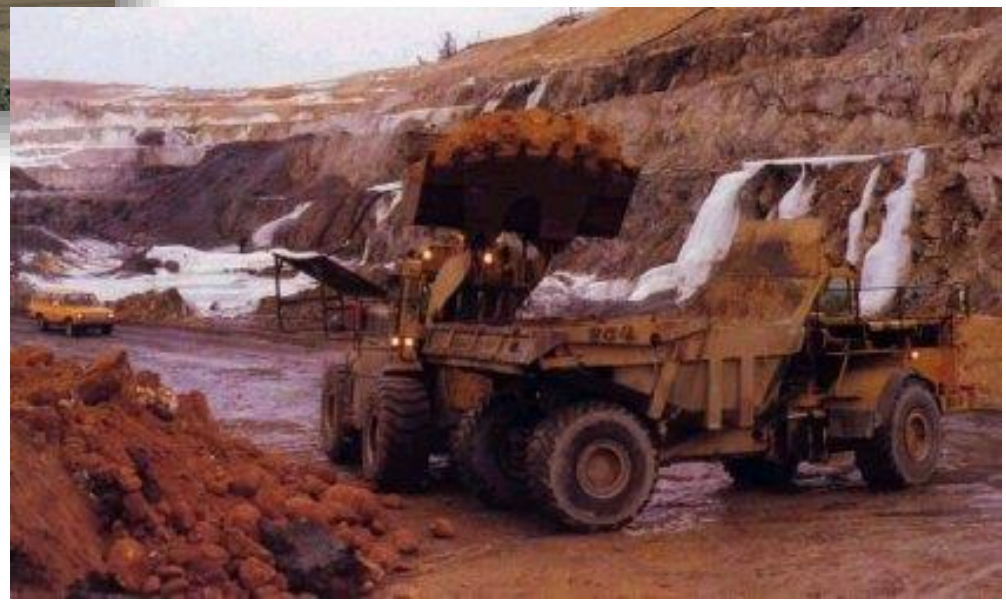
FUEL CYCLE


Enrichment
Chemistry
Mining
Fuel fabrication
Reactors
Recycling
Mox fuel fabrication
Spent fuel
management
Services
Other sources
of electric power
Transmission
Distribution

FUEL CYCLE - MINING

Uranium Mine in Niger
(Sahara Desert)

uran[nucelar.pl]

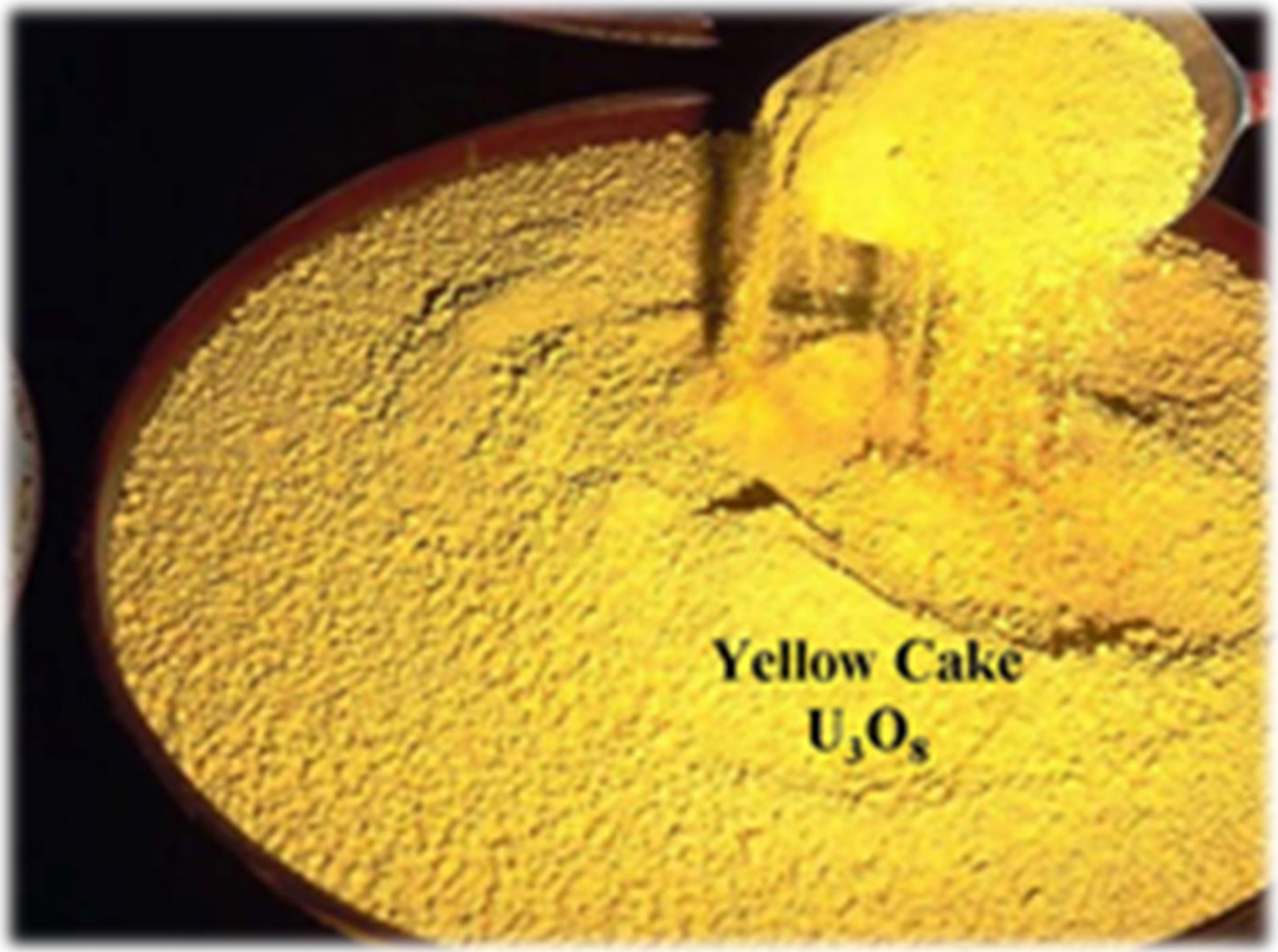


Uranium Mine in Canada[nucelar.pl]

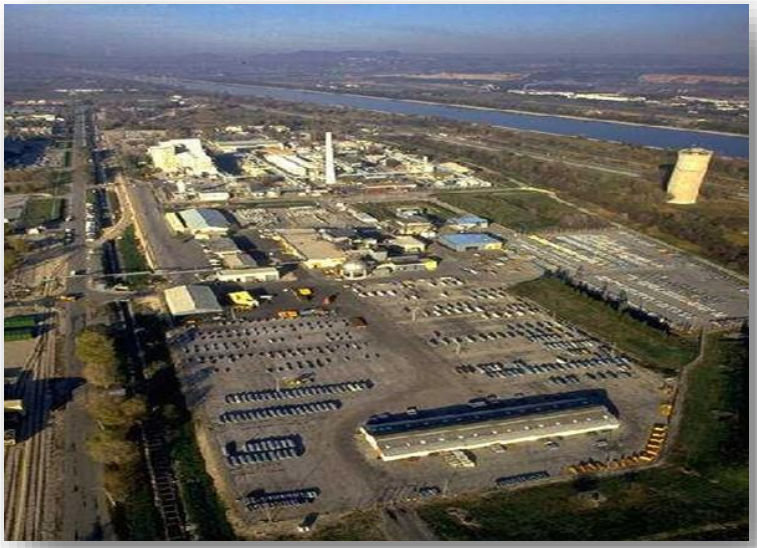
Natural uranium:

- 99,3 % U238;
- 0,7 % U235
- >> U234

FUEL CYCLE - CHEMISTRY



FUEL CYCLE - ENRICHMENT



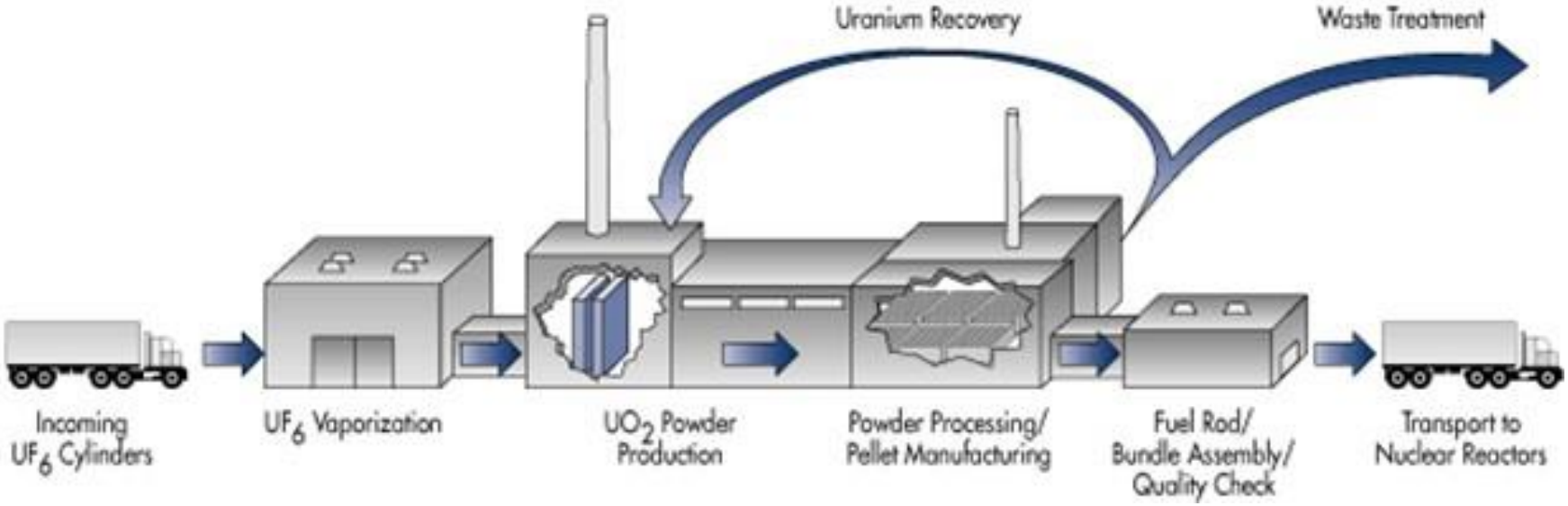
Comurhex, Pierrelate, France

Instalation to enrichment uranium.[nucelar.pl]

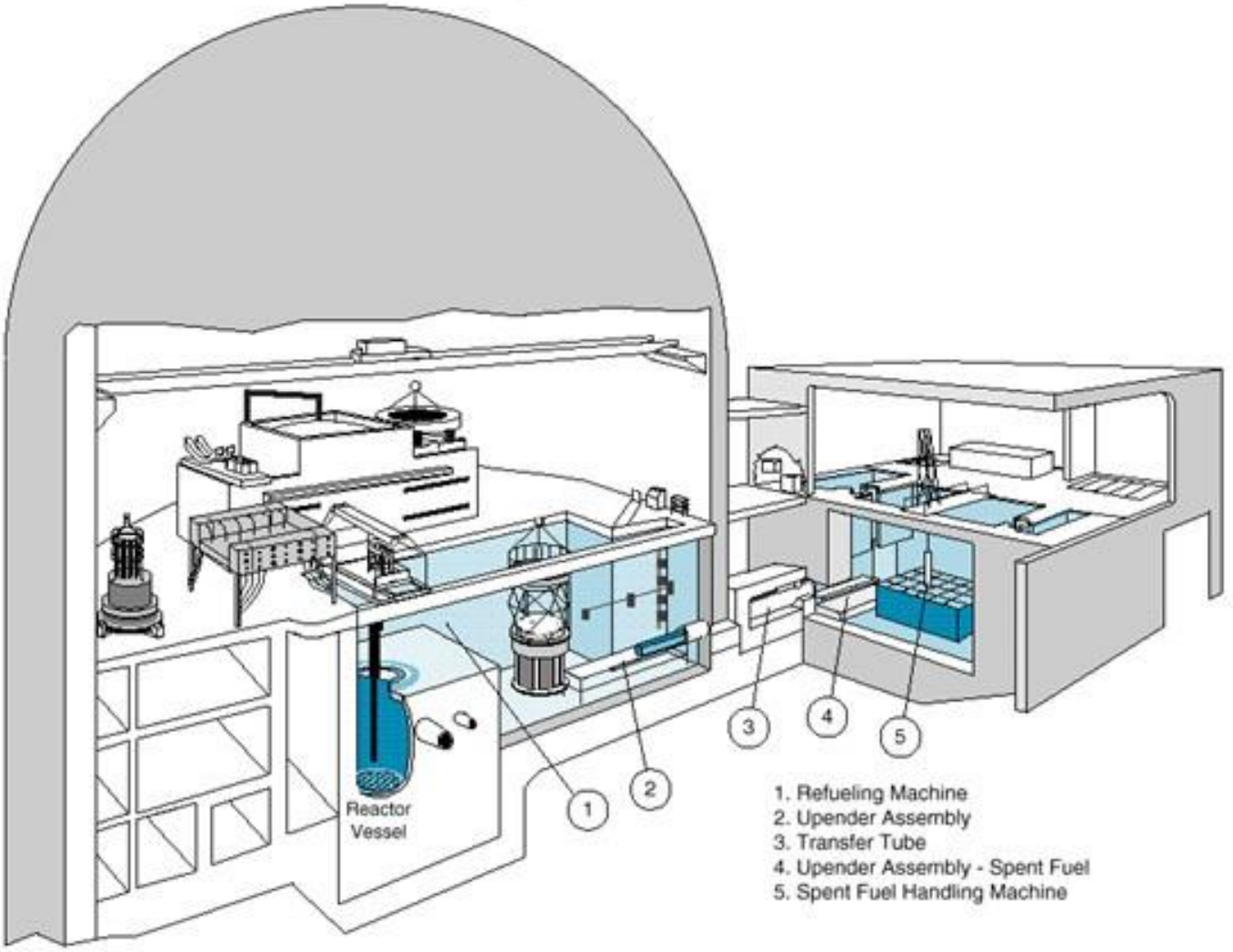
Two methods of ureanium enrichment:

- Gaseous diffusion
- Centrifugation

FUEL CYCLE – FUEL PRODUCTIONS

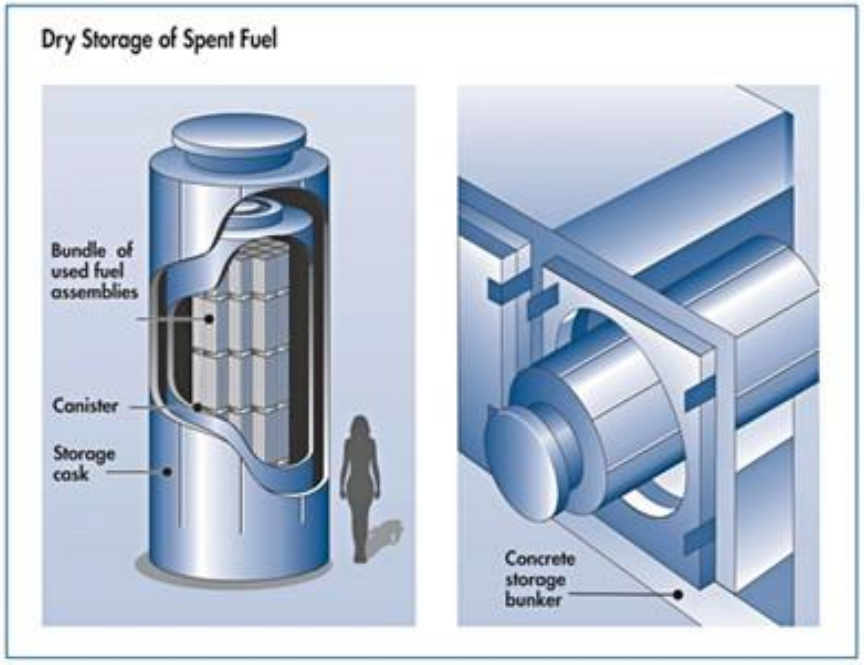


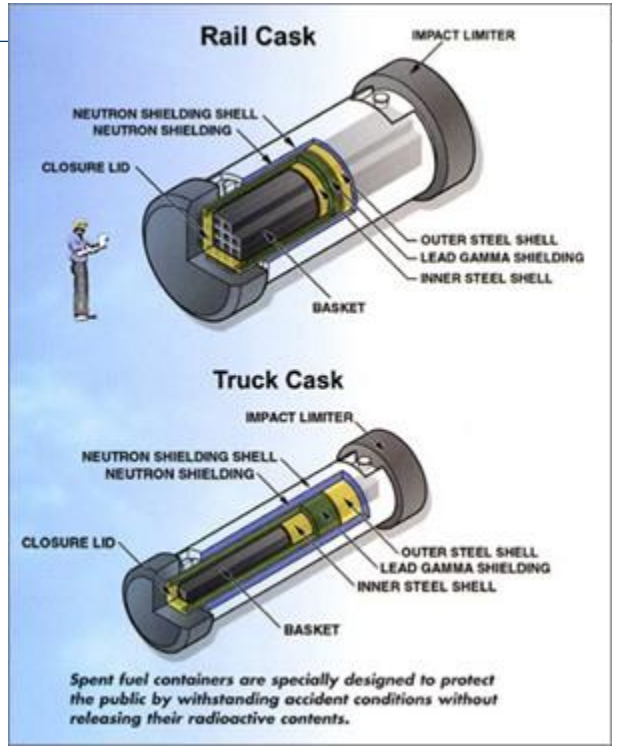
FUEL CYCLE – SPENT FUEL



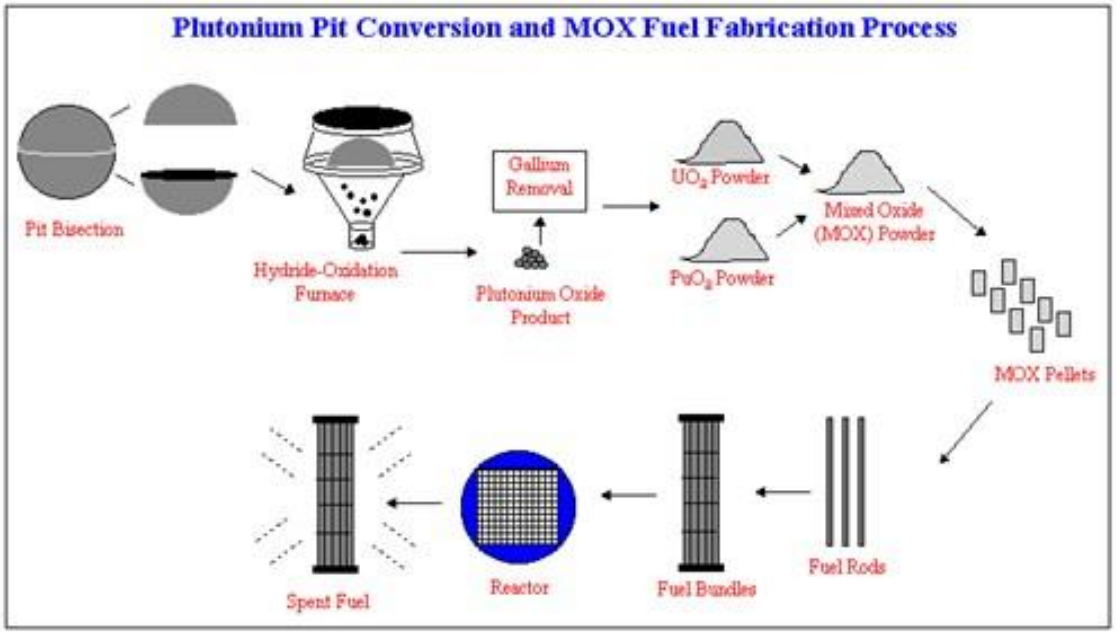
The spent fuel removed from the ractors and continues to realise heat and is still radioactive.

FUEL CYCLE – SPENT FUEL





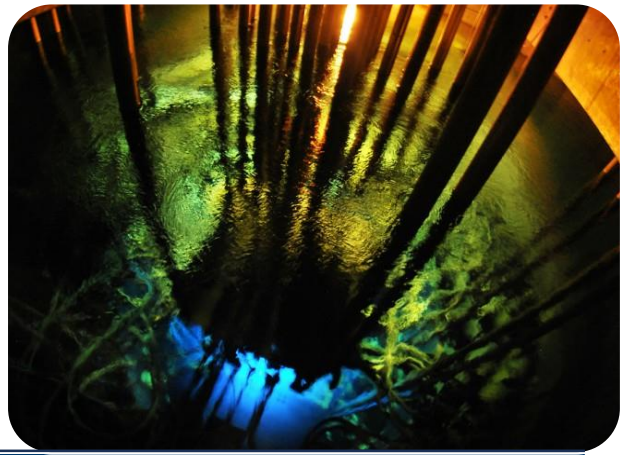
FUEL CYCLE - MOX



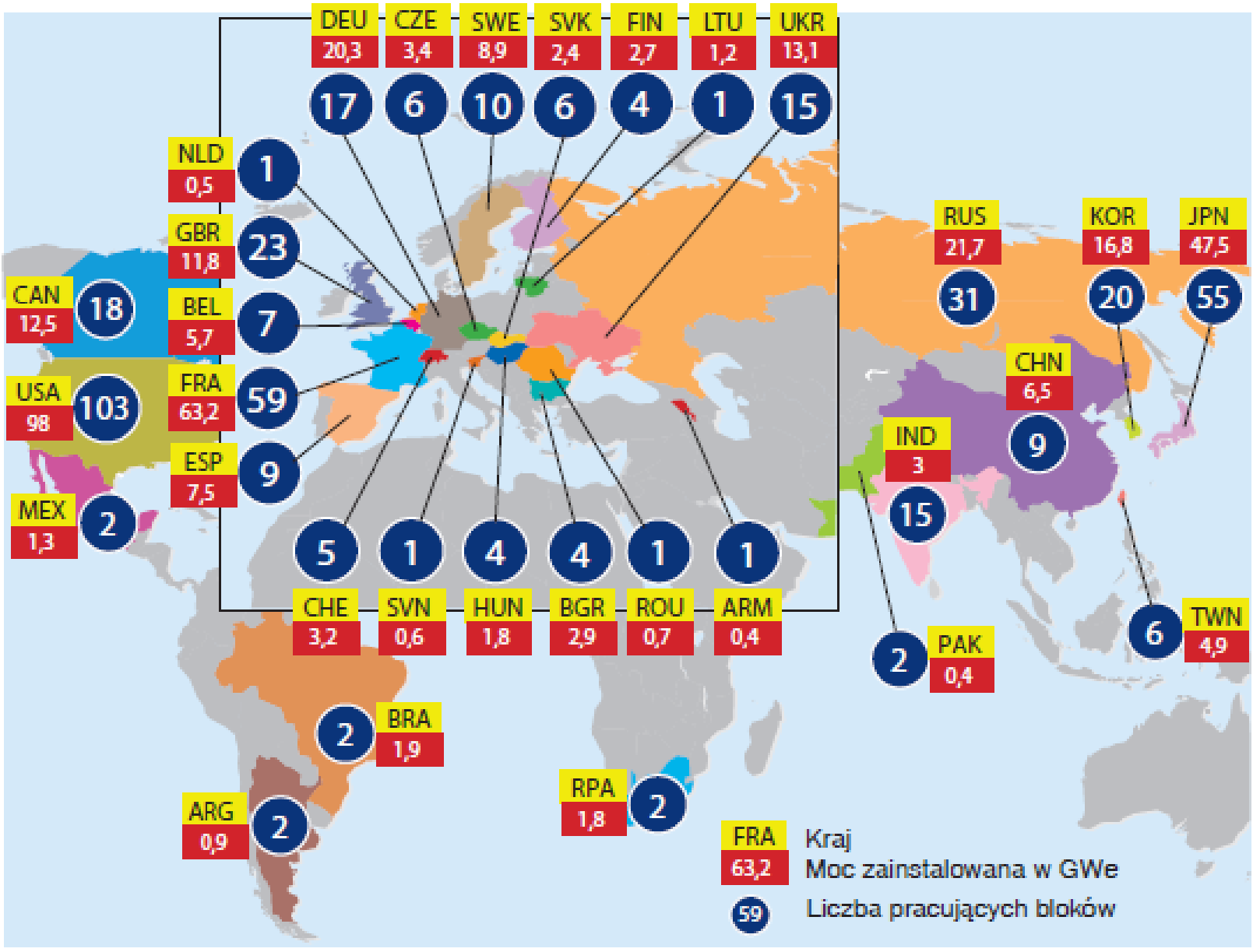
Fuel reprocessing plant, Marcoule, France

FUEL CYCLE – LA HAGUE

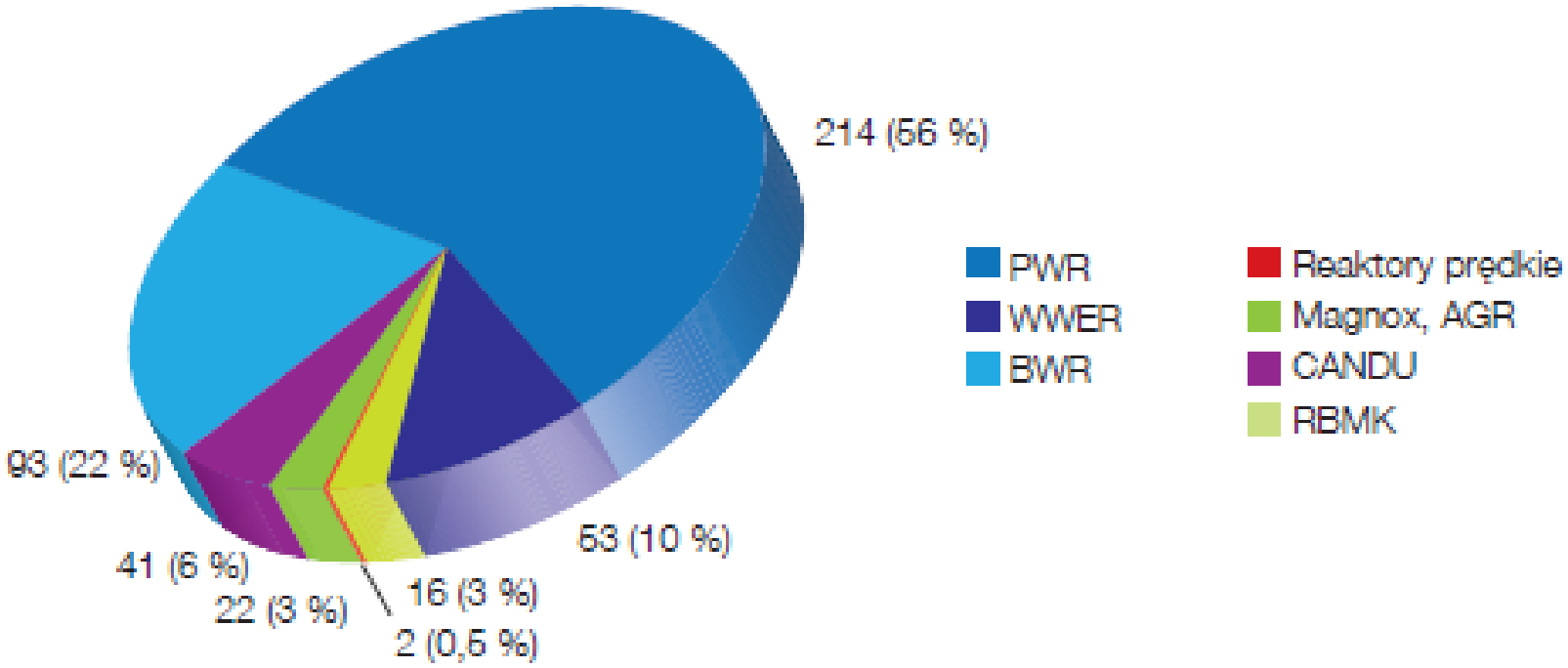
GENERATION OF ENERGY IN NUCLEAR POWER PLANT



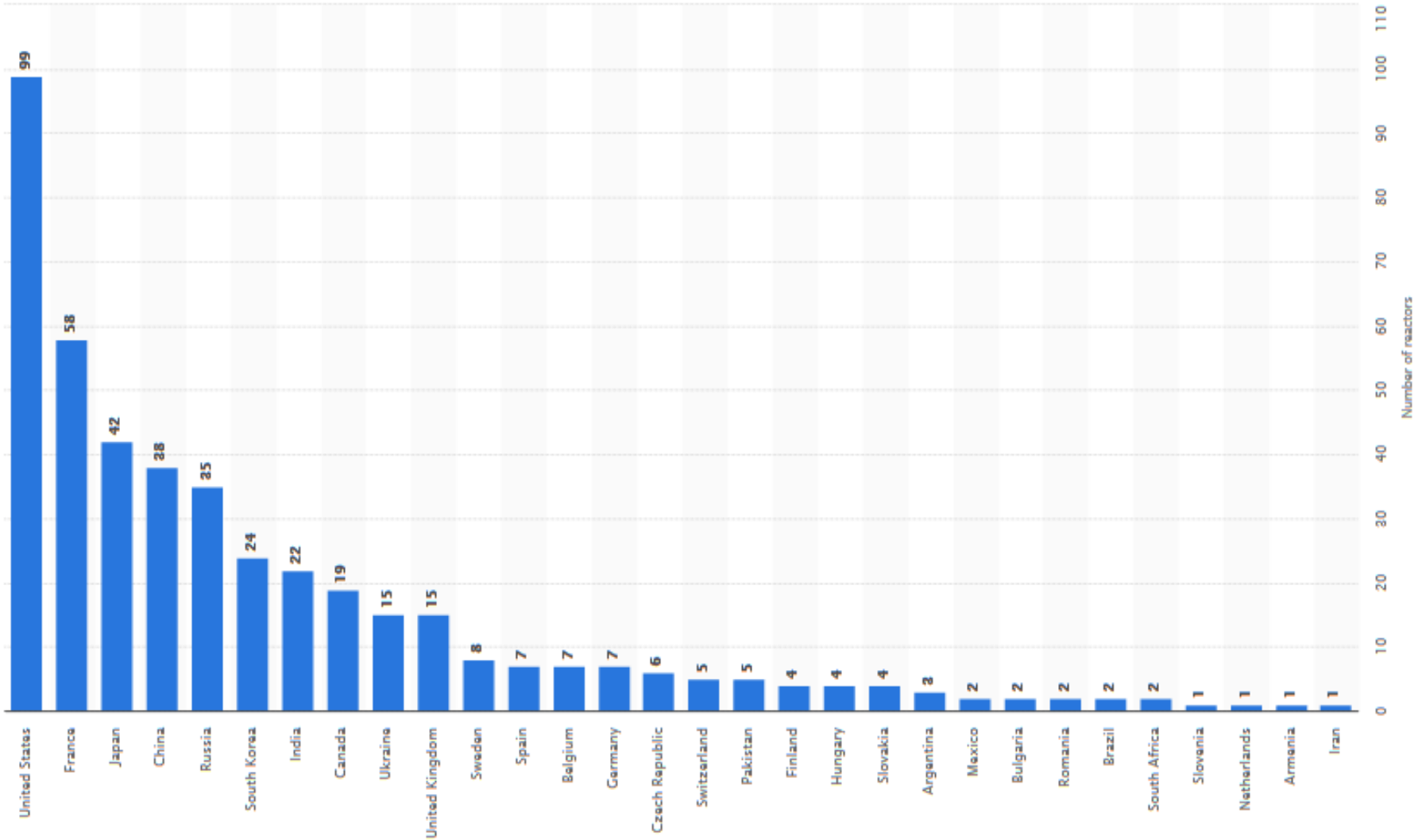
NUCLEAR POWER REACTORS



NUCLEAR POWER REACTORS

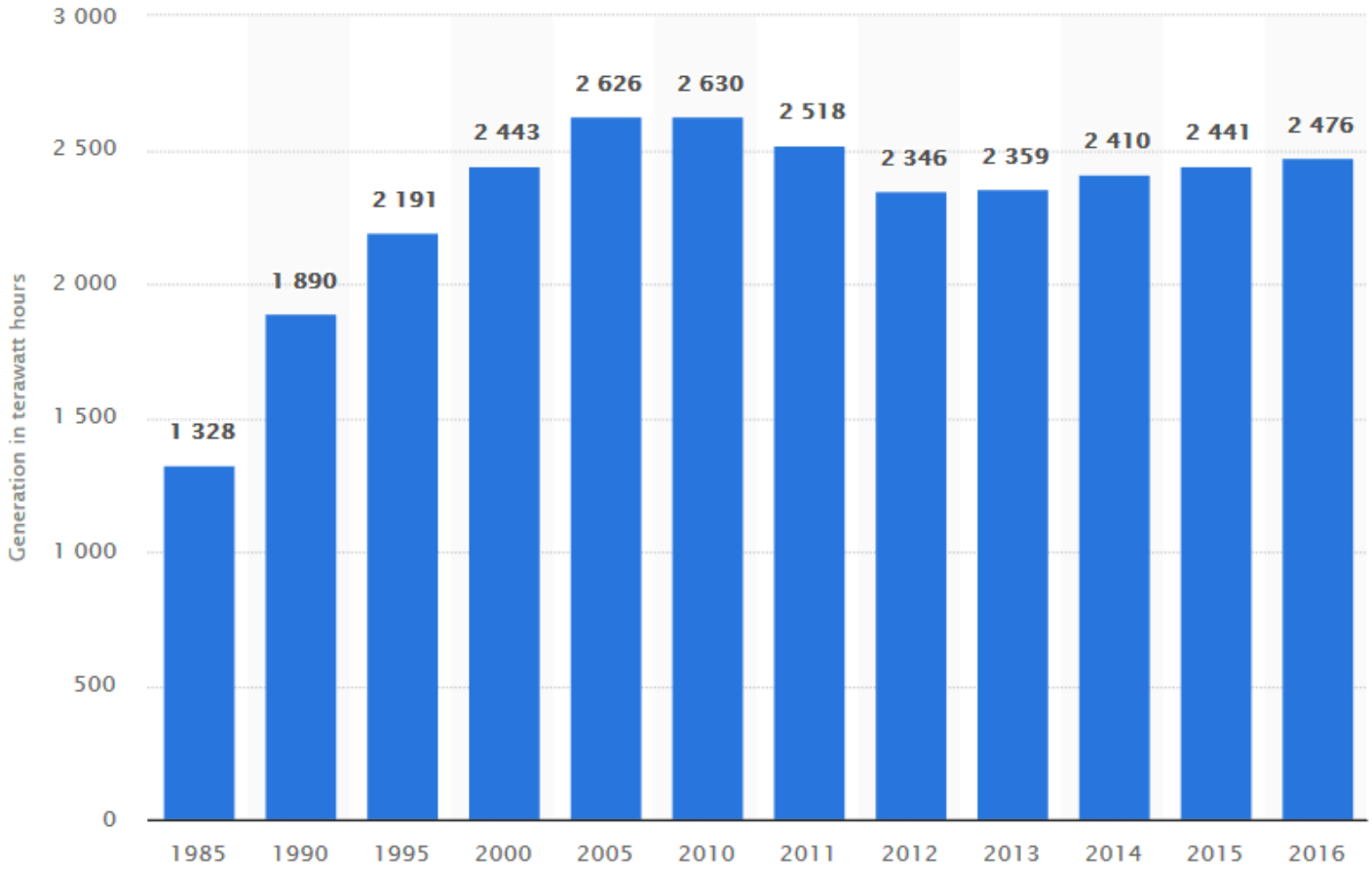


NUCLEAR POWER REACTORS

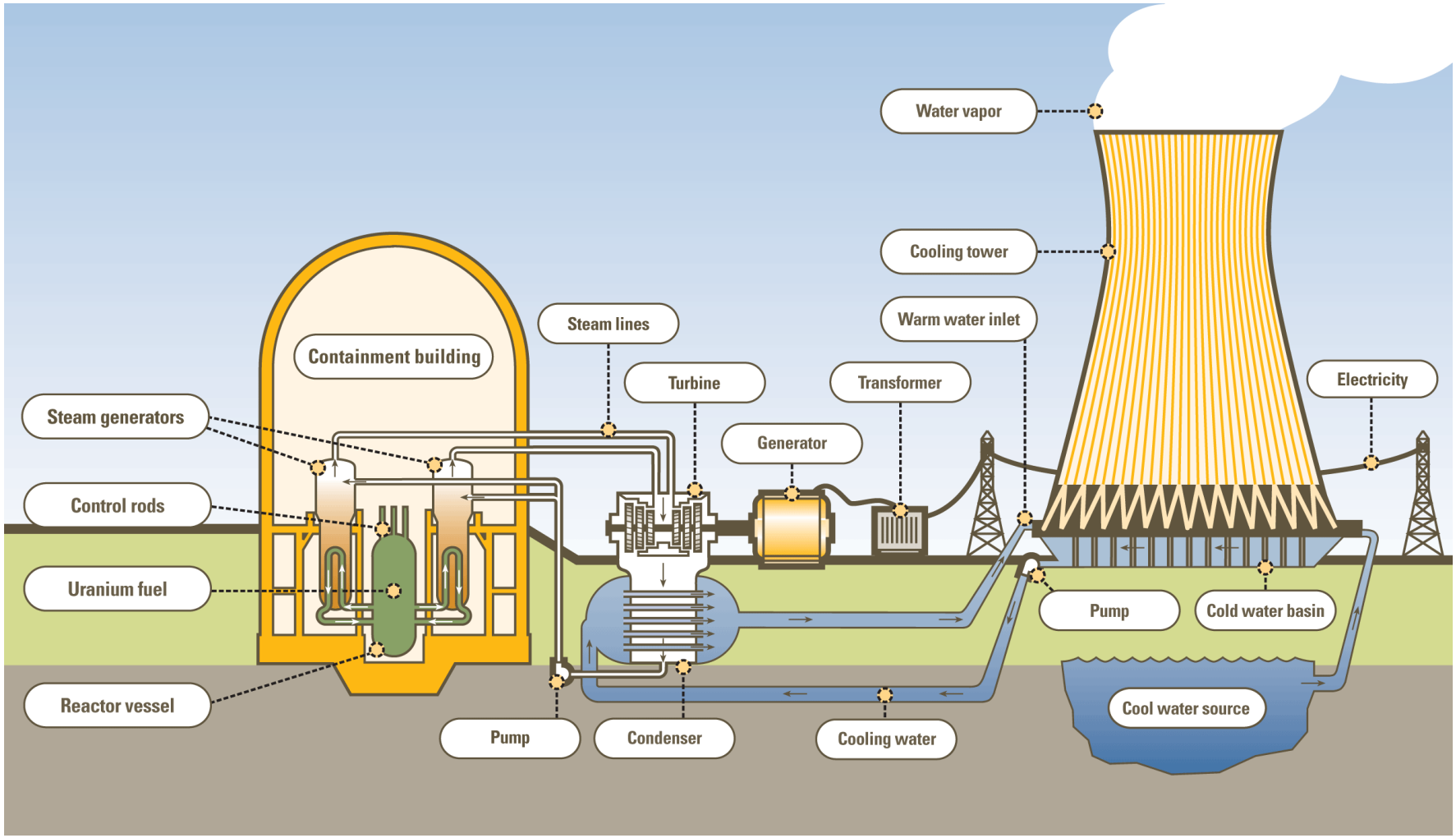


NUCLEAR POWER REACTORS

Global nuclear power generation from 1985 to 2016 (TWh)



NUCLEAR POWER PLANT



CONSTRUCTION OF NUCLEAR POWER PLANT

NP in numbers:

Shin-Kori,
2 X **1,000 MW PWR**
Start operating **28 Ferbuar 2011**

Area: **ap. 13 hectares**

Numbers:

Over 900 tyś ton of concrete

Ap. 7,5 mln people involved in project

Ap. 3000 km electric cable

62-75 mounths

CONSTRUCTION OF NUCLEAR POWER PLANT

REACTOR BUILDING - RB

- Control Rods
- Pressurizer
- Steam Generator
- Reactor Vessel
- Bor Cycle System
- Primary Circuit
- Cooling System
- Safety system

NUCLEAR ISLAND- NI

- Nuclear building
- Electric building
- Pool building

NUCLEAR ISLAND – NI BUILDING OF DEACTIVATION

CONSTRUCTION OF NUCLEAR POWER PLANT

NUCLEAR ISLAND – **NI – NUCLEAR BUILDING**

CONSTRUCTION OF NUCLEAR POWER PLANT

NUCLEAR ISLAND – **NI – ELECTRIC BUILDING**

CONSTRUCTION OF NUCLEAR POWER PLANT

Engine room

Multipurpose building

CONSTRUCTION OF NUCLEAR POWER PLANT

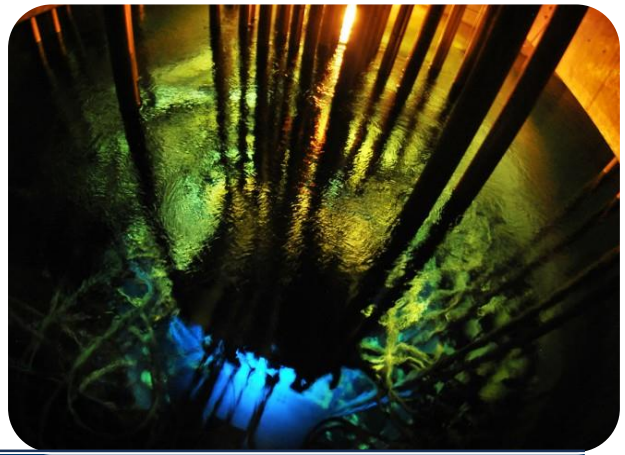
Cooling sytems

- III circut

Cooling tower

Water drain III circut

NATIONAL NUCLEAR ENERGY EXPIRIENCE



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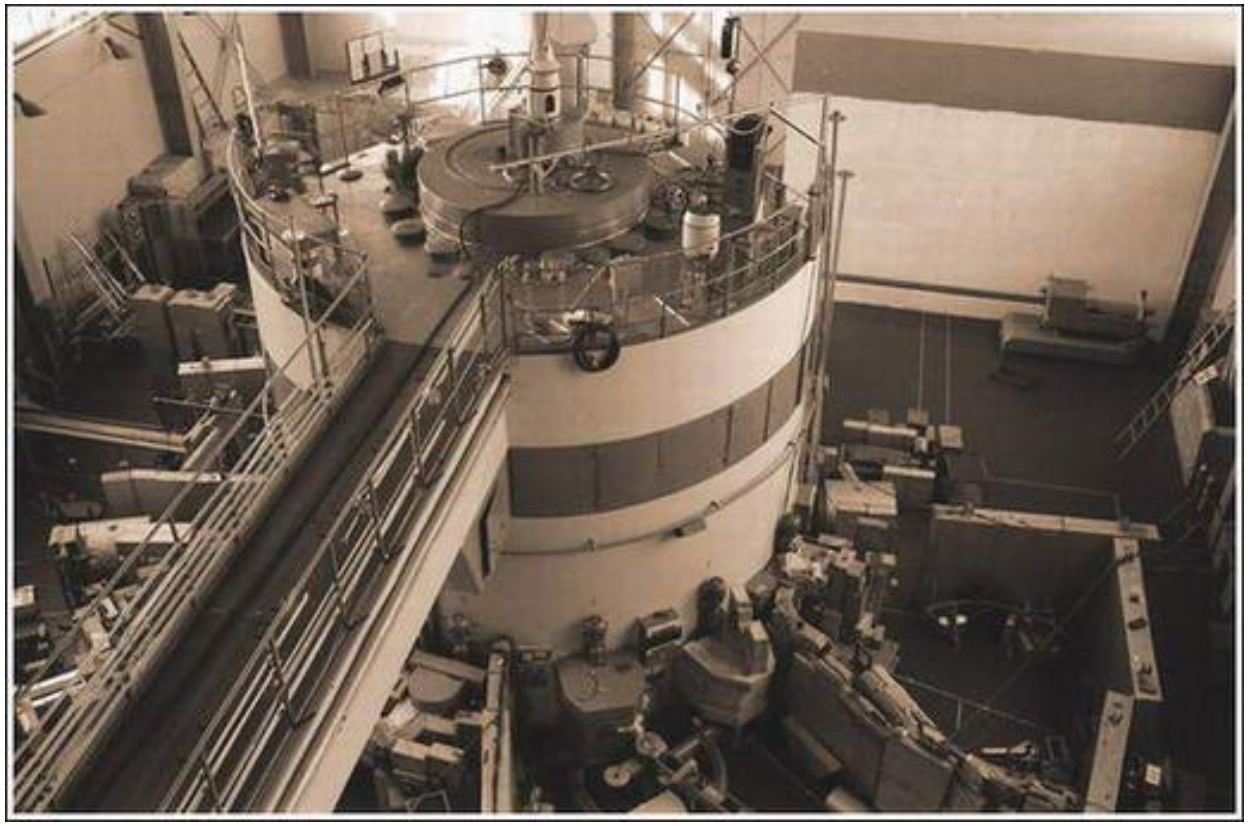
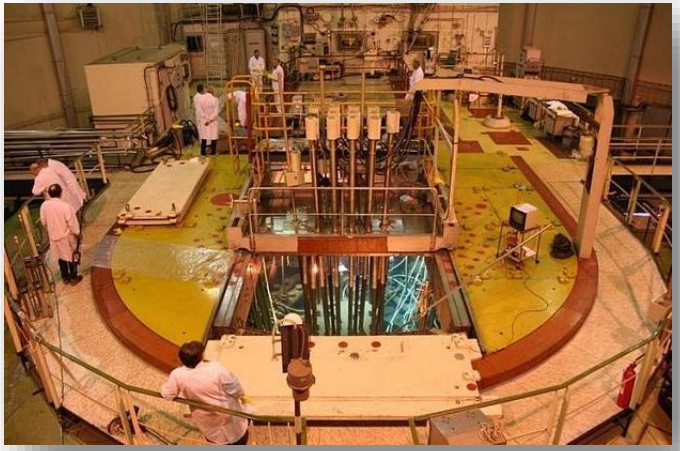
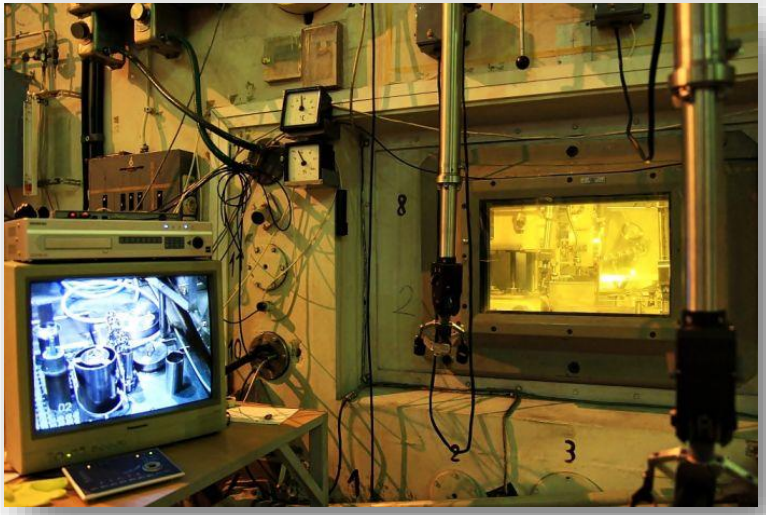


EWA reactor hall at the Institute for Nuclear Research in Świerk (around 1965)

NATIONAL NUCLEAR ENERGY EXPIRIENCE – REACTOR MARIA





NATIONAL NUCLEAR ENERGY EXPIRIENCE – MAIN RADIOLOGICAL SAFETY LABORATORY

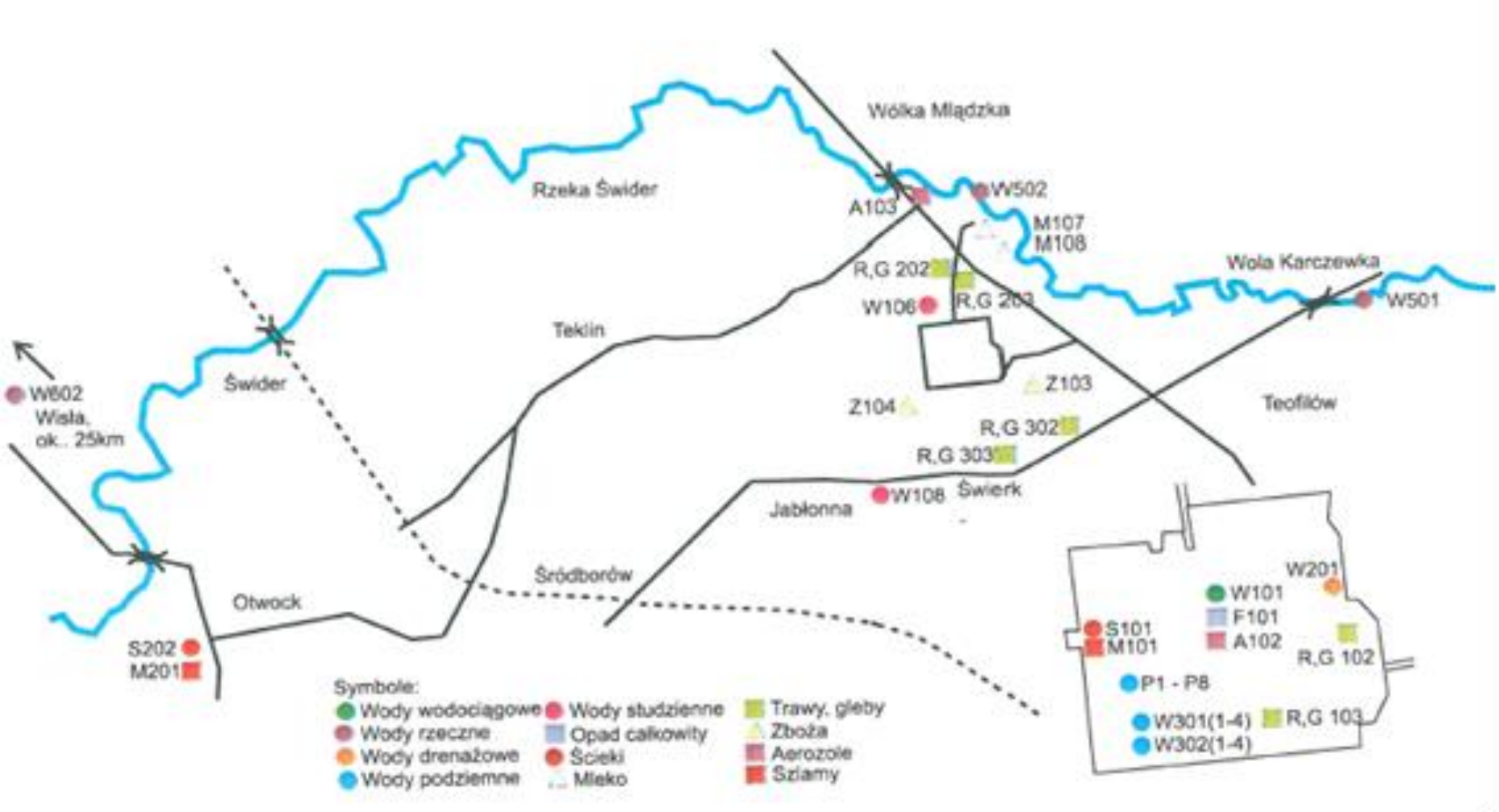
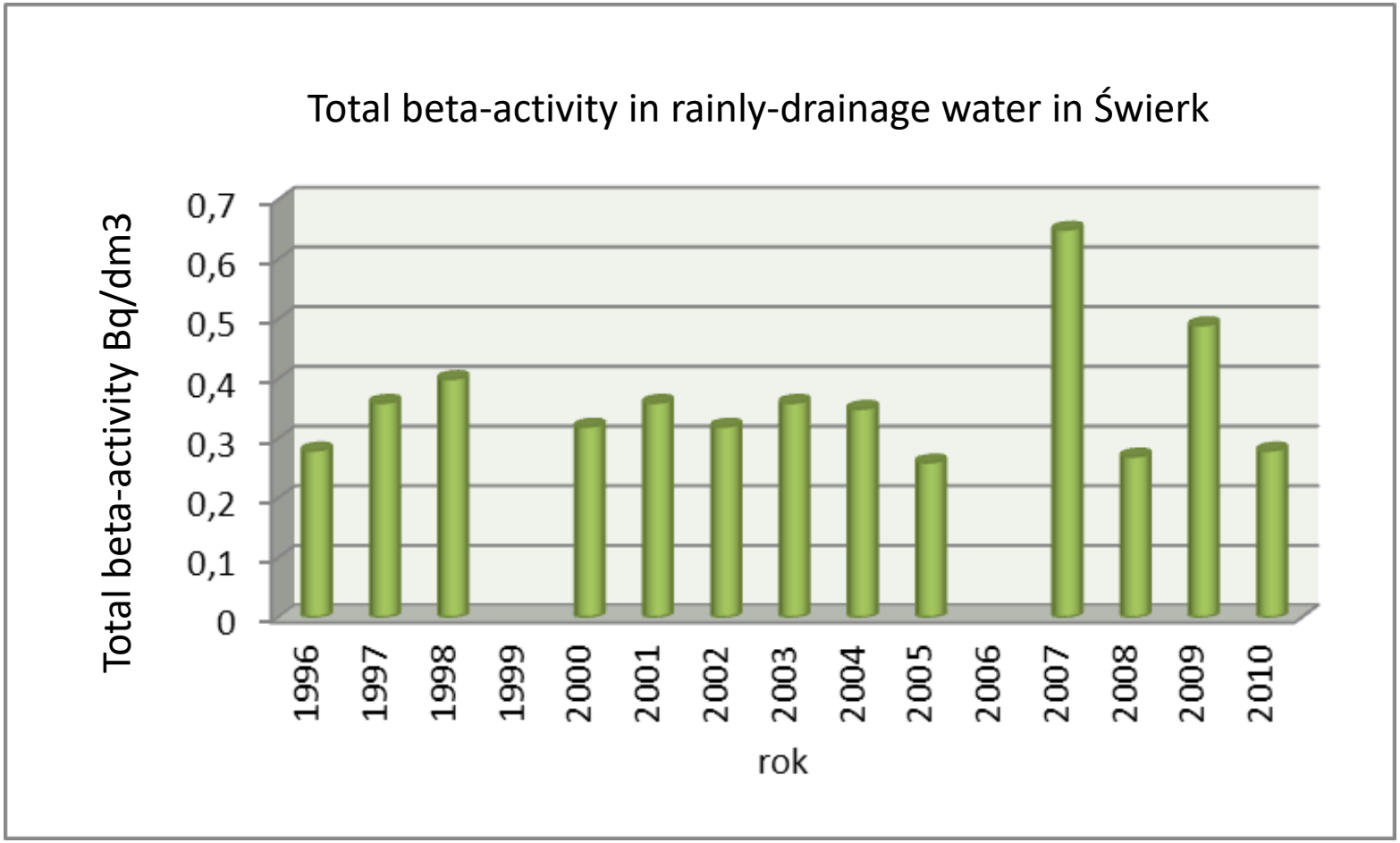


fig. Collection points of environmental samples in and around the resort in Świerk

NATIONAL NUCLEAR ENERGY EXPIRIENCE – MAIN RADIOLOGICAL SAFETY LABORATORY



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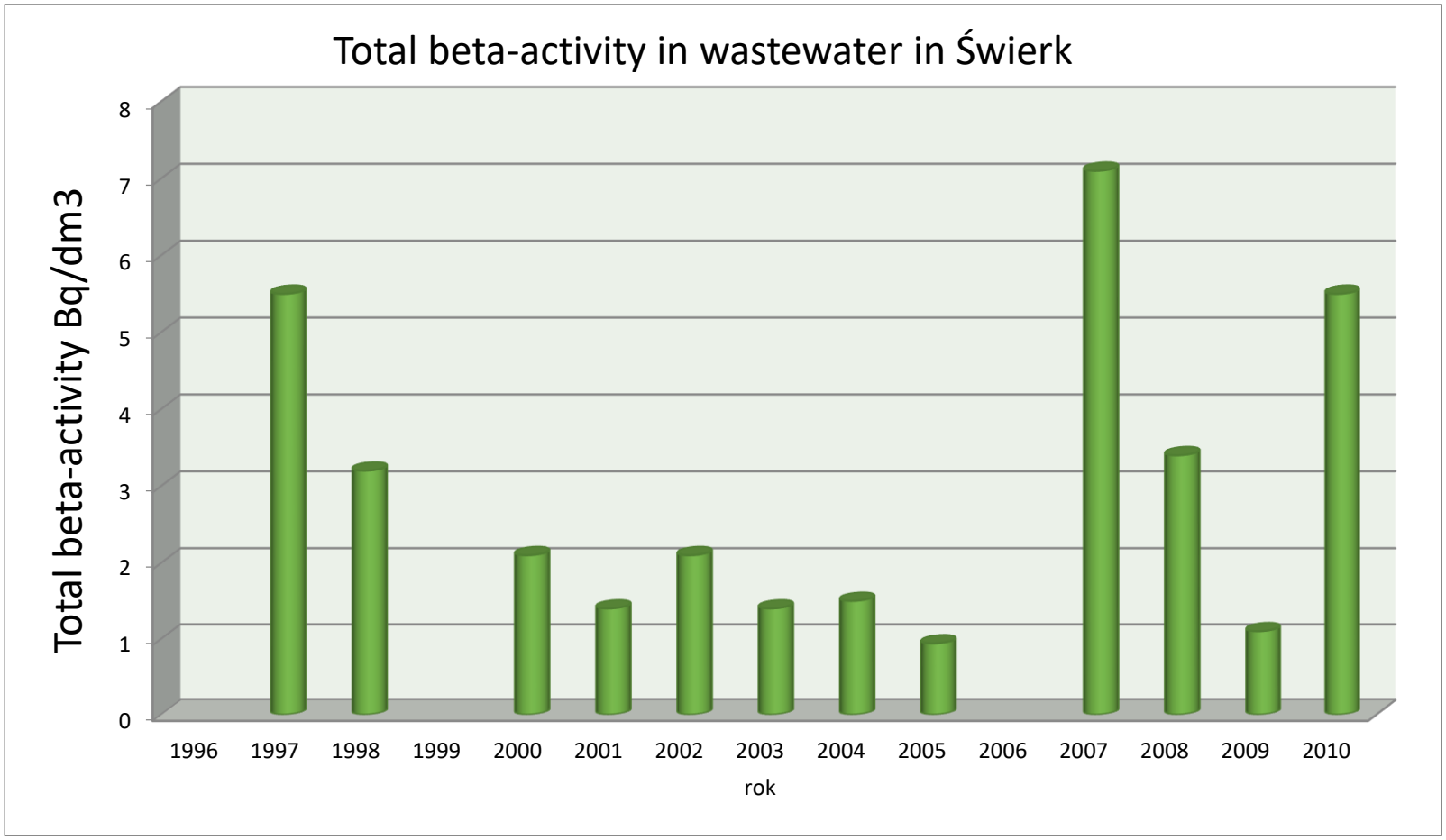

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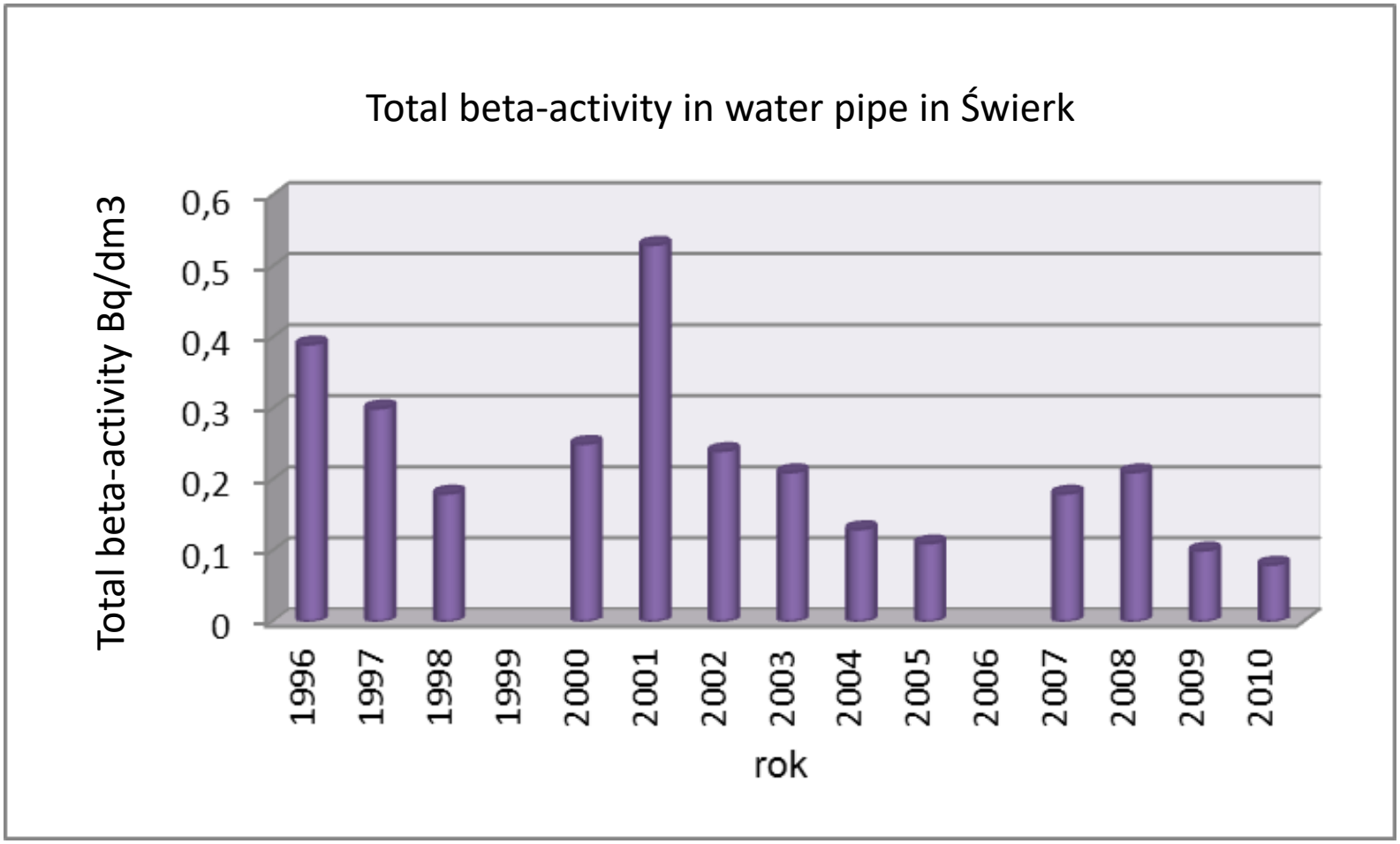
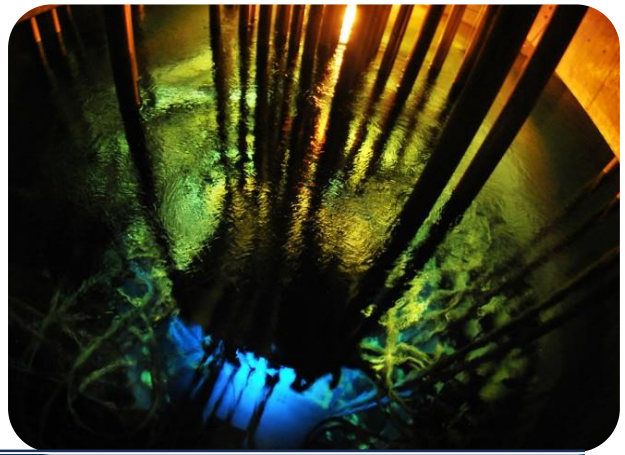
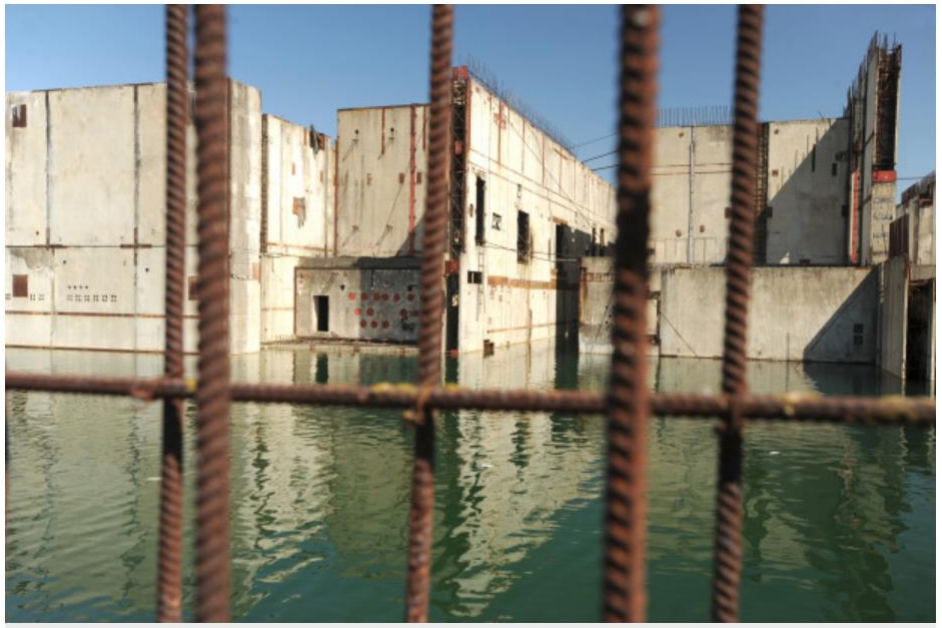


POLISH NUCLEAR POWER PLANT



„ELEKTROWNIA JĄDROWA ŻARNOWIEC W BUDOWIE”

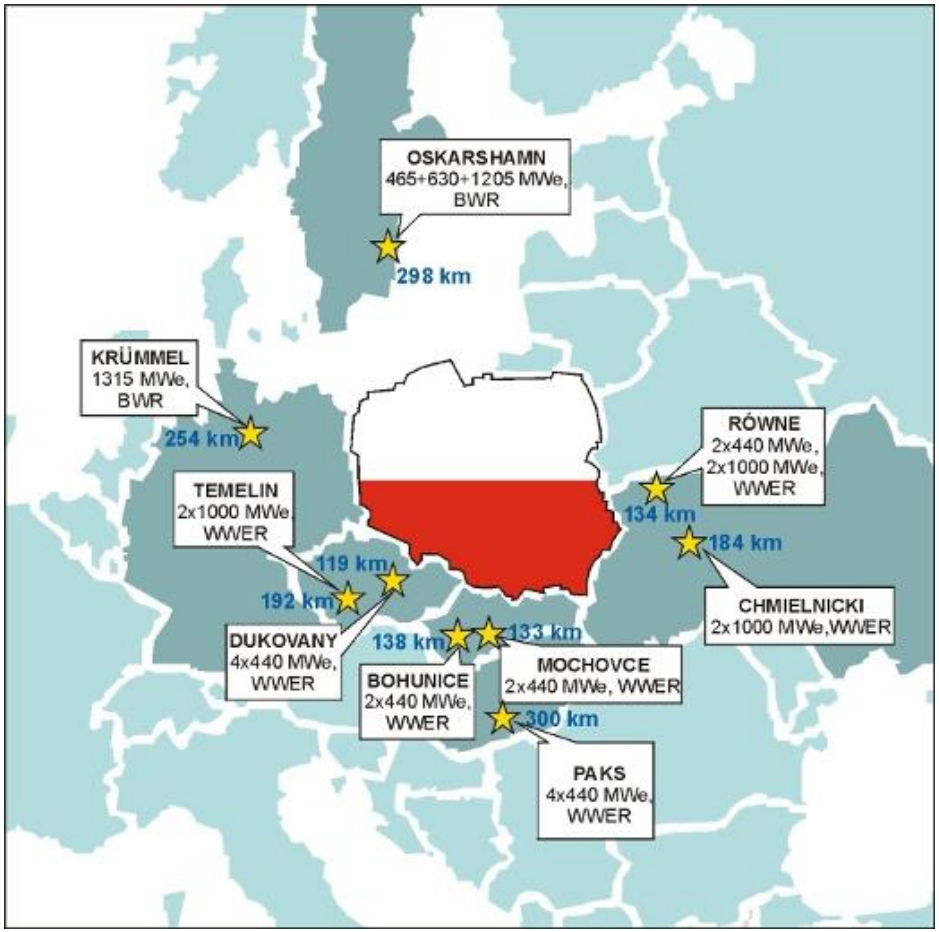
- 1972: Szczecin area, Ustka, Hel, Lubiatowo, Przegalina, Biała Góra;
- Kartoszyno -> Żarnowieckim



„ELEKTROWNIA JĄDROWA ŻARNOWIEC W BUDOWIE”

The investment was to occupy an area of 425 ha intended for the gym, facilities and accompanying facilities

„ELEKTROWNIA JĄDROWA ŻARNOWIEC W BUDOWIE”



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Thank you for your attention