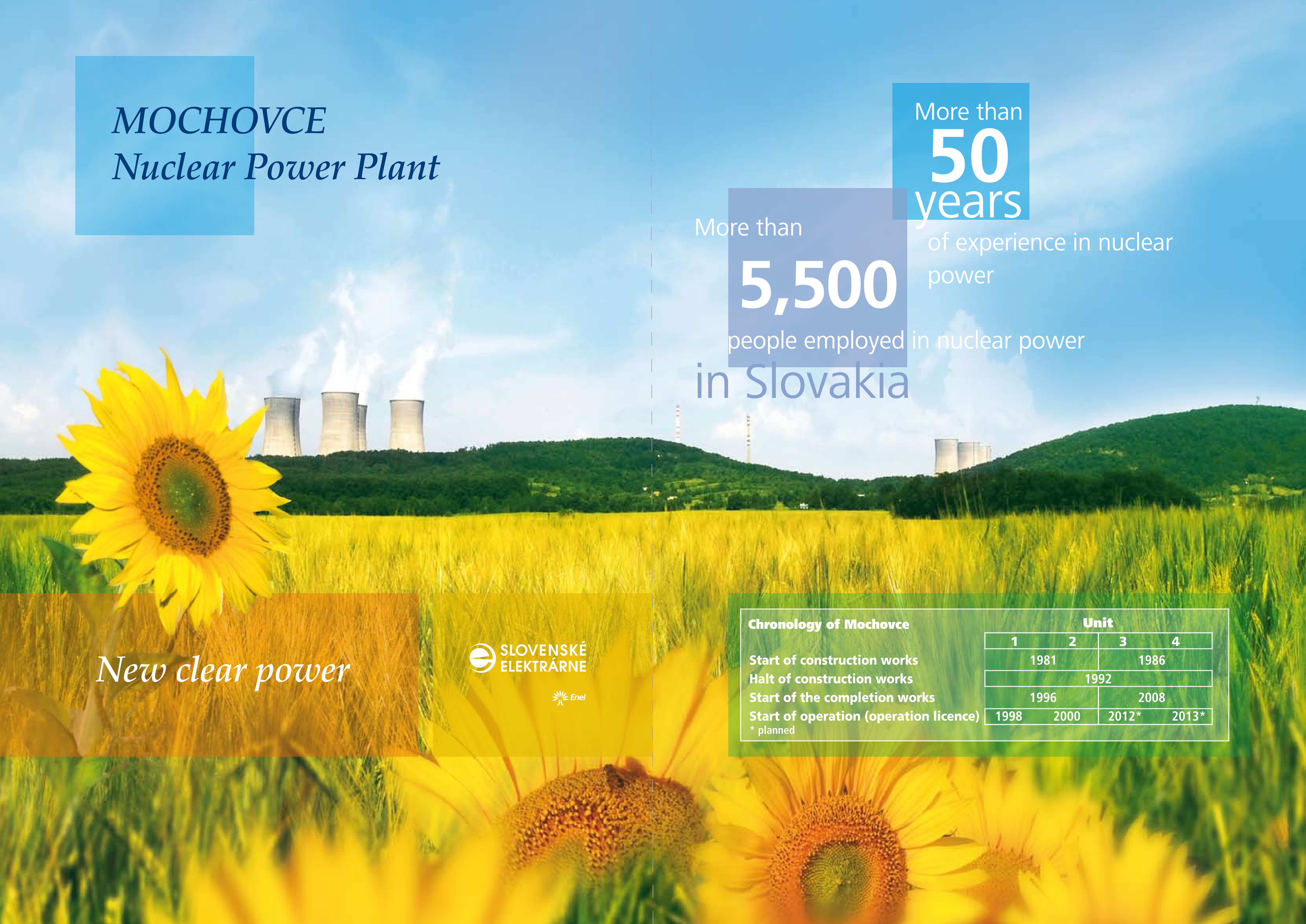


MOCHOVCE Nuclear Power Plant

New clear power

SLOVENSKÉ ELEKTRÁRNE

Enel

More than **50** years of experience in nuclear power

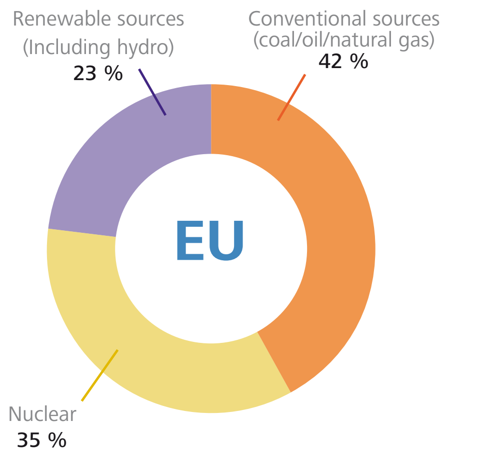
More than **5,500** people employed in nuclear power in Slovakia

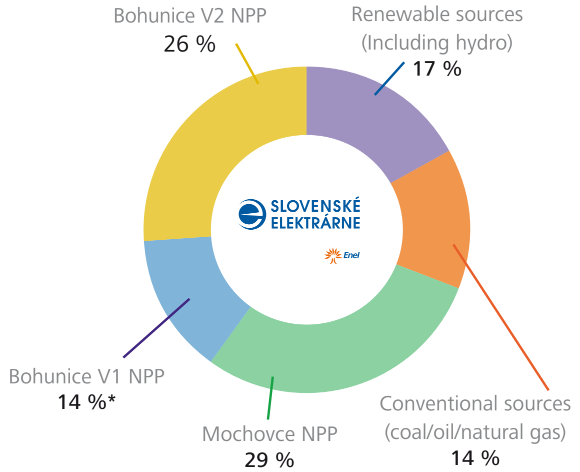
Chronology of Mochovce

	Unit 1	Unit 2	Unit 3	Unit 4
Start of construction works	1981		1986	
Halt of construction works	1992			
Start of the completion works	1996		2008	
Start of operation (operation licence)	1998	2000	2012*	2013*

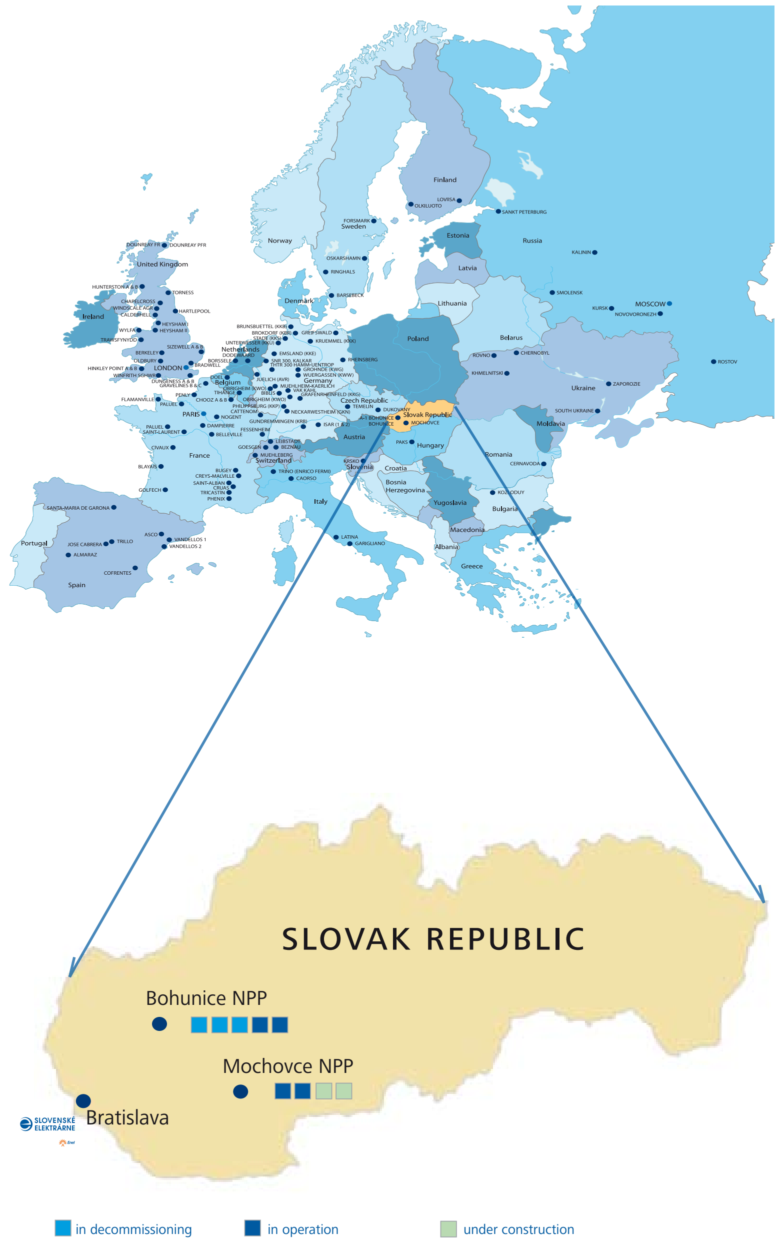
* planned

Nuclear in energy mix





* Bohunice V1 shutdown permanently in 2008



- The role of nuclear power plants (NPP) in the world energy mix is continuously increasing with the reduction of fossil fuel reserves.
- Nuclear power plants emit no greenhouse gas to the atmosphere, in this way NPPs annually contribute to CO_2 emission reduction by 800 million tonnes in Slovakia. Without nuclear–generated electricity, the emissions would be higher by two-thirds in the EU.

Nuclear fuel cycle

3 FUEL FABRICATION

The pressurized water reactors use the fuel in form of the ceramic fuel pellets which are hermetically encased in metal tubes to form fuel rods. The fuel rods are arranged into fuel assemblies. The operation of one Mochovce reactor requires approximately 8.5 tonnes of uranium fuel a year.

2 CONVERSION AND ENRICHMENT

The process of refining and conversion is necessary for the conversion of the uranium compounds, present in the yellow cake, in a gaseous form suitable for uranium 235 enrichment (uranium hexafluoride - UF6). Uranium consists of a mixture of two isotopes – natural uranium U-238 and fissile uranium U–235. There is only a very little concentration of U–235 in natural uranium (0.7%) therefore it is necessary to enrich its concentration in the fuel to more than 4%.

1 URANIUM MINING AND TREATMENT

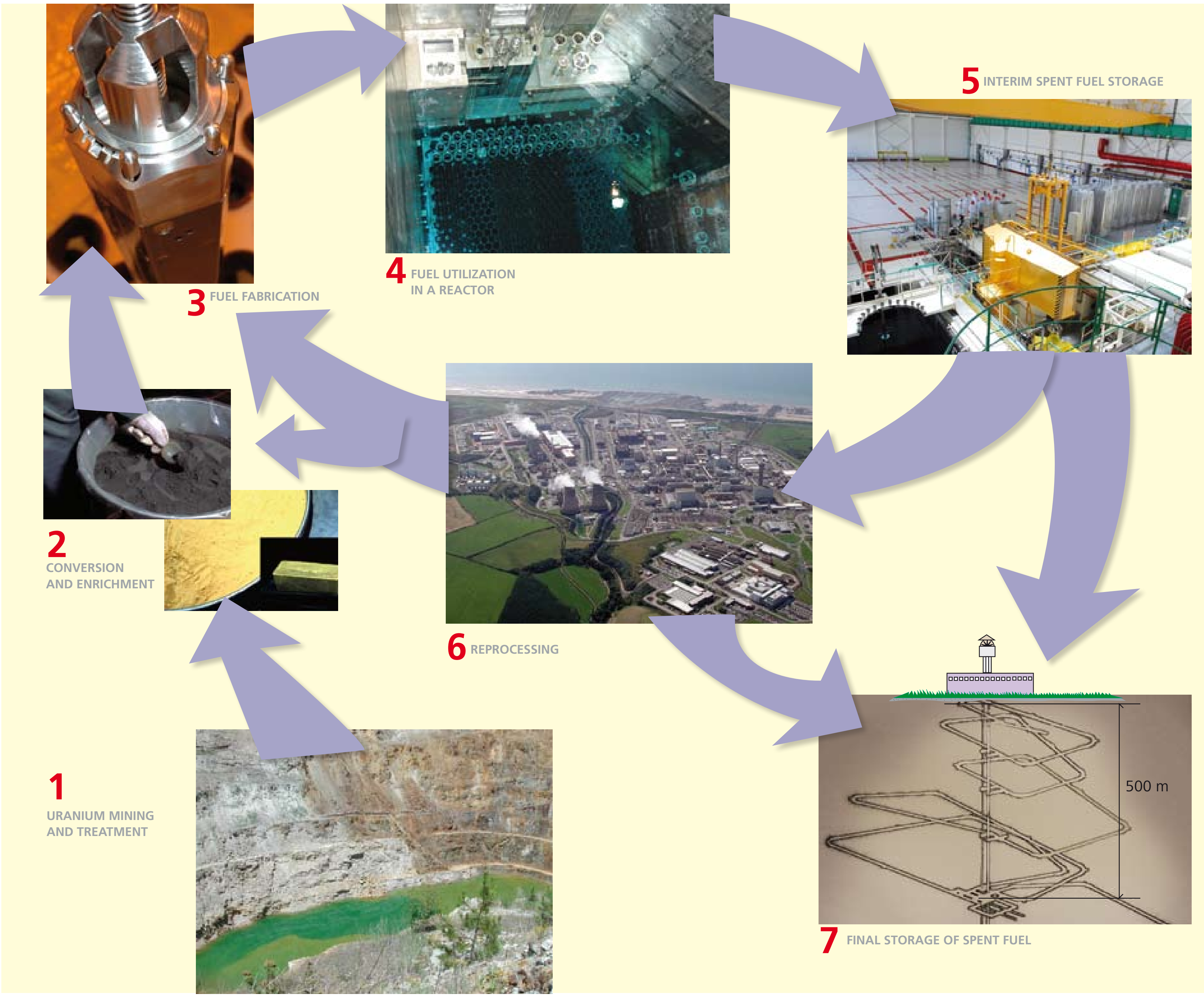
Uranium is extracted in underground or open pit mines. The original ore may contain from 0.1% to 3% of uranium. The greatest amounts of uranium ore is extracted in Canada, Australia and Kazakhstan. By leaching (a chemical treatment), the so-called „yellow cake“ is obtained, which contains more than 80% of uranium.

4 FUEL UTILIZATION IN A REACTOR

The energy released by fission of uranium in the reactor is removed by coolant – water – and then converted into electricity in a turbine generator.

5 INTERIM SPENT FUEL STORAGE

Spent fuel is moved to a spent fuel pool after 4 to 5 years of operation in the reactor. Fuel is handled in water, which provides sufficient protection against leak of radioactive isotopes to the environment. The fuel is being cooled down there. After 5 years, the spent fuel can be transported to the interim spent fuel storage.



6 REPROCESSING

The spent fuel contains about 95% of U-238, but also about 5% of fissile products, which have originated in the reactor. In reprocessing plants, the spent fuel is separated into reusable uranium and waste.

7 FINAL STORAGE OF SPENT FUEL

Studies that define the optimal approach to the final spent fuel storage are being carried out and other possibilities of using spent fuel with the help of new technologies in nuclear industry are being considered. There is currently no country with a final deep repository of spent fuel.

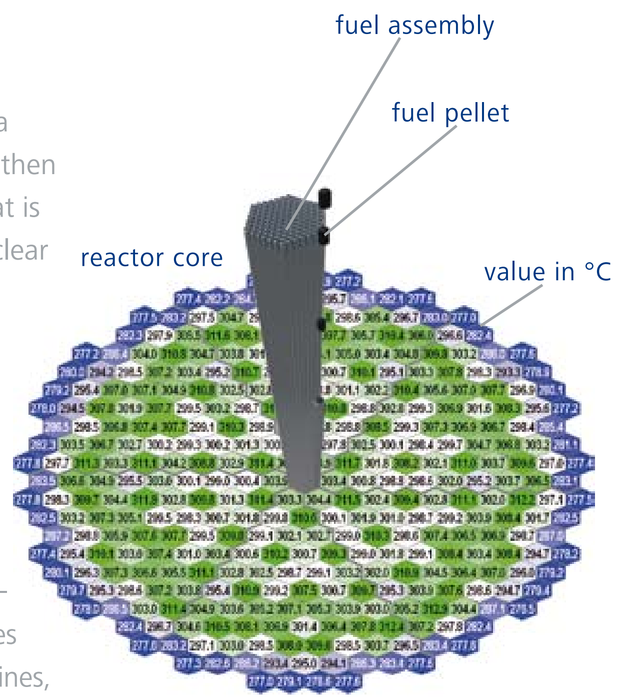
46 mil. kWh of electricity is produced out of 1 t of natural uranium. This equals to 20,000 t of black coal or 8.5 mil. m³ of natural gas.

Electricity generation

Each unit supplies 11% of electricity consumed in Slovakia

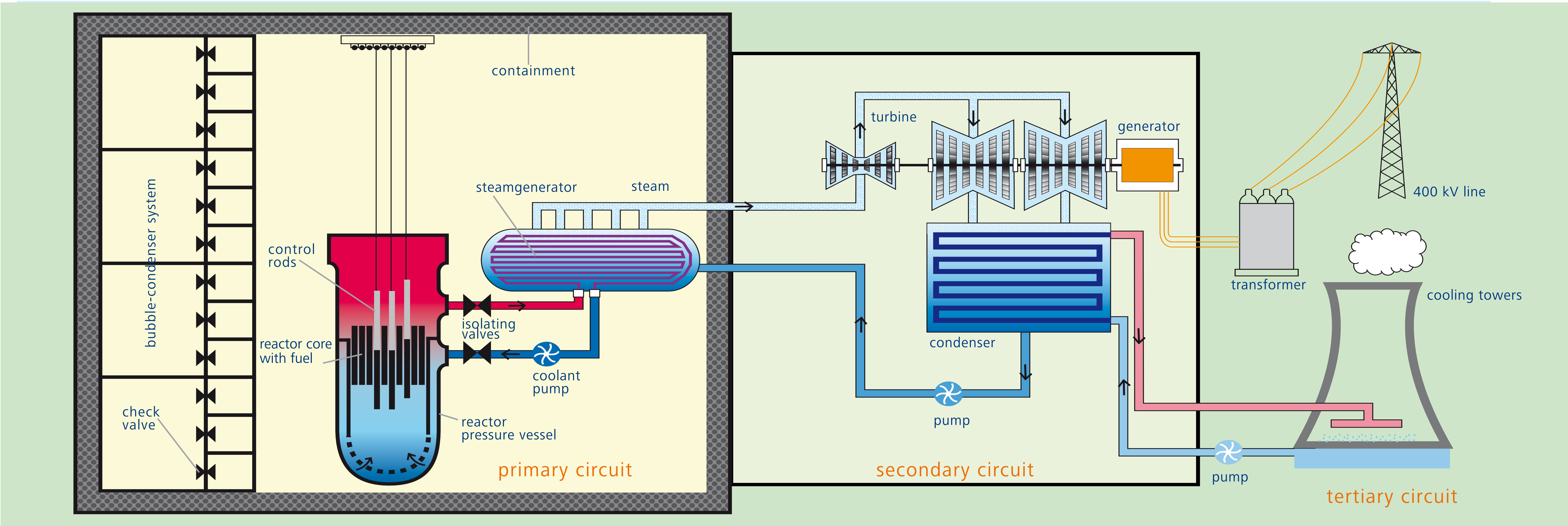
The principle of electricity generation in a nuclear power plant is quite similar to a conventional fossil fuel plant – the main difference is the source of heat which is then converted into electricity. In conventional thermal power plants the source of heat is fossil fuel (coal, gas, etc.), while in nuclear power plants the source of heat is nuclear fuel.

Fuel assemblies are placed in the **reactor pressure vessel**, where chemically treated water ("primary water") runs through channels in fuel assemblies and removes heat generated in the fission reactions. The heated water exits the reactor at a temperature of about 300°C and is conveyed to special heat exchangers – the **steam generators**. Here primary water transfers the heat removed from the core to the secondary circuit water. Both circuits are hermetically separated. While cooled-down primary water gets back to the reactor core, secondary circuit water evaporates in the steam generators. The high-pressure steam produced in this way is led to turbines,



where it expands, causing the rotation of the turbine shaft connected to the **generator**, thus producing electricity. After expanding in the turbine, the steam condenses in the **condenser** and returns back to the steam generator. Steam collected in the condenser is condensed and cooled by the third cooling circuit - in **cooling towers**. Evaporation is compensated with water taken from the nearby Hron river. In this way, there is no possibility of direct contact between the primary water cooling the reactor core and water returned to the environment in the form of small droplets and steam from the cooling towers.

Nominal output power of the Mochovce NPP Units 1&2 was increased by 7% in 2008. This brings the electric output of each unit from 440 MW to 470 MW – an increase that can cover approximately 10 % of the 4.9 TWh household consumption in Slovakia.

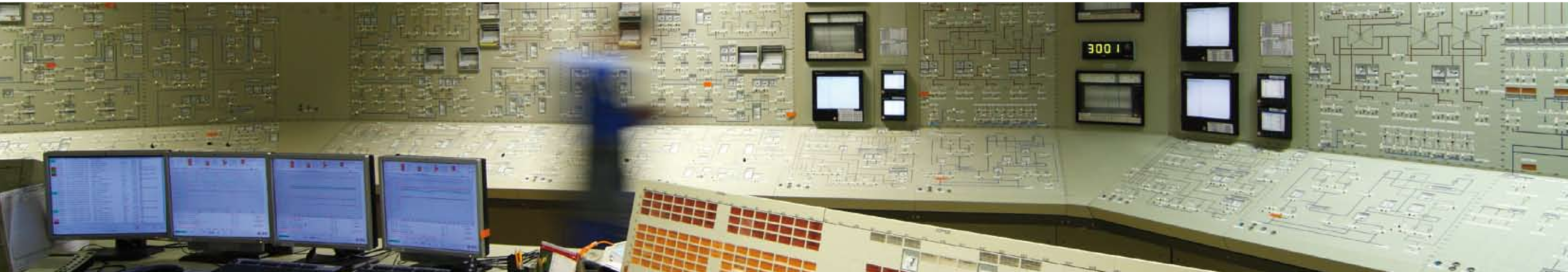


Mochovce 1&2 safety features

- Construction of Units 1&2 included an extensive **programme of design safety improvements**. In addition to Slovak, Czech and Russian industry, the plant completion involved leading **West-European companies**, such as Framatome, Siemens, and EdF.
- Numerous **international safety evaluations** (IAEA, WANO, WENRA, RISKAUDIT) have concluded that the safety level of the reactors operated in Slovakia is comparable to that of nuclear power plants operated in Western Europe.
- The technology of Mochovce 1&2 is based on a **robust design**, relatively low unit power and power density, and high volumes of water in the cooling circuits, which ensures wide and stable operational range for the plant. This implies high performances of the plant in accident prevention and, consequently, an inherently high level of nuclear safety.
- **Triple redundancy** design is adopted for safety systems, which means that each plant safety system is actually replicated into three redundant, independent and fully-separated sub-systems, each of which is fully capable of performing the required safety functions.
- **A full-scope simulator,** able to reproduce the plant performacne and behavior in real time, is installed on site to ensure an effective training of NPP operators.

Mochovce 3&4 evolutionary design

- The design of Mochovce 3&4 is based on a proven and well-consolidated **pressurized water reactor (PWR) technology** and includes up-to-date technological developments and safety improvement measures, such as:
  - inclusion of systems for severe accidents management;
  - adoption of the latest digital technology for Instrumentation and Control;
  - improvement of units' seismic resistance;
  - enhancement of fire protection system;
  - inclusion in the design of operational experience from similar plants.
- Design modifications and safety improvements were approved by the Nuclear Regulatory Authority of the Slovak Republic. The upgraded plant design **meets or exceeds current international safety requirements** and is comparable with nuclear power reactors currently under construction in the EU.
- An independent international **Safety Board** of six leading international nuclear safety experts has reviewed the design in order to ensure that international requirements and best-practices were incorporated; this Board review was additional and preceeded approval process performed by the National Nuclear Regulatory Authority.
- **Positive opinion about the Mochovce NPP Units 3&4 was expressed also by the European Commission within the framework of the Euratom Treaty.**



Containment

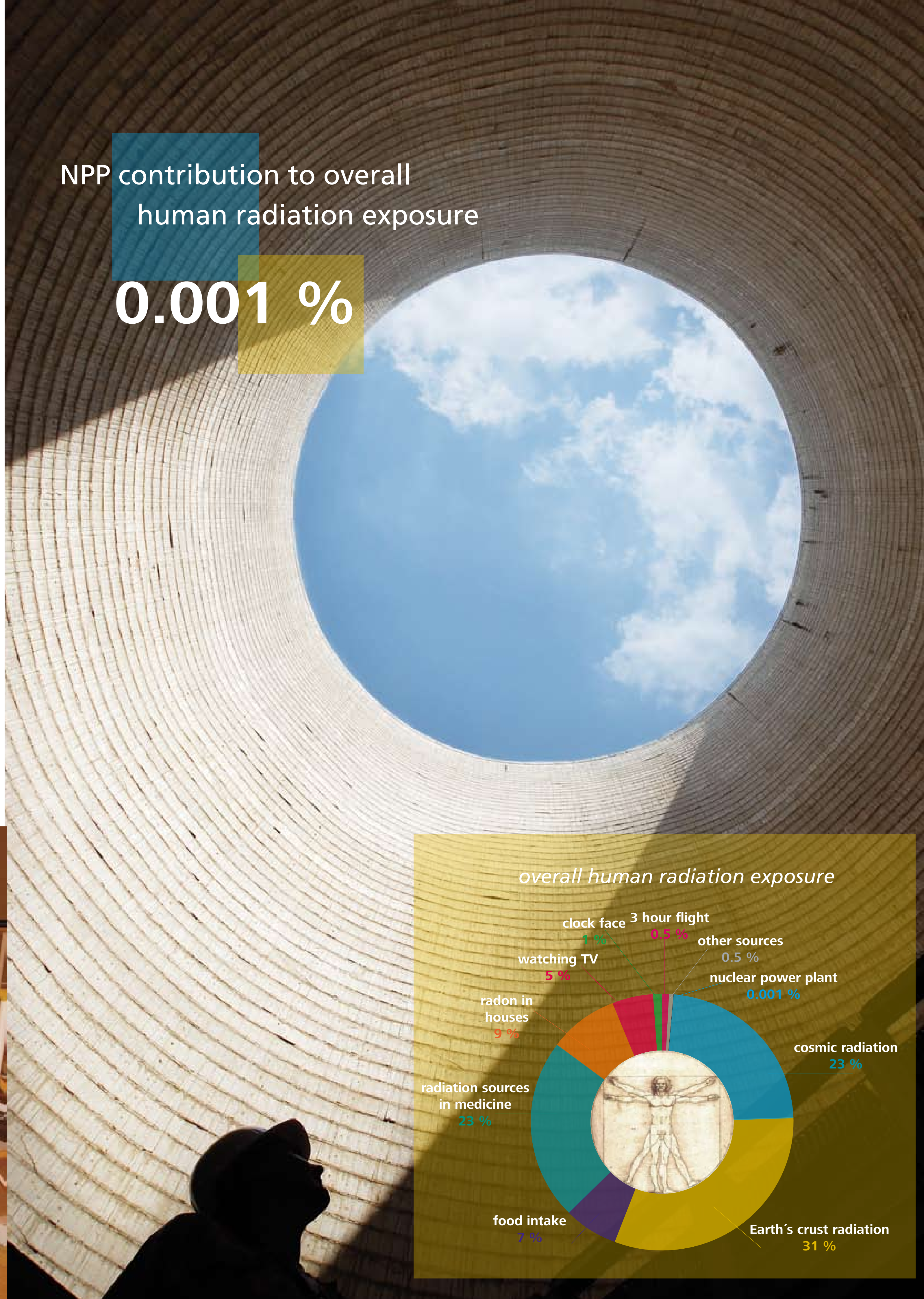
- In compliance with applicable international requirements, all the four units of the Mochovce NPP are equipped with a **containment** system fully capable to cope with accidents, thus minimising any off-site radiological consequences. Containment capability to withstand accidents is supported by extensive studies and tests mostly funded by EU and performed at the European level over the past fifteen years.
- This type of containment is of a pressure-supression type, relying on large volumes of water to condense steam released from the reactor coolant system in case of piping rupture, and to keep sub-atmospheric pressure inside.
- Containment design has taken into account all potential external hazards according to Slovak and IAEA requirements.
- The containment has a very small exposed surface, because of the favourable site orography and of several surrounding civil structures, and is made up of **1.5 m-thick reinforced-concrete walls**. This ensures the highest level of protection against external hazards, including an aircraft crash. It has to be underlined that Slovakia is a part of **NATO Integrated Air Defence System** covering air threats.

Radiation protection

Radiation protection of the power plant staff and population is crucial for the safe operation of the Mochovce NPP. The use of **ALARA** principle ensures that the radiation exposure inside and outside the power plant is **A**s **L**ow **A**s **R**easonably **A**chievable and well below the limits set by legislation. Through adoption of an effective radiation protection and monitoring programme, the impact of NPP operation on the environment and human health is negligible with respect to other radiation sources present in every-day life (see figure on the opposite page).

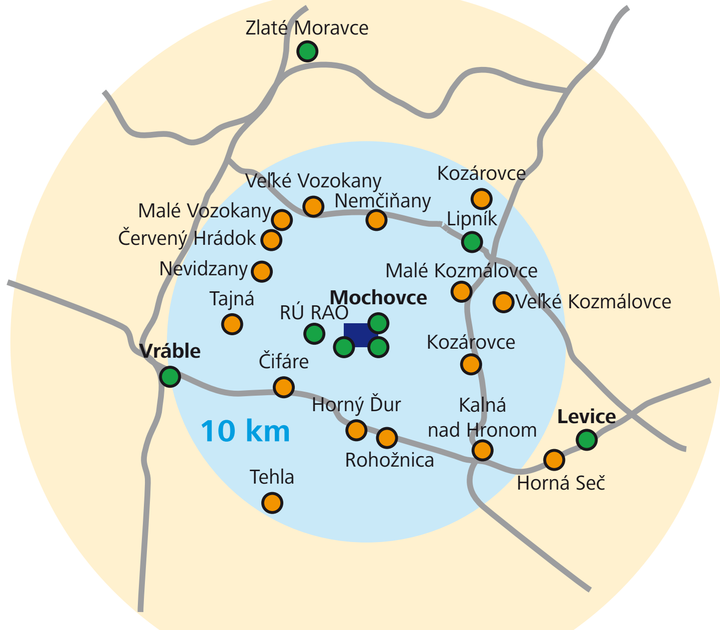
Nuclear plants produce small amount of radioactive waste. One Mochovce unit produces annually approximately **60 m^3** of liquid and **15 tons** of solid low-level radioactive wastes (RAW), and about **10 tons** of spent fuel. The waste is treated safely and separated from environment. No leak of radioactivity has ever occurred during many years of operation.

Liquid radioactive wastes are treated in Mochovce, solid ones in the Bohunice RAW Treatment Centre, and then disposed of in the National Radioactive Waste Repository in Mochovce.

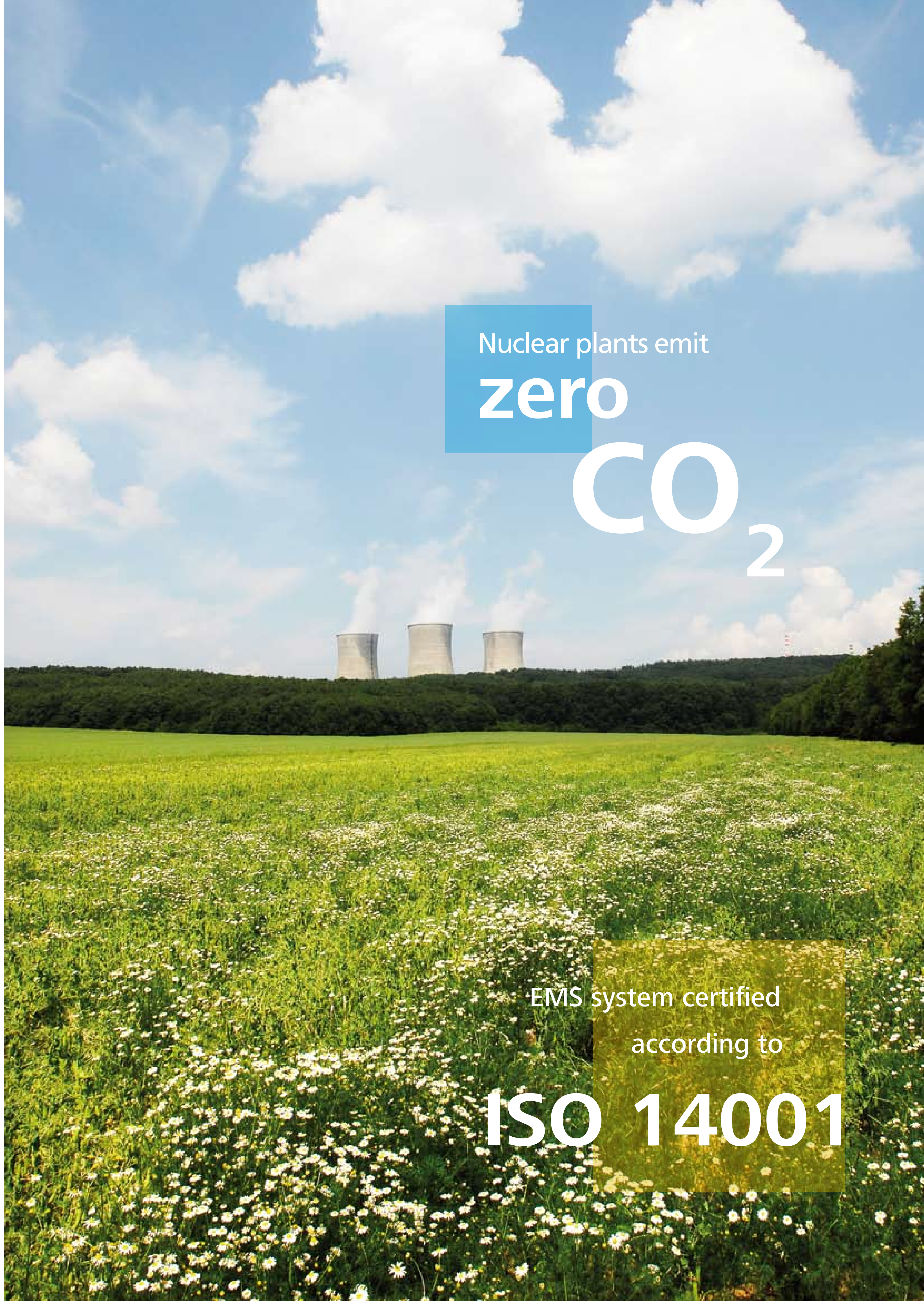


Environmental protection

- Nuclear power plants are environment-friendly and significantly contribute to the obligation to reduce emissions of harmful greenhouse gas to the atmosphere. Regular environmental impact studies of the Mochovce NPP operation have proven that the power plant meets all international requirements and that the operation impact is minimal.
- Water required for cooling is taken from a water dam built on the nearby Hron river, which ensures sufficient supply of water even in extremely dry climate conditions. The impact of the discharged waters on the quality of the Hron river water, fauna and flora is negligible.
- The care and efforts of Mochovce NPP staff to reduce environmental impacts of the plant operations is demonstrated by the use of the environmental management system according to ISO 14 001.
- Emissions to the atmosphere and effluents to the hydrosphere are regularly measured and assessed in the 20-km area around the plant. There are 25 monitoring stations of the tele-dosimetry system, which continuously monitor the dose rate of gamma radiation, activity of aerosols and radioactive iodine in the air, soil, water and food chain (feed, milk, agricultural products). The volume of radioactive substances contained in liquid and gaseous discharges is considerably lower than the limits set out by authorities.



Map of the monitoring stations around Mochovce NPP



Environmental Impact Assessment

- The process of evaluating the environmental impact of the future operation (**EIA**) for Units 1&2 was undertaken in the past, and the same study is carried out for Mochovce Units 3&4.
- In 2007, the preliminary environmental impact study, produced by an internationally renowned company with over 50 years of experience, confirmed that the operation of all four units at the Mochovce NPP will have no significant adverse effects on the environment. Indeed, the project will result in a number of positive effects, both providing economic benefits to the immediate and surrounding communities and avoiding greenhouse gas emissions when compared to conventional plants.
- Based on a requirements of the Slovak Ministry of Environment, the EIA process, including public participation according to Espoo and Aarhus Conventions, is carried out for Units 3&4, too, even though Mochovce 3&4 have a valid construction permit.

Basic figures

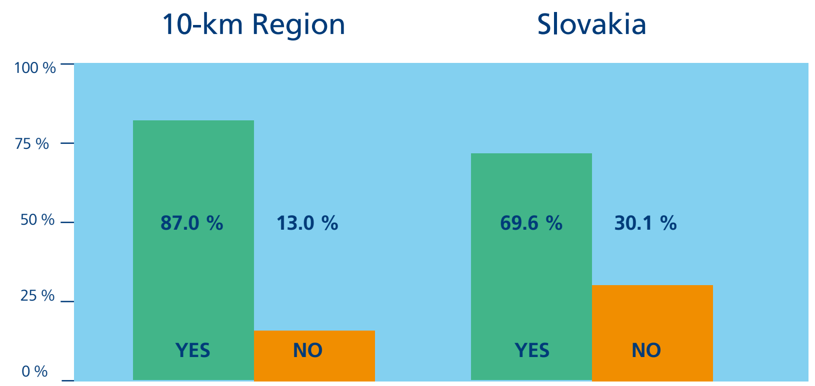
- Mochovce units meet or exceed current international safety requirements.
- Mochovce Unit 3 will be put into commercial operation in **2012** and Unit 4 in early **2013**.
- Each unit will have **440 MWe** output.
- Some **3,500** people will work at site during the peak of the construction.
- Another approximately **230-250** experts will be employed in positions needed for plant operation.

	Units 1&2	**Units 3&4**
Reactor type	PWR – pressurised water reactor VVER 440/V-213	
Reactor thermal power	1,471 MWt	1,375 MWt
Electrical gross power	470 MWe*	440 MWe
Primary circuit	6 loops	
Working pressure/ temperature	12.26 MPa / 267 – 298°C	12.26 MPa / 267 – 295°C
Reactor pressure vessel (h/ø)	11,805 mm / 3,542 mm	
Secondary circuit		
Steam generator (6 per unit)	PGV - 213	
Volume of steam generated	479 tons per hour	444 tons per hour
Steam pressure and temperature at outlet	4.69 MPa / 259.9 °C	4.74 MPa / 260.6 °C
Turbine (2 per unit)	220 MWe	220 MWe
Generator rated power	259 MVA	300 MVA
Terminal voltage	15.75 kV	
Rated current	3 x 9,500 A	3 x 10,950 A
Tertiary circuit		
Max. temperature of cooling water	33°C	
Height of cooling towers (4 per 2 units)	125 m	

*after power upgrade

Public Acceptance

One of the fundamental conditions of nuclear energy development is the public acceptance. Over **two-thirds** of the Slovak population (and over **87%** of the population in 10-km area around the power plant) is **in favour of the completion of Units 3&4**. (Based on several public opinion polls performed in recent years in Slovakia, the last one being taken in 2007 by the independent agency GfK).



Opinion of Slovak population
on Mochovce NPP Units 3&4 completion (GfK, 2007)

The main communication strategy of the Unit 3&4 completion project is **openness** and **transparency**. Different communication channels are used to improve the communication with the public:

- **The Civic Information Committee of Mochovce NPP** consists of 15 well-known authorities from the region. They regularly meet the management of the Mochovce NPP to stay informed all the time.
- **The Mochovce Regional Association** consolidating municipalities in 20-km area of the Mochovce NPP, and **the Association of Municipalities** in 5-km area.
- **Infocentre** is available for visitors Monday to Friday from 7.30 am to 4.00 pm. Qualified lecturers guide visitors on a plant tour. Up-to-date information is issued in a monthly magazine **atom.sk** which is distributed throughout the region for free.

More information at **www.seas.sk**.

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