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**TOPIC: Nuclear power plant Dukovany**

**NAME: Kryštof Olšovský**

**PROJECT: Comparison of energy potencial of Iceland and the Czech Republic**

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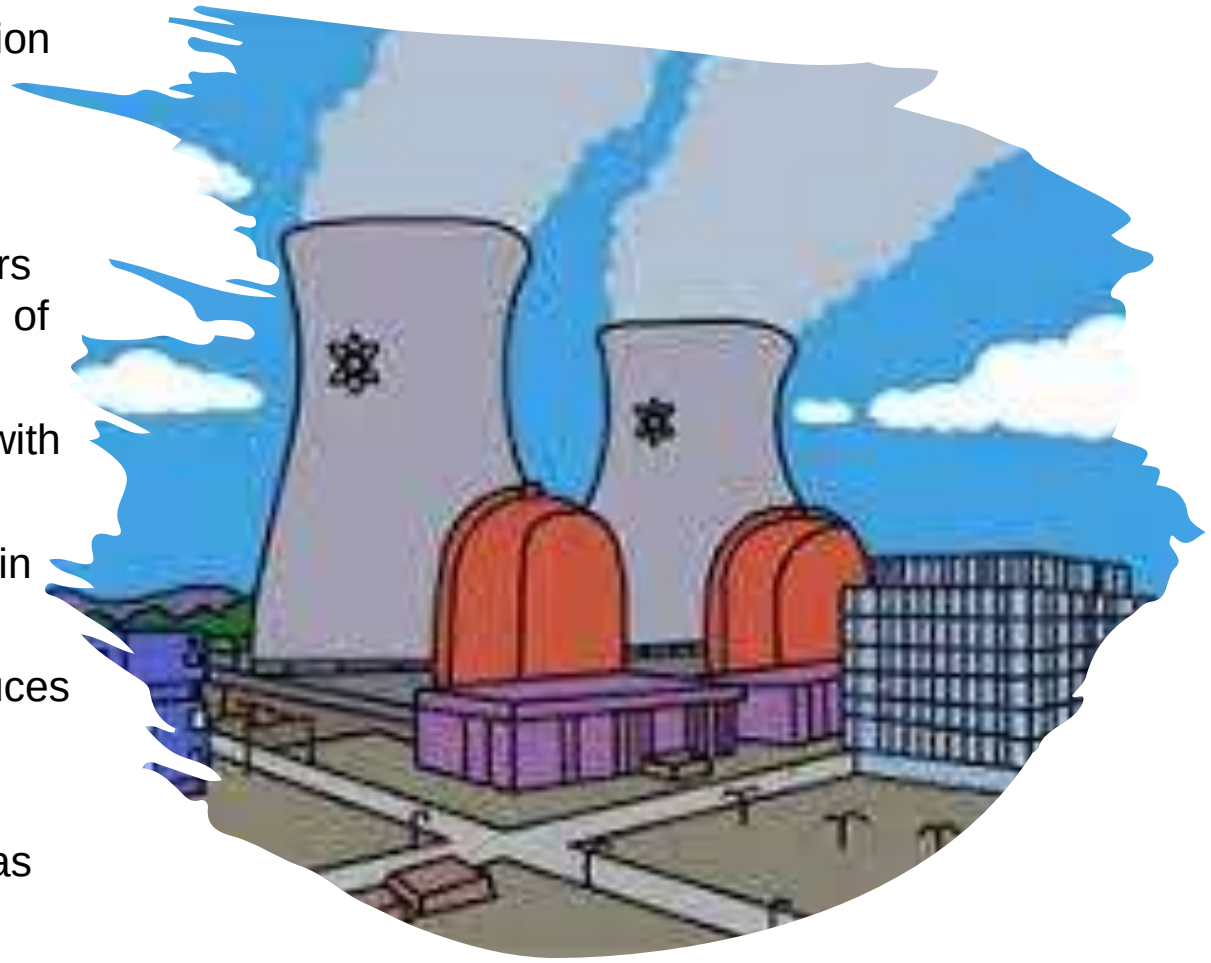
Nuclear power plant

# Dukovany

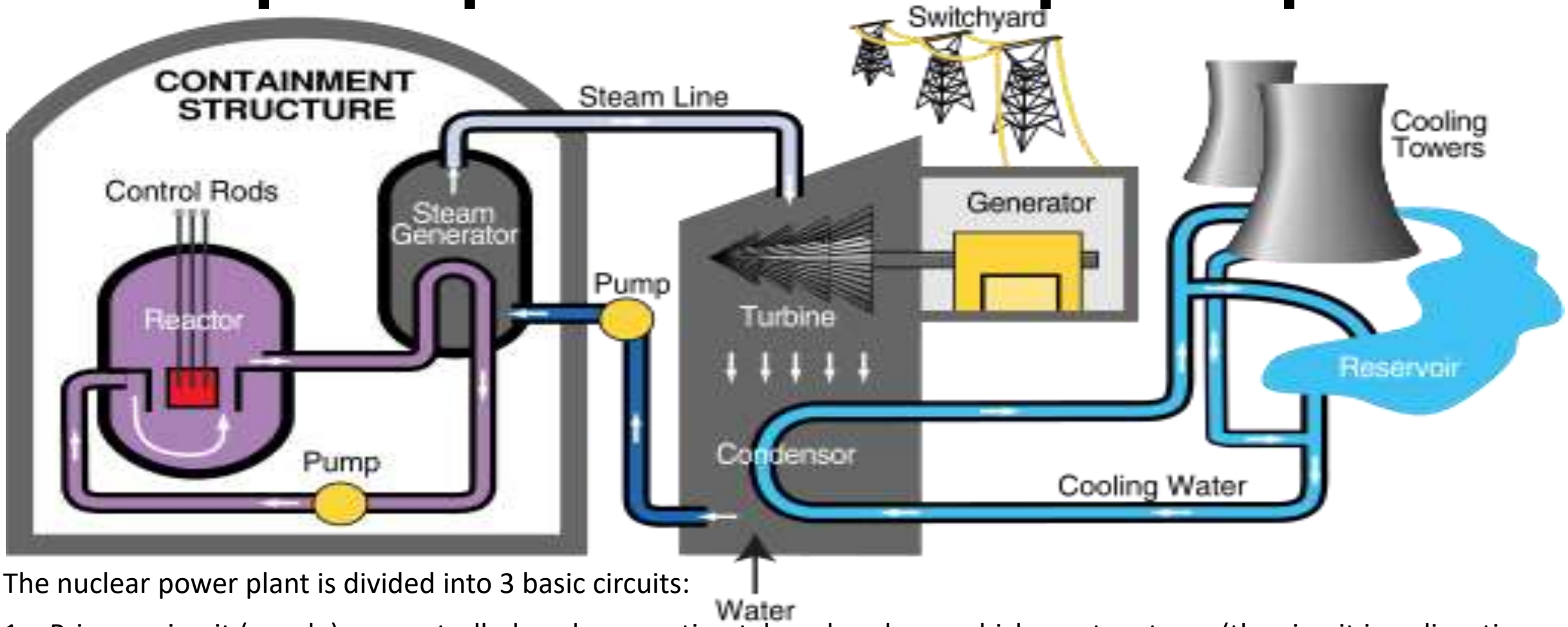
Kryštof Olšovský CZ

# What is a nuclear powerplant ?

- A nuclear power plant is an electricity generation plant respective technological equipment, serving to conversion of binding energy of the nuclei of heavy elements into Electricity.
- To put it simply, a nuclear power plant is thermal power plant and from a conventional thermal power plant differs basically only in the source of heat needed to formation of steam.
- It usually consists of a nuclear reactor, steam turbines with alternator and from many other devices.
- Heat is generated by fission of enriched uranium U235 in nuclear reactor.
- The resulting steam drives the steam turbine and produces an electric energy in the turboalternator.
- An important mention is that this source of el. energy is completely carbon-free and therefore in 2022 the EU has recognised this resource El. energy as *green*



# The principle of a nuclear power plant



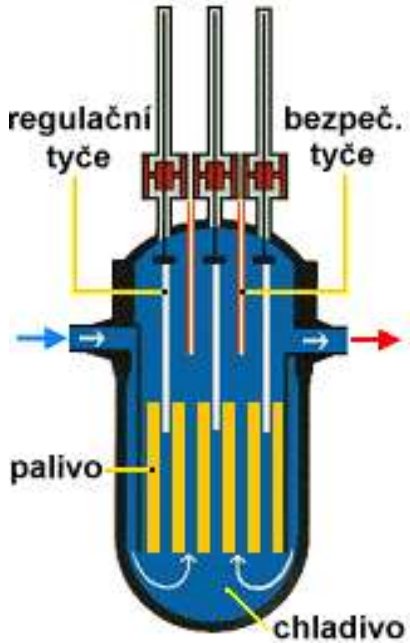

The nuclear power plant is divided into 3 basic circuits:

1. Primary circuit (purple) – a controlled nuclear reaction takes place here, which creates steam (the circuit is radioactive and is hermetically sealed)
2. Secondary circuit (dark blue) – this is where thermal energy is converted into mechanical energy (turbine)
3. Tertiary circuit (light blue) – this is where the cooling of the water in the cooling tower takes place

- Conversion of moss energy to electric (gray,black) + transformation to higher voltage (400Kv)

# Primary circuit

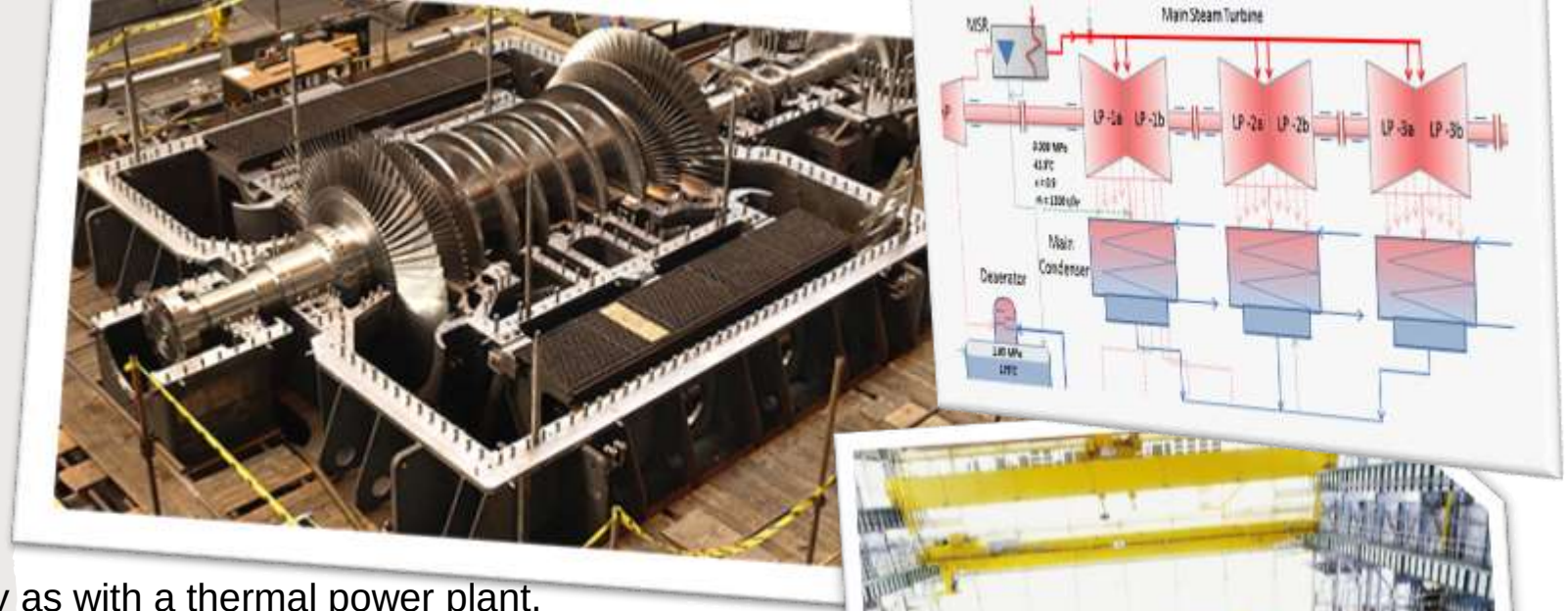
- In the primary circuit, nuclear energy is converted into thermal energy.
- The entire primary circuit is impermeably separated from the surrounding environment in hermetic boxes due to the radioactivity released during fission.
- The heart of the primary circuit is the nuclear reactor.
- Fuel is placed in a nuclear reactor.
- Fuel (enriched uranium in the form of uranium dioxide $UO_2$) is usually inserted into fuel rods with a diameter of about 9 mm.
- These are grouped into bundles forming fuel assemblies.
- The design of the cartridge ensures that the fuel rods do not touch each other and at the same time
- have been well cooled by a cooling medium.
- As a moderator to slow down the released neutrons, chemically modified water.
- At the same time, this water serves as a cooling medium for efficient heat dissipation from the fuel.
- Cooling water is heated to a temperature of approx. 300 °C
- As the temperature of water increases, its ability to slow down neutrons increases, and so naturally inhibits the unlimited start of the chain fission reaction in the reactor.



# Primary circuit

- In case of necessity to immediately stop the reactor are prepared emergency bars.
- Emergency rods are normally extended upwards above the active a zone where holds a signal by means of electromagnets and, if necessary, turns off the electromagnets, and the rods fall freely into the active zone, thereby stopping the fission reaction.
- The entire reactor core, which is surrounded by a reflector and a layer material performing the function of biological protection.
- The task of this material is to slow down and capture neutrons and absorb gamma radiation.
- The heated water from the reactor is drained into a heat exchanger – a steam generator.
- Here, heat is transferred from the primary circuit to the secondary circuit.
- Hot cooling water flows through thin tubes that are inside the steam generator.
- immersed in water of the secondary circuit and heated to the boiling point.
- In doing so, a large amount of steam develops from the boiling water of the secondary circuit.
- From the steam generator, the cooling water is returned back to the reactor via a circulation pump, which maintains the circulation of water in the primary circuit.
- Water circulates between the reactor and the steam generator in a closed loop.

# Secundary circuit



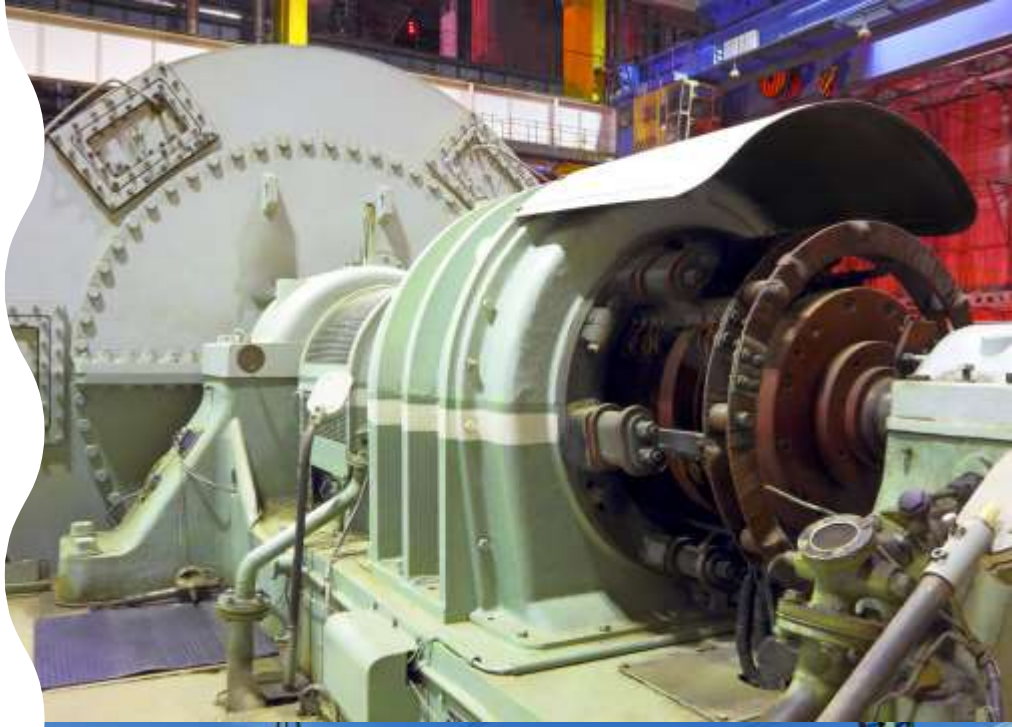
- The secondary circuit works in the same way as with a thermal power plant.
- Its main part is a steam turbine - its blades are rotated by superheated steam.
- The turbine is divided into a high-pressure part and a low-pressure part, which are connected by a common
- the shaft  together with the turboalternator.
- After exiting the turbines, it is drained into condensers, where it cools and condenses into water.
- This water can be reheated, converted into steam or used, for example, in heating.
- The process is repeated.
- However, it is necessary to constantly cool the condenser with flowing water to make the condensation process it was done correctly.
- Next, stroking water flows into the cooling circuit.

# Tertiary (cooling) circuit

- Nuclear power plants can be recognized from a great distance by massive concrete cooling towers, above which constantly float white clouds.
- Their task is to provide enough cool water, which is required to liquefy the steam after it has passed through the steam turbine.
- When the steam in the turbine surrenders its energy comes to Capacitor.
- Steam by touching cold pipes liquefies, releases the so-called.
- condensation heat and water in the pipes are heated.
- Heated water from the condenser goes to the cooling tower (up to 150m high).
- Here, shower heads are sprayed from a height of 10 m to 20 m, in drops it falls down and cools with flowing air.
- Some of the falling water evaporates into the air.
- Cooled water is collected in the pool under the tower and the pumps return it back to the condenser, where it is ready again take the heat of steam in the condenser.

# Turbogenerator + transformator

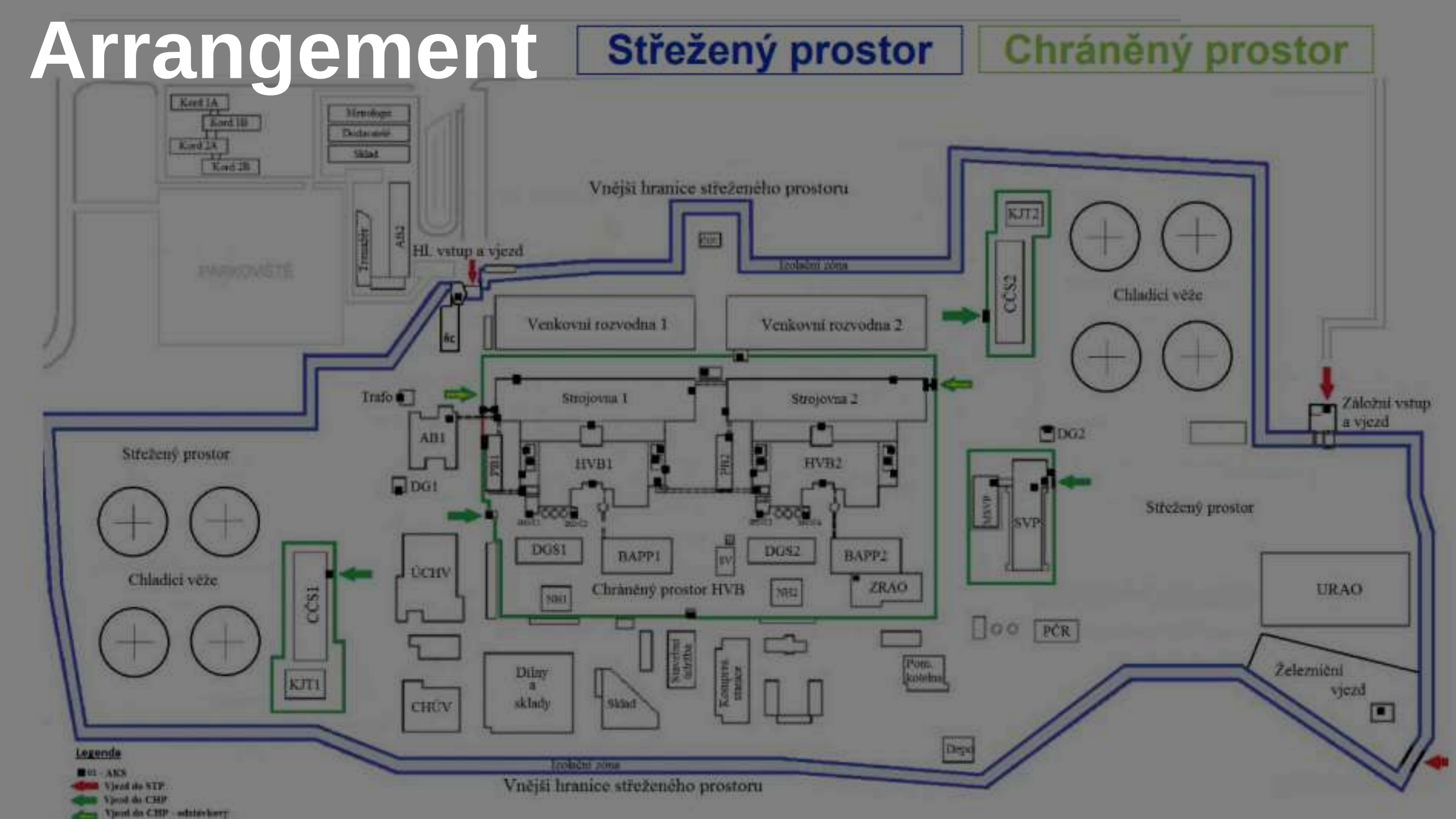
- The electric generator is the most commonly used rotating electromechanical machine, used to produce electricity.
- For optimal torque transfer from the turbine, it is electric generator located on a common rotor and together with the turbine forms one unit – turbo-generator.
- The electric generator works on the principle of electromagnetic induction – rotating magnetic field formed by rotor coils and generates alternating electrical voltage in the fixed coils of the stator.
- In current energy systems, three-phase power lines.
- Then the energy travels through the cables to the transformer (1 phase or 3 phase ), where it is transformed to a higher voltage (usually 400kV).
- Further, in the power plant we find backup sources, because the power plant  consumes about 20% of the energy produced for its own operation.



# Dukovany a history

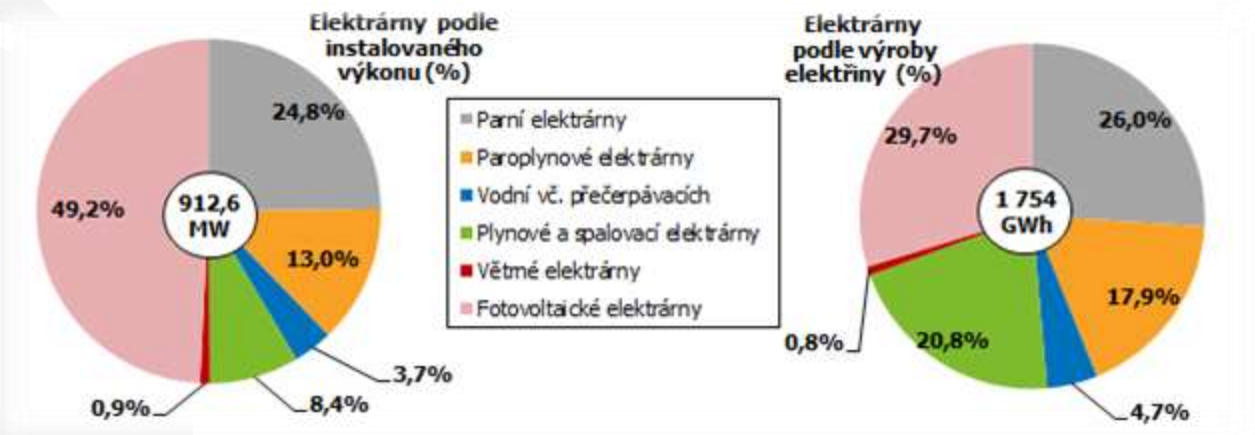
- Dukovany Nuclear Power Plant is located nearby village Dukovany (Třebíč District), on the border of the Region Vysočina and south Moravian Region.
- It was the second nuclear power plant in the former Czechoslovakia
- It is build about 25 kilometers southeast of Třebíč in a triangle that is delimited by the villages of Dukovany, Slavětice and Rouchovany, nearby Dalešice, whose lower reservoir (Mohelno Water Reservoir) serves as a source for cooling water.
- Dukovany powerplant began to be built in 1978, the first block was commissioned in 1985, last, fourth in 1987

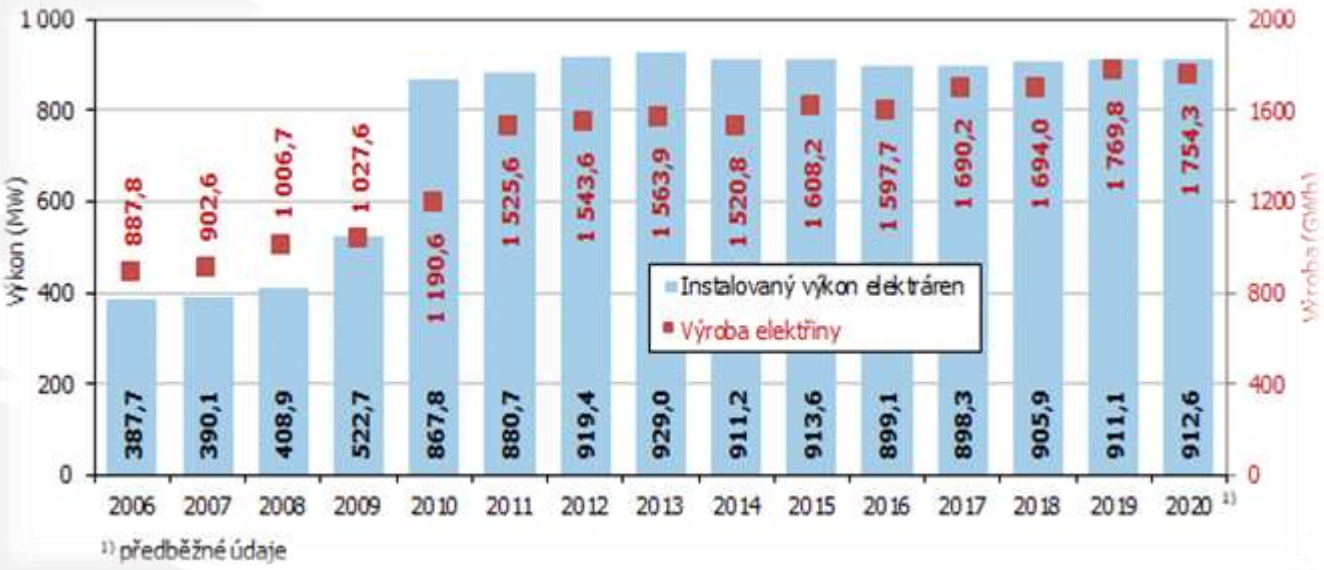
# Arrangement



# Nuclear power plant parameters

- Nuclear power plant long-term covers about 20% of total electricity consumption in the Czech Republic
- In order to increase the efficiency and use of power reserves occurred during the operation of the power plant modernization of equipment and increase of installed capacityfrom the original 4 x 440 MW to the current 4 x 510 MW.
- The total installed capacity of the power plant is 2040 MW.
- The expected operation of the existing units is within a year 2045-47.
- Three thousand employees work directly in the power plant for CEZ Group
- The power plant has 8 cooling towers 125 m high
- Construction costs were about 25 billion CZK



# Spent fuel storage

- Used nuclear fuel must first be replaced for a new one and leave it in the pool than move to temporary storage.
- It is assumed that if there is no used differently, will be stored after several years of storage permanently deposited in a deep geological repository.
- Commencement of operation of the first part of the deep geological repository, where will be used fuel from nuclear storage power plant transferred, is planned for 2065
- Because we have not only to keep fuel, which is it is necessary to store so that a warehouse for radioactive objects (overalls, apparatuses,...)

# Construction of additional units

- The key issue of the further development of the nuclear power plant Dukovany is the construction of the fifth and sixth units of the power plant.
- This is in line with the stategy for energy sector a concept which, in the context of gradual phasing-out, production in coal-fired power plants counts on an increase in production from renewable and nuclear sources, temporarily supplemented with gas sources.
- The new unit should replace part of the current performance a power plant that should slowly end after 2035.
- In March 2020, the power plant received a permit for the construction of two more nuclear units.
- In March 2021, it was announced that the tender decision completion
- In March 2022, ČEZ received a letter with applications for the launch of a tender for the construction of a new unit.

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