Clean energy
Enel is an International Group active in 40 countries on four continents.

Among the listed utilities in Europe, Enel is the second-largest by installed capacity and one of the leaders in terms of shareholders' number, with 1.4 million investors. The Group is also present in the top rankings of world’s largest utilities by market capitalization.

Enel generates 291.2 TWh/year of electricity using a balanced mix of energy resources. The generation plants have a total capacity of 97,336 MW, with over a third provided by renewable sources of energy; use of the latter is increasing constantly, especially in North, Central and South America. The Group distributes energy by 1.8 million km of power lines.

Moreover, Enel sells electricity to 60.9 million customers and gas to 4 million end-users, including residential and business customers.

Slovenské elektrárne is the Company in the Enel Group that operates in Slovakia.
<table>
<thead>
<tr>
<th>Countries</th>
<th>Net installed capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>98,036 MW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity production</th>
<th>Electricity distribution</th>
<th>Electricity sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>291.2 TWh</td>
<td>434.1 TWh</td>
<td>311.6 TWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Renewable installed capacity</th>
<th>Share of electricity without CO₂ emissions</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>35,508 MW</td>
<td>42 %</td>
<td>60.8 mil.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employees</th>
<th>EBITDA</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>74,877</td>
<td>17.7 billion Euros</td>
<td>27.2 billion Euros</td>
</tr>
</tbody>
</table>

1) It includes all countries where the Group has at least 1 MW in capacity or where sales activities are carried out. It also includes the countries where the Enel Group has business relations, projects in progress or representative offices. It includes El Salvador where Enel has a non-consolidated partnership with LaGeo.

2) Data as of 31 December 2011

3) Data as of 8 March 2011
Slovenské elektrárne, subsidiary of Enel Group, is the largest power generating company in Slovakia and the second largest in Central and Eastern Europe. It also generates and sells heat, and provides ancillary services to the power grid. Slovenské elektrárne has 5,739 MWe of installed capacity (December 31, 2012) in an ideal production mix of nuclear, hydro and thermal sources. It operates 34 hydroelectric, 2 nuclear, 2 thermoelectric and 2 photovoltaic plants.
<table>
<thead>
<tr>
<th></th>
<th><strong>Installed capacity</strong></th>
<th><strong>Electricity production</strong></th>
<th><strong>Electricity supply</strong></th>
<th><strong>Investments</strong></th>
<th><strong>Human resources</strong></th>
<th><strong>Savings of CO₂ emissions from one Unit of NPP</strong></th>
<th><strong>EBITDA</strong></th>
<th><strong>Mochovce 34 project</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5,739&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>22&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>20&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>771&lt;sup&gt;2)&lt;/sup&gt;</td>
<td>4,667</td>
<td>3.7&lt;sup&gt;3)&lt;/sup&gt;</td>
<td>806&lt;sup&gt;2)&lt;/sup&gt;</td>
<td>3,500</td>
</tr>
<tr>
<td></td>
<td>MW</td>
<td>TWh</td>
<td>TWh</td>
<td>mil. €</td>
<td>employees</td>
<td>mil. tonnes</td>
<td>mil. €</td>
<td>workers</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>1) Installed capacity, gross production and net electricity supply including Gabčíkovo HPP (VEG). VEG is owned by Vodohospodárska výstavba, š.p., and operated by Slovenské elektrárne</td>
<td></td>
<td></td>
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<td></td>
<td>2) As of 31 December 2011</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>3) International Nuclear Events Scale</td>
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</tr>
</tbody>
</table>
Nuclear power plants have a firm place in the global energy mix and their role is increasing with the reduction of fossil fuel reserves. Nuclear energy as a ‘carbon-free’ source has an irreplaceable role in terms of EU member states’ commitment to reduce CO₂ emissions by 20% from 1990 to 2020.

Nuclear power plants emit no greenhouse gas into the atmosphere. In this way NPPs annually contribute to CO₂ emission reduction by 800 million tonnes worldwide and by 15 million tonnes in Slovakia. Without nuclear-generated electricity, emissions in the EU would increase by two-thirds.
Electricity generated in 2012 (~22 TWh)

Slovenské elektrárne generates 89% of its electricity without GHG emissions
Electricity Generation

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

There are fuel assemblies inside the reactor. The coolant (chemically treated water) flows through channels in the fuel assemblies and removes heat generated in the fission reaction. The heated water of the primary circuit passes from the reactor at the temperature of about 300°C and is conveyed to heat exchangers – steam generators. Here the primary water transfers the heat removed from the core to the colder water of the secondary circuit. Both circuits are hermetically separated. Cooled primary water returns to the reactor; the secondary circuit water evaporates in the steam generators. High-pressure steam produced in this way is led into turbines where it strikes turbine blades and causes them rotating. The turbine shaft is connected to the generator which produces electricity. After expanding in the turbine, the steam condenses in the condenser and returns back to the steam generator as water. The condenser is cooled by the third cooling circuit – in cooling towers. Water evaporated from cooling towers is compensated from the nearby Hron River. In this way, there is no possibility for direct contact between the primary water cooling the reactor and water returned to the environment in the form of steam from the cooling towers.
Thermal scheme of VVER 440/V-213

Primary circuit

Secondary circuit

containment

reactor

control rods

nuclear fuel assemblies

reactor coolant piping (water)

reactor coolant pump

steam generator

main steam piping (steam)

high-pressure stage of turbine

400 kV line

generator

transformer

cooling tower

pump

condenser

Circuit of cooling towers

Thermal scheme of VVER 440/V-213
The nuclear fuel cycle is a series of industrial processes which involves the production of electricity from uranium fission in nuclear power plants. Uranium is a relatively common element - a slightly radioactive metal that occurs in the Earth’s crust. It is about 500 times more abundant than gold and about as common as tin. It is present in most rocks and soils as well as in rivers and in sea water. It must be processed before it can be used as fuel for a nuclear reactor.

1. Uranium Mining & Treatment

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

2. Conversion & Enrichment

Uranium compounds present in the yellow cake are converted into gaseous form (uranium hexafluoride – UF₆) suitable for the enrichment of uranium 235. Uranium, which is present in natural resources, consists primarily of two isotopes: U-238 and U-235. There is only a very small concentration of fissionable U-235 in natural uranium 238 (0.7 % on average). Therefore it is necessary to enrich its concentration in the fuel up to 4.95 %. The use of centrifuges is the most common commercial process of enrichment.

3. Fuel Fabrication

UF₆ is chemically treated to form UO₂ (uranium dioxide) powder. It is then pressed and sintered at a high temperature (1,400 °C) into ceramic-pellet form, which is hermetically encased in zircalloy tubes. A fuel rod is formed of 126 tubes. The operation of one VVER-440 reactor requires 7 to 9 tonnes of uranium fuel. Fresh nuclear fuel does not pose any significant risk as it is a weak source of radiation and is activated only in a nuclear reactor.
4. Fuel Use in a Reactor

The energy released by the fission of uranium in a reactor is removed by the coolant (water) and then converted into electricity in a turbine generator. Fuel in the reactor must always be flooded with water, otherwise it might become overheated. At temperatures above 1,500 °C the fuel cladding starts melting, at temperatures above 2,500 °C even the fuel melts down. Some of the U-238 in the fuel is turned into plutonium in the reactor core. The main plutonium isotope is also fissile and this yields about one-third of the energy in a typical nuclear reactor.

5. Interim Fuel Storage

After 5 to 6 years of operation in the reactor, the spent fuel is moved to a spent-fuel pool immediately adjacent to the reactor. There it is cooled and its radiation level decreases. Water provides an excellent radiation shield and absorbs residual heat produced by the spent fuel. After 5 years of cooling, the spent fuel can be transported to the interim storage in Bohunice, where it is stored in water ponds. The construction of dry interim storage (special containers cooled only by natural air circulation) is being considered on the Mochovce site, too, thus eliminating future spent fuel transports.

6. Fuel Reprocessing

Spent fuel contains about 95 % uranium, 1 % plutonium and 4 % highly radioactive fission products formed in the reactor. The fuel can be recycled in reprocessing plants, where it is separated into three components: uranium, plutonium and waste. Uranium and plutonium are used in fresh fuel containing a mixture of the fissile isotopes U and Pu (MOX fuel). The reprocessing process, however, is finance- and energy-demanding, therefore there are only a few reprocessing plants in the world. Spent fuel from Slovak NPPs is not reprocessed, but temporarily stored in interim storage.

7. Final Storage of Spent Fuel

At present there are no storage facilities available for the final disposal of spent fuel. Though studies of the optimal approach to the final disposal of spent fuel are in progress, there is no urgent need for a final solution as the total volume of spent fuel is relatively small and can easily be stored in interim storage. Furthermore, other options for using the spent fuel with new technologies are being investigated. A geological survey in Slovakia is being conducted to identify possible sites for final disposal. It is assumed that a final repository could be available by around 2030.
Safety of Units 1&2

The construction of Units 1&2 included an extensive programme of design safety improvements. In addition to the Slovak, Czech and Russian industry, the plant completion involved leading West-European companies.

International evaluations (IAEA, WANO, WENRA, RISKAUDIT) confirmed high safety level of the reactors in Slovakia.

VVER technology is based on a robust design, relatively low unit power, and high volumes of water in the cooling circuits. Therefore the power plant is very effective in accident prevention and has inherently high level of nuclear safety.

A triple-redundancy design has been 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 them being fully capable of performing the required safety function.

The power plant has a full scope simulator able to reproduce plant performance and behaviour for effective training of control room operators.

The nominal output power of Mochovce NPP Units 1&2 was increased by 7% in 2008 (from 440 MW to 470 MW) – an increase that covers approximately 10 % of household consumption in Slovakia.

The nominal output power was increased by 7 % in 2008.
Mochovce 3&4 design is based on proven and well-consolidated pressurized water reactor (PWR) technology and includes up-to-date technological developments and safety improvement measures, the most important featuring the following:

- systems for severe-accident management
- the latest commercially available digital technology for Instrumentation and Control
- improvement of the units’ seismic resistance
- enhancement of the fire protection system
- the design includes the best operational practice

Design modifications were approved by the Nuclear Regulatory Authority of the Slovak Republic. The upgraded plant design meets or even 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.

A positive opinion about Mochovce NPP Units 3&4 was also expressed by the European Commission within the framework of the Euratom Treaty.
All four units of the Mochovce NPP are equipped with reinforced concrete protective shell (containment) system of the nuclear island fully capable of minimising the scope of any off-site radiological accident consequences.

The containment capability to withstand accidents is supported by extensive studies and tests performed at the European level.

This type of containment functions on the principle of condensing the steam released from the reactor coolant system in case of a piping rupture, thus reducing pressure inside the containment.

**Containment is one of the four barriers preventing the leak of radiation into the environment**
The containment includes **bubble condenser system** composed of 12 floors of bubble channels for condensing steam and 4 air traps for gas capture.

The containment is made up of **1.5 m-thick** reinforced-concrete walls, has a very small exposed surface, is favourably site-integrated, and surrounded by several civil structures.

This ensures the highest level of protection against external hazards, including an aircraft crash. Moreover, the Slovak Republic is a part of the **NATO Integrated Air Defence System** covering air threats.
Radiation Protection

For radiation protection of the power plant staff and population, the ALARA principle is applied. This principle ensures that the radiation exposure inside and outside the power plant is As Low As Reasonably Achievable and well below the limits set by legislation.

The impact of the NPP operation on the environment and human health is negligible with respect to other radiation sources present in everyday life.

There are 24 monitoring stations of the tele-dosimetry system in the 20 km radius around the power plant, which continuously monitors the dose rate of gamma radiation, volume activity of aerosols and radioactive iodine in the air, soil, water and food chain (feed, milk, agricultural produces). The volume of radioactive substances contained in liquid and gaseous discharges is considerably lower than the limits set out by authorities.

Overall human radiation exposure

- 3 hour flight: 0.5%
- Clock face: 1%
- Watching TV: 0.001%
- Radon in houses: 9%
- Radiation sources in medicine: 23%
- Food intake: 31%
- Cosmic radiation: 23%
- Other sources: 5%

NPP contribution to overall human radiation exposure:

0.001 %
Environment

Nuclear power plants are environmentally friendly and contribute significantly to the obligation to reduce the emission of harmful gases into the atmosphere.

The process of evaluating the environmental impact of future operation (EIA) for Units 1&2 was undertaken in the past (1993-1994), as well as for Mochovce NPP Units 3&4 (2009-2010). All the studies confirmed that the operation of all four units of Mochovce NPP will not have a significant adverse effect on the environment. Indeed, the project will result in a number of positive effects – economic and social ones.

Nuclear plants produce a small amount of radioactive waste. One unit annually produces approximately 17 m³ of liquid and 15 tonnes of solid low-activity waste and 7 tonnes of spent fuel. Liquid radioactive waste is treated in Mochovce and solid radioactive waste in Bohunice Treatment Centre. Treated waste is stored in fibre-concrete containers in the National Radioactive Waste Repository in Mochovce.

The water required for cooling is taken from a water reservoir built on the nearby Hron River.

One Unit saves

3.7 mil. t

CO₂ emissions every year
Stress Tests

Immediately after the Fukushima accident, European politicians, representatives of the nuclear industry and regulatory bodies agreed on the undertaking of power-plant safety reviews. All 15 member states of the EU operating nuclear power plants were involved. The testing of the two Bohunice NPP V2 units and all four Močovce NPP units was carried out mainly through engineering analyses, calculations and reports.

Stress tests analysed extraordinary external events – earthquakes, floods, and impacts of other events that might result in the multiple loss of power-plant safety functions. The combination of events, including loss of power supply, long-term water supply breakdown, as well as loss of power supply due to extreme climate conditions were also assessed.

Stress tests revealed no deficiencies requiring immediate action; the further safe operation of neither the operating units nor the units under construction was put in doubt. Identified measures would further increase nuclear safety, for example by adding mobile diesel-generator for recharging of back-up batteries.

Over 55 years of experience in nuclear energy, and 5,000 job opportunities in Slovakia.
Benefits for Region

Nuclear power plants are the pillar of the Slovak power industry, supplying over 50% of electricity to the grid and contributing to international commitment of Slovakia in reducing the greenhouse gas emissions.

Mochovce 3&4 completion is the largest single private investment in the history of Slovakia. Some 3,500 people work on site. Nearly 60% of the work on site is performed by Slovak companies.

In order to improve and make communication with the public more transparent, regional associations of municipalities were established at Mochovce and Bohunice regions, who nominate members to Civic Information Committees. Those are in direct contact with the power plants management. Visitor centres are also available for the broad public at both locations.

The Company supports local projects in the areas of culture, education, nature, sport and the social area through the Energy for the Country programme.
## Basic Figures

<table>
<thead>
<tr>
<th></th>
<th>Units 1&amp;2*</th>
<th>Units 3&amp;4**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactor type</strong></td>
<td>PWR – pressurised water reactor WER 440/V-213</td>
<td></td>
</tr>
<tr>
<td><strong>Reactor thermal power</strong></td>
<td>1,471 MWt</td>
<td>1,375 MWt</td>
</tr>
<tr>
<td><strong>Electrical gross power</strong></td>
<td>470 MWe*</td>
<td>471 MWe**</td>
</tr>
<tr>
<td><strong>Primary circuit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 loops</td>
<td></td>
</tr>
<tr>
<td><strong>Working pressure/ temperature</strong></td>
<td>12.26 MPa/267 – 297 °C</td>
<td></td>
</tr>
<tr>
<td><strong>Reactor pressure vessel (h/ø)</strong></td>
<td>11,805 mm/3,542 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary circuit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam generator (6 per unit)</td>
<td>PGV - 213</td>
<td></td>
</tr>
<tr>
<td><strong>Volume of steam generated</strong></td>
<td>480-500 tons per hour</td>
<td>450 tons per hour</td>
</tr>
<tr>
<td>Steam pressure and temperature at SG outlet</td>
<td>4.7 MPa/260 °C</td>
<td></td>
</tr>
<tr>
<td><strong>Turbine (2 per unit)</strong></td>
<td>235 MWe</td>
<td>264 MWe</td>
</tr>
<tr>
<td>Generator rated power</td>
<td>259 MVA</td>
<td></td>
</tr>
<tr>
<td><strong>Terminal voltage</strong></td>
<td>15.75 kV</td>
<td></td>
</tr>
<tr>
<td>Rated current</td>
<td>3 x 9,500 A</td>
<td>3 x 10,950 A</td>
</tr>
<tr>
<td><strong>Tertiary circuit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. temperature of cooling water</td>
<td>33 °C</td>
<td></td>
</tr>
<tr>
<td><strong>Height of cooling towers (4 per 2 units)</strong></td>
<td>125 m</td>
<td></td>
</tr>
</tbody>
</table>

* after Unit 1&2 power upgrade, ** higher efficiency of Unit 3&4
## Mochovce NPP History

<table>
<thead>
<tr>
<th>Event</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of construction works</td>
<td>1981</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halt of construction works</td>
<td></td>
<td>1992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start of completion works</td>
<td>1996</td>
<td></td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Phasing to the grid</td>
<td>1998</td>
<td>1999</td>
<td>2014*</td>
<td>2015*</td>
</tr>
</tbody>
</table>

*Planned*
Since March 2010, Slovenské elektrárne operates two photovoltaic power plants – in Mochovce and coal fired power plant Vojany. The 5.19 mil. euros investment now generates nearly 1,000 MWh of electricity annually. The plants have an important position in the company’s portfolio, in particular for their contribution to the environment – each plant saves up to 1300 tonnes of greenhouse gas emissions every year if compared to electricity generated from coal.

There are 4,136 panels installed at the 2 hectare land near the nuclear power plant Mochovce. The photovoltaic electricity from Mochovce is used for the non-technological operation of the future nuclear power plant Mochovce 3&4, for its construction site and construction equipment, thus making it the first absolutely clean energy source with zero greenhouse gas emissions. Total installed capacity of the plant is 0.95 MWp (MW peak – solar panel output at standardised radiation density of 1 kW/m²).
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