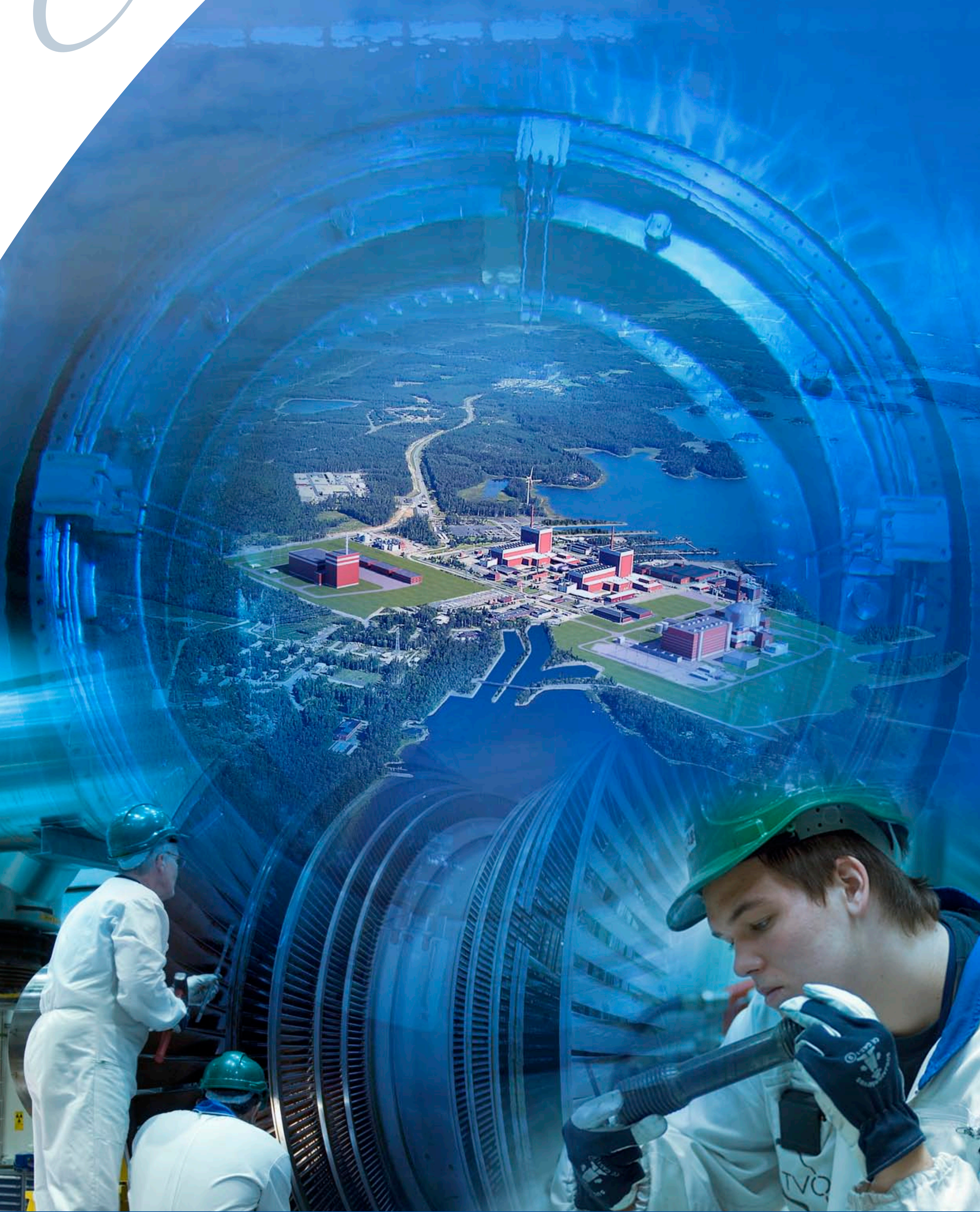
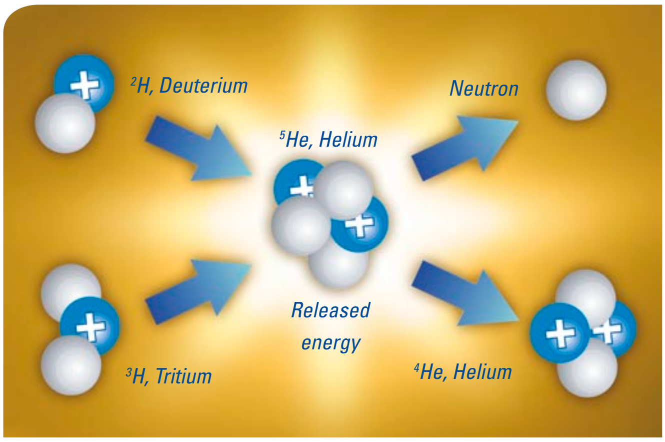
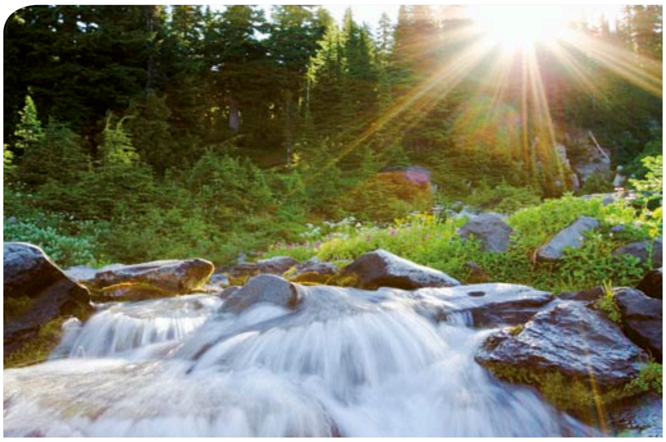
Olkiluoto, the centre of Finnish nuclear power expertise



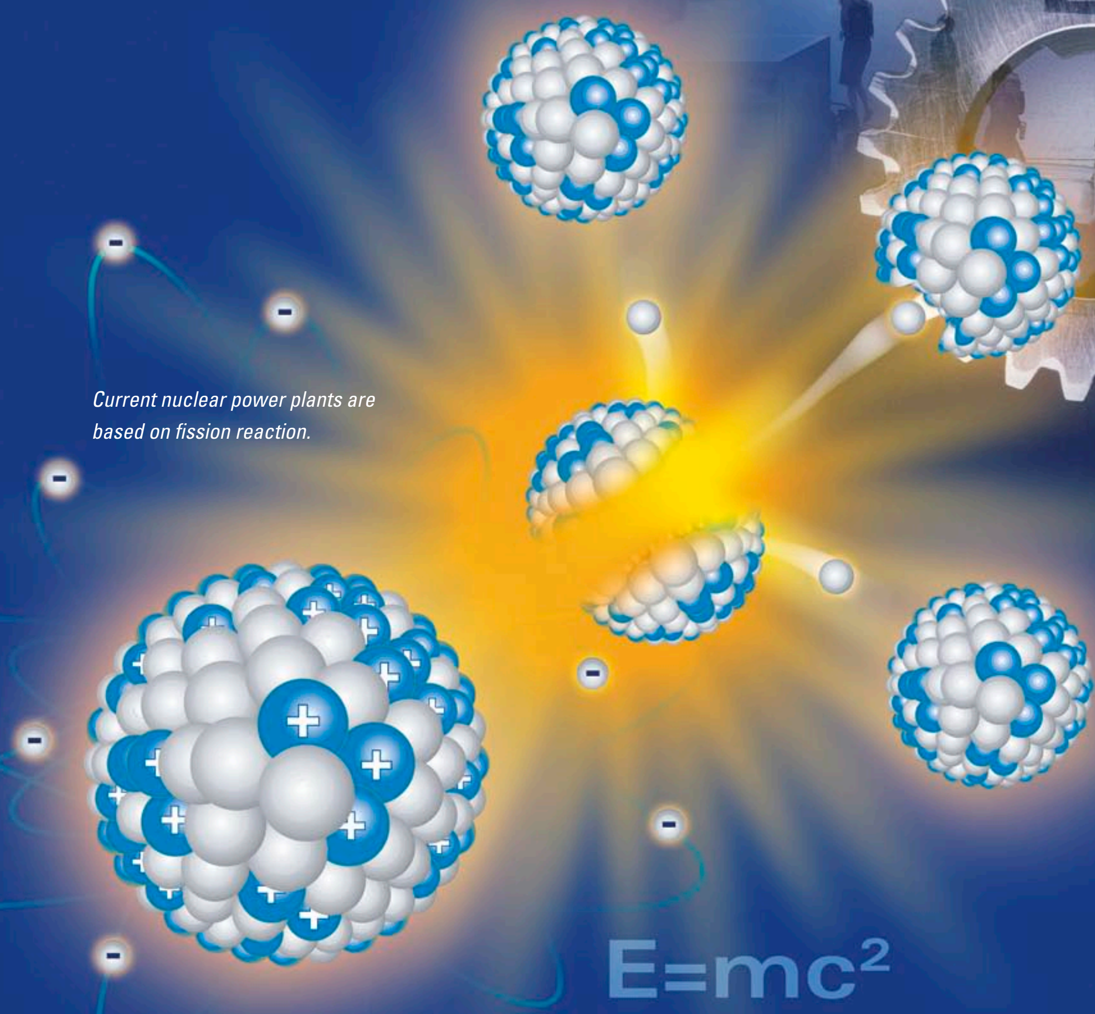
The life-sustaining heat generation from the sun is based on fusion reaction. The technical implementation of fusion power plant still requires decades of development work.





The sun is the sustenance of life and an energy source.

Electricity keeps the wheels of society turning.



Current nuclear power plants are based on fission reaction.

Life needs energy

Life is based on an endless cycle of energy. Energy does not disappear, but changes its state according to the laws of physics. The transformation takes place of its own accord in the natural world or comes about through human activity.

The sun is like a giant power plant; it derives its energy from internally generated fusion in which hydrogen nuclei combine to form helium nuclei. Nearly all known energy reserves are based directly or indirectly on the energy from the sun.

Naturally occurring energy sources include coal, oil, natural gas, uranium, peat, wood and other biomasses, the potential energy in water, wind, solar energy and geothermal heat.

The majority of current global energy production is based on burning fossil fuels such as coal, oil and natural gas. The burning fuel reacts with oxygen, thus producing carbon dioxide and simultaneously releasing heat, i.e. energy.

What is energy?

Energy can be defined as the ability to work. Energy changes its state and often this transformation manifests itself as work. Material and energy are two aspects of the same thing. Material can be changed into energy and energy into material.

The basic unit of energy is a joule (J). The unit of power, or the speed at which the energy is used, is a watt (W).

Fusion and fission

Fusion means a nuclear reaction where light atomic nuclei combine to create heavier nuclei and release energy.

Fission is the opposite of fusion and refers to disintegration - splitting. Fission is a reaction in which a heavy atomic nucleus is split into two intermediate-mass nuclei, which releases energy.

Fission in a nuclear power plant

The current nuclear power plants are based on fission technology. Nuclear energy is released by splitting the heavy nuclei of uranium fuel in a nuclear reactor into intermediate-mass nuclei, which releases energy and neutrons. Releasing the neutrons causes a chain reaction that keeps the nuclear reactor working. Energy is released primarily as kinetic energy by fission, which is transformed into thermal energy and then into electricity.

What is electricity?

An electric charge is one of the basic properties of an elementary particle. It manifests itself as a force action between charged particles. An electric current is the movement of electric charges. Electricity is produced by generators. Electricity can be transmitted relatively easily and transformed into other forms of energy. The basic unit of electricity consumption is a kilowatt-hour (kWh).

How is electricity generated?

In a power plant, the production of energy, including electricity, means converting different energy sources into a form that can be exploited.

Water, steam, gas or wind, for example, spins the turbines in a power plant. The turbines spin the generators and rotational energy is transformed into electricity in the generator.

The story of uranium*

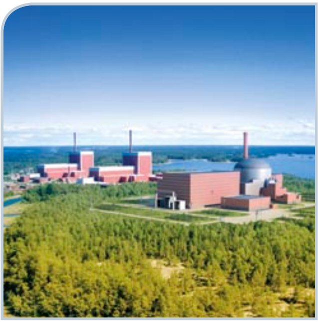
The universe has been shaped into its present form as a result of countless stellar nuclear reactions, and one of the outcomes is our solar system and our own planet, Earth. The story of nuclear reactions is, therefore, also a part of the story of humankind.

The universe, which was created in a hot initial explosion billions of years ago, comprised at first only hydrogen and helium, from which the galaxies and stars were condensed under gravitational force. Other elements were created in the stellar nuclear reactions. The elements important for life, such as carbon, nitrogen, oxygen and sulphur were created in slow fusion reactions in massive stars. Elements heavier than iron, such as uranium, were created in collapses of giant stars i.e. supernova explosions.

** Theory nowadays valid in the scientific field.*

TVO generates electricity for the nation

Teollisuuden Voima Oyj (TVO) generates electricity for its shareholders at cost price and builds new power production capacity. TVO is a private limited company founded in 1969. It is part of the Pohjolan Voima Group.



TVO produces electricity using nuclear power, coal and wind.

TVO generates electricity using nuclear power and wind power at Olkiluoto in Eurajoki. In addition, TVO has a 45% share in the Meri-Pori coal-fired power plant. The electricity is distributed to TVO's owners and, from them, to consumers all over Finland. Around half of the electricity goes to industry and the rest to households, agriculture and the service sector.

TVO's Olkiluoto nuclear power plant units, Olkiluoto 1 (OL1) and Olkiluoto 2 (OL2), are identical and equipped with boiling water reactors. After the modernisation of the turbine plants the electrical output of each unit is 860 MW, i.e. a total of 1,720 MW. TVO's share of the output at the Fortum Meri-Pori coal-fired power plant is 257 MW. The wind- power plant at Olkiluoto generates 1 MW.

New OL3 unit under construction

In 2005, the Government granted a construction licence for the Olkiluoto 3 unit, OL3, to be built at Olkiluoto. The municipality of Eurajoki also approved the building permit in 2005. When ready, the OL3 unit will produce around 1,600 MW of electricity.

The Franco-German consortium AREVA NP/Siemens has overall responsibility for the construction project.

According to the plans, the commercial operation of the OL3 unit will begin in 2012.

Responsibility, pre-emptive thinking, transparency and continuous improvement

TVO's values are responsibility, pre-emptive thinking, transparency and continuous improvement. The company's vision is to be a world-class nuclear power company that has earned the respect of Finnish society, and its mission is to produce electricity for its shareholders safely, reliably, in an environmentally sustainable way and economically.

Long-term approach, systematic planning and meticulous care

Thanks to its long-term, systematic and cautious approach, TVO keeps the current OL1 and OL2 units safe, up-to-date, well maintained, reliable and competitive in terms of production costs.

The new unit Olkiluoto 3 is being built during the period 2005–2012. This is a high-quality, safe project that complies with the technical requirements and is delivered on time and in accordance with the budget.

Posiva and TVONS

Posiva Oy is owned by TVO and Fortum Power and Heat Oy. Its business strategy is to manage the final disposal of spent nuclear fuel from it's shareholders' nuclear power plants at Olkiluoto and Loviisa. TVO has a 60% interest in Posiva Oy.

The subsidiary company TVO Nuclear Services Oy (TVONS) markets and sells TVO's expertise in nuclear power.

Olkiluoto, the centre of nuclear power expertise

Electricity keeps society on the move, which means work and prosperity for all the nation. At TVO, we bear our share of the responsibility for supplying electricity to the Finnish industry and to the Finnish electricity consumers. We produce electricity safely and reliably, without producing carbon dioxide emissions and without disturbing the environment.

Nuclear power is a sustainable form of electricity generation. Its environmental impacts in the entire production chain – from uranium mine to disposal of spent fuel – are insignificant. At Olkiluoto there is a facility for low- and intermediate-level waste, and research ensures that the spent fuel from our plant units can be safely disposed of in the local bedrock.

At Olkiluoto we also have the means to construct a fourth nuclear power plant unit on the island. An application for a decision-in-principle was submitted to the Government in April 2008. The environmental impacts have been assessed with care. The construction of Olkiluoto 3 has strengthened our expertise, and the island's infrastructure is in place. The municipality of Eurajoki has approved the project.

During its 40-year history our company has become one of the world's leading producers of nuclear power, and we are constantly being praised for our expertise and skills in the field. Our vision is to remain a world-class nuclear power company that is highly valued by Finnish society.

I hope that the information in this brochure will give You, the reader, a picture of how we at TVO as a producer of electricity live up to the expectations that our shareholders and society have of us.

Jarmo Tanhua
President and CEO

TVO's owners and shareholding (%) 31 December 2008

	A series OL1 and OL2	B series OL3	C series Meri-Pori	Total
Etelä-Pohjanmaan Voima Oy	6.5	6.6	6.5	6.6
Fortum Power and Heat Oy	26.6	25.0	26.6	26.0
Karhu Voima Oy	0.1	0.1	0.1	0.1
Kemira Oyj	1.9	–	1.9	1.1
Oy Mankala Ab	8.1	8.1	8.1	8.1
Pohjolan Voima Oy	56.8	60.2	56.8	58.1
	100.0	100.0	100.0	100.0

Electricity generated by TVO is distributed for consumption through its shareholders. TVO has three share series, A, B and C, which grant entitlement to electricity generated by the different power plant units.

The story of uranium

** Our own solar system is thought to have been created when an entire star collapsed in a supernova explosion and its contents subsequently spread into space to form an inter-stellar cloud. Later, when the cloud began to contract, the Sun was condensed in the centre with planet elements around it. In the intense heat, the constituents were arranged in the evolving Earth according to their weight: the heaviest in the middle and the lightest on the outer shell. The heat released by the fission of the radioactive materials in the Earth, i.e. a reaction that kept the Earth in a molten state, was needed for arranging the constituents.*
Heavy elements, such as uranium, iron and nickel sank into the Earth's interior. Fissions by the radioactive materials still heat the inner part of the Earth and preserve it in a molten state.

** Theory nowadays valid in the scientific field.*

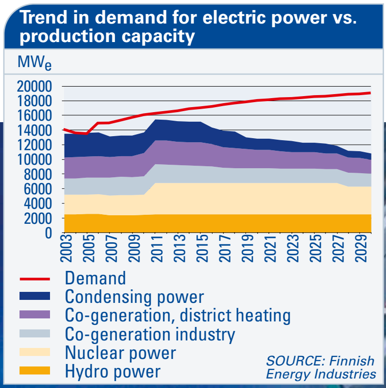
Nuclear power in use
Under construction*
OL3 was granted a construction licence in 2005

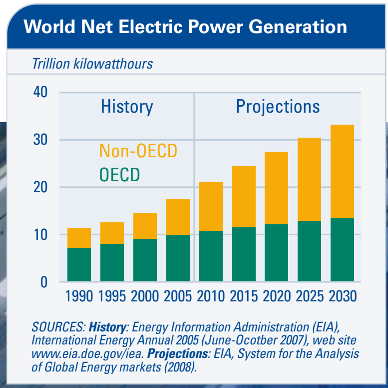
* In 2009, there are 44 units under construction in 13 countries.

There are 438 units in use in 30 countries in 2009.

Source: IAEA

The growth in electricity consumption is particularly rapid in countries experiencing fast economic growth, mainly in the Far East. Most new nuclear power plants are built in these countries.





The demand for electricity is growing, even though new industrial processes and domestic appliances are designed to be energy-efficient. New electrical goods for both working life and leisure time are constantly coming onto the market.

Electricity makes the world go round

Electricity is one of the cornerstones of modern society. It is an important basic commodity for households and an essential ingredient in production and industry. In the next 20 years global electricity consumption is expected to almost double.

A viable energy system is a guarantee of the functionality of the country's economy and thus contributes to the well-being of everyone who lives in Finland.

The consumption of electricity in Finland is divided almost equally between industry and the other sectors of society: namely households, services and agriculture.

Electricity is needed for industrial processes, for heating industrial premises and homes during the cold seasons and for cooling when it is warm. It is used for heating water, for refrigeration, and for the increasing quantities of leisure equipment and electronics.

Demand for electricity is increasing in Finland

Economic growth increases the need for electricity while the rising standard of living raises household consumption.

The consumption of electricity in Finland grew throughout the 1900s, and the growth is expected to continue over the long term at an average rate of over 1% a year. The industry sector predicted in the spring 2008 that the consumption of electricity in Finland will reach almost 107 TWh by 2020 and be close to 115 TWh by 2030.

In affluent, prosperous Finland, the need for electricity will increase in all areas. Despite the continuing improvements in the already high energy efficiency, the need for electricity in the industry will grow. The manufacture of even higher quality industrial products increases the demand for electricity in particular.

It is thought that the consumption of electricity in services will increase dramatically in the future - by approximately a quarter by the year 2020.

The living space in Finland is larger than before, and families have become smaller in size. The number of holiday homes and second homes has been growing in Finland, and they are better equipped. There will also be a larger number of electrical appliances in the future. The use of electric heat pumps for heating will gradually become more common. Electricity consumption will also rise in the future in the form of an energy source for cars.

Greater demand for electricity production

According to a study conducted by the Finnish Energy Industries, Finland needs major investment in new electricity production capacity. Over the next 10 years or so, the country will see the decommissioning of many power plants that are becoming obsolete. There has to be far less dependence on imports, as the capacity that Finland's neighbouring regions have for producing electricity for export is constantly diminishing. The demand for electricity is growing, in spite of the improvements that are constantly being made in the area of energy efficiency. The differential between the amount of electrical power required and Finland's own production capacity will be around 5,500 MW by 2020 and 8,400 MW by 2030. This shortfall needs to be made up to the best possible extent through the production of Finnish CO_2-free electricity at a reasonable price. By and large, nuclear power is a high-standard energy source for its excellent security of supply, its competitive production costs and its low emissions.

The story of uranium

** Earth's molten inner core creates a powerful magnetic field that functions as a protective shell and a preserver of life. The radioactive materials in the inner core, such as uranium, keep the iron in a molten state. The magnetic field prevents high-energy electromagnetic radiation and particle fallout from the Sun, i.e. the solar wind from accessing the Earth. The solar wind's attempt to penetrate the Earth can be seen in the form of the Northern Lights. The hot core of the Earth also creates a phenomenon known as plate tectonics, as a result of which the carbon accumulated in sedimentary rock spreads deep into the Earth's mantle and is re-released through volcanic activity. This carbon circulation keeps Earth's temperature in balance and prepares the way for life-supporting conditions.*

** Theory nowadays valid in the scientific field.*

Competitiveness for industry, well-being for the nation

Source: Fingrid

Over half of electricity demand in Finland is consumed for by industry, and of this amount over half is the industrial baseload continuously required by the forest, metal and chemical industries. Generating this base-load power is particularly well suited to nuclear power.

The well-being of industry means well-being of the Finnish society.

TVO generates around one sixth of the electricity consumed in Finland. A total of 86.9 billion kilowatt-hours (TWh) was consumed in Finland in 2008, of which TVO generated about 15.2 TWh.

Since the late 1970s, TVO has generated more than 350 TWh of electricity for Finnish society.

The electricity produced by TVO serves Finnish industry and society as a whole, and guarantees well-being for Finnish consumers.

TVO generates baseload power in an cost-effective manner

Nuclear power is very well suited to the Finnish electricity production system.

The cost of fuel in a nuclear power plant is low, accounting for some 15% of production costs. The fluctuation in the price of fuel affects production costs less with nuclear energy than, for example, with electricity from gas or coal.

The price of electricity produced from nuclear power is stable and predictable. Nuclear power suits particularly well to meet the basic demand for electricity.

The biggest share of the production costs of nuclear power is the investment. It accounts for around 60% of the costs of a new unit and it decreases gradually during production time over the years to come.

The operation costs of a new power plant unit account for some 15% of production costs, and waste management accounts for about 10%.

Provision for the disposal of spent nuclear fuel accounts for the largest share of waste management costs. The money for future waste management comes out of the price of the electricity produced and is collected into the State Nuclear Waste Management Fund.

High capacity factors indicate good performance

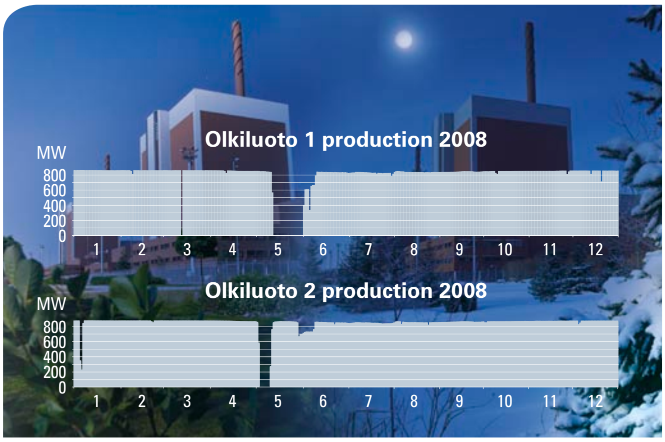
A nuclear power plant's capacity factor shows how well the plant is achieving planned output and operating time. The capacity factors for both TVO's plant units, OL1 and OL2, have always been top class in global terms. High capacity factors are a sign of reliable operation.

Safety measured on the international INES scale

The international, seven-level INES scale (International Nuclear Event Scale) is used to describe incidents in nuclear power plants. No INES events that would have seriously affected safety have occurred at the TVO units.

The safety of the plant is always the priority in all TVO's operations. Plant safety is continuously monitored.

The Olkiluoto power plant units generate electricity day and night, summer and winter. The only exceptions are the annual outages and various periodic tests.



No greenhouse gases

The generation of nuclear energy produces virtually no emissions under normal conditions. A nuclear power plant does not produce emissions that promote the greenhouse effect or acidification, or particle emissions that deteriorate the air quality.

The international agreements for controlling climate change also call for carbon dioxide emissions reductions in Finland. Electricity produced by TVO helps achieve these targets. During their operating life, the TVO units have already reduced the carbon dioxide emissions of the Finnish electricity production by around a third compared to a situation where the corresponding amount of electricity would have been produced with coal.

Well-being and services for everyday life

Services include many types of activities aimed at increasing well-being.

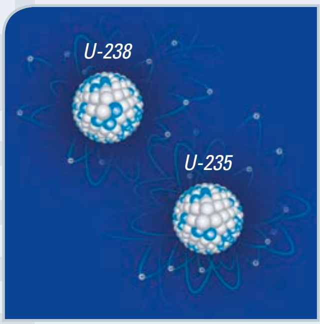
People's everyday life and daily routines are more dependent on electricity than ever. An interruption to the supply of electricity can, at worst, paralyse the functions of society. On-line retail services and banking now play a significant part in services that benefit the consumer.

The number of appliances making housework easier is increasing. Electrical appliances simplify the everyday life for people at work and for those of advanced years.

The number of elderly people is growing in Finland and the need for different services, especially health services, is increasing. Every effort is made in Finland to support safe, independent living. New, modern electrical solutions make the everyday life of all citizens easier in many different ways.

The story of uranium

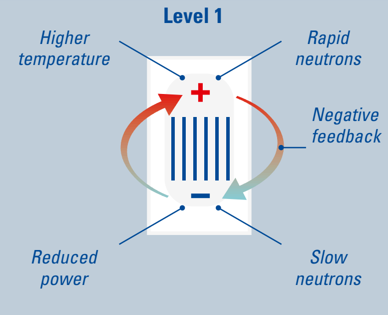
The fuel of a nuclear power plant is uranium, the heaviest element in the nature. The uranium occurring in nature is generally the U-238 form. Atoms of the same element that differ from each other in terms of the number of neutrons in the nucleus are called isotopes. U-238 is the heaviest uranium isotope. There are more neutrons in its nucleus that in the lighter U-235 isotope, which accounts for about 0.7 per cent of natural uranium. Nuclear power plants also use the uranium which has been obtained as a result of nuclear disarmament.



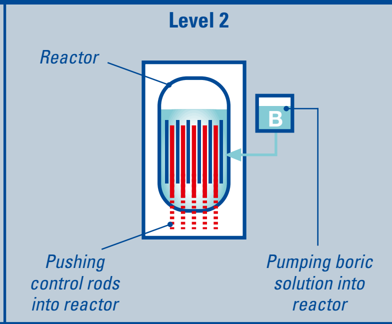
Safety relies on two main principles:

1. The defence-in-depth principle
2. Multiple barriers to release

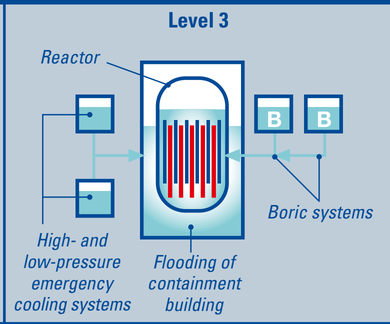
Examples of the defence-in-depth principle



As the reactor temperature rises, its power is reduced, as the increased boiling produces fewer slow neutrons and thus slows down the chain reaction.

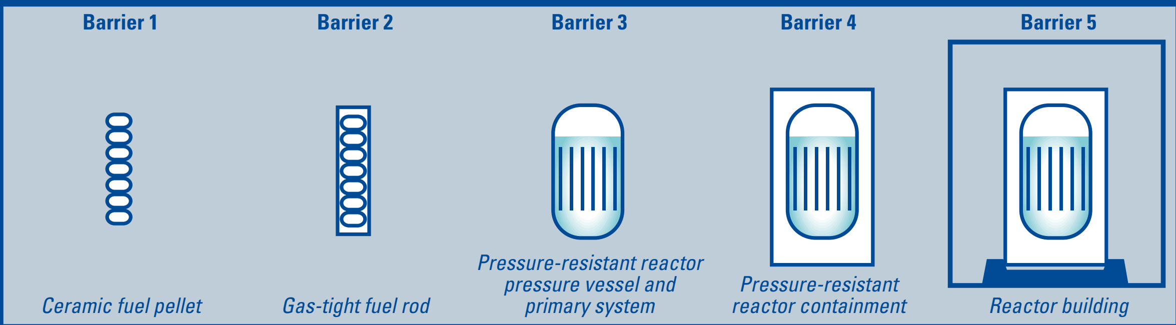


The reactor can be shut down in a few seconds by means of two systems with different operating principles.



In an accident situation the safety systems prevent or alleviate the consequences.

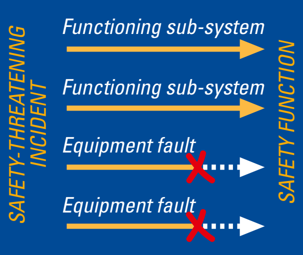
Multiple barriers



One of the main principles of nuclear safety is the arrangement of multiple barriers between radioactive materials and the environment.

Examples of other important safety principles

Parallel principle

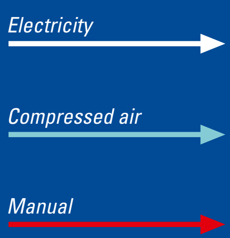


Safety systems comprise several self-replacing parallel sub-systems.

Separation principle

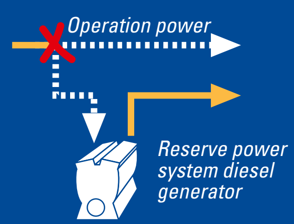
Parallel sub-systems in the safety systems are placed so that simultaneous damage to them, e.g. in a fire, is unlikely.

Diversity principle



The same function is implemented with systems based on different operating principles.

Safe-state principle



If the system loses its driving power, it falls back to a state that is as safe as possible for the plant.

Safe generation of nuclear energy

The primary objective of all staff at TVO's nuclear power plant is to ensure the safe operation of the plant units in all circumstances. No chances are taken when it comes to safety. Staff strive to anticipate malfunctions and eliminate them with an array of technical safety systems.

The starting point in planning a nuclear power plant is the assumption that there will be technical faults and operators can make human errors. The potential for different malfunctions is carefully analysed during the design stage of a nuclear power plant and units are equipped with an array of technical safety systems that are based on tried and tested technology and reliable test results.

Multiple safety systems

The nuclear power plant units at Olkiluoto are equipped with multiple safety systems operating on different principles, which help detect malfunctions and bring them rapidly under control.

The automation and electricity supply for the safety systems is separate from the systems for normal operations.

According to Government decision 395/91, the systems for the main safety functions must be able to operate even if any individual component in the system is inoperable, or if a component affecting the safety function is out of use because of repairs or maintenance.

Anticipating malfunctions

TVO uses probability-based safety and operating (up-time) models for anticipating malfunctions.

TVO's operations and safety are continuously improved by collecting reports on even the minor 'near misses' from each staff member.

A shift supervisor and operators, all holding a licence for operating the plant, are present in the control rooms of the units at all times.

Constant supervision by the authorities

The operation of TVO's nuclear power plant is continuously supervised in accordance with the Nuclear Energy Act and the Nuclear Energy Decree. Authorities supervise the operation of plant units in accordance with strict guidelines.

The Radiation and Nuclear Safety Authority (STUK) is the supervisory authority for the Finnish nuclear power plants. TVO regularly submits reports to STUK on its operation.

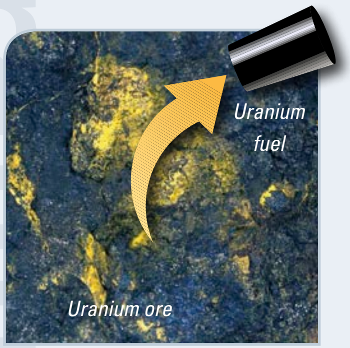
Nuclear fuel is also supervised by the International Atomic Energy Agency (IAEA) and the European Atomic Energy Community (EURATOM).

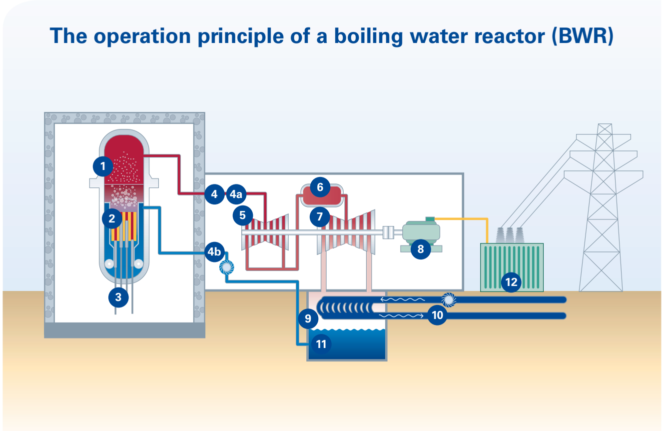
Continuous training with a simulator

Training for supervisors at OL1 and OL2 lasts about three years. The training involves theory studies as well as using a training simulator that accurately simulates the plant operations.

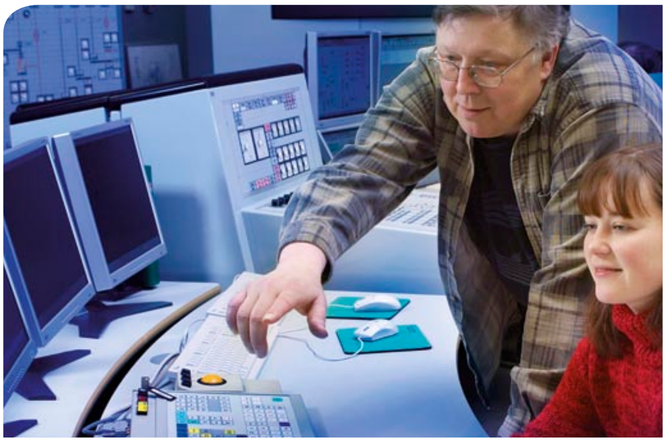
The nuclear power plant units are operated only by people who have demonstrated their knowledge of the plant and their ability to manage the systems. Competence tests and theory exams are administered by STUK. Only those who have passed the exam and gained a licence can work as plant supervisors at OL1, OL2 and the new OL3 plant.

The radiation level caused by uranium in natural surroundings is low. Uranium is a common element in nature; it is more common than gold, for example. The estimated amount of uranium dissolved in the Earth's seas is 4 billion tonnes. The Earth's crust generally holds an average of about four grammes of uranium per tonne. Uranium reserves are expected to last for centuries. The largest known uranium deposits are in Australia, Canada, Kazakhstan, Uzbekistan, South Africa and Namibia. Uranium is mined from deposits in which there are between 0.3 and 200 kilos of uranium per tonne of ore. In Finland there are some 4,500 kilos of uranium in an area of one square kilometre at a depth of one metre in the outer layer. It is known that there are several uranium areas in Finland, and their mining possibilities are being studied.

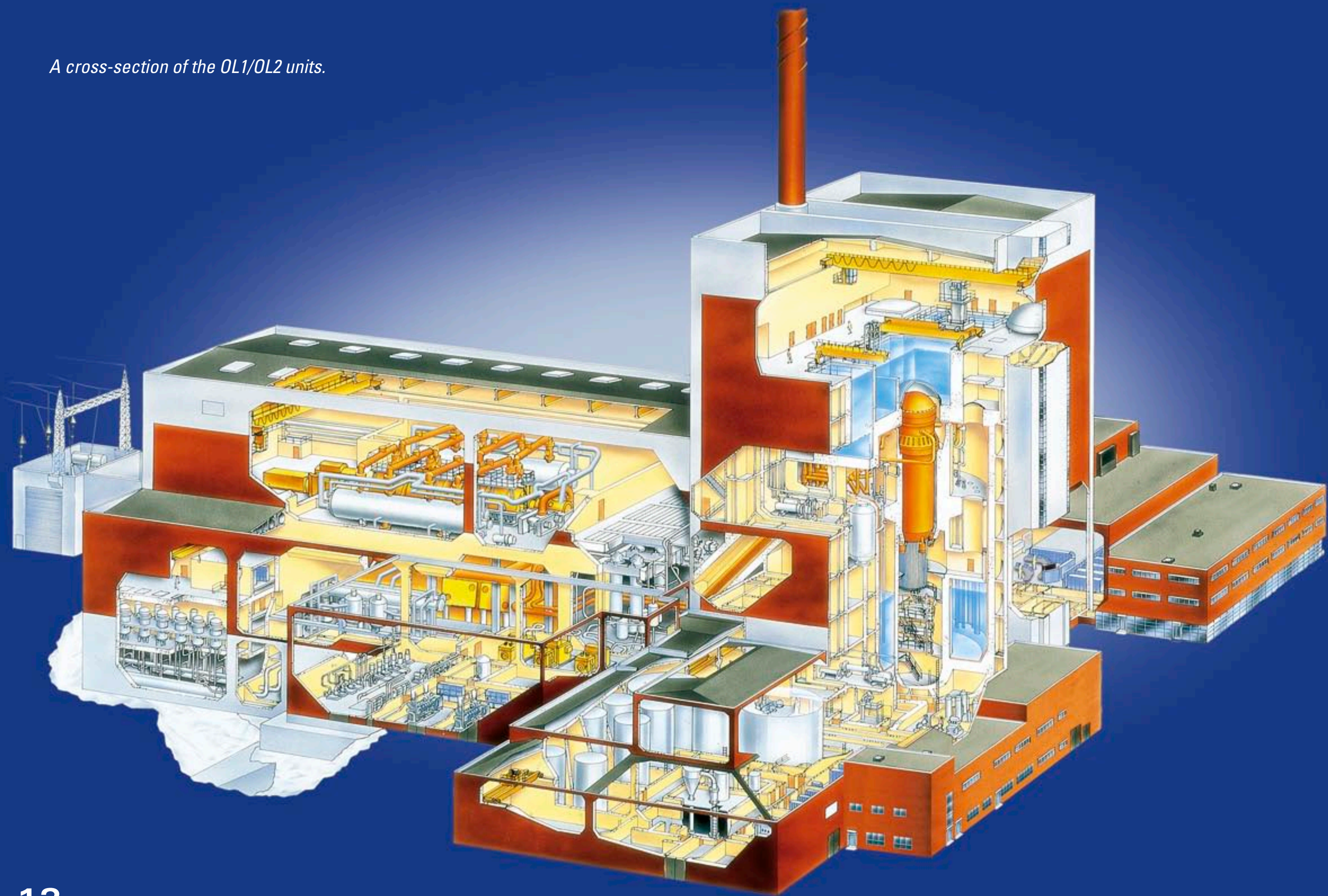




1. Reactor
2. Core
3. Control rods
4. Primary circuit
4a. Steam for the turbine
4b. Water for the reactor
5. High pressure turbine
6. Reheater
7. Low pressure turbine
8. Generator
9. Condenser
10. Sea water circuit
11. Condensation water
12. Transformer



Training for nuclear power plant operators lasts several years.



A cross-section of the OL1/OL2 units.

OL1 and OL2 are kept up-to-date

The cornerstone of TVO's operations is to ensure that its existing plant units, OL1 and OL2, are kept safe, up-to-date, reliable and in a perfect condition and that the production costs remain at a competitive level. This is achieved through the company's long-term, systematic and cautious approach.

TVO keeps its OL1 and OL2 nuclear power plant units up-to-date. The units are continuously modernised and developed further in order to meet the latest requirements

Units serviced and inspected every year

Outages take place each year at both plant units. By the end of 2008, a total of 56 annual outages have been performed.

A two-week service outage takes place every other year. Besides refuelling, scheduled inspections and preventive maintenance and repairs, also major modifications and modernisation are carried out and the condition of the unit is inspected during the outage. Every other year there is a shorter refuelling outage, when, in addition to refuelling and repairing, the condition of the unit is inspected.

Continuous and systematic modernisation

In addition to the regular annual outages, once in about ten years TVO also performs an extensive service outage. This is when the major modifications are carried out.

The OL1 reheater was changed in the annual outage.

Between 1995 and 1998 a modernisation project was carried out at the OL1 and OL2 units, focusing on the reactors and turbines. In all, approximately 40 large projects were included in this plant modernisation programme.

The renovation of the turbine plant was carried out in 2005 and 2006. The reheaters, high pressure turbines, turbine automation and the 6.6 kV medium voltage switchgear units were replaced.

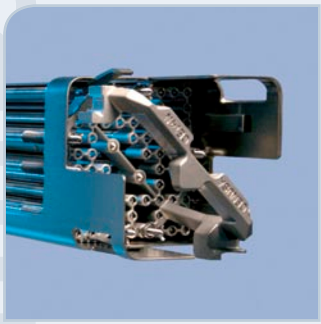
The long annual outages scheduled for 2010 (OL1) and 2011 (OL2) will involve the replacement of the low pressure turbines, seawater pumps, the inner isolation valves in the main steam pipes, and the main generators. These changes increase the efficiency of the turbine plant and should result in the output increase of up to 25 MW per plant unit.

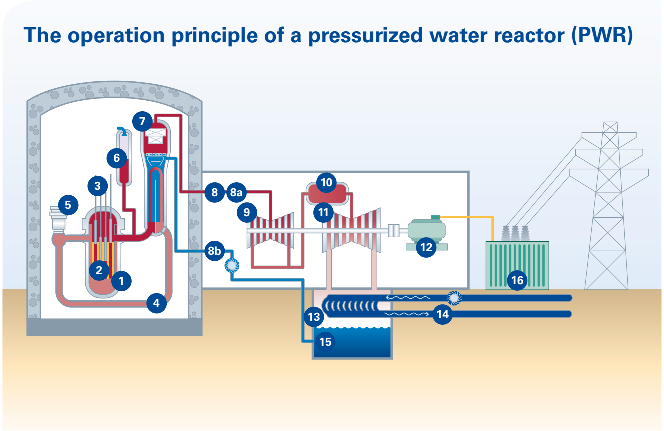
Thorough testing after modifications

An extensive pre-operation test will be undertaken at the plant units after the structural changes have been implemented. Test runs performed in accordance with the test operation programme are monitored on-site by the Finnish Radiation and Nuclear Safety Authority (STUK).

The story of uranium

At the first enrichment phase, the mined uranium ore is turned into uranium concentrate with about 70 per cent of uranium. For the isotope enrichment it is converted into gaseous uranium hexafluoride. The amount of fissionable U-235 in the isotope concentrate is quintupled. The enriched uranium is reconverted into uranium dioxide powder which is then sintered into fuel pellets. These are loaded into fuel rods and combined into assemblies. In reactors OL1 and OL2 at Olkiluoto, one assembly contains about 180 kilos of uranium. The OL3 fuel assemblies contain around 530 kg of uranium. The uranium fuel used by TVO is produced in Germany, Sweden and Spain. The enriched uranium is faintly radioactive. Fresh, unused uranium fuel is not a radiation risk.

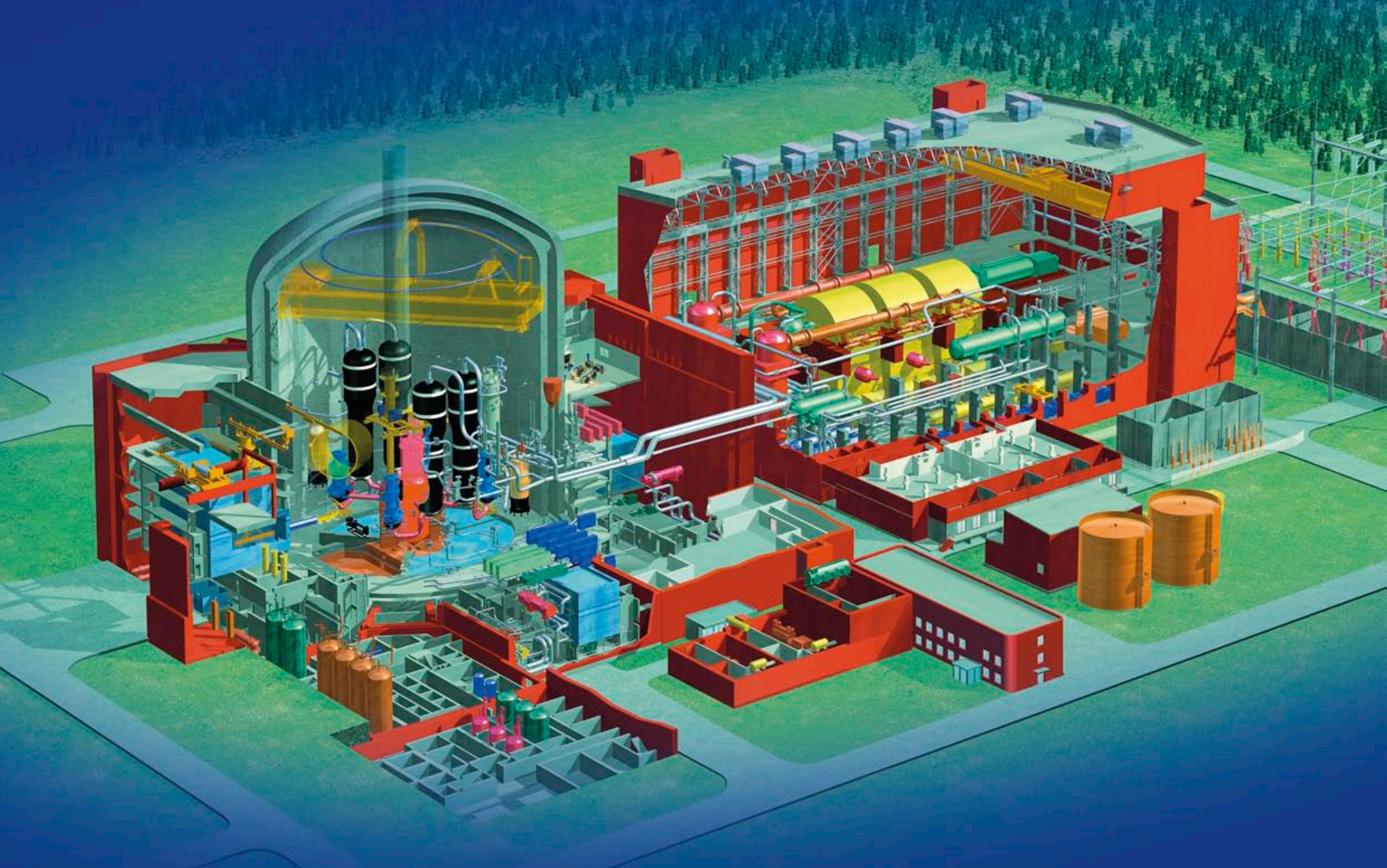




1. Reactor
2. Core
3. Control rods
4. Primary circuit (water circuit)
5. Main reactor coolant pump
6. Pressurizer
7. Steam generator
8. Secondary circuit
8a. Steam for the turbine
8b. Water for the steam generator
9. High pressure turbine
10. Reheater
11. Low pressure turbine
12. Generator
13. Condenser
14. Sea water circuit
15. Condensation water
16. Main transformer

The reactor pressure vessel arrived by sea at Olkiluoto in early 2009.

A cross-section of the OL3 unit.



The latest technology at OL3

Finland’s fifth nuclear power plant unit, OL3, is being built at the western end of Olkiluoto Island, next to the units OL1 and OL2. The Franco-German consortium formed between AREVA NP and Siemens is responsible for the delivery of the OL3 unit in its entirety on a ‘turn-key’ basis.

Within the consortium, AREVA NP is responsible for the delivery of the nuclear island and Siemens is responsible for the turbine island. Both companies are leaders in their respective fields.

Progressive and moderate evolution of proven technology

The new OL3 unit will be equipped with an EPR-type reactor (European Pressurized Water Reactor). The electrical output of the plant unit will be approximately 1,600 MW.

OL3 will be advanced in many respects, representing the state-of-the-art technology in the nuclear industry. In particular, OL3 will contain many improved safety features. The positive operational experience and proven technology of N4 and Konvoi units in France and Germany, respectively, form the basis for the technical design of the unit.

A number of new technical features have been added to further improve safety, production capacity and reliability.

The construction project calls for precision, also in the paperwork.

Major improvements compared with Europe’s newest plants

Among the many improvements in the design of OL3, the key ones are:

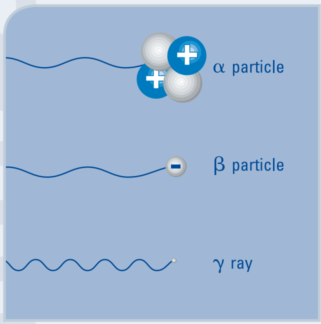
- The potential for a severe reactor accident has been taken into account in the basic design and the structure of the unit.
- The digital control and automation system has a hard-wired back-up system.
- The unit has been designed to withstand the impact of a large passenger plane.

Furthermore, the electricity production will be more efficient and economical. There will also be less radioactive waste produced per each megawatt-hour due to the more efficient use of nuclear fuel.

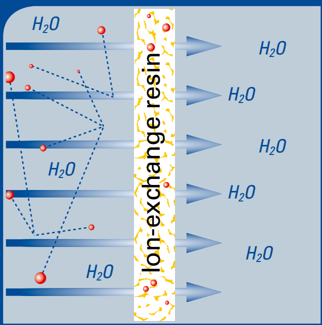
Electricity for several decades

The planned operating life time of the OL3 unit is at least 60 years. Components and structures difficult to replace, such as the reactor pressure vessel and the reactor containment building, have been designed to last at least six decades. Other structures and components can be replaced more frequently, if necessary.

Radioactive materials and the radiation emitted by them are present everywhere in nature. α-radiation and β-radiation are both long-wave particle radiation, against which thin layers such as skin or plastic give protection. When an atom nucleus is split in the nuclear fission at a power plant, not only α and β radiation but also short-wave penetrative gamma radiation is created. Water, lead, concrete and steel give protection against gamma radiation. Finns receive most of their radiation dosage from radiation occurring in natural conditions. More than half of the Finns’ radiation dosage comes from radon, which is created in the radioactive decay chain of the uranium found in natural surroundings.



All the material to be used in the nuclear power plant is checked.



The process water is filtered as clean as possible.

Employees at the unit wear protective clothing and accessories appropriate for the tasks. Work sites are always protected in accordance with the instructions provided by radiation monitoring.

Nuclear power plant operators continuously undergo further training. Training on a simulator forms an important part of the training. The licence entitling a person to run a plant is valid for three years at a time.

Jarmo Konsi, the local inspector of STUK, is responsible for such tasks as monitoring the plant operation, issuing the start-up permit after outages and supervising the licence exams.

Classification on the INES scale

INES events at TVO

		Class	-00	-01	-02	-03	-04	-05	-06	-07	-08
Major accident	7	7	–	–	–	–	–	–	–	–	–
Serious accident	6	6	–	–	–	–	–	–	–	–	–
Accident with off-site risk	5	5	–	–	–	–	–	–	–	–	–
Accident without off-site risk	4	4	–	–	–	–	–	–	–	–	–
Serious incident	3	3	–	–	–	–	–	–	–	–	–
Incident	2	2	–	–	–	–	–	–	–	–	–
Anomaly	1	1	–	1	1	7	–	3	–	2	5
No safety significance	0	0	6	7	5	10	6	3	4	5	5

Exceptional events at nuclear power plants are classified according to the International Nuclear Event Scale (INES). In Finland, the classification is carried out by the Finnish Radiation and Nuclear Safety Authority (STUK). INES 1 events at Olkiluoto have included for excample a minor fire which started from an oil leak and the isolation valve of a steam line failing to close in scheduled testing.

Constantly developing safety culture

Continuous improvement and pre-emptive thinking are two of TVO's values. There is always room for improvement, and predictive actions help to prevent malfunctions. Safety culture emerges from working practices and the attitudes of individuals.

According to the definition by the International Atomic Energy Agency (IAEA), a safety culture is an "assembly of characteristics and attitudes in organisations and individuals, which establish that, as an overriding priority, nuclear safety issues receive the attention warranted by their significance". The definition applies generally to the nuclear power sector.

Petri Koistinen, Head of HRD, is responsible for safety culture evaluation and development. Safety is taken into account in the day-to-day operations, particularly in relation to human factors.

At TVO a safety culture is considered a prerequisite for company operations. Safety is the most important issue in decision-making. TVO's management, supervisors and staff consider safety to be a fundamental part of all company activity. All staff and subcontractors are continuously trained in safety issues.

TVO is an active player in international nuclear power organisations and is involved in developing safety at both its own nuclear power plant units and within the nuclear power sector as a whole.

Self-assessment – a part of safety culture

TVO has introduced self-assessment as an aid to continuous development. Information on the state of the safety culture is collected in different ways to form the basis of the assessment and the data gathered is analysed carefully. Questionnaires are used for collecting information, and guidelines, manuals, research results and records are examined. Discussions in small groups are a part of the self-assessment process.

The results of self-assessment are carefully analysed at TVO. Operating models are drawn up on the basis of the results to make further improvements to TVO's operations.

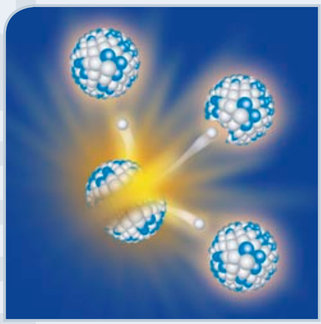
High level of professionalism and work ethic

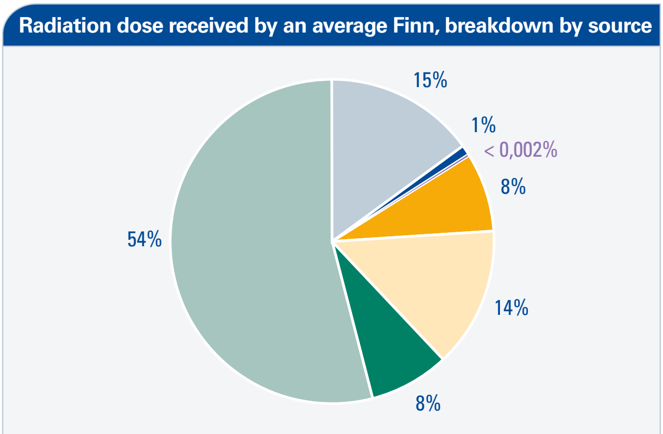
The staff at TVO know that the work at a nuclear power plant calls for a high level of professionalism and discipline.

Employees at TVO keep looking for areas in their units where improvements can be made and participate in designing even better working procedures.

TVO's operations and production are held in high regard by the global nuclear sector. TVO and its personnel are constantly striving for improvment.

In a nuclear power plant reactor some of the fuel's uranium nuclei are split and at the same time 2 or 3 neutrons are released. The kinetic energy from fission product atoms and neutrons is converted into heat when they collide with the surrounding atom nuclei. The neutrons slow down upon impact with water molecules and a decelerated neutron can split a new uranium nucleus. The number of nuclear fissions is controlled by regulating the neutrons' speed or, for example, by binding the neutrons to the material of the control rod. The heat is conducted in the form of steam to the turbine, and the kinetic energy of the turbine shaft is then converted into electricity in the generator.





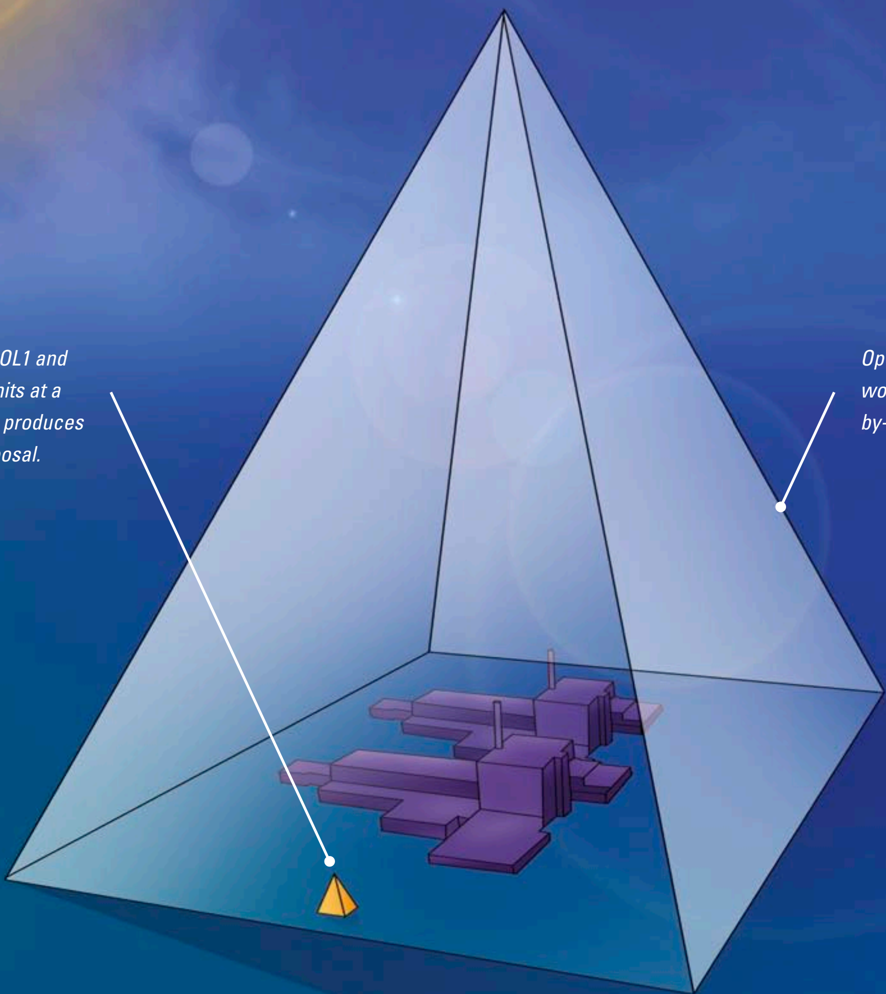
ARTIFICIAL SOURCES

- *Medical exposure* 15%
- *Nuclear fallout (Chernobyl, nuclear testing)* 1%
- *Olkiluoto nuclear power plant* < 0,002%

NATURAL SOURCES

- *Cosmic rays (sun and space)* 8%
- *External radiation from soil and buildings (building materials)* 14%
- *Natural radioactivity in the body* 8%
- *Radon gas in indoor air* 54%

The potential environmental impacts of nuclear power plants is constantly monitored by, for example, taking samples.



Forty years of operation of OL1 and OL2 nuclear power plant units at a 90 per cent capacity factor produces 970 m³ of spent fuel for disposal.

Operation at a coal-fired power plant would produce near 28,000,000 m³ of by-products and waste.

Emissions on a fraction of official limits

The state of the environment around the Olkiluoto nuclear power plant is monitored regularly. The power plant's permissible emission limit values are specified in the operating conditions and the water permit.

Nuclear energy operations cause virtually no emissions, nor do nuclear power plants produce emissions that contribute to the greenhouse effect and acidification. The most extensive environmental impact from a nuclear power plant is an increase in local water temperature by a few degrees.

Environmental management system guides operations

TVO's environmental management system ensures that operations move towards higher levels of environmental protection.

TVO is constantly identifying environmental issues, for which it establishes monitoring and measurement programmes and sets annual targets for improving environmental protection.

Minor air emissions

Limit values for radioactive emissions from the nuclear power plant are set by the authorities.

TVO's radioactive emissions into the air clearly fall below the official limits and are, at most, a few per mille of what is permitted. Radiation doses are so small that they are dwarfed by the much greater natural background radiation levels.

The environment around the nuclear power plant is measured with monitoring instruments. No radioactive materials originating from the nuclear power plant have been detected in tests on residents in the vicinity of the plant.

Food produced in the vicinity of Olkiluoto is monitored regularly.

Minimal discharges into the sea

The activation and fission products discharged into seawater from the plant are just a few tenths of a per cent of limit values and tritium emissions are only a few per cent of officially set levels.

The process water from the nuclear power plant is continuously purified and any fission and activation products are removed. The spent ion-exchange resins are solidified with bitumen and sent for final disposal in the low-level and intermediate-level waste repository, the VLJ cave at Olkiluoto, in tightly packed drums.

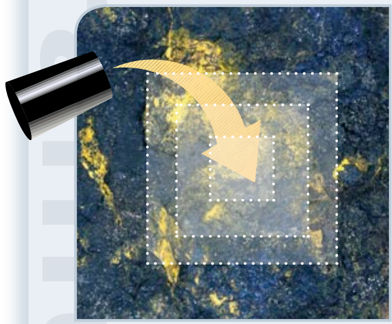
Radiation from the nuclear power plants dwarfed by natural background radiation levels

Nuclear power is responsible for less than 0.1% of the average annual radiation dose in Finland. The permissible emission level of radioactive substances into the immediate environment has been determined in such a way that no one living in the vicinity of the plant may receive a radiation dose greater than 0.1 millisieverts a year. In Finland people receive an average annual radiation dose of around 4 millisievert.

The story of uranium

In natural nuclear reactors, the fission of uranium was initiated without human influence. Rich uranium deposits created conditions in which the natural reaction could start.

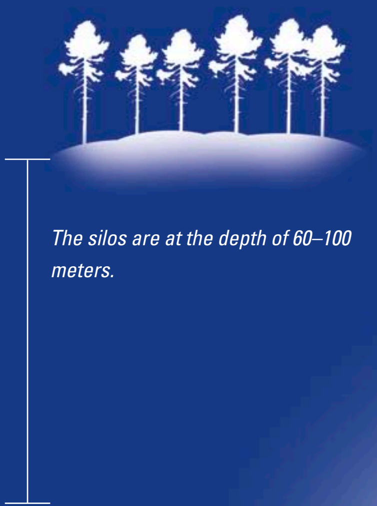
The best-known natural reactor is Oklo in Gabon, where a chain reaction commenced two billion years ago, resulting in a natural reactor. The reactor is thought to have been in operation for hundreds of thousands of years. The final outcome was the generation of the same radioactive materials as in spent nuclear fuel. Most of the nuclear waste created in a natural reactor has gradually degraded into stable elements. The location of the fission products have resulted into the conclusion that the "nuclear waste" created in the operation of a natural reactor has not moved from its place of origin.



Correspondingly, the spent nuclear fuel of modern-day power plants is stored in the uranium's original birthplace, deep in the bowels of the Earth, with multiple layers of safety arrangements.

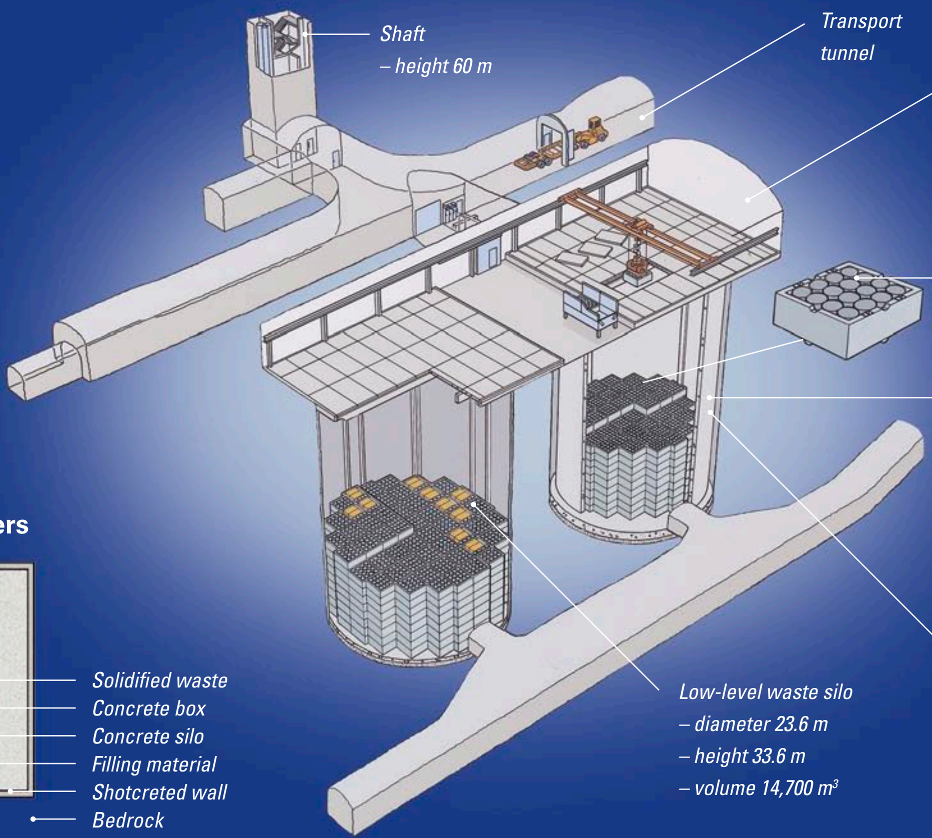
Low-level waste includes protective clothing, flame-retardant fabrics and plastics.

The ion-exchange resins used to purify the process water are solidified with bitumen and cast into steel drums. The bituminization process is controlled from the waste management building control room.

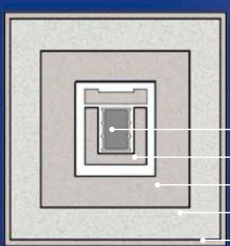


The silos are at the depth of 60–100 meters.

Final repository for operating waste (VLJ)



Multiple barriers



Low-level and intermediate-level waste

At the Olkiluoto nuclear power plant, waste is sorted and processed in accordance with the environmental management system. Some of the waste contains radioactive materials, and these are always processed separately.

Waste generated in the operation of the power plant and in annual outages is called operating waste, which is further divided into low-level and intermediate-level waste.

Protective clothing and ion-exchange resins

Low-level waste is miscellaneous waste contaminated with radioactive material. It includes flame-retardant fabrics, plastics, protective clothing, tools and machine parts and pipes removed from the power plant.

Intermediate-level waste consists of the ion-exchange resins used to purify the process water.

Waste is packed in the waste management building

Both the Olkiluoto 1 and 2 power plant units have a waste management building where the operating waste is packed into steel drums. Soft low-level waste is packed into 200 litre drums, which are then compacted to about half their original size to fit twice the number of drums into the repository. The compacted drums are packed into concrete boxes. Scrap metal in low-level waste is cut up or crushed and packed directly into the concrete boxes.

The ion-exchange resins used for purifying the process water are dried and solidified with bitumen, and then cast into 200-litre drums. These drums too are packed in concrete boxes.

Waste is taken to the repository with a radiation-shielded vehicle.

Final repository: the VLJ cave

The repository for low-level and intermediate-level waste is the VLJ cave on the Olkiluoto site. Packed into concrete boxes, the waste is transported by a radiation-shielded vehicle into the cave, where it is transferred to low-level and intermediate-level silos excavated into the bedrock at a depth of 60 to 100 m.

There is also a separate space in the VLJ cave for storing the small quantities of radioactive waste that are generated as a result of scientific research and health care in Finland.

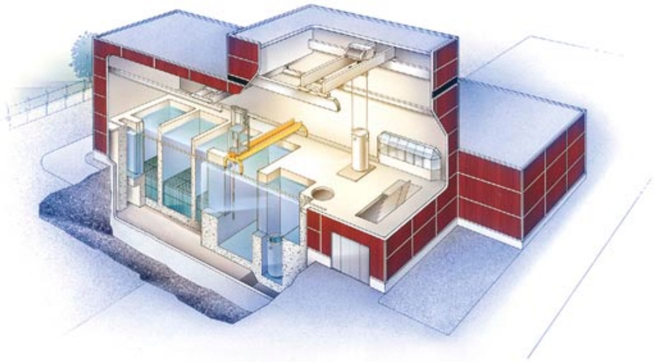
The safety of the VLJ cave is secured by surrounding the radioactive materials with multiple barriers. The most effective barrier is the bedrock itself, but it is supplemented by other barriers.

The story of uranium

** The elements will continue their course in the solar system and galaxy. Our solar system was created about five billion years ago and it will hurl its mass into space once again after billions of years. The atoms will return to the cycle of the elements and be used again in the creation of new stars, planets and life.*

** Theory nowadays valid in the scientific field.*

Spent uranium fuel from the OL1 and OL2 units is stored in water pools in the interim storage facility known as the KPA Store.



Spent fuel assemblies are placed in pools to cool them down and to dampen their radiation. A little over 2 m of water is enough to protect against radiation.

Final disposal of spent nuclear fuel

Spent fuel will be disposed of in the bedrock at the depth of hundreds of metres. Posiva Oy, owned by TVO and Fortum Power and Heat Oy, is responsible for the final disposal of spent nuclear fuel coming from its shareholders' nuclear power plants at Olkiluoto and Loviisa. Posiva Oy is constructing an underground rock characterisation facility at Olkiluoto.

Finnish law prohibits the import and export of nuclear waste. All nuclear waste generated in Finland is processed, stored and disposed of in a repository within the Finnish territory.

After removal from the reactor, spent fuel assemblies are placed in pools in the reactor hall to cool down for a few years. During this time, the radioactivity of the fuel assemblies is reduced considerably, to less than a hundredth part.

Interim storage facility (the KPA store)

After a few years of cooling, the spent fuel assemblies are packed in a strong transfer container filled with water. This container is transported with a specially designed vehicle to the on-site interim storage facility, the KPA store.

Before being transferred to the final repository, spent fuel assemblies will spend some 40 years in storage pools in the KPA store.

Disposal of spent fuel at Olkiluoto

Studies on the final disposal of highly radioactive spent nuclear fuel were initiated by TVO in the late 1970s, and Olkiluoto was selected as the final disposal site in 2001. The practical construction of the repository is the responsibility of Posiva Oy, a joint venture by TVO. The final disposal will begin in 2020.

Spent fuel assemblies are transported to the interim storage facility in a transfer container made of spheroidal graphite cast iron.

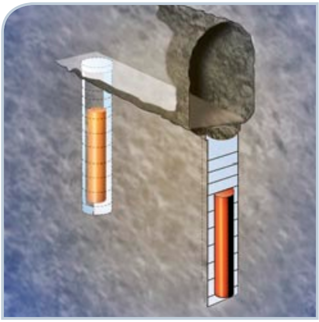
Spent fuel from the current units at Olkiluoto and the unit under construction, and spent fuel from the nuclear power plant at Loviisa will be disposed of in the repository.

Construction of final disposal characterisation facilities has begun

In 2004, Posiva Oy started construction of an underground characterisation facility called ONKALO. The final disposal depth will be reached in years 2009-2010. After that it is possible to collect confirmed information from planned depth. In year 2012 Posiva aims to submit the application for the construction license of the final disposal facility.

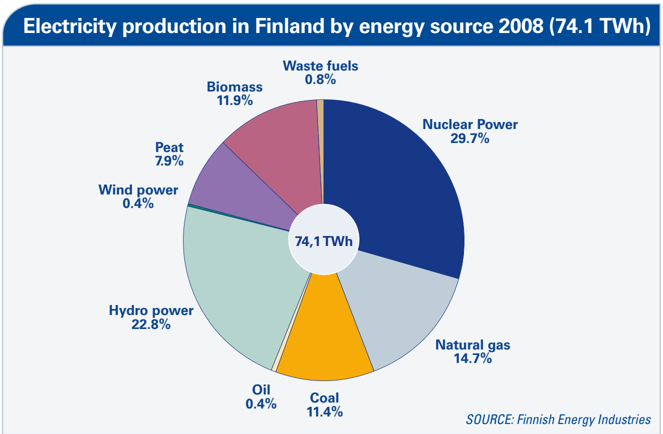
Funds have already been collected in the State Nuclear Waste Management Fund

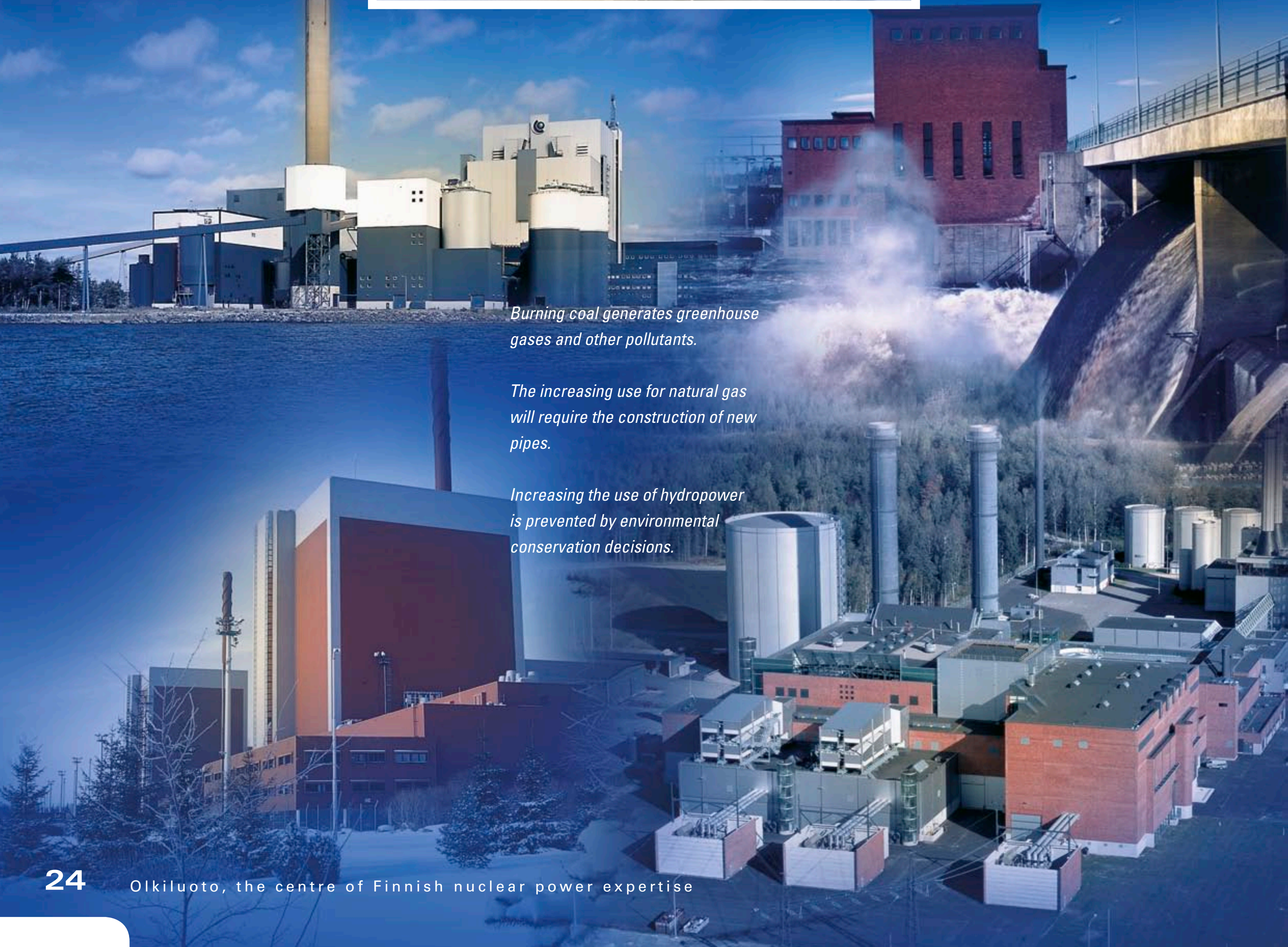
According to the principles specified in the Nuclear Energy Act, funds for undertaking nuclear waste management are collected in advance out of the price for nuclear electricity. Funds are set aside in the State Nuclear Waste Management Fund, which at the beginning of 2009 totalled around EUR 1.8 billion. TVO's contribution to this is around EUR 1 billion. These funds also cover the nuclear power plants' dismantling costs.



Construction of the final repository is preceded by careful studies of the integrity and geological stability of the bedrock. The spent fuel will be packed in copper-cast iron canisters and stored some 420 m below ground.

Finland employs several different ways of generating electricity. Finland also imports a considerable amount of electricity from Russia, the other Nordic countries, and Estonia.





Burning coal generates greenhouse gases and other pollutants.

The increasing use for natural gas will require the construction of new pipes.

Increasing the use of hydropower is prevented by environmental conservation decisions.

Nuclear power's important role in electricity production in Finland

Electricity production in Finland is diversified, decentralised and relies on different production methods. The main energy sources for electricity are nuclear power, hydropower, coal, natural gas, wood fuels, peat, oil and wind.

There are about 400 power plants in Finland. Nuclear power plants generate around one fourth of all the electricity consumed in Finland.

The two nuclear power plant units at Olkiluoto produced around one sixth of the electricity consumed in Finland in 2008.

Finland will remain as independent as possible from political and other decisions made by other countries, if the main share of the electricity we need is produced in our country.

Imports

Over the last decade Finland has imported between 5 and 20 per cent of the electricity it has consumed. Of this, imports from Russia have accounted for over a half. Nuclear power, hydropower, coal, oil and natural gas have been used for generating imported electricity.

Coal

Flue gases are generated when fossil fuels are burned and the most problematic of these is carbon dioxide, which is a greenhouse gas that cannot be eliminated from flue gases using current technology. Sulphur dioxide, nitrogen oxides and fine particles are also released into the atmosphere when fossil fuels are burnt.

Natural gas

The natural gas that is consumed in Finland comes from around 3,300 km away in western Siberia. Guaranteeing the supply of natural gas will require the construction of additional pipelines. Extending the gas pipeline to the west coast is still at the planning stage. Connecting Finland to the European network is dependent on the willingness of the parties to invest in the scheme and the situation in the central European markets.

Hydropower

Almost all Finnish waterways that have not been included in conservation decisions have already been equipped with hydropower plants. Large-scale additional construction of hydropower facilities for the production of electricity will not be possible in Finland unless some of the conservation decisions are reconsidered.

Domestic fuels

The use of renewable energy is being promoted by investment aid and tax incentives. Most of the increase in renewable energy has been in bioenergy, i.e. energy recovery from wood and other types of biomass. Waste fuels, peat and other biofuels accounted for around 19% of the production of electricity in Finland in 2008.

Peat

Peat is a slowly renewable biomass. The current consumption rate of peat in Finland more or less corresponds to the renewal rate. Carbon dioxide emissions from burning peat, i.e. its impact on the greenhouse effect, are studied with extensive research. Specific releases of carbon dioxide from biopower plants can be reduced using a combination burning method of wood and peat.

Wind

The wide-scale exploitation of wind power is limited by high costs, the need for regulating power due to fluctuations in production, and finding suitable locations.

Wind, field bio mass and solar panels are suitable for small-scale electricity production.

40 years' experience and 800 nuclear power experts.

TVO has the means to make a quick start on the OL4 project.

The area's infrastructure is in place

1. *OL1*
2. *OL2*
3. *OL3*
4. *OL4*
5. *Interim storage facility for spent nuclear fuel*
6. *Underground repository for operating waste*
7. *Final disposal facility for spent fuel*
8. *Training centre*
9. *Gas turbine plant 100 MW*
10. *Power line*
11. *Shipping channel*
12. *Road network*
13. *Accommodation village*
14. *Visitor's centre*

Olkiluoto Island is an excellent place for nuclear power production.

Olkiluoto, the core of nuclear expertise

TVO is well prepared to begin the construction of the fourth plant unit, and to carry out the project in a safe manner. The company is ready to put all its four plant units into use in order to produce reliable nuclear electricity for Finland at a fair price and help in mitigating the climate change.

TVO filed an application for a decision in principle on the construction of a fourth nuclear power plant unit at Olkiluoto in April 2008. At the same time, Posiva Oy, co-owned by TVO and Fortum, submitted a separate application for a decision in principle on the final disposal of spent nuclear fuel from OL4.

Olkiluoto is prepared for a fourth unit

Various fundamental structures are required for the production of nuclear power, in addition to the plant itself. The plans for the Olkiluoto area have made it possible to develop the island for nuclear power production. The municipality of Eurajoki has consistently shown its support for major construction projects implemented by TVO and Posiva over the years.

The island is well prepared for producing, constructing, operating and maintaining nuclear energy facilities as well as for managing nuclear waste. The island's cooling water capacity is excellent, and roads, grid connections, workshops, warehouses, water and wastewater networks, a shipping channel, a gas turbine plant, an electric power supply, a training centre, an accommodation village and a Visitors' Centre have already been constructed. Approximately 800 experienced TVO professionals and thousands of workers involved with the OL3 construction project work on the island.

Nuclear waste management under control at Olkiluoto

The site has an interim storage facility for spent nuclear fuel and a final repository for low- and intermediate-level waste, the VLJ cave. Protective clothing, machine and equipment parts and ion-exchange resins are packed tightly and then stored in the VLJ cave. The spent nuclear fuel in the interim storage facility will be cooled in storage pools for at least 40 years after leaving the reactor, during which time the fuel's radioactivity will fall considerably. Posiva Oy is responsible for the safe disposal of the spent nuclear fuel from the plants that belong to its owners. It intends to begin the final disposal of nuclear fuel at Olkiluoto in 2020.

Finnish expertise and the long time experience

The main factor in the success of OL4 is the know-how and experience of TVO's approximately 800 experts. The capacity factors at OL1 and OL2 are among the best in the world, testifying to the skills and the excellent condition of the plant units. During TVO's 40-year history the company has developed an uncompromising safety culture and safety is always the priority at its nuclear power production plant units. Olkiluoto is prepared for a fourth unit.

Decades of excellent relations with our neighbours have resulted in broad regional and local support for TVO. As part of the licensing process for OL4, the EIA procedure involved wide-ranging discussions with local residents.

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