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Fact sheet: Olkiluoto 3

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World's largest, first-of-a-kind nuclear reactor is being built in Olkiluoto, Finland by the French company Areva. Construction started in 2005, making Olkiluoto 3 the first nuclear plant ordered in developed countries after the Chernobyl accident. The project has been plagued from the onset by quality problems, delays and cost overruns.

Promises and reality

In Finland, parliament has the last say on nuclear projects. Here is what the parliament was told about the project before their vote by TVO and by the pro-nuclear trade and industry ministry that produced the material that "guided" the parliament in their decision.

Promise: Olkiluoto 3…	**Reality**
…will cost EUR2.5 billion and take 4 years to build.[1]	The contracted price was EUR3 billion and the agreed construction time 4.5 years. The cost overrun is EUR2.3 billion so far, putting realized cost at about EUR5.5 billion, and major uncertainties still exist. Construction will take at least 7.5 years, with new delays anticipated.[2]
…is the easiest and cheapest way to reach Kyoto targets.[3]	The emission reductions that OL3 was claimed to deliver were overblown. It was supposed to reduce CO2 emissions by 7-10 million tons per year, but now the reductions are expected to be a third of this[4] (see figure 1). The delay of the reactor means that it will not help in reaching the Kyoto target practically at all since it will come to operation at most only half a year before the Kyoto target period ends. A lot of emission reduction options were abandoned because Olkiluoto 3 was expected to deliver the needed reductions. Reaching Kyoto targets would have been easier and cheaper without Olkiluoto 3.
…will deliver cheap electricity, saving consumers EUR0.5 billion a year[3]	According to Finnish heavy industry, the delay of OL3 will cost Nordic electricity consumers EUR3 billion in higher prices. [5] Electricity price during 2008-2012 would have been lower had Olkiluoto 3 not been built.
…is a market financed private investment[1]	The French export credit agency Coface and several public banks headed by Bayerische Landesbank are involved in ensuring a very low interest rate and favorable terms for the project.[6] About 60 % of direct investment comes from companies controlled by Finnish state and municipalities.[7]
…will offer jobs to Finnish workers. Half of the investment will stay in Finland. [1]	All significant subcontracts have been won by foreign companies and even in Olkiluoto itself, only about a third of the workforce is Finnish.[8] A maximum of 25% of the investment stays in Finland. There would have been more jobs and business opportunities had Olkiluoto 3 not been built and renewable energy sources be allowed to grow instead.[9]
…is going to reduce Finland's reliance on energy imports from Russia[3]	Imported gas is used for district heating and peak load generation – nuclear power cannot provide either. Also electricity is imported mainly in situations of high demand. Because of the failure to increase energy efficiency in buildings as well as the in the housing and services sector, Finland will be more reliant on Russian electricity and gas after Olkiluoto 3 is in use than before the decision to build it.[10]
…will not hinder development of energy efficiency and renewable energy. New policies will be introduced.[1]	Development of renewable electricity sources, especially wind, has lagged behind and development of combined heat and power has stalled.[11] Despite huge potentials, Finland is ranked by Ernst&Young the third least attractive country for investments in renewable energy and least attractive for wind. The ranking covers 25 countries.[12] (see also figure 2)

Olkiluoto 3 is often presented as a showcase of an open process in a democratic country. The process might have been democratic but the information that the democratic decisions were based on has turned out to be false and misleading.

Safety problems[13]

Olkiluoto 3 was also supposed to be substantially safer than present reactors, "set a new standard" for nuclear safety. Finnish nuclear safety authority STUK has detected about 3000 safety and quality problems in the OL3 project, ranging from minor to critical.[14] STUK has prevented many extremely serious quality failures that passed quality control by TVO and Areva. On the other hand, contractors are known to have on several occasions attempted to hide their mistakes by e.g. fabricating measurements, covering up defective structures and failing to record shoddy repair work. The authority themselves has said that the number of problems is so large that it is possible that all of them are not detected[15].

It is alarming that there have been problems in manufacturing several of the key parts of the primary circuit of OL3. The primary circuit is the subsystem of a nuclear power plant that is probably most crucial to safety. The control and instrumentation system of the reactor controls every aspect of reactor operation as well as emergency systems. The primary circuit is subject to extreme heat, pressure and radiation for decades. Its components are hard, some impossible, to replace once the reactor is in use.

To curtail operating costs, the EPR reactor is designed to burn nuclear fuel more intensely than currently operating reactors. This increases the risks associated with each phase of the fuel cycle from reactor operation to transport, intermediate storage and final storage of high-level waste, in some cases by up to a factor of ten. There is also a major risk of liabilities to taxpayers, as costs of managing spent fuel explode.

Examples of problems (see also page 5)

- The Finnish, UK and French nuclear safety authorities have found the design of the control and instrumentation system – the nerve center – of the reactor to be at odds with basic principles of nuclear safety. The two parallel digital systems are not sufficiently separate for one to be able to reliable provide back-up if the other fails. The reactor lacks hard-wired control by default, which means the plant operators are completely dependent on the complex digital systems for controlling all aspects of reactor operation. The highest-level nerve center can be overridden by lower-level systems with lower safety classification. STUK is requiring these defects to be addressed, but it is unclear whether Areva is able to completely redesign the systems to meet the standards.
- The primary coolant circuit was found to have too large and irregular grain size. The problem was caused by an attempt by the subcontractor to save time and reduce costs. All eight pipes have been recast and the original problem has been avoided. However, cracks were found around seams between pipes after welding, which indicates faulty material or incorrect welding method. Failure of the primary coolant circuit can initiate a severe nuclear accident.
- Damages on the surface of the primary coolant pipes were partially welded without any supervision or written records, using unacceptable methods. The surface of the pipes was welded to cover damages on their surface, which can have weakened the pipes beyond repair.
- Coolant system pipes inside the reactor building were welded using an inappropriate method and without effective supervision, which can have weakened the structures.
- The concrete containment building of the reactor was welded for at least half a year before the obligatory tests and paperwork had been carried out. Tests to ensure the quality of welds were not carried out.
- Steel liner of reactor containment was manufactured by a Polish machine yard that had no earlier experience of nuclear projects. Safety standards were violated in welding and holes were cut in wrong places. The bottom of the liner is wavy and it was damaged during storage. Violations continued during assembly of the liner in Olkiluoto.The substandard quality of the liner can lead to higher radioactive releases in case of an accident.
- Concrete base slab of the reactor is more porous than was allowed, making the structure more vulnerable to chemically reactive substances. This can lead to long term deterioration of the reactor containment building. The concrete has a high water content, which could, under certain accident conditions, lead to rapid formation of cracks.

What caused the problems?

- Olkiluoto 3 is constructed under a tight schedule, with considerable cost pressure. The same is likely to hold for any future nuclear projects. The unrealistic price and timetable of Olkiluoto 3 have been a strong incentive for Areva to cut down prices and to refuse to perform time-consuming corrections when problems arise. Areva's attempts to reduce costs led the company to select cheap, incompetent subcontractors, overlook safety related problems and not to provide nuclear safety training to workers.

- Construction of Olkiluoto 3 was allowed to commence before the design of the reactor was finalized, even though this should not be legal in Finland. Nuclear industry has high hopes of cutting down lead times through this procedure. Because of fast track licensing, Olkiluoto 3 subcontractors have used outdated blueprints and Finnish authorities have been at times unable to supervise work as they haven't had the design documents.
- New reactor designs are inherently harder to build and control because of larger size and fuel burn-up, which places high demands on construction.
- The stagnation of nuclear construction over the last decade or two has caused a lack of competent personnel and manufacturing capacity. Together with complicated project structures (Olkiluoto 3 involves over 1000 subcontractors from over 25 countries) and long control chains, this makes quality assurance prone to failures.

Waste disposal

In Olkiluoto, nuclear waste company Posiva is conducting a research project on the possibility of burying highly radioactive nuclear waste permanently underground. The project is based on a concept developed in Sweden in 1970s. No permission to build, let alone operate, a nuclear waste storage site has been granted and the company needs to continue research at least until 2012 before it is even ready to apply for a permit. There are several concerns and open questions that have not been addressed.

The status of the project[16]

- The government has made a decision in principle that construction of a waste dump in Olkiluoto would be in the overall interest of the society if the environmental requirements can be met. The decision allows the construction of an underground rock characterization facility which is now underway.
- Little site specific research was undertaken before the decision, which is why the decision is "in principle". The only stance that government authorities have officially taken so far is that they cannot without further research exclude the possibility that the requirements can be met.

Concerns

- The plan is to pack the waste in copper canisters, because copper is the most corrosion resistant metal after gold and silver. It was assumed that the canisters would last a hundred thousand years, but new peer-reviewed research shows that the canisters could be corroded in a thousand or even a few hundred years. This finding alone is enough to put the project in jeopardy. In addition, it highlights the gaps in knowledge.
- The bedrock in Olkiluoto is very old and full of cracks, and most importantly the groundwater there flows upwards to the Baltic sea, which dramatically aggravates the possible impacts of any leaks in the repository (see figure 3). The planned disposal site is located on a narrow peninsula and partially directly under the Baltic Sea. Olkiluoto was chosen for waste storage because of political, not geological reasons – the municipality where the reactors are located was the only one that could be persuaded to accept the project.
- The understanding of the long term dynamics of the bedrock has advanced hugely after the waste disposal concept applied in Olkiluoto was put together. Contrary to older beliefs, there can be strong earthquakes, 8-9 on Richter scale, associated with ice ages, which undermines the whole idea of stable bedrock.
- Spent nuclear fuel remains very hot for centuries. There are hundreds of other open questions related to behavior of different materials under heat from the radioactive waste, risk of damage to canisters during manufacturing or burial, effects of methane and hydrogen formation, amount and effects of corrosive sulphides, effects of fresh water intrusion, risk of human intrusion, to name a few.
- When the storage site would be closed it would be fully at the responsibility of the society. There are no plans or money set aside for monitoring the site or retrieving the waste and cleaning up the mess in the case of leakage.
- Basically all research at the site is conducted by the waste disposal company itself.

The waste disposal project has proceeded faster than anywhere else in the world and that has lead to overlooking some expert recommendations and too much haste in initial phases of site characterization. There is no real need for the hurry, since the waste will have to cool down in intermediate storage sites for decades after the reactors are closed down. The nuclear industry, however, desperately needs to be able to say that they have a "solution" to the problem of nuclear waste – in order to get to build more reactors and accumulate even more waste.

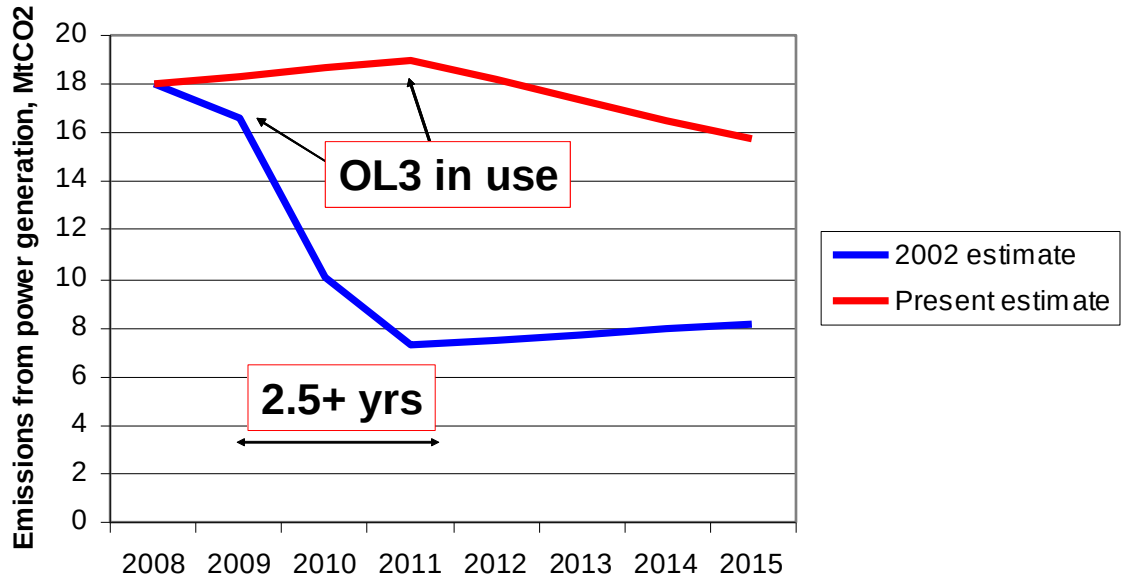


Figure 1. In a new scenario commissioned by Finnish energy industry[4], the emission reductions achieved by Olkiluoto 3 are a third of what the Finnish parliament was told in 2002[3]. In addition, the more than 3 year delay means that the reactor is of no help in fulfilling the Kyoto target that covers years 2008-2012.

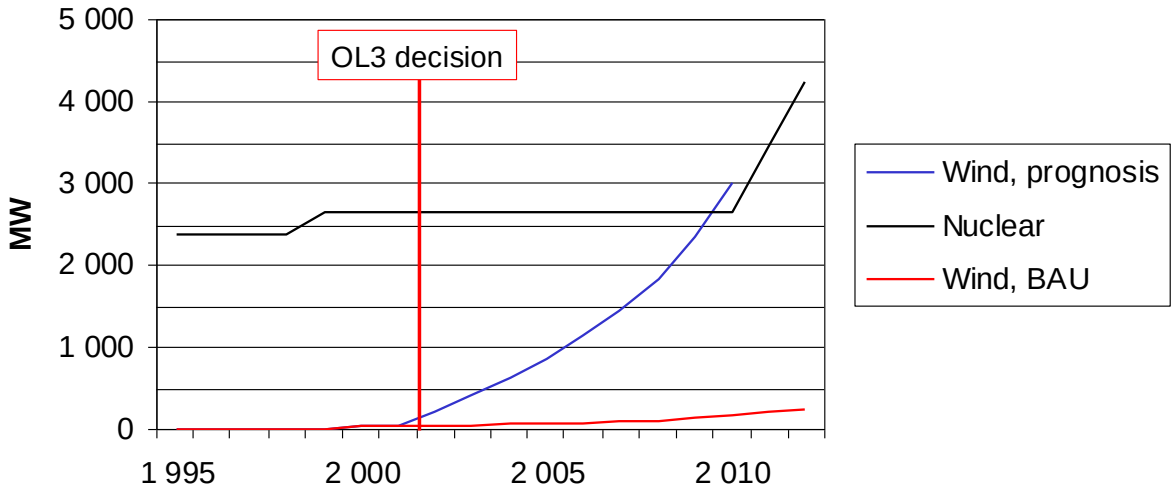


Figure 2. In 2001, Wind power capacity in Finland was projected to reach 3000 MW by 2010 (blue curve), which could have created 10 000 jobs. After the decision on OL3, made in 2002, interest in renewables evaporated and the prospects for wind power look bleak (red curve).

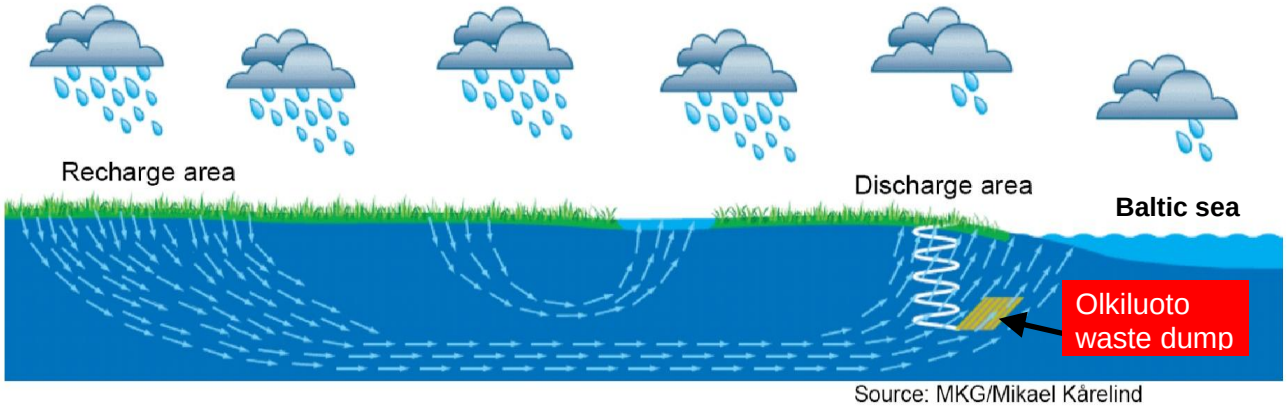


Figure 3. The proposed waste repository in Olkiluoto is on the coast of the Baltic sea, in a place where the groundwater flows from the bedrock directly into the sea.

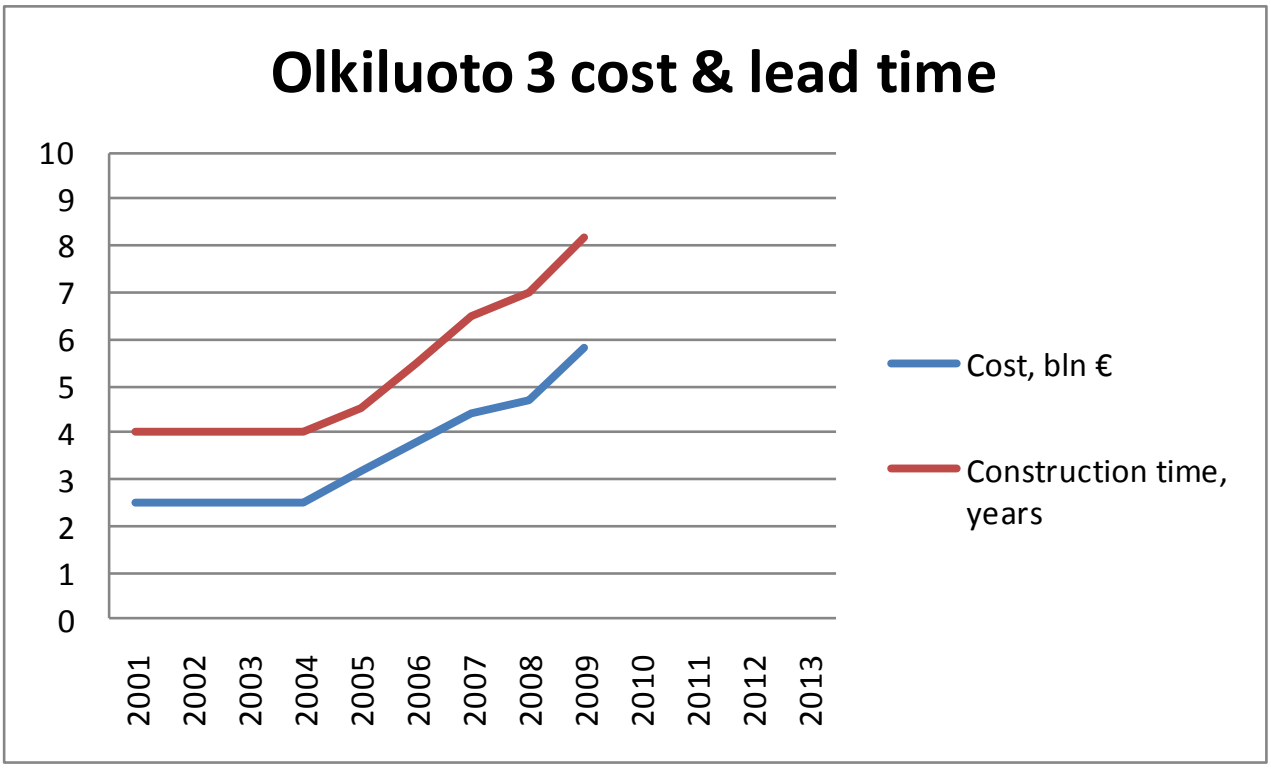


Figure 4. The development of Olkiluoto 3 cost estimates and construction time since the decision by Finnish government in 2002 and start of construction in 2005.

Safety threats in Olkiluoto

World's largest, first-of-a-kind nuclear reactor is being built in Olkiluoto, Finland with a very tight timetable and budget. There are over 2300 reported quality problems in the project so far. The compromises made during contruction increase the risk of accidents. Safety regulations have been violated for months without the Finnish authorities finding out. The Finnish nuclear safety regulator has also had to allow installation of faulty components when manufacturing a new one would take too much time or money.

The reactor is now about 38 months behind schedule. The French supplier Areva will probably have to compensate the Finnish investor TVO for the costs of delays that amount to at least 1.5 billion euros already. The delay will cost electricity users about 3 billion euros, and no one will compensate them. If the problems and violations during construction lead to low reliability of the reactor or an accident, the costs will also be borne by the Finnish society.

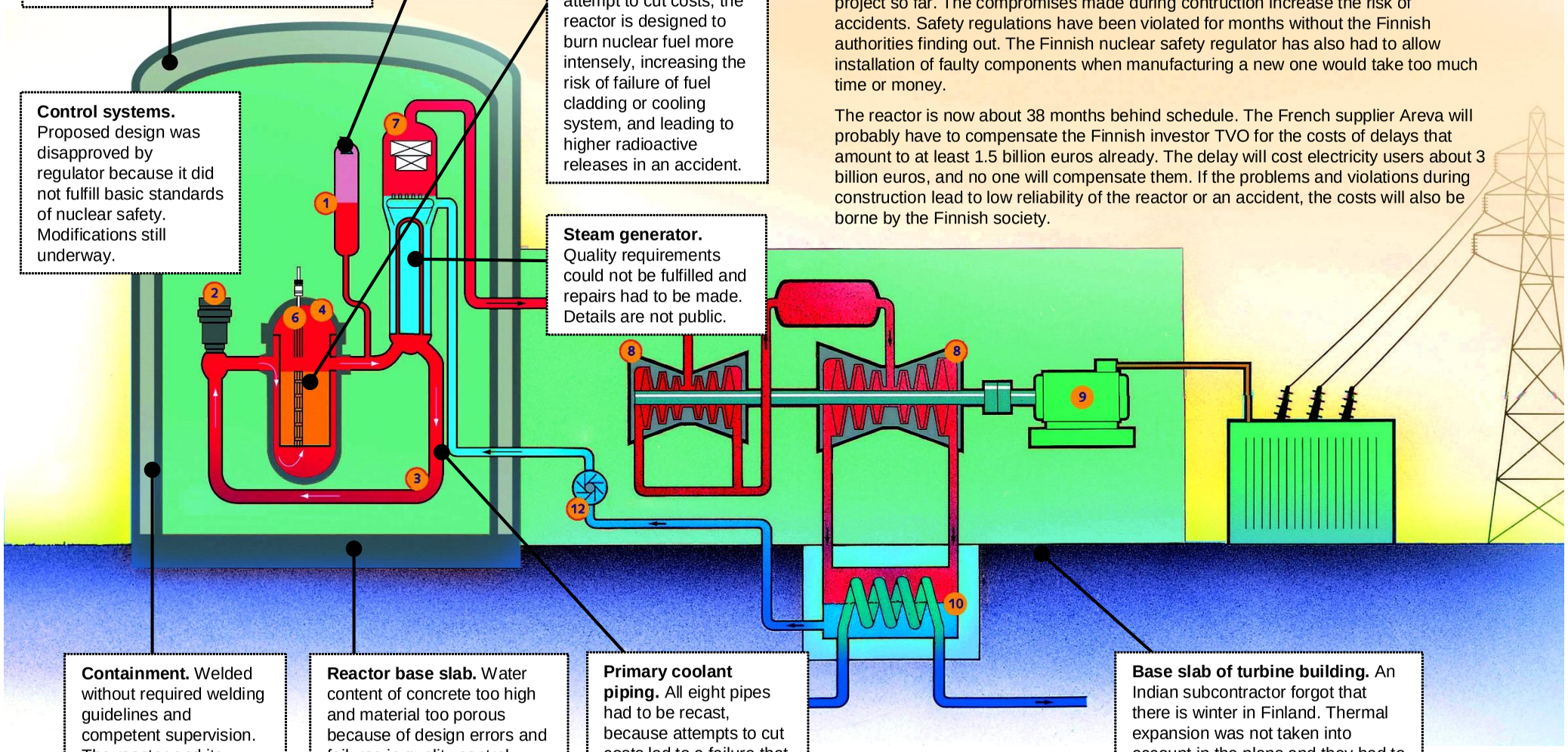
Steel liner of containment. Welded with inappropriate methods in a Polish machine yard with no earlier nuclear experience. Lots of weld seams were found defective. Holes were cut in wrong places. Was damaged when falling in a storm.

Pressurizer. Four out of five pieces had to be recast because of malfuction. STUK, TVO and Areva had all inspected the facility and failed to spot the problem.

Nuclear fuel. In an attempt to cut costs, the reactor is designed to burn nuclear fuel more intensely, increasing the risk of failure of fuel cladding or cooling system, and leading to higher radioactive releases in an accident.

Control systems. Proposed design was disapproved by regulator because it did not fulfill basic standards of nuclear safety. Modifications still underway.

Steam generator. Quality requirements could not be fulfilled and repairs had to be made. Details are not public.



Containment. Welded without required welding guidelines and competent supervision. The reactor and its cooling system is to be installed on this potentially defective structure.

Reactor base slab. Water content of concrete too high and material too porous because of design errors and failures in quality control.

Primary coolant piping. All eight pipes had to be recast, because attempts to cut costs led to a failure that made testing the pipings for cracks impossible. Cracks found around weld seams of new pipes.

Base slab of turbine building. An Indian subcontractor forgot that there is winter in Finland. Thermal expansion was not taken into account in the plans and they had to be completely redone.

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For more information

For briefings, background information etc, see: www.olkiluoto.info

On safety problems

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[12] Ernst&Young 2007: Renewable Energy Country Attractiveness Indices Q3.
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