2006

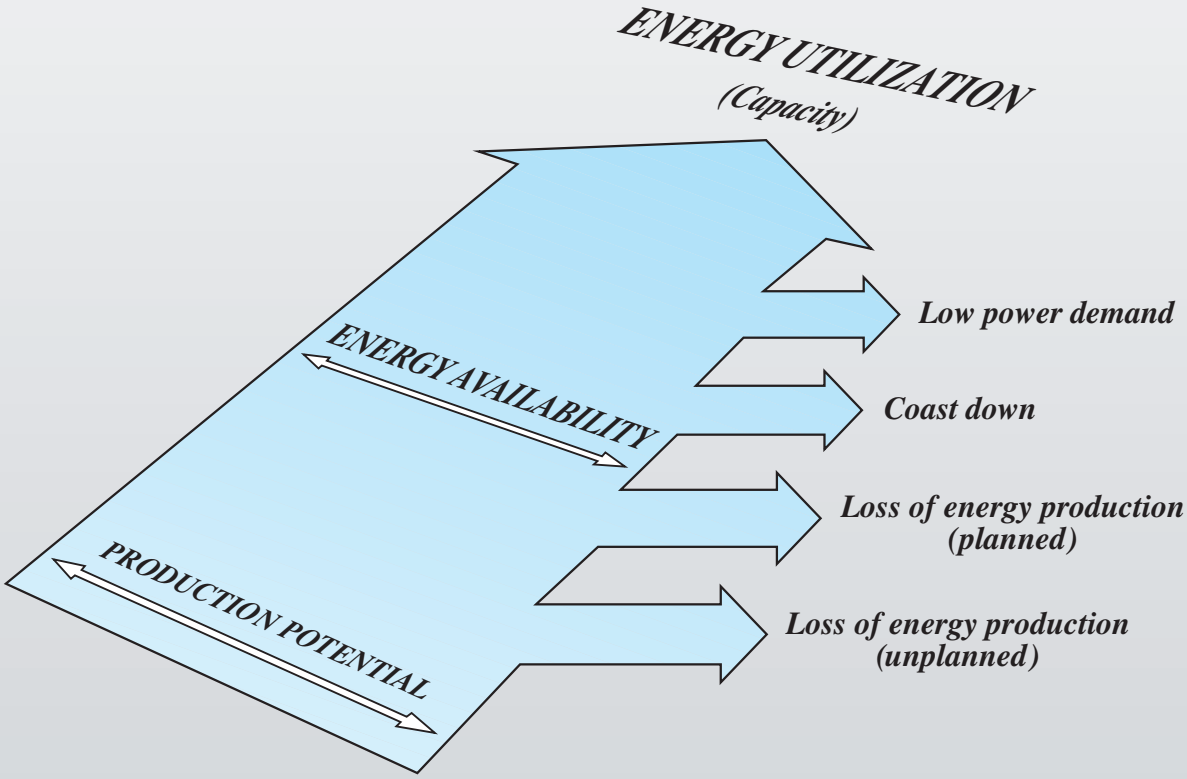
Summary of

Operating Experience

in Swiss Nuclear Power Plants

2005

swissnuclear
Nuclear Energy Section of swisselectric



SWISS NUCLEAR POWER PLANTS

Power station	Type of reactor	Net output (MWe)	Commercial operation
Beznau (KKB)	PWR	365	Unit 1: Dec. 24, 1969
		365	Unit 2: March 15, 1972
Mühleberg (KKM)	BWR	355	November 6, 1972
Gösgen (KKG)	PWR	970	November 19, 1979
Leibstadt (KKL)	BWR	1165	December 15, 1984

DEFINITIONS

(Corresponding to the UNIPEDE classification «Statistical Terminology Employed in the Electrical Supply Industry»)

$$\text{Energy Utilization Factor} = \frac{\text{Energy Utilization}}{\text{Production Potential}}$$

$$\text{Energy Availability Factor} = \frac{\text{Energy Availability}}{\text{Production Potential}}$$

Energy Utilization
– energy actually produced within a specific period

Production Potential
– potential energy production assuming maximum capacity continuously available throughout a specific period

Energy Availability
– potential energy production assuming available capacity during a specific period

Net production of the Swiss nuclear park was 22 TWh in 2005. The Leibstadt nuclear power plant was shut down for five months because of major damage to the main generator. This led to a decrease of 15.6% of the overall electricity production in Switzerland compared with 25.43 TWh in 2004.

Worldwide energy consumption is growing fast, energy prices have reached new peaks and the importance of nuclear power for a safe, efficient and reliable electricity supply becomes ever more evident.

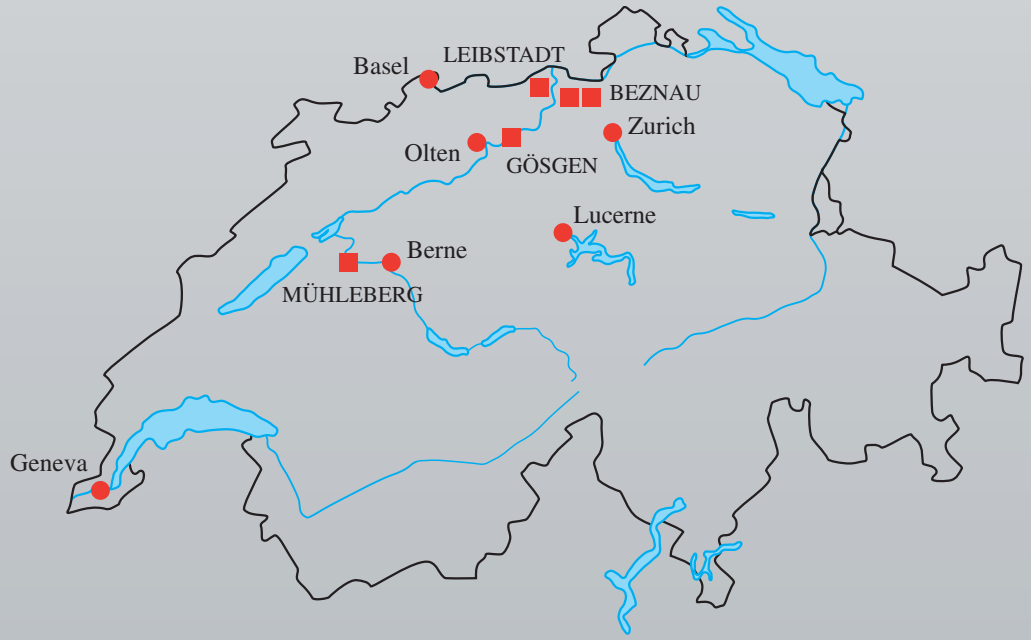
In addition to China, India, South Korea, Russia, Finland and France, all of which are building or planning to build more nuclear power plants, the Baltic states, the Netherlands and the USA are reconsidering the nuclear option. In Switzerland, the Swiss Federal Office of Energy recently acknowledged that nuclear energy will remain important to help ensure security of electricity supply. Politicians and the public increasingly recognise the economic and ecological advantages of using nuclear technology to generate electricity.

The electricity failure which paralysed the Swiss railway network last year, together with the five-month shutdown of Leibstadt, concentrated public attention on the importance of a guaranteed electricity supply. The Russian-Ukrainian gas dispute at the end of 2005 demonstrated what happens when countries are too dependent on foreign sources of supply. This event raised public awareness about the importance of reliable domestic electricity production.

As in previous years, Switzerland's five nuclear power plants continued to operate competitively and at high levels of safety and availability.

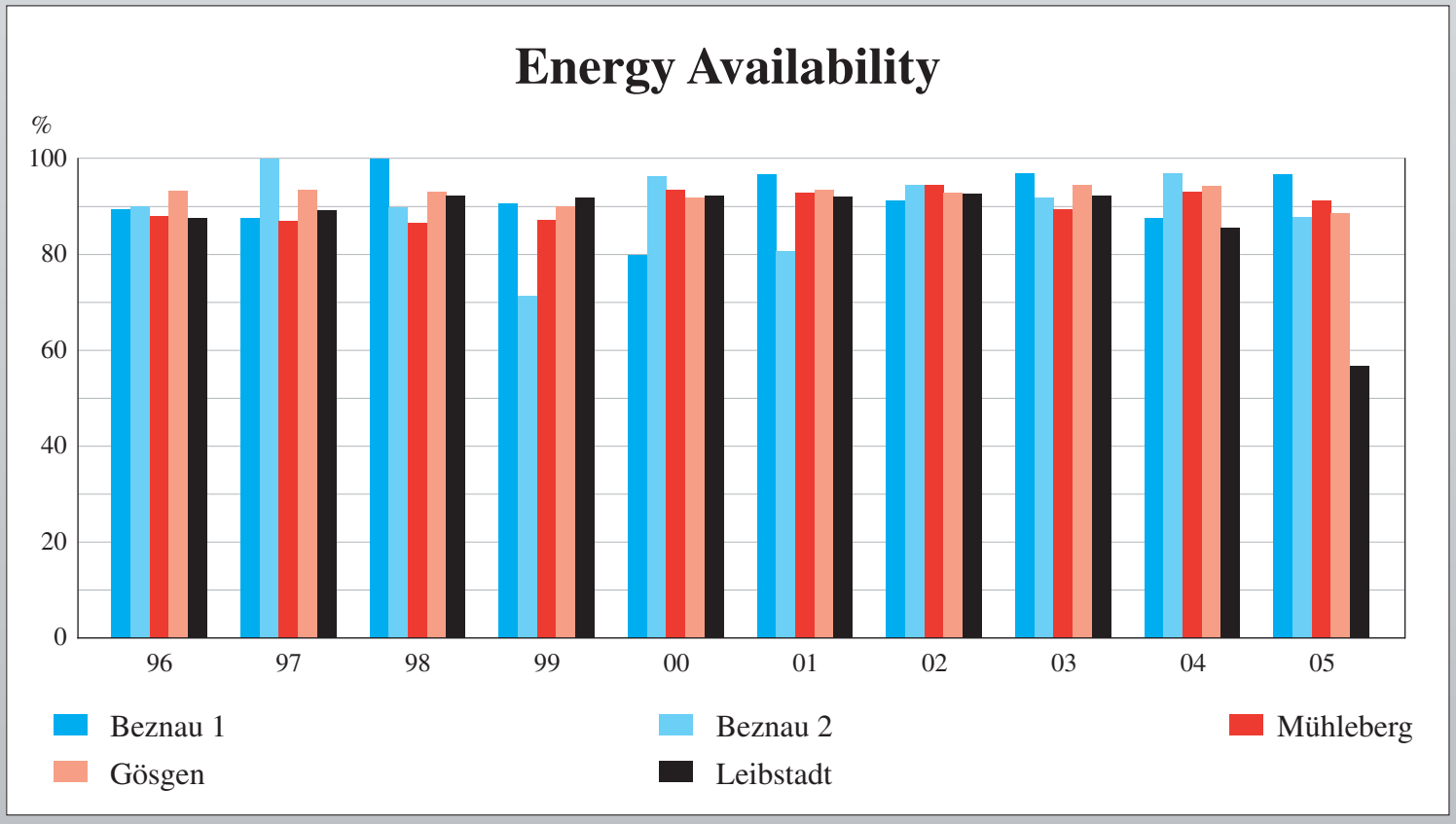
Peter Hirt
President Swissnuclear

Kurt Kohler
President Group of the Managers of Swiss NPPs

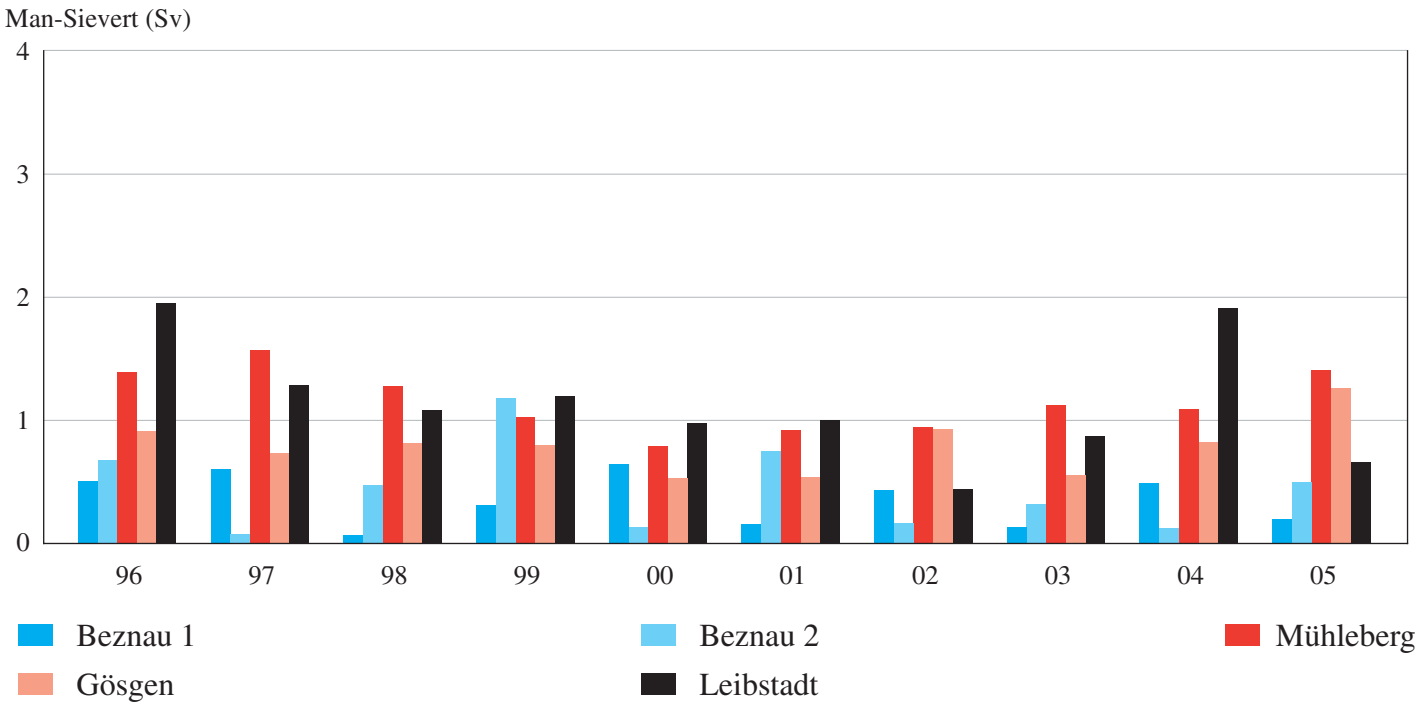


Swiss Nuclear Power Plants: Production Figures 2005 and History

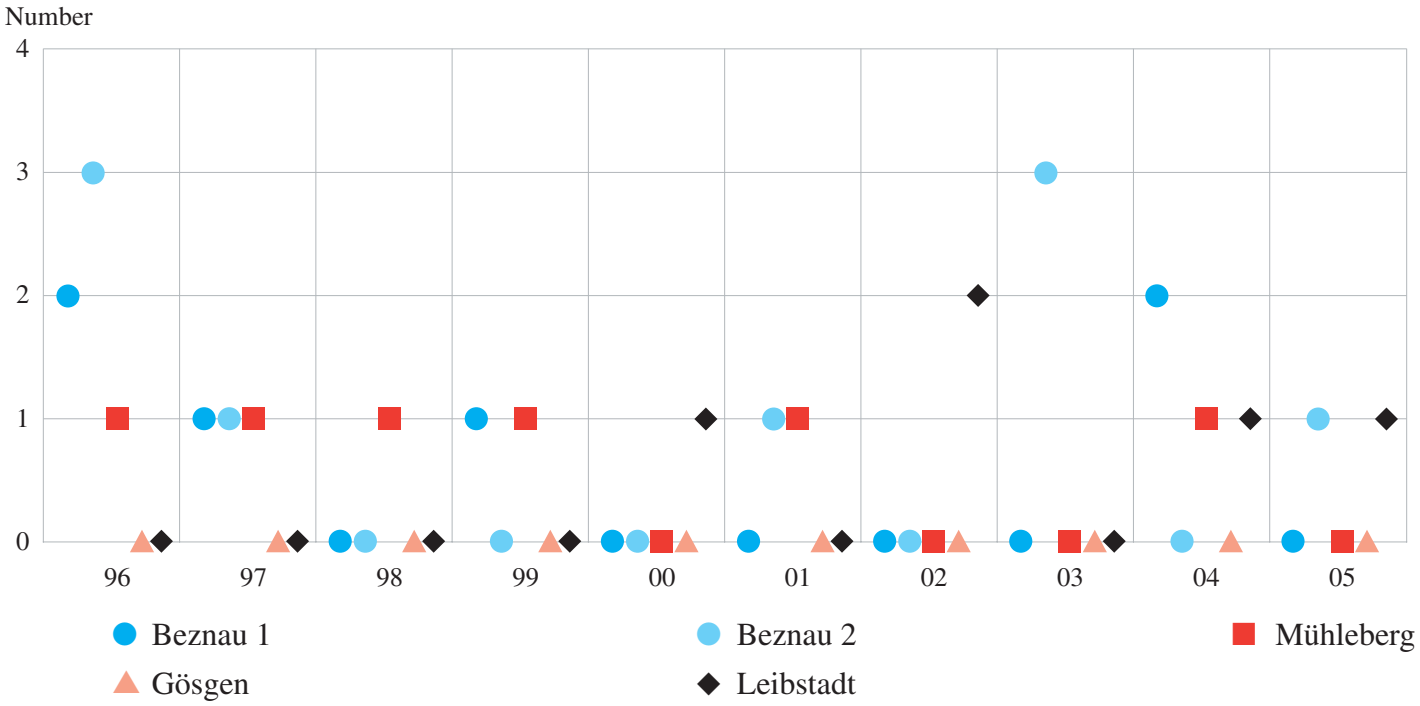
	Gross production MWh	Net production MWh	Total operating time (power production) h	Total gross production since start of operation MWh	Total net production since start of operation MWh
KKB 1	3 225 905	3 095 961	8491	96 446 412	92 282 047
KKB 2	2 917 392	2 799 907	7728	95 698 912	91 706 183
KKM	2 972 270	2 855 314	8130	87 832 235	83 918 372
KKG	7 997 470	7 582 951	7755	204 958 969	193 434 071
KKL	6 062 712	5 738 549	5003	173 758 015	164 724 073



Collective Exposure

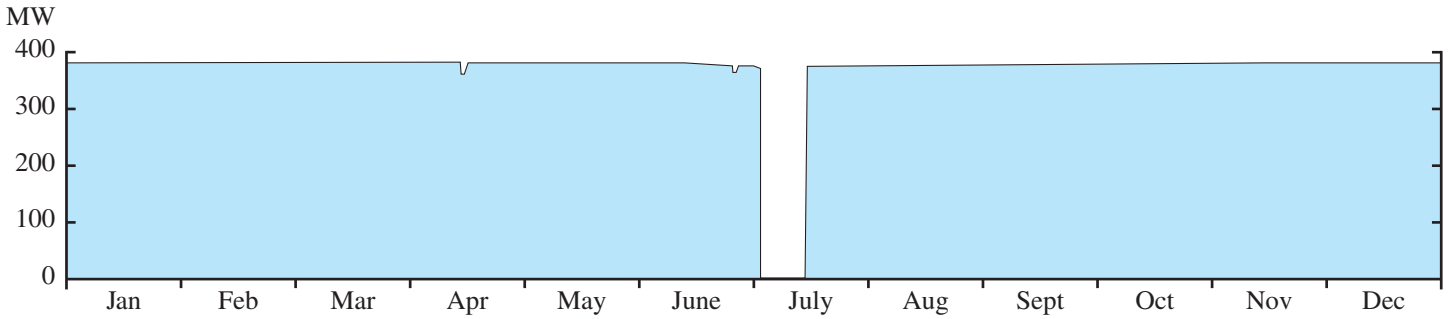


Reactor Scrams



Beznau 1

Operating Experience 2005



Important to Safety

Scrams:
There were no automatic scrams during power operation.

Important to Availability

April 14: A disturbance of a control system of one of the two turbines led to a short load reduction and an opening of blow off valves.

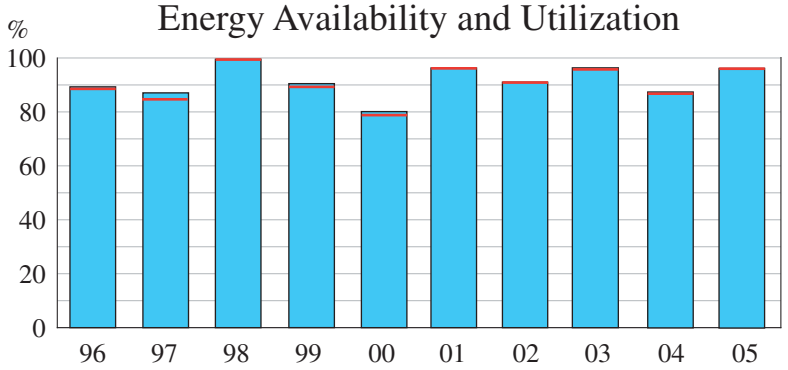
July 2 to July 13: The refuelling outage lasted 11 days and served to replace 20 from a total of 121 fuel elements. 16 of the new elements contain enriched reprocessed uranium and 4 are MOX elements. The examination of the control rod drive penetrations through the head of the pressure vessel showed no defects. – The refuelling outage was postponed from mid-June to the beginning of July. This postponement avoided the parallel outage of a third nuclear power plant (all generating base load electricity) in a period, where the repair work of the Leibstadt generator and the refuelling outage of the Gösgen power plant took place.

Net Production	3 095 961 MWh
Energy Availability	96,7 %
Energy Utilization	96,7 %

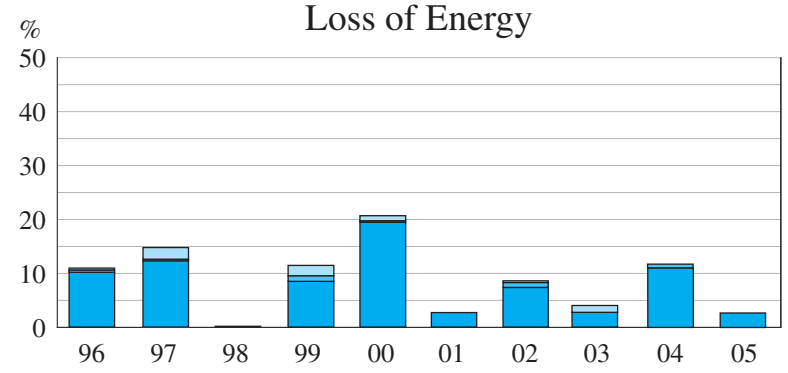
History

Characteristics

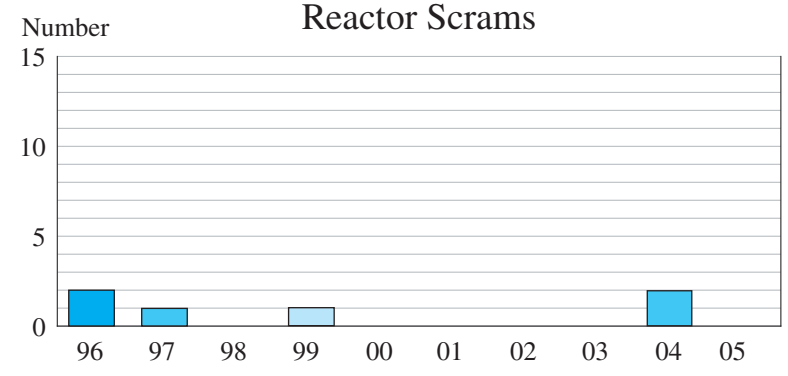
Energy Availability and Utilization



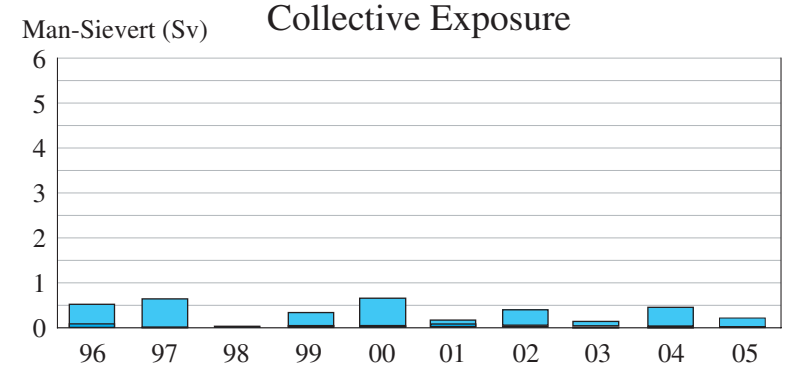
Loss of Energy

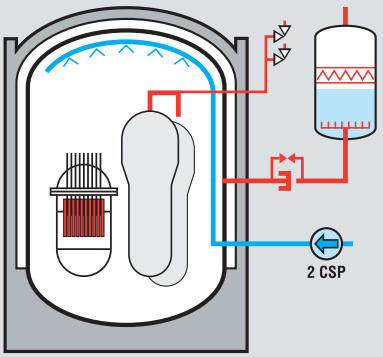


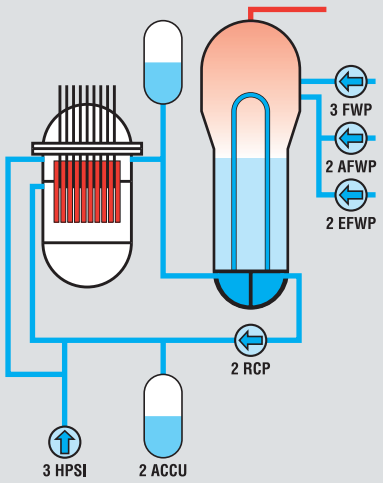
Reactor Scrams

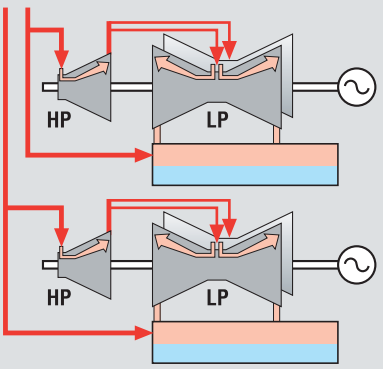


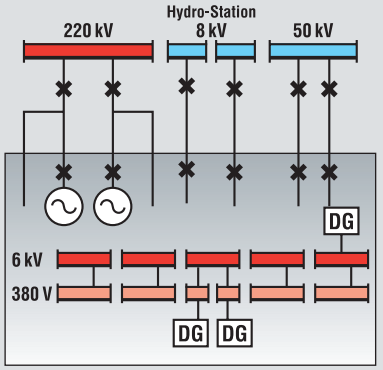
Collective Exposure





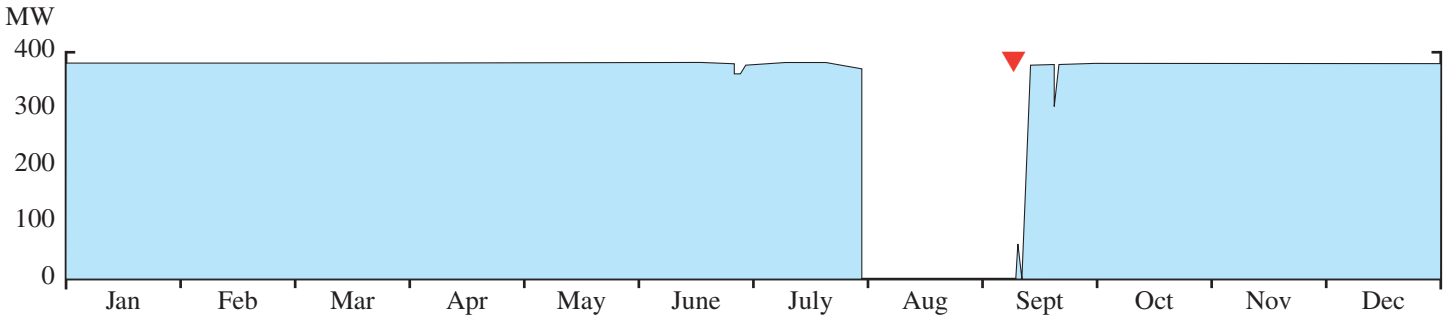






Beznau 2

Operating Experience 2005



Important to Safety

Scrams:
There was one automatic scram during restart operation after the refuelling outage.

September 10: A disturbance of the condensate level controller in a low-pressure preheater led to the shutdown of the turbine group 22 and in succession – according to design – to an automatic reactor scram. The reactor power before scram was at 17%. On September 11, the turbine group could be synchronized with the grid without further disruption.

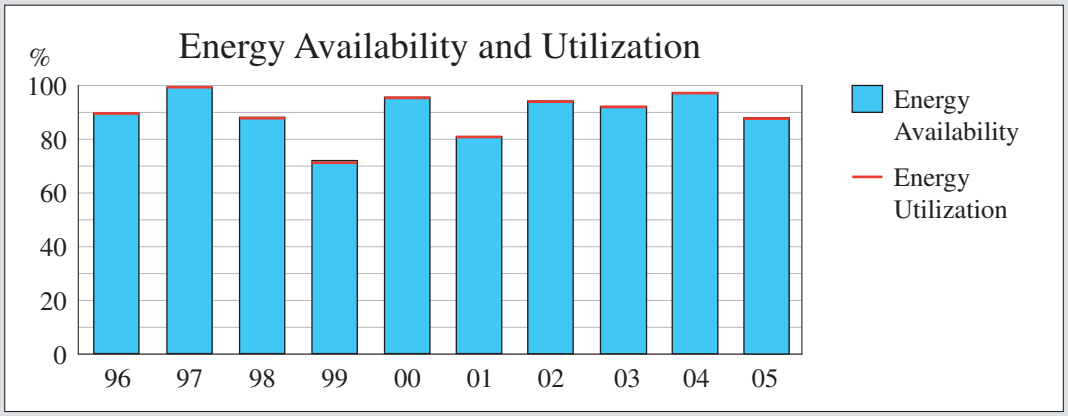
Important to Availability

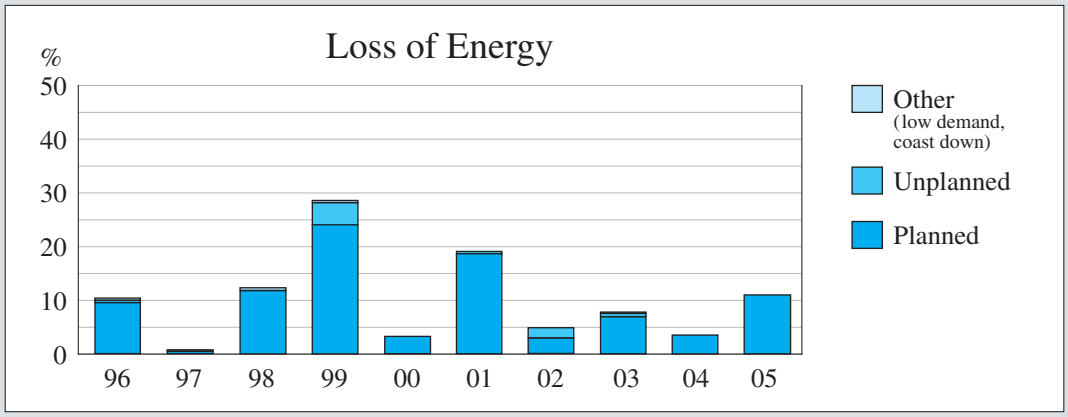
July 30 to September 8: The refuelling outage lasted 43 days. 20 out of a total of 121 fuel elements were replaced. The new elements contain enriched reprocessed uranium. A key activity of the revision was the ultrasonic inspection of the welding seams on the reactor pressure vessel and its nozzles. KKB again made use of a remote controlled manipulator whose examination tools are interchangeable underwater. The equipment provided a good service and good measurement results. The inspection showed the plant and machinery in good conditions. Other important tasks were the inspection of a high-pressure turbine, of a generator and of a feedwater pump. As in unit 1 the year before, an advanced digital controlled turbine protection and control system was installed in unit 2. The renovation of a steam exhaust silencer was managed successfully.

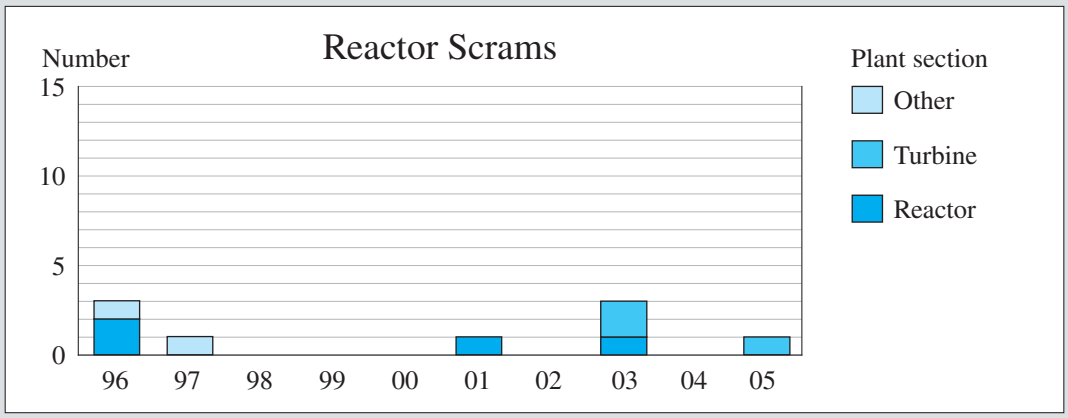
Net Production	2 799 907 MWh
Energy Availability	87,9 %
Energy Utilization	87,9 %

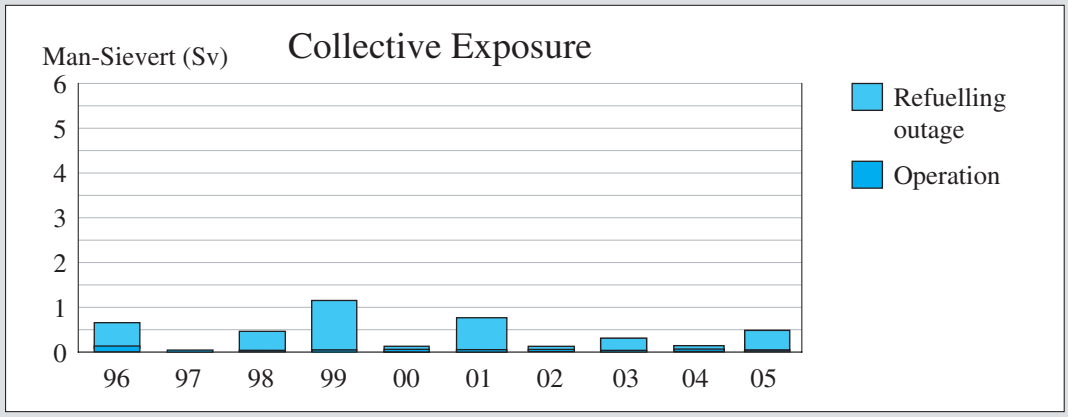
History

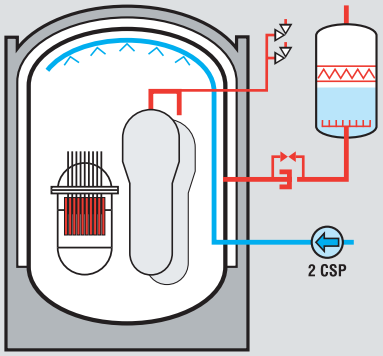
Characteristics

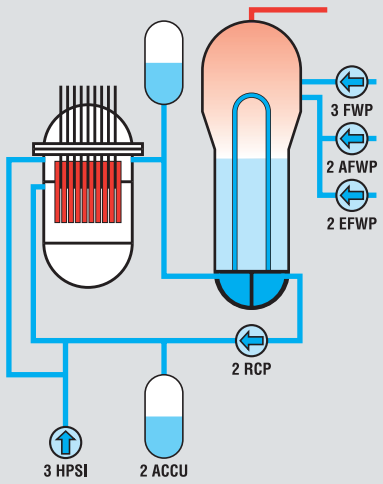


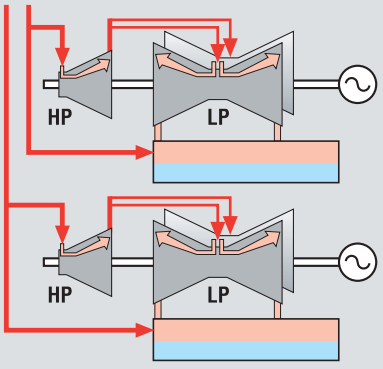


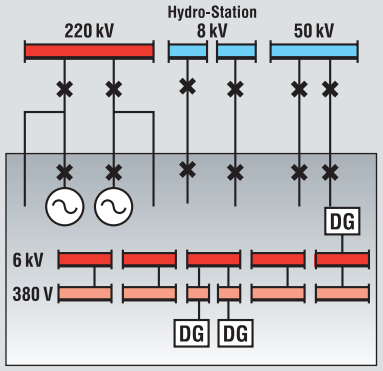






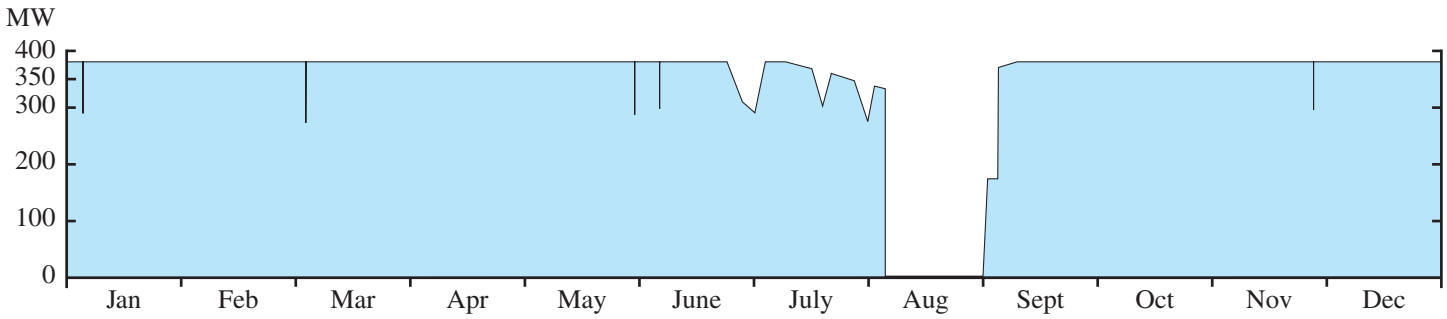






Mühleberg

Operating Experience 2005



Important to Safety

Scrams:

There was no automatic scram during power operation.

Other:

From June 15 to July 4 an on-line noble metal chemical application was performed to protect reactor pressure vessel internals.

Important to Availability

July 10: The planned coastdown operation began. The power at end of cycle reached 97.1%.

Refueling outage August 7 to September 2: The planned refueling outage lasted 27 days. In-service inspections and ultrasonic tests of the reactor pressure vessel were successfully carried out. Also inspections of the core shroud were performed. One of the four built-in tie rods was inspected. The high pressure preheater turbine B was replaced. 40 out of 240 fuel elements were replaced.

Load reductions:

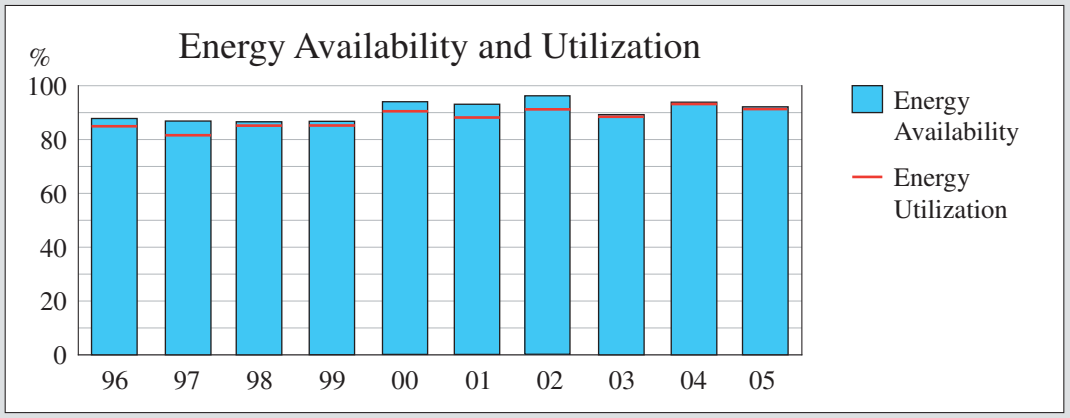
A total of nine load reductions (> one full power hour) occurred.

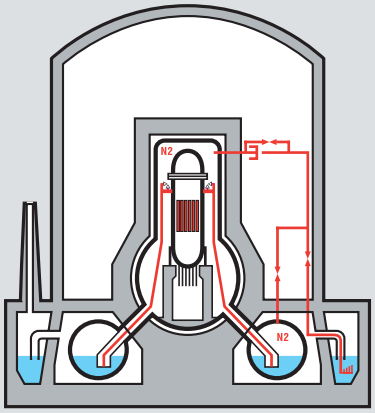
Five planned load reductions were required for periodic surveillance tests, combined with rod pattern adjustments and preventive maintenance. From June 20 to August 3 and September 6 to 10, four planned load reductions were made due to high temperature of the cooling water.

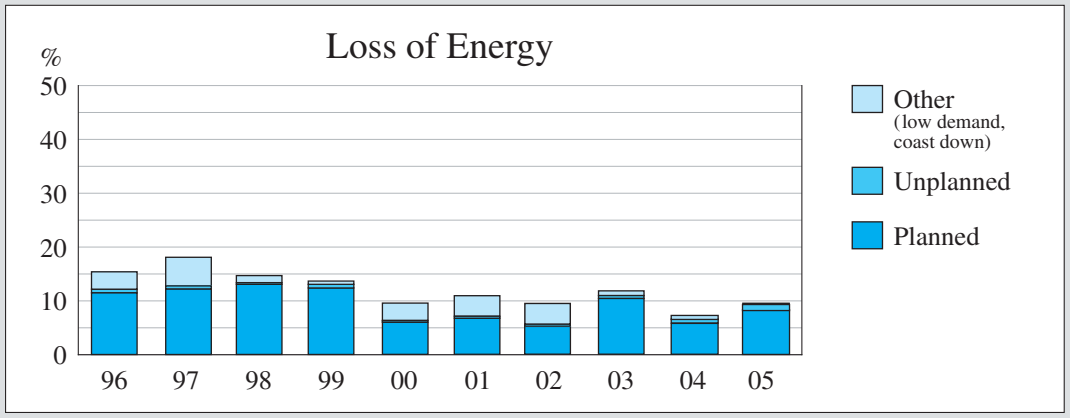
Net Production	2 855 314 MWh
Energy Availability	91,2 %
Energy Utilization	90,9 %

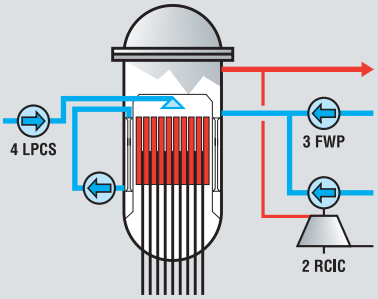
History

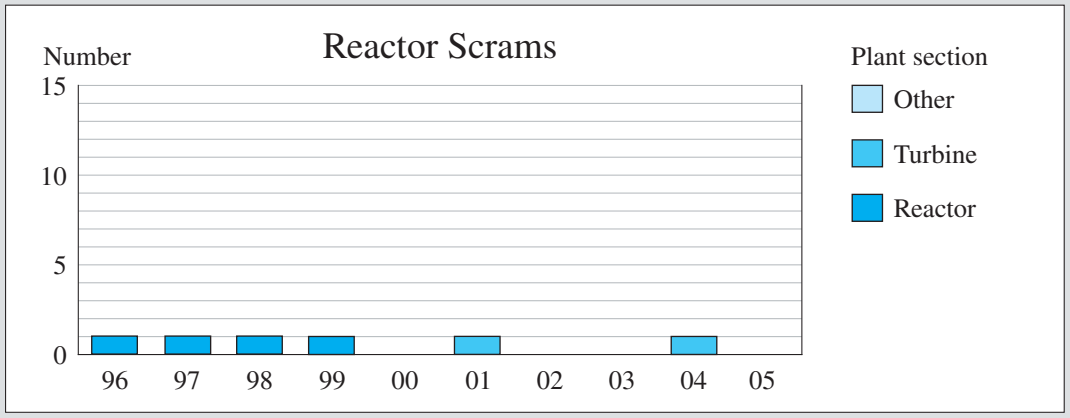
Characteristics

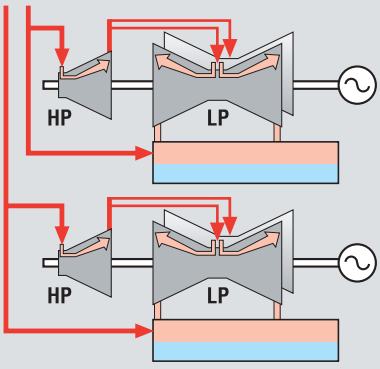


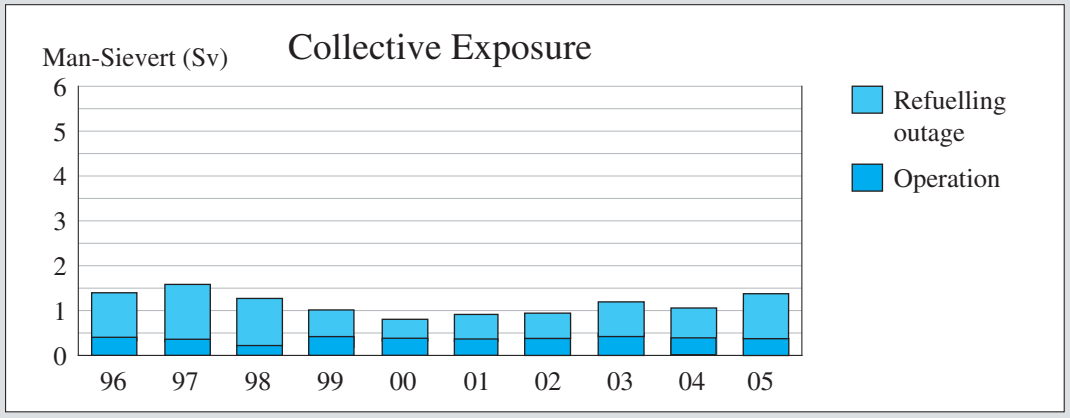


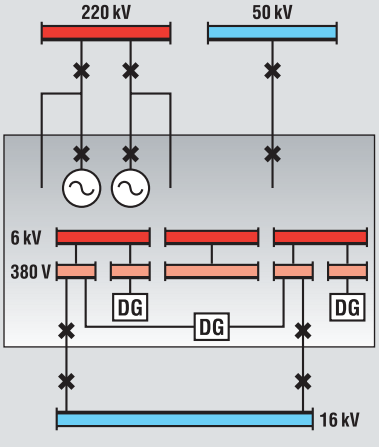






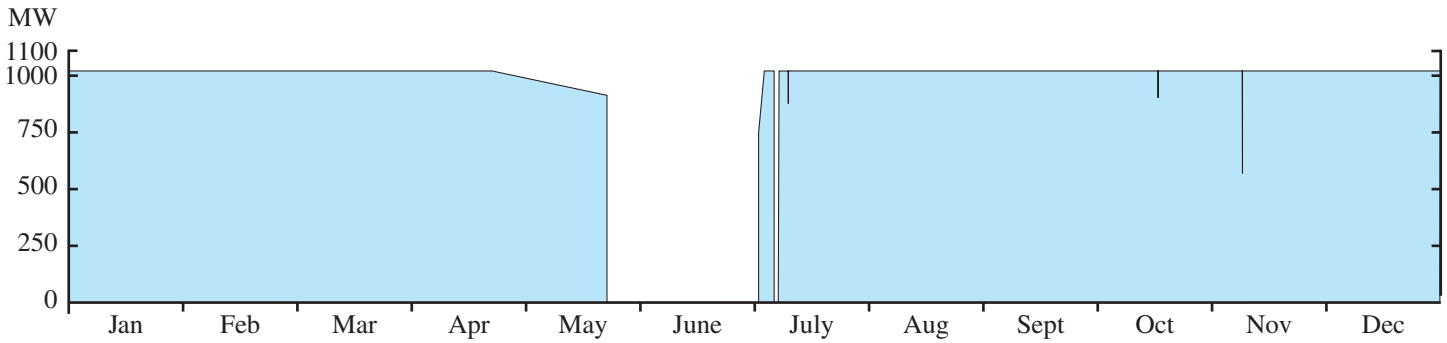






Gösgen

Operating Experience 2005



Important to Safety

Scrams:

2005 was the 15th consecutive year of operation without unplanned scrams.

Important to Availability

April 22: Start of coastdown operation. The power level at the end of the cycle was 93%. Coastdown operation led to a production loss of about 1½ equivalent full power days.

Refuelling outage, May 21 to July 1:

The duration of the refuelling outage was 41½ days, ½ day shorter than scheduled.

In addition to general preventive maintenance and inspection work, the following major work was performed:

- Exchange of the primary safety valves and a part of the surge line
- Loading of 40 new fuel elements (36 ERU elements). No new MOX fuel elements were loaded for the 27th cycle
- Leak rate test of the steel containment
- Pressure test of the whole primary system
- Exchange of the high-pressure turbine
- Exchange of the cooling-elements in the cooling tower
- Extensive inspection of the main generator

July 4: Unplanned load reduction due to a fail signal from the turbine control system.

July 7: Unplanned load reduction after a fall in of a control rod.

October 12: Unplanned load reduction due to a signal from the DNB-monitoring system. (DNB=Departure of nucleate boiling).

November 9: Unplanned load reduction after a trip of a main cooling water pump.

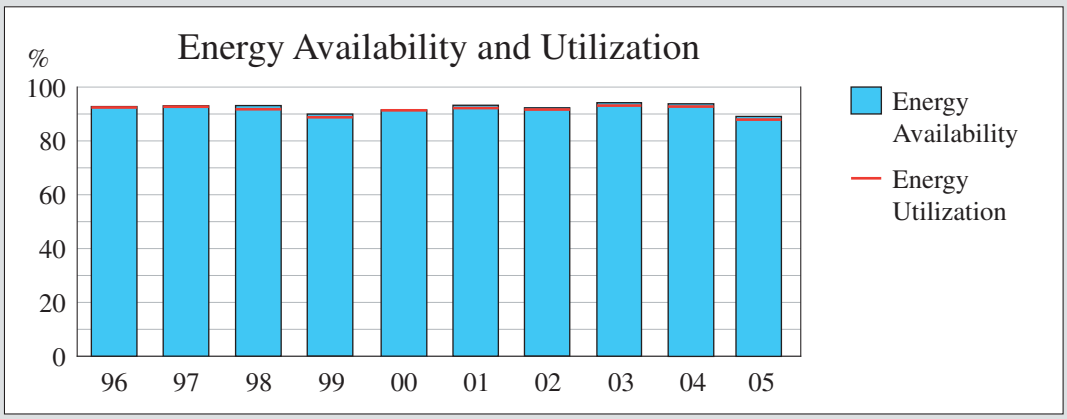
Other:

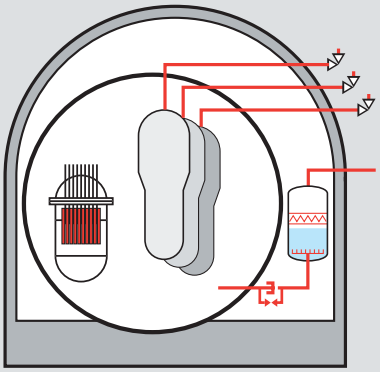
All the work done around the turbines and the reheating of the steam resulted in 13.3 MW more power at the generator.

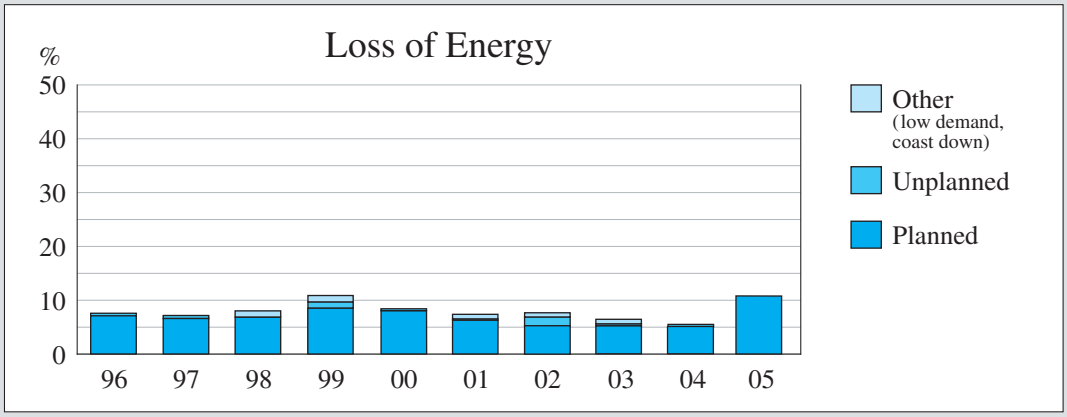
Net Production	7 582 951 MWh
Energy Availability	88,6 %
Energy Utilization	88,2 %

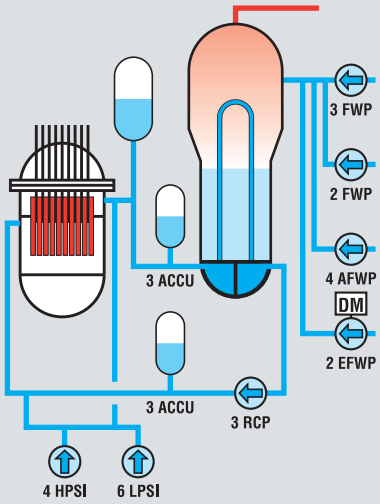
History

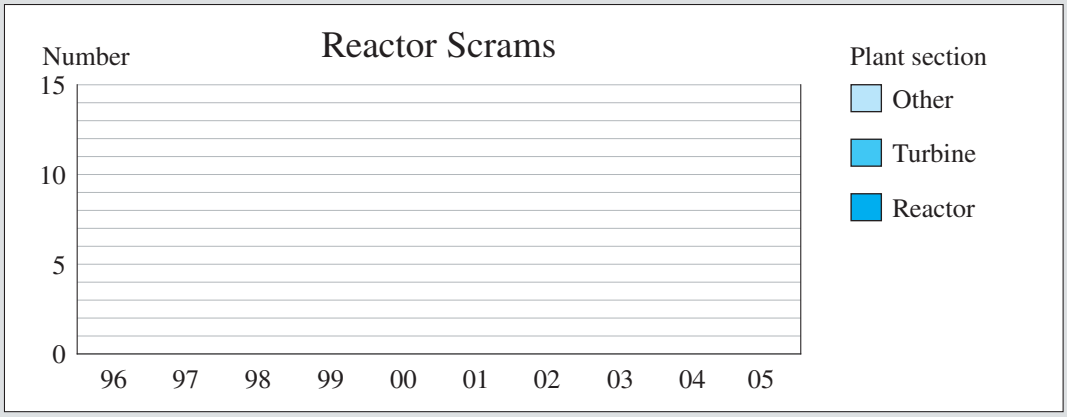
Characteristics

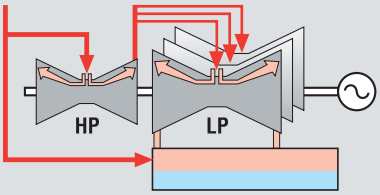


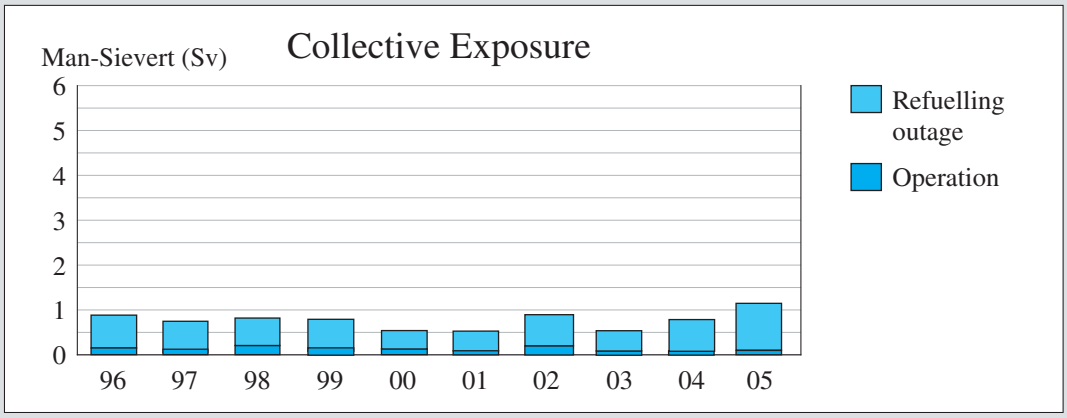


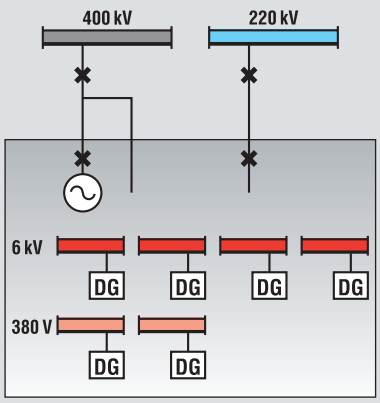






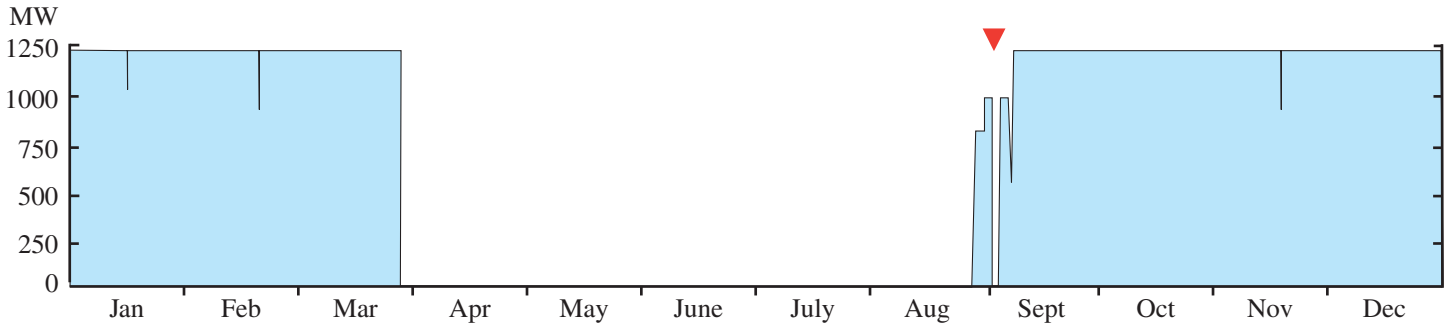






Leibstadt

Operating Experience 2005



Important to Safety

Scrams:

There was one automatic scram during power operation.

September 1: During an RPS surveillance on the main steam isolation valve limit switches, a main steam relief valve (SRV) was inadvertently opened and went unnoticed. The SRV's discharge to the suppression pool heated up the suspression pool to the TSL scram setpoint of 39°C and the reactor scrammed per design.

Important to Availability

January 15: Leakage from moisture separator reheater condensate regulatimg valve.

February 19: MSIV monitoring and control rod pattern adjustment.

March 28 to August 29: Ground in main generator stator.

– Repaired the main generator

– During the repair of the main generator, in parallel performed numerous other maintenace activities including the 21st refuelling outage – loaded 76 new and reinserted fuel bundles (out of 648).

September 1: Automatic scram (see Important to Safety).

September 5: Main generator reduction due to isophase bus cooling problem.

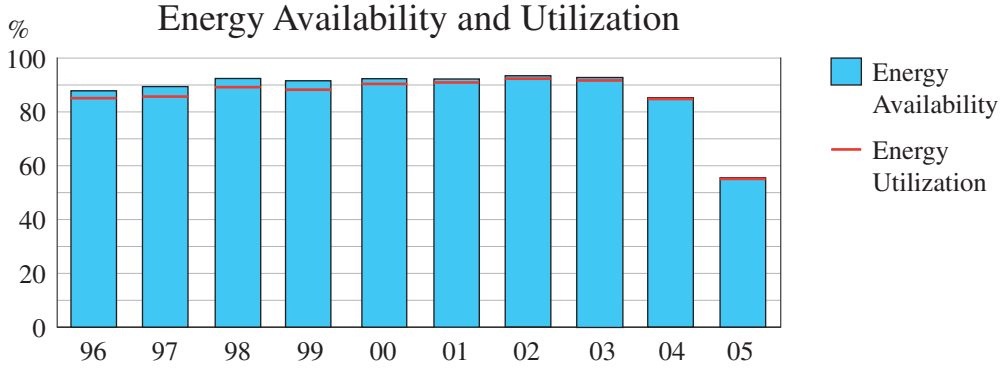
November 19: MSIV monitoring and control rod pattern adjustment.

Net Production	5 738 549 MWh
Energy Availability	56,7 %
Energy Utilization	56,5 %

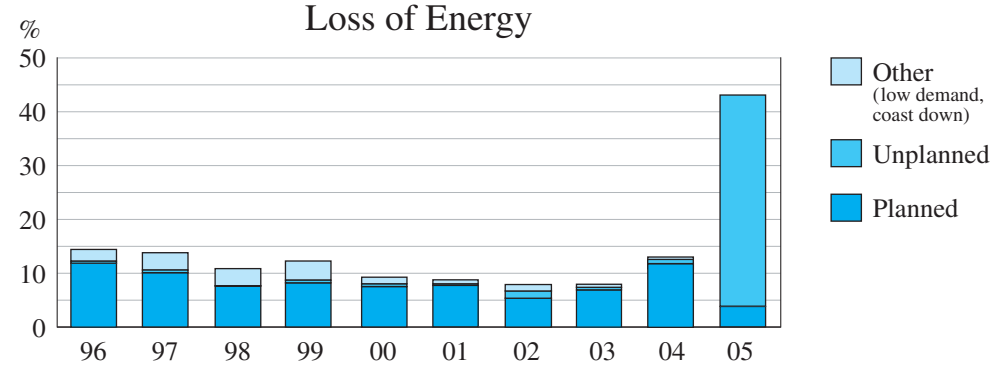
History

Characteristics

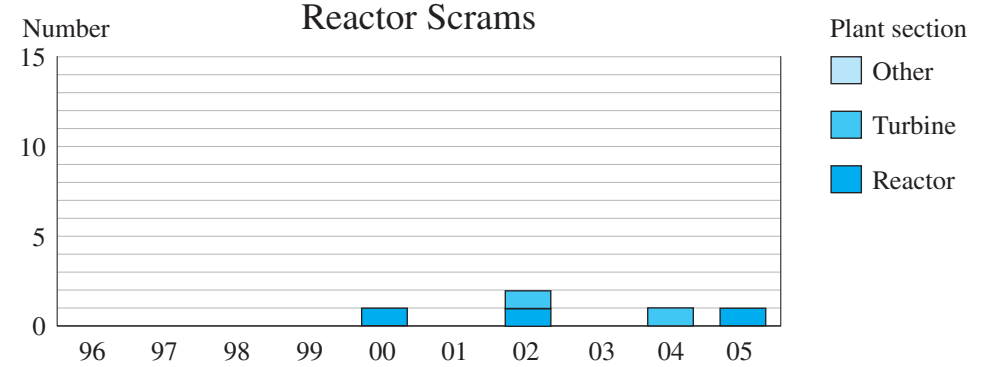
Energy Availability and Utilization



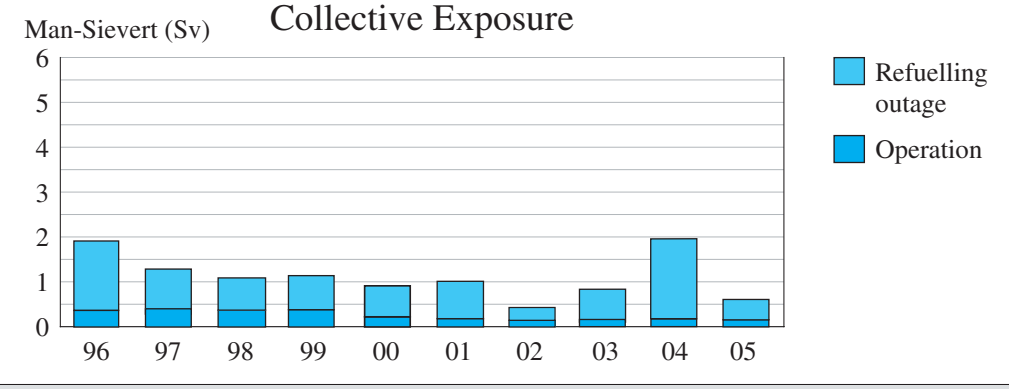
Loss of Energy

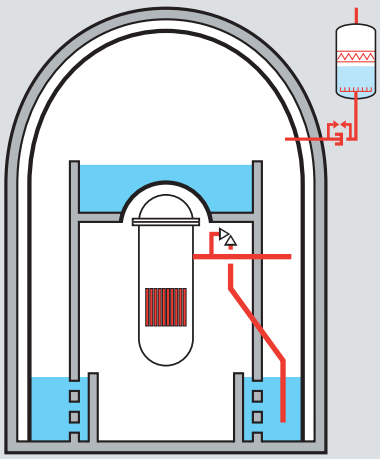


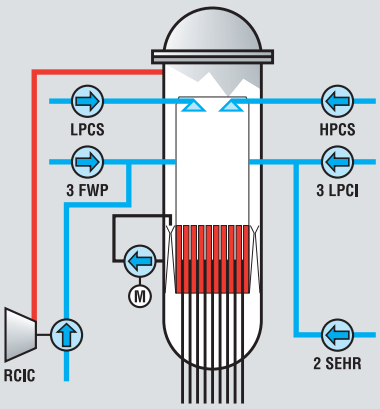
Reactor Scrams

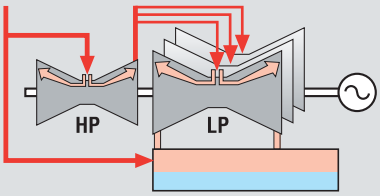


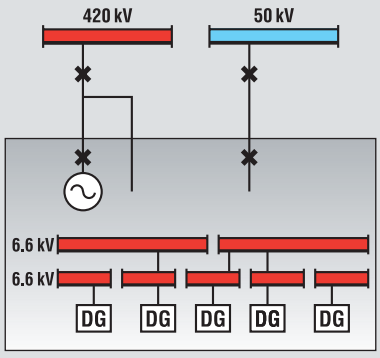
Collective Exposure











The first two Swiss nuclear power plants, Beznau and Mühleberg, each belong to a single large public electric utility, whereas the two later plants, Gösgen and Leibstadt, are partner plants of several electric utilities and public service companies. The concept of partner nuclear power plants made it possible, when they were set up in the seventies, for medium-sized and smaller organisations to share in economically attractive, large-scale power generation plants and to gain access to the latest technology. In each case one of the partners has responsibility for the business management on behalf of the others.

The Beznau nuclear power plant is fully owned by its operator, Nordostschweizerische Kraftwerke AG.

Likewise, the Mühleberg nuclear power plant belongs fully to BKW FMB Energie AG.

The partners of Kernkraftwerk Gösgen-Däniken AG (KKG) are:
– Aare-Tessin AG für Elektrizität (ATEL, 40%, managing partner)
– Nordostschweizerische Kraftwerke AG (NOK, 25%)
– the City of Zurich (15%)
– Centralschweizerische Kraftwerke AG (CKW, 12.5%)
– Energie Wasser Bern (EWB, 7.5%)

Kernkraftwerk Leibstadt AG (KKL) is owned by the following partners:
– Nordostschweizerische Kraftwerke AG (NOK, 22.8%, managing partner)
– Aare-Tessin AG für Elektrizität (ATEL, 27.37%)
– Elektrizitäts-Gesellschaft Laufenburg AG (EGL, 16.28%)
– Centralschweizerische Kraftwerke AG (CKW, 13.57%)
– BKW FMB Energie AG (9.55%)
– AEW Energie AG (5.43%)
– Energie Ouest Suisse, Lausanne (EOS, 5%)

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