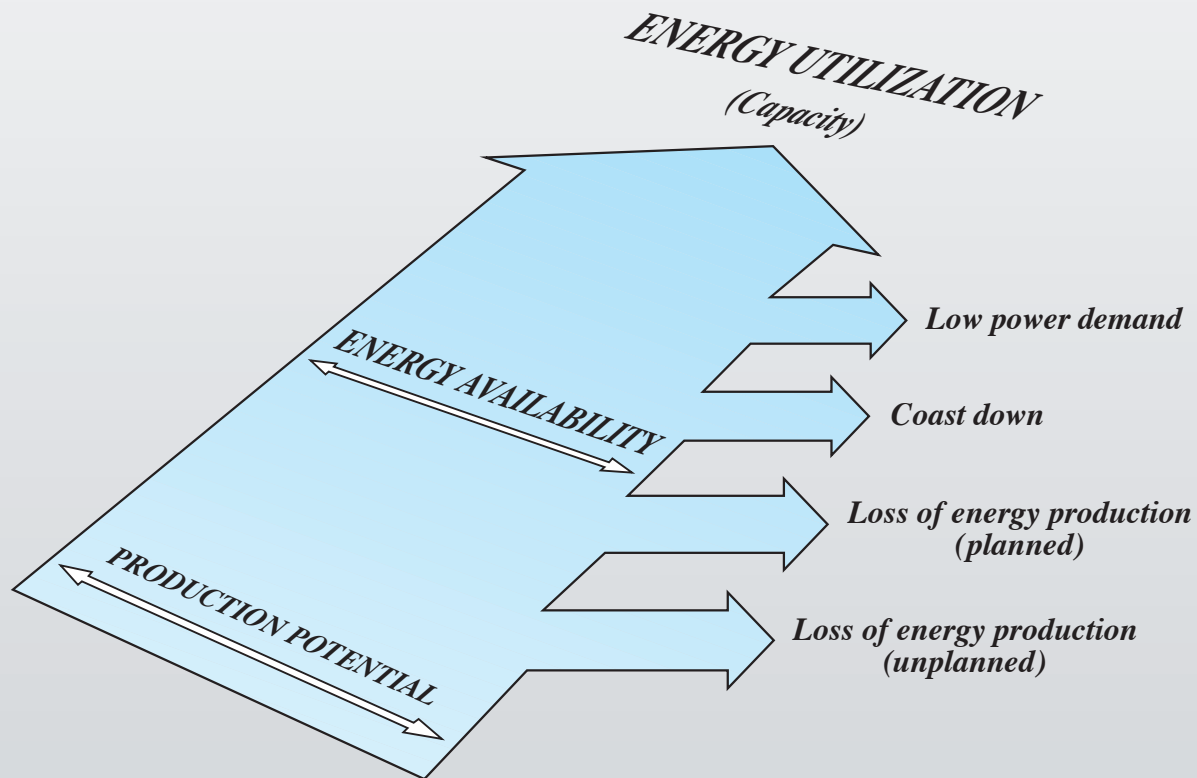


Summary of

# Operating Experience

in Swiss Nuclear Power Plants

2006



## 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 UNIPED 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

In 2006, electricity production from Swiss nuclear power plants reached a new high of 26.2 terawatt hours (TWh). The availability of the five Swiss nuclear power plants was 93.4%.

The Swiss government recently published its study «Energy Perspectives 2035» and declared its energy policy for the coming years. The government plans to increase the promotion of energy efficiency measurements as well as of renewable energies. In addition, the government acknowledged that nuclear energy will remain important for the security of Switzerland's supply of electricity. Therefore it considers the replacement of existing and the building of new nuclear power plants.

The government's policy supports the conclusions and plans of the Swiss electricity industry. Several electricity companies recently announced project studies for building a new nuclear power station. First results are expected in 2008. Thus the political debate over the future of nuclear energy is under way. As public opinion polls show, a majority of Swiss are in favour of the use of nuclear energy and support the replacement of the existing nuclear power plants by new ones.

As in previous years, Switzerland's five nuclear power plants have again reached a high level of security, availability and competitiveness.

Peter Hirt  
President Swissnuclear

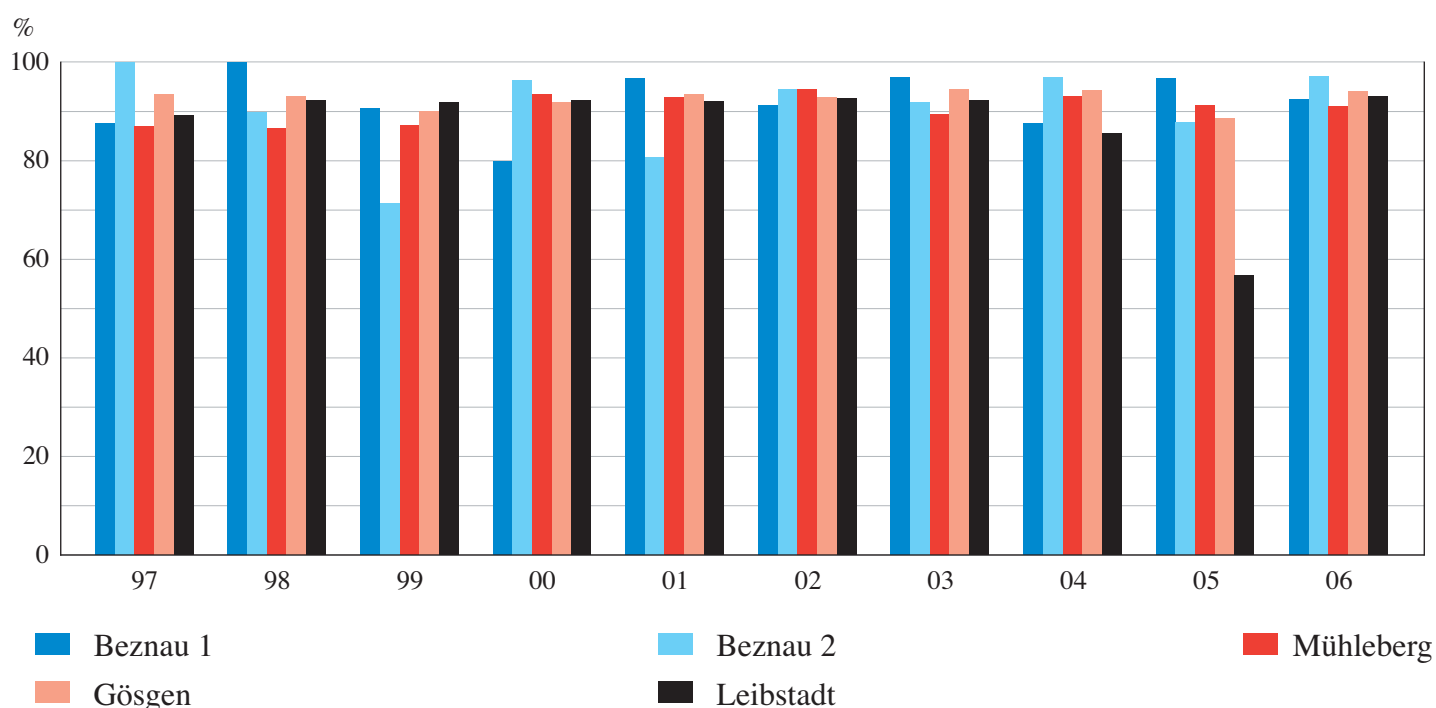
Kurt Kohler  
President Group of the Managers of Swiss NPPs



# Swiss Nuclear Power Plants: Production Figures 2006 and History

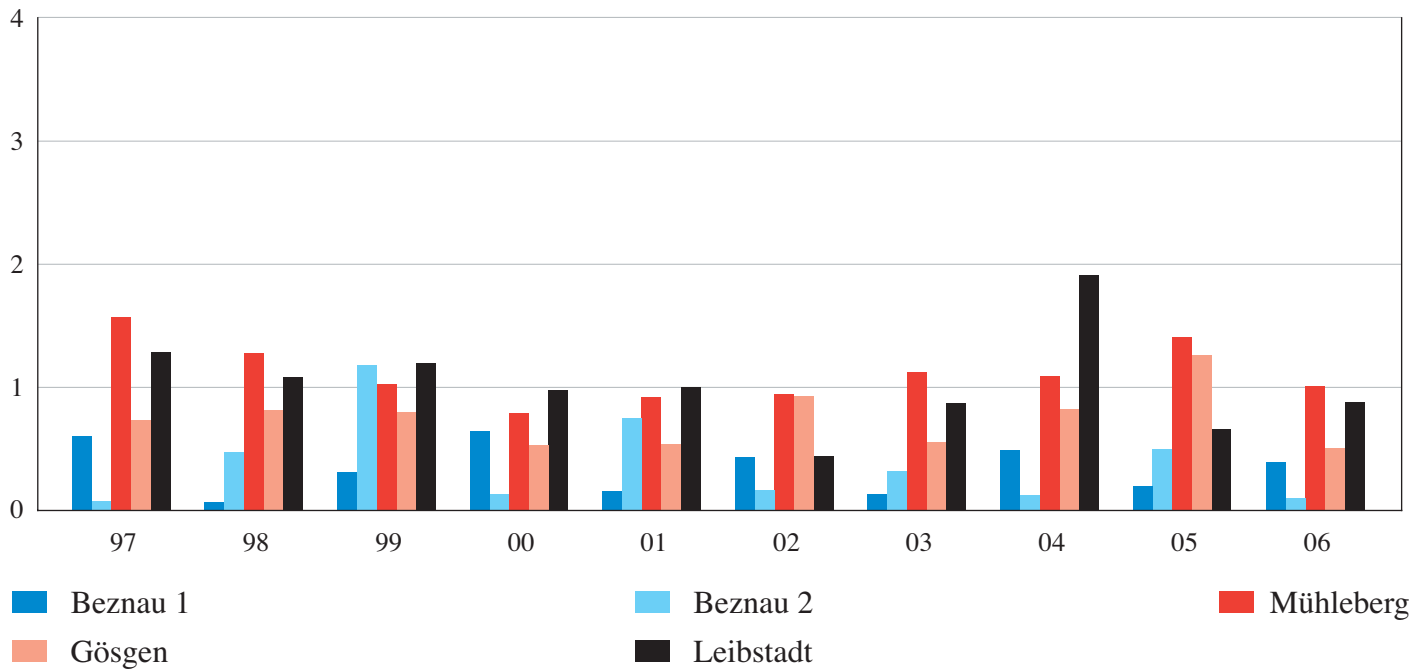
	Gross production MWh	Net production MWh	Total operating time (power production) h	Total gross production since start of operation MWh	Total net production since start of operation MWh
KKB 1	3 075 948	2 950 681	8114	99 522 360	95 232 728
KKB 2	3 201 967	3 073 230	8517	98 900 879	94 779 413
KKM	2 995 770	2 882 881	8174	90 828 005	86 801 253
KKG	8 537 989	8 099 097	8230	213 496 958	201 533 168
KKL	9 837 492	9 367 041	8278	183 595 507	174 091 114

## Energy Availability



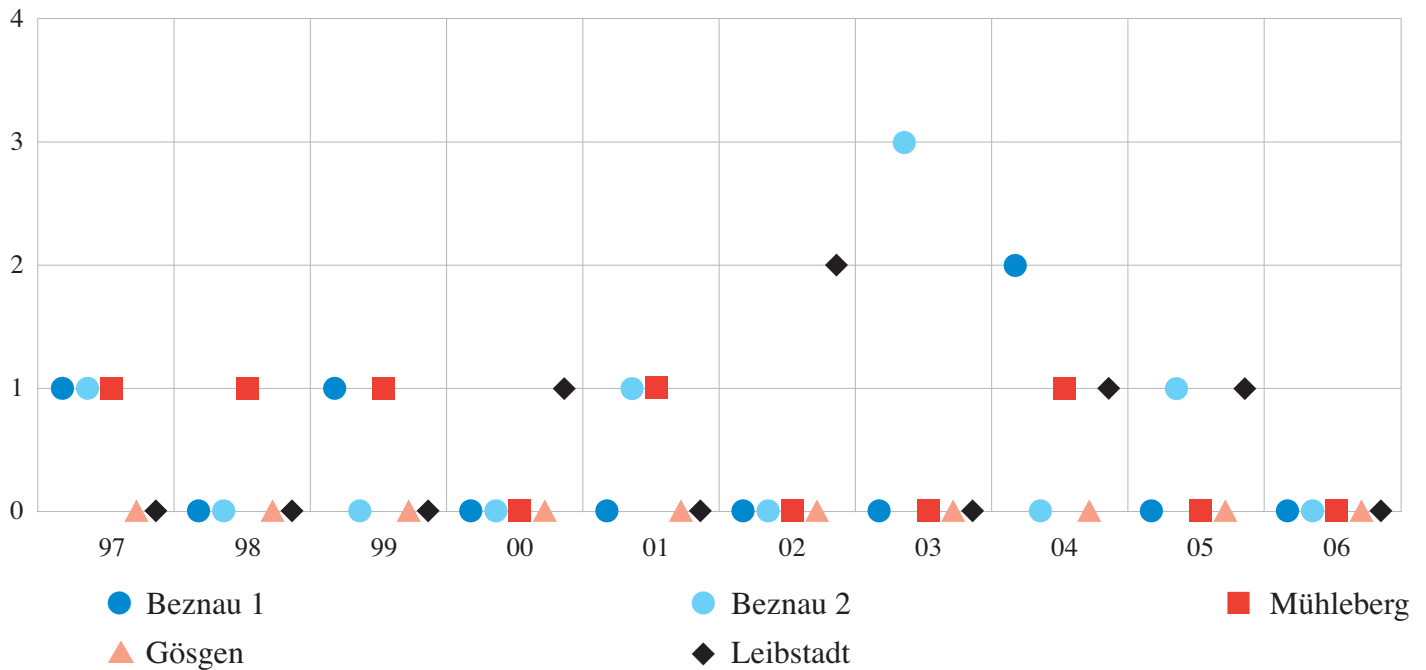
## Collective Exposure

Man-Sievert (Sv)



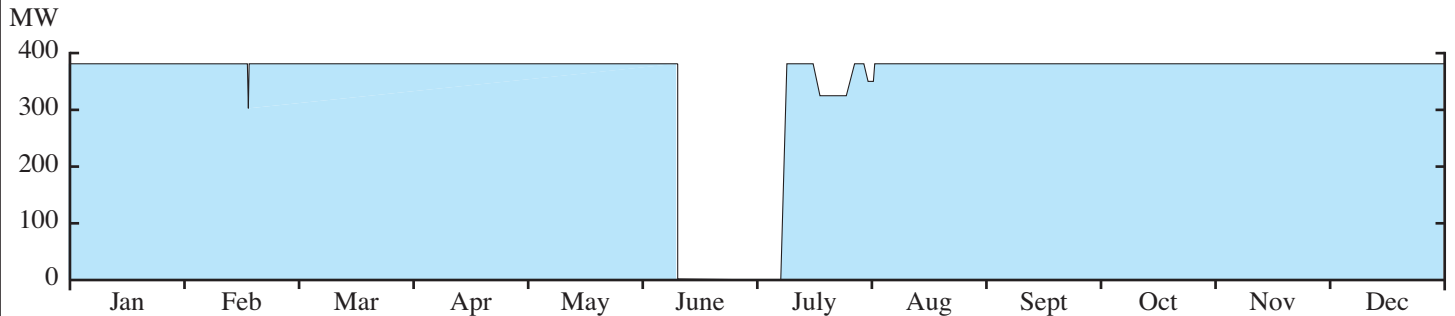
## Reactor Scrams

Number



# Beznau 1

## Operating Experience 2006



### Important to Safety

#### Scrams:

There were no automatic scrams during power operation.

#### Other:

In April, a review of the Integrated Management System (IMS) was successfully completed. The final report states that the management system fulfils all requirements of the international standards ISO 9001, ISO 14001 and OHSAS 18001. The report underlines, that the management system is continuously updated and adopted.

### Important to Availability

**February 17:** A disturbance in the control system for the control rods led to a 20 percent load reduction for a few hours. Nuclear safety was not affected.

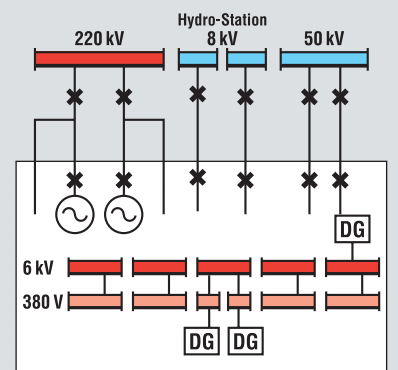
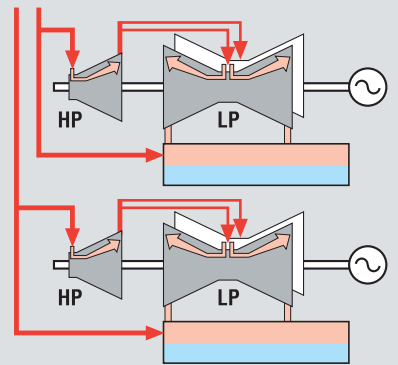
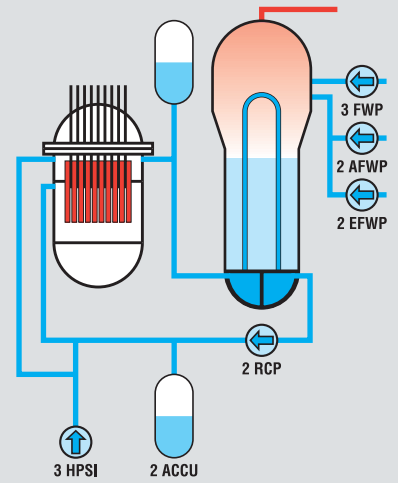
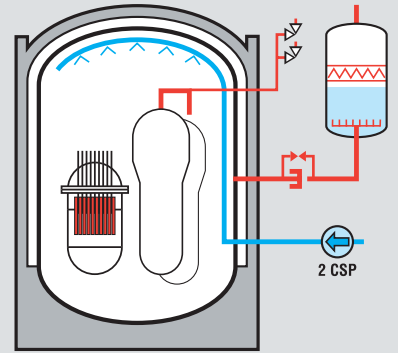
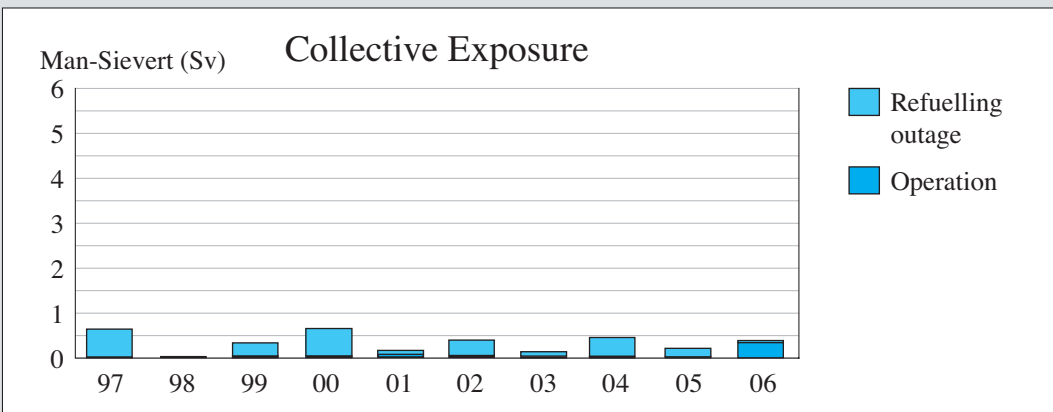
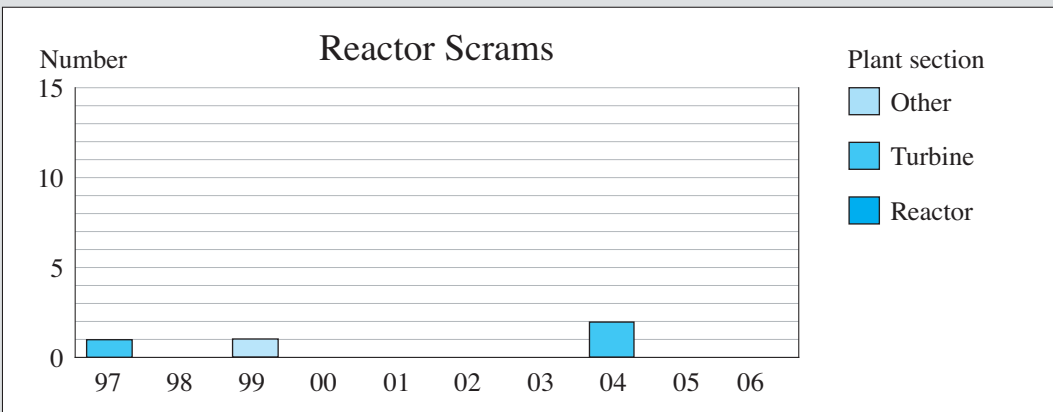
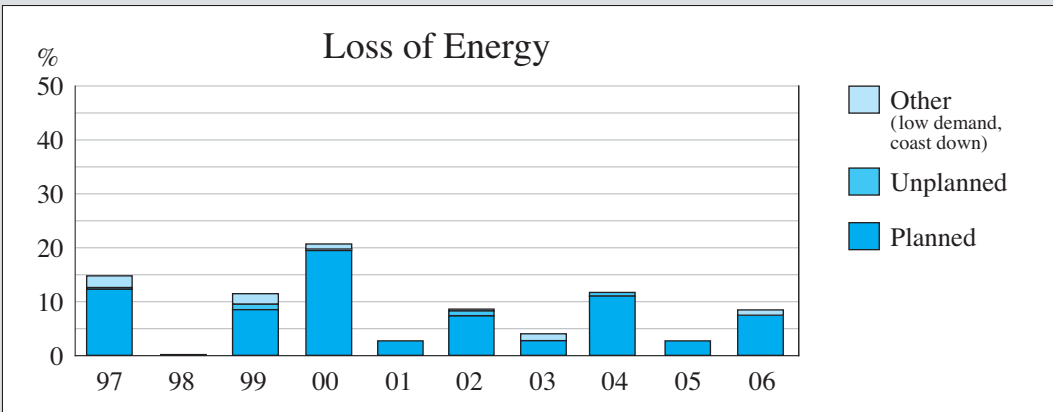
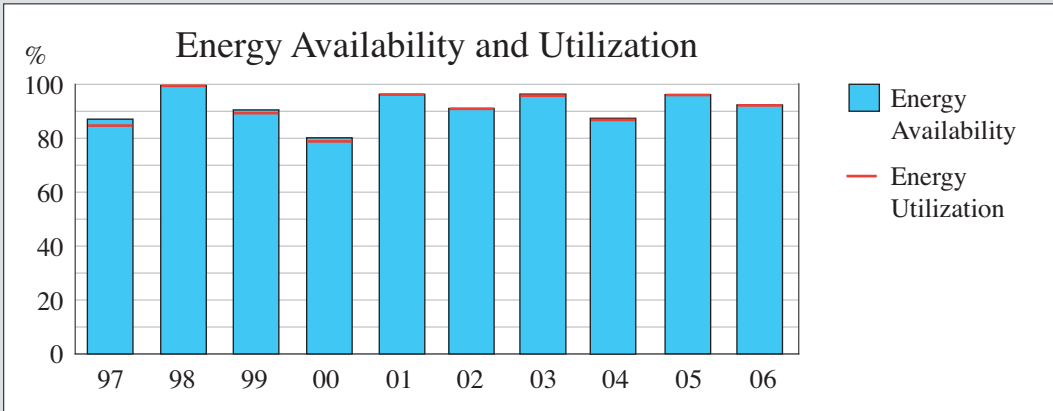
**June 9 to July 6:** The planned refuelling outage lasted 27 days and served to replace 24 from a total of 121 fuel elements. 20 of them are new uranium elements and 4 are MOX elements. Key activities of the revision were inspections of the reactor vessel head and its control rod drive penetrations as well as the eddy current testing of all the steam generator tubing. One generator rotor was replaced and one high pressure turbine was refitted. All inspections showed the plant and machinery in good condition.

**July and August:** The load was partially reduced on some days due to high temperature of the cooling water.

Net Production	2950681 MWh
Energy Availability	92,4 %
Energy Utilization	92,2 %

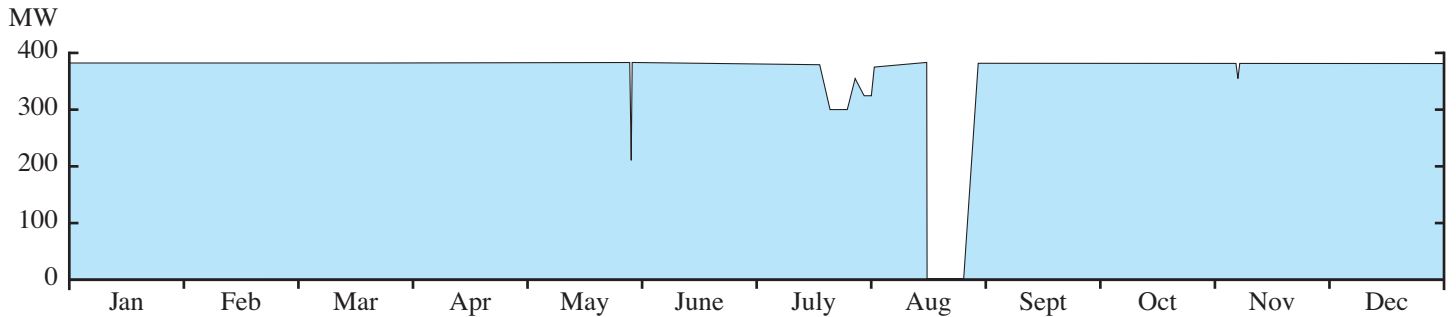
# History

# Characteristics



# Beznau 2

## Operating Experience 2006



### Important to Safety

#### Scrams:

There were no automatic scrams during power operation.

#### Other:

In April, a review of the Integrated Management System (IMS) was successfully completed. The final report states that the management system fulfils all requirements of the international standards ISO 9001, ISO 14001 and OHSAS 18001. The report underlines that the management system is continuously updated.

### Important to Availability

**August 15 to August 25:** The refuelling outage lasted 10 days and served to replace 32 from a total of 121 fuel elements. 24 of the new elements are MOX elements and 8 are new uranium elements. All inspections showed the plant and machinery in good condition.

**May 28:** Because of the low electricity demand on this Sunday, the output capacity was reduced by 180 megawatt for half a day.

**July and August:** The capacity was partially reduced on some days due to high temperature of the cooling water.

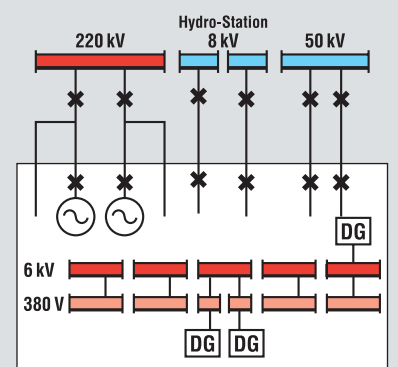
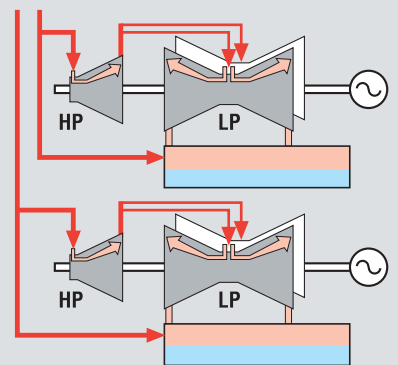
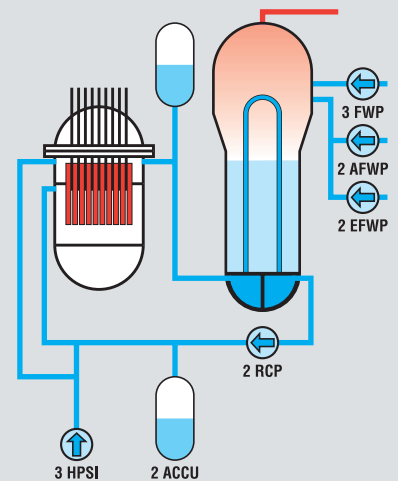
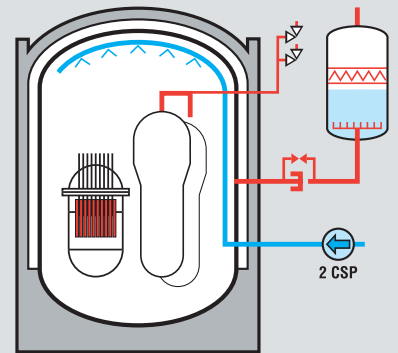
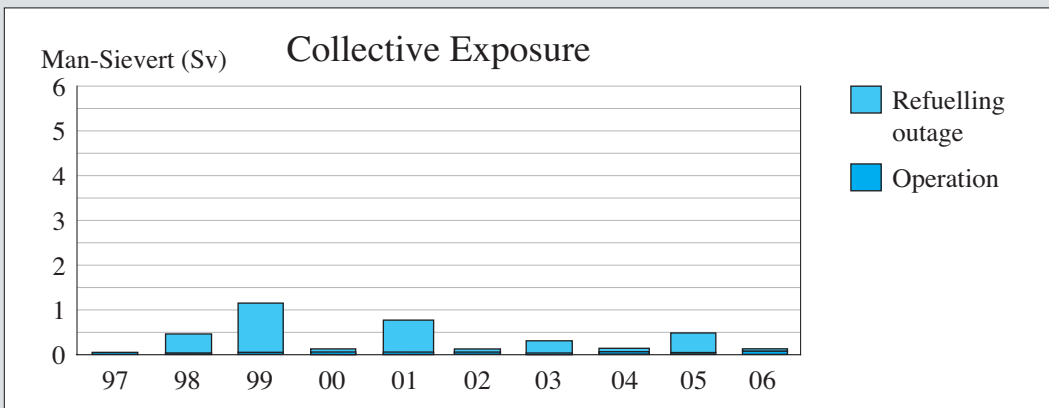
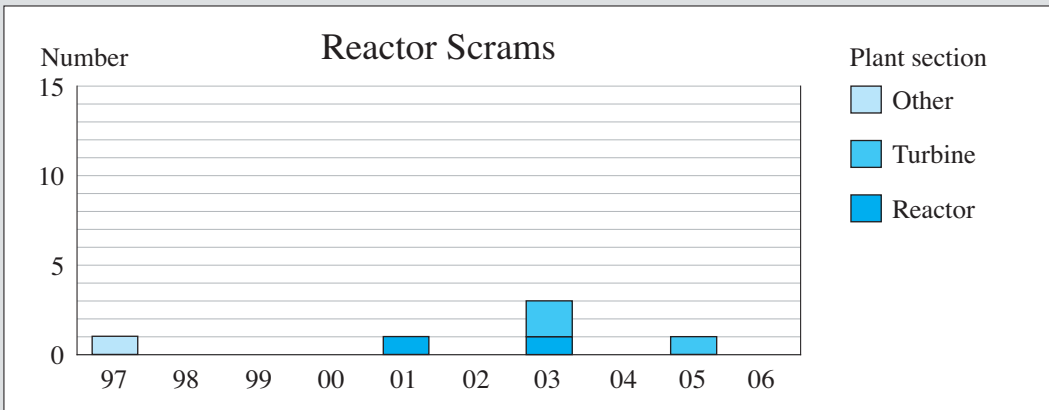
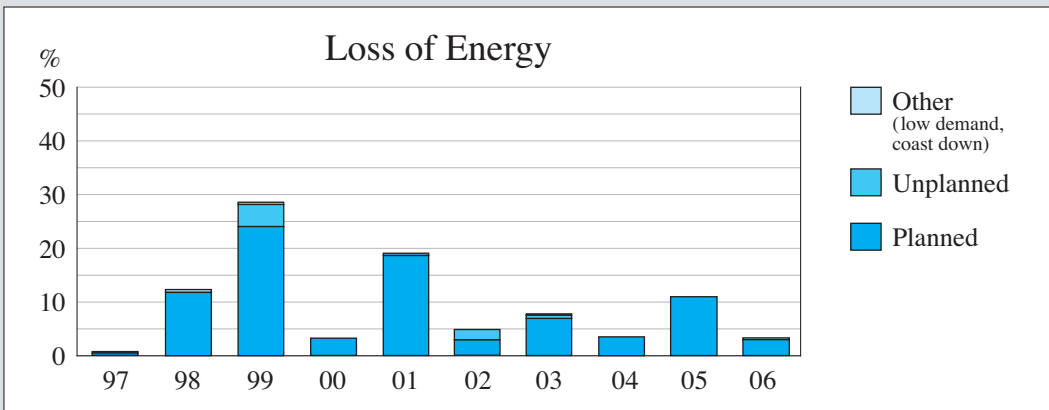
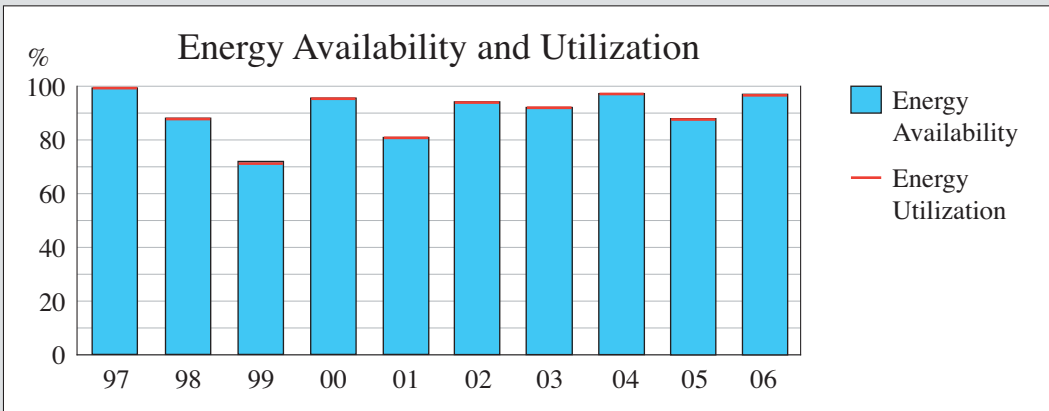
**November 4:** The Europe-wide grid disturbance led to a short output reduction of one of the two turbines.

Net Production	3073 230 MWh
Energy Availability	97,0 %
Energy Utilization	96,7 %



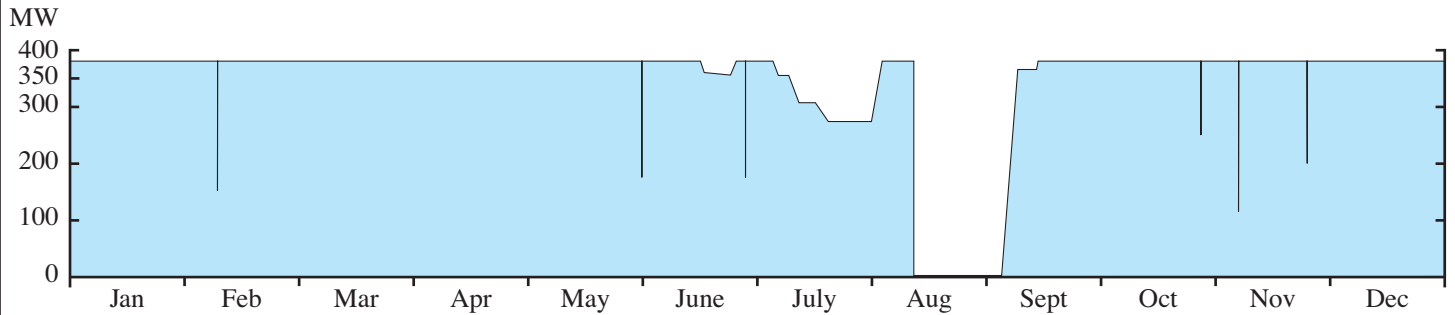
# History

# Characteristics



# Mühleberg

## Operating Experience 2006



### Important to Safety

#### Scrams:

There was no automatic scram during power operation.

#### Other:

From January 18 to 26 an on-line noble metal chemical application was performed to protect reactor pressure vessel internals.

### Important to Availability

**August 7:** The planned coast-down operation began. The power at end of cycle reached 97.7%.

**Refuelling outage August 13 to September 6:** The planned refuelling outage lasted 25 days. In-service inspections and ultrasonic tests of the reactor pressure vessel were successfully carried out. Also inspections of the in-vessel core spray lines and core shroud were performed. One of the four built-in tie rods was inspected. The high pressure turbine A was modified for efficiency improvement. 36 out of 240 fuel elements were replaced.

#### Load reductions:

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

Two unplanned load reductions took place. The first was caused due to an unexpected behavior of the turbine

control system on February 11. The second was due to a damaged feed water vent line in the turbine building on November 6.

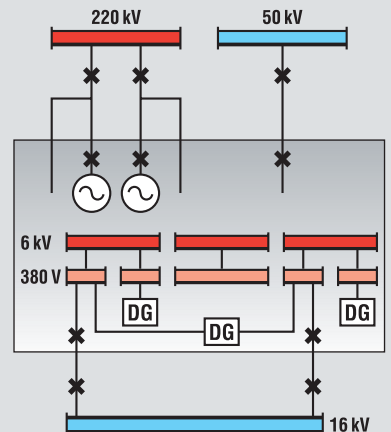
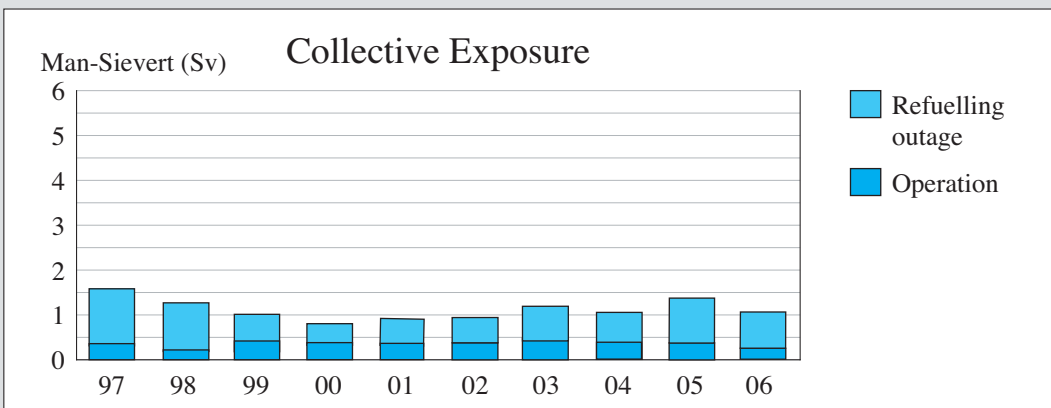
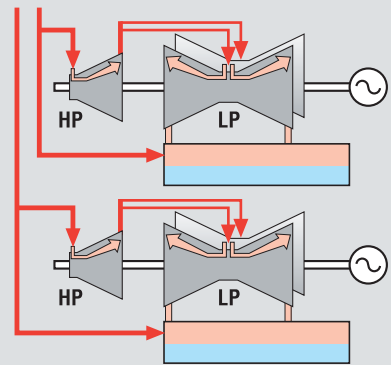
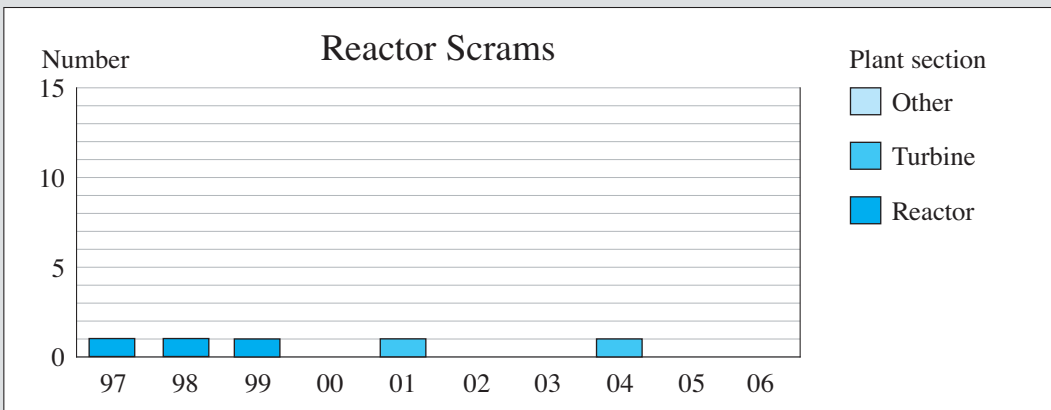
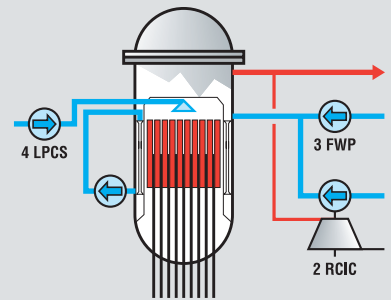
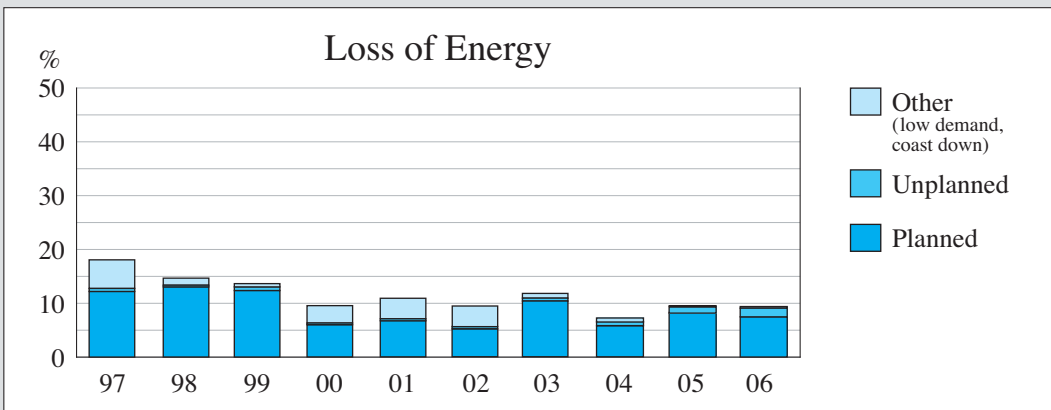
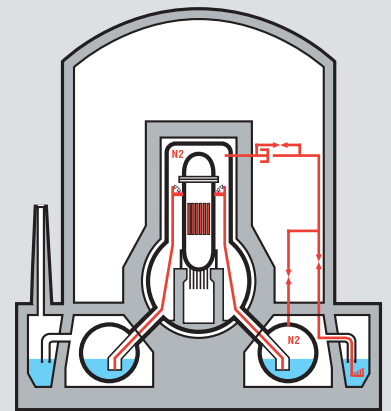
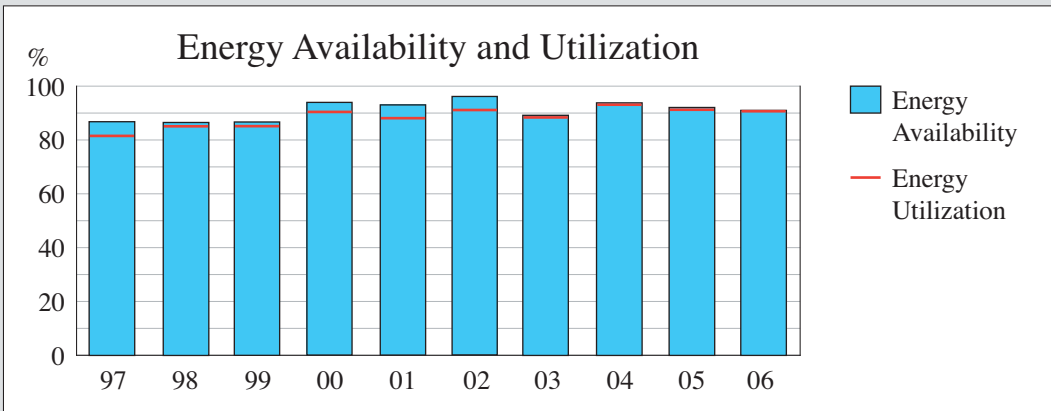
Four planned load reductions were required for periodic surveillance tests, combined with rod pattern adjustments and preventive maintenance.

From June 16 to 27, July 1 to August 12 and September 12 to 17, three planned load reductions were made due to high temperature of the cooling water.

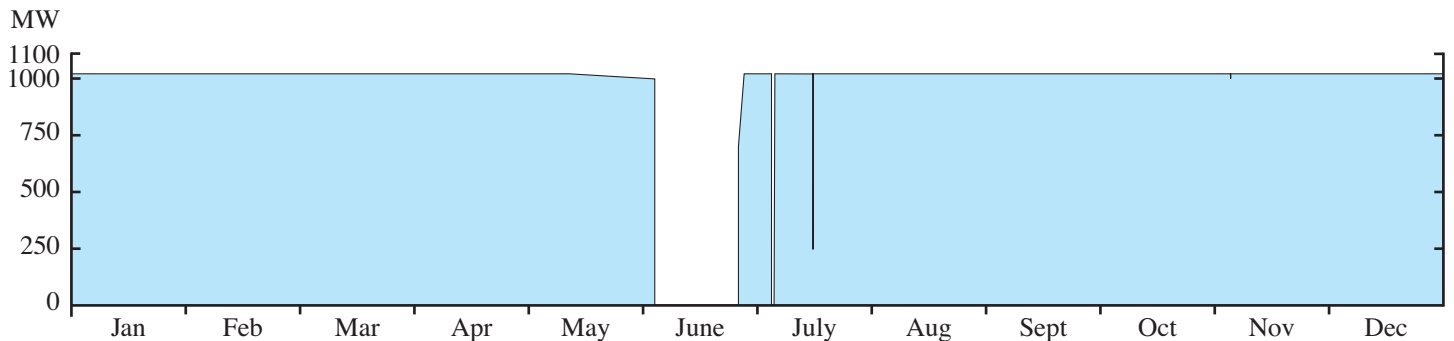
Net Production	2882881 MWh
Energy Availability	91,1 %
Energy Utilization	91,0 %

# History

# Characteristics



## Operating Experience 2006



### Important to Safety

#### Scrams:

2006 was the 16th consecutive year of operation without unplanned scrams.

### Important to Availability

With a production of 8538 GWh, KKG has reached the best result since start of operation.

**May 11:** Start of coast down operation. The power level at the end of the cycle was 96.5 %. Coast down operation led to a production loss of about 1 equivalent full power day.

#### Refuelling outage, June 03 to June 25:

- The duration of the refuelling outage was 22 day, 1 day longer as scheduled
- In addition to general preventive maintenance and inspection work, the following major work was performed:
  - Ultrasonic inspection of the reactor vessel and the reactor vessel head
  - Loading of 52 new fuel elements (24 ERU elements). 28 new MOX fuel elements were loaded for the 28th cycle
  - Exchange of the sump-strainer of the residual heat removal system
  - Exchange of the impeller of all main feedwater pumps

- Replacement of the exciter with the reserve exciter
- Replacement of the seismic instrumentation

**July 4:** Unplanned load reduction with turbine trip due to maintenance.

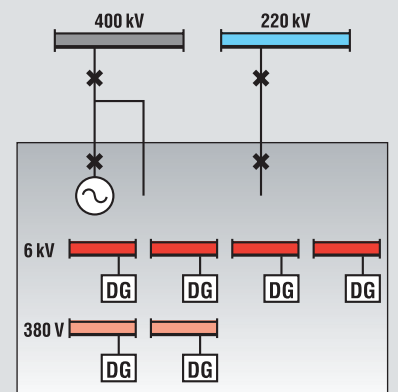
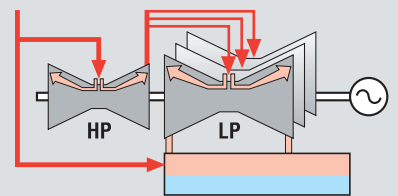
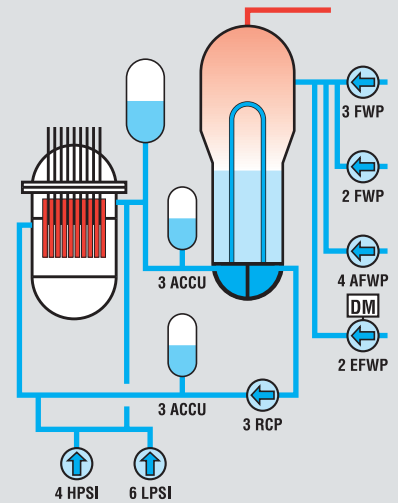
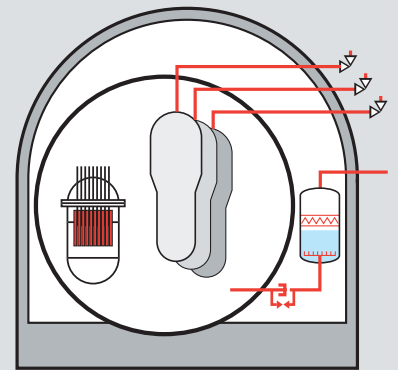
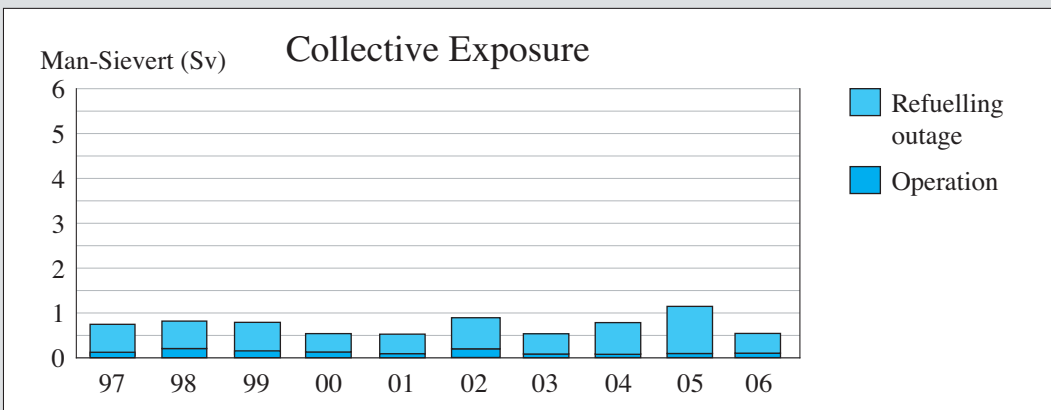
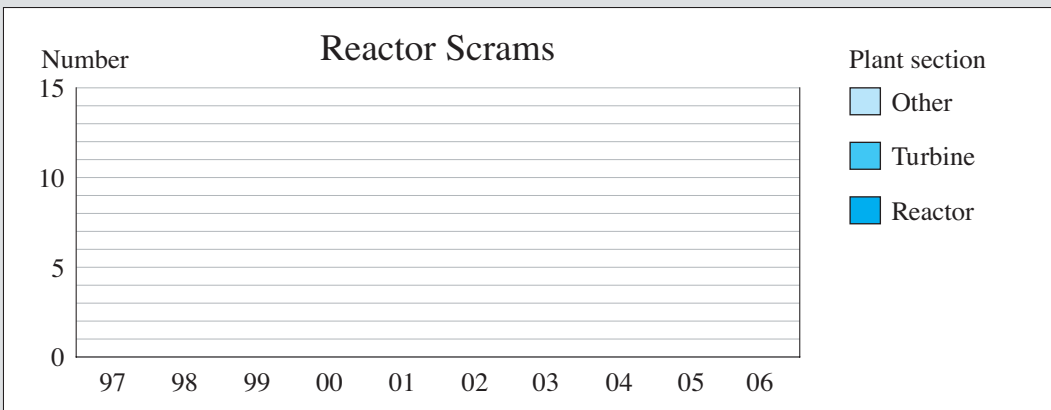
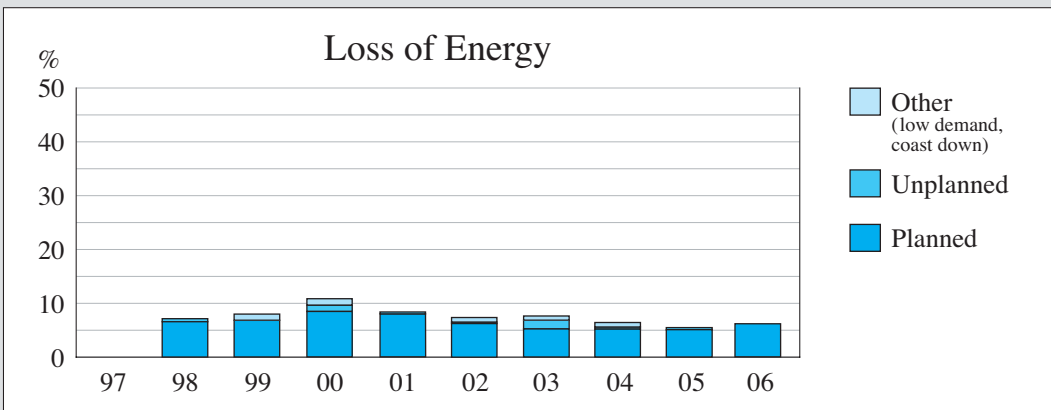
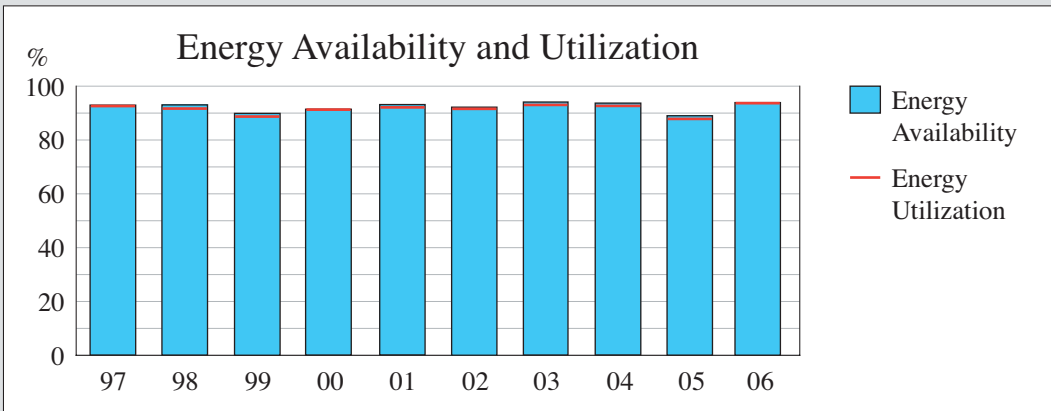
**July 15:** Unplanned load reduction after a trip of a main reactor pump.

**November 4:** Unplanned load reduction due to the grid disturbance in parts of Europe.

Net Production	8 099 097 MWh
Energy Availability	93,9 %
Energy Utilization	93,7 %

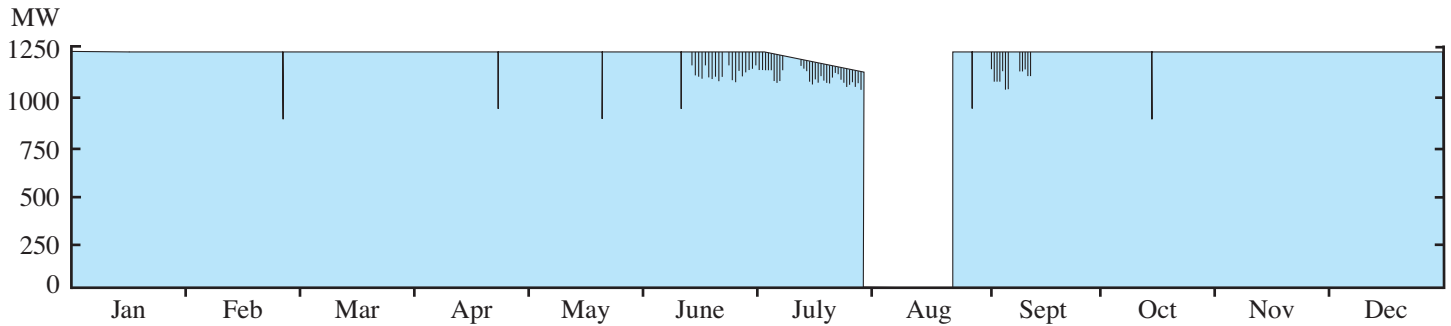
# History

# Characteristics



# Leibstadt

## Operating Experience 2006



### Important to Safety

#### Scrams:

There were no automatic scrams during power operation.

### Important to Availability

**February 24:** Loss of high pressure feedwater heater string.

**April 22:** Control Rod pattern adjustment.

**May 20:** MSIV monitoring and Control Rod pattern adjustment.

**June 10:** Control Rod pattern adjustment.

**July 2:** Begin End-Of-Cycle Coastdown.

**July 29 to August 21:** 22<sup>nd</sup> Refuelling outage.

- Duration was 23.1 days (scheduled 20)
- Loaded 128 new and reinserted 6 fuel bundles (out of 648)

**August 26:** Control Rod pattern adjustment.

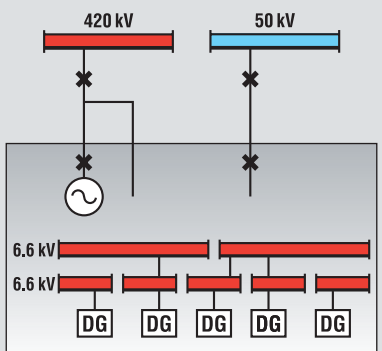
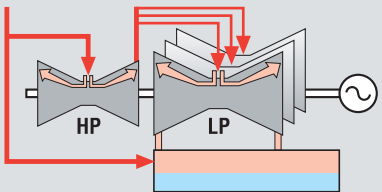
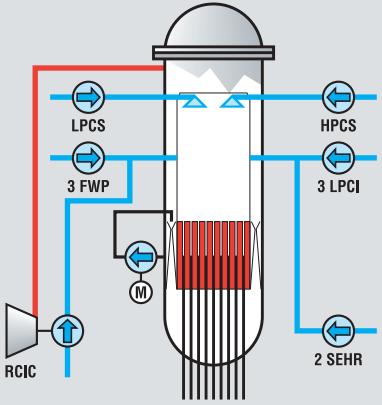
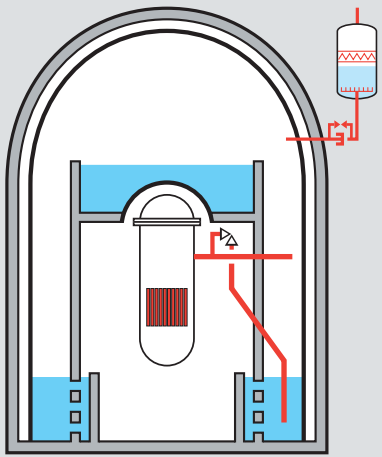
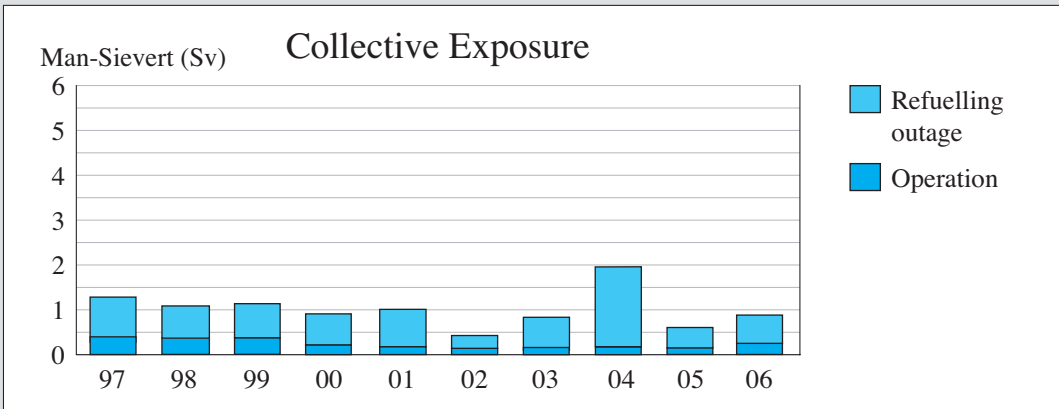
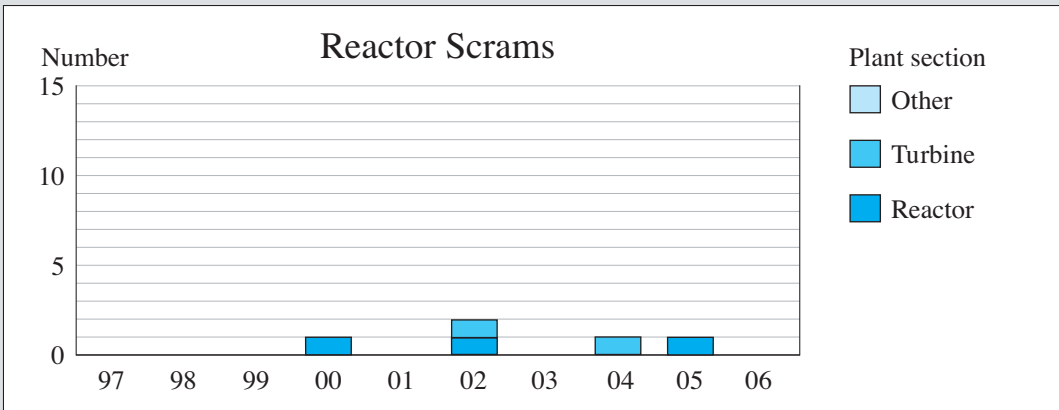
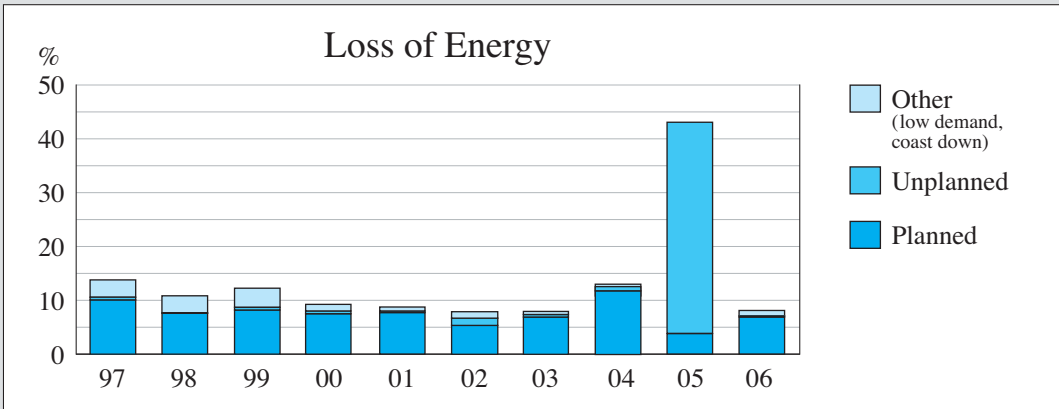
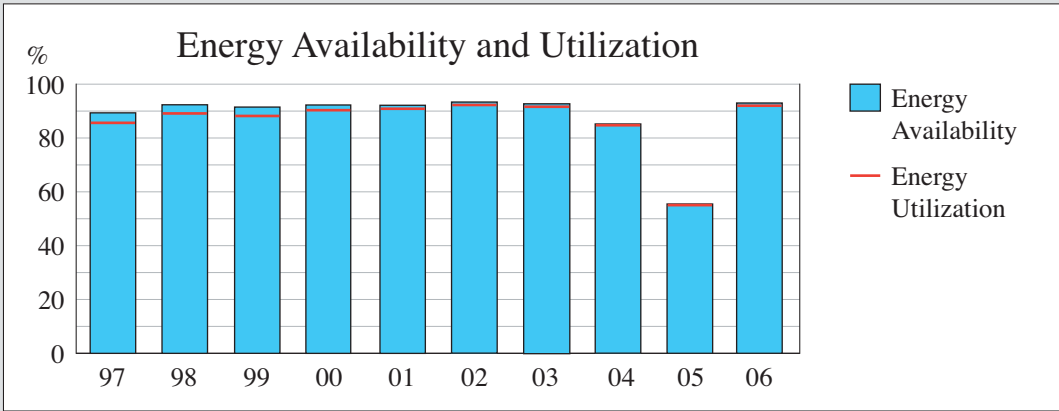
**October 14:** MSIV monitoring.

**June/July/Sept:** Small load reductions due to higher condenser pressure caused by high ambient temperature.

Net Production	9 367 041 MWh
Energy Availability	93,0 %
Energy Utilization	92,1 %

# History

# Characteristics



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, 40.0%, managing partner)
- Nordostschweizerische Kraftwerke AG (NOK, 25.0%)
- the City of Zurich (15.0%)
- 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, 27.4%)
- Elektrizitäts-Gesellschaft Laufenburg AG (EGL, 16.3%)
- Centralschweizerische Kraftwerke AG (CKW, 13.6%)
- BKW FMB Energie AG (9.5%)
- AEW Energie AG (5.4%)
- Energie Ouest Suisse, Lausanne (EOS, 5.0%)

Copies of this report are available from:

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