Nuclear power plants
Operating results 2018*

In 2018 the German nuclear power plants generated 76.00 billion kilowatt hours (kWh) of electricity gross. No German nuclear power plant ceased operation in 2018 due to the revision of the German Atomic Energy Act in the political aftermath of the accidents in Fukushima, Japan, in 2011. Seven nuclear power plants with an electric gross output of 10,013 MWe were in operation on 31 December 2018.

Six power plants in operation in 2018 achieved results with a gross production greater than 10 billion kilowatt hours, one power plants even produced more than 11 billion kilowatt hours and one more than 12 billion kilowatt hours.

German nuclear power plants achieved two of the world’s ten best production results in 2018 (“Top Ten”). At the end of 2018, 451 reactor units were in operation in 31 countries worldwide and 53 were under construction in 16 countries. The share of nuclear power in world electricity production was around 11%. German nuclear power plants have been occupying top spots in electricity production for decades thus providing an impressive demonstration of their efficiency, availability and reliability.

The Chooz B-2 nuclear power plant in France (capacity: 1,560 MWe gross) achieved the world record in electricity production in 2018 with 12.4 billion kilowatt hours. The German nuclear power plants Isar 2 (KKI 2, 12.1 billion kilowatt hours) and Emsland (KKE, 11.3 billion kilowatt hours) took the second and forth place.

Additionally German nuclear power plants are leading with their lifetime electricity production. The Brokdorf, Grohnde, Isar 2 and Philipsburg 2 nuclear power plant have produced more than 350 billion kilowatt hours since their first criticality.

### Operating results of nuclear power plants in Germany 2017 and 2018

<table>
<thead>
<tr>
<th>Nuclear power plant</th>
<th>Rated power</th>
<th>Gross electricity generation in MWh</th>
<th>Availability factor* in %</th>
<th>Energy availability factor** in %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gross in MWe</td>
<td>net in MWe</td>
<td>2017</td>
<td>2018</td>
</tr>
<tr>
<td>Brokdorf KBR</td>
<td>1,480</td>
<td>1,410</td>
<td>5,778,146</td>
<td>10,375,751</td>
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<tr>
<td>Emsland KKE</td>
<td>1,406</td>
<td>1,335</td>
<td>11,323,704</td>
<td>11,495,686</td>
</tr>
<tr>
<td>Grohnde KWG</td>
<td>1,430</td>
<td>1,360</td>
<td>9,684,880</td>
<td>10,946,635</td>
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<tr>
<td>Gundremmingen KRB B****</td>
<td>1,344</td>
<td>1,284</td>
<td>9,689,710</td>
<td>93.10</td>
</tr>
<tr>
<td>Gundremmingen KRB C</td>
<td>1,344</td>
<td>1,288</td>
<td>9,929,820</td>
<td>10,361,862</td>
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<tr>
<td>Isar KKI 2</td>
<td>1,485</td>
<td>1,410</td>
<td>11,523,513</td>
<td>12,127,490</td>
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<tr>
<td>Neckarwestheim GKN II</td>
<td>1,400</td>
<td>1,310</td>
<td>10,540,800</td>
<td>9,703,700</td>
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<tr>
<td>Philippsburg KKP 2</td>
<td>1,468</td>
<td>1,402</td>
<td>7,853,827</td>
<td>10,993,639</td>
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<tr>
<td>Total (in 2017)</td>
<td>11,357</td>
<td>10,799</td>
<td>76,324,400</td>
<td>76,004,763</td>
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<tr>
<td>Total (in 2018)</td>
<td>10,013</td>
<td>9,515</td>
<td>76,004,763</td>
<td>90.85</td>
</tr>
</tbody>
</table>

* Availability factor (time availability factor) \( k_t = tN/TV \): The time availability factor \( k_t \) is the quotient of available time of a plant (TV) and the reference period (tN). The time availability factor is a degree for the deployability of a power plant.

** Energy availability factor \( kW = WW/WN \): The energy availability factor \( kW \) is the quotient of available energy of a plant \( WW \) and the nominal energy \( WN \). The nominal energy \( WN \) is the product of nominal capacity and reference period. This variable is used as a reference variable (100 % value) for availability considerations. The available energy \( WW \) is the energy which can be generated in the reference period due to the technical and operational condition of the plant. Energy availability factors in excess of 100 % are thus impossible, as opposed to energy utilisation.

*** Inclusive of round up/down, rated power in 2018.

**** The Gundremmingen nuclear power plant (KRB B) was permanently shutdown on 31 December 2017 due to the revision of the German Atomic Energy Act in 2011.

All data in this report as of 31 March 2019.
In the year 2018 nuclear power plant Brokdorf (KBR) was on the grid with an availability factor of 84.70% in total 7,937 operating hours. Gross generation for the year under review amounted to 10,376,751 MWh. Also in 2018, the thermal reactor power was limited to a maximum of 95% with a coolant temperature reduced by 3 K of nominal power due to the specifications of ME 02/2017 “Increased oxide layer thickness on fuel rod cladding tubes of fuel assemblies”.

Due to high summer temperatures, temporary reductions in output were necessary in the months of July to September in order to comply with the water law permit.

Planned shutdowns
On 1 April 2018 the plant was shutdown for the 30th refuelling and annual major revision:
The revision included the following priorities:
- **Reactor**
  - Offload of the reactor pressure vessel.
  - Oxide layer measurement and visual inspection of fuel elements.
  - Inspection of control elements.
  - Ultrasonic test, reactor pressure vessel, bottom part.
- **Main coolant pump YD40**
  - Ring exchange of e-motor.
  - Inspection of the axial bearing.
  - Replacement mechanical shaft seal.
- **Feed water system**
  - Pressure testing.
- **Coolant**
  - Works on pump stationary head VE30/40.
  - Works on main coolant water channel VA10-30.
- **Turbine**
  - Standard service.
  - Inspection primary water cooler of generator.
- **Transformers**
  - Exchange of transformers CS12, CS21, CT31.
- **Batteries**
  - Exchange, redundancy 1

Unplanned shutdowns and reactor/turbine trip
On 2 May 2018, the generator was disconnected from the grid and shut down to remove a seal leakage at a non-return flap of the steam generator blowdown system. On 5 May 2018, after completion of the repair, a malfunction in the turbine control at one of two electro-hydraulic converters (EHU) occurred during start-up of the plant. After clearing of the failure the main synchronisation took place on 6 May 2018.

On 12 August 2018 the plant was disconnected from the grid for repairing the speed monitor selection circuit of the turbine protection system.

Power reductions above 10% and longer than for 24 h
In the period from 12 to 13 October 2018, power reduction was carried out for the inspection and repair of a connecting slide valve between a force-locking basin and a pump antechamber of the secured secondary cooling water system as well as for the detection and removal of a condenser pipe leakage in the turbine condenser.

In addition, load reductions were carried out in order to implement the grid-supporting power control in accordance with the specifications of the mission control centre.

Delivery of fuel elements
During the reporting year 28 fuel elements were delivered.

Waste management status
By the end of the year 2018 33 loaded CASTOR© cask were located at the on-site intermediate storage Brokdorf.
Operating data

Review period 2018

**Plant operator:** PreussenElektra GmbH  
**Shareholder/Owner:** PreussenElektra GmbH (80 %), Vattenfall Europe Nuclear Energy GmbH (20 %)  
**Plant name:** Kernkraftwerk Brokdorf (KBR)  
**Address:** PreussenElektra GmbH, Kernkraftwerk Brokdorf, 25576 Brokdorf, Germany  
Phone: 04829 752560, Telefax: 04829 511  
Web: www.preussenelektra.de

First synchronisation: 10-1 4-1986  
Date of commercial operation: 12-22-1986  
Design electrical rating (gross): 1,480 MW  
Design electrical rating (net): 1,410 MW  
Reactor type: PWR  
Supplier: Siemens/KWU

The following operating results were achieved:

- **Operating period, reactor:** 7,937 h  
- **Gross electrical energy generated in 2018:** 10,375,751 MWh  
- **Net electrical energy generated in 2018:** 9,838,252 MWh  
- **Gross electrical energy generated since first synchronisation until 12-31-2018:** 350,567,809 MWh  
- **Net electrical energy generated since first synchronisation until 12-31-2018:** 333,249,131 MWh

- **Availability factor in 2018:** 90.60 %  
- **Availability factor since date of commercial operation:** 89.84 %  
- **Capacity factor 2018:** 79.65 %  
- **Capacity factor since date of commercial operation:** 86.19 %  
- **Downtime (schedule and forced) in 2018:** 9.40 %  
- **Number of reactor scrams 2018:** 0

**Licensed annual emission limits in 2018:**  
- Emission of noble gases with plant exhaust air: 1.0 \( \times 10^{15} \) Bq  
- Emission of iodine-131 with plant exhaust air: 6.0 \( \times 10^{7} \) Bq  
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): 5.55 \( \times 10^{10} \) Bq

**Proportion of licensed annual emission limits for radioactive materials in 2018 for:**  
- Emission of noble gases with plant exhaust air: 0.079 %  
- Emission of iodine-131 with plant exhaust air: 0.000 %  
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): 0.000 %  
- Collective dose: 0.142 Sv
Apart from the 19 days refuelling outage the Emsland nuclear power plant had been operating uninterrupted and mainly at full load during the review period 2018. Producing a gross power generation of 11,495,686 MWh with a capacity factor of 94.67 % the power plant achieved a very good operating result.

Planned shutdowns
31th refuelling and overall annual maintenance inspection:
The outage took 19.0 days from breaker to breaker. In addition to the replacement of 40 fuel elements the following major maintenance and inspection activities were carried out:
- Inspection of core and reactor pressure vessel internals.
- Inspection of a reactor coolant pump.
- Inspection of pressurizer valves.
- Pressure test on different coolers and tanks.
- Inspection on main condensate pump.
- Maintenance works on different transformers.
- Different automatic non-destructive examinations.

Unplanned shutdowns and reactor/turbine trip
Turbine scram due to increased turbine vibrations after the end of the outage.

Power reductions above 10 % and longer than for 24 h
22 April to 25 May: Stretch-out operation.

Delivery of fuel elements
24 Uranium-fuel elements were delivered.

Waste management status
4 CASTOR© cask loading were carried out during the review period 2018. At the end of the year 47 loaded casks were stored in the local interim storage facility.
Operating data

Review period 2018

**Plant operator:** Kernkraftwerke Lippe-Ems GmbH
**Shareholder/Owner:** RWE Power AG (87.5 %), PreussenElektra GmbH (12.5 %)
**Plant name:** Kernkraftwerk Emsland (KKE)
**Address:** Kernkraftwerk Emsland, Am Hilgenberg, 49811 Lingen, Germany
Phone: 0591 806-1612
Web: www.rwe.com

First synchronisation: 04-19-1988
Date of commercial operation: 06-20-1988
Design electrical rating (gross): 1,406 MW
Design electrical rating (net): 1,335 MW
Reactor type: PWR
Supplier: Siemens/KWU

The following operating results were achieved:

- Operating period, reactor: 8,310 h
- Gross electrical energy generated in 2018: 11,495,686 MWh
- Net electrical energy generated in 2018: 10,951,033 MWh
- Gross electrical energy generated since first synchronisation until 12-31-2018: 346,818,969 MWh
- Net electrical energy generated since first synchronisation until 12-31-2018: 328,829,904 MWh
- Availability factor in 2018: 94.78 %
- Availability factor since date of commercial operation: 94.07 %
- Capacity factor 2018: 94.67 %
- Capacity factor since date of commercial operation: 93.93 %
- Downtime (schedule and forced) in 2018: 5.22 %
- Number of reactor scrams 2018: 0

**Licensed annual emission limits in 2018:**
- Emission of noble gases with plant exhaust air: 1.0 \times 10^{15} Bq
- Emission of iodine-131 with plant exhaust air: 5.0 \times 10^9 Bq
  (incl. H-3 and C-14)
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): 3.7 \times 10^{10} Bq

**Proportion of licensed annual emission limits for radioactive materials in 2018 for:**
- Emission of noble gases with plant exhaust air: 0.099 %
- Emission of iodine-131 with plant exhaust air: 0.0 %
  (incl. H-3 and C-14)
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): 0.00 %
- Collective dose: 0.059 Sv
During the reporting year 2018 the nuclear power plant Grohnde was put off the grid for a 26-day major revision with refuelling and achieved an availability factor of 92.8%. The gross production amounted to 10,946,634 MWh.

Opposite to the scheduled 21-day downtime the revision extended by 159 hours due to the maintenance of equipment and repair works of valve RL71 S003.

The plant was additionally taken off the grid for 4.5 hours on 29 July 2018 due to the repair of a speed monitoring device selection switch. The reactor was in hot-stand-by operation during this work.

Planned shutdowns
24 February to 22 March: 35th Refuelling and major annual revision: Nuclear power plant Grohnde was shut down as scheduled after a 3-day stretch-out operation on 24 February 2018 for the revision and 35th refuelling.

The main planned works during this year’s revision were:
- Unloading and loading with the replacement of 56 fresh fuel elements.
- Full inspection of 20 fuel elements.
- Eddy current test of 23 control elements.
- Visual inspection of 15 flow restrictor assembly.
- Main coolant pump YD40 D001: Conversion of the motor and axial bearing revision HKMP YD20 D001.
- Inspection of the safety feed water pump TH35 D001.
- Cleaning of the nuclear intercooler TF10 B001.
- Non-destructive tests of the YB10 and YB40 steam generators and the secondary side.
- Start-up test of the fuel element centering pins of the UKG.
- Work and tests in the redundancies with the focus on the activities in the main redundancy 1/5 (maintenance work on valves and actuators as well as tests on containers, batteries and electrotechnical branches).

Due to a leakage at a blind plug of the valve detected during the start-up process RL71 S003 was triggered by hand on 20 March at 02:10 RESA and was shut down to subcritical cold for repair.

Unplanned shutdowns and reactor/turbine trip
29 July: Downtime for repair of the speed monitoring device selection switch. The plant was taken off the grid for 4.5 hours.

Power reductions above 10% and longer than for 24 h 22 to 26 June: Due to disturbances of the speed monitoring device selection switch the reactor power was reduced down to 80%.

Load sequence operation was carried out in April, October, November and December due to the requirements of the load distributor.

WANO Review/Technical Support Mission
A WANO Peer Review took place at the KWG from 16 to 27 April 2018. This was a so-called “optimised” peer review, which was carried out for the first time according to a concept specially agreed for this purpose. A team of 14 peers from six nations scrutinized many areas of the power plant, identifying areas with potential for improvement. At the end of the review, the results were communicated to the power plant management and executives in a workshop.

Delivery of fuel elements
In February 2018 20 U-/U-Gd-fuel elements of Westinghouse were delivered.

Waste management status
Between September and November 2018, a total of four CASTOR©-V/19 containers were loaded. Thus 34 CASTOR©-V/19 containers are currently stored in the ZL-KWG.

General points/management systems
In September 2018, the monitoring audit of the quality management system (ISO 9001) and the recertification of the environmental management system (ISO 14001) and the occupational health and safety management system (OHSAS 18001) were successfully carried out.
Operating data

Review period 2018

**Plant operator:** Gemeinschaftskernkraftwerk Grohnde GmbH & Co. OHG  
**Shareholder/Owner:** PreussenElektra GmbH (83,3 %), Stadtwerke Bielefeld (16,7 %)  
**Plant name:** Kernkraftwerk Grohnde (KWG)  
**Address:** Gemeinschaftskernkraftwerk Grohnde GmbH & Co. OHG, P.O. bx 12 30, 31857 Emmerthal, Germany  
**Phone:** 05155 67-1  
**Web:** www.preussenelektra.de

- **First synchronisation:** 09-05-1984  
- **Date of commercial operation:** 02-01-1985  
- **Design electrical rating (gross):** 1,430 MW  
- **Design electrical rating (net):** 1,360 MW  
- **Reactor type:** PWR  
- **Supplier:** Siemens/KWU

The following operating results were achieved:

- **Operating period, reactor:** 8,131 h  
- **Gross electrical energy generated in 2018:** 10,946,634 MWh  
- **Net electrical energy generated in 2018:** 10,339,242 MWh  
- **Gross electrical energy generated since first synchronisation until 12-31-2018:** 377,574,203 MWh  
- **Net electrical energy generated since first synchronisation until 12-31-2018:** 356,969,277 MWh  
- **Availability factor in 2018:** 92.80 %  
- **Availability factor since date of commercial operation:** 91.70 %  
- **Capacity factor 2018:** 91.70 %  
- **Capacity factor since date of commercial operation:** 91.30 %  
- **Downtime (schedule and forced) in 2018:** 7.20 %  
- **Number of reactor scrams 2018:** 0

**Licensed annual emission limits in 2018:**  
- **Emission of noble gases with plant exhaust air:** 9.0 \cdot 10^{14} Bq  
- **Emission of iodine-131 with plant exhaust air:** 7.5 \cdot 10^{7} Bq  
- **Emission of nuclear fission and activation products with plant waste water (excluding tritium):** 5.55 \cdot 10^{10} Bq

**Proportion of licensed annual emission limits for radioactive materials in 2018 for:**  
- **Emission of noble gases with plant exhaust air:** 0.005 %  
- **Emission of iodine-131 with plant exhaust air:** 0.000 %  
- **Emission of nuclear fission and activation products with plant waste water (excluding tritium):** 0.000 %  
- **Collective dose:** 0.124 Sv
In the review year 2018, unit C of Gundremmingen nuclear power plant was operated at full load without any major restrictions except for one planned outage for refuelling.

From 1 March to 21 April 2018 unit C was in stretch-out operation.

During the shutdown a total of 138 fuel elements were unloaded and replaced with 120 fresh and 18 (8 MOX) partially spent fuel elements.

During the outage all safety relevant workings were monitored by the relevant nuclear controlling authority, the Bavarian State Ministry of the Environment and Consumer Protection (StMUV), and consulted authorized experts. The inspection of the technical systems with regard to safety and reliability confirmed the excellent condition of the plant.

A gross total of 10,361,862 MWh of electricity was produced.

Planned shutdowns

21 April to 26 May 2018: 32nd refuelling and annual major inspection.

The following major activities were carried out:

- Refuelling and sipping of all fuel elements inside the core; result: two defective fuel elements.
- Works on turbine, generator and auxiliary systems.
- Inspection of main isolation valves of feedwater, main steam and residual heat removal system.
- Emptying of redundancy 5 for preventive measures on valves, torque motors, motors, pumps and tanks.
- Inspection of one emergency diesel generator.
- Extensive non-destructive testing of pipes and tanks.
- Emptying of main cooling water system, cleaning of cooling tower pond, exchange of cooling tower installations.
- Optimisation measures to ensure non-interaction between permanently shut down unit B and operating unit C.

Unplanned shutdowns and reactor/turbine trip

None.

Power reductions above 10 % and longer than for 24 h

25 and 26 February: Periodic tests.
1 March to 21 April: Stretch-out operation.
11 to 14 November: Period tests, change of the control rod traversing order, leak detection in turbine condenser.

Peer Reviews

Between 5 and 16 March, an “optimized” WANO Peer Review for a period of two instead of three weeks took place at KGG. The following focus areas were analysed: work safety, fire protection, chemistry, radiation protection, handling of fuel assemblies, management of nuclear fuel.

Delivery of fuel elements

In 2018, for Gundremmingen unit C 132 fresh fuel elements were delivered.

Waste management status

At the end of 2018, the local interim storage facility accommodated 60 loaded CASTOR© casks with each 52 spent fuel elements out of units B and C.
Operating data

Review period 2018

**Plant operator:** Kernkraftwerk Gundremmingen GmbH  
**Shareholder/Owner:** RWE Power AG (75 %), PreussenElektra GmbH (25 %)  
**Plant name:** Kernkraftwerk Gundremmingen C (KRB C)  
**Address:** Kernkraftwerk Gundremmingen GmbH, Dr.-August-Weckesser-Straße 1, 89355 Gundremmingen, Germany  
**Phone:** 08224 78-1, **Telefax:** 08224 78-2900  
**E-mail:** kontakt@kkw-gundremmingen.de  
**Web:** [www.kkw-gundremmingen.de](http://www.kkw-gundremmingen.de)

First synchronisation: 11-02-1984  
Date of commercial operation: 01-18-1985  
Design electrical rating (gross): 1,344 MW  
Design electrical rating (net): 1,288 MW  
Reactor type: BWR  
Supplier: Siemens/KWU, Hochtief

The following operating results were achieved:

- **Operating period, reactor:** 7,920 h  
- **Gross electrical energy generated in 2018:** 10,361,862 MWh  
- **Net electrical energy generated in 2018:** 9,874,200 MWh  
- **Gross electrical energy generated since first synchronisation until 12-31-2018:** 330,941,755 MWh  
- **Net electrical energy generated since first synchronisation until 12-31-2018:** 305,182,060 MWh  
- **Availability factor in 2018:** 90.40 %  
- **Availability factor since date of commercial operation:** 89.20 %  
- **Capacity factor 2018:** 89.90 %  
- **Capacity factor since date of commercial operation:** 87.60 %  
- **Downtime (schedule and forced) in 2018:** 9.60 %  
- **Number of reactor scrams 2018:** 0

**Licensed annual emission limits in 2018**  
(values added up for Units B and C, site emission):

- Emission of noble gases with plant exhaust air: \(1.85 \cdot 10^{15}\) Bq  
- Emission of iodine-131 with plant exhaust air: \(2.20 \cdot 10^{15}\) Bq  
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): \(1.10 \cdot 10^{11}\) Bq

**Proportion of licensed annual emission limits for radioactive materials in 2018 for** (values added up for Units B and C):

- Emission of noble gases with plant exhaust air: 0.93 %  
- Emission of iodine-131 with plant exhaust air: 0.39 %  
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): 0.30 %  
- Collective dose: 0.55 Sv

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**Collective radiation dose of own and outside personnel in Sv**

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
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<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.59</td>
<td>0.78</td>
<td>1.36</td>
<td>1.14</td>
<td>1.49</td>
<td>0.84</td>
<td>0.89</td>
<td>0.55</td>
</tr>
</tbody>
</table>
On 22 January 1988 unit 2 of Isar nuclear power plant (KKI 2) fed for the first time electricity into the grid. 9 April 2018 marked the 30th anniversary of the start of commercial power operation at the Isar unit 2 nuclear power plant and was the first nuclear power plant in the German generation statistics. With gross electricity generation of 12,127,490 MWh and a unit capability of 95.24 %, Unit 2 achieved an excellent operating result in 2018.

In the evening hours of 16 September 2018, KKI 2 was the third single block plant worldwide to achieve gross generation of 350 billion kWh since its first criticality. In addition, the 250,000 generator operating hours were performed on 5 September 2018 at around 7 pm.

Planned shutdowns
14 to 29 July: Refuelling and annual major inspection with duration of 15.8 days. During the revision 40 new fuel elements were inserted.

Unplanned shutdowns and reactor/turbine trip
3 August: On 3 August at 01:29 a.m. the plant had to be taken off the grid due to a repair of a drainage valve. At 19:32 o’clock the mains was switched back.

Power reductions above 10 % and longer than for 24 h
None.

Safety Reviews
21 February: Management evaluation KKI.
1 March: Company review.
13 and 15 March: Inspection in accordance with §16 Störfall Verordnung – Brandschutz und Immissionsschutz (Major Accidents Ordinance – Fire Protection and Immission Control).
12 to 13 June: Internal “Audit Plant Monitoring” at KKI.
7 August: Management system, status discussion.
27 September: 2nd operational review KKI (half-year review 2018).
4 to 10 October: Management system audit.
7 and 8 November: Internal Audit “Processing and Execution of Projects”.

WANO Review/Technical Support Mission
22 January to 9 February: WANO Peer-Review.

Delivery of fuel elements
In the reporting year 32 uranium fuel elements from Westinghouse were delivered. 24 uranium fuel elements are in stock at the dry storage.

Waste management status
Currently 59 CASTOR© V-casks (26 units CASTOR© V/19, 26 units of CASTOR© V/52 (85-type) and 7 TN© 24E-casks) are stored in the on-site intermediate storage BELLA.

The interim storage facility was taken over by BGZ Gesellschaft für Zwischenlagerung mbH on 1 January 2019.

The completion of the project “Structural optimisation of the KKI BELLA warehouse” was in November 2018.

General points
A grid failure on 8 April 2018 (2-pole short-circuit on a 400 kV line) led to repercussions via the neighbouring Ottenhofen switching plant to the plant. Numerous consumers were briefly switched off via undervoltage monitoring. A voltage drop to 9 kV occurred on the 10 kV bus. Many of the consumers switched on again automatically.

The voltage drop had no influence on the system performance and did not lead to any tripping in the block protection and safety system.

Emergency exercise with expert ESN on 27 November 2018: The exercise began outside working hours. The scenario assumed was a “station black out”, fire alarm in the emergency food building and failure of various emergency measures. The emergency exercise was completed professionally and purposefully with a highly motivated team.
Operating experience with nuclear power plants 2018

VGB PowerTech

Operating data

Review period 2018

**Plant operator:** PreussenElektra GmbH

**Shareholder/Owner:** PreussenElektra GmbH (75 %), Stadtwerke München GmbH (25 %)

**Plant name:** Kernkraftwerk Isar 2 (KKI 2)

**Address:** PreussenElektra GmbH, Kernkraftwerk Isar, Postfach 11 26, 84049 Essenbach, Germany

**Phone:** 08702 38-2465, **Telefax:** 08702 38-2466

**Web:** www.preussenelektra.de

First synchronisation: 01-22-1988

Date of commercial operation: 04-09-1988

Design electrical rating (gross): 1,485 MW

Design electrical rating (net): 1,410 MW

Reactor type: PWR

Supplier: Siemens/KWU

The following operating results were achieved:

- Operating period, reactor: 8,367 h
- Gross electrical energy generated in 2018: 12,127,490 MWh
- Net electrical energy generated in 2018: 11,477,215 MWh
- Gross electrical energy generated since first synchronisation until 12-31-2018: 353,725,813 MWh
- Net electrical energy generated since first synchronisation until 12-31-2018: 334,444,116 MWh
- Availability factor in 2018: 95.46 %
- Availability factor since date of commercial operation: 93.28 %
- Capacity factor 2018: 95.24 %
- Capacity factor since date of commercial operation: 92.37 %
- Downtime (schedule and forced) in 2018: 4.54 %
- Number of reactor scrams 2018: 0
- Licensed annual emission limits in 2018:
  - Emission of noble gases with plant exhaust air: $1.1 \times 10^{15}$ Bq
  - Emission of iodine-131 with plant exhaust air: $1.1 \times 10^{10}$ Bq
  - Emission of nuclear fission and activation products with plant waste water (excluding tritium): $5.5 \times 10^{10}$ Bq

Proportion of licensed annual emission limits for radioactive materials in 2018 for:

- Emission of noble gases with plant exhaust air: 0.07 %
- Emission of iodine-131 with plant exhaust air: < limit of detection
- Emission of nuclear fission and activation products with plant waste water (excluding tritium): < limit of detection
- Collective dose: 0.064 Sv
During the reporting year 2018 the Neckarwestheim II nuclear power plant (GKN II) generated a gross output of 9,703,700 MWh. The net electrical energy generation amounted 9,099,358 MWh of which 8,949,140 MWh were fed into the public three-phase supply and 754,560 MWh into the static conversion unit of the Deutsche Bahn AG. The plant was 7,121 h on the grid. This corresponds to an availability of 81.29%. Since the commissioning of the three-phase-machine 329,830,184 gross and 308,416,137 MWh net were generated.

Planned shutdowns
1 September to 8 November: 34th and annual major inspection:
- Refuelling with exchange of 28 new fuel elements.
- Eddy current tests of the heating tubes of all 4 steam generators.
- Major overhaul of four source isolating valves at system JNA.
- Complete overhaul of the residual heat removal pump with motor JNA30-AP001.
- Complete overhaul of intercooling pumps KAA30/31-AP001.
- Internal inspection of the flood pool JNK30 with submarine (at UK-Loop).
- Major overhaul of the stop valve KAA30-AA010 and various KAB flaps in UJB and UKA.
- Secondary tube bottom flushing of all 4 steam generators.
- Major overhaul of the main feed pump LAC20-AP001.
- Partial overhaul of the main condensate pump LCB30-AP001.
- Major overhaul of the main steam safety valve and the blow-off shut-off valve for LBA10.
- Major overhaul of live steam shut-off valve and shut-off valve before safety valve on LBA20.
- Inspections of the turbo set and generator.

Unplanned shutdowns and reactor/turbine trip
20 September to 8 November: Unplanned extension of the revision.

Power reductions above 10 % and longer than for 24 h
3 to 31 August: Stretch-out operation.
1 to 7 and 24 to 29 January, 17 and 18 March, 29 April, 21 to 24 July, 8 to 11 and 21 to 22 December: Load sequence operation.
Operating data

Review period 2018

Plant operator: EnBW Kernkraft GmbH (EnKK)
Shareholder/Owner: EnBW Erneuerbare und Konventionelle Erzeugung AG (98.45 %), ZEAG Energie AG, Deutsche Bahn AG, Kernkraftwerk Obrigheim GmbH
Plant name: Kernkraftwerk Neckarwestheim II (GKN II)
Address: EnBW Kernkraft GmbH, Kernkraftwerk Neckarwestheim, Im Steinbruch, 74382 Neckarwestheim, Germany
Phone: 07133 13-0, Telefax: 07133 17645
E-mail: poststelle-gkn@kk.enbw.com
Web: www.enbw.com

First synchronisation: 01-03-1989
Date of commercial operation: 04-15-1989
Design electrical rating (gross): 1,400 MW
Design electrical rating (net): 1,310 MW
Reactor type: PWR
Supplier: Siemens/KWU

The following operating results were achieved:
Operating period, reactor: 7,127 h
Gross electrical energy generated in 2018: 9,703,700 MWh
Net electrical energy generated in 2018: 9,099,358 MWh
Gross electrical energy generated since first synchronisation until 12-31-2018: 329,830,184 MWh
Net electrical energy generated since first synchronisation until 12-31-2018: 308,416,137 MWh
Availability factor in 2018: 81.29 %
Availability factor since date of commercial operation: 93.09 %
Capacity factor 2018: 81.00 %
Capacity factor since date of commercial operation: 92.71 %
Downtime (schedule and forced) in 2018: 18.71 %
Number of reactor scrams 2018: 0

Licensed annual emission limits in 2018:
Emission of noble gases with plant exhaust air: 1.0 · 10^15 Bq
Emission of iodine-131 with plant exhaust air: 1.1 · 10^16 Bq
Emission of nuclear fission and activation products with plant waste water (excluding tritium): 6.0 · 10^10 Bq

Proportion of licensed annual emission limits for radioactive materials in 2018 for:
Emission of noble gases with plant exhaust air: 0.06 %
Emission of iodine-131 with plant exhaust air: < limit of detection
Emission of nuclear fission and activation products with plant waste water (excluding tritium): < limit of detection
Collective dose: 0.118 Sv

Collective radiation dose of own and outside personnel in Sv

Availability factor in %
Capacity factor in %

Collective radiation dose of own and outside personnel in Sv
In the reporting year 2018 the nuclear power plant block Philippsburg 2 (KKP 2) generated a gross output of 10,993,639 MWh. The net electrical power generation consisted of 10,323,151 MWh. The plant was 7,939 h on the grid. This corresponds to a availability factor of 90.63 %.

Since the commissioning of the plant 366,161,155 MWh gross and 347,076,473 MWh net were generated.

Planned shutdowns
11 May to 15 June: 33rd refuelling and annual major inspection. Major inspection work carried out:
- Inspection of one of the three main feed pumps.
- Eddy current testing of two of the four steam generators.
- Leak test of reactor containment.
- Inspection of the main cooling water system.
- Engine replacement on two of six main cooling water pumps.
- Maintenance work on individual emergency power generators.

Unplanned shutdowns and reactor/turbine trip
18 August: Turbine trip (TUSA) via the criterion “high condenser pressure”.

Power reductions above 10 % and longer than for 24 h
15 March to 11 May: Stretch-out operation
26 July to 24 August: Reduction of heat input into the Rhine and compliance with the permissible outlet temperature.
15 October to 2 November: Reduction of heat input into the Rhine and compliance with the permissible outlet temperature.
8 November to 3 December: Reduction of heat input into the Rhine and compliance with the permissible outlet temperature.

Integrated management system (IMS) EnKK (NPP P, GKN, KWO)
The integrated management system (IMS) of the EnBW Kernkraft GmbH (EnKK) with its partial system for nuclear safety (SMS), quality management (QMS/QSU) as well as environmental and energy management (UMS, EnMS, Umwelt- und Energiemanagementsystem) were also in 2018 continuously further developed. Scope and content of each process descriptions were gradually adapted to the different internal requirements and related approval criteria. Beside the confirmation of conformity for the IMS, the recertification of the EnKK energy management system (EnMS, Energiemanagementsystem) according to DIN EN ISO 50001 took place in 2018 to improve energy efficiency. The certificate was thus extended by three years.

The completeness and effectiveness of the process-oriented IMS, including the quality management measures, were confirmed by appropriate internal audits as well as by a several-day inspection by the expert (ESN) and the supervisory authority at the GKN and KKP sites.

The modular and demand-oriented structure of the IMS according to KTA1402 also enables continuous and efficient adaptation to the site-specific requirements in operation/post-operation in subsequent years. Another important focus will be the gradual integration of dismantling aspects into the IMS in order to exploit synergy effects.

Waste management status
During the year 2018 in total 2 transportation and storage casks of type CASTOR® V/19 were stored in the on-site intermediate storage. Altogether 33 loaded CASTOR® V/19 and 29 loaded CASTOR® V/25 casks were at the on-site intermediate storage.
Operating data

Review period 2018

**Plant operator:** EnBW Kernkraft GmbH (EnKK)
**Shareholder/Owner:** EnBW Erneuerbare und Konventionelle Erzeugung AG (98.45 %), ZEAG Energie AG, Deutsche Bahn AG, Kernkraftwerk Obrigheim GmbH
**Plant name:** Kernkraftwerk Philippsburg 2 (KKP 2)
**Address:** EnBW Kernkraft GmbH, Kernkraftwerk Philippsburg, P.O. box 11 40, 76652 Philippsburg, Germany
Phone: 07256 95-0, Telefax: 07256 95-2029
E-mail: Poststelle-kkp@kk.enbw.com
Web: www.enbw.com

First synchronisation: 12-17-1984
Date of commercial operation: 04-18-1985
Design electrical rating (gross): 1,468 MW
Design electrical rating (net): 1,402 MW
Reactor type: PWR
Supplier: Siemens/KWU

The following operating results were achieved:

- **Operating period, reactor:** 7,965 h
- **Gross electrical energy generated in 2018:** 10,993,639 MWh
- **Net electrical energy generated in 2018:** 10,323,151 MWh
- **Gross electrical energy generated since first synchronisation until 12-31-2018:** 366,161,155 MWh
- **Net electrical energy generated since first synchronisation until 12-31-2018:** 347,076,473 MWh
- **Availability factor in 2018:** 90.63 %
- **Availability factor since date of commercial operation:** 88.76 %
- **Capacity factor 2018:** 90.47 %
- **Capacity factor since date of commercial operation:** 88.49 %
- **Downtime (schedule and forced) in 2018:** 9.37 %
- **Number of reactor scrams 2018:** 0

**Licensed annual emission limits in 2018:**
- **Emission of noble gases with plant exhaust air:** $1.1 \times 10^{15}$ Bq
- **Emission of iodine-131 with plant exhaust air:** $1.1 \times 10^{10}$ Bq
- **Emission of nuclear fission and activation products with plant waste water (excluding tritium):** $5.5 \times 10^{10}$ Bq

**Proportion of licensed annual emission limits for radioactive materials in 2018 for:**
- **Emission of noble gases with plant exhaust air:** 0.12 %
- **Emission of iodine-131 with plant exhaust air:** < limit of detection
- **Emission of nuclear fission and activation products with plant waste water (excluding tritium):** 0.04 %
- **Collective dose:** 0.115 Sv