

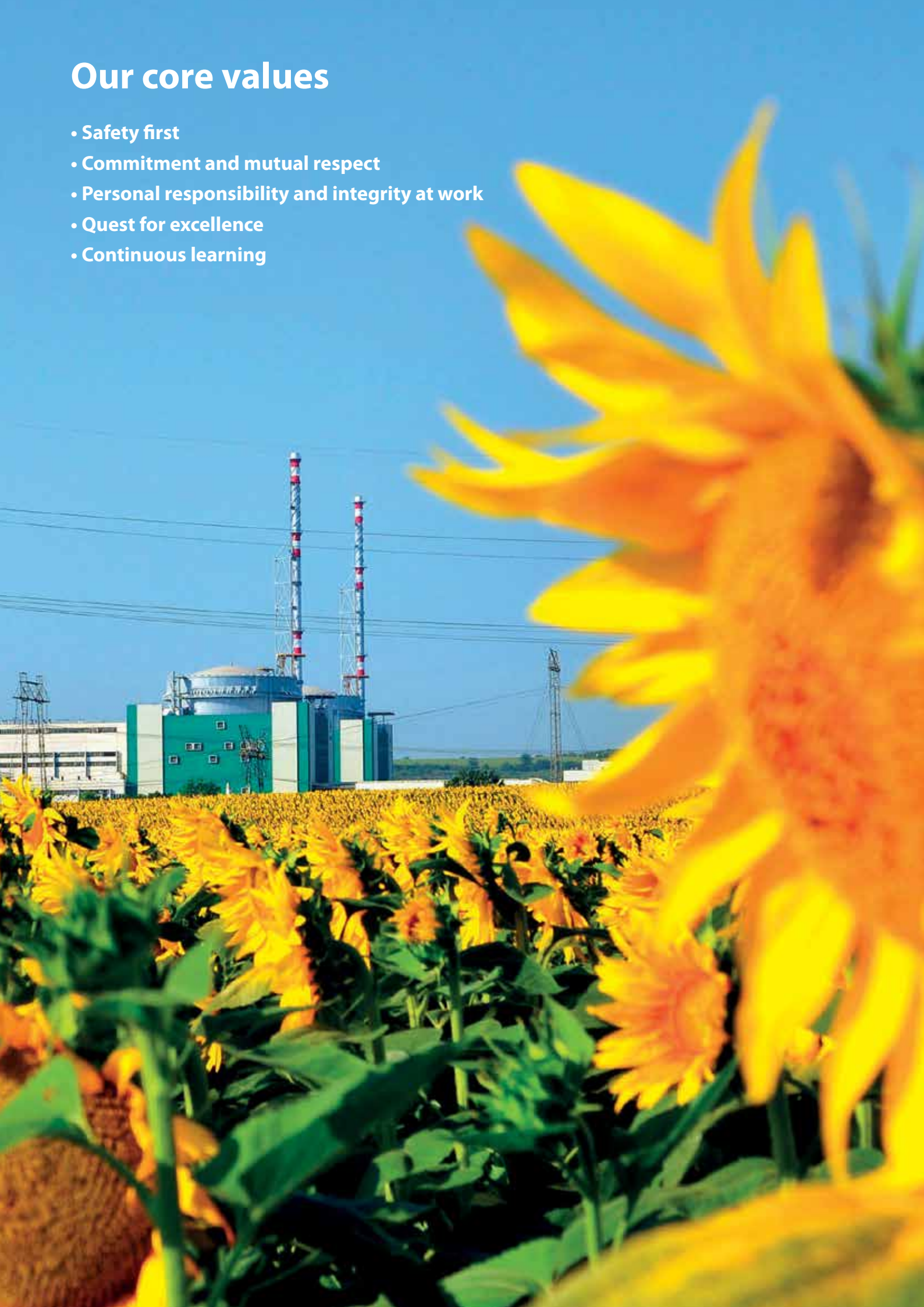


**2017**

# **ANNUAL REPORT**

# Our core values

- Safety first
- Commitment and mutual respect
- Personal responsibility and integrity at work
- Quest for excellence
- Continuous learning



**Dear readers,**



This annual report edition summarises the main performance results of Kozloduy NPP in 2017. Our achievements undoubtedly describe the year as a successful one thanks to the professionalism and commitment of the remarkable plant staff.

Throughout the whole year 2017 we have been working hard, dedicated to the mission of ensuring safe, effective and clean power generation. The reliable operation of the nuclear units provided more than one third of the electricity produced in Bulgaria, averting the environmental impact of huge quantities of greenhouse and other harmful gases. With the output of 15.5 million MWh we reinforced the plant's key role as a leading producer of electrical power in the country.

The advancement of safety as a top priority and the application of best world practices has been demonstrated to the Moscow Centre of the World Association of Nuclear Operators (WANO-MC) in the framework of a Peer Review, and a pilot Crew Performance Observation of the main control room groups trained at the full-scope simulator. We openly demonstrated our activities, and willingness for continuous improvement of all work processes. The past year will also be recorded in the history of the nuclear power plant and of the Bulgarian energy sector with the successful completion of the programme for unit 5 lifetime extension. This fact was confirmed by the Nuclear Regulatory Agency issuing an operating licence for another 10-year period, which brought a deserved recognition for the plant's long-term efforts toward enhancing the safety and operational reliability of the nuclear power capacities. The conclusions of all the analyses made indicate no restrictions for the safe operation of unit 5 until 2047. I am convinced that we will soon be able to congratulate ourselves on the same successful outcome regarding unit 6.

Thus, over the future decades, Kozloduy NPP will continue to provide electricity at an affordable price, ensuring the stability of the national energy system, and, through the saved harmful emissions, contribute to the achieving of global environmental objectives.

**Ivan Andreev,**  
Chief Executive Officer  
Kozloduy NPP EAD





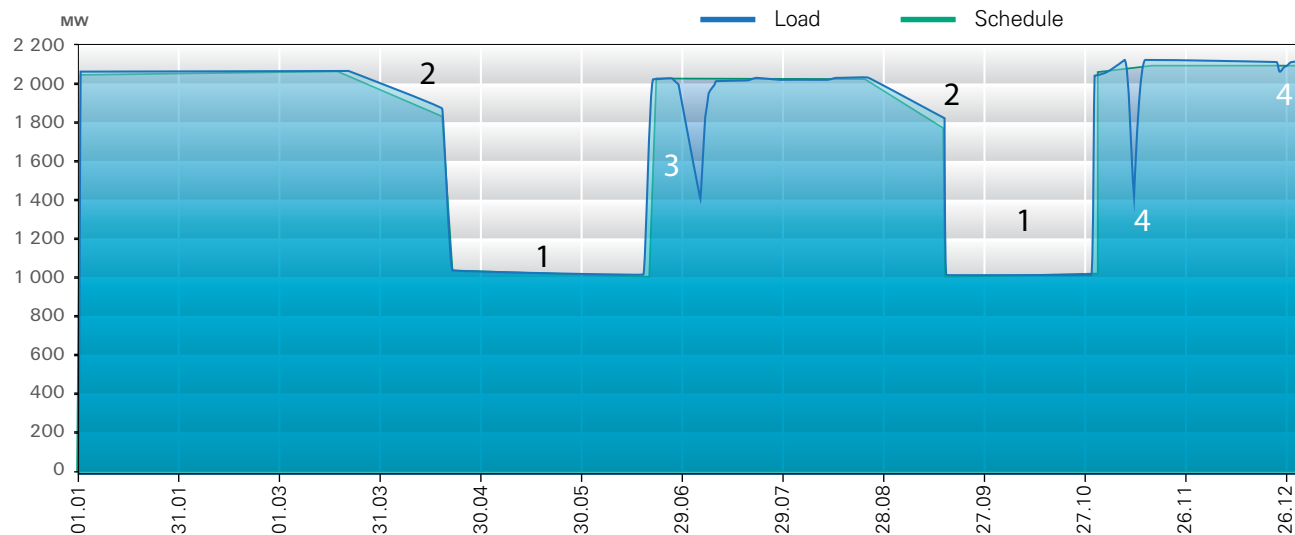
## PRODUCTION AND MAINTENANCE PROGRAMMES IMPLEMENTATION

### PLANT OPERATION MODES

In 2017, units 5 and 6 of Kozloduy NPP operated with optimum loading of the generating capacities, minimum

unplanned deviations from the schedule, and without any events that may impact safety or the environment.

Kozloduy NPP – average daily load schedule in 2017



Legend:

- 1 – Scheduled annual outage with refuelling
- 2 – Coast down operation mode
- 3 – Unplanned shutdown
- 4 – Scheduled tests

Following the successful completion of the project for thermal power uprating of unit 6 to 104%, in the timeframe November – December, 2017, planned trial tests were performed to verify the preparedness of the unit to operate at a higher thermal power level. Those activities were

conducted in accordance with a comprehensive programme approved by the Nuclear Regulatory Agency (NRA) and they comprised:

- verification of the functionality of the reconstructed components and systems;

- trials of the performance of the replaced equipment and components for operation at a higher thermal power level;
- verification of the functioning of the algorithms of the unit instrumentation, control and protection systems for dynamic transients with switching off of main equipment

pieces (primary circuit main coolant pumps), etc. The test results have been submitted for analysis to the nuclear plant main designer, OKB "Gidropress", for preparation of a final report with recommendations for the long-term operation of unit 6 at a thermal power of 104%.

## GENERATION AND SALES

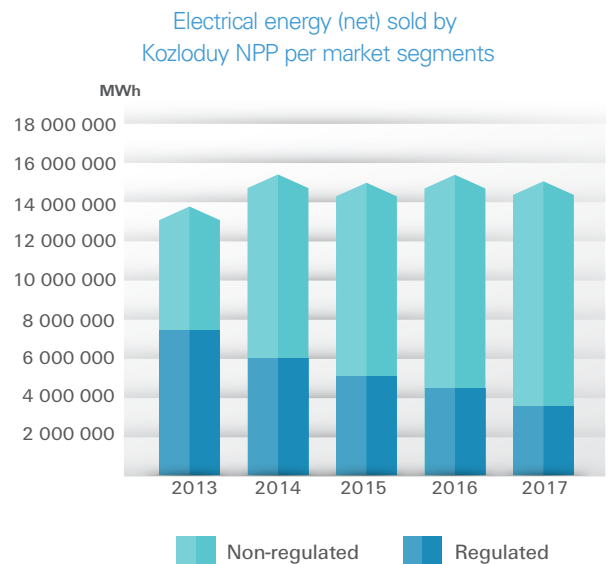
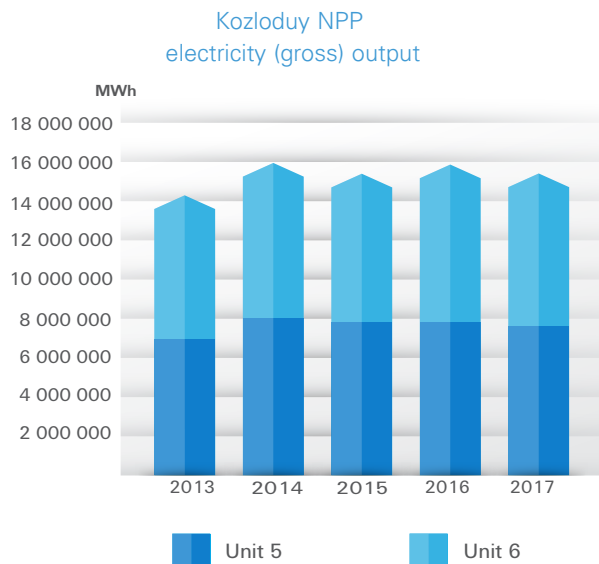
The (gross) electricity production of Kozloduy NPP in 2017 amounted to 15 545 499 MWh, which constituted 34.3% of the national electricity output.

Since July 1974, when unit 1 started its commercial operation, to the end of 2017, the nuclear power plant has produced a total of 601 383 841 MWh of electricity, while strictly adhering to all requirements for safety during operation of nuclear facilities and precluding any environmental impact. Since commissioning in 1987 to the end of 2017, Unit 5 has generated 170 401 525 MWh of electricity, while Unit 6 has generated 159 986 359 MWh as of its commissioning in 1991.

Kozloduy NPP provided to the national electrical energy system 14 718 368 MWh of net active power, sold according to the current normative basis.

Taking into account the tendency towards broadening of the electricity market in Bulgaria, in 2017, the plant sold 24% of its net electricity generation on the regulated market, and the rest of it was successfully traded on the free market.

Being the first Bulgarian company to start selling on the free market and having successfully operated in a dynamic market environment for more than 10 years now, Kozloduy NPP remained the major, preferred, and most secure supplier of electricity in 2017, too.



## HEAT GENERATION

In addition to its role of a major electricity producer of national importance, Kozloduy NPP provides also thermal energy for heating of the town of Kozloduy, as well as for a number

of production and auxiliary facilities on site. The heat sold to the end consumers (domestic or other) throughout 2017 amounted to 90 GWh.

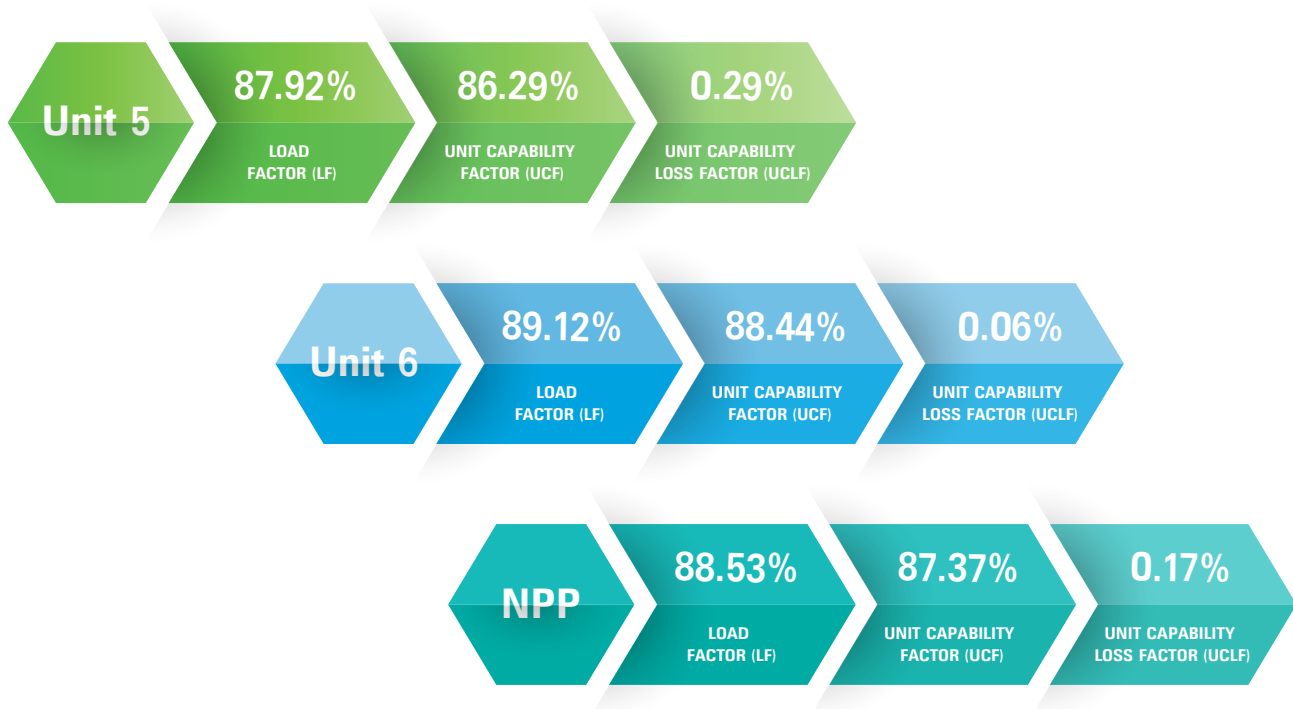


## SPECIFIC PERFORMANCE INDICATORS

The plant specific performance indicators reflect the complex impact of various factors on the production, reliability, and safety of the nuclear installations as production facilities.

The performance indicator values that Kozloduy NPP achieved in 2017 demonstrate a stable and high level of reliability and safety.

Performance indicators of Kozloduy NPP in 2017



According to the performance criteria of the World Association of Nuclear Operators (WANO), UCF values exceeding 85% testify of a very good efficiency and reliability level in the operation of nuclear power plants. Regardless of the longer outage of unit 5 in 2017, and the scheduled tests conducted on unit 6 as per the programme for thermal power update to

104%, the UCF value for Kozloduy NPP is a very good one. While the WANO criteria establish UCLF values of up to 3% as indicative of a high level of reliability and safety, Kozloduy NPP attained far more satisfactory results in 2017. Only one reactor trip with a duration of 19 hours was registered.



## MAINTENANCE PROGRAMME

In compliance with its licensing conditions, the requirements for safe operation set out in the technical specifications, and the plant internal requirements, Kozloduy NPP performs annually the necessary maintenance and repair activities. The objective is to ensure the operability of all the facilities at units 5 and 6 and the common plant facilities (components, systems and structures of the safety systems, systems important to safety, and the systems of significance for the production process).

The plant maintenance programme comprises preventive maintenance, scheduled annual outages, functional tests and checks, specialised inspections and diagnostic non-destructive testing.

The activities are performed in accordance with a preliminary time schedule, and the technological conditions. The main scope of the annual maintenance programme is performed while the units are shutdown for outage and refuelling, with optimum efficiency of organisation and coordination of both activities and teams of workers. During outages, the required maintenance activities run in combination with the implementation of the planned projects for lifetime extension, thermal power uprating to 104% of the reactor units, equipment lifetime management, and a number of other measures to enhance the plant robustness to extreme external impacts.

The total outage duration for unit 5 was 48 calendar days in 2017. The most significant modernisation consisted in replacing the stator of generator №9 with a new one, modified for 1100 MW, which was part of the project for thermal power uprate to 104%. Thanks to the experience accumulated with the replacement of generator №10 in 2015, and the preparatory activities delivered successfully in 2016 and 2017, the modernisation was completed within shorter timeframes.

The following were among the more significant maintenance and modernisation works performed on unit 5 over the reporting period:

- finalising the second leg of the modernisation of the steam generator separation systems, as per the project for thermal power uprate to 104%;
- comprehensive assessment of the turbine equipment and implementing the recommendations of the final reports per the programme for plant life extension, inclusive of replaced check valves of the main steam pipelines;
- overhaul of turbine K-1000-60/1500-2, together with a comprehensive assessment of the first low pressure cylinder and of the shaft line components;
- replacement of pipeline sections in order to improve the reliability of the systems for service water supply, fire suppression, etc.

The unit 6 outage lasted 40 calendar days in 2017. Some of the more important activities, implemented while the unit was shutdown, included as follows:

- finalising the measures for the reactor thermal power uprate to 104%;
- overhaul of turbine K-1000-60/1500-2, together with a comprehensive assessment of the high pressure cylinder, as per the plant life extension programme;
- overhaul of the turbine drive of a feed water pump, combined with a comprehensive assessment as per the plant life extension programme;
- maintenance of rotating mechanisms, valves, heat exchangers, tanks, electrical and electronic equipment, replacement of pipeline sections to improve the reliability of the systems for service water supply, fire suppression, etc.

In 2017 too, the repair activities and modernisations planned to ensure the safe, reliable and long-term operation of the facilities and operability of the equipment on the two units were fulfilled in the required scope and with the necessary high quality. The nuclear power plant used own funds to finance all these activities.





## SAFETY

### LICENSING REGIME

Kozloduy NPP EAD is the operator of two nuclear power units – 5 and 6, with reactor type WWER-1000, model B-320, and two spent nuclear fuel (SNF) storage facilities. This activity is subject to state regulation on behalf of the Nuclear Regulatory Agency (NRA) at the Council of Ministers of the Republic of Bulgaria. Specialised oversight is exercised by the Ministry of Environment and Water, Ministry of Health (MoH), Ministry of Regional Development and Public Works, State Agency for Metrological and Technical Surveillance and other state bodies.

All the activities related to the operation of Kozloduy NPP Units 5 and 6 and the spent nuclear fuel storage facilities are performed in compliance with the provisions of the operating licences issued by the NRA. Specialised training for activities on nuclear facilities and activities with ionising radiation sources (IRS) has been performed in compliance with the provisions of the specialised training licence issued by the NRA.

After the successful implementation of the activities from the Plant Lifetime Extension Preparation Programme of Unit 5 and the conduct of a Periodic Safety Review (PSR), an application for the unit operating licence renewal for a

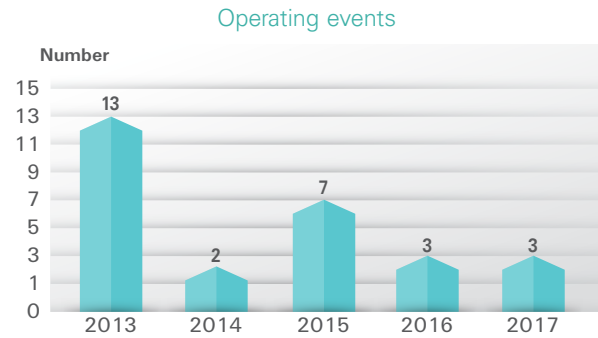
new 10-year period was submitted to the NRA. The review of the application documents together with the additional assessments and justifications support the feasibility of unit's 5 safe operation throughout the operating licence period declared. The conducted comprehensive assessment confirmed the equipment possessed the required service life margin for the subsequent licensing period. On 3 November 2017, the NRA issued to Kozloduy NPP a unit 5 operating licence for a period of 10 years, containing certain conditions that the plant has to perform for the gradual transition to operation of unit 5 at thermal power uprated to 104%.

In 2017, the activities at unit 6 were focused on implementing the unit lifetime extension preparatory programme, as well as the licensing conditions related to operation at uprated thermal power to 104%. After the NRA approved the comprehensive programme for tests at uprated thermal power, following the 2017 annual outage, the envisaged activities for confirming the possibility for operation of unit 6 at uprated thermal power were implemented in a staged manner. The reporting documentation submitted to the NRA confirms that the test results meet the criteria for success.



## NUCLEAR SAFETY

All the activities related to the operation of the nuclear facilities of Kozloduy NPP are performed while strictly observing the conditions stated in the licenses, the requirements in the technological specifications, and the operating procedures. In 2017, three operating events were registered at Kozloduy NPP, and reported to the NRA. All of them were rated level 0 as per the INES scale (events without safety significance). Based on the causes identified during the analyses, corrective measures were assigned and performed in order to avoid recurrence. There were no reactor scrams at units 5 or 6 during the reporting year.

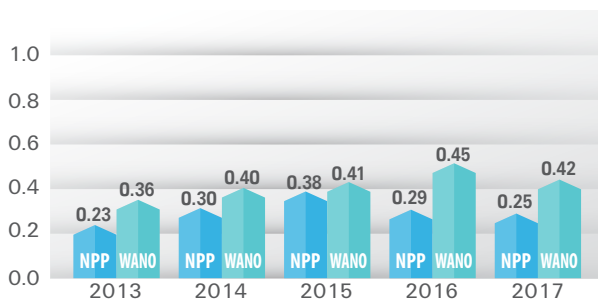


## RADIATION PROTECTION

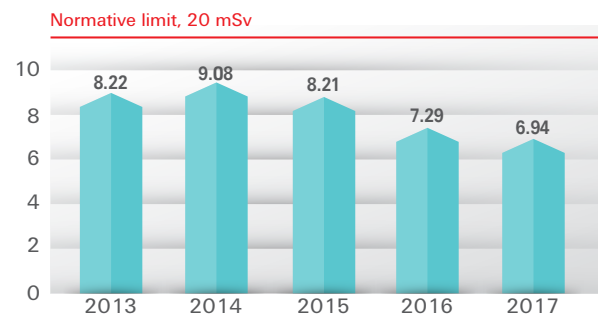
Ensuring a high level of radiation protection is a leading priority of the safety policy of Kozloduy NPP, and is based on the ALARA principle for continuous improvement of the measures limiting the impact of ionising radiation. To this effect, staff training and motivation are in place, good practices from the plant own and international operating experience are applied, preliminary planning and preparation of the activities before the annual outages are conducted, as well as analyses of the completed activities, and a reliable and efficient radiation monitoring. Analyses of the values registered for individual and collective radiation exposure in 2017 confirmed that Kozloduy NPP ranks among the leading nuclear power plants in the world with high achievements regarding radiation protection, while data for the reporting period prove the effectiveness of the measures implemented. The results obtained are consistent

with those of preceding years, irrespective of the fact that in 2017 a number of complex activities were performed within the radiologically controlled area in connection with the service life extension of units 5 and 6, and with their thermal power uprating to 104%. The maximum individual dose over the last year was 6.94 mSv, which constitutes 35% of the normative annual exposure limit for the staff, and is lower than the previous year. The collective dose exposure in 2017 was also lower than in recent years. The collective dose in 2017 was 0.25 man.Sv, on average for each reactor. Data from the annual WANO report for 2017, show that the annual collective dose intake during the operation of one PWR type of reactor was 0.42 man.Sv. The average value of the collective dose for a single reactor of Kozloduy NPP remained lower than the WANO indicator – a trend that has remained unchanged over a consecutive year.

Collective dose for a single reactor of Kozloduy NPP, compared to the WANO indicator, man.Sv/unit



Maximum individual effective dose in the Kozloduy NPP radiologically controlled area, mSv



## RADIATION MONITORING OF EMISSIONS DISCHARGED TO THE ENVIRONMENT

Radiation monitoring of the liquid and gaseous discharges at Kozloduy NPP is carried out in compliance with the highest international standards. Independent monitoring of the discharges to the environment is also performed by the Nuclear Regulatory Agency, the Ministry of Environment and Water (MEW), and the National Centre of Radiobiology and Radiation Protection (NCRRP). They have determined the admissible limit values for the content of radioactive substances in the exhaust air and waste waters. In addition, the nuclear power plant has regulated reference levels for every radioactive component in the discharges, with values considerably lower than the allowable ones. The information about the Kozloduy NPP radioactive emissions to the environment is reported to the European Commission on an annual basis.

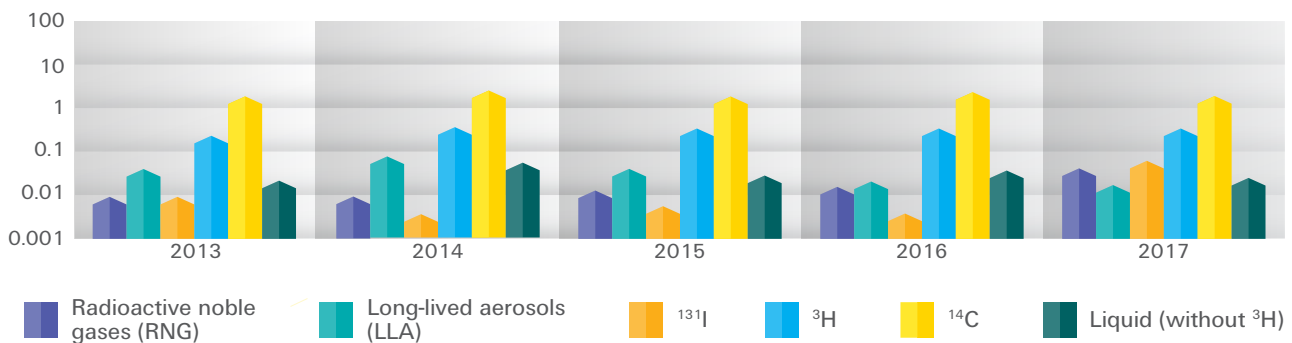
In 2017, the trend persisted for the content of radioactive substances in airborne and liquid discharges to the environment, remaining considerably below the reference levels. The radiation monitoring results prove the effectiveness of the measures applied for strict control of the technological processes and the high quality of operation of the nuclear facilities.

The radioactive noble gases (RNG) and long-lived radioactive aerosol emissions do not exceed 0.03% of the respective reference levels, and the iodine-131 (<sup>131</sup>I) emission is 0.05% of the reference level. Since 2010, Kozloduy NPP has also monitored the content of carbon-14 (<sup>14</sup>C) and tritium (<sup>3</sup>H) in the exhaust air. In 2017, the discharges of <sup>14</sup>C and <sup>3</sup>H



were 1.5% and 0.2%, respectively, of the reference levels established for the plant site. The content of radioactive substances in the liquid effluents remained significantly lower than the reference levels. The activity measured in the plant drain waters did not exceed 0.02% of the specified annual limits. The tritium content in the liquid emissions makes up for approximately 14% of the annual limits. The low levels of radioactive discharges from Kozloduy NPP determine also the very low dose exposure values for the public in the area surrounding the plant.

Total activity of airborne (RNG, LLA, <sup>131</sup>I, <sup>3</sup>H and <sup>14</sup>C) and liquid discharges in % of the statutory annual limits for the site



## RADIOACTIVE WASTE MANAGEMENT

The radioactive waste (RAW) generated from the operation of the nuclear power plant did not exceed the estimated design quantities.

In 2017, 560 m<sup>3</sup> of compressible solid radioactive wastes and 27 tons of non-compressible solid radioactive wastes were generated. Emptying of the interim storage facilities for solid RAW, located in the EP-2 Auxiliary Building 3, continued and

a total of 60 m<sup>3</sup> of wastes were handed over to the State Enterprise RAW throughout the last year.

The water treatment process generated 180 m<sup>3</sup> of liquid radioactive concentrate.

All of the RAW generated in 2017 have been transferred for treatment to the State Enterprise RAW.

## SPENT NUCLEAR FUEL MANAGEMENT

The spent nuclear fuel (SNF) of Kozloduy NPP is stored in compliance with all applicable safety requirements. After being kept for a specified time period in special spent fuel pools (SFP) located near the reactors, the SNF assemblies are transferred to the pool type spent fuel storage facility (SFSF), which is common for all the nuclear power units. The dry spent fuel storage facility (DSFSF) stores spent nuclear fuel from the retired units 1, 2, 3, and 4, loaded in Constor 440/84 casks inside the wet SFSF.

In 2017, during unit 5 annual outage, 42 fuel assemblies were removed from the reactor and transferred to SFP-5. Forty-eight SNF assemblies were moved from SFP-5 to the

SFSF for under-water storage. During the unit 6 refuelling outage, 42 spent fuel assemblies were moved from the reactor to SFP-6. Thirty-six SNF assemblies were transferred for wet storage from SFP-6 to the SFSF.

The WWER-440 spent fuel assemblies transported to Russia for reprocessing were 232, while 252 SNF assemblies were loaded in three CONSTOR 440/84 casks and moved to the DSFSF.

In 2017, on behalf of the NRA, IAEA and EC, fourteen inspections were carried out on the spent nuclear fuel at units 5 and 6, the wet spent fuel storage facility, and the dry spent fuel storage facility.

## EMERGENCY PLANNING AND PREPAREDNESS

The general objective of Kozloduy NPP emergency planning and preparedness is to maintain well-trained staff, develop and plan early warning and disclosure measures for the plant personnel and the public and ensure environmental protection.

In accordance with the national legislation and the international requirements in the nuclear energy field, Kozloduy NPP (KNPP) has developed an emergency response plan including a system of measures for effective limitation and mitigation of the consequences of a potential nuclear, radiation or other accident, natural disasters or calamities.

Every year, to ensure good preparedness of the personnel, emergency preparedness trainings, exercises and drills are planned and conducted. In 2017, the number of plant workers that took such training was 1315. Planned briefings have been and conducted per departments on the topic of response actions in emergency situations with the staff actually using personal protection equipment. The entire personnel has been provided with leaflets – Instruction on Emergency Preparedness, and guidebooks – Rules on



Behaviour and Response of Kozloduy NPP Staff in the Event of a Radiation Accident.

Two general emergency response exercises were conducted last year. The participants in them were the individuals on duty under the Emergency Plan, the plant sanitary



Full-scope simulator for reactors WWER-1000



team, and shift teams of the plant Transport Department, FSS-1000, KNPP Regional Police Department, KNPP Fire Safety and Civil Protection Regional Department and the Occupational Medicine Service. Five drills were carried out together with NRA and two drills with representatives of the Decommissioning Specialised Division for units 1-4 of

SE RAW.

The performance of all the scheduled actions confirmed the high level of preparedness for response action of the plant emergency teams, good coordination and excellent communication between the plant and the national structures involved in emergency planning and preparedness.

## PHYSICAL PROTECTION

The state-of-the-art plant physical protection system and its full compliance with the national and international requirements for effectiveness against potential threats was confirmed by the inspections performed on behalf of the NRA, and the security assessment carried out by Mol in 2017.

The good training practice of the security personnel was continued, the planned activities for development of the nuclear security culture were carried out and a course was delivered on the topic of "Organisation of physical protection at NPPs".

To enhance the efficiency in the field of cybersecurity,

training was conducted on counteracting current cyber-threats. At the same time, introduction continues of the measures necessary to increase computer security.

In compliance with the normative requirements, modernisation of the technical security systems is under way. The security system of the spent fuel storage facility has been extended and upgraded. A new generation of security instrumentation was installed to modernise the surveillance system of the service water supply canals.

No violations of the nuclear power plant physical protection system were made in the reporting year.

## FIRE SAFETY

The high level of fire safety at Kozloduy NPP is maintained in compliance with all the national legislation requirements, and those of the IAEA standards and the European Union. In order to ensure effective protection of the personnel and the production process, a complex of technical and organisational actions is carried out in the company, the best world practices are applied and the necessary fire safety training of personnel is implemented.

In 2017, the plant continued the staged replacement of the fire detection systems. Fire safety assessment is systematically

performed on the activities of external organisations working on-site and construction supervision is exercised throughout the implementation of all projects. The internal inspections conducted to assess the observance of the fire safety rules and norms number 557. Over the last year, no fire safety related events occurred at Kozloduy NPP.

In March, the Vratsa Fire Safety and Public Protection Regional Directorate undertook a control inspection which confirmed the high level of fire safety maintained on the plant.



## RADIOECOLOGICAL MONITORING

The radioecological monitoring of Kozloduy NPP covers all the major environmental components – air, water, soil, vegetation, food, etc., in compliance with the European and the national standards. The scope, range and monitored parameters are stipulated in a long-term programme agreed with the NRA, the NCRRP at the Ministry of Health, and the Executive Environment Agency at the Ministry of Environment and Water. The Programme fully complies with the national and European normative requirements in the field including Article 35 of the EURATOM Treaty, Recommendations of EC 2000/473/ EURATOM and 2004/2/ EURATOM. A parallel independent monitoring is performed by the oversight bodies – ExEA and NCRRP. The implementation of monitoring programmes is subject to regulatory control by the NRA.

The monitored area includes the plant industrial site, the 2-km Precautionary Action Zone, the Bulgarian area of the 30-km Urgent Protective Action Planning Zone, and monitored points within a radius of 100 km surrounding the plant in the Bulgarian territory, where monitored points are established. The measurements are performed in fixed monitoring posts and through field measurements with a mobile laboratory along specified routes. Air, water, soil, vegetation, crops, milk, fish, etc. samples are collected periodically for analysis. The background gamma-radiation is constantly measured in the settlements in the region, where a broad access to the radiation situation information is provided to the public. Over 4 100 analyses of the radioactivity in more than 2 400 samples of different environmental constituents were conducted throughout 2017. The quality of the analyses and measurements performed is ensured by annual participation in prestigious international inter-laboratory comparisons and competence tests involving reference samples.

The radiological indicators results from the analyses of NPP environmental samples made in 2017 are within the background levels specific for the region, and no adverse

impact from the nuclear power plant operation has been found. The human-induced activity levels detected are many times below the permissible limits for the relevant radiological indicators and analysed samples, which confirms that the radiological situation is completely favourable. The results of the internal radiation monitoring are verified by the independent radioecological studies under programmes of the MEW and NCRRP.

In 2017, the gamma background levels at the on-site monitored points and the measurement points within the 100-km zone were fully comparable with and did not deviate from the natural gamma background specific levels for the region.

To notify the public living in the 30-km zone, there is an automated information system for radiological monitoring with a total of 13 local measuring stations installed in different populated areas. The data are displayed on information boards in public places and transmitted through wireless on-line connection to the central station at Kozloduy NPP, and thenceforth to the Executive Environment Agency. The system data also show values that are within the natural background limits. The atmospheric air human-induced activity throughout the year 2017 was of values close to the background ones ( $2 \mu\text{Bq}/\text{m}^3$ , on average) which is much below the permissible limits. No radiological effects due to the operation of Kozloduy NPP on the water of the Danube river and drinking water sources in the region were observed. The total beta activity of the water from natural water bodies ranged between 0.02 – 0.15 Bq/l, which is below 30% of the maximum permissible limit of 0.5 Bq/l stipulated in Regulation H-4/2014. The content of tritium in the samples from the open ponds was around the Minimum Detectable Activity of up to 5 Bq/l. The radiological condition of drinking water complies with the health standards (Regulation No. 9 of 16 March 2001). The total beta activity measured in the regional drinking water sources ranges between 0.018 and



0.20 Bq/l. No tritium presence has been registered. The human-induced activity of soil has not been affected by the operation of Kozloduy NPP. The activity of  $^{137}\text{Cs}$  throughout 2017 varied up to 37 Bq/kg, the average value being 10 Bq/kg. The activity of  $^{90}\text{Sr}$  ranged from 0.1 and 3.4 Bq/kg, which is typical for the soils in this geographic region. The human-induced activity in the vegetation studied is within the normal limits –  $^{137}\text{Cs}$  to 2.7 Bq/kg and  $^{90}\text{Sr}$  – to 1.4 Bq/kg. The radioactivity of the staple foods produced in the region, such as milk, agricultural crops, etc., is within normal background radiation levels, much below the relevant permissible limits (Regulation No. 10 of 2002). The human-induced activity of fish in the Danube river, upstream and

downstream Kozloduy NPP site, is also examined. The results are comparable with the data from the previous years of operation, and with the period preceding the plant first start-up, which confirms the absence of impact from Kozloduy NPP on the staple foods and ichthyofauna in the region.

Since 2012, all the main analytical activities performed by the Environmental Monitoring Department have been accredited by the Bulgarian Accreditation Service (BAS) according to BDS EN ISO/IEC 17025, which is an evidence of the competence and the high quality of the performed analyses. In 2016, after an audit carried out by the BAS, the validity of the accreditation was extended to 2020.

## PUBLIC DOSE EXPOSURE EVALUATION

Verified and validated modelling codes for evaluation are used for evaluating the KNPP radiological impact on the population residing in the vicinity of the plant. They are based on the CREAM methodology adopted by the European Union and have been adapted to the geographical and hydrological specifics of the Kozloduy NPP surrounding area. They are verified through independent oversight by NCRPP, at the MoH, and compared with data of evaluated doses to the public that are periodically published by the European Commission for the nuclear power plants of the EU member states.

In 2017, the maximum individual effective dose to a critical group of the population from the surveillance zone, total for airborne and liquid discharges from Kozloduy NPP to the environment is conservatively evaluated at 5  $\mu\text{Sv/a}$ , using microclimate data.

This value is only 0.2% of the radiation due to the natural background radiation for the country (2.33 mSv/a), and 0.5% of the set normative limit (1 mSv/a). Over the past 10 years, the values of the maximum individual effective doses to the population have varied in the range of 4-7  $\mu\text{Sv/a}$ , which is several hundred times below the natural radiation background exposure (2330  $\mu\text{Sv}$ ), and negligible compared to the annual public limit of 1000  $\mu\text{Sv}$ . The results are comparable with those for the nuclear power plants both in the EU, and worldwide.

The evaluated maximum individual dose to a member of the public, living within the 30-km area of the plant, is even lower – 1.37  $\mu\text{Sv/a}$ , and it has remained almost unchanged over the years.

## ENVIRONMENTAL MANAGEMENT – NON-RADIOLOGICAL ASPECTS

The environmental management system of Kozloduy NPP EAD forms part of the integrated management system of the plant. The plant environmental policy includes the structure, planning, responsibilities, procedures and processes for forming, maintaining and continually improving the environmental safety of the nuclear power plant.

In 2017, all conditions and measures in the permits issued to the plant as per the Environmental Protection Act, were fulfilled. All the necessary information, records and reports were provided to the competent environmental authorities. A modification was made to the permit for waste water discharge in the main drain canal, in connection with the removal from service of  $\Phi 300$  sewerage pipeline.

In compliance with the requirements for the use of chemicals, a decision was obtained to approve the Kozloduy NPP safety report. The Kozloduy Municipality was submitted the information necessary for the preparation of an off-

site emergency plan – as part of the Municipality Plan for Protection against Disasters, in connection with article 108 of the Environmental Protection Act. Last year, a drill was performed of personnel response actions in case of an accident involving dangerous chemical substances.

Fifty-eight tonnes of non-radioactive waste were handed over to licensed external organisations for subsequent safe treatment. The second stage of the Landfill for Non-Radioactive Domestic and Industrial Waste entered commercial operation in March 2017. The design holding capacity of the waste storage facility is 28 460  $\text{m}^3$ , while the design service life of stage 2 is 15 years.

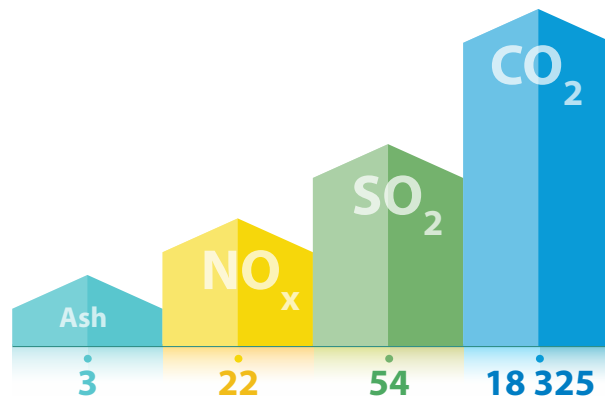
In 2017, samples from surface, underground and waste waters were collected and analysed according to the Programme for Plant Monitoring of Waters, and the Monitoring Programme of the Landfill for Non-Radioactive Domestic and Industrial Waste. The assays were performed



by accredited laboratories, namely the Regional Laboratory – Vratsa at the ExEA; the test laboratory EcoLab at DIAL OOD, laboratories of the KNPP Engineering Chemistry Section, at the Quality Division, and the Radioecological Monitoring Department, at the Safety Division. The data resulting from the nearly 3 000 analyses performed with water samples showed no rising trend in the values of the monitored indicators. There were no recorded values exceeding the permissible limits resulting from the operation of Kozloduy NPP, and the values are close to those from the previous years.

The five inspections performed by the Vratsa Regional Inspectorate for Environment and Water, and 11 inspections on behalf of the Pleven Water Management Basin Directorate for the Danube Region, found no deviations from the requirements for environmental protection and the permits issued. These results confirm that the activities performed at Kozloduy NPP are in full conformity with the environmental normative provisions and the permits issued.

Emissions of greenhouse and harmful gases saved in 2017 by Kozloduy NPP compared with conventional thermal power plants (thousands tons)



### OCCUPATIONAL HEALTH AND SAFETY

Maintaining of health and safety at work at Kozloduy NPP is carried out in compliance with the requirements of the current legislation and the implementation of the company's policy in this field. A set of organisational and technical measures was introduced in order to ensure safe working environment; also collective and personal protective equipment is provided to prevent the impact of hazardous industrial factors on the workers.

The working environment factors are measured periodically, and the work specific risks are assessed with the purpose of successfully removing or limiting the risks to the workers' health and safety. The workers are informed about the potential risks and the countermeasures undertaken.

It is of particular importance for a safe labour process to

maintain high awareness of the personnel by systematically conducting briefings and trainings.

All the workers are provided sanitary and medical service, reduced working hours, regulated intervals for work and rest, free food, while the workers in higher risk ambient conditions receive Industrial Accident Risk insurance.

No accidents at work occurred in 2017 in the company and the indicators characterising industrial safety accident rate continue the steady trend of maintaining low values. The annual industrial safety accident rate at Kozloduy NPP is 0.33, which is significantly lower than the average value of 1.22 for the industry, and below the mean value of 0.67 for the country.



## PROGRESS ON THE PROJECT OF KOZLODUY NPP UNITS 5 AND 6 LIFETIME EXTENSION

In 2017, all the activities scheduled for the national priority project of Lifetime Extension of Kozloduy NPP units 5&6 were completed in full scope.

Out of 262 measures planned for unit 5 the completed ones were 226, 15 are currently in progress, 21 have been scheduled for the new licensing period. Out of 227 measures planned for unit 6 the completed ones were 77, 125 are currently in progress, 25 have been scheduled for the coming licensing period.

The professional project management involves quality assurance and control, efficient communication among

workplace experts, holding of technical committee meetings, and also project progress review meetings (PRMs) with the contractors. Over the reporting period, under the main contract for units 5 and 6, the PRMs held with contractors were 11, the expert technical committee sittings were 31 for discussing the results of the calculations made, and 8 coordination council meetings were held.

The financing of the plant life extension (PLEX) project for the two 1000 MW units is provided by the plant business programme, and the implemented activities are entirely self-financed.

### ACTIVITIES IN 2017 FOR UNIT 5 LIFETIME EXTENSION PROJECT

The activities planned in the unit 5 PLEX Preparatory Programme were completed. A Programme Implementation Report was issued to document the implementation of measures that are subject to NRA control, and an Implementation Report on Licensing Condition No 22.1 c) of Licence series E, No. №3000/02.10.2009, for the operation of KNPP unit 5.

The activities were finalised as per one of the main contracts entitled "Assessment of metal control programmes, and of structures, systems and components of the unit 5 secondary equipment".

During the unit's 2017 annual outage, the PLEX project activities were focused on the project measures with due dates' extension, and on the recommendations originating from the implementation of the Preparatory Programme for extending the operating life of the unit.

On the primary circuit side, a pump assembly was replaced in the system for emergency core cooling, valves of the pressuriser and sprinkler systems, bolts and brake disc of



the polar crane, etc. Replacements in the instrumentation and control system included powering assemblies, racks, pulse lines, "sapphire" detectors and other components.

On the secondary circuit side, assessments were performed of the high pressure cylinder casing and rotor, bandage rings, diaphragms, guide blades, etc. Replaced equipment included return valves of the main steam line and the service water pump propeller.

Measurements and diagnostics were performed on the insulation characteristics of the stator windings of the synchronous generators of the emergency diesel generators, and three electric motors of the main circulation pumps.

Rehabilitation actions were performed on the concrete steel lining of the cooling water intake and outgoing canals, and

of the turbine foundation components. Repair works were initiated on the main technological overhead passage. Assessment was completed of the underground pipelines for service water of the safety related loads.

A terms of reference was prepared for "Measurements of the actual geometry of the core baffle of reactors type WWER-1000. Processing and analysis of the data obtained. Defining the parameters for unlimited swelling of the core baffle material and the conditions for repeating the calculations to justify the operating life".

**On the grounds of the completed activities over the two stages of the PLEX project for unit 5, and in conformity with the Safe Use of Nuclear Energy Act, on 3 November,**

**2017, the NRA issued an operating licence for a new 10-year period of Kozloduy NPP unit 5.**

## ACTIVITIES IN 2017 FOR UNIT 6 LIFETIME EXTENSION PROJECT

For the implementation of the main project activities, in the beginning of 2016, a contract was signed with the consortium of Rusatom Service JSC and Risk Engineering Ltd. entitled "Development of a Feasibility Justification for Kozloduy NPP Unit 6 Lifetime Extension to 60 Years: Analyses, Calculations and Quantitative Assessment of the Residual Lifetime of Structures, Systems and Components". In 2017, the contract deliverables approved were 173.

During the 2017 annual outage of the unit, the PLEX related activities included further non-destructive testing of the primary and secondary thermal and mechanical equipment, which is part of the input data preparation as needed for developing a justification for equipment lifetime extension to 60 years.

On the primary circuit, assessment was performed of a heat exchanger of the emergency core cooling system, a high temperature filter, pipeline penetrations, valves, etc. The ultrasonic thickness measurement was repeated regarding the main circulation pumps casings. As part of the retrofitting and seismic strengthening of the polar crane metal structure, fixing elements of beams were replaced in the reactor building. On the secondary circuit side, the assessments covered the turbine high pressure cylinder, separator-reheater, high pressure deaerator, deaeration columns, etc. Regarding the instrumentation and control systems and electrical equipment, partial replacements were made of

racks, pulse signal lines, cables and cable routes of the equipment installed in areas of HELB ambient conditions. The power supply devices of the control rods underwent re-examination; measurements were made of partial discharges and dielectric losses of the electric motors of the main circulating pumps. Preparations were made for cable replacement (from junction boxes to containment penetrations) ensuring temperature control of the reactor circulation loops and the pressuriser.



**In 2018, finalisation is due of the PLEX project for unit 6, including the preparation and submission to the Nuclear Regulatory Agency of the package with documents required to apply for licence renewal for a subsequent 10-year period of operation.**





## INVESTMENT PROGRAMME IMPLEMENTATION

In 2017, the plant spent a total of BGN 81 450 thousand of own funds as per the Investment Programme toward implementing the activities for ensuring safe operation of the nuclear facilities and the two strategic projects – for lifetime extension and thermal power uprate of units 5 and 6. The long-term assets commissioned throughout the last year had a value of BGN 80 802 thousand.

A significant share of the reported investment costs went to the realisation of the two priority projects. Financing went toward actions planned for safety maintaining and enhancement, inclusive of actions on the “Programme for implementation of the recommendations ensuing from the

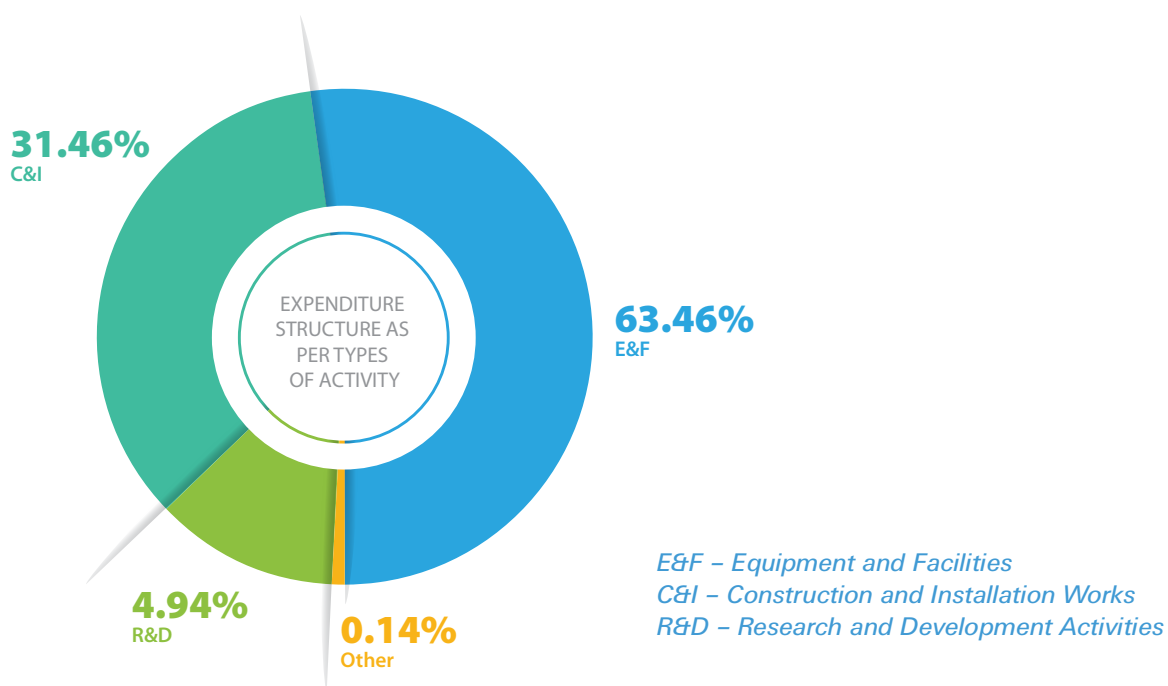
performed stress tests of the nuclear facilities”, and on the “Programme for implementation of measures to improve safety of the spent fuel storage facility (SFSF): provision as per section 26.1 of the SFSF operating licence”. All the investment activities were completed as needed for ongoing maintenance of the units, the auxiliary facilities and the infrastructure, as well as measures to maintain and strengthen the plant security and physical protection.

To implement activities related to safety enhancement, licensing conditions, normative documents requirements and events stemming from stress tests and the National Action Plan of the Republic of Bulgaria, the sum of



BGN 8 910 thousand was invested. All the measures were implemented in compliance with the Safe Use of Nuclear Energy Act and pursuant to the terms and conditions of the licences and permits issued by the authorised oversight and supervisory bodies. Under the Investment Programme, 38 measures were funded of the "Programme for maintaining and enhancing safety at Kozloduy NPP EAD in 2017, 2018, and 2019". Part of these actions are included in individual programmes related to the stress tests performed, executing the projects related to the operating life extension of units 5 and 6 and their thermal power uprate, and satisfying the licensing conditions of the operating licences for the power units and the SFSF. Last year saw the continuing staged implementation of the Programme for Energy Efficiency of Kozloduy NPP as per the company's obligations under the Energy Efficiency Act, in view of achieving a stable improvement of the energy consumption indicators. A total of BGN 28 127 thousand went toward investments in the plant lifetime extension project. Each of the measures finalised over the reporting period

was documented in a close-out report that certified satisfying of the recommended measures and the recommendations arising from the comprehensive assessment of the actual condition and residual life evaluation of the SSCs of units 5 and 6 during Stage 1 of the project. In 2017, a total of BGN 14 630 thousand went toward the implementation of the project for reactor installation thermal power uprate to 104%, as per the Investment Programme. The activities set out in the strategic milestones have been performed in line the approved time schedules. The investment activities for routine maintenance of the nuclear power units, auxiliary facilities and infrastructure are worth BGN 29 783 thousand. A considerable part of the costs were for the supply of long lead, important spare parts. Ensuring the stock of such spare parts aims at reducing the risk of prolonged downtimes when a need of maintenance arises, as well as preventing unplanned downtimes related to the scheduled annual outages. Spares were supplied for valves, fan coolers, for turbine OK12A, also graphite seal rings, spiral wound gaskets and other specific spare parts.





## FINANCIAL PERFORMANCE

In pursuance of the main priority in its financial policy – maintaining financial stability by increasing collection of sales proceeds and effective cost management, Kozloduy NPP achieved very good financial and economical performance indicators in 2017.

This allowed sufficient own financial resources to be accrued for the implementation of the priority activities and projects, in line with the company's business programme approved by the Bulgarian Energy Holding EAD.

In 2017, the plant reported total revenue of BGN 930 million, which exceeds that of the previous year by BGN 91 million. The exceedance is due to the higher revenues from electricity sales at both market segments, which amount to BGN 910 million, marking a significant nominal increase of BGN 100 million (12.4%) compared to 2016.

The largest share in the reported growth have the revenues from electricity sales at freely negotiated prices, which amount to BGN 764 million, compared to BGN 674 million in 2016. The increased revenues are the result of both the structural changes in market sales, and the higher selling prices in 2017.

The revenues from sales at regulated prices during the year amounted to BGN 146 million, with an increase of BGN 10 million compared to the previous year, as a result of the increase in the regulated price as of 1 July 2017.

In connection with its participation on the balancing electricity market, Kozloduy NPP carried out transactions to purchase electricity deficits and sell surplus electricity in order to compensate for grid imbalances in the country. As a consequence, a decrease in electricity sales revenue was reported by BGN 4 million.

In 2017, the operating expenses of the company amounted to BGN 800 million, by BGN 35 million less than the previous year. This is mainly due to decreased expenses on the project for unit 6 lifetime extension related to its forthcoming finalisation and reduced scope of activities remaining, as well as to the lower amount of water usage fee due to a change in the regulatory framework.

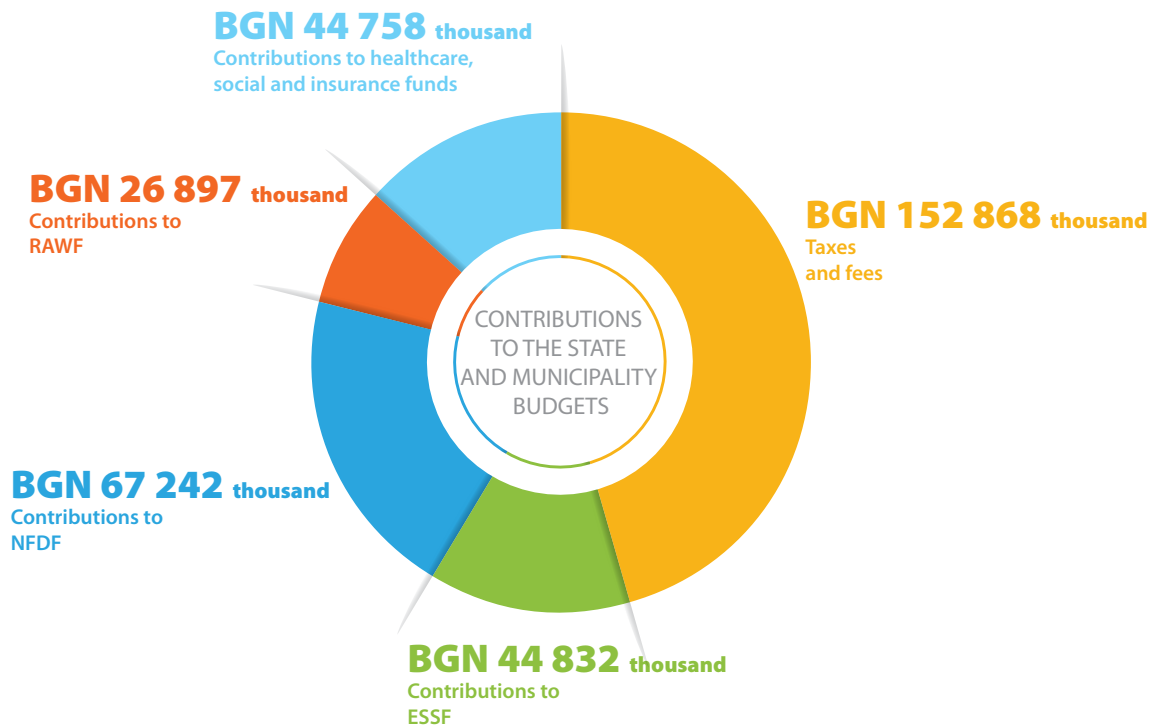
The company's profit after taxes amounts to BGN 118 million.

Kozloduy NPP continues to pursue its effective policy of debt management. Regular payments went toward the loan of the year 2000, under the Modernisation Programme, in accordance with the terms of the Loan Agreement with EURATOM. In 2017, repayment instalments of principal and interest were paid to the amount of BGN 45 million. An important point in the debt management was the full repayment of the 2<sup>nd</sup> tranche on 16.01.2017, and the amounts paid off over the period 2002 – 2017 total BGN 37 million.

The nuclear power plant closed the year 2017 without any overdue payments. Financing was provided of the Company's priority activities related to the safe operation of the nuclear facilities, and the implementation of the investment projects for units 5 and 6 lifetime extension and their thermal power uprate.

All due payments for securing the next fuel campaigns of both units, the obligatory insurance premiums, and payments to Nuclear Facilities Decommissioning (NFDF), Radioactive Waste (RAWF), and Electricity System Security Funds (ESSF), were effected in time.





The commitments were fulfilled to the personnel and insurance institutions as well as the obligations under commercial contracts for the implementation of the maintenance and investment programmes. In 2017, BGN 337 million were paid to the state and municipal budgets. This sum total breakdown per items is as follows: BGN 94 million to the Nuclear Facilities Decommissioning Fund and the RAW Fund, BGN 45 million to the Electricity System Security Fund, taxes and fees – BGN 153 million, and BGN 45 million – to the social and health insurance funds.

As at 31.12.2017, Kozloduy NPP EAD ended with BGN 178 million cash liquidity.

The company's cash management is mainly focused on compliance with the Rules and Regulations for Concentration under Decree of the Council of Ministers No.127/27.05.2013,

through adhering to the requirement that at the end of each month the net exposures in one financial institution do not exceed 25 percent of the total cash of the company. Implementation of the above Rules is part of the measures implemented at the nuclear power plant, which are aimed at diversifying the financial resources and reducing the risk of unrecoverable receivables in case of bankruptcy of banking institutions.

A table presents key indicators of the results achieved from the company's activity and evaluation of the condition and performance of Kozloduy NPP in 2017 in comparison with the previous year.



## FINANCIAL PERFORMANCE INDICATORS

Nº	BGN, thousand	Statement as at 31.12.2017	Statement as at 31.12.2016	Change 2017/2016 (%)
k.1	k.2	k.3	k.4	k.5=(k.3/k.4)-1
1	Total operating income	930 398	839 079	10.88%
2	Total operating costs	(799 605)	(834 681)	-4.20%
3	EBITDA <sup>1)</sup>	322 171	183 239	75.82%
4	EBIT <sup>2)</sup>	130 793	4 398	2 873.92%
5	EBT <sup>3)</sup>	130 127	1 145	11 264.80%
6	EBIT margin	14.1%	0.5%	2 720.00%
7	EBITDA margin	34.6%	21.8%	58.72%
8	Total assets	3 396 750	3 341 672	1.65%
9	LTA <sup>4)</sup>	2 657 603	2 759 914	-3.71%
10	Working capital <sup>5)</sup>	465 861	325 710	43.03%
11	Cash and cash equivalents	178 211	76 018	134.43%
12	Equity	2 721 473	2 608 757	4.32%
13	Return on equity <sup>6)</sup>	4.78%	0.04%	11 850.00%
14	Return on assets <sup>7)</sup>	3.83%	0.03%	12 666.67%

<sup>1)</sup> EBITDA – earnings before interest, taxes, depreciation and amortisation from continuing operations;

<sup>2)</sup> EBIT – earnings before interest and taxes from continuing activities;

<sup>3)</sup> EBT – earnings before taxes from continuing activities;

<sup>4)</sup> LTA - long-term tangible assets + expenses on LTA acquisition;

<sup>5)</sup> Working capital – current assets minus current liabilities;

<sup>6)</sup> Return on equity - EBT/Equity

<sup>7)</sup> Return on assets - EBT/Total assets

## FINANCIAL STATEMENT

	<b>Assets</b>	<b>31 December, 2017 BGN thousand</b>	<b>31 December, 2016 BGN thousand</b>
<b>Non-current assets</b>	Property, plant and equipment	2 657 603	2 759 914
	Intangible assets	11 170	5 908
	Investment property	4 095	4 059
	Investments in subsidiaries	15 161	15 161
	Loans granted to related parties	12 740	14 940
	Receivables from related parties	23 039	-
	Other long-term receivables	5 123	-
	Available-for-sale financial assets	232	232
	<b>Non-current assets</b>	<b>2 729 163</b>	<b>2 800 214</b>
<b>Current assets</b>	Nuclear fuel	235 443	224 810
	Inventory	58 762	60 320
	Trade and other receivables	37 372	57 983
	Loans granted to related parties	2 374	2 352
	Receivables from related parties	155 425	119 459
	Income tax receivables	-	516
	Cash and cash equivalents	178 211	76 018
	<b>Current assets</b>	<b>667 587</b>	<b>541 458</b>
	<b>Total assets</b>	<b>3 396 750</b>	<b>3 341 672</b>
	<b>Equity and liabilities</b>		
<b>Equity</b>	Share capital	244 585	236 165
	Statutory reserves	19 785	19 649
	Revaluation reserve of non-financial assets	1 384 245	1 385 591
	Reserve from revaluations of defined benefit plans	(35 095)	(30 524)
	Other reserves	984 126	984 126
	Retained earnings	123 827	13 750
	<b>Total equity</b>	<b>2 721 473</b>	<b>2 608 757</b>
<b>Non-current liabilities</b>	<b>Liabilities</b>		
	Loans	66 132	105 004
	Retained amounts under construction contracts	159	87
	Financing	179 950	185 509
	Liabilities for employee retirement benefits	49 752	44 073
	Deferred tax liabilities	177 558	182 494
	<b>Non-current liabilities</b>	<b>473 551</b>	<b>517 167</b>
<b>Current liabilities</b>	Trade and other payables	131 234	124 302
	Payables to related parties	9 079	1 051
	Loans	40 056	44 268
	Financing	6 054	6 036
	Retained amounts under construction contracts	5 034	3 522
	Liabilities for employee retirement benefits	8 333	6 627
	Provisions for spent nuclear fuel	668	29 942
	Income tax payables	1 268	-
	<b>Current liabilities</b>	<b>201 726</b>	<b>215 748</b>
	<b>Total liabilities</b>	<b>675 277</b>	<b>732 915</b>
	<b>Total equity and liabilities</b>	<b>3 396 750</b>	<b>3 341 672</b>





## STATEMENT OF PROFIT OR LOSS AND OTHER COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER

	<b>2017</b>	<b>2016</b>
	<b>BGN thousand</b>	<b>BGN thousand</b>
Revenue from electricity sales	909 712	809 553
Revenue from thermal energy sales	2 138	2 010
<b>Revenue from sales of production</b>	<b>911 850</b>	<b>811 563</b>
Revenue from financing	5 615	3 744
Receipts from sales of services, goods, and other sales	12 933	23 772
Material costs	(145 770)	(147 492)
Hired services costs	(120 828)	(174 594)
Employee benefits costs	(204 479)	(190 309)
Depreciation costs	(191 378)	(178 841)
Other costs	(141 276)	(133 240)
Changes to work in progress	3 244	(10 266)
Acquisition of plant, facilities, and equipment on free market commercial basis	882	61
<b>Profit from operating activity</b>	<b>130 793</b>	<b>4 398</b>
Financial costs	(3 532)	(4 271)
Financial income	2 866	1 018
<b>Profit before tax</b>	<b>130 127</b>	<b>1 145</b>
Income tax income/(expenses)	(12 430)	214
<b>Annual profit from continuing operations</b>	<b>117 697</b>	<b>1 359</b>
Annual profit from discontinued operations	202	-
<b>Annual profit</b>	<b>117 899</b>	<b>1 359</b>
<b>Other comprehensive income</b>		
<b>Items that will not be reclassified subsequently to profit or loss</b>		
Revaluation of the liabilities under defined benefit plans	(5 079)	(11 824)
Revaluation of non-financial assets	-	(22)
Income tax relating to items that will not be reclassified subsequently to profit or loss	508	1 184
<b>Other comprehensive income/(loss) for the year, net of tax</b>	<b>(4 571)</b>	<b>(10 662)</b>
<b>Total comprehensive income/(loss) for the year</b>	<b>113 328</b>	<b>(9 303)</b>



## CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER

	<b>2017</b>	<b>2016</b>
	<b>BGN thousand</b>	<b>BGN thousand</b>
<b>Operating activity</b>		
Proceeds from customers	1 008 644	855 829
Payments to suppliers	(299 882)	(321 507)
Payments to personnel and social security institutions	(191 548)	(185 103)
Payments for fees, commissions, and the like	(27)	(36)
Payments to the RAWF, NFDF, and ESSF	(138 971)	(124 895)
(Payments to)/Proceeds from income tax	(15 437)	(5 096)
Cash flows related to other taxes and payments to the state budget	(115 190)	(97 138)
Cash flows related to insurance policies	(15 298)	(9 876)
Other cash flows from operating activities	18 392	45 411
Net cash flows from continuing operations	250 683	157 589
Net cash flows from discontinued operations	(9 517)	-
<b>Net cash flows from operating activities</b>	<b>241 166</b>	<b>157 589</b>
<b>Investment operations</b>		
Acquisition of property, plant, and equipment	(96 858)	(127 967)
Proceeds from sales of property, plant, and equipment	14	3
Proceeds from loans	2 150	2 634
Interest received	422	475
Dividends received	1 028	529
<b>Net cash flows from investment operations</b>	<b>(93 244)</b>	<b>(124 326)</b>
<b>Financing operations</b>		
Repayments of loans	(42 784)	(44 251)
Interest paid	(2 334)	(2 845)
Dividends paid	(611)	-
<b>Net cash flows from financing operations</b>	<b>(45 729)</b>	<b>(47 096)</b>
<b>Net change in cash and cash equivalents</b>	<b>102 193</b>	<b>(13 833)</b>
<b>Cash and cash equivalents at the beginning of the year</b>	<b>76 018</b>	<b>89 851</b>
<b>Cash and cash equivalents at the end of the year</b>	<b>178 211</b>	<b>76 018</b>





## INTERNATIONAL COOPERATION

In pursuance of its main priority to ensure a higher level of safety, Kozloduy NPP studies and applies the world's best practices and keeps constant information and operating experience exchange. This is achieved through intensive and open cooperation with the International Atomic Energy Agency (IAEA), the World Association of Nuclear Operators (WANO) and other international and national non-governmental organisations. The active partnership with other plants and specialised research institutions in the nuclear energy field also makes an indisputable contribution. Throughout the last year, representatives of the Bulgarian nuclear power plant took part in a number of missions and inspections such as the OSART mission of IAEA in Krsko NPP – Slovenia, Oikiluoto NPP – Finland, the WANO peer review at Edwin I. Hatch NPP – the USA, the pre-SALTO mission in Oskarshamn NPP – Sweden, a peer review in

Kola NPP – Russia, WANO technical support missions in Zaporozhye NPP, Khmel'nitski NPP and the State Enterprise "National Nuclear Energy Generating Company "Energoatom" in Ukraine, Leningrad NPP, Balakovo NPP, Kursk NPP and Bilibino NPP in Russia.

The Moscow Centre of the World Association of Nuclear Operators (WANO-MC) performed a Peer Review in Kozloduy NPP from 23<sup>rd</sup> November to 8<sup>th</sup> December. At the same time, there was a pilot Crew Performance Observation of the main control room crews trained at the full-scope simulator for reactor type WWER-1000 (FSS-1000) at the KNPP Training Centre. In the framework of the peer review the plant performance was reviewed in two fundamental, six functional and ten performance objectives allocated to eleven areas: Organisation and Administration, Operations, Maintenance, Engineering, Radiological Protection,





Performance Improvement, SOER, Chemistry, Training, Fire Protection and Emergency Preparedness.

Under the cooperation plan between Kozloduy NPP and WANO-MC, in April the plant hosted a technical support mission entitled "Trend analysis in all areas of NPP performance – conduct of operations, maintenance and repair, technical support, and oversight and analysis".

The nuclear power plant hosted two international benchmarking meetings with Russian experts. The first one included "Concern Rosenergoatom" OJSC representatives and was on the topic of "Integrated Management System". At the other meeting representatives of JSC "Atomenergoremont", Russia, became familiar with different aspects of the maintenance activities for pipeline valves, aiming to enrich with new methods the practices used in the four LWGR-1000 units of Kursk NPP.

In August, Kozloduy NPP hosted the International Workshop on Effects of Water Chemistry on Operational Lifetime of Nuclear Power Plants Equipment. The event, organised by WANO-MC together with the Bulgarian nuclear power plant, brought together thirty-five experts from Iran, China, Russia, Slovakia, Czech Republic, Ukraine and Bulgaria. The workshop particularly highlighted the role of water chemistry on the potential for lifetime extension of the WWER type of

nuclear reactors.

Kozloduy NPP was a co-organiser of the annual international conference of the Bulgarian Atomic Forum – BULATOM, on "Bulgarian Nuclear Energy – National, Regional and World Energy Security", held in the beginning of June, 2017, under the patronage of the Ministry of Energy and the Bulgarian Nuclear Regulatory Agency. The participants in the conference were diplomats, representatives of leading companies in the nuclear field, Bulgarian and foreign experts. The Bulgarian nuclear power plant hosted the Seventh Meeting of the Technical Directors/Chief Engineers of the Nuclear Power Plants and Operating Organisations Members of WANO-MC which was held in Sofia. The 28 participants in the meeting were representatives of NPPs and companies in the nuclear field from Russia, Ukraine, Armenia, Hungary, Lithuania, Finland, Slovakia, Iran, Bulgaria and the WANO-MC. A vast number of topics were discussed at the forum. They were connected with good practices in nuclear power plants operation encompassing nuclear fuel management and storage and the organisation of maintenance works; experience in the decommissioning of nuclear power installations; new NPP construction projects; innovative science researches in the nuclear energy field, etc.





## HUMAN RESOURCES MANAGEMENT

### PERSONNEL PROFILE

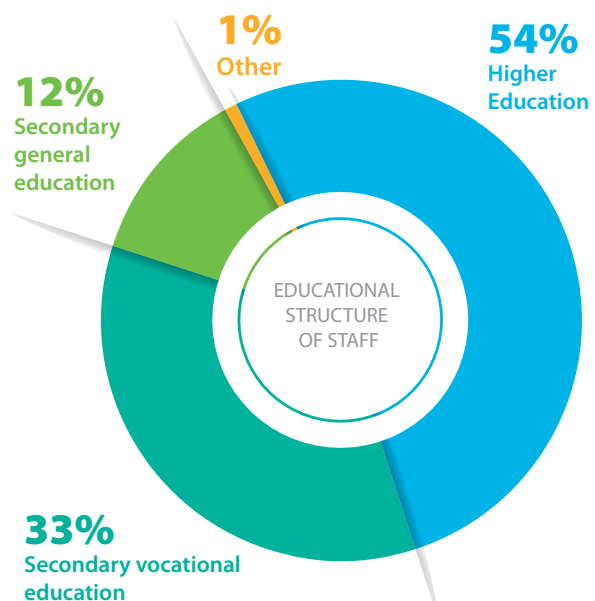
The long-term safe operation of the nuclear power units is a strategic goal in the Management Policy of Kozloduy NPP, and the active participation of the personnel – a key factor for success.

In compliance with the requirements to personnel in the power units operating licences, the company is committed to provide the necessary numbers of properly qualified employees to ensure the safe implementation of the activities.

The number of plant employees is maintained in compliance with the approved positions payroll list. Of the new employees joining the NPP team last year, 55% have a higher education degree, and 29% of them are under 30-years of age. Forty-eight percent of the newcomers have taken positions such as physicists, chemists and experts in the fields of the nuclear energy, electrical equipment, construction, investments, etc.

### COMPETENCE AND HIGH QUALIFICATION

The availability of qualified personnel is an essential requirement for safe operation and ensures successful acquisition of knowledge and skills to achieve a high level of performance of the activities. More than one half of the plant personnel hold university degrees, while one third have graduated secondary vocational schools.



## CARE FOR THE NEXT GENERATION OF SPECIALISTS

Units 5 and 6 plant life extension requires measures to provide for the long-term operation ensuring the necessary human resources.

That is why the company regularly takes part in university career expositions. Throughout 2017, once again the plant demonstrated its career opportunities at the Internship forum of Sofia University St. Kliment Ohridski, and at Career Days organised by the Technical University of Sofia. Those exhibitions provide young specialists with information about job opportunities at the largest electricity generating power plant in Bulgaria and about the employee benefits offered by the company.

Being a socially responsible company assisting the professional orientation of school and university students as well as unemployed young people on the labour market, during the past year, Kozloduy NPP took part in the Educational Panorama held as an initiative of Kozloduy Municipality and in the Labour Market for Young People Aged up to 29, organised by the Kozloduy Employment Bureau.

For the fourth consecutive year, the plant took part in the European project of Youth Education and Employment under the Operational Programme "Human Resource Development" of the National Employment Agency, thus assisting unemployed young people in finding realisation at the company.

In April 2017, Kozloduy NPP took part in a workshop organised

by the Bulgarian Nuclear Society which was entitled "Career and personal accomplishments via employment in the nuclear sector in Bulgaria and across the world." This event informed young people interested in nuclear energy about the opportunities for work and career development at Kozloduy NPP.

In June, the Bulgarian NPP participated in an international workshop held under the auspices of Khmel'nitski NPP, Ukraine. At the meeting focused on human resource management and staff rejuvenation process, Bulgarian, Ukrainian, Russian, and Czech specialists discussed means to attract young specialists to the industry, use of global experience in human resource management, staff motivation methods, coaching, etc.

In July and August 2017, for the thirteenth consecutive year, 19 university students successfully completed paid internship programmes at the plant. Apart from that, eight students completed individual unpaid internships enriching their theoretical knowledge from university and receiving valuable assistance in the preparation of their graduate theses.

By organising the 2017/2018 scholarship programme admission, Kozloduy NPP demonstrated its willingness to invest in human resources and a strong commitment to the professional development of the next generation of engineering specialists.

## MOTIVATION OF PERSONNEL

Maintaining a high employee motivation is one of the priorities for an effective management of the company. Annually, since 2007, motivation polls have been conducted to facilitate feedback from the employees. In 2017, the

questionnaire was updated, and the pilot poll was conducted at the end of the year. The results have shown the highest motivation since its first conduct.







## PERSONNEL TRAINING

The staff training and qualification system employed at Kozloduy NPP complies with the relevant national requirements, international standards, and established best practices. Thanks to the Personnel and Training Centre Division, the power plant is licensed to conduct specialised training on activities carried out in nuclear facilities and work with ionising radiation sources issued by the Bulgarian Nuclear Regulatory Agency.

The training process goals are consistent with the priority stated in the plant's Management Policy for maintaining certified, competent and motivated personnel, enforcing a high level of safety culture; development of a corporate culture in which qualification is of crucial importance; effective use and management of personal and corporate

knowledge; encouraging the acquiring of the necessary knowledge, skills and positive attitude to work.

The mandatory specialised training is based on the systematic approach requirements. The specialised training proceeds in conformity with the programmes for initial or continuing training; individual programmes are developed for the licensed personnel; the rest of the personnel are trained in accordance with approved curriculum schedules. The specialised training is delivered at the Training Centre premises, or at workplaces, employing different forms such as classroom, simulator, hands-on and on-the-job training.

The same training requirements apply to the preparation of both the plant's and subcontractor's personnel assigned to perform activities in nuclear facilities.

## RESOURCES

The Training Centre provides a varied well-maintained material and technical facilities for delivering of quality training: classrooms equipped with modern teaching aids, a mockup room, workshops for vocational instruction using realistic machinery. In 2017, refurbishment was completed of the premises intended for hands-on training of individuals carrying out activities in the radiologically controlled area (RCA). Using equipment that simulates the real-time conditions at the radiological control facility, practical training

on RCA entry and exit requirements is conducted efficiently and quickly.

The WWER-1000 Full-Scope Simulator (FSS-1000) providing for the specialised initial and continuing training of the operating personnel performing functions to ensure and control nuclear safety, is maintained in a condition such as to reflect the current state of the KNPP reference unit 6. For that purpose, 45 of the design modifications implemented on unit 6 were also introduced at the FSS-1000 configuration.

## THEORY AND PRACTICE

Apart from the classroom training, increasingly the power plant implements e-learning under the ESTRA platform which is accessible to plant and contractors' staff. Thus, simultaneous training of practically unlimited number of people and planning flexibility are ensured in order to satisfy training needs in a timely manner while fully taking into account the workload of the trainees. Throughout 2017, the platform provided access to the basic training courses for contractors – in Bulgarian, Russian, and English. A total of 257 employees have completed such training. For the Kozloduy NPP staff, ESTRA offers both initial and continuing training. Throughout 2017, 29 employees used ESTRA for initial training, 821 persons used it for continuing training, and 137 – for extraordinary training.

Apart from classroom and workshop training at the Training Centre, and through ESTRA-based e-learning, staff knowledge and skills are also cultivated in the field. In 2017, on-the-job training amounted to 3 850 hours. It was delivered by more than 300 lecturers and instructors on topics related to the immediate operating and maintenance activities performed by the staff.

The following courses were conducted at the FSS-1000 in 2017: initial simulator training for various positions; continuing training of units 5 and 6 MCR operator crews;

extra-schedular training sessions; general emergency training; training of FSS-1000 trainers; and, verification and validation of symptom-based emergency procedures.

As a result of the analysis of the FSS-1000 training needs, 8 scenarios were developed for the spring and 9 for the autumn semesters.

In 2017, trainings, internships, and professional practice terms were organised and carried out for 28 students from different study courses and programmes at the technical universities in Sofia and Gabrovo, and Sofia University St. Kliment Ohridski .



## INTERNATIONAL PROJECTS

Under an international project, six multimedia courses on different production process topics were developed. Their



implementation in the ESTRA platform will render this type of training even more effective.

As part of the long-lasting partnership with the Belarusian State University, in 2017, a one-week training course was delivered to a group of 18 Belarusian students and 5 of their instructors, at the Kozloduy NPP Training Centre.

International cooperation in the field of training was extended with a two-week benchmarking visit of a team of Egyptian specialists, IAEA scholarship students, involved in the organisation of the training process at the future first Egyptian nuclear power plant.

The increasing striving for partnership on behalf of many foreign organisations has proven the high degree of competence of the Training Centre staff and excellent opportunities for training at Kozloduy NPP.





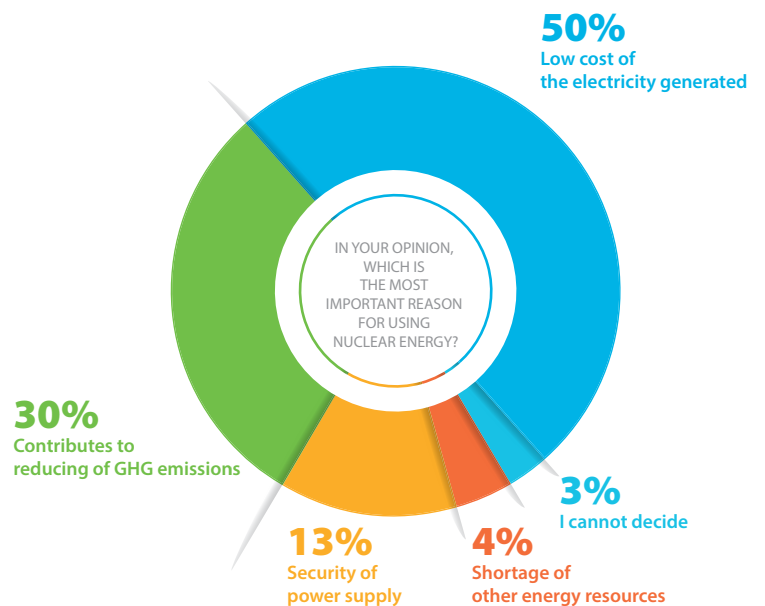
## PUBLIC RELATIONS

Kozloduy NPP has always satisfied growing public interest, following the well-established principles of transparency and open dialogue.

In order to gain personal impressions and knowledge of this high-tech enterprise, more than 1 300 people visited the nuclear power plant in 2017. Among them were secondary school, university and military school students, lecturers, representatives of diplomatic missions and government institutions, energy industry specialists and many other citizens from the country and abroad. Nearly half, 48%, of all the visitors to the Bulgarian NPP were children and young people studying at different secondary and higher schools. During the annual Open Day initiative held on 1 July, 2017, visits were organised to the main control rooms and turbine halls of the 1000 MW units 5 and 6. Experts from the plant told the visitors how the manufacturing process is carried out and how the safe operation of the nuclear power installations is ensured. The Information Centre showed documentaries about the construction and development of the first nuclear power plant on the Balkans. The visitors were also provided numerous information materials for Kozloduy NPP.



By participating in the opinion poll conducted for years, visitors have the opportunity to express their attitude to the nuclear power plant and nuclear energy. The results clearly confirm that the majority of respondents – 94% – have no objections to it. The low price of the electricity produced is indicated by 50% of the participants as the most important reason for its use; next comes its ecological effect pointed out by 30%.







All those interested in Kozloduy NPP may visit the corporate site and receive further information. Up-to-date data on power generation, safe operation, environmental monitoring information, emergency preparedness, environmental assessments, etc. are published on the site. The printed editions of the “Parva Atomna” newsletter, annual report, leaflets, brochures, etc. that are distributed free throughout the year are also available in electronic form on the plant web site.

In 2017, the trend was preserved for high interest in the site: [www.kznpp.org](http://www.kznpp.org) had around 500 000 hits over the year.




In response to public attention to Kozloduy NPP, special events focusing on its activities and role for environmental protection are regularly organised. A secondary school student’s conference entitled “50 Years of Bulgarian Atomic Energy – Safe, Reliable and Environmentally Friendly” was held on 10 March, 2017. This event was organised by Women

in Nuclear (WiN-Bulgaria) and under the auspices of Kozloduy NPP. More than 90 students from the towns of Kozloduy and Belene joined this forum of youth.

In late 2017, a project supported by the nuclear power plant was successfully realised by the Bulgarian Union of Veterans in Nuclear Industry. This was a permanent exposition opened in the Vratsa Regional Historical Museum and dedicated to the history of Kozloduy NPP. The official opening ceremony was attended by many citizens, journalists, museum specialists and former plant managers. Through multimedia and information boards the new exposition room presents different stages of the construction and operation of the nuclear power plant. The aim is to preserve for the future generations the history, atmosphere and spirit of important historical moments and achievements of the Bulgarian nuclear energy and giving grounds for national pride.



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Kozloduy NPP EAD  
Kozloduy 3321  
phone: 0973 7 20 20  
fax: 0973 8 05 91  
e-mail: [info@npp.bg](mailto:info@npp.bg)  
[www.kznpp.org](http://www.kznpp.org)