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Resourcing with green energy

Energy production in Waste water treatment plant Kubratovo

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22/06/2018

"Sofiyska voda" as a part of Veolia, operates the full water cycle of Sofia Municipality - water supply, wastewater collection services and wastewater treatment. What is special about the water cycle of Sofia is that in 2017 over 91% of the electrical energy required for the all services, is provided by own production.

Sofiyska voda operates the water cycle of Sofia and is responsible for the water supply, wastewater collection services and wastewater treatment.

Sofia wastewater treatment plant (WWTP) is designed to treat the city mixed wastewater (domestic, industrial and storm water) to an extent which allows for it to be discharged into the Iskar River, the receiving water body. The city sewerage network is a combined type, which means that surface water from rainfalls and snowmelt enter the plant. To cover peak water flow, the plant facilities are sized to take hydraulic load equal to twice the maximum hourly flow in dry weather. The wastewater flows by gravity through the sewerage system of Sofia to the WWTP. The length of sewers and collectors is approximately 1,700 km.
For its activities the company manages energy-intensive assets, which in 2017 consumed over 25 400 MWh electricity.

Sofia WWTP has a design capacity of **1.3 million p.e.** and treats more than 400 000 m^3 of domestic and industrial wastewater daily to the most strict EU requirements.

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The plant was commissioned in 1984 and historically consumed between 16 000 and 24 000 MWh electricity annually. Following the installation of combined heat and power (CHP) units in **2010** the energy produced annually on site rose from **15 288 MWh** to **23 100 MWh in 2017**. Implemented measures to reduce energy consumption led to an excess of 4 300 MWh in 2017, i.e. the plant produced 23 % more energy than was needed for its operation.

The continuous optimizations in the Sofia WWTP operations – optimized aeration process, improved anaerobic digestion process and utilized **heat potential** of on-site CHPs - led in 2017 to achieving **123 % energy self-sufficiency** at Sofia WWTP and **91%** energy self-sufficiency of the whole water supply system

of Sofia Municipality. This progress has been achieved through targeted initiatives as:

Energy efficiency - particularly in 2017, when the company commissioned **new frequency-regulated air blowers** for the biological step, which increased the efficiency of the process by **11 per cent**. In parallel, a project for utilising exhaust heat from the CHP engines was implemented and it brought additional installed capacity of 570 kW, which has been of great importance as an additional heat source to **increase the temperature of the anaerobic digesters** on site. This project has resulted in an increase of **10 %** in the energy produced on site.

Air flow regulation - STAR system dissolved oxygen control module, assigns the required dissolved oxygen concentration in each section of the aeration tanks, based on real-time measurements. The new magnetic bearings turbo blowers are regulated by the pressure difference in the air piping with control of the iris valves. The achieved efficiency compared to **2016 is 11,5 %**, or 0,46 kW/kgBOD with the new blowers.

1973-1975 was designed the first urban wastewater treatment plant (WWTP) in Bulgaria

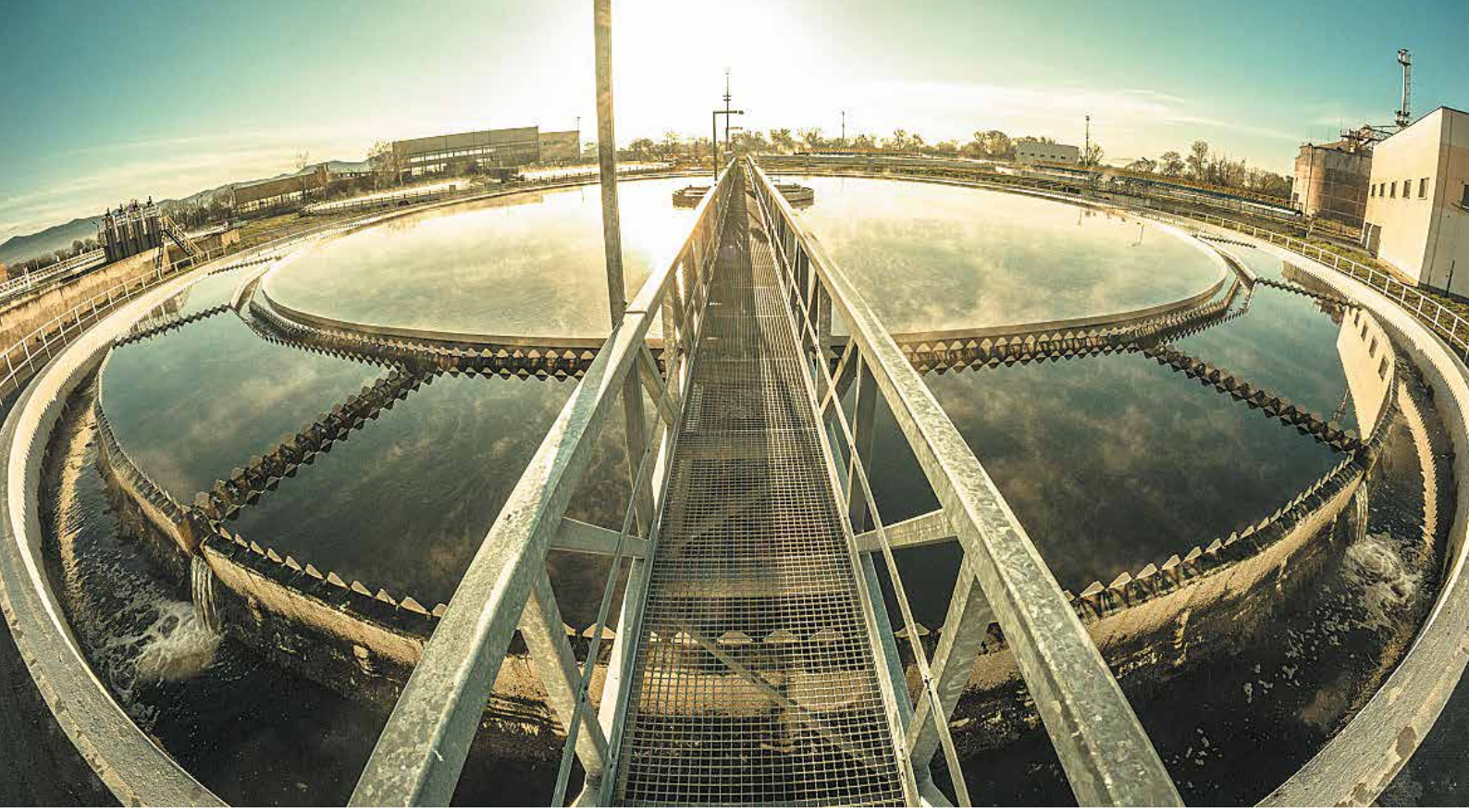
1984 WWTP starting operation

1994-1996 Partial reconstruction of the sludge treatment facilities

2000 25-year Concession Agreement signed with the Municipality of Sofia

2009 The Company commissions cogeneration installation for generation of electricity and heat from biogas.

2011 Nitrogen and phosphorus are removed from wastewater

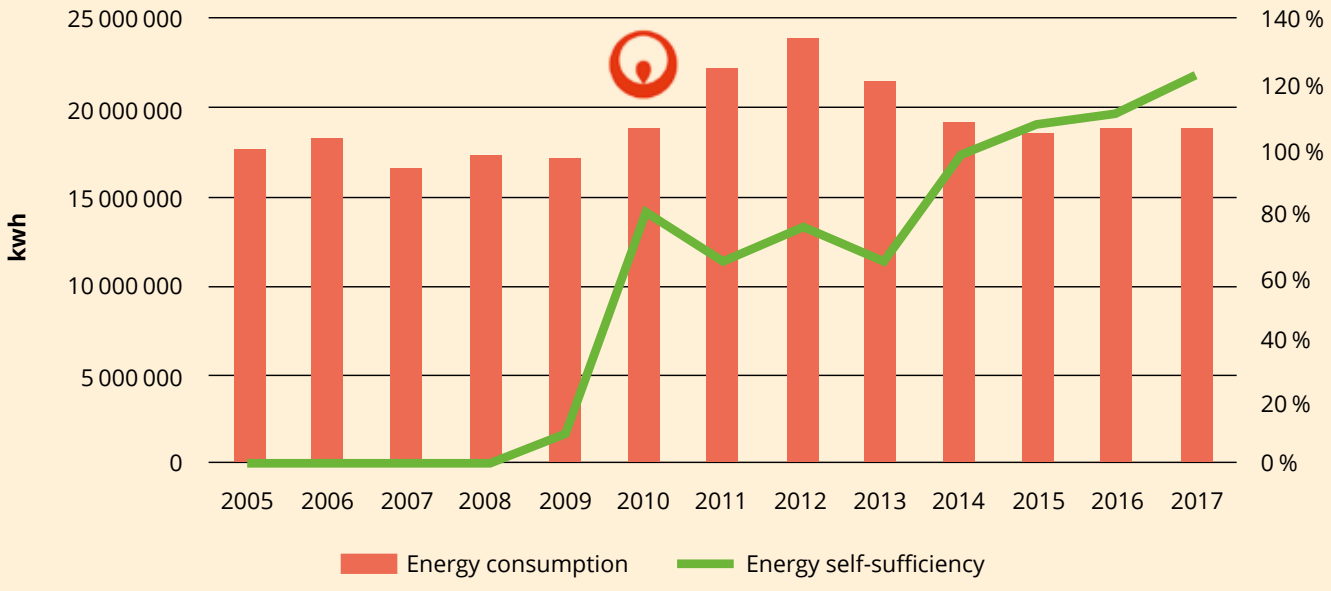


Energy SCADA monitoring - the development and improvement of the Energy SCADA in 2017 allows more precise control over the electrical and thermal consumption at every stage of the process. Analyzing the information is an important part of the **energy management** and a major factor for improvement of efficiency.

Digestion temperature - the new system for utilizing heat from exhaust systems of the CHPs provides an additional capacity of 570 kW/h. This allows to keep the temperature in anaerobic digestion process above 37-38°C even in the cold span of the year and to improve the **quality of digestion process** and **biogas production**. This also prevents **digester foaming** (due to Microthrix parvicella).

With its environmental performance Sofia WWTP is paving the way for Sofia water cycle to be among the **first fully energy neutral water cycles in the world.**

Trend of WWTP energy consumption and self-sufficiency



Description of the site

Capacity

Design capacity: 480 000m³/d, 1 600 000 PE

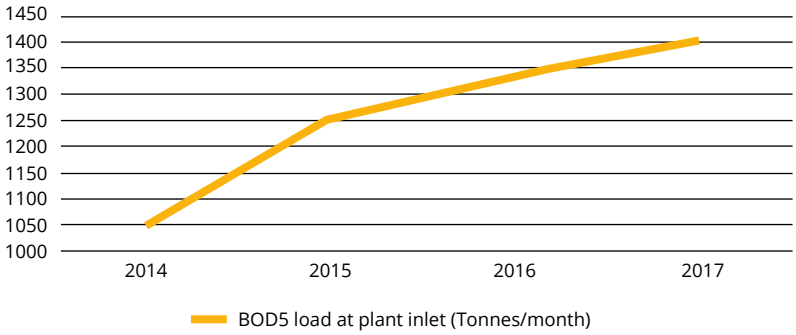
Inlet load	Design Load	Real Load
COD, mgO2/l	-	290
BOD, mgO2/l	164	128.9
TP, mg/l	5.8	3.7
TN, mg/l	40	31.9
SS, mg/l	173	154

STAR optimization system

The STAR lite optimization system is operating in Kubratovo WWTP since the beginning of 2013. The control modules included are regulation of dissolved oxygen, return sludge, metal dosing, recirculation, flow distribution and sludge age.

General Layout of the plant
With its environmental performance Sofia WWTP is paving the way for Sofia water cycle to be among the first fully energy neutral water cycles in the world.

BOD5 load at Sofia WWIP inlet



Main Treatment stages

Waste Water treatment	
Screening	10 coarse (distance between bars 30 mm) and 10 fine screens (distance between bars 6 mm)
Grit removal	6 aerated channels for sand and grease removal, with classifiers and/or sand fields, for sand dewatering
Primary Settling	4 radial primary settling tanks, 54 m diameter, 5.5 m deep, with pumping station for primary sludge, continuous operation
Grease removal	From grit chambers – mechanically removed, PSTs and SSTs – to gravity thickening
Biological treatment	6 aeration tanks, 173 000 m³ total volume, 5.5 m deep, with two convertible zones – BioP/Denitrification (23 000 m³) and Denitrification/Nitrification (29 000 m³), denitrification zone (42 000 m³), two constant aeration zones (79 000 m³). Each AT has two regulated, internal recirculation pumps - 3.2 m³/s each
- Removal of Phosphorus	Either in BioP zone in summer, or chemical precipitation with FeCl3 in winter, dozed in the last aerated corridor, automated by STAR system
- Removal of Nitrogen	Nitrification with preliminary denitrification, with internal recirculation pumps, regulated by STAR system
- Blowers	Four Sulzer HST blowers, 14 000 Nm³/h each, regulated by STAR system DO control
Secondary settling	10 radial SSTs, 54 m diameter, 5.5 m deep, with 3 pumping stations for return sludge
Recirculation of AS	3 automated pumping stations, with 3 pumps each
Internal waste water flows	Two separate flows - sludge waters from gravity thickening and sludge waters from dewatering, drying beds and internal waste waters, gathered in a 6 000 m³ reservoir and pumped at inlet when load is low
Sludge Treatment	
Excess sludge treatment	Gravity pre-thickening in 2 radial thickeners, mechanical thickening in 3 drum and one belt thickeners
Primary Sludge treatment	Only pumping from PSTs
Anaerobic Stabilization	4 anaerobic, mesophilic digesters, 7 000 m³ each, with pump and gas agitation, continual feeding of mixed sludge
Sludge Dewatering	2 gravity thickeners, used as buffers, 5 belt filter presses
Liming	1 silo, mixing after dewatering, before drying beds
Biogas utilization	3 CHPs – 1 063 kW electrical/1 088 kW heat power each (GE Jenbacher); 2 hot water boilers in operation only in cold winter conditions. Produced electrical energy is utilized in plant; excess energy is sold to the grid. Heat energy is mainly utilized for heating anaerobic digesters
Exhaust gases heat utilization	570 kW exhaust gas heat utilizer, for additional heating of digesters and buildings
Sludge Disposal	After drying beds, sludge is used in farming as a fertilizer

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