

Generation in the Russian Federation

Generation in the Russian Federation includes two segments: ‘Electric Power Generation in the Russian Federation’ and ‘Thermal Power Generation in the Russian Federation’.

‘Electric Power Generation in the Russian Federation’ segment

The segment is managed by JSC Inter RAO – Electric Power Plants, which runs 21 major power plants in Russia with total installed capacity of 22.9 GW. The power plants use different types of fuel (gas, coal, and fuel oil), which makes it possible to optimally utilize the advantages of each type depending on the geographical location and the economic situation in the region. Fuel diversification also reduces the risk of a decline in power generation in the event of disruptions to fuel supplies.

Generating assets are distributed throughout the Russian Federation and, consequently, have a lower degree of sensitivity to macroeconomic changes in the regions where they operate. The synergistic effects generated from the use of different types of fuel and the optimal geographical distribution of assets lends additional stability to the Company’s business model.

The CDA program has made it possible to renovate outdated facilities, remove inefficient equipment, and introduce modern equipment with a low fuel component. At present, the average specific fuel consumption for electricity supply¹ does not exceed 300 grams of fuel equivalent per kWh.

The Mayakovskaya and Talakhovskaya TPPs with total capacity of 316 MW as well as two units of the Pregolskaya TPP with capacity of 227 MW were commissioned in the Kaliningrad Region in 2018.

LAUNCH OF THE MAYAKOVSKAYA AND TALAKHOVSKAYA TPPS

IN 2018, THE MAYAKOVSKAYA AND TALAKHOVSKAYA TPPs WERE COMMISSIONED WITH TOTAL CAPACITY OF 316 MW. THE POWER PLANTS WERE BUILT AS PART OF A PROJECT TO ENSURE THE ENERGY SECURITY OF THE KALININGRAD REGION, WHICH IS BEING IMPLEMENTED BASED ON INSTRUCTIONS FROM RUSSIAN PRESIDENT VLADIMIR PUTIN AND IN ACCORDANCE WITH A DIRECTIVE OF THE RUSSIAN GOVERNMENT. UNDER THE PROJECT, FOUR POWER PLANTS WITH TOTAL INSTALLED CAPACITY OF 1 GW WILL BE BUILT IN THE REGION BY 2021. THE MAIN EQUIPMENT OF THE PLANTS IS 100% RUSSIAN-MADE. THE MAYAKOVSKAYA AND TALAKHOVSKAYA TPPs ARE DESIGNED TO HANDLE PEAK LOADS IN THE ENERGY SYSTEM OF THE KALININGRAD REGION.

LLC Kaliningrad Generation

A subsidiary of JSC ROSNEFTEGAZ with a minority stake held by PJSC Inter RAO, whose assets are leased from a subsidiary of PJSC Inter RAO, was established for the construction of power plants in the Kaliningrad Region. The company’s assets include the Mayakovskaya TPP (Gusev), Talakhovskaya TPP (Sovetsk), Pregolskaya TPP (Kaliningrad), and Primorskaya TPP (Svetlovsk urban district).

LIST OF KEY ASSETS²

- | | |
|----------------------------|---------------------------|
| 1. Verkhnetagilskaya TPP | 8. Kashirskaya TPP |
| 2. Gusinoozyorskaya TPP | 9. Kostromskaya TPP |
| 3. Dzhubginskaya TPP | 10. Permskaya TPP |
| 4. Ivanovskiye CCGT | 11. Pechorskaya TPP |
| 5. Irikliinskaya TPP | 12. Northwest CHPP |
| 6. Kaliningradskaya CHPP-2 | 13. Sochinskaya TPP |
| 7. Kaliningrad Generation | 14. Urengoyanskaya TPP |
| • Pregolskaya TPP | 15. Kharanorskaya TPP |
| • Mayakovskaya TPP | 16. Cherepetskaya TPP |
| • Talakhovskaya TPP | 17. Yuzhnouralskaya TPP |
| | 18. Yuzhnouralskaya TPP-2 |
| | 19. Nizhnevartovskaya TPP |

¹ Specific fuel consumption for busbar output.

² Detailed descriptions of the assets are available on the website: <http://irao-generation.ru/>

The Pregolskaya TPP is being built on a territory adjacent to the Kaliningradskaya CHPP-2. The design includes four combined-cycle plants with unit capacity of 114 MW for each power unit. The new sources of capacity consisting of four combined-cycle power units with total capacity of 456 MW will ensure the energy security of the Kaliningrad Region and make its energy system more maneuverable. All the core equipment of the plant was produced by Russian enterprises: 6F.03 gas turbines were delivered by Russian Gas Turbines (Rybinsk, Yaroslavl Region), the generators for them were supplied by the Novosibirsk Scientific and Production Association ELSIB, the steam turbines came from the Power Machines plant in Kaluga, and Podolsk Engineering Plant manufactured the waste heat boilers.

'Thermal Power Generation in the Russian Federation' segment

The segment is comprised of three major heat generating companies with total installed electric power capacity of 6.52 GW and installed thermal power capacity of 19,437 Gcal/h. The segment also includes three heating networks with total length of 2,449 km.

LIST OF KEY ASSETS

- | | | |
|----------------|-------------------------|-----------------------|
| 1. JSC TGC-11 | 2. JSC Tomsk Generation | 3. Bashkir Generation |
| > JSC Omsk RTS | > JSC Tomsk RTS | Company Group |
| | | > LLC BashRTS |

JSC TGC-11

JSC TGC-11 is one of the largest heat generating companies in Siberia. The company's power facilities have installed electric power capacity of 1,565.2 MW, which accounts for more than 97% of the total installed capacity in the operating area of the Omsk Regional Dispatch Office of JSC System Operator of the Unified Energy System (1,601.2 MW as of January 1, 2019).³ Electricity generation by JSC TGC-11 plants in 2018 amounted to more than 96% of the total output in the operating area of the Omsk Regional Dispatch Office (6.424 bln kWh of 6.626 bln kWh). The power facilities of JSC TGC-11 have installed thermal capacity of 3,669.24 Gcal/h. JSC TGC-11 manages: CHPP-3, CHPP-4, CHPP-5, JSC Omsk RTS (subsidiary), EC-2, Kirovsky District Boiler House, Heat Networks, Thermal Inspectorate and Energy Audit, and Teploenergosbyt.

The company uses various types of fuel (gas, coal, and fuel oil), which ensures the reliable operation of generating equipment and minimizes logistical risks.

As part of the CDA program at Omskskaya CHPP-3, the boiler equipment was modernized and a new PGU-90 and a new gas turbine with capacity of 120 MW were commissioned. The Omskskaya CHPP-5 wrapped up modernization work on its turbine units. The large-scale CDA program enabled JSC TGC-11 to join the list of '100 Best Organizations of Russia' in the category of 'Ecology and Environmental Management' in 2018.

JSC Omsk RTS

JSC Omsk Heat Distribution Networks (Omsk RTS) unites the heating grid and heat supply business as well as heat generation from boiler sources in Omsk. The company includes the joint venture Heat Networks (Heat Networks JV), Teploenergosbyt JV, Heat Inspectorate and Energy Audit JV, CHPP-2 JV, and Kirov Regional Boiler House JV.

JSC Omsk RTS exclusively serves the main district heating network. The length of its heating networks is 267 km.

JSC Tomsk Generation

JSC Tomsk Generation produces electric and thermal power. The company unites the generating capacity of the city of Tomsk. Using its own sources (TPP-2, CHPP-3, and CHPP-1), the company provides Tomsk with 96% of its thermal power and handles 23% of the electric power needs of the Tomsk Region. The company's plants have installed electric power capacity of 485.7 MW and installed thermal power capacity of 2,390.5 Gcal/h.

JSC Tomsk RTS

JSC Tomsk RTS is a subsidiary of JSC Tomsk Generation. JSC Tomsk RTS includes: the Heat Networks JV, Teploenergosbyt JV, and Thermal Inspectorate and Energy Audit JV.

The Thermal Networks joint venture transmits thermal power from thermal power plants and state district power plants and is responsible for the operation of main and intra-district thermal power networks.

To provide Tomsk subscribers with hot water, JSC Tomsk RTS signed an agreement with LLC Tomskvodokanal to provide cold water for the city's hot water supply needs via a closed system. Cold water is supplied to central heating points and local sources, where it is heated by boilers. JSC Tomsk RTS purchases about 2.8 million cubic meters of cold water per year for these purposes.

JSC Tomsk RTS purchases thermal power as hot water and coolant from JSC Tomsk Generation – the sources of heat supply are the Tomsk TPP and CHPP. JSC Tomsk Generation treats the water to be fed to hot water supply networks. The total length of its heating networks is 638 km.

³ Source – http://so-ups.ru/index.php?id=rd_u_omsk

LLC Bashkir Generation Company

LLC Bashkir Generation Company (BGC) manages generating assets in the Republic of Bashkortostan and coordinates the work of LLC Bash RTS. The company unites 19 large and small power plants that are located throughout Bashkortostan and provide energy to residents of the republic and neighboring regions. The company's generating assets include one thermal power plant, ten combined heat and power plants, seven hydroelectric power plants (including five small micro-hydroelectric power plants), and one wind power plants.

The installed thermal power capacity of LLC BGC and LLC Bash RTS accounted for more than 95%¹ of the total capacity of heat supply sources in the Republic of Bashkortostan (12,245.0 Gcal/h of 12,570.9 Gcal/h) as of the end of 2018.

LLC BGC devotes considerable attention to environmental issues: it has implemented a number of projects to reduce the volume of wastewater generation,

water consumption, and pollutant emissions to the atmosphere. Sludge dewatering equipment installed by the company with mechanical purification of natural waters helps to minimize the negative environmental impact since sludge water disposal facilities have been eliminated. The dehydrated sludge is used when leveling the urban landscape. Automated emission control has been installed at a number of plants.

According to SO UES,² power plants in the operating area of the Bashkir Regional Dispatch Office generated 24.45 billion kWh of electricity in 2018, of which 18.86 billion kWh (more than 77%) was generated at the generating facilities of LLC BGC. The operating area of the Bashkir Regional Dispatch Office has generating facilities with installed electrical capacity of 5,581 MW, of which 4,445 MW (approximately 80%) belong to the power plants of LLC BGC.

SMALL GENERATING FACILITIES MANAGED BY LLC BGC

CHPP	Facility	Turbines	Installed electric power capacity, MW	Installed thermal power capacity, Gcal/h
	Tyupkilda Wind Power Plant	3 ET-550	0.55	
		Total	1.65	
Ufinskaya CHPP-1	Mechetlinskaya Small Hydroelectric Power Plant	2 PR20/1-G-100	0.2	
		1 PR20/1-G-5	0.045	
		Total	0.445	
Sterlitamakskaya CHPP	Slakskaya Small Hydroelectric Power Plant	2 PR20/1-G-35	0.045	
		1 PR20/1-G-25	0.022	
		Total	0.1	
Novo-Sterlitamakskaya CHPP	Avzyanskaya Small Hydroelectric Power Plant	PR20-G-60	0.09	
	Uzyanskaya Small Hydroelectric Power Plant	PR-50	0.055	
	Kaga Small Hydroelectric Power Plant	PR20-G-60	0.09	
Zauralskaya CHPP	Turbine set	7 JMS 620	2.49	2.2
		Total	17.43	15.4

¹ Source – http://bashstat.gks.ru/wps/wcm/connect/rosstat_ts/bashstat/ru/statistics/

² Source – http://so-ups.ru/index.php?id=rdu_bashkiria

LLC BashRTS

LLC BashRTS is a subsidiary of LLC Bash RTS and provides heat to eight cities of Bashkortostan: Ufa, Blagoveshchensk, Sterlitamak, Salavat, Ishimbay, Sibay, Neftekamsk, and Agidel, and is the main guaranteed supplier of thermal power in the republic with some 1.7 million consumers. In order to support the administrative management of the heating network areas and boiler shops scattered throughout the republic, LLC BashRTS has established Ufa Production Office and two branches: BashRTS-Sterlitamak and BashRTS-Neftekamsk.

LLC BashRTS serves 26 boiler houses, 305 central heating points, and 21 pumping stations. The total length of heating networks is 1,544 km. LLC BashRTS has total installed electric and thermal power capacity of 24 MW and 3,587 Gcal/h, respectively.

SMALL GENERATING FACILITIES MANAGED BY LLC BashRTS

CHPP	Facility	Turbines	Installed electric power capacity, MW	Installed thermal power capacity, Gcal/h
Shaksha CCGT	GTU	GTE-10/95 BM	8.0	6.88
Ishimbay CCGT	GTU	GTE-10/95	8.0	6.88
Agidel CCGT	GTU	1 URAL-4000 2 URAL-400	4.0 4.0	3.44 3.44

Use of co-generation technology

Co-generation is the joint generation of electrical and thermal power in a single device. Co-generation facilities include CHP plants with heat and power turbines, TPP/CHP plants with combined-cycle gas turbines as well as gas turbines operating in a closed cycle. Co-generation technology allows for releasing both electrical and thermal power to the consumer. An increase in the supply of thermal power from the unit increases its efficiency factor and reduces fuel consumption for energy generation and, consequently, emissions of harmful substances into the atmosphere. The effect from the use of co-generation primarily depends on whether consumers have thermal power, so energy facilities with co-generation energy production are located in large cities.

Energy facilities³ operating with a co-generation cycle are located in almost all the regions of the Inter RAO Group. In 2018, these plants generated 14.166 billion kWh of electric power and 32,220,000 Gcal of thermal power in co-generation mode.

³ Power facilities with co-generation include facilities with 100% extraction turbines, CCGT, and GTU operating in a closed cycle that supply thermal power to consumers.

The largest CHPP (and, consequently, the facility at which co-generation technology is used) within the Inter RAO Group is Omskskaya CHPP-5 of TGC-11. The main consumers of this power facility are people living in the central part of Omsk. As of the end of 2018, this power facility had installed electric power capacity of 735 MW and thermal power capacity of 1,763 Gcal/h. Heat and power generation turbines are used to generate heat and electricity, including one of the most powerful ones used in the country – the T-185/220-130. In 2018, this energy facility provided consumers with 3,584,560 Gcal of thermal power. Almost 1.948 billion kWh of electric power were generated in co-generation mode and accounted for 61% of the electric power generated by the power plant.

LAUNCH OF THE ZATONSKAYA CHPP

IN 2018, A LARGE-SCALE PROJECT FOR THE CONSTRUCTION OF THE NEW HIGH-EFFICIENCY ZATONSKAYA CHP PLANT WAS COMPLETED AS PART OF THE CDA PROGRAM. THE PLANT IS DESIGNED TO PROVIDE THERMAL POWER TO A NEWLY BUILT MICRO-DISTRICT IN UFA. TWO NEW UNITS WITH GTE-160 AND T-60/73-7.8/0.04 GAS AND STEAM TURBINES ARE ABLE TO PROVIDE CONSUMERS WITH HEAT IN THE AMOUNT OF 300 GCAL/H. THE SPECIFIC CONSUMPTION OF EQUIVALENT FUEL FOR THE ELECTRICITY SUPPLIED AMOUNTED TO 256.5 G/KWH. THE COMMISSIONING OF THIS PLANT MARKS THE CONTINUATION OF THE INTER RAO GROUP'S PLANNED WORK TO IMPROVE THE EFFICIENCY OF GENERATING FACILITIES.

CO-GENERATION

TOMSK TPP-2

(operated since 1945)

THE COMBINED PRODUCTION OF HEAT AND ELECTRICITY AT A POWER PLANT USING FUEL CO-GENERATION TECHNOLOGY IS USED TO OBTAIN TWO FORMS OF ENERGY - THERMAL AND ELECTRIC POWER

COAL INTAKE CONVEYER
feeds crushed coal to the boiler

COAL MILL
coal crushing

VENTILATION PIPE

ELECTROFILTERS
removal of small fly ash particles from exhaust gases

STEAM TURBINE

CONDENSOR
thermal power output

ELECTRIC POWER OUTPUT
Electric current for consumers

thermal efficiency of standard coal plants

45%

87%

thermal efficiency of co-generation units

COOLING TOWERS

WATER FILTRATION AND DESALINATION UNIT

Water

Water

Surplus water

FURNACE

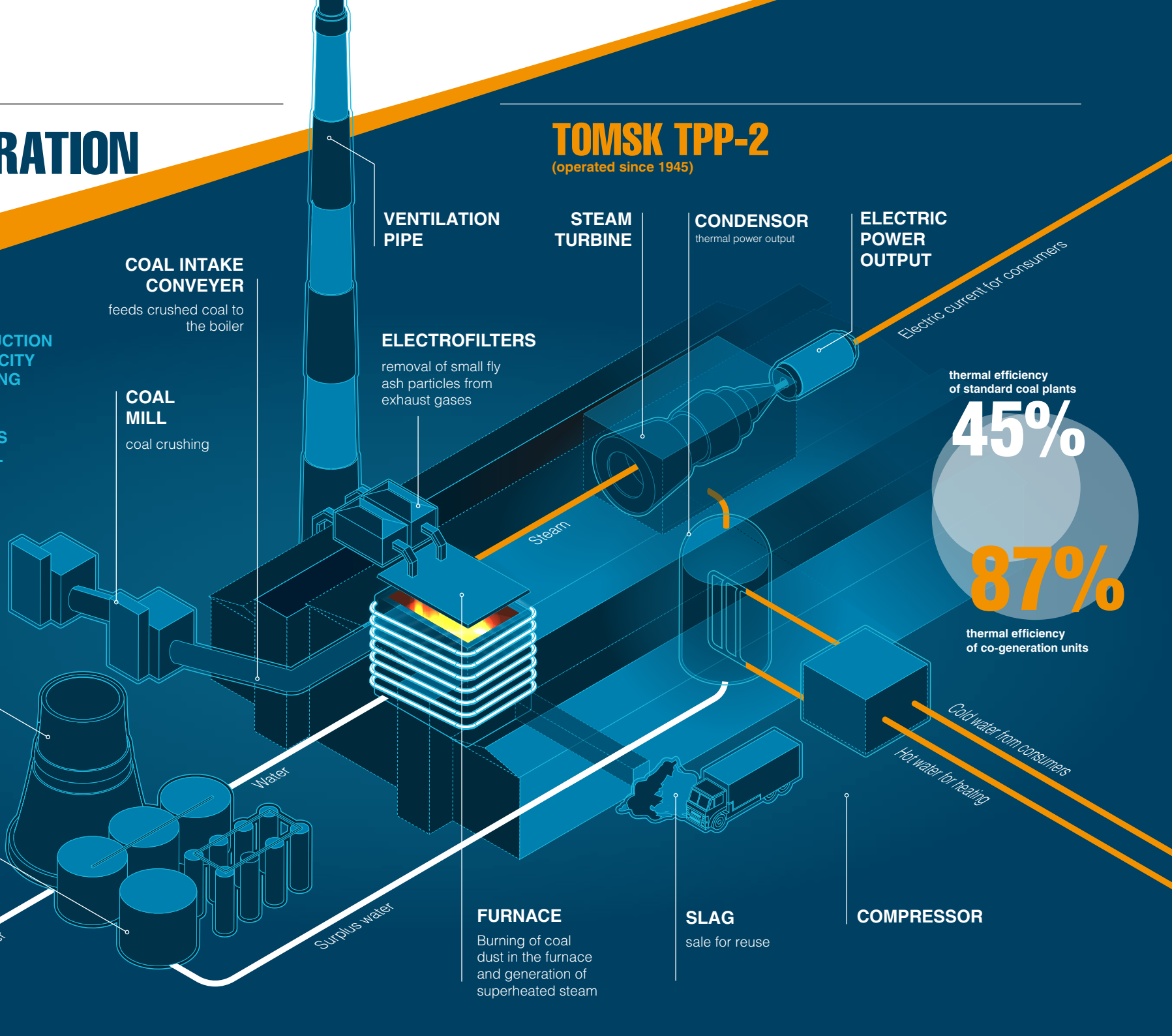
Burning of coal dust in the furnace and generation of superheated steam

SLAG

sale for reuse

COMPRESSOR

Cold water from consumers
Hot water for heating



Repair activities

The repair programs for the production assets of the Inter RAO Group for 2018 were compiled based on the technical repair needs of fixed production assets and took into account:

- the technical condition of equipment, buildings, and structures
- the need to ensure the reliable and safe operation of power facilities
- the existence of cost-effective repair effects

In 2018, actual repair costs at Russian generating and heating grid subsidiaries amounted to RUB 14.468 billion – 99.7% of the planned targets (RUB 14.513 billion). A total of 17 major and mid-level repairs of power units were carried out on the main equipment of the Russian generating subsidiaries of the Inter RAO Group in addition to repairs on 22 turbine generators and 22 energy boilers. All the assets of the Inter RAO Group successfully completed the repair campaign in 2018.

Generating capacity modernization program

The CDA-1 program, which made it possible to commission roughly 30 GW of new capacity at thermal power plants (including 6.1 GW at new units of the Inter RAO Group's plants), was basically completed in 2019 and resulted in the upgrading of roughly 15% of the total installed power generation capacity in Russia. Funding for the CDA-1 program is estimated at RUB 1.3 trillion. Nevertheless, despite the significant amount of capital investments, the commissioning of CDA units helped to halt the aging of TPP facilities in the industry as a whole, but did not drastically upgrade the production capacity in the sector. According to various estimates, more than 50 GW of TPPs need to be upgraded or decommissioned by 2035 (about 30% of the total installed capacity of TPPs). Moreover, in the absence of modernization measures, a number of energy systems of the UES of the Russian Federation may experience a shortage of electricity in 2022-2024.

Based on forecasts, the Russian Ministry of Energy proposed a mechanism for selecting projects to modernize the generating facilities of thermal power plants (the CDA-2 or CDA-Modernization Program) with the commissioning of 41 GW (39 GW excluding the Far East) by 2031 and with capital investments capped

at RUB 1.45 trillion (in 2021 prices). If a project is selected under this program, the generating company receives a guaranteed return on investment within 16 years taking into account the base rate of return of 14%.

The modernization projects will be selected based on competitions that should be held annually. The first selection of modernization projects is scheduled in March-April 2019 for three years all at once: 2022, 2023, and 2024. The main generating equipment allowed for selection includes turbines, boilers, and generators if their service life has expired, but had a high load in the previous two years. Following modernization, the thermal power plant will have to work on the market for at least 15 years.

The CDA-2 program is essentially launching a new investment cycle in the generating sector of the electric power industry with a volume of utilized capacity and investment that is comparable with that of the CDA-1 program. Moreover, taking into account the requirements for the high degree of localization of the equipment that may be involved in the CDA-2 program, the Russian power engineering industry will be given a significant impetus to develop the production of modern equipment, including high-power gas turbines.

The Inter RAO Group intends to be involved in selections for the modernization of thermal power plants with the highest possible positive economic effect from the implementation of modernization measures. Participation in the CDA-2 program will substantially upgrade the existing equipment of thermal power plants and enhance its efficiency. The total volume of the Inter RAO Group's participation in modernization may amount to about a quarter of the total installed capacity in the Russian Federation.