

Energy conservation and efficiency

PURCHASE OF ELECTRIC AND THERMAL POWER

Type of energy	2016	2017	2018	Change vs. 2017, %
Electric power, thousand kWh	11,860	15,987	12,115	-24.2
Thermal power (for production and business needs and to compensate for losses), thousand Gcal	3,517	3,462	4,011	15.9

Energy Conservation and Efficiency Improvement Programs

The Inter RAO Group consistently continues to work on optimizing business processes to manage energy conservation and improve energy efficiency at all its major Russian and foreign generating assets. Projects to improve energy efficiency are highly innovative and based on the best world practices. The Company carries out its own research and development and also collaborates with Russian and foreign industry leaders.

The Energy Conservation and Energy Efficiency Improvement Program (ECEEIP), a targeted program that was established at the Group's production assets and consolidated for the Company as a whole, is the main practical tool used to achieve energy conservation and energy efficiency improvement targets within the Energy Management System. The Commission on Energy Conservation and Energy Efficiency Improvement of the Company and its subsidiaries is involved in the process of establishing the program and reporting on its implementation. The ECEEIP is a medium-term program and has a five-year planning period based on the rolling planning principles. All ECEEIP indicators are compiled with a breakdown by production unit, power plant, and companies of the Group. The ECEEIP for 2018–2022 was approved at a meeting of the PJSC Inter RAO Management Board.⁴

The ECEEIP measures are divided into two sections: measures with a "direct" energy effect and measures with an "accompanying" energy effect. The measures with a "direct" energy effect include those developed specifically to generate an energy effect; its share in the total economic effect of such measures exceeds 80%. These measures should be commercially justified with a mandatory calculation of cost efficiency in accordance with the Methodology for Assessing the Cost Efficiency of Investment Projects with Capital Investments.

Strategic objectives to improve the efficiency of generating capacity:

- implement the main provisions of the energy strategy of the Russian Federation and the Energy Efficiency and Energy Development state program of the Russian Federation
- achieve the goals set forth in the Strategy of PJSC Inter RAO
- achieve the target indicators for energy conservation and improving energy efficiency envisaged by the Inter RAO Group's Innovative Development Program
- ensure the sustainable use of energy resources through the implementation of energy conservation and energy efficiency improvement measures
- improve the energy efficiency indicators of energy-intensive production assets both individually and for the Group as a whole while minimizing operating and development costs
- establish and improve an integral and efficient system for managing energy conservation and improving energy efficiency (development of an energy management system)
- mitigate the negative environmental impact

Results of the fulfillment of the Inter RAO Group's Energy Conservation and Efficiency Improvement Programs for 2018

1. The following key energy efficiency performance indicators (KEEPPI) were achieved.
 - for heat and electricity generation activities (thermal power plants and boiler houses, excluding generation at hydroelectric power plants and wind farms):
 - > fuel heat utilization factor (FHUF) – 49.49% (target – 48.48%, 2017 – 48.35%, standard – 49.22%). The indicator was met with a positive trend in relation to the previous year;
 - > specific overconsumption of fuel equivalent – 1.935 g/kWh (target – 1.432 g/kWh, 2017 – 1.750 g/kWh). The indicator was not met;

⁴ Minutes No. 739 dated March 1, 2017

- for heat supply activities (heat networks):
 - > total relative heat losses when transmitted through heat networks – 18.61% (target – 16.64%, 2017 – 17.05%). The indicator was not met;
 - > specific electricity costs when transmitting thermal power through heat networks – 6.11 kWh/Gcal (target – 7.07 kWh/Gcal, 2017 – 6.51 kWh/Gcal, standard – 6.36 kWh/Gcal). The indicator was met with a positive trend in relation to the previous year.
- 2. The following target production indicators (TPI) were achieved.
- for heat and electricity generation activities (thermal power plants and boiler houses):
 - > specific consumption of fuel equivalent for electricity supply – 296.99 g/kWh (target – 299.26 g/kWh, 2017 – 303.14 g/kWh, standard – 298.72 g/kWh). The indicator was met with a positive trend in relation to the previous year;
 - > specific consumption of fuel equivalent for heat supply – 144.36 kg/Gcal (target – 145.39 kg/Gcal, 2017 – 143.90 kg/Gcal, standard – 145.09 kg/Gcal). The indicator was met;
 - > specific consumption of electricity for internal needs for electricity generation – 3.76% (target – 3.92%, 2017 – 3.86%, standard – 3.93%). The indicator was met with a positive trend in relation to the previous year;
 - > specific consumption of electricity for internal heat production needs – 32.69 kWh/Gcal (target – 34.12 kWh/Gcal, 2017 – 33.12 kWh/Gcal, standard – 33.89 kWh/Gcal). The indicator was met with a positive trend in relation to the previous year;
- for heat supply activities (heat networks):
 - > relative process (standard) losses of thermal power during the transmission of thermal power through heat networks – 14.29% (target – 13.67%, 2017 – 13.65%). The indicator was not met;
 - > relative excess losses of thermal power during the transmission of thermal power through heat networks – 4.32% (target – 2.96%, 2017 – 3.40%). The indicator was not met;
 - > relative losses of coolant during the transmission of thermal power through heat networks – 2.37% (target – 2.41%, 2017 – 2.45%). The indicator was met with a positive trend in relation to the previous year;
 - > share of heat supplied to consumers calculated using metering devices – 64.98% (target – 63.80%, 2017 – 63.86%). The indicator was met with a positive trend in relation to the previous year.
- 3. Energy resources saved from the commissioning of new capacity:
 - fuel equivalent – 1.164 billion tons of fuel equivalent
 - thermal power – 116,676 Gcal
 - electric power – 15.055 bln kWh
 - water – 4.742 bln cub. m
- 4. Taking into account the commissioning of new capacities, the implementation of the Program's measures resulted in:
 - FHUF increasing by 1.40% abs.
 - specific fuel overburning decreasing by 0.33 g/kWh
 - specific fuel equivalent consumption for electric power decreasing by 9.99 g/kWh
 - specific fuel equivalent consumption for thermal power decreasing by 0.18 kg/Gcal
 - heat energy losses decreasing by 0.38% abs.
 - electricity costs when transmitting thermal power through heat networks decreasing by 0.01 kWh/Gcal
- 5. The economic effect from the implementation of the Program's measures amounted to almost RUB 3.807 billion taking into account the commissioning of new capacities.
- 6. The costs of implementing the Program's measures amounted to RUB 5.773 billion taking into account the commissioning of new capacities.

Use of energy conservation technologies

The Inter RAO Group includes power facilities that operate in a co-generation cycle. These power facilities¹ have total installed electric power capacity of 6.9 GW, which makes up 24% of the total installed capacity of the Group's Russian assets, and total installed thermal power capacity of 14,979 Gcal/h. The assets that are equipped with heat turbines (combined-cycle gas turbine units and gas turbine units) are located in the cities of Ufa, Tomsk, Omsk, Kaliningrad, St. Petersburg, and Sochi, among others. To enhance the efficiency and reliability of the equipment and reduce the environmental impact of production, the Company plans to continue work to modernize core equipment, service water supply systems, gas cleaning units, and electrical equipment in the future.

¹ Power facilities with co-generation include facilities with 100% heat-generating turbines, combined-cycle gas turbine units, and gas turbine units operating in a closed cycle that supply heat to consumers.

Use of renewable and secondary energy sources in Russia

LLC Bashkir Generation Company supports the use of alternative energy sources in economically and technically justified situations, in particular in remote or technologically isolated areas. This is consistent with the provisions of Federal Law of the Russian Federation No. 261-FZ dated November 23, 2009 "On Energy Conservation and Energy Efficiency Improvement and Amendments to Certain Legislative Acts of the Russian Federation."

LLC Bashkir Generation Company uses renewable energy sources (RES) and secondary energy sources (SES) to produce energy for its own needs and for sale to the following outside consumers:

- hydroelectric power plants (the Pavlovskaya and Yumaguzinskaya HPPs)
- small and micro hydroelectric power plants (the Mechetlinskaya, Slakkaya, Avzyanskaya, Uzyanskaya, and Kaginskaya MHPPs)
- the wind power plant of the Tyupkilda wind farm

According to expert estimates, the use of renewable energy sources at LLC Bashkir Generation Company in 2018 prevented the emission of 837 tons of pollutants into the atmosphere and 362,200 tons of greenhouse gases (CO₂ equivalent).

Fuel consumption

RUSSIAN GENERATING ASSETS OF THE GROUP

Fuel types	Total fuel consumption				Energy usage, GJ			
	2016	2017	2018	Change vs. 2017, %	2016	2017	2018	Change vs. 2017, %
total renewable ¹					1,196,527,997	1,192,904,861	1,179,131,756	-1.2
Oil fuel, tons	378	149	74	-50.3	14,668,639	5,944,112	2,899,090	-51.2
heating oil	378	147	73	-50.3	14,660,234	5,867,290	2,869,304	-51.1
diesel fuel	0	2	1	-50.0	8,405	76,822	29,786	-61.2
Gas, thousand m ³	28,052	28,448	28,481	0.1	964,125,985	975,565,393	974,982,820	-0.1
natural	24,350	24,812	24,767	-0.2	834,564,063	847,831,633	845,277,703	-0.3
associated	3,684	3,620	3,664	1.2	128,990,161	127,225,933	128,166,457	0.7
industrial enterprises	18	17	51	200.0	571,760	507,828	1,538,660	203.0
Coal, tons	12,481	12,354	11,831	-4.2	217,733,373	211,395,356	201,249,846	-4.8
bituminous	6,198	5,621	5,491	-2.3	115,674,295	101,847,834	98,694,757	-3.1
brown	6,283	6,733	6,340	-5.8	102,059,078	109,547,522	102,555,089	-6.4

¹ The Group's Russian generating assets do not have any renewable energy sources that use biofuels.

TOTAL ENERGY CONSUMPTION

Indicator	Total energy consumption in 2018		Total decrease in energy consumption, TJ			
	physical indicator	TJ	2016	2017	2018	Change vs. 2017, %
Fuel, thousand tons of fuel equivalent	40,243.42	1,179,454.15	3,451.96	3,951.06	3,097.95	-21.6
Electricity, mln kWh ¹	6,224.05	22,406.59	80.78	50.95	54.20	6.4
Heat, Gcal ²	432,987.26	1,812.92	0.05	0.09	0.03	-66.7

RESULTS OF THE FULFILLMENT OF THE INDICATORS OF THE ENERGY CONSERVATION AND EFFICIENCY IMPROVEMENT PROGRAM

Indicator	Measurement unit	2016	2017	2018	Change vs. 2017, %	Comments
Generation	mln kWh	118,131.89	122,087.33	121,765.18	-0.3	Including electricity generation at HPPs and wind farms
Electric power output from busbars	mln kWh	112,373.66	116,336.20	116,118.85	-0.2	Including electricity generation from busbars at HPPs and wind farms
Thermal power output from collectors	thousand Gcal	39,959.52	39,798.51	41,551.26	4.4	
ENERGY INTENSITY						
Specific fuel consumption for electric power output	g/kWh	307.45	303.14	296.99	-2.0	
Specific fuel consumption for thermal power output	kg/Gcal	145.04	143.90	144.36	0.3	
FHUF	%	48.00	48.35	49.49	2.4	Excluding electricity generation from busbars at HPPs and wind farms
Specific overconsumption (overburning) of fuel equivalent	g/kWh	1.78	1.75	1.93	10.3	Excluding electricity generation from busbars at HPPs and wind farms
Total relative heat losses during transmission via heat networks	%	17.66	17.05	18.61	9.1	
Relative electricity costs for the transmission of heat via heat networks	kWh/Gcal	6.55	6.51	6.11	-6.1	

¹ Total electric power consumption includes: internal needs, business needs, and production needs (in-house production and purchased), and electricity consumption for the transmission of thermal power via heat networks.

² Total thermal power consumption includes: production and business needs for generation and production and the business needs and internal needs of heat networks.

Indicator	Measurement unit	2016	2017	2018	Change vs. 2017, %	Comments
DECREASE IN ENERGY CONSUMPTION						
Total decrease in fuel and energy consumption as a direct result of energy conservation and energy efficiency improvement initiatives	thousand tons of fuel equivalent	117.78	134.81	105.703	-21.6	
	mln kWh	22.44	14.15	15.055	6.4	
	thousand Gcal	12.52	22.45	7.463	-66.8	Excluding reductions in heat losses in heat networks
	mln cub. m.	0.95	0.0005	4.726	945,100.0	Excluding coolant losses in heat networks
DECREASE IN ENERGY DEMAND FOR THE PRODUCTION OF GOODS OR SERVICES						
Decrease in fuel consumption for the production of thermal and electric power resulting from measures to reduce energy consumption	g/kWh	1.03	1.14	0.89	-21.9	
	kg/Gcal	0.12	0.28	0.18	-35.7	
Decrease in heat losses during transmission via heat networks	%	0.44	0.46	0.38	-17.4	
Decrease in electricity costs for the transmission of heat via networks	kW/Gcal	0.01	0.00	0.01	100	
Decrease in electricity consumption for internal needs resulting from measures to reduce energy consumption ³	%	0.02	0.01	0.01	0.0	
Decrease in heat consumption for internal needs resulting from measures to reduce energy consumption	Gcal	12,520.34	22,445.72	7,462.87	-66.8	
Decrease in electricity consumption for internal needs resulting from measures to reduce energy consumption	kWh	22,438,902.42	14,153,651.74	15,054,991.28	6.4	

³ Determined as the ratio of the absolute value of the decrease in electricity consumption for internal needs (kWh) versus electric power generation (kWh).

ENERGY CONSERVATION AND EFFICIENCY IMPROVEMENT INITIATIVES (2018 PROJECTS)

Energy company	Energy conservation measures	Savings achieved				Expenditures, RUB mln
		thousand tons of fuel equivalent	mln kWh	thousand Gcal	RUB mln	
UEG	Verkhnetagilskaya TPP: modernization of the steam boiler at Station No. 16 with the replacement of the cubes of the bottom deck air heater and the replacement of the lens compensators with gland-type joints	1.20	0.00	0.00	3.925	6.649
	Verkhnetagilskaya TPP: retooling of Turbine Unit No. 9 with the replacement of the end seals of the low-pressure cylinder with removable ones	0.83	0.00	0.00	2.702	2.445
	Iriklinskaya TPP: retrofitting of the turbine vacuum system of Unit 1 (Inventory No. IRI1400149) with a ball cleaning system	1.46	0.00	0.00	5.249	2.295
	Iriklinskaya TPP: modernization of steam boiler PK-41 of the power unit of Station No. 1 with the replacement of the gasket RVP-A, B, C, D with more effective gaskets	2.04	0.00	0.00	7.318	35.300
	Kaliningradskaya TPP-2: reconstruction of the contours of gas condensate heaters (GPH) of waste-heat boilers (WHB) of Stations No. 21 and 22	0.42	0.00	0.00	1.658	10.996
	Permskaya TPP: reconstruction of the exhaust fans of the gas and air duct of the 800-MW power unit of Station No. 2	0.24	0.00	0.00	0.645	20.624
	Permskaya TPP: examination of the refurbishing of the seals of the medium-pressure cylinder of the heat accumulator of the 800-MW power unit of Station No. 3 during the overhaul period	0.65	0.00	0.00	1.774	2.366
	Pechorskaya TPP: overhaul of the gas duct of Power Unit No. 1	0.25	0.00	0.00	0.777	1.290
	Urengoyanskaya TPP: overhaul of the K-160-7.5 turbine unit of the casting and mechanical plant, repair of a capacitor with the elimination of defects in the piping system as part of the turbine overhaul	1.18	0.00	0.00	2.426	15.095
	BGC	Ufimskaya CHPP-2: installation of a variable-frequency drive on booster pump PPN-2A	0.00	0.06	0.00	0.025
Sterlitamaskaya CHPP: modernization of the regenerative air heater PK-1 with 100% replacement of the gasket with a modernized one		0.27	0.00	0.00	1.038	10.647
TGC-11	Orenburgskaya CHPP-5: modernization of Evaporator Unit No. 2 to reduce plant losses of steam and condensate	0.00	0.00	2.36	1.610	60.368
	Orenburgskaya CHPP-5: modernization of Evaporator Unit No. 4 to reduce plant losses of steam and condensate	0.00	0.00	3.89	2.765	17.455
	Orenburgskaya CHPP-3: cleaning of turbine condensers PT-60-90/13, Station No. 9	0.75	0.00	0.00	2.686	0.344
	Orenburgskaya CHPP-4: replacement of first-stage forging cubes of the compressor unit of Station 9	0.50	0.00	0.00	1.027	9.698
Omsk RTS	Restoration of the thermal insulation structure on the above-ground pipelines (heat network sections planned for 2018)	0.00	0.00	2.87	2.792	29.677
	Overhaul of pipelines of underground heat networks (heat network sections planned for 2018)	0.00	0.00	5.41	5.256	192.519
TomskRTS	Restoration of the thermal insulation of the centralized heat supply system networks of Tomsk (2017-2018)	0.00	0.00	12.32	5.814	23.313