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Small-Capacity Power Engineering in Russia

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Abstract—Estimated scales on which small-capacity power-generating installations are used in Russia are presented.

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A generally accepted notion of small(-capacity) power engineering has not been established yet. This term is usually understood to mean generation of electricity by any types of power station with a capacity of up to 25 MW that operate either independently or as part of large electric power systems. In the latter case, the term "distributed generation" is used, the essential feature of which is that such installations supply their power output directly to a public distribution network. An increase in the share of distributed generation in an electric power system gives rise to problems related to efficient management of the operation of such a system.

Commercial development of territories not covered by centralized supply of electric power became the main factor due to which small power engineering has gained acceptance in the country. Such territories make up more than two-thirds of the country's total area. Recently, new factors have begun to play a noticeable role in the development of small power engineering, in particular, economic growth in the areas covered by centralized supply of electric power in which essential infrastructural limitations exist (lack of technological possibilities for connecting to electric networks). According to the data of the Federal Service for State Statistics (Rosstat), the combined volume of applications for connection to electric networks that were not satisfied in the country in 2007 totaled 2.3 GW, which is equal to around 12.6% of the required power that was requested by consumers in applications for connection (Table 1). It can be seen from this table that the most difficult situation with respect to connection arose in the Southern Federal District. The volume of applications that were not satisfied in that district totaled 785 MW or 28.9% of the overall claimed power. A difficult situation with respect to electric networks is observed in the Central and Siberian Federal Districts, the power companies in which refused to satisfy consumer applications for connection to power supply by a total of 643 and 459 MW, respectively.

In recent years, poor quality of power supply (poor reliability of power supply or supply of electric energy the parameters of which do not comply with the requirements of relevant standards) has become a serious problem in many regions of the country. As a result, efficient operation of modern appliances and equipment, including those used by population, is impossible without using individual means of uninterruptible (backup) power supply.

Technical achievements made in the field of small-capacity power-generating equipment are another important factor facilitating development of small power engineering in Russia. Small-capacity power-generating equipment with acceptable technical and economic indicators has become available on the market, including that in Russia. Highly efficient small-capacity gas turbine units (GTUs), including microturbines, gas-piston units, wind power units, photovoltaic converters, etc. are examples of such equipment.

The existing system of statistical monitoring does not make it possible to reliably present the scales on which small power engineering is being developed in Russia. The author of this paper made an attempt to fill this gap by processing the sparse statistical information that is available on this subject. The results of this endeavor are presented here.

Table 1. Claimed electric power nonsatisfied due to the lack of technological possibility of connecting to electric networks in 2007

Federal district	Power of nonsatisfied applications for connection, MW	Fraction of nonconnected power with respect to that claimed in applications, %
Central	643	13.5
North-west	39	6.9
South	785	28.9
Volga	52	3.6
Ural	203	5.6
Siberian	459	11.8
Far East	90	9.5
Russia	**2271**	**12.6**

Table 2. Fraction of small power-generating sources in the electric power industry of Russia (2007)

Type of power station	Installed capacity			Production of electric energy		
	Total thousand MW	Fraction of small power-generating sources		Total billion kW h	Fraction of small power-generating sources	
		thousand MW	%		billion kW h	%
TPSs	153.3	11.4	7.4	675.8	21.9	3.2
HPSs	46.8	0.3	0.7	179.0	1.3	0.7
NPSs	23.7	0	0.0	160.0	0.0	0.0
GeoTPSs and WPSs	0.1	0.1	100	0.5	0.5	100
All power stations	**224.0**	**11.8**	**5.2**	**1015.3**	**23.7**	**2.3**

Table 3. Technological structure of the small power engineering of Russia (2007)

Type of power station	Installed electrical capacity		Production of electric energy		Supply of thermal energy		Equivalent number of hours of operation a year at full electric power, h/yr
	MW	%	million kW h	%	thousand GJ (thousand Gcal)	%	
Diesel	6505	55.35	7407	31.28	2.64 (0.63)	0.61	1139
Including portable ones	1291	10.99	1868	7.89	0	0.00	1446
Gas-piston	2046	17.41	5542	23.40	8.21 (1.96)	1.91	2709
Gas-turbine	63	0.54	175	0.74	0.67 (0.16)	0.15	2775
Steam-turbine	2719	23.13	8744	36.93	280.14 (66.86)	64.99	3216
Including biomass-fired ones	117	0.99	487	2.05	11.77 (2.81)	2.73	4169
Mini HPSs	320	2.72	1320	5.57	0	0.00	4123
Geothermal65.05	90	0.77	485	2.05	139.41 (33.27)	32.34	5380
Wind	10	0.09	7	0.03	0	0.00	647
All power stations	**11753**	**100.0**	**23680**	**100.0**	**431.07 (102.88)**	**100.0**	**2015**

According to Rosstat data, the combined capacity of small power stations in Russia that were in operation in 2007 totaled 11.8 GW and they produced 23.7 million kW h of electric energy (Table 2). The share of small power sources reached 5.2% of the capacity of all power stations in the country and 2.3% of electricity generated. The equivalent number of hours for which small generating capacities are used is much smaller than that typical for large generating capacities (2105 and 4670 h/yr).

Thermal power stations account for 96.4% of the power generated by small power sources. Diesel power stations (DPSs) and steam-turbine power stations dominate among them (Table 3). This table was also drawn up on the basis of information received from Rosstat. DPSs account for around 55% of the combined capacity of all small power stations and for 31% of the electric energy they generate. Steam turbine units account for 23% of the power capacity of small power stations and 37% of the electric energy they generate. The electrical capacities of steam-turbine units are utilized three times more intensely than those of diesel power units (3216 and 1139 h/yr, respectively). Steam-turbine power stations are the absolute leader among small power-generating units with respect to heat supply (65%). Another 32% of the heat is supplied from geothermal power stations. The combined capacity of gas-piston power stations that are in operation in Russia has reached a significant level of more than 2 GW. Small gas-turbine power stations have not received considerable development in Russia as yet.

Small electric power engineering on the basis of renewable energy sources (RESs) also has not received wide acceptance. According to Rosstat data, the level of the combined capacity of Russian power stations built around RESs in 2007 totaled about 540 MW, including 320 MW at mini hydro power stations, 117 MW at biomass-fired steam turbine units, 90 MW at geothermal power stations, and 10 MW at wind power stations (WPSs). There is almost no commercial-grade solar power engineering in the country. The combined contri-

Table 4. Development of small power engineering in Russia for the period from 2002 to 2007

Type of power station	Increase in					
	electrical capacity		production of electric energy		Equivalent number of hours of operation a year at full electric power, h/yr	
	MW	%	million kW h	%	h/yr	%
Diesel	1021	19	1192	19	5	0
Including portable ones	397	44	879	89	341	31
Gas-piston	1051	106	4422	395	1583	141
Gas-turbine	45	250	149	574	1333	92
Steam-turbine	158	6	1773	25	494	18
Including biomass-fired ones	59	102	365	301	2071	99
Mini HPSs	29	10	419	46	1031	33
Geothermal	20	28	336	225	3265	154
Wind	3	50	0	0	–325	–33
All power stations	**2327**	**25**	**8291**	**54**	**382**	**23**

bution of RES-based power stations in the country's electric power industry is insignificant, 0.24% of the total electrical capacity and 0.23% of the generation of electricity. It should be noted that the equivalent number of hours for which the installed capacity of Russian RESs is utilized a year is very low: its value was equal to only 647 h/yr in 2007. On the contrary, geothermal power stations were utilized very intensely in that period of time (5380 h/yr).

Small power engineering is developing in Russia at quite high rates. According to Rosstat data, the combined capacity of small power sources has increased by 2.3 GW, or by 25%, for the last 5 years (Table 4). This increase was mainly due to the commissioning of diesel and gas-piston power stations (GPPSs). Portable units were commissioned at the highest rate among all DPSs. Small-capacity biomass-fired steam-turbine units and small gas-turbine power stations (GTPSs) began to be intensely put into operation in the period from 2002–2007. The same period of time saw almost all types of small power stations (except DPSs and especially WPSs) beginning to be used much more intensely. The equivalent number of hours of utilizing the capacity of gas-piston and geothermal power stations increased by a factor of 2.5, and that of gas turbine and biomass-fired steam power stations, by a factor of 2. At wind power stations, this indicator dropped by one-third. The period from 2001 to 2007 witnessed the capacity utilization factor of Russian WPSs dropping from 11.7 to 7.4, which was mainly due to technical reasons. The value this indicator has at WPSs outside of Russia is several times higher and is predominantly determined by weather conditions [1]. In Germany, the value this indicator had in the same period of time varied in the range from 14 to 18%; in Finland it varied from 17 to 23%; in Denmark, from 19 to 24%, in the United States, from 20 to 27%; and in Canada, from 29 to 35%.

It follows from an analysis of the Rosstat data that small power engineering has been developed to the greatest extent in the Ural Federal District, in which more than 26% of all capacities of small power stations in the country is concentrated (Table 5). The Northwest and Siberian Federal Districts are other regions in which small power engineering has also been developed to a considerable extent.

The territories and industry branches to which the diesel power stations presented in Table 3 are affiliated can be determined, and their fuel efficiencies can be estimated on the basis of information gathered by Rosstat for approximately 40% of them (Tables 6 and 7). In the vast majority of cases, these are DPSs with a capacity of more than 500 kW.

It follows from Table 6 that 94% of electric energy is generated by diesel power stations located in the eastern and northern regions of the country, territories that

Table 5. Territorial structure of small power engineering

Federal district	Installed capacity, %	Production of electric energy
Central	10.3	11.2
Northwest	20.6	24.5
South	6.0	3.1
Volga	10.5	8.7
Ural	26.3	29.7
Siberian	19.3	19.3
Far East	7.0	3.5
Russian Federation	**100.0**	**100.0**

Table 6. Structure of the production of electric energy and specific consumption of fuel at Russian diesel power stations in different federal districts (2007)

Federal district	Structure of electricity production, %	Specific consumption of fuel, gce/(kW h)
Central	1.0	358
Northwest	11.8	385
South	1.7	391
Volga	3.2	470
Ural	27.2	395
Siberian	13.6	451
Far East	41.5	380
Russian Federation	**100.0**	**397**

Table 7. Structure of electricity production and specific consumption of fuel at Russian diesel power stations in different sectors of economy (2007)

Sector of economy	Structure of electricity production, %	Specific consumption of fuel, gce/(kW h)
Production of minerals	40.6	391
Processing industry	1.7	366
Power engineering	39.1	417
Civil construction	7.0	356
Agriculture	1.4	383
Transport and communications	0.9	417
Services	9.3	377
Total	**100.0**	**397**

contain vast zones without centralized power supply. Production of minerals and power engineering (housing and communal facilities) are the main sectors of economy in which DPSs are used. A considerable consumption of electric energy generated by DPSs is also observed in the civil construction and service industries, i.e., sectors of the economy involving a large number of small consumers situated far away from power lines.

The DPSs that are in operation in Russia feature poor fuel efficiency. The specific consumption of fuel at these stations averaged over the country is around 400 gce/(kW h), which is one-third higher as compared with the characteristics of modern diesel-generators commercially available on the Russian market. Considerable variations of this indicator from region to region are noted: from 360 in the Central Federal District to 450 and 470 gce/(kW h), respectively, in the Siberian and Volga Federal Districts. The differences in the fuel efficiencies of DPSs used in different industries are not so significant; nonetheless, the most efficient use of DPSs is observed in the civil construction industry, and the least efficient in power engineering (mainly housing and communal facilities) and transport.

Table 8 contains data on the consumption of fuel at Russian small power stations that were prepared on the basis of information received from Rosstat. As was already mentioned, Rosstat gives data on fuel consumption only for approximately 40% of the DPSs listed in Table 3. The author of this paper carried out assessments of fuel consumption at the remaining DPSs on the basis of the country average specific consumption of fuel at diesel power stations taken from Table 6. The obtained estimates showed that the total quantity of fuel consumed in 2007 at small power stations in Russia exceeded 19.2 million tce, with 68% of this quantity consumed at steam turbine power stations.

A logical question arises: how fully do the official statistical data published in the country reflect the development of small power engineering? Numerous facts allow a conclusion to be drawn that official statistics omits a considerable part of small sources of electric power, especially those having the smallest capacity (power stations with a capacity of less than 500 kW). In particular, the scales on which wind power engineering has been developed in Russia are estimated at 12–16 MW [2–4] as opposed to 10 MW according to official data (see Table 3).

An analysis of the market of small power-generating installations that has developed in Russia has shown that power stations built around internal-combustion engines (ICEs) predominate in it:

Table 8. Consumption of fuel by small power-generating sources in Russia (2007), thousand tce

Power stations	Gas	Fuel oil	Diesel fuel	Coal	Peat	Biomass	Other	Total
Diesel	70	0	2830	0	0	0	0	2900
Gas-piston	3057	0	109	0	0	0	0	3166
Gas-turbine	88	0	3	0	0	0	0	91
Steam-turbine	8997	1294	40	1811	32	465	451	13090
Including biomass-fired ones	185	85	0	0	0	465	0	735
Total	**12212**	**1294**	**2982**	**1811**	**32**	**465**	**451**	**19247**

Table 9. Import of ICE-based power-generating installations, thousand pieces a year

Installations with unit capacity of	2001	2002	2003*	2004	2005	2006	2007*
Up to 60 kW	17.3	19.1	26.5	33.9	71.3	139.3	219.0
Including							
carburetor	14.3	16.2	22.4	28.6	63.5	124.7	193.3
diesel	3.0	2.9	4.1	5.3	7.8	14.6	25.7
60–300 kW	0.4	0.5	0.7	1.0	1.5	2.6	3.9
More than 300 kW	0.2	0.3	0.4	0.5	0.6	1.4	2.1
Total	**17.9**	**19.9**	**27.6**	**35.4**	**73.4**	**143.3**	**255.0**

* The values are tentative, since detailed statistical data are lacking.

(i) carburetor-engine power stations (mainly with a single capacity of less than 15 kW, which are most frequently used as backup or emergency sources of power supply);

(ii) diesel-engine power stations (mainly with a capacity from 15 kW and higher, which are used both as main and standby power installations); and

(iii) gas-piston-engine power stations (usually with a capacity of more than 100 kW, which are predominantly used as the main source of electric power).

Small-capacity power stations built around gas-turbine engines are constructed in the country in a considerably smaller volume.

The following power-generating installations built around ICEs are available in the country: imported ones, units manufactured at Russian plants, and systems commercially available in Russia from numerous companies, which assemble them from imported and domestically produced components. A wide spectrum of ICE-based power stations produced by all companies occupying the leading positions around the world in this area of power-generating equipment is now available in the Russian market. Scores of companies and organizations are engaged in supplies and sales of such equipment. There are also a large number of companies that assemble power stations on the basis of imported and domestically produced engines and generators. Cheaper power stations assembled of domestically produced components, which are less reliable and economically efficient, and furnished with a smaller scope of automatic control systems, find use in rural areas. However, the majority of producers who deliver their goods primarily to retail market place emphasis on imported engines and especially generators.

According to the data of the Federal Customs Service of Russia, the import of power-generating installations built around ICEs is growing very rapidly (Table 9) [5]. This is especially the case for small installations with a capacity of up to 60 kW, imports of which rose by more than a factor of 12 in the period from 2001 to 2007. It is observed that Chinese producers tend to win in this section of Russian market: the fraction of their equipment increased in the period from 2001 to 2006 from almost zero at its beginning to 38.6% at its end (Table 10). As regards the sectors of larger machines, companies from England and France remain the players occupying the leading positions in supplies of such machines: in 2006, the shares of their equipment were equal to 32.1 and 21.6% for installations with capacities ranging from 60 to 300 kW and 57.4 and 7.8% for installations with a capacity of more than 300 kW.

No statistical data are available on the quantities of imported ICE-based power-generating installations expressed in units of power. The author of this paper prepared estimates of such indicators categorized into three statistical groups, which are summarized in Table 11. The calculations were carried out proceeding from the following prerequisites.

(i) The average capacities of single units are as follows. For the first group (up to 60 kW), they are equal to 6 kW for carburetor engines and 20 kW for diesel engines; for the second group, they are equal to 120 kW; and for the third group, 650 kW.

(ii) The value of $\cos\varphi$ is taken equal to 0.8 for all electric generators.

According to these estimates, the import of ICE-based power-generating installations in Russia reached

Table 10. Structure of the import of ICE-based power-generating installations with a capacity of up to 60 kW, %

Country	2001	2002	2003	2004	2005	2006
Germany	36.4	37.2	32.1	29.2	41.1	34.8
Spain	1.0	1.3	3.0	4.0	2.2	2.2
China	0.0	0.3	7.9	12.3	27.2	38.6
France	25.5	26.7	22.0	19.3	11.2	7.5
Japan	27.8	22.4	21.6	21.2	9.6	7.1
Italy	2.9	3.9	2.9	2.3	1.2	1.7
England	1.4	4.7	4.0	3.7	2.8	2.0
Other	5.0	3.5	6.5	8.0	4.7	6.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 11. Import of ICE-based power-generating installations, MW

Capacity of single installations	2001	2002	2003	2004	2005	2006	2007
Up to 60 kW	117	124	173	222	430	832	1339
60–300 kW	38	49	71	94	147	248	377
More than 300 kW	105	140	203	266	337	732	1077
Total	**260**	**313**	**447**	**582**	**914**	**1812**	**2793**

Table 12. Volumes of ICE-based power-generating installations, MW, commissioned in Russia

Capacity of single installations	2001	2002	2003	2004	2005	2006	2007
Up to 60 kW	134	151	206	265	470	919	1442
60–300 kW	30	45	63	81	137	279	415
More than 300 kW	1379	1441	1277	998	953	1352	1695
Total	**1543**	**1637**	**1546**	**1344**	**1560**	**2550**	**3552**

2.8 GW in 2007. The rates with which the import of such installations increased in the last years remained very high: 57% in 2005, 98% in 2006, and 54% in 2007.

The structure of ICE-based power-generating installations imported to the country remained stable. The fraction of installations with capacities of up to 60 kW varied in the range 38–48%; those with capacities 60–300 kW, 13–16%; and those with a capacity of more than 300 kW, 37–46%. The annual quantities in which of such installations were exported from Russia in the period from 2001 to 2007 was also very stable: 7–8 MW of installations with a capacity of up to 60 kW (440–460 units), 20–25 MW of installations with a capacity of 60–300 kW (20–25 units),

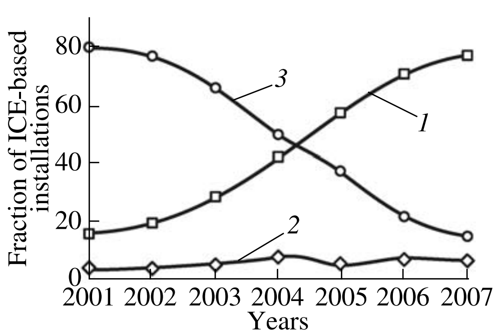

Fig. 1. Structure of the supplies of IEC-based power stations to the Russian market. (*1*) Imports, (*2*) assembling from imported parts, and (*3*) domestic production.

and 7–12 MW of installations with a capacity of more than 300 kW (13–23 units).

The volumes in which small ICE-based power-generating installations are produced and assembled in Russia are not reflected in explicit form in the existing statistical reports. A judgment on these volumes can be made with a considerable degree of uncertainty from indirect data (the volumes in which diesel-generators, diesels, and ac electric generators are produced at Russian enterprises, the volumes in which this equipment is imported, etc.). Thus, the volumes in which ICE-based power stations are sold in Russia can be estimated as the following: 2.5 GW in 2006 and 3.6 GW in 2007 (Table 12). Considerable changes occurred in the structure of supplies of such power stations (in terms of their capacities) for the period from 2001 to 2007: the fraction of imported installations increased from 16 to 77%, whereas that of domestically produced installations dropped from 81 to 16%, and the fraction of power stations assembled in Russia from imported parts increased from 3 to 7% (Fig. 1).

The volumes in which small power stations built around gas-turbine engines (with a capacity of single units up to 20 MW) were commissioned in Russia were much more modest (Table 13) [6]. For example, the combined capacity of gas-turbine units (GTUs) that were commissioned in the country in 2006 totaled around 266 MW. This volume included only 0.2 MW of GTUs with a capacity of single unit less than 1 MW. The volume of small GTUs that were commissioned in 2007 increased considerably: up to 324 MW. The increase in the volume of GTUs with a capacity of up to 1 MW was especially noticeable: the combined capacity of such GTUs that were commissioned in 2007 totaled around 1.9 MW.

The total annual volumes in which power stations built around ICEs and small gas-turbine engines were sold in Russia reached 2.8 GW in 2006 and 3.9 GW in 2007, quantities that are significantly larger than those in which power-generating capacities were commissioned in large power engineering (Table 14). The structure of sales of small power-generating installations underwent considerable changes in the period from 2001 to 2007 (Fig. 2): a drastic increase occurred in the fraction of installations with a capacity of up to 60 kW (from 8 to 37%), as well as in that of installations with a capacity in the range 60–300 kW (from 2 to 11%), whereas the fraction of installations with a capacity of more than 300 kW dropped from 90 to 52%.

The volumes of small power-generating installations on the basis of ICEs and gas-turbine engines commissioned in Russia that were accumulated (combined capacities) in the period from 2001 to 2007 reached 13.4 GW against the 9.6 GW of the combined capacities of large power stations that were commissioned in the same period of time (Table 14). Installations with a capacity of more than 300 kW predominate in the structure of combined commissioned capacities of small

Table 13. Commissioning of small gas-turbine units in Russia, MW

GTUs	2000	2001	2002	2003	2004	2005	2006	2007
Domestically produced	47.3	42.1	110.7	57.2	221.7	70.9	258.4	205.6
Imported	0.0	0.0	59.1	34.3	25.2	22.6	7.2	117.9
Total	**47.3**	**42.1**	**169.8**	**91.5**	**246.9**	**93.5**	**265.6**	**323.5**
Including those with unit capacity of								
100 kW	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.9
100 kW–1 MW	0.0	0.0	1.6	4.8	2.4	0.0	0.0	0.0
1–10 MW	47.3	42.1	111.6	86.7	79.4	93.5	142.9	172.6
More than 10 MW	0	0	56.6	0	165.1	0	122.5	149.0

Table 14. Volumes in which small power-generating installations built around ICEs and gas-turbine engines were commissioned in Russia

Commissioned capacity of power stations	2001	2002	2003	2004	2005	2006	2007	2002–2007
Small power stations:								
up to 60 kW	134	151	206	265	470	919	1443	3454
60–300 kW	30	47	68	83	137	279	415	1029
more than 300 kW	1422	1609	1363	1243	1046	1617	2017	8895
Total	**1586**	**1807**	**1637**	**1591**	**1653**	**2815**	**3875**	**13378**
Large power stations	2773	579	1851	950	2861	1307	2082	9630

* According to the data of the Central Dispatch Board of the fuel and energy complex.

power-generating installations: 66%, or 8.9 GW. Installations with a capacity of up to 60 kW accounted for 26% (3.4 GW), and the remaining 8% was due to installations with a capacity from 60 to 300 kW (1.0 GW).

The differences between the estimated combined capacities of small power stations that were commissioned in Russia for the period from 2002 to 2007 (around 13.4 GW in Table 14) and statistical data on the increases in the capacities of small power-generating sources that occurred for this period of time (approximately 2.3 GW in Table 4) can be attributed to the following factors. First, many installations are purchased to replace existing ones for modernizing and retrofitting DPSs that are in operation (municipal and industrial ones). A considerable quantity of installations, especially those with a capacity of less than 60 MW, are purchased as standby sources of power, including those installed in cottage areas, mobile communications enterprises, boiler houses, and the like. Finally, Russian statistics does not take into account all electric generators commissioned in the country. The acting forms of statistic monitoring of the country's electric power engineering keep a fairly full account of power stations with a capacity of 500 kW or higher, whereas power stations of smaller capacity, especially those owned by organizations that do not supply power to consumers, are traced considerably poorer. Managers of small enterprises and individual entrepreneurs do not supply energy-related data to state statistical bodies at all. Hence, a large quantity of small power-generating installations remains unobservable for state statistical authorities.

The situation that exists in the Russian market of fuel and energy resources may undergo considerable changes in the years soon to come. The government is drawing up plans according to which the tariffs for electricity and natural gas are going to be increased

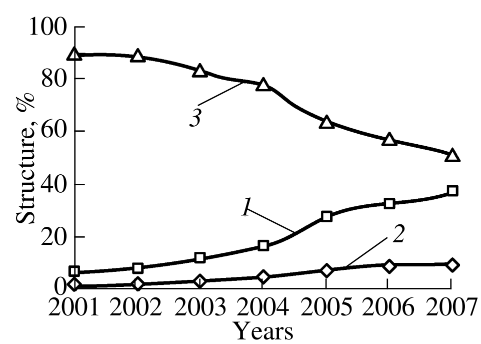

Fig. 2. Structure of the commissioned power-generating installations of different capacities built around ICEs and gas-turbine engines. Capacity of a single installation, kW: (*1*) up to 60, (*2*) 60–300, and (*3*) more than 300.

considerably. That Russia has signed international agreements on limiting the emissions of greenhouse gases places a certain burden on the country connected with the need to fulfill these limitations. This will result in that the economic indicators characterizing the operation of the country's power industry will degrade considerably as these limitations are fulfilled, especially as regards coal-fired power stations. The delays that are expected in the implementation of investment programs of power-generating and electric network companies (which are characterized by a long investment cycle) may make the situation regarding fulfilling applications for connection to public electric networks considerably worse. Significant changes may occur in the market of power-generating equipment. Owing to scientific–technical progress, we should expect that further improvements will be made in the technical–economic and operational indicators of small power-generating installations, including those employing RESs. The country has huge resources of local fuels, in particular, peat, as well as renewable kinds of energy. The predicted rapid growth of the agricultural and timber processing complexes will result in large quantities of agricultural and wood wastes being generated. These factors will facilitate further development of small power engineering in Russia.

REFERENCES

1. *Electricity Statistics* (IEA, 2006).
2. P. P. Bezrukikh, "Wind Power Engineering," Al'ternativnaya Energetika, No. 3, 12–16 (2008).
3. A. Grigor'ev and V. Chuprov, "Use of Renewable Sources of Energy in Russia: Whether the Patient is Alive or Dead?" Energorynok **59** (10), 23–30 (2008).
4. V. G. Nikolaev and S. V. Ganaga, "Wind Power Stations as an Alternative Method for Considerably Increasing the Generation of Electricity in Russia," Malaya Energetika, Nos. 1–2, 72–82 (2008).
5. *Customs Statistics of Foreign Trade in the Russian Federation. Annual Collections for 2000—2007* (FTS RF, Moscow, 2000–2007) [in Russian].
6. "Catalogues of Gas Turbine Equipment for 2007 and 2008," Gazoturbinnye Tekhnologii (2007, 2008).