Aspects of progress of power supply isolated Northern areas of Yakutia

A.N. Kuzmin, E.J. Mikheyeva, N.V. Pavlov

In article are considered a possibility of introduction in the north of Republic Saha (Yakutia) cogeneration installations of low power on the basis of Vapor and gas of the turbine and the diesel generating engines working on an organic type of fuel, their expediency using

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The power supply system of Republic Saha (Yakutia) possessing all traditional signs of electro power branch of the Russian Federation, has a number of the specific problems connected with scale of its service area.

One of serious problems is created with small power of northern part of the republic covering the area 1,7 million km^2 or 53 % of territory of republic where 14 administrative-territorial divisions – areas with the population nearby 100 thousand person are located. The given territory represents slightly the mastered zone with the center accommodation of economic activities, weak economic communications between areas and transport insolubility.

Electro supply, basically, the population, the budgetary organizations and the enterprises is carried out from more 90 diesel power stations and gas turbine stations the small capacity, working only on дальнепривозном diesel fuel which content is connected with high expenses of material means and work at insufficient maintenance of reliability of electro supply.

Specific number of the attendants (regular factor) reaches 6 per/Mwt, that in 4-5 times above appropriating parameters on large power stations of republic. Average specific expense of fuel in 2008 has made 402 g of conditional fuel on kwt h, that exceeds recommended normative (319-377 g of conditional fuel on kwt h) And similar parameters on Far East FD (355 g of conditional fuel on kwt h). The average net cost of the electric power developed diesel power stations, on a condition 2009 has made 18,75 rub/kwt. For comparison a net cost of diesel generation of the Russian Federation – 10,2 rub/kwt.

Because of small number of hours of use of the installed capacity it is direct to the population of northern areas counting upon soul in 2008 it is realized 1,02 thousand in kwt h, that on 32 % below from the developed norms for these conditions.

Especially the key role owing to severe climatic conditions is played with a heat supply. Duration of the heating period of northern areas reaches till 365 day in a year. The minimal rated temperature of air lays within the limits of from-46 up to-62°C. Average rated temperature of the heating period – -13,4÷-25,6°C.

The heat supply in considered region is carried out from the order of 240 boiler-houses with total capacity 940 Gcal/h where basically boilers of low power (<3 Gcal/h) are established. Boiler installations at annual useful vacation of the order 1400 thousand Gcal of thermal energy cover about 70 % consumption of heat northern areas.

For maintenance of demands for thermal energy in 2008 in boiler northern areas it has been run out 353 thousand here of which 56 % were made with coal, more than 28 % – oil, about 12 % – gas condensate, more than 3 % – fire wood.

In boiler-houses low enough efficiency of use of fuel where average specific expense has in recent years made 246÷252 kg of conditional fuel on Gcal.

The low technical condition, obsolescence of objects of power, absence of the equipment and possibility of introduction of the advanced economic means of small power reduces reliability of power supply of the isolated consumers of the north of republic.

The problem of reliability of small power is aggravated with range and complexity of

A.N. Kuzmin, E.J. Mikheyeva, N.V. Pavlov. Century of Pauls, College of physicotechnical problems of the North it. V.P. Larionov of the Siberian Branch of the Russian Academy of Science, Yakutsk, Russia (e-mail: milena74@bk.ru).

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delivery of fuel resources. In territory of considered northern areas it is developed only Zirynskoe the coal deposit (area Verhnekolymsky), providing 15 % of consumed fuel. All volume of diesel fuel is delivered because of limits of republic (distance from item Osetrovo of Irkutsk region up to seaport of Tiksi river by – 3690 km).

Delivery of 74 % of demand for coal fuel 14 northern areas and all volume of hydrocarbon raw material (oil and gas a condensate) thermal power station of republic (river-sea-river-automobile winter road) with extent 1-3 thousand in km provides from Central and Western energy areas of republics under the iterative transport diagram.

The problem fuel of supply the remote consumers get a special acuteness in connection with the constant tendency to rise in price of fuel resources and tariffs for its transportation.

In 2030 the total demand 14 northern areas in the electric power will increase in comparison with 2010 in 2,3 times and will make 790 million kw h, consumption of heat will increase in 1,5 times and 2040 thousand Gcal will make [4].

Nevertheless, in small power of northern part of Yakutia there was a serious complex of problems which requires enhanced attention.

Special natural-climatic conditions, extensiveness of territory, small density consumption of energy render impossible maintenance of northern consumers from the centralized system of electro supply. Progress of power here also will be in the long term focused on the dispersed small power.

Existing problems of small power set thinking both on alternative energy sources, and about an indispensability of development of rational directions supply by fuel.

Interference of manufacture electric and thermal energy and supply by fuel for considered small independent consumers predetermines an indispensability of their complex research.

At a level 2030 of demand of new industrial projects in Ust-Yanskiy, Olenekskiy and Anabarskiy areas and growth consumption of energy in item of Tiksi of area Bulunskiy it supposed cover 3 floating NTPS (336 million in kw h), reception of the electric power from (265 million in kw h). Demands of industrial targets for thermal energy will be provided with electro boiler-houses [4].

At a covering of the others electric and thermal loads traditional DPS, boiler-houses and conservation of existing structure supply by fuel in 2030 for power needs is required 624 thousand here organic fuel, including 34% diesel (1 % in individual sources of heat), 40% of coal, 18% of oil boiler fuel, 8% gas condensate. Their total cost at the consumer will make 6,9 billion rubles (in the prices 2008).

With use forecasting fuel and energy balances (FPB) are performed works on a background of perspective directions energy and fuel of supply.

The preliminary choice of effective versions of power supply for specific consumers is based on their technical and economic comparison. As the basic target criterion the minimum of industrial expenses, a net cost energy strikes root.

For decrease in expenses of power supply of the isolated consumers of the north of republic, except for recommended to input floating NTPS, can receive application of thermal power station of low power (thermal power station of MM) on coal [1]. However at work of thermal power station only for consumers of housing and communal services loading of steam turbines throughout a year is not provided, that does not allow making good use of the installed electric capacity of turbines with against pressure. At installation condensations turbines with the adjusted selections low parameters of vapor and imperfection of a thermodynamic cycle lead to high specific expense of conditional fuel – in 2,0 times above, than on DPS. As a result high expenses for consumed coal and a payment of wide range of qualified personnel lead to high costs of thermal power station. Their profitability in comparison with the traditional diagram energy supplying (DPS in a combination to boiler-houses) can be reached only due to a high difference in the price of coal and replaced diesel fuel. Besides construction of thermal power station will cause an increase of volume of consumed coal, a problem of its duly delivery and accordingly expansions of dry-cargo fleet that will demand high monetary investments. For many removed consumers of the north of republic the problem of delivery of coal on greater distances for short timeframe seasonal types of transport is

aggravated with its complexity caused links of the transport diagram with low throughput of waterways, no docking marine navigation and navigation on headwaters of the small rivers, indispensability overload and storages of fuel in a way.

The excessive increase of scales of use of imported coal will increase probability of infringements normal fuel supply which consequences were failures of timeframes of the beginning and the termination of a cold season of separate consumers and settlements, not heat facilities, etc.

From the point of view of convenience of transportation, long-time storage and leaning on compliance with the main rule of rational power supply (fuel supply): «than more finely the consumer, especially high-quality energy resource it should be provided» for power supply of the isolated consumers of northern areas a priority should be given two power resources: to liquid fuel and an intensification of its savings as to new energy source [2].

At input floating NTPS and uses in all generating installations of diesel fuel the general demand FER in 2030 year comparison with a version of conservation of existing structure fuel supply (in view of floating thermal power stations) will decrease for 18 % and 512 thousand here will make. Total cost of fuel will make the order 10,0 against 6,9 billion rubles for conservation of existing structure fuel supply.

In conditions of the north of Yakutia thermal loads exceed demands for the electric power that will allow cogeneration to provide the maximal power and economic effects of use of diesel fuel.

Thus the most actual and scale in progress of small power is equipment DPS utilization heats, introduction of new small thermal power stations with diesel installations and GTI.

As show calculations on GTI-TPS in comparison with DPS-TPS more expense of fuel, but it is less depreciation charges and fund of a payment of the personnel. As a result at considered capacities 2,5 and 6,0 Mwt, in a range of the existing prices for diesel fuel to the most effective by criterion of a net cost released энергий is GTI-TPS (tab. 1).

For settlements of the north of Yakutia GTI-TPS have optimum a parity of manufacture electric and thermal energy. Gas turbine thermal power station surpass DPS with recycling heat on productivity on 1 kw of electric capacity, to the general efficiency, a supposed mode and operating conditions, to ecological parameters. Thus, at loads 2-3 Mwt and more expediently to consider GTI with cogeneration, for small consumers with loads of 300-2500 kw – DPS with recycling heat.

TABLE 1. COMPARATIVE EFFICIENCY OF VARIOUS TYPES OF THERMAL POWER STATION ON DIESEL FUEL.

Parameter	Unit of measurement	DPS-TPS on diesel fuel		GTI-TPS on diesel fuel	
The installed capacity:					
- Electric	Mwt	2,5	6,0	2,5	6,0
- Thermal	Gcal/h	2,7	4,8	5,8	14,1
Vacation of energy:					
- Electric	mln. kwt h	8,0	19,2	8,0	19,2
- Thermal	thous. Gcal	10,6	18,8	22,6	55,1
Initial capital investments	mln. rub.	97,0	216,0	125,0	270,0
Constant component of expenses	mln. rub.	14,8	34,2	12,0	28,0
Annual expense of fuel	thous. t cf	5,0	10,1	5,4	11,4
Expenses for fuel	mln. rub.	80,0-110,0	162,0-22,0	87,0-136,0	182,0-251,0
Industrial expenses	mln. rub.	94,8-24,8	196,0-256,0	99,0-148,0	210,0-279,0
Net cost					
- The electric power	rub./kwt h	6,7-8,7	6,2-8,0	5,2-6,8	3,8-5,0
- Thermal energy	thous. rub./ Gcal	3,9-5,2	4,1-5,4	2,5-3,4	2,5-3,3

Application GTI-TPS with individual capacity 2,5 Mwt is appropriate also economical in rather large settlements, basically in the regional centers, 8 northern areas.
Total capacity of these GTI-TPS, consisting of 18-23 blocks, makes 45,0÷57,5 Mwt, a rough electric power output 68-80 million in kw ч, heats – 360-460 thousand Gcal [3]. In northern areas on objective of heating it is possible to utilize heat DPS total capacity 47 Mwt with development 65 million in kw h (tab. 2).

TABLE 2. THE ASSESSMENT OF PRIORITY DIRECTIONS IN USE OF VARIOUS TYPES OF SMALL THERMAL POWER STATIONS ON AREAS OF NORTH YAKUTIA

Area	The normative installed electric capacity of the regional center, Mwt	ТЭЦ ММ				
		Floating NTPS, Mwt	DPS-TPS, Mwt	GTI-TPS on liquid fuel, Mwt	Thermal power station (TPS) on coal, Mwt	ONLY, Mwt
Abuiskiy	11,6	–	2,2	5,0	–	*7,17*
Allaihovskiy	12,1	–	2,0	10,0	–	*11,915*
Anabarskiy	9,3	12	0	2,5-5,0	–	*14,5-17,0*
Bulunskiy	27,6	12	5,8	–	–	*17,815*
Verkhnekolumskiy	17,4	–	9,7	–	12	*21,655*
Verkhoynskiy	21,6	–	6,4	12,5-15,0	–	*18,91-21,41*
Zhiganskiy	15,7	–	0,8	–	6	*6,755*
Momskiy	12,4	–	0,8	5,0-7,5	–	*5,83-8,33*
Nizhnekolumskiy	18,0	–	3,2	–	6	*9,185*
Oimyakonskiy	51,2	–	4,4	–	–	*4,440*
Olenekskiy	10,4	–	0,8	2,5-5,0	–	*3,26-5,76*
Srednekolumskiy	16,7	–	3,9	–	6	*9,88*
Ust-Yanskiy	16,9	60	6,9	5,0-7,5	–	*71,875-74,375*
Eveno-Butantaiskiy	8,1	–	0,3	2,5	–	*2,8*
Total installed electric capacity, Mwt		84,0	47,2	45,0-57,5	30	*206-218,7*
Development e/p mln. kw h/year		336	65	75	53	*529*
Savings (+), the overexpenditure (-) conditional fuel: due to replacement e/p DPS, thous. tcf		87	17	18	-24	*98*
due to replacement p/e Boiler-house, thous. tcf		6,7	13,1	11,6	-2,7	*28,7*

In tab. 3 is presented prognoses summary FEB northern areas per 2030 at use GTI-TPS by total development nearby 75 million in kw h to the electric power (a physical equivalent 9,2 thous. tcf) and 410 thousand Gcal of thermal energy (58,6 thous. tcf) in Abuiskiy, Allaihovskiy, Anabarskiy, Verkhoyanskiy, Momskiy, Olenekskiy, Ust-Yanskiy, Eveno-Butantaiskiy areas and DPS-TPS the general development 65 million in kw h the electric power (8,0 thous. tcf) and 190 thousand Gcal of heat (27,1 thous. tcf) in all 14 areas. On the combined energy sources 76 % of electric energy and 34 % of heat are developed. Other part is made DPS without recycling heat and boiler-houses accordingly. The general expense of fuel will decrease up to 476 thous. tcf (9,2 bln. rub.). Decrease in consumption of fuel due to introduction combined energy saving up technologies 7 % or 25 thous. t (36 thous. tcf), that in dollar value – will make about 700 mln. rub. (in the prices 2008).

TABLE 3. FUEL AND ENERGY BALANCE OF NORTHERN AREAS RS (Y) IN 2030 (AT USE OF THE COMBINED MANUFACTURE OF ENERGY ON DPS AND GTI), THOUSEND TONN CONDITIONAL FUEL

Parameters	Diesel fuel	Gasoline	Nuclear fuel	Electric energy	Thermal energy	Total	%
Import primary FER	585,7	9,8	86,4	32,6	-	714,5	
Consumption FER	**585,7**	**9,8**	**86,4**	**32,6**	**-**	**714,5**	**100**
Transformation FER, all	**-475,5**	**-**	**-86,4**	**64,4**	**343,2**	**-154,3**	**21,6**
from them:							
on manufacture e/p, in total:	**-81,4**	**-**	**-47,0**	**77,0**	**-**	**-51,4**	**7,2**
including -DPS	-60,0	-	-	18,5	-	-41,5	5,8
-NTPS	-	-	-47,0	41,3	-	-5,7	0,8
-GTI-TPS	-12,1	-	-	9,2	-	-2,9	0,4
-DPS-TPS	-9,3	-	-	8,0	-	-1,3	0,2
on manufacture p/e, in total:	**-394,1**		**-39,4**	**-12,6**	**343,2**	**-102,9**	**14,4**
including - boiler-houses	-191,0	-	-	-	153,2	-37,8	5,3
-NTPS	-	-	-39,4	-	30,0	-9,4	1,3
- electroboiler-houses	-	-	-	-12,6	12,0	-0,6	0,08
-GTI-TPS	-77,1	-	-	-	58,6	-18,5	2,6
-DPS-TPS	-30,0	-	-	-	27,1	-2,9	0,4
-individual sourses	-96,0	-	-	-	62,3	-33,7	4,7
Own needs and losses	**-**	**-**	**-**	**-12,5**	**-51,2**	**-63,7**	**8,9**
Final consumption	**110,2**	**9,8**	**-**	**84,5**	**292,0**	**496,5**	**69,5**
The same in %	**22,2**	**2,0**	**-**	**17,0**	**58,8**	**100**	**-**

Comparative technical and economic calculations show, that the thermal power station of MM on coal can be effective only at smaller costs of coal, т. е. In regional centers Zhiganskiy and the Kolyma group of the areas located in relative proximity from coal deposits or near to river transport arteries (tab. 2). In tab. 4 it is presented prognoses PEB, similar at use of the combined manufacture of energy on DPS and GTI (tab. 1), but with introduction п.п. Zuryanka, Cherskiy, Srednekolumsk, with. Zhigansk coal thermal power stations (tab. 2). On small thermal power stations 529 million in kw h the electric power and 1109 thous. Gcal of heat or 85% and 46% all manufacture accordingly is developed.

At introduction in the set forth above settlements of coal thermal power stations of MM in fuel balance of 4 areas 112 thous. t (94,6 thous. t cf) zuryanskiy and 21 thous. t (16,2 thous. t cf) dzhebariki-hainskiy coals that will reduce consumption in northern areas of diesel fuel with 476 up to 401 thousand t cf (tab. 3 and 4) is involved.

Total consumption of organic fuel will increase for 8,0 %: from 476 up to 514 thous. t cf, however cost of fuel will decrease for 1,2 bil. rub. and will make 8,0 bil. rub.

In structure TER for manufacture energy 65% diesel fuel will make, 14% nuclear fuel, 2 the electric power, about 19% coal, including 14% of extraction in northern area (zuryanskiy) and 5 % imported (dzhebariki-hainskiy).

The volume and cost of organic fuel on power supply of northern areas in 2030 in the prices 2008 in directions of progress energy and fuel supply will make:

- 624 thousand here and 6,9 bln. rub. at conservation of existing structure fuel supply;
- 512 thous. t cf and 10,0 bln. rub. at work of all energy of sources on diesel fuel;
- 476 thous. t cf and 9,2 bln rub.
- At use of the combined manufacture энергий on DPS and GTI;
- 514 thous. t cf and 8,0 bln. rub. at additional use to GTI-TPS and DPS-TPS 4 coal thermal power stations of MM.

For input of the set forth above thermal power stations of low powers (except for floating NTPS) 8,0-9,0 bln. rub. of initial capital investments (in the prices 2008) is required.

The savings of conditional fuel at application will make 30,0-35,0 thous. t cf, including due to replacement of electric power DPS 10-12 thous. t cf, thermal energy – 20-23 thous. t cf, that

195-235 and 185-210 mln. rub. accordingly in dollar value will make.

TABLE 4. FUEL AND ENERGY BALANCE OF NORTHERN AREAS RS (Y) IN 2030 (AT USE OF THERMAL POWER STATION ON COAL, GTI-TPS, DPS-TPS ON DIESEL FUEL), THOUSEND TONN CONDITIONAL FUEL

Parameters	Diesel fuel	Coal	Gasoline	Nuclear fuel	Electric energy	Thermal energy	Total	%
Extraction (manufacture) FPR	-	252,9	-	-	-	-	252,9	
Import primary FPR	511,1	27,4	9,8	86,4	32,6	-	667,3	
Export primary FPR	-	-166,3	-	-	-	-	-166,3	
Consumption FPR	**511,1**	**114,0**	**9,8**	**86,4**	**32,6**	**-**	**753,9**	**100**
Transformation FPR, all	**-400,9**	**-114,0**	**-**	**-86,4**	**64,4**	**343,2**	**-193,7**	**25,7**
from them:								
on manufacture e/p, in total:	**-60,3**	**-45,3**	**-**	**-47,0**	**77,0**	**-**	**-75,6**	**10,0**
including -DPS	-38,9	-	-	-	12,0	-	-26,9	3,6
-NTPS	-	-	-	-47,0	41,3	-	-5,7	0,7
-TPS	-	-45,3	-	-	6,5	-	-38,8	5,1
-GTI-TPS	-12,1	-	-	-	9,2	-	-2,9	0,4
-DPS-TPS	-9,3	-	-	-	8,0	-	-1,3	0,2
on manufacture p/e, in total:	**-340,6**	**-68,7**	**-**	**-39,4**	**-12,6**	**343,2**	**-118,1**	**15,7**
including - boiler-houses	-137,5	-	-	-	-	110,3	-27,2	3,6
- NTPS	-	-	-	-39,4	-	30,0	-9,4	1,2
- TPS	-	-68,7	-	-	-	42,9	-25,8	3,4
- electroboiler-houses	-	-	-	-	-12,6	12,0	-0,6	0,07
- GTI-TPS	-77,1	-	-	-	-	58,6	-18,5	2,5
- DPS-TPS	-30,0	-	-	-	-	27,1	-2,9	0,4
- individual sourses	-96,0	-	-	-	-	62,3	-33,7	4,5
Own needs and losses	**-**	**-**	**-**	**-**	**-12,5**	**-51,2**	**-63,7**	**8,4**
Final consumption	**110,2**	**-**	**9,8**	**-**	**84,5**	**292,0**	**496,5**	**65,9**
The same in %	**22,2**	**-**	**2,0**	**-**	**17,0**	**58,8**	**100**	**-**

CONCLUSION

Decentralized power supply of northern areas is carried out from DPS and GTI, fine boiler and individual sources of heat. Low operational characteristics energy sources, high cost of fuel and transport tariffs lead to greater expenses by manufacture energy.

Substantial growth of coal at progress of small power of north RS (Y) is inexpedient and it is uneconomical.

To successful progress of small power at reduction of volumes of transportations, expenses for transportation, maintenance of stability and reliability energy and fuel of supply, improvement of social and economic conditions of residing of the population will assist use in all objects of power of high-quality liquid (diesel) fuel. The most rational direction of progress of power supply scale use of the combined manufacture electric, thermal energy on diesel fuel is represented to authors. Cogeneration will allow to provide the maximal power and economic effects at use of imported fuel. However for decrease in consumption of expensive diesel fuel near to coal deposits expediently to use thermal power station of MM on coal. At such diagram of power supply the structure of demand for fuel will make: 78 % diesel fuel, 22 % – coal, basically local manufacture (86 %).

As one of directions of increase of reliability of maintenance with diesel fuel it has to be noted expediency of accommodation in territory of northern areas of mini-oil refining installations. For supply by their raw material in republic there are favorable preconditions, namely availability of a significant amount of hydro carbonic resources.

Projects of objects of small power financial are not attractive to private investors, but their importance shows an indispensability of the

state support of its progress, especially for territories of the North.

Without progress of small power on the basis of modern saving up energy technologies and reliable fuel of maintenance effective development of territory, and the main creation of normal, comfortable conditions of a life of the population of North RS (Y) is impossible.

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BIOGRAPHIC DATA

Kuzmin Anatoly Nikolaevich – the scientific employee of the Department of problems of power of Institute of physic-technical problems of the North it. V.P. Larionov the Siberian Branch of the Russian Academy of Science. In Institute works with 1978 after the termination of Tomsk Polytechnic Institute it. S.M. Kirov on a specialty: "Physic-power installations". Area scientific researches – development of rational directions of progress local systems of power supply in the North.

Mikheyeva Elena Jurevna – the scientific employee of the Department of problems of power of Institute of physic-technical problems of the North it. V.P. Larionov the Siberian Branch of the Russian Academy of Science. In Institute works with 1996 after the termination of the Yakut State University it. M.K. Ammosov on a speciality: "Thermophysics". In 2000 has ended postgraduate study at Uralsk the state technical university on a speciality "Industrial power system". Area of scientific researches – prospects of progress of small power of the North.

Pavlov Nikita Vladimirovich – the engineer-electronics of the Department of problems of power of Institute of physic-technical problems of the North it. V.P. Larionov the Siberian Branch of the Russian Academy of Science. In Institute works with 2004 after the termination of the Yakut State University it. M.K. Ammosov on a speciality: "Information economist". Area of scientific researches – development of tools of research of thermal power station.