

"ENERGY-EFFICIENT TECHNOLOGIES"

INNOVATIVE PROJECT

**DEVELOPMENT
OF NEW 45 MW AND 60 MW
GAS TURBINE INSTALLATIONS**

UKRAINE 2008

CONTENTS

1. PROJECT NAME AND OBJECTIVE	3
2. PROJECT GENERAL FEATURES	5
3. FINANCIAL SCHEME OF PROJECT IMPLEMENTATION	8
4. SOURCES OF PROJECT FINANCING	11
5. PROJECT IMPLEMENTATION TERM	11
6. PROJECT PAY-BACK PERIOD	11
7. EXPECTED RESULTS OF PROJECT IMPLEMENTATION	12
8. DESIGN-AND-ESTIMATE DOCUMENTATION AVAILABILITY	12
9. INFORMATION ABOUT THE COMPANY EMPLOYING THE PROJECT	14

1. PROJECT NAME AND OBJECTIVE

Energy self-sufficiency of Ukraine ensures a stable operation of the industrial potential and well-being of its citizens. At present the most optimal way of developing the electric-power industry and creating the energy self-sufficiency system consists in using high-efficient technology of fuel combustion with considerable waste heat recovery. The technology is based on the principle of using gas turbine installations and cogeneration units, based thereon, with available heat factor of up to 98% and combined-cycle plants with 50% to 55% efficiency. Application of such power installations allows to practically reducing fuel consumption by 30% and 50% respectively. It is vital to note a number of advantages of power installations based on gas turbine technologies:

- Combination of high maneuverability and the highest thermal efficiency. The time for starting such electrical power station and reaching the nominal power does not exceed 20 to 30 minutes, and in cases of emergency it takes 10 minutes. Such high maneuverability makes it feasible to detect any power change in a daily schedule for the area where the power station is located. Considering the deficiency of on-peak power in Ukraine, the possibility of operation in an on-peak power mode is of paramount importance;
- A small scope of capital development, a comparatively low cost and a short pay-back time respectively.
- The possibility of forming a distributed system of electric-power industry that will allow to efficiently ensure the energy self-sufficiency of the state.

The SE "Zorya"-“Mashproekt” RPC has elaborated new gas turbine installations for electric-power industry of 45 MW (GTE-45) and of 60 MW (GTE-60). The design has been made on the basis of the Presidium of the Technical-Scientific Council Resolution "About choosing and developing of new gas turbine engines and basic trends in designing of gas turbine equipment" dated 10.02.2003.

The objective of the innovative project being offered: Developing of new domestic high-performance gas turbine installations and, based thereupon, cogeneration and combined-cycle plants for electric-power industry and heat-power industry that would ensure operation by employing energy-efficient technologies and be in compliance with the world environmental protection standards.

The name of the innovative project being offered: " Developing of new 45 MW and 60 MW gas turbine installations for electric-power industry".

With the purpose of implementing the suggested innovative project in a full scope the SE "Zorya"-“Mashproekt” RPC has elaborated the design documentation. The "DneprVNIPI-energoprom" design institute has fully executed, within the framework of the feasibility report, the following technical-and-commercial offers on usage of new gas turbine installations for electric-power industry:

- Combined-cycle plant PGU-85 equipped with GTE-60 gas turbine engine developed by SE "Zorya"-“Mashproekt” RPC (0301.H1Π01.ТКΠ) 2006;
- Combined-cycle plant PGU-170 equipped with GTE-60 gas turbine engines developed by SE "Zorya"-“Mashproekt” RPC (0301.H1Π02.ТКΠ) 2006;
- Combined-cycle plant PGU-220 of steam-dump type equipped with GTE-60 gas turbine engine developed by SE "Zorya"-“Mashproekt” RPC (0301.H1Π03.ТКΠ) 2006.

2. PROJECT GENERAL FEATURES

2.1 Gas Turbine Installation Components

2.1.1. Gas turbine engine on skid with separately mounted air cooler of the turbine blades cooling system;

2.1.2. Gas turbine engine heat-and-sound-proof enclosure equipped with metal plate covering, ventilation system, piping and spraying devices of fire-extinguishing system, gas concentration control sensors, fire alarms, warning systems and electric lighting systems;

2.1.3. Turbogenerator in a sound-proof enclosure with excitation system, with closed-circuit air cooling system, with industrial water-operated coolers;

2.1.4. Reduction gear with shaft-turning mechanism and attached oil pump unit fitted in a sound-proof housing;

2.1.5. Thyristor starting device;

2.1.6. Gas turbine installation supporting systems: fuel feeding, lubrication, pneumatic control, cooling;

2.1.7. Integrated air-cleaning device (KBOY) with self-cleaning filters and silencer unit,

2.1.8. GT engine inlet volute;

2.1.9. Exhaust duct;

2.1.10. Automatic regulation, control, protection and monitoring system (CAY), turbo-compressor overspeed system, vibration control and vibration diagnostics system of GT engine, RG (reduction gear) and generator;

2.1.11. The systems of fire-extinguishing and gas concentration control of GT installation;

2.1.12. GT engine flushing system;

2.1.13. Low voltage complete arrangement for distributing and control over the auxiliaries using equipment HK PYCH-380/220;

2.1.14. Sets of:

- assembling parts and accessories;
- spare parts for a guaranteed period of operation;
- spare parts for STW (setting-to-work);
- tooling and accessories;
- assembly and operation documentation.

2.2 GT installations basic technical data

2.2.1. GTE-45 and GTE-60 gas turbine installations are intended for operation in base, half-peak and peak classes of application in compliance with the State Standard GOST 29328-92.

2.2.2 The basic parameters of gas turbine installations GTE-45 and GTE-60 are placed in Table 1.

Table 1

GTE-45 and GTE-60 basic parameters

Sl.No.	Parameter description	GTE-45	GTE-60
1	GT engine power output, kW	47700	63500
2	Efficiency at GT engine output shaft (with regard for losses), %	36.3	38.8

2.3 GT installation functions

The main functions of GTE-45 and GTE-60 gas turbine installations:

- ensuring of electric power and heat generation for the waste-heat boiler when operating as a part of a cogeneration plant or combined-cycle plant in a base-class application – both in constructing of new and reconstructing of existing projects;
- ensuring of electric power generation for meeting peak load demands;
- being used as “gas turbine superstructures”, i.e. in addition to the already available one, with the purpose of increasing the efficiency of existing heating-and-power plants and boiler houses.

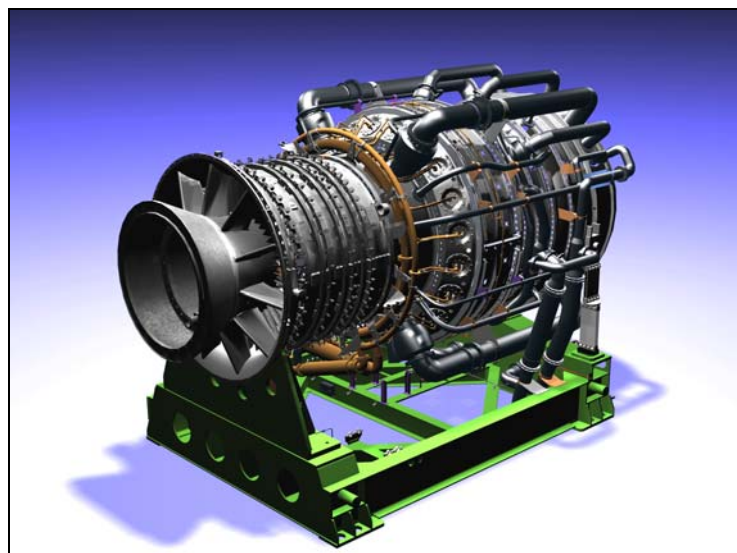
2.4 Advantages of gas turbine installations development

The principal advantages of developing gas turbine installations:

- effective application of the funds earlier invested, of intellectual and technical resources;
- gaining of profit from GT installation sales;
- 30% to 50% cost cutting for the fuel purchased by the state for electric power and heat generation, the energy-efficient technologies being employed at thermal power stations and heating-and-power plants;
- demonstrating of possibilities and of the technical level of the Ukrainian state-of-art technology in the province of energy-efficient, environmentally safe technologies. Feasibility of marketing expansion;
- ensuring of population employment. Improvement of social sphere.

2.5 GT installation comparative parameters

The comparative technical and value indicators for gas turbine installations of various companies based on the data contained in the "Gas Turbine World. 2004 – 2005" annual are placed in Table 2.



Gas turbine engine 45-60 MW

Table 2

Comparative technical and value indicators for GTE

GTE model	OEM	Power (ISO), kW	Efficiency (ISO), %	Price, thousand USD	Price per 1 kW, USD
GTE-45 GTE-60	SE "Zorya"- "Mashproekt" RPC	47700 63500	36.1 38.8	8400 9150	176 144
GTX100	Alstom	43000	37.0	11830	275
FT8 Twin	MAN Turbomaschinen	51350	38.4	14800	287
V64.3	MAN Turbomaschinen	63000	35.4	14175	225
LM6000PD	GE Aero Energy Products	42330	41.1	10200	241
GT8C2	Alstom	57000	33.8	16100	281

3. FINANCIAL SCHEME OF PROJECT IMPLEMENTATION

3.1 The plan of project investing

3.1.1. The investment project value consists of the following expenditures:

- The expenses associated with carrying out of Research and Development (НИОКР) for developing GTE-45 and GTE-60 gas turbine installations;
- The expenses pertaining to technical re-equipment of gas turbine installation mass production at the SE “Zorya”-“Mashproekt” RPC with the aim of meeting market demands.

3.1.2. Research and Development input pattern (cost structure).

- Elaborating of project documentation set for mass production of the engine and component parts. The estimated expenditures amount to 767 thousand EURO.
- Testing of components and parts at the test benches of SE “Zorya”-“Mashproekt” RPC research division and various research institutes. The estimated expenditures amount to 1632 thousand EURO.
- Process design and manufacturing of gas turbine engine equipment. The estimated expenditures amount to 8809 thousand EURO.
- Process design and manufacturing of reduction gear. The estimated expenditures amount to 408 thousand EURO.
- Developing of design documentation, manufacturing and mounting of the stand for testing gas turbine engine and reduction gear at SE “Zorya”-“Mashproekt” RPC test station and as a part of the “Kaborga” experimental station for the existing electric generator with electric power generation. The estimated expenditures amount to 653 thousand EURO.
- Performing of full-scale testing of new gas turbine installation at SE “Zorya”-“Mashproekt” RPC test station within 300 hours and as a part of the “Kaborga” experimental station. The estimated expenditures amount to 3719 thousand EURO.

The total estimated sum of expenses for R & D amounts to 15987 thousand EURO.

3.1.3. The expenses associated with technical re-equipping of GT installations mass production are shown in Table 3. The expenses value is substantiated by the necessity of ensuring a high technology level in manufacturing of gas turbine equipment and hence, acquiring high-precision equipment produced by the world known companies.

Table 3

List of metal-working machinery
for supporting GTE-45 and GTE-60 mass production

#	Description	Model	OEM	Designation	Q-ty	Price (thousand EURO)
1	6-coordinate Grinder,	CORBUS BBA	SCHNEE- BEER Switzerland	Manufacturing of intricate profile broaches	1	850,0
2	Vertical centre	MILLENNIUM VTC 150/180 2F	DANOBAT Spain	Highly productive disk ma- chining	1	830,0
3	5-coordinate ma- chining centre	Picomax-95	ALFLETH Switzerland	Machining of die molds	1	450,0
4	Band resaw	CP520AF; CP420AN; CR260NC	DANOBAT Spain	Cutting of rods, cutting of blank parts for titanium blades	3	250,0
5	Vertical machining centre	TV-800/4	DANOBAT Spain	Highly productive machining of discs	1	420,0
6	Horizontal borer	FR-14000	DANOBAT Spain	Machining of large size frames and casings of re- duction gears	1	1700,0
7	Gear grinder	MEGA 1250	HÖFLER Germany	Gear grinding of spur gear- wheels □ up to 1250	1	1200,0
8	EDM wire-cut ma- chine	of “Adhzikut” type		Manufacturing of high- accuracy parts, reducing of material consumption	1	150,0
9	Grinding centre for machining of root portion and periph- eral surfaces of tur- bine blades	DANOBAT	DANOBAT Spain	Highly productive machining of turbine blades	1	1600,0
10	Thread-rolling ma- chine	PW 15e PRS	PROFIROLL Germany	Manufacturing of fixing de- vices from heat-resistant steels	1	100,0
11	Swiss auto	STAR SR-32J	ALFLETH Switzerland	Manufacturing of fittings of intricate profile	2	600,0
Total sum of expenses for purchasing of the equipment						8150,0

The total sum of the expenses connected with acquiring of high-tech equipment for mass production of GTE-45 and GTE-60 amounts to 8150 thousand EURO or 8150 thousand EURO.

The total sum of the expenses related to developing of the project is 24144 thousand EURO.

Investing of the project is executed in conformity with the Schedule of Jobs pertaining to establishing and commissioning of mass production of GTE-45 and GTE-60 GT installations. The net worth (capital base) expenses of the SE "Zorya"-“Mashproekt” RPC till 01.01.2007 amount to 2887 thousand EURO.

The investment schedule is given below:

The 1st year of investment (2007). The funds for R&D – 33834 thou. EURO. The funds for technical re-equipment – 1631 thou. EURO. The total amount – 5465 thou. EURO.

The 2nd year of investment (2008). The funds for R&D – 5546 thou. EURO. The funds for technical re-equipment – 3263 thou. EURO. The total amount – 8891 thou. EURO.

The 3rd year of investment (2009). The funds for R&D – 3719 thou. EURO. The funds for technical re-equipment – 3263 thou. EURO. The total amount – 6982 thou. EURO.

3.2 Commercial GT Installations Production Program.

The following schedule is being developed for manufacturing of GT Installations with regard for realization of the Program of Production Technical Re-equipment:

The 1st year of investment (2007). No mass production. Manufacturing of a pilot unit.

The 2nd year of investment (2008). No mass production. Manufacturing of a pilot unit

The 3rd year of investment (2009). No mass production. Testing of the first pilot unit.

Exploratory (interagency) testing.

The 4th . year of investment (2010). Manufacturing of commercial installation GTE No.1

The 5th . year of investment (2010). Manufacturing of commercial installations GTE No.2 and No.3.

The 6th year and onward. Manufacturing of 3 commercial GTE installations a year.

4. SOURCES OF PROJECT FINANCING

The sources of project financing are as follows:

- Funds for R&D and technical re-equipment – long-term bank credit with APR (annual percentage rate) of 16%.
- Budgetary funds – for full compensation of a long-term bank credit.

5. PROJECT IMPLEMENTATION TERM

The time period for project implementation is 3 years.

6. PROJECT PAY-BACK PERIOD

6.1. The tentative average sale price of the gas turbine installation with regard for electric generator and ACS (automatic control system) amounts to 10604 thou. EURO. The cost of electric generator and ACS is 1272 thou. EURO. The sale price of the SE “Zorya”-“Mashproekt” RPC work is 9331 thou. EURO.

6.2. The prime cost of the work performed by Zorya”-“Mashproekt amounts to 6525 thou. EURO.

6.3. The planned assessable income on one GTE is $9331 - 6525 = 2806$ thou. EURO. The tax on income is 842 thou. EURO. The net income on one GTE amounts to 1964 thou. EURO.

6.4. The enlarged estimation of project pay-back is shown in Table 4. Repayment of the credit principal amount is effected by SE “Zorya”-“Mashproekt” RPC during the period of 2010 through 2013. Repayment of interest on credit is made through compensation out of budgetary funds in the amount of 14271 thou. EURO.

6.5. The project pay-back term is 3.6 years.

7. EXPECTED RESULTS OF PROJECT IMPLEMENTATION

- elaborating of advanced gas turbine installations that would ensure covering of base and peak loads for cogeneration and combined-cycle plants energy-efficient technologies of thermal power stations and heat-and-power plants within the framework of creating the energy self-sufficiency system of Ukraine;
- developing of advanced installations that meet the world standards in terms of environmental protection;
- developing of design, research-and-development, process and production base by “Zorya” - “Mashproekt” RPC as a designer and manufacturer of gas turbine engines and plants for electric-power industry, natural gas industry and shipbuilding;
- increase of gas turbine equipment sales in the world market by demonstrating “Zorya”-“ Mashproekt” RPC engineering capabilities. Strengthening of the Company image;
- ensuring of population employment, social protection level increase.

8. DESIGN-AND-ESTIMATE DOCUMENTATION AVAILABILITY

The design documentation has been elaborated in a full scope.

The following technical-and-commercial proposals concerning usage of new gas turbine installations in electric-power industry have been issued by the “DneprVNIIPenergo-prom” design institute in the volume of feasibility study:

- PGU-85 combined-cycle plant with GTE-60 turbine engine developed by the SE "Zorya"-“Mashproekt” RPC (0301.H1Π01.ТКΠ). 2006;
- PGU-170 combined-cycle plant with GTE-60 gas turbine engines developed by the SE "Zorya"-“Mashproekt” RPC (0301.H1Π02.ТКΠ). 2006;
- PGU-220 combined-cycle plant of dump type with GTE-60 gas turbine engines developed by the SE "Zorya"-“Mashproekt” RPC (0301.H1Π03.ТКΠ). 2006.

Table 4

**Payback estimation of the project of developing
new 45 MW and 60 MW gas turbine installations for electric power industry (thousand EURO)**

Year	1 st loan	16%	2 nd loan	16%	3 rd loan	16%	Σ loan	Σ %	Number of en- gines	Net profit per annum	Net cash flow	Repayment of interest on loan
2007	5465	874	-	-	-	-	5465	874	-	-	-	874
2008	5465	874	8891	1423	-	-	14356	2297	-	-	-	2297
2009	5465	874	8891	1423	6982	1117	21338	3414	-	-	-	3414
2010	-	-	-	-	-	-	-	-	1	1964	-19374	3100
2011	-	-	-	-	-	-	-	-	2	3928	-15445	2471
2012	-	-	-	-	-	-	-	-	3	5892	-9553	1528
2013	-	-	-	-	-	-	-	-	3	5892	-3661	586
2014	-	-	-	-	-	-	-	-	3	5892	2232	-
2015	-	-	-	-	-	-	-	-	3	5892	8124	-
2016	-	-	-	-	-	-	-	-	3	5892	14016	-
2017	-	-	-	-	-	-	-	-	3	5892	19909	-
2018	-	-	-	-	-	-	-	-	3	5892	25801	-
2019	-	-	-	-	-	-	-	-	3	5892	31693	-
Total amount of interest on loan redeemed from the budgetary funds												14271

9. INFORMATION ABOUT THE COMPANY EMPLOYING THE PROJECT.

9.1. Company abbreviated name and ЕДРПОУ code:

SE "Zorya"-“Mashproekt” RPC. Code 31821381

9.2. Form of ownership: *State Enterprise*

9.3. Field of activity (specialization): *Machine building, gas turbine manufacturing*

9.4. Company setting up date: *7th May, 1954*

9.5. Numbers employed: *13600 persons.*

9.6. Postal address: *42-A, Oktyabrskyy pr., Nikolaev 54018, Ukraine*

9.7. Head of the Company: *Mr. Andrei I. Khomenko, General Director*

9.8. Contact person: *Mr. Rustem I. Raimov,*

Head of electric-power plant projects

9.9. Phone: *(+38 0512) 49-73-37, 49-74-06*

Fax: *(+38 0512) 55-68-68*

E-mail: *rir@mashproekt.nikolaev.ua*

9.10. Blank fill date: *24.01.2007*

Head of electric-power installation projects

R.I.Raimov