Options for Modernization of Heat Supply to Consumers of Condensing Power Plant

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Abstract — **High competition and strict requirements of the wholesale electricity and capacity market make optimization of heat supply schemes an urgent issue for generating companies. Replacement of life-expired generation equipment with new capacities based on advanced technologies is a priority goal for the energy industry development. This work focuses on condensing power plant (CPP), which is the only source in the city that supplies heat to all consumer categories. The plant carries out quantitative and qualitative heat supply regulation according to the temperature profile of 135/70°C with a cutoff of 110/70°C. The study examines the possibility of CPP modernization based on three options: building a pressure-reducing cooling unit 140/12, commissioning an auxiliary boiler house, and building a 110 MW combined-cycle gas plant. This paper presents technical solutions for the considered options and preliminary technical and economic calculations of their efficiency.**

Index Terms: – **auxiliary boiler house; boiler unit; combined-cycle gas plant; pressure-reducing cooling unit; water heater.**

I. Introduction

This paper considers optimization solutions of a scheme of heat supply to consumers from a condensing power plant (CPP), which is the only source in the city. For reliable and uninterrupted heat supply during the heating period, part of the CPP power units operate at minimum loads of 110 MW, which leads to losses from electricity sales in the wholesale electricity and capacity market (WECM), since the cost of electricity generated at some points of time (night, weekends, holidays) exceeds market

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electricity prices. According to the data provided by the Production and Technical Department of the CPP, its loss in the year under consideration was RUR 50 million.

Thus, this study aims to:
1. Develop technical solutions to optimize the scheme of heat supply to urban consumers.
2. Evaluate the effectiveness of the solutions developed.

The accomplishment of the set goals involved the analysis of:
1. The plant operating conditions.
2. The heat network operation.
3. The technical condition of the CPP equipment.
4. Heat and electricity generation, specific fuel consumption rates, and the development of the heat balance for the CPP.

II. Materials and methods

The following options are considered to optimize heat supply to consumers:
1. Construction of a pressure-reducing cooling unit (RCU) 140/12 with a steam capacity of 50 t/h, and reconstruction of RCU 12/6.
2. Commissioning of an auxiliary boiler house (ABH).
3. Construction of a combined-cycle gas plant (CCGP) with a capacity of 110 MW.

A. Construction of RCU 140/12 with a steam capacity of 50 t/h and reconstruction of RCU 12/6

To optimize heat supply with no additional units employed, one can construct RCU 140/12 with a steam capacity of 50 t/h (Fig. 1), which entails a reduced steam flow in the steam header of 12 atm, then to the network water heater PSV-500-I (33.64 t/h of steam from RCU 140/12 and 24.49 t/h of steam from two turbines using RCU 25/12) located in the turbine hall of stage 1 of the main building and through RCU 12/6 and a steam header of 7 atm to PSV-500-II (16.36 t/h from RCU 140/12 via RCU 12/6 and 16.1 t/h from two turbine extractions via RCU 25/6) located in the turbine compartment. With a nominal steam capacity of 640 t/h and nominal steam consumption of 575.5 t/h per turbine, the backup steam capacity of power boilers of each power unit is 64.5 t/h [1, 2].

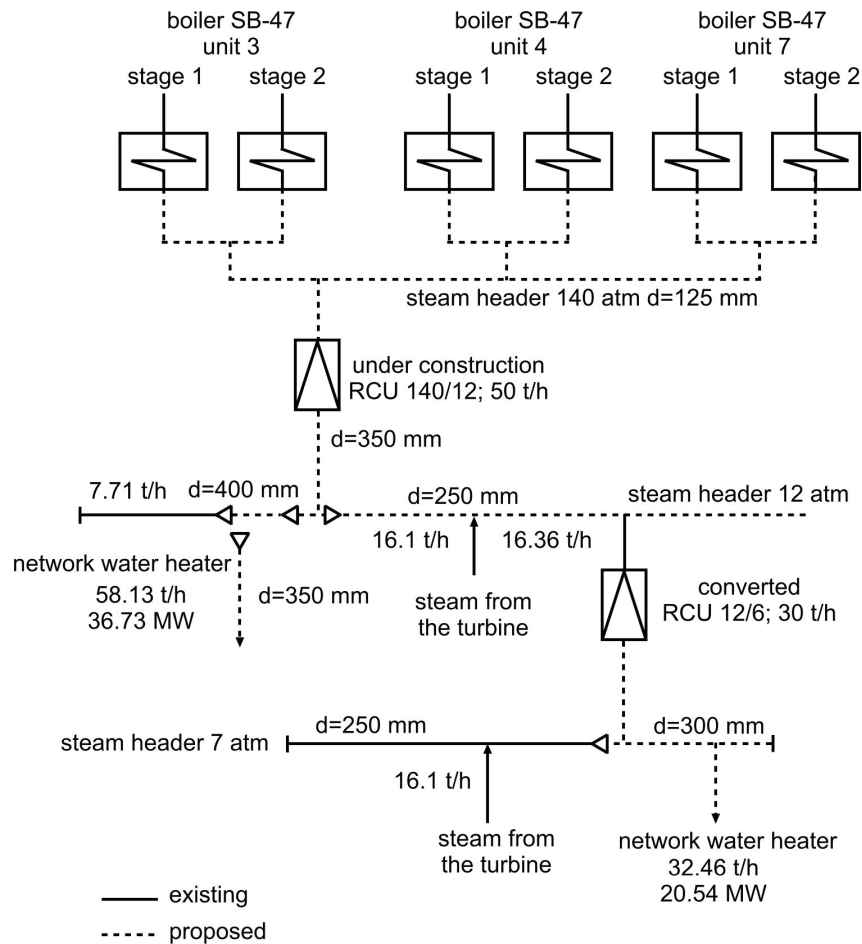At the same time, the steam consumption through the 12 atm header will be:

Fig. 1. Schematic diagram of RCU 140/12 connection.

TABLE 1. Distribution of heat output under current conditions.

| Source | Current conditions of heat output | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		-		-
From extraction 2 of turbines	3	-	1	-
From extractions 4 and 5 of turbines		31.65 (63.24)		16.08 (25.94)

TABLE 2. Distribution of heat output with RCU 140/12 in operation.

| Source | Proposed heat supply scheme | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		21.26 (33.64)		10.35 (16.36)
From extraction 2 of turbines	1	10.29 (16.1)	1	10.29 (16.1)
From extractions 4 and 5 of turbines		20.53 (27.7)		20.53 (27.7)

TABLE 3. Distribution of heat output under current conditions.

| Source | Current conditions of heat output | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		-		-
From extraction 2 of turbines	2	3.04 (4.8)	1	7.19 (11.35)
From extractions 4 and 5 of turbines		45.59 (63.24)		22.80 (31.62)

TABLE 4. Distribution of heat output with RCU 140/12 in operation.

| Source | Proposed heat output scheme | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		21.26 (33.64)		10.35 (16.36)
From extraction 2 of turbines	1	10.79 (16.1)	1	10.29 (16.1)
From extractions 4 and 5 of turbines		20.53 (27.7)		20.53 (27.7)

TABLE 5. Heat output distribution under current conditions.

| Source | Current conditions of heat output | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		-		-
From extraction 2 of turbines	5	7.76	3	4.95
From extractions 4 and 5 of turbines		113.97 (158.1)		68.38 (94.86)

- 50 t/h with RCU 140/12;
- 32.2 t/h from the second extraction of turbine units (2 power units);
- 58.13 t/h at PSV-500 of the first stage;
- 7.71 t/h for fuel oil production;
- 16.36 t/h with RCU 12/6.

The steam consumption through the 7 atm steam header at the same time will be:
- 16.36 t/h with RCU 12/6;
- 16.1 t/h from the second extraction of turbine units;
- 32.46 t/h for the PSV-500 network water heater of the second stage.

Distribution of heat output (at an outdoor temperature of –5.2°C) under current conditions and the conditions with RCU 140/12 in operation is presented in Tables 1 and 2.

In Table 1–6, Q is heat output, MW; G is steam consumption, t/h.

Tables 1 and 2 indicate that commissioning of RCU 140/12 at an outdoor temperature of –5.2°C will allow the decommissioning of two power units and reduce the load on the remaining power units to 110 MW.

Distribution of heat output (at an outdoor temperature of –22 to –24°C) under current conditions and the conditions with RCU 140/12 in operation is presented in Tables 3 and 4.

TABLE 6. Heat output distribution with RCU 140/12 in operation.

| Source | Proposed heat output scheme | | | |
| | Stage 1 | | Stage 2 | |
	Quantity of power units	Q, MW (G, t/h)	Quantity of power units	Q, MW (G, t/h)
From RCU 140/12		21.26 (33.64)		10.35 (16.36)
From extraction 2 of turbines	4	15.48 (24.49)	3	10.79 (16.1)
From extractions 4 and 5 of turbines		91.18 (126.48)		68.38 (94.86)

Tables 3 and 4 indicate that the commissioning of RCU 140/12 at an outdoor temperature of –22 to –24°C will allow decommissioning of one power unit and reducing a load of remaining power units to 110 MW.

Heat output distribution (at an outdoor temperature of – 34°C) under current conditions and the conditions with RCU 140/12 in operation is presented in Tables 5 and 6.

Tables 5 and 6 show that commissioning of RCU 140/12 at an outdoor temperature of –34°C will allow decommissioning of one power unit.

To increase the flexibility of the heating plant when commissioning the new RCU 140/12, it is necessary to provide a cross-connection between the live steam boilers so that when one of the power units is stopped, RCU 140/12 remains in operation [3, 4]. Estimation of the power unit operation duration and equipment layout characteristics should take into account that cross-connection for live steam should be arranged between power units 3, 4, and 7, as the most loaded ones [5, 6]. The hot steam header diameter will be 125 mm to ensure the required performance of RCU 140/12.

The existing thermal capacity of the network water heater PSV-500 of the first stage with the parameters of heating steam P = 8 atm and t = 250°C is 15.58 MW, which corresponds to the consumption of 24.69 t/h of heating steam by PSV-500 of the first stage and 7.71 t/h by the fuel oil industry.

To increase steam consumption by PSV-500 of the first stage to 58.13 t/h (36.73 MW), it is necessary to relay the existing steam pipeline of 12 atm with a diameter of 250 mm:
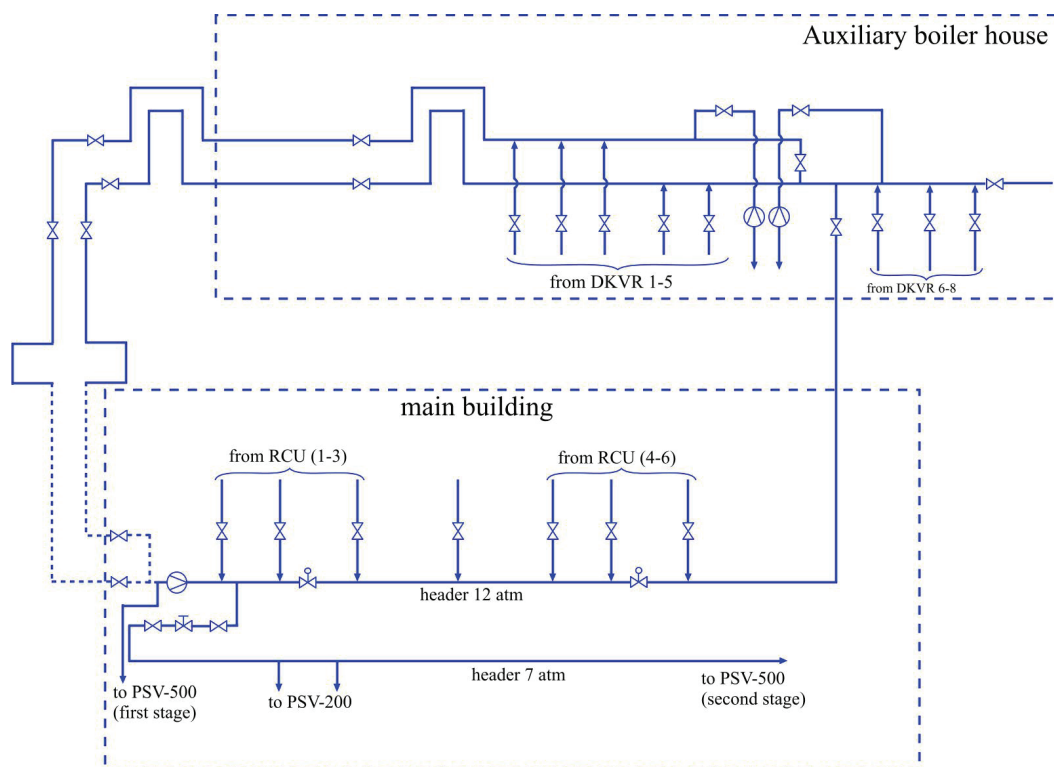

Fig. 2. The diagram of steam supply from ABH to the water heater PSV-500.

- on the section from RCU 140/12 to the tie-in to the 12 atm steam header of the first stage with a diameter of 350 mm;
- on the section from the header with RCU 140/12 to the header to PSV-500 of the first stage with a diameter of 400 mm;
- on the section from PSV-500 of the first stage to the tie-in to the 12 atm steam header with a diameter of 350 mm.

B. Commissioning of ABH

The option of upgrading the existing heat supply scheme by commissioning the ABH [7-9] is suggested to optimize the heat supply from CPP without involving additional power units.

The diagram of the steam supply from ABH to the water heater PSV-500 of the first and second stages is presented in Fig. 2.

Commissioning of ABH implies the steam supply from the existing boiler house to the steam header of 12 atm [10, 11].

There are seven steam boilers in the ABH. Technical parameters of the produced steam are P_o = 23 atm, T_o = 370°C.

The boiler house is connected to the steam headers of 12 and 7 atm, which are located in the CPP main building.

According to the calculations, the actual steam production with parameters P_o = 8 atm and T_o = 210°C is 34.8 t/h by boilers DKVR-10-23 (5.8 t/h × 6 pcs. = 34.8 t/h) and 11.0 t/h by boiler DKVR-20-23. The total steam production by the boiler house is 45.8 t/h or 29.16 MW, which is slightly less than the total capacity of the boiler group, and the second extraction of one power unit at a load of 110 MW (30.82 MW). The average weighted specific consumption of reference fuel (hereinafter fuel, in

tonnes of oil equivalent, t.o.e.) for heat production for the boiler house will be $b_{t.o.e.-abh}$ = 136.8 kg/MW [12-14].

Currently, boiler DKVR-10-23 is in operation. The service life of other boilers has expired.

Years of commissioning and service life extension of boilers are presented in Fig. 3.

As seen from Fig. 3, most boilers were put in service in 1967-1968, and service life for most of them has expired.

To increase the steam flow to the network water heater (PSV-500) of the first stage up to 70.49 t/h (44.54 MW), it is required to transfer the existing steam pipeline of 12 atm with a diameter of 250 mm from the condensate pump to PSV-500 of the first stage to the pipeline with a diameter of 400 mm [15].

Thus, the commissioning of ABH will allow removing no more than one power unit from the "forced" operation in the heating period [16,17].

The annual hot water supply was Q_{ta} = 323 618.7 MW with an average annual specific fuel consumption for heat supply of 147.2 kg/MW.

Consumption of fuel for heat production at CPP [18] is as follows:

$$G_{t.o.e.} = (Q_{ta} \cdot b_{t.o.e.-h.y.}) / 1\,000 =$$
$$= (323\,618.7 \cdot 147.2)/1\,000 \approx 47\,636.7, \quad (1)$$

where $b_{t.o.e-h.y.}$ is specific fuel consumption for heat production from thermal power plant.

The planned heat supply from ABH for three months (December, January, February) of the heating period is as follows:

$$Q_{abh} = 29.16 \cdot 90 \cdot 24 = 62\,985.6, \quad (2)$$

where:
- 29.16 is heat production by ABH, MW/hour;
- 90 is the duration of boiler operation, day;
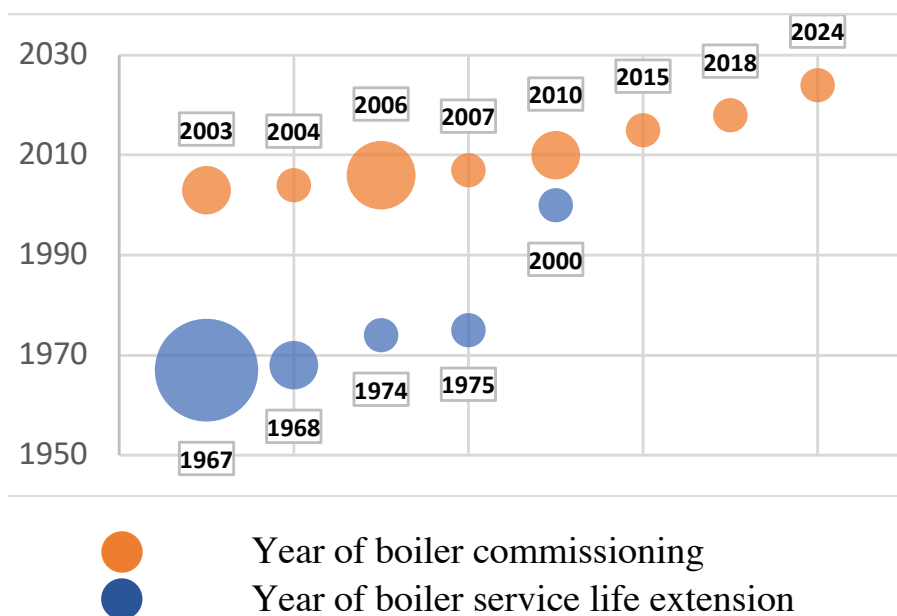- 24 is the number of hours per day, an hour.

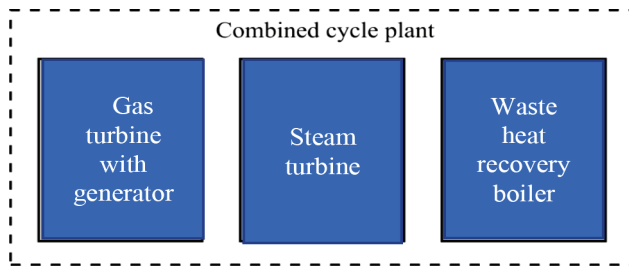*Fig. 3. Data on boiler commissioning and service life extension.*

Fig. 4. The CCGP configuration.

TABLE 7. The preliminary cost of the project for 110 MW CCGP construction at CPP.

No.	Type of work, equipment, and costs	Price, RUR million (without VAT)
1	Equipment, including gas turbine plants, waste heat recovery boilers, steam turbine plants, electrical equipment, auxiliary equipment.	3 000
2	Construction and installation	900
3	Commissioning	100
4	Design and survey	200
5	Unforeseen expenses	300
6	Dismantling of the existing power unit	500
	Total	5 000

TABLE 8. Specific parameters of the 110 MW CCGP for heat and electricity supply.

No.	Type of work, equipment, and costs	Price, RUR million (without VAT)
1	Equipment, including gas turbine plants, waste heat recovery boilers, steam turbine plants, electrical equipment, auxiliary equipment.	3 000
2	Construction and installation	900
3	Commissioning	100
4	Design and survey	200
5	Unforeseen expenses	300
6	Dismantling of the existing power unit	500
	Total	5 000

Consumption of fuel for heat supply from ABH:

$$G_{abh} = (Q_{abh} \cdot b_{t.o.e.-abh}) /1\,000 = (62\,985.6 \cdot 136.8) /1\,000 \approx 8\,616.4. \quad (3)$$

Heat supply from power units when involved in the ABH operation is:

$$Q_{h.y.} = Q_{ta} - Q_{abh} = = 323\,618.7 - 62\,985.6 = 260\,633.1. \quad (4)$$

Fuel consumption for heat supply from power units when involved in the ABH operation is:

$$G_{h.y.} = (Q_{h.y.} \cdot b_{t.o.e.-h.y.})/1\,000 = = (260\,633.1 \cdot 147.2) /1\,000 \approx 38\,365.2. \quad (5)$$

Fuel saving for hot water heat supply during the ABH operation (December, January, February) is as follows:

$$E_{abh} = G_{t.o.e.} - (G_{abh} + G_{h.y.}) = = 47\,636.7 - (8\,616.4 + 38\,365.2) = 655.1, \quad (6)$$

which corresponds to RUR 1.966 million.

C Construction of 110 MW combined-cycle gas plant (CCGP)

Nowadays, one of the most common and successful solutions for replacing obsolete capacities is the construction of combined-cycle power units. In the Republic of Tatarstan, natural gas combined-cycle plants were put into operation at the Kazan CHPP-1 and CHPP-2, the Yelabuga CHPP, and the Nizhnekamsk industrial zone, where they proved to be an effective solution for the combined electricity and heat generation.

The possibility of upgrading the CPP by constructing a 110 MW CCGP to deliver electricity to an outdoor 110 kV switchgear and supply heat for heating needs is considered.

The CCGP configuration is shown in Fig. 4.

The heat output of a steam turbine with adjustable extractions used as part of a CCGP is 87.23 MW. An increase in the efficiency of gas turbine exhaust gases can be achieved by installing gas network water heaters in the waste heat recovery boiler, which allow an additional production of about 5.82–6.98 MW. Thus, the total heat output of the combined-cycle plant will be 93.04–94.20
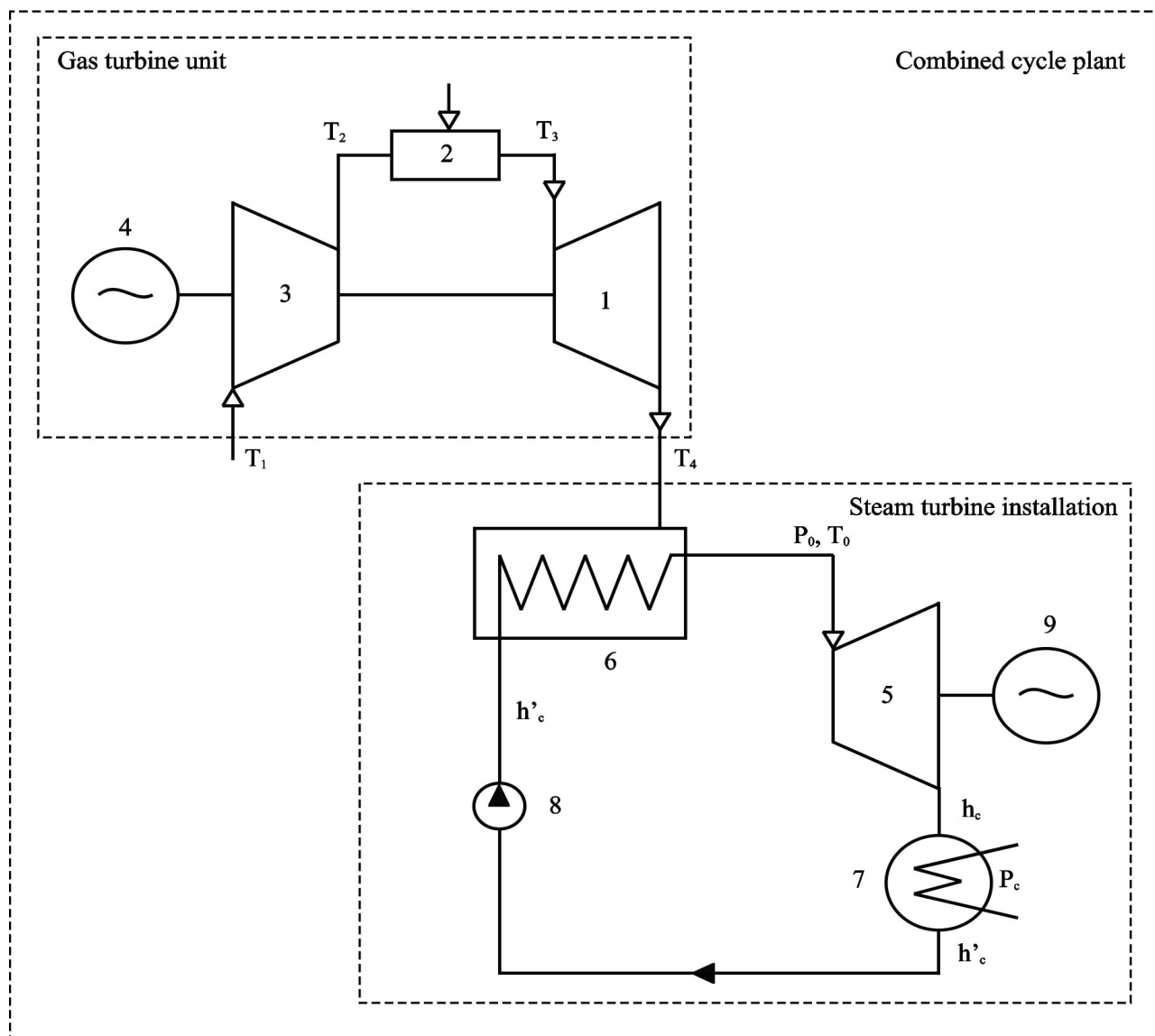
TABLE 9. Costs of the solution.

No.	Item	Estimated cost, RUR thousand
1	Equipment	19 000
2	Revision of the existing project	250
3	Replacement of RCU 12/6	2 000
4	Replacement of the 12 atm steam header with a diameter of 400 mm and replacement of the 12 atm steam header with the PSV-500	3 000
5	Installation of gate valves	1 500
	Total	25 750

Fig. 5. The CCGP heat network diagram.

MW, which partially covers the heat demand of the residential area, the main building, and the industrial site of CPP (the heat load at a rated outdoor temperature of $-34°C$ is 195.38 MW).

The CPP heat flow diagram, including 100 MW CCGP, will provide heat supply to consumers as efficiently as possible [19].

An estimated cost of the project for 110 MW CCGP construction at CPP is presented in Table 7.

The cost of building the 110 MW combined-cycle plant, according to the calculations performed in the pre-feasibility study for the construction of the unit, is RUR 4.5 billion. The cost of equipment indicated in Table 7 is based on technical and commercial quotes of manufacturers. The cost of items 2–6 in Table 7 is determined factoring in the implemented projects for the construction of combined-cycle power units in the Republic of Tatarstan. Given the cost for dismantling of one CPP power unit, which is

RUR 0.5 billion, the total cost of this technical solution will be RUR 5.0 billion. According to expert estimates, the implementation period of this option will be three years. The heat network diagram of the CCGP is shown in Fig. 5. Table 8 indicates specific parameters of the 110 MW CCGP.

The designations used in Fig.5 are 1 – gas turbine; 2 – combustion chamber; 3 – compressor; 4 – compressor electric motor; 5 – steam turbine; 6 - heat recovery boiler; 7 – condenser; 8 – condensate pump; 9 – generator.

III. RESULTS

The results of the feasibility studies of the proposed technical solutions are presented below.

A. Construction of RCU 140/12 with a steam capacity of 50 t/h and reconstruction of RCU 12/6

The existing heating capacity of the network water heater PSV-500 of the second stage under the heating steam

parameters $P = 7$ atm and $t = 250°C$ is 17.60 MW, which corresponds to the consumption of 27.8 t/h of heating steam of PSV-500 of the second stage (actual throughput of the pipeline is 27.8 t/h).

To increase steam consumption at PSV-500 of the second stage to 32.46 t/h (20.64 MW), it is necessary to relay the existing steam pipeline with a pressure of 7 atm and diameter of 250 mm in the section from RCU 12/6 to PSV-500 of the second stage with a diameter of 300 mm to replace RCU 25/6 due to its unsatisfactory technical condition.

The specific fuel consumption for heat production with the commissioning of RCU 140/12 will remain at the level of the existing actual values and amount to 146.17–147.9 kg.o.e./MW.

The costs of the option are summarized in Table 9.

The simple payback period is determined by the formula:

$$C = S_{cost}/(S_{econ.} - S_{cost.year}), \qquad (7)$$

where S_{cost} is project costs, RUR thousand;
$S_{cost.year}$ is annual project costs, RUR thousand ($S_{cost.year} = 0$);
$S_{econ.}$ is the total economic effect of the project for the heating period determined by the financial results of the source activity in the wholesale electricity and capacity market in the months with losses ($S_{econ.} = $ RUR 50 000 thousand). Information provided by the station's technical department.

The simple payback period will be:

$$C = 25\ 750/50\ 000 \approx 0.5$$

of the heating period.

At the same time, the specific capital investment per 1 Gcal is determined by the formula:

$$K = S_{cost}/W_{power}, \qquad (8)$$

where W_{power} is heat output of the commissioned equipment, MW (30.18 MW).

The specific capital investment (RUR million) per 1 MW will be:

$$K = 25.750/30.18 \approx 0.853.$$

B. Commissioning of ABH

The annual cost of maintaining the ABH performance:
- Maintenance and repair of instrumentation, material, and equipment are RUR 1.3 million.
- Operating costs, maintenance of boilers and additional equipment are RUR 0.68 million.

The payback period is calculated by the formula:

$$C = S_{cost}/(S_{econ} - S_{an.cost}), \qquad (9)$$

where:
S_{cost} is the costs of the project, RUR 39 250 thousand;
$S_{an.cost}$ is the annual costs of the project, RUR 1 980 thousand;
S_{econ} is the project economic effect during the heating period (49 899 + 1 966, RUR thousand), where 49 899 is the plant's loss according to the Finance Department; 1 966 is fuel saving for the period of the ABH operation.

The payback period is:

$$C = 39\ 250/\ (49\ 899 + 1\ 966 - 1\ 980) \approx 0.79\ (10)$$

of heating period.

The formula determines specific capital investment (RUR million) per 1 MW:

$$K = S_{cost}/W_{power}, \qquad (11)$$

where W_{power} is the heat capacity of the new equipment, Gcal/h (29.16 MW).

Specific capital investment (RUR million) per 1 Gcal is:
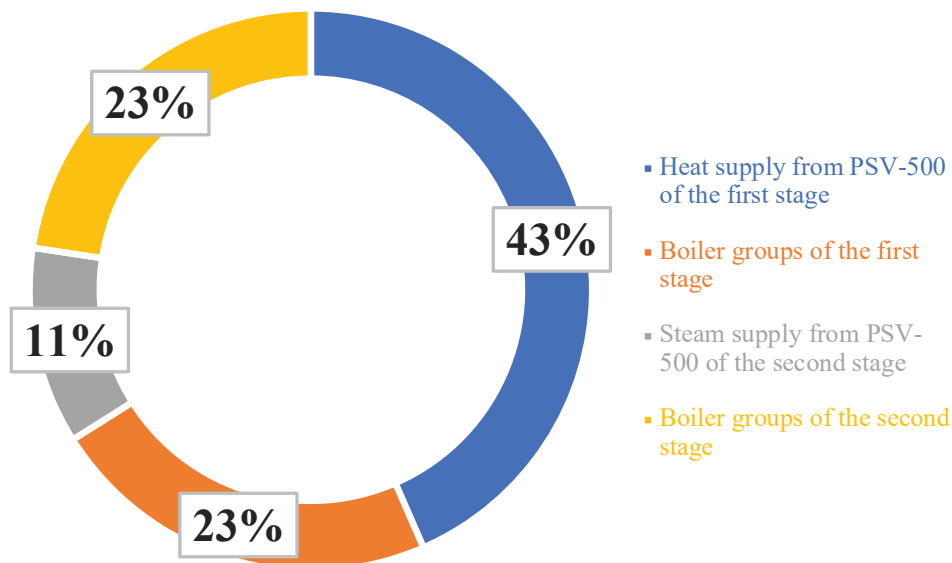
$$K = 39.25/29.16 \approx 1.35. \qquad (12)$$

Fig. 6. Unit commitment required to meet heat load at an air temperature of -24ºC.

- Heat supply from PSV-500 of the first stage
- Boiler groups of the first stage
- Steam supply from PSV-500 of the second stage
- Boiler groups of the second stage

Figure 6 presents the unit commitment necessary to ensure the heating load of consumers. Thus, the most significant heat supply is from PSV-500 of the first stage.

C. Construction of 110 MW CCGP

Annual fuel saving in hot water heat generation at 110 MW CCGP was calculated according to the following algorithm [20].

Fuel consumption for hot water heat supply under the existing scheme will be:

$$G_{t.o.e.} = (Q_{tg} \cdot b_{t.o.e.-h.y.})/1\,000 =$$
$$= (278\,262 \cdot 147.2)/1\,000 \approx 40\,960.2, \tag{13}$$

where Q_{tg} is heat output for hot water according to the Technical Department.

Fuel consumption for heat production with the 110 MW CCGP in operation will be:

$$G_{ccp} = (Q_{tg} \cdot b_{h/p-ccp-110})/1\,000 =$$
$$= (278\,262 \cdot 126.91)/1\,000 \approx 35\,314.23, \tag{14}$$

where $b_{h/p-ccp-110}$ is specific fuel consumption for heat production at a combined cycle gas plant.

Annual fuel saving for heat supply from the CPP will be:

$$E_{year\,h/p} = G_{t.o.e.} - G_{ccp} =$$
$$= 40\,960.2 - 35\,314.23 = 5\,645.97. \tag{15}$$

The saving was calculated for the following initial conditions:
- the number of utilization hours of 110 MW CCGP is 8 300 h./y.;
- the combined cycle gas plant operates for a base-load power generation of 110 MW.

According to the reported data, the actual electricity output of CPP is 8 662 876 thousand kWh (E_{aeo}).

The average annual specific consumption of fuel for electricity generation is 349 g/kWh.

Fuel consumption for electricity generation at the whole plant is:

$$G_{t.o.e.} = (8\,662\,876\,000 \cdot 349)/10^6 \approx 3\,023\,343.7. \tag{16}$$

Power generation at 110 MW CCGP, MWh, is:

$$E_{ccp} = (110\,000 \cdot 8\,300)/10^3 = 913\,000. \tag{17}$$

Power output from 110 MW CCGP, MWh, is:

$$E_{ccp\,vac.} = (110\,000 \cdot 8\,300)/10^3 \cdot 0.9404 = 858\,585.2. \tag{18}$$

According to the reported data, the auxiliary power consumption is 5.96%.

Fuel consumption for electricity supply from 110 MW CCGP is:

$$G_{ccp} = (858\,585\,200 \cdot 252.4)/10^6 \approx 216\,706.9, \tag{19}$$

where 252.4 is specific fuel consumption for electricity supply (Table 8).

Electricity supply by power units of the plant without electricity supply from 110 MW CCGP, MWh, is:

$$E_{eb} = E_{aeo} - E_{ccp\,vac.} =$$
$$= 8\,662\,876 - 858\,585.2 = 7\,804\,290.8. \tag{20}$$

Fuel consumption for electricity supply by power units of the plant, excluding 110 MW CCGP, is:

$$G_{t.o.e.-eb} = (E_{eb} \cdot b_{eb})/10^6 =$$
$$= (7\,804\,290\,800 \cdot 348.8)/10^6 \approx 2\,722\,136.6, \tag{21}$$

where b_{eb} is average specific fuel consumption for electricity generation.

Annual fuel saving for CPP is:

$$E_{year\,e/p} = G_{t.o.e.} - G_{ccp} - G_{t.o.e.-eb} =$$
$$= 3\,023\,343.7 - 216\,706.9 - 2\,722\,136.6 = 84\,500.2. \tag{22}$$

The total annual fuel saving due to the commissioning of 110 MW CCGP will be:

$$E_{year} = E_{year\,h/p} + E_{year\,e/p} =$$
$$= 5\,645.97 + 84\,500.2 = 90\,146.17. \tag{23}$$

The expected economic effect of the project (RUR million) will be:

$$S_{sav.} = E_{year} \cdot Z_f /10^6 =$$
$$= 90\,146.17 \cdot 4\,700/10^6 \approx 423.69, \tag{24}$$

where Z_f = 4 700 RUR/t.o.e. is the fuel cost.

The formula for calculating the payback period is:

$$PP = S_{cost}/S_{sav.} \tag{25}$$

The simple payback period will be:
$$PP = 5\,000/423.69 \approx 11.80.$$

In this case, the specific CapEx per 1 Gcal are determined by the formula:

$$SCI = S_{cost.}/W_{power}, \tag{26}$$

where W_{power} is the heat output of the newly introduced equipment, Gcal /h (94.2 MW).

The specific capital investment (RUR million) per 1 MW will be:

$$SCI = 5\,000/94.2 \approx 53.08.$$

IV. CONCLUSION

The optimization option of the heat supply scheme based on the construction of RCU 140/12 with a steam capacity of 50 t/h will partially cover the district heating load of 29.08 MW and 110.45 MW. The remaining power units can operate at a 110 MW load.

The commissioning of ABH with lower parameters partially reduces the plant heating load of 29.16 MW, which provides a heat output of one CPP power unit under "forced" heat generation. The remaining power units can operate at a 110 MW load.

The main criterion for the option of 110 MW CCGP is the replacement of obsolete generating equipment with new capacities.

At the same time, the option of building the 110 MW CCGP with a heat output of 94.2 MW with a calculated

heating load of 195.38 MW does not fully solve the problem of upgrading the heat supply scheme.

With the project period of about 4.5-5 years, there can be considerable losses due to power units operating under the conditions of "forced" heat generation. Nevertheless, it is worth noting that CCGPs are a promising option for the energy industry due to their high efficiency and acceptable payback periods within the framework of power supply contract programs designed to provide the investment in the construction of new generating capacities.

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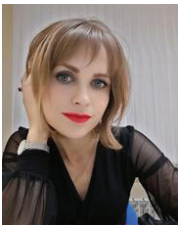
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