2nd Plenary Meeting Concerted Action for the Energy Efficiency Directive

Poland - practical experiences and financial supporting schemes, role of natural gas, biomass and CHP

Madrid, 21-22.03.2023

KAPE
Krajowa Agencja Poszanowania Energii S.A.

CONCERTED ACTION
ENERGY EFFICIENCY DIRECTIVE

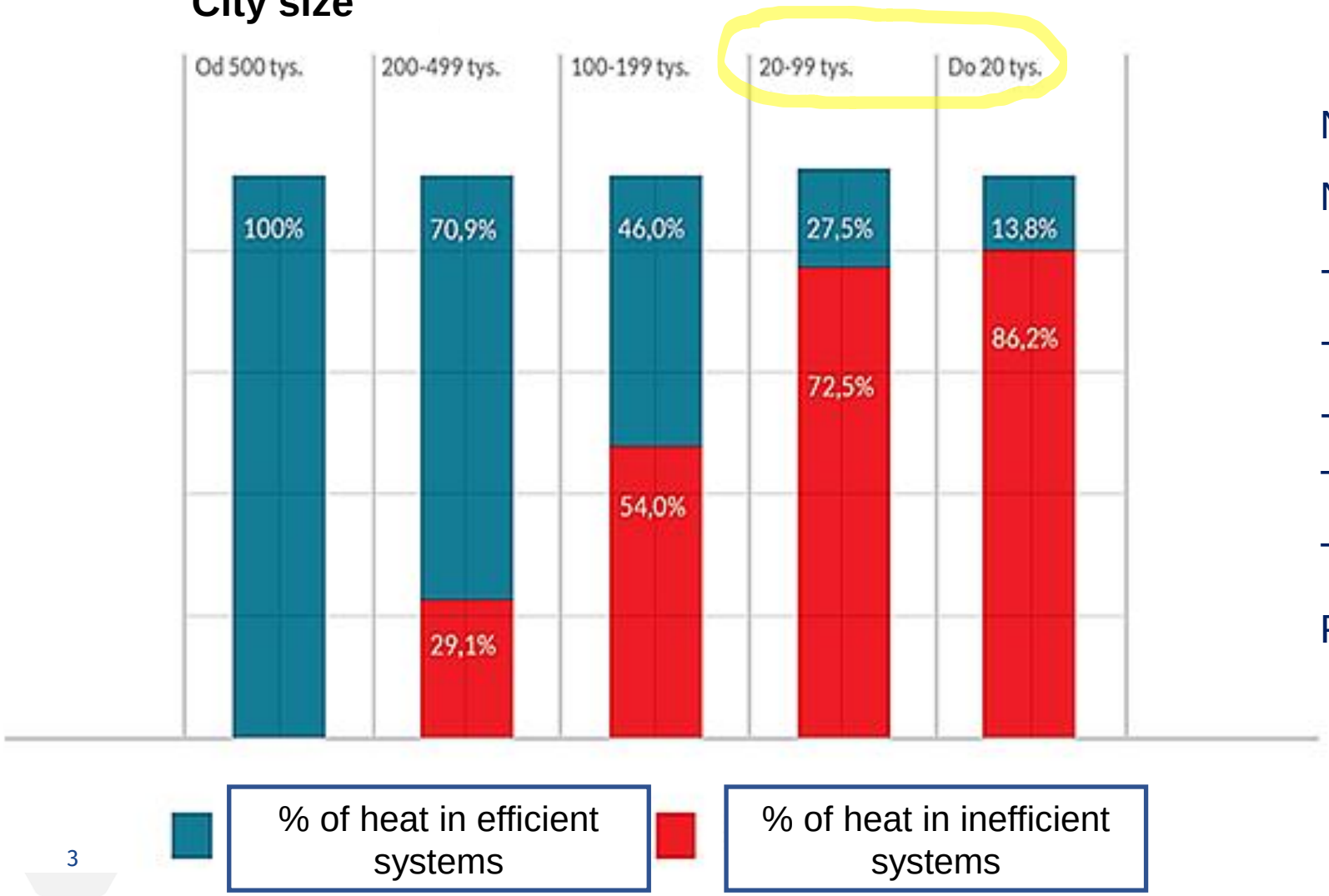
Agenda

1. Current structure of district heating in Poland
2. Case Study, current state
3. Purpose and objectives of modernization
4. Comparison of selected variants of CHP vs. Biomass + Heat Pump solution
5. Comparison of selected parameters - CO2 emissions
6. Profitability analysis
7. NPV sensitivity analysis to fuel prices
8. Changes in fuel prices 2021-2023
9. Conclusions based on the Case Study

KAPE

Actual Heating Systems structure in Poland

City size



Number of licensed heat generators – 378

Number of companies by installed capacity:

- 218 entities up to 50 MW
- 150 entities from 50 MW to 1000 MW
- 10 entities above 1000 MW

Total heat production in 2021: 425 000 TJ

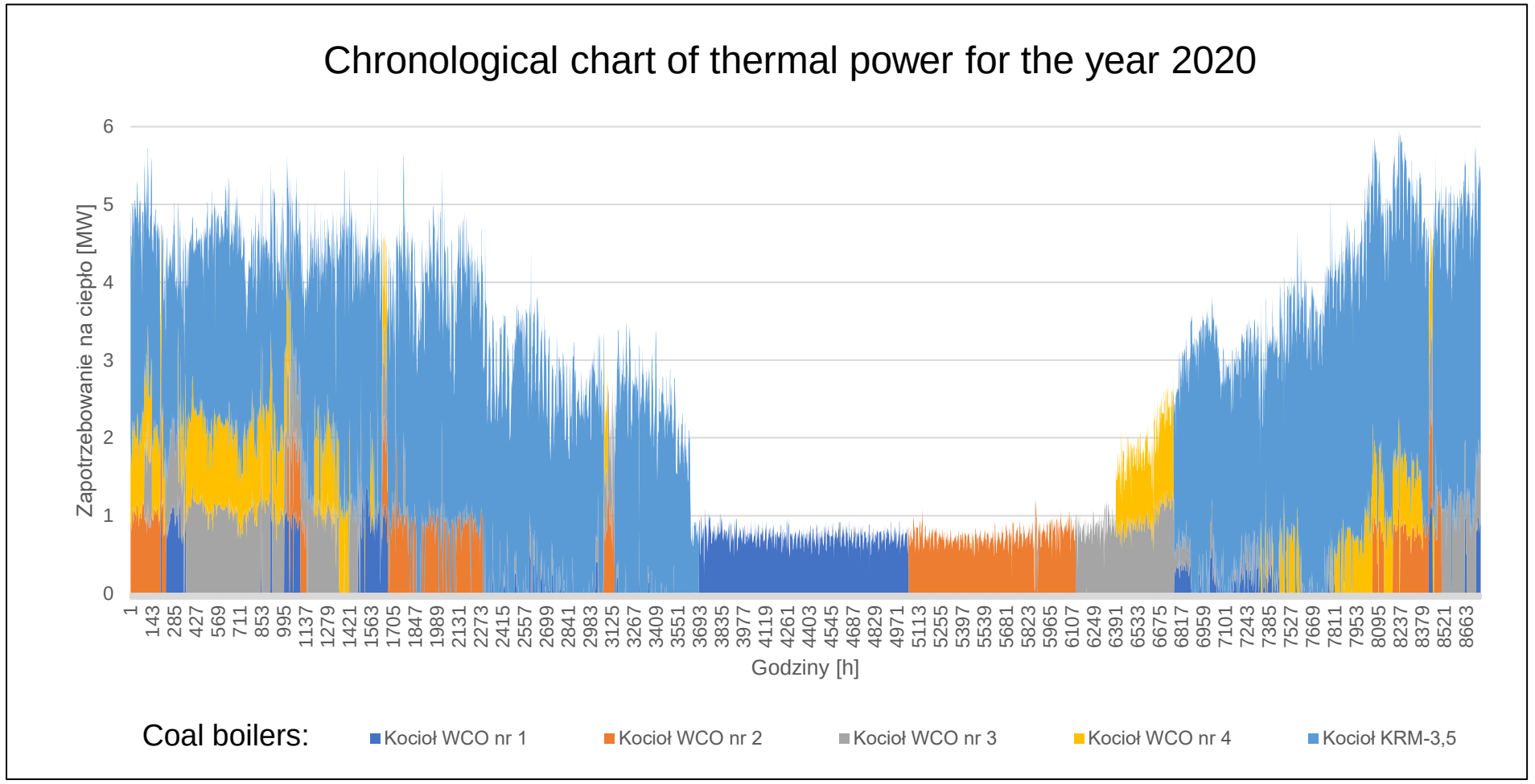
Total installed capacity: 54 GW

Primary fuel: coal (69.5%)

KAPE

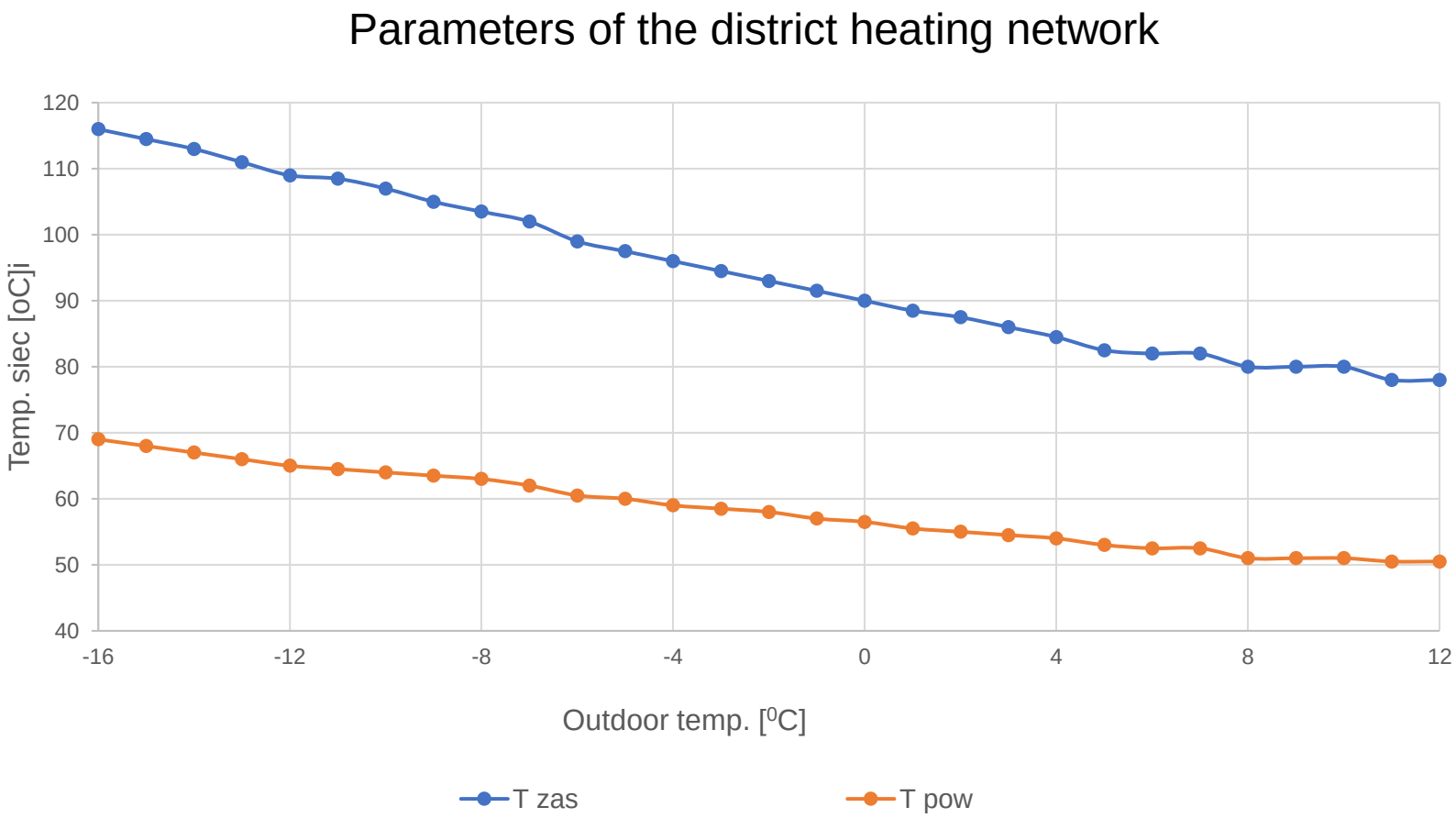
Case Study, current state

District boiler plant capacity in 2020



Case study, current state

Regulatory table of network water temperatures in the district heating system



Purpose of modernization - efficient district heating system

Modernization in two stages - the first stage, to achieve the parameters of efficient district heating and cooling with some of the coal sources remaining, the second stage is to eliminate the remaining coal sources and select new sources, depending on the current situation (technologies, fuel and energy prices, regulations)

Definition

‘efficient district heating and cooling’ means a district heating or cooling system using at least 50 % renewable energy, 50 % waste heat, 75 % cogenerated heat or 50 % of a combination of such energy and heat;

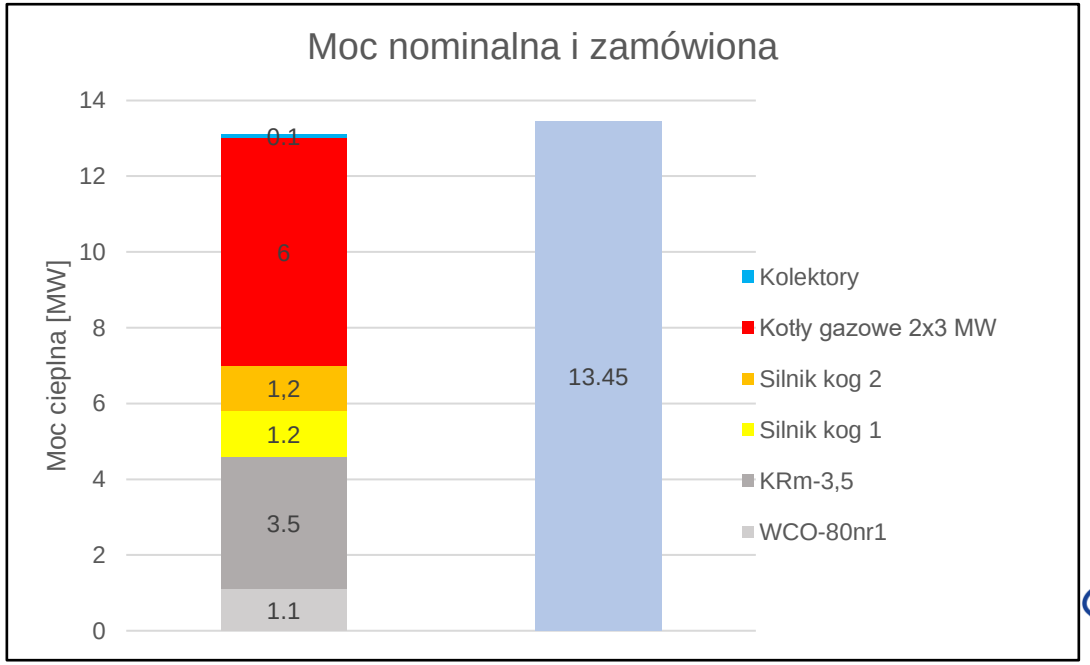
KAPE

CHP variant

Installed and ordered power

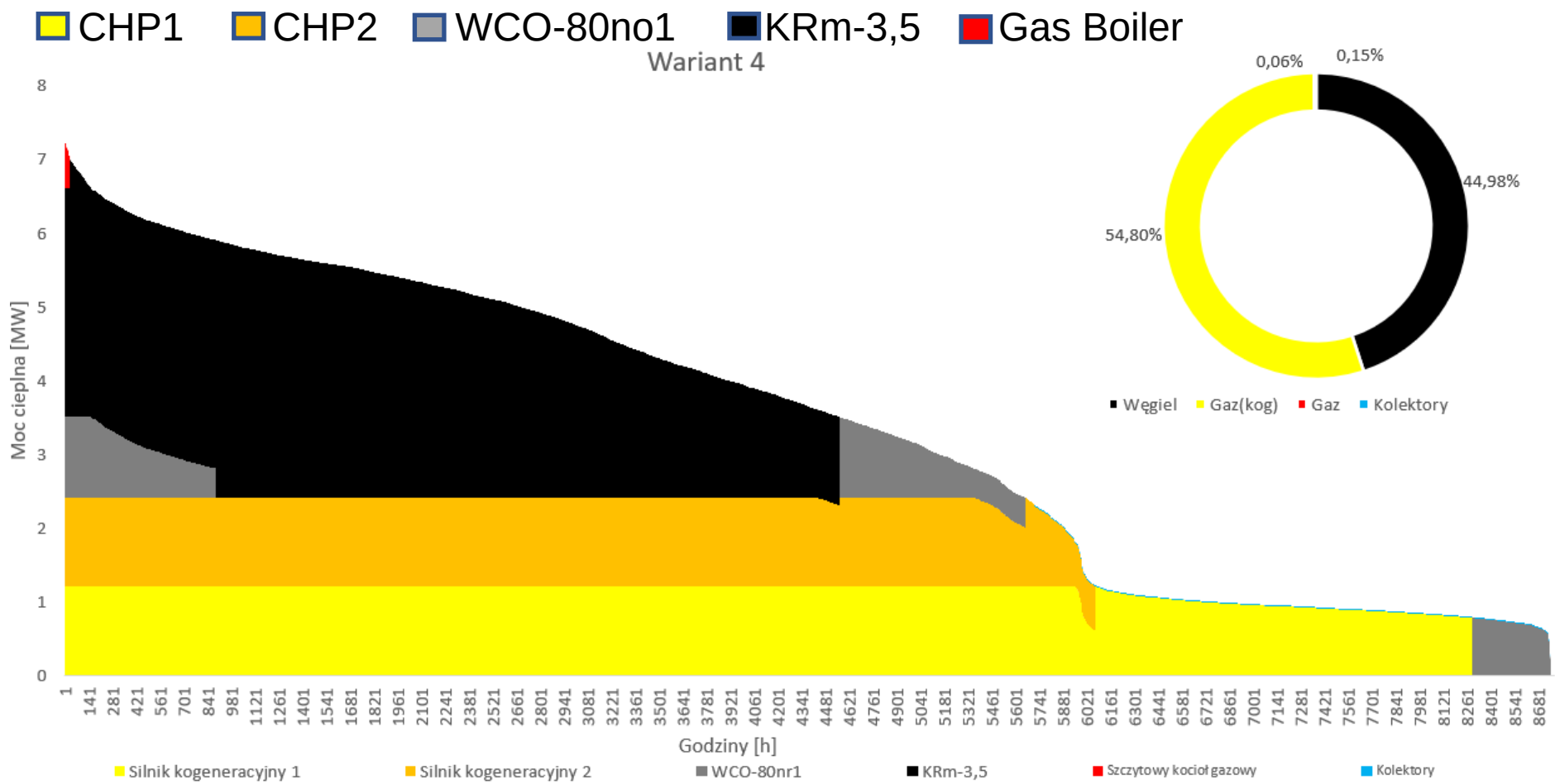
The CHP variant is based on the following generation equipment:

- Solar collectors with an installed capacity of 0.1 MWt
- 2 gas-fired boilers with a capacity of 3 MWt each
- 2 gas-fired cogeneration engines with a cap. of 0.999 MWe/1.2 MWt
- **Existing** KRm-3.5 coal-fired boiler with a capacity of 3.5 MWt,
- **Existing** WCO-80 No. 1 coal-fired boiler with a capacity of 1.1 MWt



CHP variant

Ordered graph of heat demand

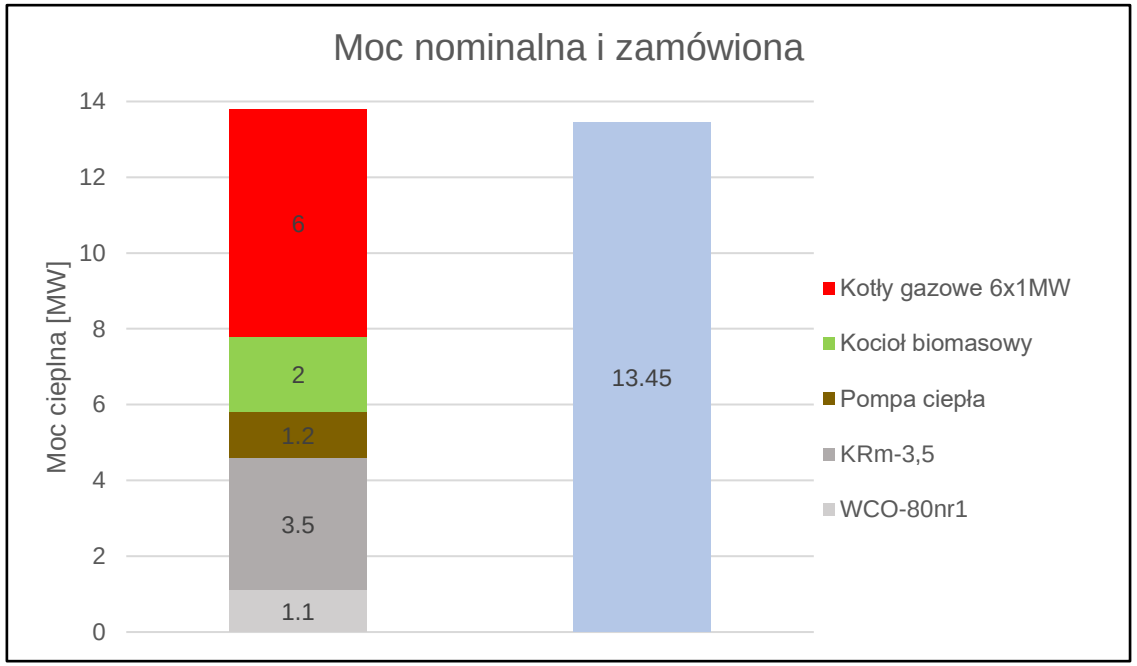


Biomass+Heat Pump variant

Installed and ordered power

The Biomass+Heat Pump variant is based on equipment:

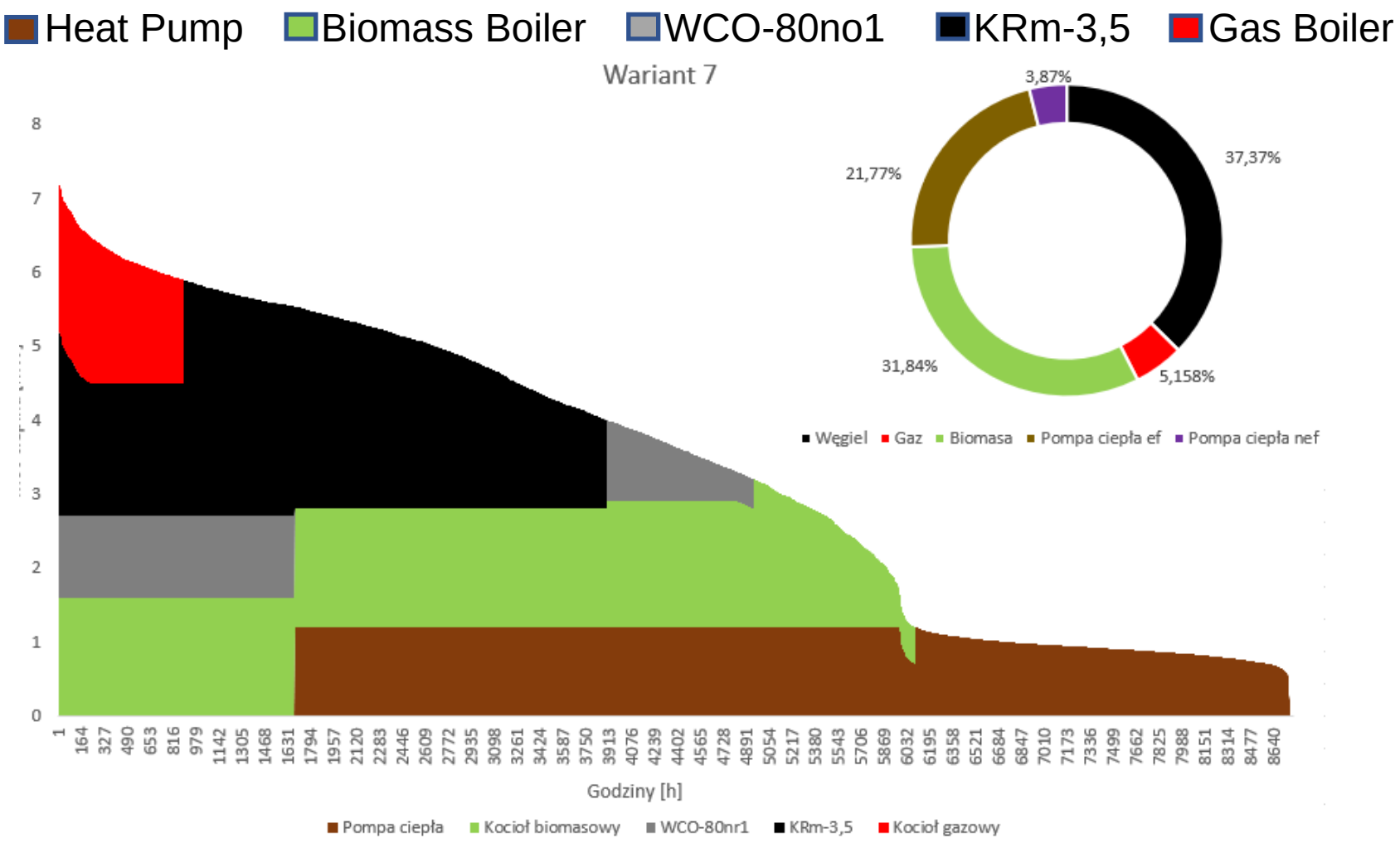
- 2 gas boilers with a capacity of 3 MWt each
- A biomass boiler with a capacity of 2 MWt
- Ground heat pump with a capacity of 1.2 MWt
- **Existing** KRm-3.5 coal-fired boiler with a capacity of 3.5 MWt
- **Existing** coal-fired boiler WCO-80 No. 1 with a capacity of 1.1 MWt
- Photovoltaic farm with a capacity of 2.5 MWe for heat pump purposes and sale of electricity to the grid



KAPE

Biomass+ Heat Pump variant

Ordered graph of heat demand



Comparison of variants - amount of energy produced GJ/year

L.p.		CHP	Biomass + Heat Pump
1	Heat production, GJ/year (or Electricity production, MWh/year)		
2	Coal boilers	48 477	40 269
3	Biomass boiler	0	34 313
4	CHP	59 063	0
5	Gas boilers	68	5 559
6	Sun collectors	165	0
7	Heat pump	0	27 631
8	**Heat production total**	**107 772**	**107 772**
9	Heat loss in transmission	15 088	15 088
10	Electricity production	13 728	2 685
11	System efficiency	86,53%	80,32%

KAPE

Comparison of variants – CO_2 emissions

.		Ton/year	CHP	Biomass + HP
1	Biomass emissions CO_2		0,0	4 179,6
2	Coal emissions CO_2		5 970,7	5 067,8
3	Gas emissions CO_2		6 683,5	366,7
4	Emissions SO_2		25,6	22,7
5	Emissions NO_x		16,8	15,8
6	Emissions CO		13,2	27,0
7	Dust emissions		4,9	7,9
8	Slag and ash from biomass		0,0	82,7
9	Slag and ash from coal		260,0	220,7
	Total CO_2 emissions, ton/year		**12654,2**	**9614,1**

KAPE

Profitability analysis, prices 2021/2022

Variant	Capital expenditures (undiscounted total)	NPV	IRR	SPBT	Electricity production	Electrecity own needs	Electricity sales
-	PLN	PLN	%	Lata	MWh	MWh	MWh
CHP	14 589 950	13 190 723	10,54%	10,14	13 728	546	13 182
Biomass + Heat Pump	23 653 950	-2 503 257	2,92%	13,17	2 685	1 057	1 628

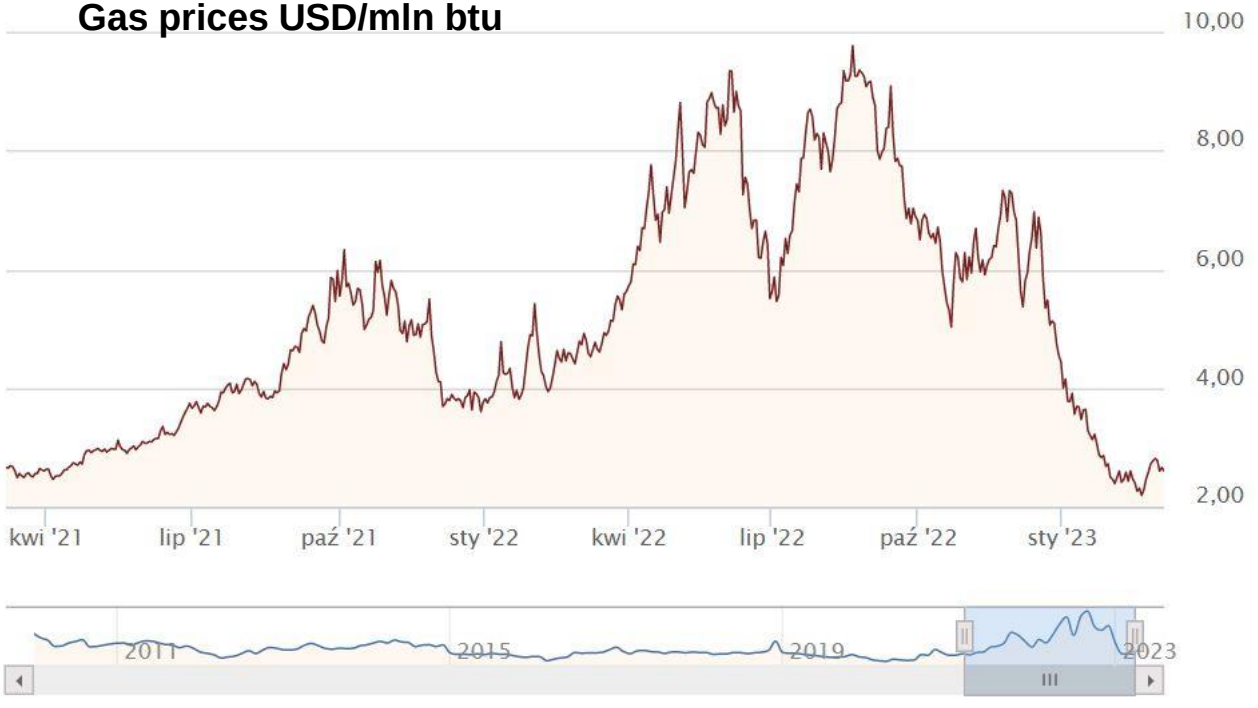
Assumptions:

- Coal price + transportation: 10,68 EUR/MWh 50.20 PLN/MWh (13.96 PLN/GJ)
- Gas price (includes fixed charges): 53,40 EUR/MWh 251.00 PLN/MWh
- Biomass price: 19,89 EUR/MWh 93.50 PLN/MWh (26.00 PLN/GJ)
- Electricity sales price: 80,85 EUR/MWh 380.00 PLN/MWh
- Guaranteed premium: 31,59 EUR/MWh 148.48 PLN/MWh

KAPE

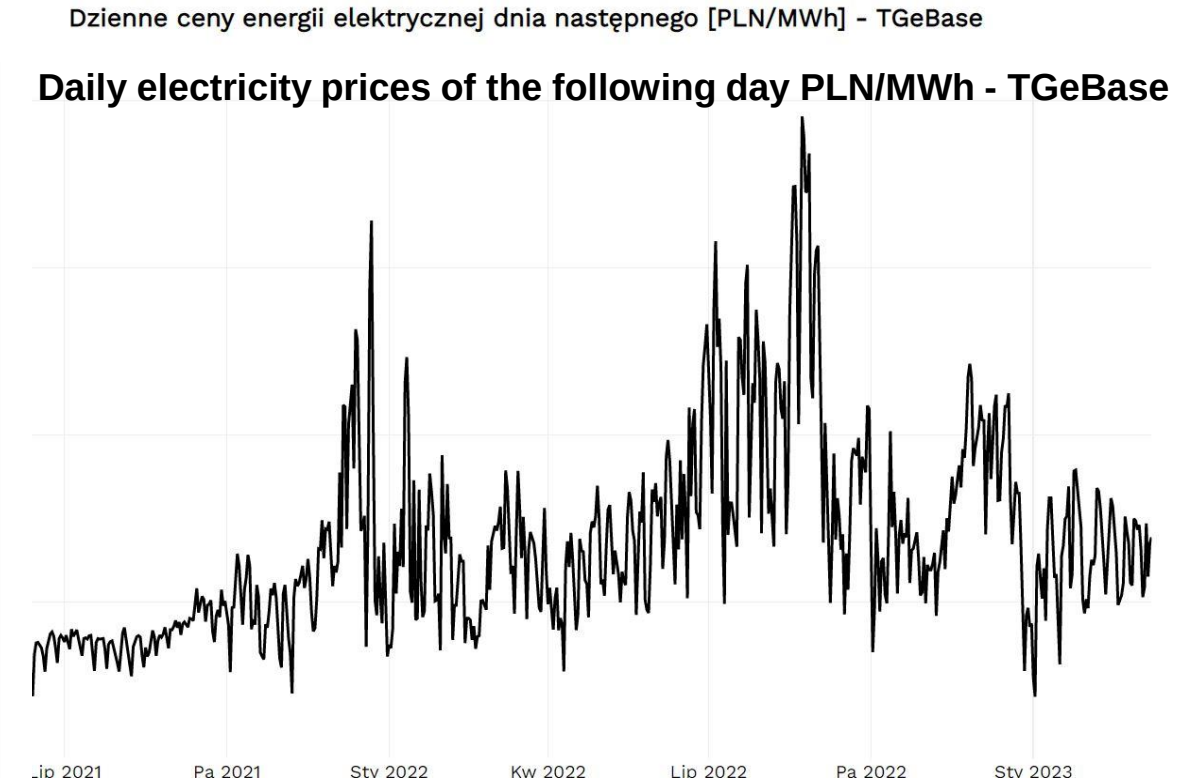
Fuel price changes 2022 - 2023

Gas prices USD/mln btu



Source: Puls Biznesu

Daily electricity prices of the following day PLN/MWh - TGeBase



Source: Energy.instrat.pl

Fuel price changes 2022 - 2023

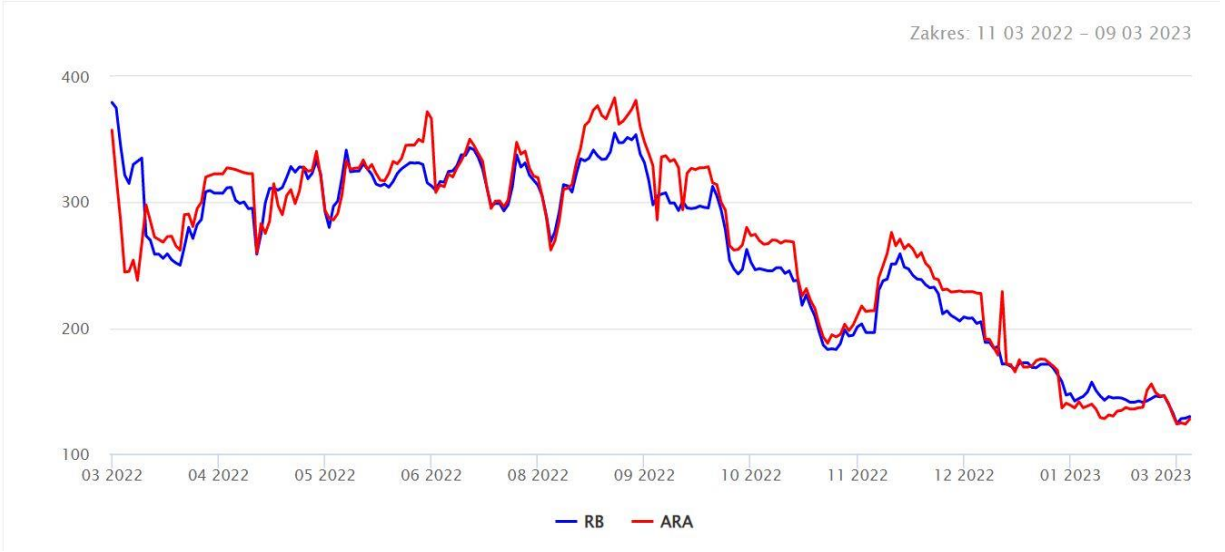
Coal price

Amsterdam-Rotterdam-Antwerpia

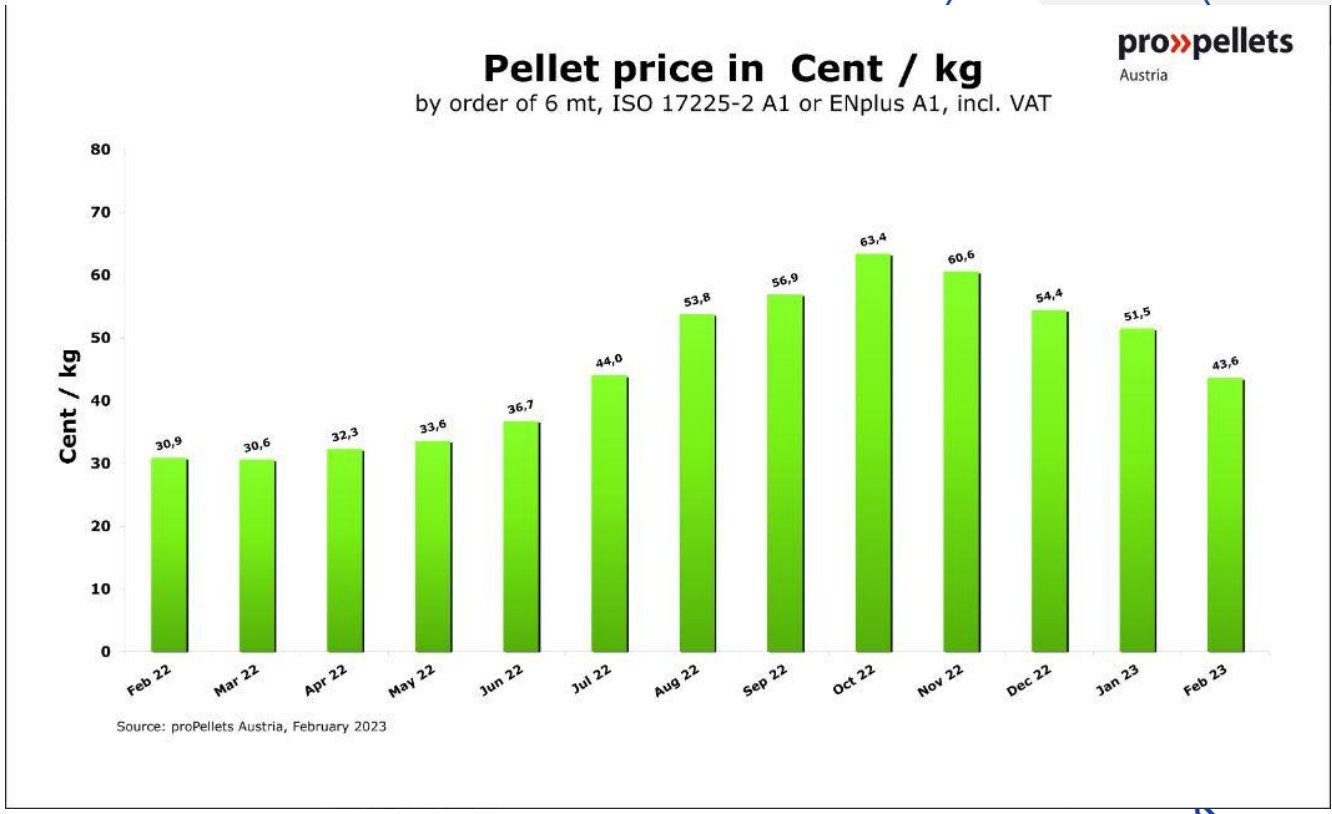
127,65 USD
3,23%

Richards Bay (RPA)

Aktualna wartość
129,65 USD 1,01%



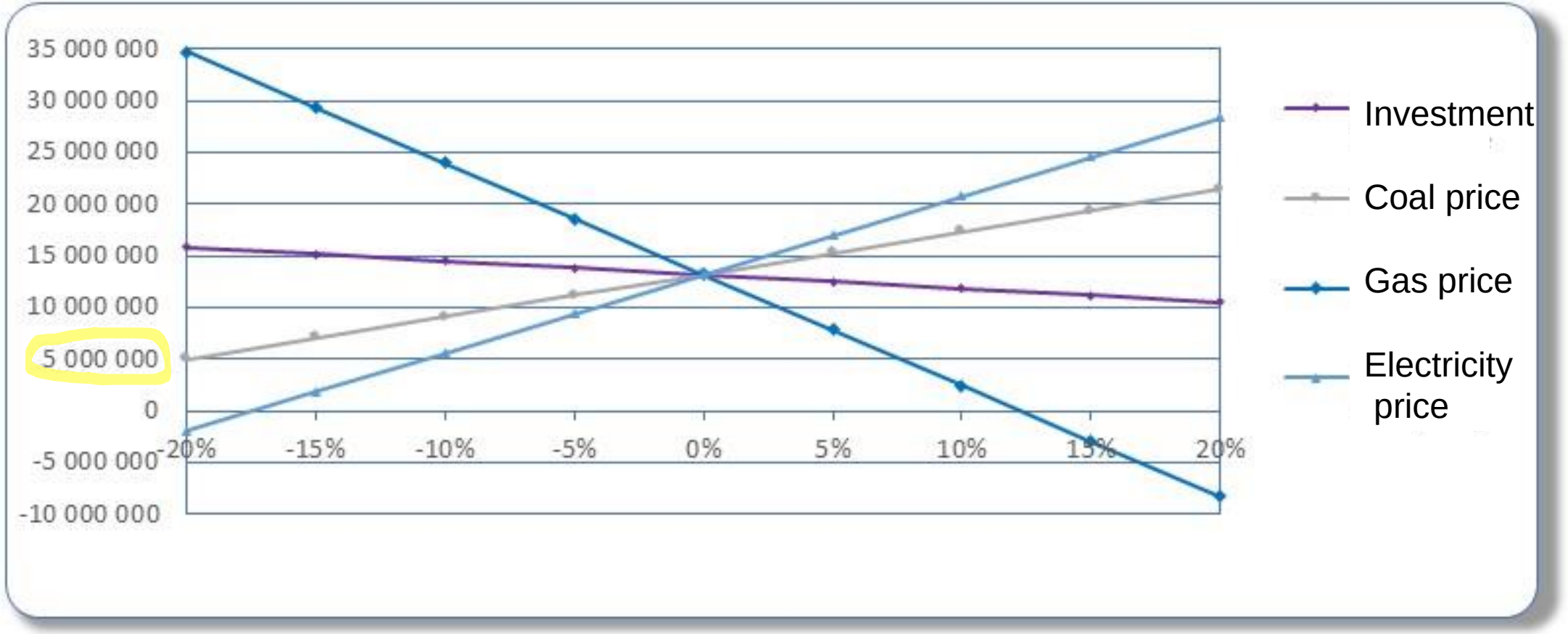
Source: WNP.PL



Source: ProPellets Austria

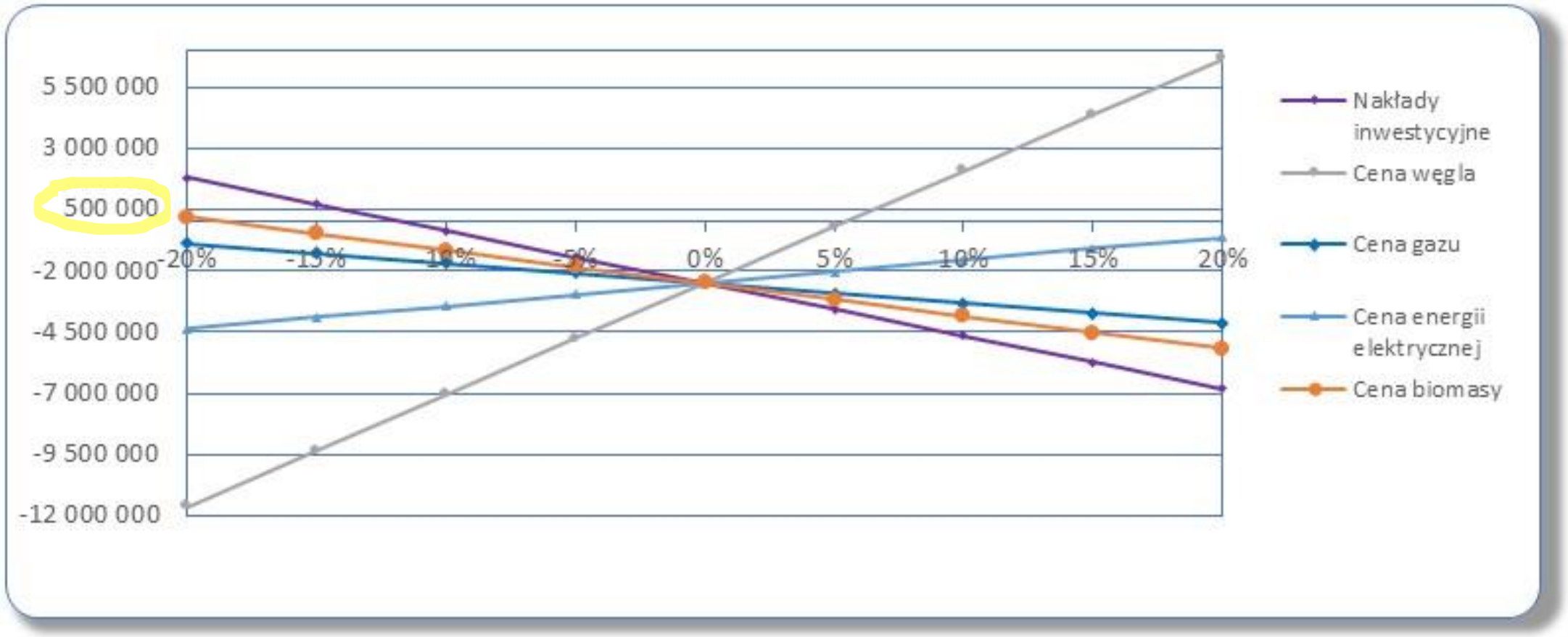
NPV sensitivity analysis on fuel prices and investment cost: CHP

NPV (PLN)	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Nakłady inwestycy	15 845 533,61	15 181 830,89	14 518 128,17	13 854 425,45	13 190 722,73	12 527 020,01	11 863 317,29	11 199 614,57	10 535 911,85
Cena węgla	4 995 505,92	7 044 310,12	9 093 114,32	11 141 918,53	13 190 722,73	15 239 526,94	17 288 331,14	19 337 135,35	21 385 939,55
Cena gazu	34 690 914,41	29 315 866,49	23 940 818,57	18 565 770,65	13 190 722,73	7 815 674,81	2 440 626,89	-2 934 421,02	-8 309 468,94
Cena energii elektr	-1 965 180,89	1 823 795,02	5 612 770,92	9 401 746,83	13 190 722,73	16 979 698,64	20 768 674,54	24 557 650,45	28 346 626,35



NPV sensitivity analysis on fuel prices and investment cost: Biomass + Heat Pump

	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Nakłady inwestycy	1 792 560,19	718 605,99	-355 348,20	-1 429 302,40	-2 503 256,60	-3 577 210,80	-4 651 165,00	-5 725 119,20	-6 799 073,40
Cena biomasy	183 372,69	-488 284,64	-1 159 941,96	-1 831 599,28	-2 503 256,60	-3 174 913,92	-3 846 571,25	-4 518 228,57	-5 189 885,89
Cena węgla	-11 638 257,29	-9 354 507,12	-7 070 756,94	-4 787 006,77	-2 503 256,60	-219 506,43	2 064 243,74	4 347 993,91	6 631 744,08
Cena gazu	-870 002,17	-1 278 315,78	-1 686 629,39	-2 094 942,99	-2 503 256,60	-2 911 570,21	-3 319 883,82	-3 728 197,43	-4 136 511,04
Cena energii elektr	-4 375 021,64	-3 907 080,38	-3 439 139,12	-2 971 197,86	-2 503 256,60	-2 035 315,34	-1 567 374,09	-1 099 432,83	-631 491,57



Conclusions

The basis for planning the modernization of a district heating company must be an individual, detailed analysis of various solutions.

Sometimes it is worth considering a phased modernization (slide 6), due to the uncertainty of the conditions in a few years (technologies, fuels, regulations, needs).

No solution is obvious (slide 12), only calculations based on sound assumptions and sensitivity analysis provide the basis for decisions (slide 16 & 17).

Available support programs can significantly affect the outcome of the analysis; their availability during investment or operation is key

KAPE

Marek Tobiacelli

EKSPERT DS. ENERGY PERFORMANCECONTRACTS
EXPERT ON ENERGY PERFORMANCE CONTRACTS
tel. +48 (22) 626 09 10 • kom. +48 694 410 782
e-mail: mtobiacelli@kape.gov.pl

Krajowa Agencja Poszanowania Energii S.A.
The Polish National Energy Conservation Agency

Centrum LIM, Al. Jerozolimskie 65/79, 00-697 Warszawa
www.kape.gov.pl
kape@kape.gov.pl