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Deliverable for Poland – Activity 2
Promote Development of the Energy Services / Energy Efficiency Sector
Financial Analysis Procedures and Template for Energy Efficiency Projects

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1 Introduction

This deliverable provides an English translation of procedures and forms developed in Poland to systematically and consistently evaluate the economics of potential energy efficiency projects.

Tables 1 a, b and c provide a template for comparing various energy efficiency alternatives for buildings. The energy use calculations and resulting economic benefits, *IRR*, *NPV* of the project, etc. are calculated using the Energy Auditor Software developed by the National Energy Conservation Agency (NAPE). (Updates of the software were supported by USAID.) (Table 2 presents the Table 1 information in Polish.)

The NAPE formulation shown in Table 1 is the standard method required by the Government of Poland to be used for applications for government loans under Poland's Thermorenovation Law. NAPE has taught these methods to over 100 Polish energy engineers through USAID-sponsored seminars. Two types of seminars were used:

- 10-day energy audit/financial assessment courses, leading to certification as an energy auditor ; and
- 3-day "enhancement" courses to update methods and identify new technologies for persons who had previously been certified as energy auditors.

The course materials are covered in comprehensive textbooks (in Polish) which have previously been submitted to USAID. This memorandum provides a summary in English of the financial evaluation methods.

2 Methods to Calculate Investment Efficiency

Investment efficiency is an indicator of the relation of economic effects (i.e., cost of savings or production improvements) to the outlay of money invested to achieve these savings.

The following sections describe some indicators of investment efficiency, giving an actual project as an example. (The example project is a replacement of municipal street lighting with high efficiency lighting.)

To access the profitability of potential investment, we first must establish, for each alternative (project) the following:

- expected capital outlay (for the example it is 447,098 zl).
- size of expected savings or increased revenues, for each time period (months or years) of the project life. (See Table 3.)

2.1 Simple (Non-discounted) Methods

With this data, we can use simple methods to calculate the efficiency of the investment. Simple payback time (*SPBT*) is the number of years until accumulated savings is equal to initial outlays. (See Table 4 and Chart 1.)

The payback can be expressed by the following formula:

$$T_z = I_0 / C_t$$

where:

T_z – payback in years,

C_t – planned income (profit) received at the end of t year (adopted average),

I_0 – beginning investment.

$T_z = I_0 / C_t = 447\,098 / 127\,247 = \mathbf{3.51}$ years

With this method, the payback for the example project (on condition that annual amounts are equal) amounts to 3.5 years.

If we look at how much of the project costs will be paid directly with cash on hand ("private funds") compared to how much will be borrowed ("foreign funds"), we know that the more that is borrowed, the higher the investment costs, due to interest.

Thus, you must look at savings each month and invested costs (i.e., interest) each month to calculate actual cash flow. For the example project, there are 3 scenarios:

	Private Funds	Foreign Funds
P1	15 %	85%
P2	30 %	70%
P3	0%	100%

Tables 5 (P1) and 6 (P2) show the monthly cash flow for these 2 scenarios. Table 7 (Chart 2) compares the payback for P1, P2, and P3.

The payback for the above mentioned projects is:

P1 - 6 years,

P2 - 5 years,

P3 - 7 years.

Payback provides information about cash flow requirements (Chart 2). Making use of the chart, the return period can be calculated more precisely and therefore for project:

P1 – 5.45 years,

P2 – 4.75 years,

P3 – 6.45 years.

In spite of many virtues of this method, it does not take into consideration the cost of the time value of money. Discount methods are used for this.

2.2 *Discount Methods*

Discount methods are more realistic of the true cost of the project. The whole period of the project lifetime (functioning of the equipment to be installed) is taken into consideration. Detailed analysis using discount methods increases the accuracy of project assessment and improved the choice of investment directions.

The following are considered as discount methods:

- Net Present Value (*NPV*),
- Internal Rate of Return (*IRR*),
- Efficiency Factor.

In the above methods, time is taken into consideration through the usage of discount techniques. The value of the investment depends not only on the amount of expected cash flows but also from the distribution of the outlays and savings time.

With discount methods, we can compare the costs and benefits for the whole period, expressing this as a present value index. That is, the project alternatives can be ranked as to their relative economic attractiveness at the moment of execution of the project.

2.2.1 Rate of Discount and Weighted Average Cost of Capital (*WACC*)

The cost of capital and rate of discount are two concepts used equally. Nevertheless, for a firm there is a difference between the cost of capital and required rate of return for individual projects.

- Cost of capital for an enterprise is a rate used for discounting average income streams of a firm and defining their value. It is also a weighted average cost of capital taken from different sources. The average should be used for assessing the project on condition that the risk profile of a new project is just the same as the risk profile of the whole enterprise.
- Required rate of return for individual projects is a rate of discount used when the risk profile of an individual project differs from the firm's risk profile.

WACC can be expressed by the following formula:

$$k = V_D / (V_D + V_E) * r_D + V_E / (V_D + V_E) * r_E$$

where:

k - rate of discount

V_D - value of debt

V_E - value of private capital

r_D - rate of debt

r_E - rate of private capital

We assume that the considered projects are characterized by the same profile of risk as the enterprise, and are financed with a combination of debt and capital. These are optimal (target) financing structures. Assuming that *WACC* is the right rate of discount for individual projects (Table 8), it equals:

- P1 - 22,86 %
- P2 - 22,18 %
- P3 -23,55 %

2.2.2 Rate of Return (*R*)

The primary measure of income from investments is a rate of return. The rate of return within the investment is described by the following formula:

$$R=(FV / PV) - 1$$

The annual rate of return is expressed by the following formula:

$$R = (FV / PV)^{1/n} - 1$$

where:

R - rate of return

FV - ending value

PV- beginning value

n - number of years.

(beginning value is invested for n years according to the rate of return R with annual capitalization)

Result:

$$R = (1\ 088\ 844 / 257\ 643)^{1/7} - 1 = 22.86\%$$

2.2.3 Investment Profit Rate (Z_i)

Investment profit rate (Z_i) reveals the level of engaged capital profit:

$$Z_i = C_t / I_0$$

Project can be accepted, if $Z_i > 1$, must be rejected if $Z_i < 1$.

Result:

for P1, P2 and P3

$$Z_i = 1\ 088\ 843.57 / 447\ 098.00 = 2{,}4354 \quad (143.54\%)$$

2.2.4 Net Present Value (*NPV*)

Net present value – allows you to answer the question of what the investment value of I_0 is, if at the end of the following years (periods) incomes C_1, C_2, . . C_n are received. If *NPV is* positive, it means that the sum of present income value within the investment period is higher than the beginning outlay and the investment should be continued. Of course, a negative value means the investment is unprofitable. Changes in *NPV* for alternative P1 are shown in Table 9. *NPV* is calculated as:

$$NPV = \sum_{t=1}^{n} [C_t / (1 + r)^t] - I_0$$

where:

NPV- net present value

C_t - income received at the end of t year

I_0 - beginning investment

r - rate of discount (%)

n - number of years

Result:

NPV values for projects:

- P1 = 37 125 zlotych,
- P2 = 47 470 zlotych,
- P3 = 27 088 zlotych.

Positive net present value of all projects proves the quality of the investment. Its absolute value describes the extent of profits and not the profitability level of alternative propositions of engaged capital. For assessment of the most effective amount to be financed, variant it is necessary to determine the net present value ratio - *NPVR*.

2.2.5 Net Present Value Ratio (*NPVR*)

NPVR - this ratio uses NPV to assess the present value of first investment outlays.

$$NPVR = NPV / I_0$$

Result:

NPVR for individual projects:

- P1 = 0.0830
- P2 = 0.1061
- P3 = 0.0605

NPVR shows project P2 has a greater efficiency of initial investment than P1 or P3.

2.2.6 Internal Rate of Return (*IRR*)

Internal rate of return - defines income (compared with invested capital) gained as a result of realization of a particular investment. *IRR* equals the value of the interest rate, when net present value equals zero (Tables 10 and 11). To define *IRR* the following equation must be solved:

$$\sum_{t=1}^{n} [C_t / (1 + IRR)^t] = I_0$$

where:

IRR - internal rate of return

C_t - income received at the end of t year

I_0 - beginning investment

r - rate of discount (%)

n - number of years

Unlike *NPV,* which can be positive or negative (depending on the usage of rate of discount), *IRR* of the project is fixed once and for all and it does not depend on the rate of discount.

For this reason, a decision rule based on *IRR* must take into consideration weighted average cost of capital *(WACC)* - that is k rate of discount:

- *if IRR* $> k$, project to be accepted,
- if *IRR* $< k$, project to be rejected.

Result:

$$IRR = 25.53\%$$

The calculated internal rate of return of the example project is higher that the lost profit expense - *WACC* rate of discount. Bearing all this in mind, all projects (P1, P2, P3) can be accepted, but the one with the lowest *WACC* (P2) rate of discount is the most lucrative investment:

- P1 - $WACC = 22.86\% < IRR = 25.53\%$
- P2 - $WACC = 22.18\% < IRR = 25.53\%$
- P3 - $WACC = 23.55\% < IRR = 25.53\%$

Table 12 summarizes these results.

Table 1a

ENERGY AUDIT REPORT

RESIDENTIAL BUILDING

Identification data:

Order:

Auditor:

Building stock-taking:

The data the optimisation was made:
February 1997

Building data:

Type of building:
Municipal residential building

Localisation:

Year of construction:
1979 r.

Technology:
Szczecin form adopted by „Miastoprojekt-Gdansk"

Size:

Volume of building	33 646.8 m^3
Volume of heated part of building	:27664.4 m^3
Building space:	7237.0 m^2
Heated service's area	.: - m^2
Heated part of the building	7237.0 m^2
Living shape factor	:A/V= 0.33m^2/m^3
Number of stories	5
Number of flats	133
Number of inmates	449

Actual state of the building:

Heat penetration factor U:

walls	1.64; 1.62; 1.60 W/(m^2·K)
atic ceiling	0.91 W/(m^2·K)
basement ceiling	0.94 W/(m^2·K)
windows	3.0 W/(m^2·K)
doors	5.6 W/(m^2·K)

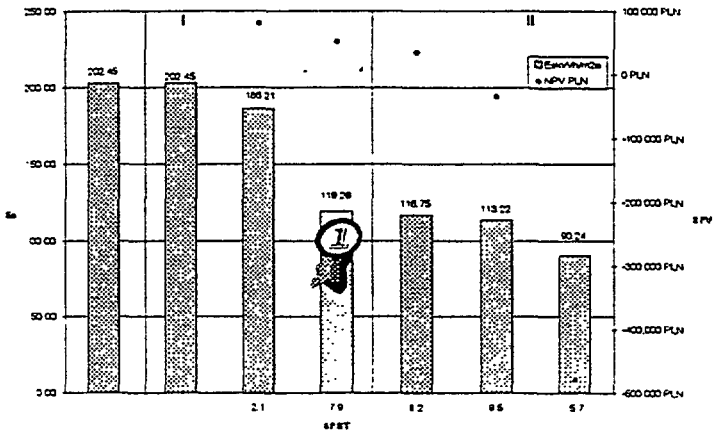
Air ventilation flow. 19 950 m^3/h

Heat system efficiency
$\eta_e = 0.95$
$\eta_r = 0.93$
$\eta_p = 0.90$
η_w = -

Energy indicators

$q_{Capacity}$	=	689.81 kW
Q	=	5 274.47 GJ/a
E	=	178.92 kWh/(m^2·a)
E_t	=	202.45 kWh/(m^2·a)
$K_{c.o.}$	=	1.67 zł/(m^2·mouth)
$D_{c.o.}$	=	0 zł/(building·a)

Energetical and economical characteristics of the best buildings' thermomodernisation variant- I
and the scope of work for a little worse variant (including the scope of work for the best variant) - **II**



The best buildings' thermomodernisation variant - I

⇒ verification of the peak heat power,
⇒ building insulation by:
- attic ceiling insulation by insulation material with R=2.8 (m^2·K)/W (Styrofoam or rockwool granulate or ekofiber),
  heat penetration factor after insulation: U = 0.26 W/(m^2·K),
- external wall and passage ceiling insulation by insulation material with R=2.7 (m^2·K)/W,
  heat penetration factor after insulation: U = 0.27; 0.28; 0.30; 0.31 W/(m^2·K).

Investment effectiveness

$Cost_{invest.}$	=	442 755.0 zł
zł/ΔMW	=	1 711 265.60 zł
zł/ΔGJ	=	13.62 zł
Capacity savings		37.5 %
Energy savings		41.1 %
Cost savings		38.8 %

Energy indicators

$q_{Capacity}$	=	431.08 kW
Q	=	3 107.23 GJ/a
E	=	105.41 kWh/(m^2·a)
E_t	=	119.26 kWh/(m^2·a)
$K_{c.o.}$	=	1.02 zł/(m^2·mouth)
$D_{c.o.}$	=	0 zł/(building·a)

Economical indexes

SPBT	=	7.9 years
NPV	=	51 549.46 zł
IRR	=	10 %

Thermomodernisation works leading to energy consumption decrease

External walls	attic ceiling	basement ceiling	windows	central heating installation	$q_{Capacity}$ kW	Q GJ/a	E kWh/(m²·a)	Es kWh/(m²·a)	$K_{t.e.}$ zl/(m²·mth)	$D_{t.e.}$ zl/(bud.·a)	$C_{invest.}$ zl	zl/ΔMW	zl/ΔGJ	Capacity savings %	Energy savings %	Cost savings %	SPBT year	NPV zl	IRR %
present situation																			
-	-	-	-	-	689.81	5274.47	178.92	202.45	1.67	0.00	-	-	-	-	-	-	-	-	-
the best buildings' thermomodernisation variant																			
-	-	-	-	verification of the peak heat power	663.34	5274.47	178.92	202.45	1.64	0.00	0.00	0	-	3.8%	0.0%	1.6%	-	-	-
-	14 cm	-	-	a/m.	619.16	4851.31	164.57	186.21	1.52	0.00	26,390.0	373,538.1	4.16	10.2%	8.0%	8.8%	2.1	80,389.89	48%
12cm	14 cm	-	-	a/m.	431.08	3107.23	105.41	119.26	1.02	0.00	442,755.0	1,711,265.6	13.62	37.5%	41.1%	38.8%	7.9	51,549.46	10%
extra works leading to energy consumption decrease																			
12cm	14 cm	-	-	a/m district panel, automatic vents	431.08	3041.81	105.41	116.75	1.01	0.00	470,315.0	1,711,265.6	14.04	37.5%	42.3%	39.5%	8.2	34,253.15	9%
12cm	14 cm	8 cm	-	a/m.	425.33	2949.63	102.22	113.22	0.99	0.00	561,705.0	2,019,599.4	16.11	38.3%	44.1%	40.8%	9.5	-34,576.13	7%
12 cm insulation material with R=2.7 m²·K/W	14 cm insulation material with R=2.8 m²·K/W	8 cm insulation material with R=1.78 m²·K/W	U=1.5 decreasing area about 28-13 m²	a/m.	341.69	2351.06	81.49	90.24	0.80	0.00	1,187,785.	3,332,826.4	27.09	50.5%	55.4%	52.3%	15.7	-477,912.52	0%

Table 1c

Nomenclature:

Type of building		–	residential building
Volume of heated part of building	m^3	–	Volume of heated part of building increased by the volume of heated compartments at the attic or in the basement and decreased by the volume of all the staircases, lifts, shaft, opened niches, loggias and galleries.
Living space area	m^2	–	according to PN-70/B-02365 Buildings' area. Rules of division, nomenclature and measures.
Heated service area	m^2	–	Heated area of services: shops, workshops etc.
Heated usable part of the building	m^2	–	Living area + corridors area + heated area of the usable rooms at the attic + heated area in the basement + heated area of services: shops, workshops etc.
Shape building factor	1/m	–	A/V - ratio area A of all exterior barriers of the heated part of building (external walls with windows and balcony doors, roofs and attic ceilings, floors on the ground or basement ceiling over the non-heated basement, ceilings over passages which separated the heated part from outdoor air, ground adherent non-heated locals) to volume of heated part of building V
Air ventilation stream	m^3/h	–	flow of ventilation air stream taken for calculation
η_e		–	heat system efficiency
η_r			- heat usage efficiency
η_p			- heat system regulation efficiency
η_w			- heat distribution efficiency
			- heat production efficiency
$q_{Capacity}$	kW	–	peak heat power
Q_c	GJ/a	–	seasonal heat energy demanded for heating during average heating season with considered efficiency of the central heating system.
E	$kWh/(m^2 \cdot a)$ or $kWh/(m^3 \cdot a)$	–	seasonal heat energy (final energy) demanded for heating during average heating season related to the heated usable part of the building, while $h \leq 2.6$ m or to the 1 m^3 volume of heated part of building, while $h > 2.6$
E_s	$kWh/(m^2 \cdot a)$ or $kWh/(m^3 \cdot a)$	–	seasonal heat energy (final energy) demanded for heating season with considered efficiency of standard central heating system to heated usable part of building, while $h \leq 2.6$ m or to the 1 m^3 volume of heated part of building while $h > 2.6$ m
$K_{c.o.}$	$zl/(m^2 \cdot month)$	–	the cost of central heating in zloties for 1 sq. metre heated usable part of the building payable monthly (recalculated for 12 months)
$D_{c.o.}$	zl/(building·a)	–	donation needed for central heating during the year (heating season) for the building
zl/ΔMW	zl	–	the cost of saved peak heat power capacity as a result of buildings' external walls thermal insulation increase
zl/ΔGJ	zl		the cost of saved final energy after implementation of suggested investments
$Cost_{invest.}$	zl	–	investment outlays for building thermomodernisation
SPBT	year	–	simple payback time - the term required to regain investment outlays
NPV	zl	–	net present value - the difference between central heating savings and thermomodernisation's outlays during 15 years term (calculated year by year with permanent discounted rate - r = 8%)
IRR	%	–	internal rate of return. Undertaking may be accept if the limited rate of return, which is the lowest accepted rate, is lower than IRR. Thus IRR is the maximum accepted discounted rate when we'd like to regain investment outlays.

Table 1 compares the different project alternatives. Note that Variant–I, with Simple Payback time of 2.1 years and *IRR* of 48% is the most attractive economically, but only saves 7% of the energy and 9% of the costs. Its attractiveness is due to the lower investment needed. However, Variant–II, with a Simple Payback time of 7.9 years achieves a 39% cost savings (41% energy savings) and still manages an *IRR* of 10%. For a building, which can afford the higher investment, Variant-II is preferred because it offers the greatest energy savings within a 10% *IRR* constraint.

Such a result is typical of energy efficiency projects; the first cm of insulation is always more cost effective that the additional cm of insulation, but to maximize future savings the project designer typically will use as much insulation as possible while still meeting the minimum *IRR* constraint.

Table 2a

KARTA AUDYTU ENERGETYCZNEGO

BUDYNEK MIESZKALNY W WARSZAWIE

Dane identyfikacyjne:

Zamawiający:
Spółdzielnia Mieszkaniowa

Wykonawca:

Inwentaryzacja budowlana:

Data opracowania: *15.08.1998 r.*

Dane o obiekcie:

Typ budynku: mieszkalny

Lokalizacja:
Warszawa

Rok budowy: 1974 r.

Technologia: wielkoplytowa

Wielkość:

Kubatura ogrzewanej części budynku:	8213 m^3
Powierzchnia użytkowa mieszkań:	2142 m^2
Powierzchnia usługowa pom. ogrzew.:	- m^2
Powierzchnia użytkowa ogrzewanej części budynku:	2142 m^2
Współczynnik kształtu budynku	A/V =0,30
Liczba kondygnacji.....	5 + piwnice
Liczba mieszkań	40
Liczba mieszkańców.....	110

Stan istniejacy budynku:

Współczynniki przenikania ciepła U:

ściany	$W/m^2 \cdot K$
stropodach	$W/m^2 \cdot K$
strop piwnicy	$W/m^2 \cdot K$
okna	$W/m^2 \cdot K$
drzwi	$W/m^2 \cdot K$
Strumień powietrza went.	m^3/h

Sprawność systemu ogrzewania w budynku

$\eta_e = 0,95$

$\eta_r = 0,80$

$\eta_p = 0,95$

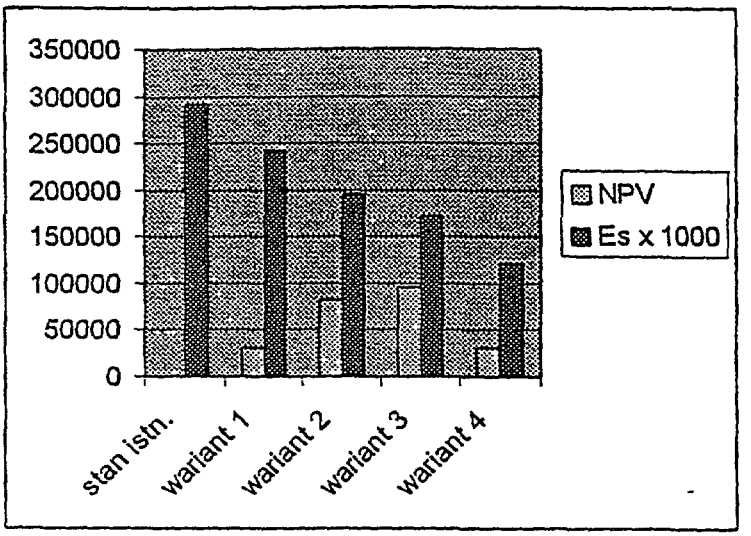
$\eta_w = 0,75$

Wskaźniki energetyczne

q_{Moc}=	189,53	kW
Q=	2530,3	GJ/a
E=	157,54	$kWh/(m^2 \cdot a)$
E_s=	290,93	$kWh/(m^2 \cdot a)$
E_v=	46,34	$kWh/(m^3 \cdot a)$
E_{vs}=	85,64	$kWh/(m^3 \cdot a)$
$K_{c.o.}$=	2,05	$zl/(m^2 \cdot m\text{-}c)$

Charakterystyka wspieranej inwestycji termomodernizacyjnej

Wybrany wariant 3



Wspierana inwestycja termomodernizacyjna

- Wymiana kotła opalanego koksem na kocioł gazowy
- Modernizacja instalacji c.o.
- Ocieplenie stropodachu

Efektywność

$Koszt_{inwest.}$	= 57400 zł	
K	= 45000 zł	t.j. 78 %
ΔEs	= 119 $kWh/(m^2 \cdot a)$	
zł/ΔMW	= 2,78 mln zł	
zł/ΔGJ	= 3,7 zł	

Oszczędność mocy 10,9%
Oszczędność energii 40,7%
Oszczędność kosztów 34,0%

Sprawność systemu ogrzewania po modernizacji

$\eta_e = 0,95$

$\eta_r = 0,95$

$\eta_p = 0,95$

$\eta_w = 0,85$

Wskaźniki energetyczne

q_{Moc}=	168,93	kW
Q=	1500,4	GJ/a
E=	139,22	$kWh/(m^2 \cdot a)$
E_s=	171,93	$kWh/(m^2 \cdot a)$
E_v=	41,12	$kWh/(m^3 \cdot a)$
E_{vs}=	50,78	$kWh/(m^3 \cdot a)$
$K_{c.o.}$=	1,35	$zl/(m^2 \cdot m\text{-}c)$

Wskaźniki ekonomiczne

SPBT=	3,21 lat
NPV =	95940 zł
IRR =	51,7%
Ef	= 254 kWh/a

Table 2b

Charakterystyka prac termomodernizacyjnych prowadzących do zmniejszenia zużycia ciepła w budynku

ściany zewnętrzne	stropodach	strop piwnicy	okna	instalacja c.o.	q_{Moc} kW	Q GJ/a	E kWh/(m²·a)	Es kWh/(m²·a)	ΔEs kWh/(m²·a)	E_v kWh/(m²·a)	E_{vs} kWh/(m²·a)	$K_{c.o.}$ zł/(m²·m-c)	$K_{Inwest.}$ zł	K zł	wkład własny %	min.zł/ΔMW	zł/ΔGJ	oszczędność mocy %	oszczędność energii %	oszczędność kosztów %	SPBT lat	NPV zł	IRR %	Ef
stan istniejący																								
					190	2530	158	291		46,34	85,64	2,05												
wspierana inwestycja termomodernizacyjna																								
				Wymiana kotła	190	2104	158	242	49	46,34	71,13	1,83	17400	13800	79		2,70	0	17	11,0	3,01	32048	59	115
				Moder. instal.	190	1692	158	195	96	46,34	57,27	1,52	34480	27000	78		2,74	0	33,2	25,9	2,60	82258	80	293
	14cm				189	1500	139	172	119	41,12	50,74	1,35	37440	45000	78	2,79	3,72	10,3	40,7	34,0	3,31	95940	52	254
dodatkowe prace prowadzące do zmniejszenia zużycia ciepła w budynku																								
14cm					123	1074	99	122	169	29,45	36,37	0,98	203640	162000	80	3,08	9,32	34,9	57,5	52,0	7,43	31117	12	31
		8cm			122	1044	96	118	173	28,62	35,34	0,96	233500	186000	80	3,46	10,47	35,6	58,7	53,3	8,30	-		
			Wym.		109	926	85	104	187	25,37	31,33	0,85	374700	300000	80	4,66	14,03	42,4	70,4	58,4	12,19	-		

Oznaczenia:

typ budynku	m^2	mieszkalny
współczynnik kształtu budynku	A/V	stosunek pola powierzchni A wszystkich przegród zewnętrznych ogrzewanej części budynku (ścian zewnętrznych wraz z oknami i drzwiami balkonowymi, dachów i stropodachów, podłóg na gruncie lub stropów nad piwnicą nie ogrzewaną do kubatury ogrzewanej części budynku.
qmoc	kW	szczytowa moc grzewcza
Q	GJ/a	sezonowe zapotrzebowanie na ciepło (energię końcową) do ogrzewania w standardowym sezonie ogrzewczym po uwzględnieniu sprawności systemu c.o.
E, E_v	$kWh/(m^2 \cdot a)$ lub $kWh/(m^3 \cdot a)$	wskaźnik sezonowego zapotrzebowania na ciepło (energie końcową) do ogrzewania w standardowym sezonie ogrzewczym do pola powierzchni użytkowej ogrzewanej części budynku, gdy h≤2.6m. lub do $1m^3$ kubatury ogrzewanej części budynku, gdy h>2.6m.
Es, E_{vs}	$kWh/(m^2 \cdot a)$ lub $kWh/(m^3 \cdot a)$	wskaźnik sezonowego zapotrzebowania na ciepło (energię końcową) do ogrzewania z uwzględnieniem sprawności systemu ogrzewania w budynku w standardowym sezonie ogrzewczym do pola powierzchni użytkowej ogrzewanej części budynku, gdy h≤2.6m. lub do $1m^3$ kubatury ogrzewanej części budynku, gdy h>2.6m.
ΔEs		wyliczona oszczędność energii w standardowym sezonie ogrzewczym $kWh/(m^3 \cdot a)$
Kc.o.	zł/(m^2 x m.-ce)	koszt ogrzania w ciągu miesiąca (w przeliczeniu na 12 miesięcy) jednego metra kwadratowego powierzchni użytkowej ogrzewanej części budynku

$Koszt_{Inwest.}$	zł	nakłady inwestycyjne na termomodernizację budynku
K	zł	część kosztów inwestycji finansowana kredytem
zł/ΔMW	zł	koszt zaoszczędzonej szczytowej mocy grzewczej po docieplenu budynku
zł/ΔGJ	zł	koszt zaoszczędzonej energii końcowej w ciągu 15 letniego okresu eksploatacji budynku po wykonaniu termomodernizacji budynku
SPTB	lat	prosty czas zwrotu
NPV	zł	zaktualizowana wartość inwestycji netto
IRR	%	wewnętrzna stopa zwrotu
Ef		efektywność ekonomiczną inwestycji termomodernizacyjnej określa się wg wzoru $Ef = (NPV / K) \cdot \Delta E_s$

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Table 3

Cost of electric energy and savings in 1997-2002

	PRICE OF ELECTRIC ENERGY IN ZONES /ZŁ/						
	1997	1998	1999	2000	2001	2002	2003
I zone	0,18	0,21	0,24	0,27	0,31	0,35	0,39
II zone	0,17	0,19	0,22	0,25	0,28	0,31	0,34

Year	Month	Power before modernization	Power after modernization	Number of burning hours	Number of days	Price for 1kWh	Cost of consumed electric energy before modernization	Cost of consumed electric energy after modernization	Savings after lighting modernization
		kW	kW	h		zł/kW	zł	zł	zł
1997	January	283,3	138,1	14,92	31	0,18	24 208,15	11 800,72	12 407,42
	February	283,3	138,1	13,42	28	0,18	19 667,16	9 587,13	10 080,03
	March	283,3	138,1	11,58	31	0,18	18 788,90	9 159,01	9 629,89
	April	283,3	138,1	9,50	30	0,17	13 341,56	6 503,60	6 837,96
	May	283,3	138,1	7,50	31	0,17	10 883,90	5 305,57	5 578,34
	June	283,3	138,1	6,42	30	0,17	9 016,09	4 395,06	4 621,02
	July	283,3	138,1	6,83	31	0,17	9 911,61	4 831,60	5 080,01
	August	283,3	138,1	8,50	31	0,17	12 335,09	6 012,98	6 322,12
	September	283,3	138,1	10,50	30	0,17	14 745,93	7 188,19	7 557,75
	October	283,3	138,1	12,58	31	0,18	20 411,43	9 949,94	10 461,49
	November	283,3	138,1	14,42	30	0,18	22 642,14	11 037,35	11 604,80
	December	283,3	138,1	15,42	31	0,18	25 019,41	12 196,19	12 823,22
	Total:						**200 971,37**	**97 967,33**	**103 004,03**
1998	January	283,3	138,1	14,92	31	0,21	27 786,11	13 544,87	14 241,24
	February	283,3	138,1	13,42	28	0,21	22 573,96	11 004,11	11 569,85
	March	283,3	138,1	11,58	31	0,21	21 565,90	10 512,71	11 053,19
	April	283,3	138,1	9,50	30	0,19	15 313,44	7 464,83	7 848,61
	May	283,3	138,1	7,50	31	0,19	12 492,55	6 089,73	6 402,82
	June	283,3	138,1	6,42	30	0,19	10 348,66	5 044,65	5 304,01
	July	283,3	138,1	6,83	31	0,19	11 376,54	5 545,71	5 830,83
	August	283,3	138,1	8,50	31	0,19	14 158,22	6 901,69	7 256,52
	September	283,3	138,1	10,50	30	0,19	16 925,38	8 250,60	8 674,78
	October	283,3	138,1	12,58	31	0,21	23 428,24	11 420,54	12 007,69

	November	283,3	138,1	14,42	30	0,21	25 988,65	12 668,67	13 319,99
	December	283,3	138,1	15,42	31	0,21	28 717,28	13 998,79	14 718,49
	Total:						**230 674,93**	**112 446,91**	**118 228,03**
1999	January	283,3	138,1	14,92	31	0,24	31 695,62	15 450,63	16 244,98
	February	283,3	138,1	13,42	28	0,24	25 750,12	12 552,39	13 197,73
	March	283,3	138,1	11,58	31	0,24	24 600,22	11 991,85	12 608,37
	April	283,3	138,1	9,50	30	0,22	17 468,04	8 515,13	8 952,91
	May	283,3	138,1	7,50	31	0,22	14 250,25	6 946,56	7 303,69
	June	283,3	138,1	6,42	30	0,22	11 804,72	5 754,44	6 050,28
	July	283,3	138,1	6,83	31	0,22	12 977,22	6 326,00	6 651,23
	August	283,3	138,1	8,50	31	0,22	16 150,28	7 872,76	8 277,52
	September	283,3	138,1	10,50	30	0,22	19 306,79	9 411,46	9 895,32
	October	283,3	138,1	12,58	31	0,24	26 724,59	13 027,41	13 697,18
	November	283,3	138,1	14,42	30	0,24	29 645,26	14 451,15	15 194,11
	December	283,3	138,1	15,42	31	0,24	32 757,80	15 968,42	16 789,39
	Total:						**263 130,90**	**128 268,19**	**134 862,71**
2000	January	283,3	138,1	14,92	31	0,27	35 933,32	17 516,38	18 416,94
	February	283,3	138,1	13,42	28	0,27	29 192,91	14 230,64	14 962,27
	March	283,3	138,1	11,58	31	0,27	27 889,27	13 595,16	14 294,11
	April	283,3	138,1	9,50	30	0,25	19 803,52	9 653,61	10 149,92
	May	283,3	138,1	7,50	31	0,25	16 155,50	7 875,31	8 280,20
	June	283,3	138,1	6,42	30	0,25	13 383,01	6 523,80	6 859,21
	July	283,3	138,1	6,83	31	0,25	14 712,28	7 171,78	7 540,50
	August	283,3	138,1	8,50	31	0,25	18 309,57	8 925,35	9 384,22
	September	283,3	138,1	10,50	30	0,25	21 888,10	10 669,77	11 218,33
	October	283,3	138,1	12,58	31	0,27	30 297,67	14 769,18	15 528,49
	November	283,3	138,1	14,42	30	0,27	33 608,83	16 383,26	17 225,56
	December	283,3	138,1	15,42	31	0,27	37 137,52	18 103,39	19 034,13
	Total:						**298 311,50**	**145 417,64**	**152 893,86**
2001	January	283,3	138,1	14,92	31	0,31	40 486,07	19 735,71	20 750,36
	February	283,3	138,1	13,42	28	0,31	32 891,65	16 033,66	16 857,99
	March	283,3	138,1	11,58	31	0,31	31 422,84	15 317,66	16 105,17
	April	283,3	138,1	9,50	30	0,28	22 312,63	10 876,72	11 435,91
	May	283,3	138,1	7,50	31	0,28	18 202,41	8 873,11	9 329,30
	June	283,3	138,1	6,42	30	0,28	15 078,64	7 350,37	7 728,27
	July	283,3	138,1	6,83	31	0,28	16 576,33	8 080,45	8 495,88
	August	283,3	138,1	8,50	31	0,28	20 629,39	10 056,19	10 573,20

	September	283,3	138,1	10,50	30	0,28	24 661,33	12 021,63	12 639,69
	October	283,3	138,1	12,58	31	0,31	34 136,38	16 640,43	17 495,95
	November	283,3	138,1	14,42	30	0,31	37 867,06	18 459,02	19 408,04
	December	283,3	138,1	15,42	31	0,31	41 842,84	20 397,09	21 445,75
	Total:						**336 107,57**	**163 842,06**	**172 265,51**
	January	283,3	138,1	14,92	31	0,35	45 336,12	22 099,96	23 236,16
	February	283,3	138,1	13,42	28	0,35	36 831,93	17 954,43	18 877,50
	March	283,3	138,1	11,58	31	0,35	35 187,15	17 152,65	18 034,50
	April	283,3	138,1	9,50	30	0,31	24 985,58	12 179,70	12 805,88
	May	283,3	138,1	7,50	31	0,31	20 382,98	9 936,07	10 446,90
2002	June	283,3	138,1	6,42	30	0,31	16 884,99	8 230,91	8 654,08
	July	283,3	138,1	6,83	31	0,31	18 562,10	9 048,45	9 513,65
	August	283,3	138,1	8,50	31	0,31	23 100,71	11 260,88	11 839,82
	September	283,3	138,1	10,50	30	0,31	27 615,64	13 461,77	14 153,87
	October	283,3	138,1	12,58	31	0,35	38 225,77	18 633,88	19 591,89
	November	283,3	138,1	14,42	30	0,35	42 403,37	20 670,33	21 733,04
	December	283,3	138,1	15,42	31	0,35	46 855,43	22 840,58	24 014,86
	Total:						**376 371,77**	**183 469,61**	**192 902,16**
	January	283,3	138,1	14,92	31	0,39	50 456,09	24 595,79	25 860,31
	February	283,3	138,1	13,42	28	0,39	40 991,48	19 982,08	21 009,40
	March	283,3	138,1	11,58	31	0,39	39 160,96	19 089,76	20 071,20
	April	283,3	138,1	9,50	30	0,34	27 807,29	13 555,20	14 252,10
	May	283,3	138,1	7,50	31	0,34	22 684,90	11 058,19	11 626,71
2003	June	283,3	138,1	6,42	30	0,34	18 791,87	9 160,46	9 631,42
	July	283,3	138,1	6,83	31	0,34	20 658,38	10 070,32	10 588,06
	August	283,3	138,1	8,50	31	0,34	25 709,55	12 532,61	13 176,94
	September	283,3	138,1	10,50	30	0,34	30 734,37	14 982,06	15 752,32
	October	283,3	138,1	12,58	31	0,39	42 542,74	20 738,27	21 804,47
	November	283,3	138,1	14,42	30	0,39	47 192,13	23 004,71	24 187,43
	December	283,3	138,1	15,42	31	0,39	52 146,98	25 420,04	26 726,94
	Total:						**418 876,75**	**204 189,48**	**214 687,27**
GROSS TOTAL:							**2 124 444,78**	**1 035 601,21**	**1 088 843,57**

Table 4
Period of payback

Project	Cash flow within period										
Periods	1	2	3	4	5	6	7	8	9	10	11
Year	0	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cash flow within period	-447 098	103 004	118 228	134 863	152 894	172 266	192 902	214 687	240 450	267 560	297 728
End of period amount	-447 098	-344 094	-225 866	-91 003	61 891	234 156	427 058	641 746	882 195	1 149 756	1 447 484
Period of payback	4 years										

Table 5

Simulation of credit repayment from savings (after modernization)

P1

Total investment		447 098
Private funds	15%	67 065
Foreign funds	85%	380 033

Annual credit interest **24%**

Year	Month	Savings	Credit engagement	Interest	Savings after interest repayment
		zł	zł	zł	zł
1997	January	12 407	380 033	7 458	4 949
	February	10 080	380 033	7 458	2 622
	March	9 630	380 033	7 458	2 172
	April	6 838	380 033	7 458	-620
	May	5 578	380 033	7 458	-1 880
	June	4 621	380 033	7 458	-2 837
	July	5 080	375 628	7 372	-2 292
	August	6 322	377 919	7 417	-1 095
	September	7 558	379 014	7 438	120
	October	10 461	378 894	7 436	3 026
	November	11 605	375 869	7 376	4 228
	December	12 823	371 640	7 293	5 530
	Total:	**103 004**		**89 081**	**13 923**
1998	January	14 241	366 110	7 185	7 056
	February	11 570	359 054	7 046	4 523
	March	11 053	354 531	6 958	4 096
	April	7 849	350 435	6 877	971
	May	6 403	349 464	6 858	-455
	June	5 304	349 919	6 867	-1 563
	July	5 831	351 482	6 898	-1 067
	August	7 257	352 549	6 919	338
	September	8 675	352 212	6 912	1 763
	October	12 008	350 449	6 878	5 130
	November	13 320	345 319	6 777	6 543
	December	14 718	338 776	6 648	8 070
	Total:	**118 228**		**82 823**	**35 405**
1999	January	16 245	330 706	6 490	9 755
	February	13 198	320 951	6 299	6 899
	March	12 608	314 052	6 163	6 445
	April	8 953	307 607	6 037	2 916
	May	7 304	304 691	5 980	1 324
	June	6 050	303 366	5 954	97
	July	6 651	303 270	5 952	700
	August	8 278	302 570	5 938	2 340
	September	9 895	300 231	5 892	4 003
	October	13 697	296 227	5 813	7 884
	November	15 194	288 343	5 659	9 535
	December	16 789	278 808	5 472	11 318
	Total:	**134 863**		**71 647**	**63 215**
	January	18 417	267 490	5 249	13 167
	February	14 962	254 323	4 991	9 971
	March	14 294	244 352	4 795	9 499
	April	10 150	234 853	4 609	5 541

2000	May	8 280	229 312	4 500	3 780
	June	6 859	225 532	4 426	2 433
	July	7 540	223 099	4 378	3 162
	August	9 384	219 937	4 316	5 068
	September	11 218	214 869	4 217	7 002
	October	15 528	207 867	4 079	11 449
	November	17 226	196 418	3 855	13 371
	December	19 034	183 047	3 592	15 442
	Total:	**152 894**		**53 009**	**99 885**
2001	January	20 750	167 606	3 289	17 461
	February	16 858	150 144	2 947	13 911
	March	16 105	136 233	2 674	13 432
	April	11 436	122 801	2 410	9 026
	May	9 329	113 776	2 233	7 096
	June	7 728	106 679	2 094	5 635
	July	8 496	101 044	1 983	6 513
	August	10 573	94 532	1 855	8 718
	September	12 640	85 813	1 684	10 956
	October	17 496	74 858	1 469	16 027
	November	19 408	58 831	1 155	18 253
	December	21 446	40 578	796	20 649
	Total:	**172 266**		**24 588**	**147 677**
epaymen	January	23 236	19 928	391	22 845
2002	February	18 877		0	18 877
	March	18 035		0	18 035
	April	12 806		0	12 806
	May	10 447		0	10 447
	June	8 654		0	8 654
	July	9 514		0	9 514
	August	11 840		0	11 840
	September	14 154		0	14 154
	October	19 592		0	19 592
	November	21 733		0	21 733
	December	24 015		0	24 015
	Total:	**192 902**		**391**	**192 511**
	Gross total:	***874 156***	***0***	***321 540***	***552 616***

Table 6

Simulation of credit repayment from savings (after modernization)

P2

Cost of investment		447 098
Private funds	30%	134 129
Foreign funds	70%	312 969

Annual credit interest 24%

Year	Month	Savings	Capital engagement	Interest	Savings after interest repayment
		zł	zł	zł	zł
1997	January	12 407	312 969	6 142	6 265
	February	10 080	312 969	6 142	3 938
	March	9 630	312 969	6 142	3 488
	April	6 838	312 969	6 142	696
	May	5 578	312 969	6 142	-564
	June	4 621	312 969	6 142	-1 521
	July	5 080	300 666	5 901	-821
	August	6 322	301 487	5 917	405
	September	7 558	301 081	5 909	1 649
	October	10 461	299 432	5 876	4 585
	November	11 605	294 847	5 786	5 818
	December	12 823	289 029	5 672	7 151
	Total:	**103 004**		**71 913**	**31 091**
1998	January	14 241	281 877	5 532	8 709
	February	11 570	273 168	5 361	6 209
	March	11 053	266 959	5 239	5 814
	April	7 849	261 145	5 125	2 724
	May	6 403	258 421	5 072	1 331
	June	5 304	257 090	5 045	259
	July	5 831	256 832	5 040	791
	August	7 257	256 041	5 025	2 232
	September	8 675	253 809	4 981	3 694
	October	12 008	250 115	4 909	7 099
	November	13 320	243 016	4 769	8 551
	December	14 718	234 466	4 601	10 117
	Total:	**118 228**		**60 699**	**57 529**
1999	January	16 245	224 348	4 403	11 842
	February	13 198	212 506	4 170	9 027
	March	12 608	203 479	3 993	8 615
	April	8 953	194 864	3 824	5 129
	May	7 304	189 735	3 724	3 580
	June	6 050	186 155	3 653	2 397
	July	6 651	183 758	3 606	3 045
	August	8 278	180 713	3 546	4 731
	September	9 895	175 982	3 454	6 442
	October	13 697	169 540	3 327	10 370
	November	15 194	159 170	3 124	12 070
	December	16 789	147 100	2 887	13 903
	Total:	**134 863**		**43 712**	**91 151**
	January	18 417	133 197	2 614	15 803
	February	14 962	117 395	2 304	12 658
	March	14 294	104 736	2 055	12 239
	April	10 150	92 497	1 815	8 335

2000	May	8 280	84 163	1 652	6 628
	June	6 859	77 534	1 522	5 338
	July	7 540	72 197	1 417	6 124
	August	9 384	66 073	1 297	8 088
	September	11 218	57 986	1 138	10 080
	October	15 528	47 905	940	14 588
	November	17 226	33 317	654	16 572
repayment	December	19 034	16 745	329	18 706
	Total:	**152 894**		**17 736**	**135 158**
2001	January	20 750		0	20 750
	February	16 858		0	16 858
	March	16 105		0	16 105
	April	11 436		0	11 436
	May	9 329		0	9 329
	June	7 728		0	7 728
	July	8 496		0	8 496
	August	10 573		0	10 573
	September	12 640		0	12 640
	October	17 496		0	17 496
	November	19 408		0	19 408
	December	21 446		0	21 446
	Total:	**172 266**		**0**	**172 266**
2002	January	23 236		0	23 236
	February	18 877		0	18 877
	March	18 035		0	18 035
	April	12 806		0	12 806
	May	10 447		0	10 447
	June	8 654		0	8 654
	July	9 514		0	9 514
	August	11 840		0	11 840
	September	14 154		0	14 154
	October	19 592		0	19 592
	November	21 733		0	21 733
	December	24 015		0	24 015
	Total:	**192 902**		**0**	**192 902**
	Gross total:	**874 156**	**0**	**194 060**	**680 097**

Table 7

Period of payback for individual projects (cost of gaining foreign capital added)

Project		Cash flow within period										
	Periods	1	2	3	4	5	6	7	8	9	10	11
	Year	0	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
P1	Cash flow within period	-447 098	13 923	35 405	63 215	99 885	147 677	192 511	214 687	240 450	267 560	297 728
	End of period amount	-447 098	-433 175	-397 770	-334 555	-234 670	-86 993	105 518	320 206	560 655	828 216	1 125 944
	Period of payback	6 years										
P2	Cash flow within period	-447 098	31 091	57 529	91 151	135 158	172 266	192 902	214 687	240 450	267 560	297 728
	End of period amount	-447 098	-416 007	-358 478	-267 327	-132 169	40 096	232 999	447 686	688 136	955 696	1 253 424
	Period of payback	5 years										
P3	Cash flow within period	-447 098	-3 245	13 280	35 280	64 612	103 140	149 232	202 853	240 450	267 560	297 728
	End of period amount	-447 098	-450 343	-437 063	-401 783	-337 172	-234 032	-84 800	118 053	358 503	626 063	923 791
	Period of payback	7 years										

Table 8

Weighted average cost of capital (WACC)

Project	Financial sources	Collected capital	Per cent fraction	Cost of individual elements	Share in creating capital cost
P1	Private	67 065	15%	18,97%	2,85%
	Debt	380 033	85%	23,55%	20,02%
WACC					**22,86%**
P2	Private	134 129	30%	18,97%	5,69%
	Debt	312 969	70%	23,55%	16,49%
WACC					**22,18%**
P3	Private	0	0%	18,97%	0,00%
	Debt	447 098	100%	23,55%	23,55%
WACC					**23,55%**

Table 9

Net present value - NPV for P1

P1

Rate of discount = **22,86%**

Year	Flows	NPV
0	-447 098	
1997	103 004	-363 262
1998	118 228	-284 941
1999	134 863	-212 225
2000	152 894	-145 127
2001	172 266	-83 597
2002	192 902	-27 516
2003	214 687	23 283

Rate of discount in month 1,91%

Rate of discount = **22,86%**

Year	Months	Flows	NPV
	0	-447 098	
	January	12 407	-434 923 zł
	February	10 080	-425 216 zł
	March	9 630	-416 116 zł
	April	6 838	-409 775 zł
	May	5 578	-404 699 zł
1997	June	4 621	-400 573 zł
	July	5 080	-396 122 zł
	August	6 322	-390 686 zł
	September	7 558	-384 309 zł
	October	10 461	-375 646 zł
	November	11 605	-366 217 zł
	December	12 823	-355 993 zł
Total:	**103 004**		
	January	14 241	-344 850 zł
	February	11 570	-335 967 zł
	March	11 053	-327 639 zł
	April	7 849	-321 836 zł
	May	6 403	-317 190 zł
1998	June	5 304	-313 414 zł
	July	5 831	-309 340 zł
	August	7 257	-304 365 zł
	September	8 675	-298 529 zł
	October	12 008	-290 601 zł
	November	13 320	-281 972 zł
	December	14 718	-272 615 zł
Total:	**118 228**		
	January	16 245	-262 480 zł
	February	13 198	-254 401 zł
	March	12 608	-246 826 zł
	April	8 953	-241 548 zł
	May	7 304	-237 323 zł
1999	June	6 050	-233 889 zł
	July	6 651	-230 183 zł
	August	8 278	-225 658 zł
	September	9 895	-220 350 zł
	October	13 697	-213 140 zł
	November	15 194	-205 291 zł
	December	16 789	-196 781 zł
Total:	**134 863**		
	January	18 417	-187 620 zł
	February	14 962	-180 316 zł
	March	14 294	-173 469 zł
	April	10 150	-168 699 zł
	May	8 280	-164 879 zł
2000	June	6 859	-161 775 zł

	July	7 540	-156 425 zł
	August	9 384	-154 335 zł
	September	11 218	-149 537 zł
	October	15 528	-143 019 zł
	November	17 226	-135 925 zł
	December	19 034	-128 232 zł
Total:	**152 894**		
2001	January	20 750	-120 002 zł
	February	16 858	-113 441 zł
	March	16 105	-107 290 zł
	April	11 436	-103 004 zł
	May	9 329	-99 573 zł
	June	7 728	-96 783 zł
	July	8 496	-93 775 zł
	August	10 573	-90 100 zł
	September	12 640	-85 789 zł
	October	17 496	-79 934 zł
	November	19 408	-73 561 zł
	December	21 446	-66 650 zł
Razem:	**172 266**		
2002	January	23 236	-59 302 zł
	February	18 877	-53 443 zł
	March	18 035	-47 952 zł
	April	12 806	-44 125 zł
	May	10 447	-41 061 zł
	June	8 654	-38 571 zł
	July	9 514	-35 885 zł
	August	11 840	-32 604 zł
	September	14 154	-28 755 zł
	October	19 592	-23 527 zł
	November	21 733	-17 837 zł
	December	24 015	-11 666 zł
Total:	**192 902**		
2003	January	25 860	-5 146 zł
	February	21 009	53 zł
	March	20 071	4 926 zł
	April	14 252	8 322 zł
	May	11 627	11 040 zł
	June	9 631	13 250 zł
	July	10 588	15 634 zł
	August	13 177	18 546 zł
	September	15 752	21 961 zł
	October	21 804	26 600 zł
	November	24 187	31 650 zł
	December	26 727	37 125 zł
Total:	**214 687**		

NPV value at the end of ind. period **37 125 zł**

Table 10

IRR calculation using NPV, where NPV=0

Rate of discount = 24,61%

Year	Flows	NPV
0	-447 098	
1997	-103 004	-364 437
1998	-118 228	-288 298
1999	-134 863	-218 599
2000	-152 894	-155 187
2001	-172 266	-97 851
2002	-192 937	-46 318
2003	-216 090	0
IRR		**24,61%**

Rate of discount in month = 2,13%

Rate of discount = 25,53%

Year	Month	Flows	NPV
	0	-447 098	
	January	12 407	-434 949 zł
	February	10 080	-425 285 zł
	March	9 630	-416 244 zł
	April	6 838	-409 959 zł
	May	5 578	-404 938 zł
1997	June	4 621	-400 865 zł
	July	5 080	-396 481 zł
	August	6 322	-391 139 zł
	September	7 558	-384 886 zł
	October	10 461	-376 411 zł
	November	11 605	-367 206 zł
	December	12 823	-357 245 zł
Total:	**103 004**		
	January	14 241	-346 414 zł
	February	11 570	-337 798 zł
	March	11 053	-329 739 zł
	April	7 849	-324 135 zł
	May	6 403	-319 659 zł
1998	June	5 304	-316 028 zł
	July	5 831	-312 119 zł
	August	7 257	-307 357 zł
	September	8 675	-301 782 zł
	October	12 008	-294 226 zł
	November	13 320	-286 019 zł
	December	14 718	-277 140 zł
Total:	**118 228**		
	January	16 245	-267 543 zł
	February	13 198	-259 909 zł
	March	12 608	-252 768 zł
	April	8 953	-247 803 zł
	May	7 304	-243 837 zł
1999	June	6 050	-240 620 zł
	July	6 651	-237 158 zł
	August	8 278	-232 938 zł
	September	9 895	-227 999 zł
	October	13 697	-221 304 zł
	November	15 194	-214 033 zł
	December	16 789	-206 165 zł
Total:	**134 863**		
	January	18 417	-197 715 zł
	February	14 962	-190 993 zł
	March	14 294	-184 704 zł
	April	10 150	-180 332 zł
	May	8 280	-176 840 zł
2000	June	6 859	-174 007 zł
	July	7 540	-170 958 zł
	August	9 384	-167 242 zł

	September	11 218	-162 893 zł
	October	15 528	-156 998 zł
	November	17 226	-150 595 zł
	December	19 034	-143 667 zł
Total:	**152 894**		
2001	January	20 750	-136 272 zł
	February	16 858	-130 389 zł
	March	16 105	-124 886 zł
	April	11 436	-121 060 zł
	May	9 329	-118 003 zł
	June	7 728	-115 524 zł
	July	8 496	-112 856 zł
	August	10 573	-109 604 zł
	September	12 640	-105 798 zł
	October	17 496	-100 639 zł
	November	19 408	-95 035 zł
	December	21 446	-88 972 zł
Total:	**172 266**		
2002	January	23 240	-82 539 zł
	February	18 881	-77 421 zł
	March	18 038	-72 634 zł
	April	12 808	-69 306 zł
	May	10 449	-66 647 zł
	June	8 656	-64 490 zł
	July	9 515	-62 169 zł
	August	11 842	-59 340 zł
	September	14 156	-56 029 zł
	October	19 595	-51 541 zł
	November	21 737	-46 666 zł
	December	24 019	-41 392 zł
Total:	**192 937**		
2003	January	26 029	-35 795 zł
	February	21 147	-31 343 zł
	March	20 202	-27 179 zł
	April	14 345	-24 283 zł
	May	11 703	-21 970 zł
	June	9 694	-20 094 zł
	July	10 657	-18 075 zł
	August	13 263	-15 614 zł
	September	15 855	-12 733 zł
	October	21 947	-8 829 zł
	November	24 345	-4 588 zł
	December	26 902	-0 zł
Total:	**216 090**		-

NPV value at the end of ind.period	**-0 zł**
Internal rate of return ***IRR***	**25,53%**

Table 11
Internal rate of return - IRR for P1, P2, P3

Year	Flows	IRR
0	-447 098	
1997	103 004	-76,96%
1998	118 228	-35,78%
1999	134 863	-10,16%
2000	152 894	5,05%
2001	172 266	14,45%
2002	192 937	20,52%
2003	216 090	24,61%
IRR		**24,61%**

Year	Month	Flows	IRR
	0	-447 098	
	January	12 407	-97,22%
	February	10 080	-83,53%
	March	9 630	-68,45%
	April	6 838	-58,31%
	May	5 578	-50,50%
1997	June	4 621	-44,49%
	July	5 080	-38,75%
	August	6 322	-33,21%
	September	7 558	-28,33%
	October	10 461	-23,59%
	November	11 605	-19,89%
	December	12 823	-16,86%
Total:	**103 004**		
	January	14 241	-14,31%
	February	11 570	-12,62%
	March	11 053	-11,24%
	April	7 849	-10,35%
	May	6 403	-9,67%
1998	June	5 304	-9,13%
	July	5 831	-8,56%
	August	7 257	-7,90%
	September	8 675	-7,18%
	October	12 008	-6,33%
	November	13 320	-5,54%
	December	14 718	-4,80%
Total:	**118 228**		
	January	16 245	-4,12%
	February	13 198	-3,64%
	March	12 608	-3,22%
	April	8 953	-2,96%
	May	7 304	-2,75%
1999	June	6 050	-2,58%
	July	6 651	-2,41%
	August	8 278	-2,20%
	September	9 895	-1,97%
	October	13 697	-1,68%
	November	15 194	-1,40%
	December	16 789	-1,11%
Total:	**134 863**		
	January	18 417	-0,84%
	February	14 962	-0,64%
	March	14 294	-0,46%
	April	10 150	-0,34%
	May	8 280	-0,25%
2000	June	6 859	-0,18%
	July	7 540	-0,10%
	August	9 384	-0,01%
	September	11 218	0,09%
	October	15 528	0,22%
	November	17 226	0,36%
	December	19 034	0,50%

Razem:	**152 894**		
2001	January	20 750	0,63%
	February	16 858	0,74%
	March	16 105	0,83%
	April	11 436	0,89%
	May	9 329	0,94%
	June	7 728	0,97%
	July	8 496	1,01%
	August	10 573	1,06%
	September	12 640	1,12%
	October	17 496	1,19%
	November	19 408	1,26%
	December	21 446	1,34%
Total:	**172 266**		
2002	January	23 240	1,41%
	February	18 881	1,47%
	March	18 038	1,52%
	April	12 808	1,56%
	May	10 449	1,59%
	June	8 656	1,61%
	July	9 515	1,63%
	August	11 842	1,66%
	September	14 156	1,69%
	October	19 595	1,73%
	November	21 737	1,78%
	December	24 019	1,82%
Total:	**192 937**		
2003	January	26 029	1,87%
	February	21 147	1,91%
	March	20 202	1,94%
	April	14 345	1,96%
	May	11 703	1,98%
	June	9 694	1,99%
	July	10 657	2,01%
	August	13 263	2,02%
	September	15 855	2,04%
	October	21 947	2,07%
	November	24 345	2,10%
	December	26 902	2,13%
Total:	**216 090**		
Internal rate of return (months)			**2,13%**
Internal rate of return (years)			**25,53%**

Table 12

Investment efficiency yardstick - estimation

Project	Outlays I_0	Savings (energy consumption) after modernization	% frame of private funds	% frame of foreign funds	Cost of gaining foreign capital (interest)	Real savings	Credit repayment period (year)	Credit repayment period (years)	Z_I	*WACC*	*IRR*	*NPV*	*NPVR*
P1	447 098	1 088 844	15%	85%	321 540	320 206	2002	5,08	143,54%	22,86%	25,53%	37 125 zł	0,0830
P2	447 098	1 088 844	30%	70%	194 060	447 686	2000	4,00	143,54%	22,18%	25,53%	47 470 zł	0,1061
P3	447 098	1 088 844	0%	100%	523 693	118 053	2003	6,91	143,54%	23,55%	25,53%	27 088 zł	0,0605

Chart 1

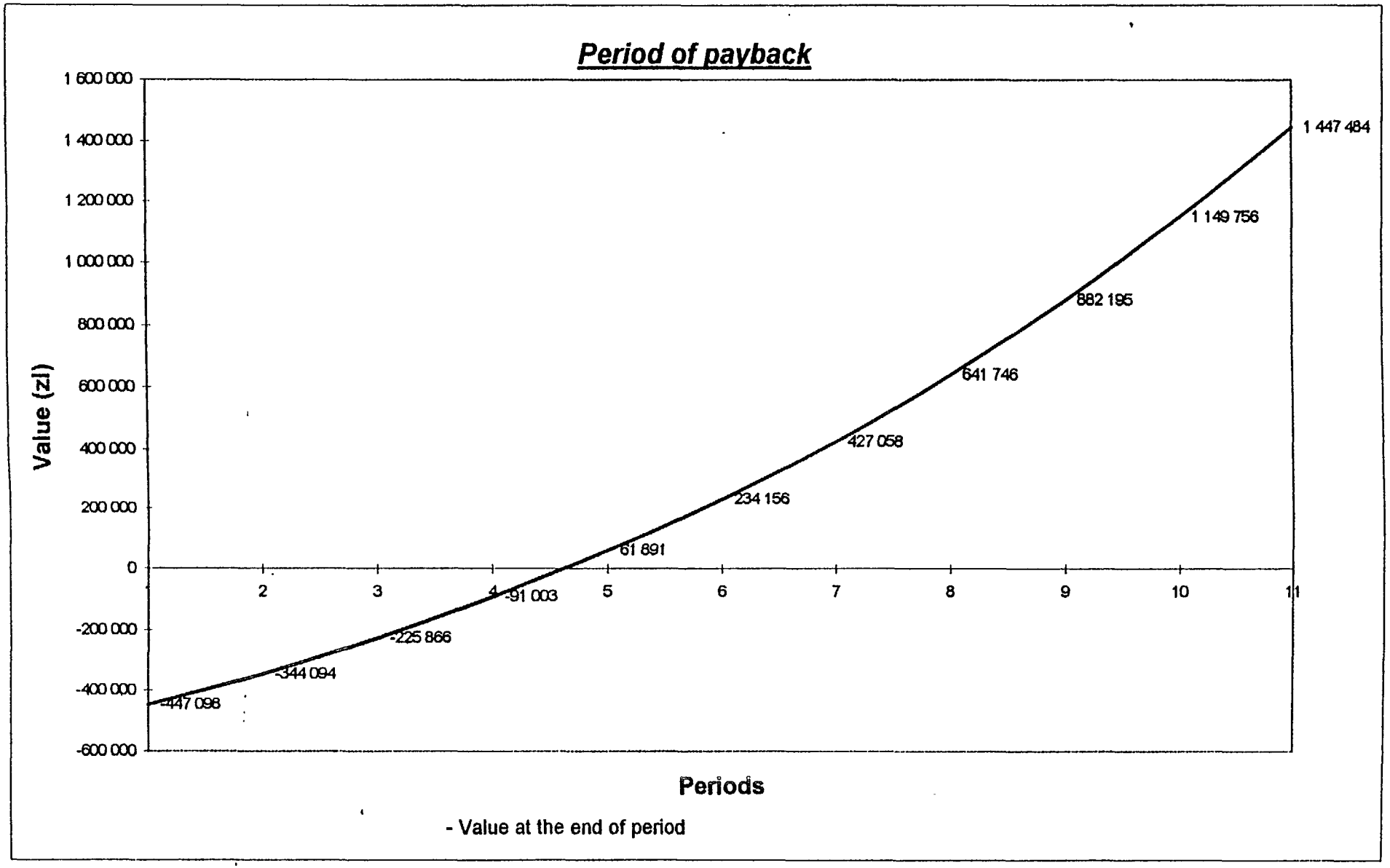
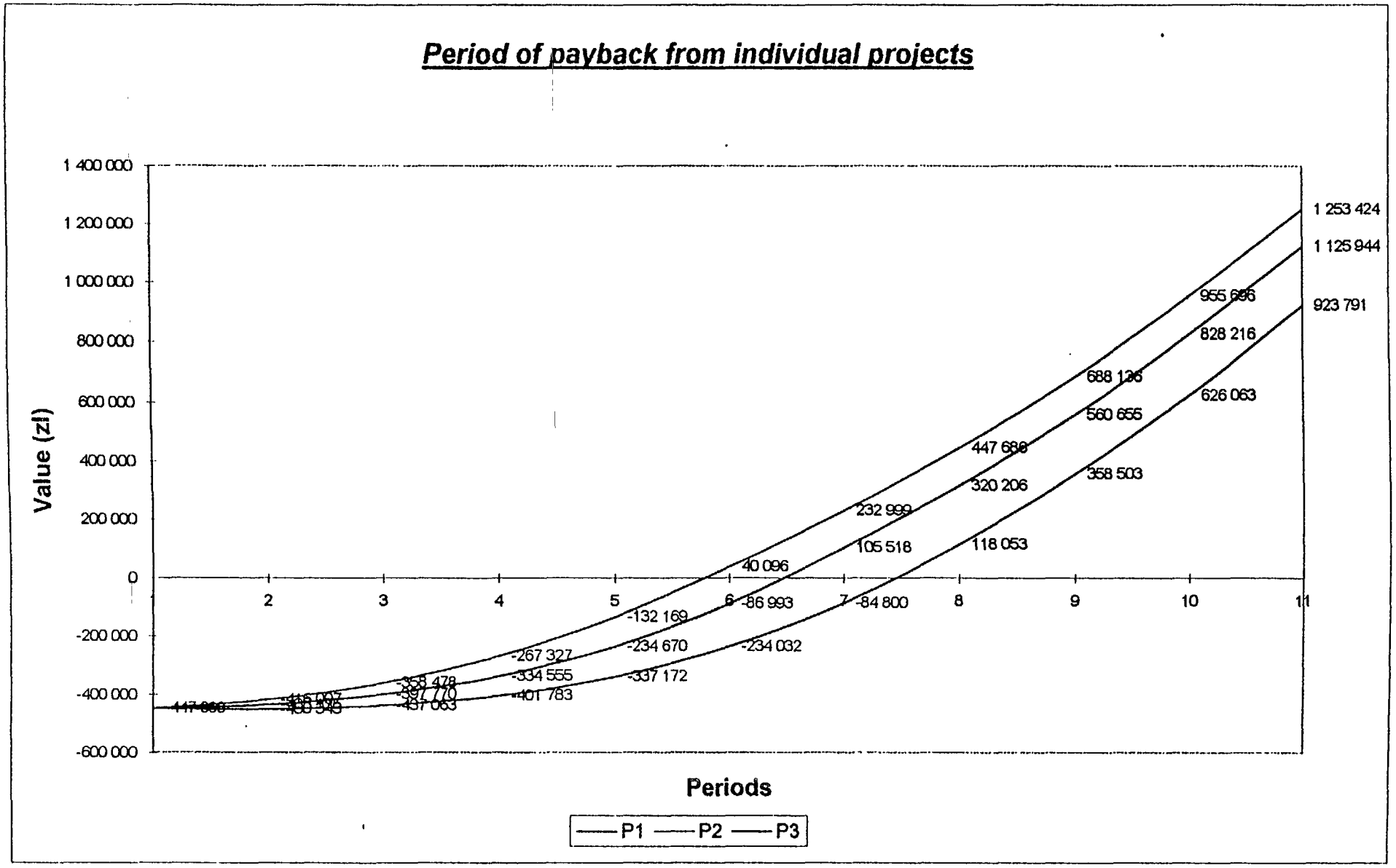

Period of payback
1 600 000
1 400 000
1 200 000
1 000 000
800 000
600 000
400 000
200 000
0
-200 000
-400 000
-600 000
Value (zl)
2
3
4
5
6
7
8
9
10
11
-447 098
-344 094
-225 866
-91 003
61 891
234 156
427 058
641 746
882 195
1 149 756
1 447 484
Periods
- Value at the end of period

Chart 2


Period of payback from individual projects
1 400 000
1 200 000
1 000 000
800 000
600 000
400 000
200 000
0
-200 000
-400 000
-600 000
Value (zł)
2
3
4
5
6
7
8
9
10
11
Periods
1 253 424
1 125 944
923 791
955 696
828 216
626 063
688 136
560 655
358 503
447 680
320 206
232 999
105 518
118 053
40 096
-86 993
-84 800
-132 169
-234 670
-234 032
-267 327
-334 555
-337 172
-358 478
-397 770
-401 783
-437 063
P1
P2
P3