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energy concepts for business parks

Baltycka Agencja Poszanowania Energii S.A.

Integrated Energy Concept for Business Park Kokoszki

PUBLIC

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Content

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List of abbreviations

BP Kokoszki – Business Park Kokoszki (Poland)

DH – District Heating

HOB – Heat Only Boiler (plant)

CHP – Combined Heat and Power (plant)

THW – Tap Hot Water

SF CHP1 – Substitute Fee for energy from gas cogeneration (CHP)

SF RES – Substitute Fee for energy from renewable sources

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1. Background and Objectives

Business parks (or business district areas) offer various opportunities and synergies for a rational use of energy and an expansion of efficient energy generation technologies (RES, CHP). Especially SMEs in such parks are often facing similar problems to implement cross-sectional (core) technologies for an efficient and sustainable generation and use of energy.

Cooperation between respective companies is a key to tap existing innovation potentials in these technologies. Therefore, the main target of GoECO is to apply a new co-operative approach to reduce energy consumption and CO2-emissions in existing business parks, i.e. the participative development and implementation of Integrated Energy Concepts for business parks in eight partner countries.

This document summarises the working results of the Baltic Energy Conservation Agency and its national partner, the Business Park in Kokoszki (BP Kokoszki), which is an industrial district of Gdańsk.

An Integrated Energy Concept is a strategy that has been developed in a standardized approach between involved consortium partners, aiming for the following objectives:

- Analysis of energy supply and demand structure of the respective business park
- Identification of energy saving potentials and appropriate core technologies
- Implementation of feasibility studies on specific core technologies that should be implemented by single enterprises or in a cooperative approach between several SMEs in the business park
- Development of a working plan for the implementation stage
- Calculation of two scenarios showing the development of the energy consumption and the generation with different investment rates
- Establishment of a Monitoring of the implemented measures by an installation of an energy management system.

The Integrated Energy Concept for the BP Kokoszki is to understand as a guidance document for implementation of different measures as well joint actions if they were feasible.

2. General Description of the Business Park

The Kokoszki business park is neither a restricted area nor does it have a single owner or administrator. Only some of the businesses located in this area own the buildings in which they are seated. In the pre-transition era there were many construction and assembly companies based in this area, which later ceased to exist but the owners of buildings or land let the premises to interested entrepreneurs .

At present there are many businesses located here, such as construction industry companies, construction and installation services companies, mechanical plants , paint manufacturers, logistics and transportation companies, sales offices and one local utilities company. Currently, local spatial management plans for Kokoszki business park are being developed. They envision a further development of the district and the establishment of industrial bases, factories and warehouses here. The plans exclude building housing estates in this area. No shopping center is planned here either.

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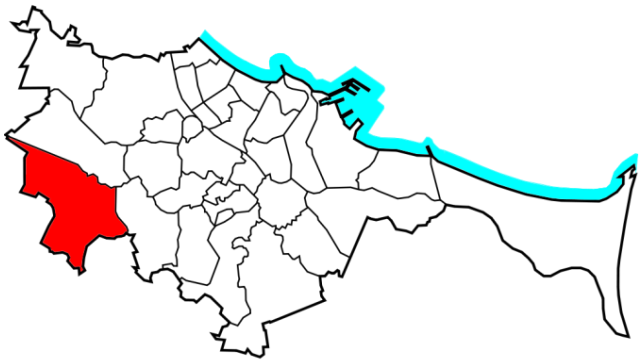

Fig. 1 Location of Kokoszki district in the city of Gdańsk

The following map shows the different buildings on the area of BP District Kokoszki:

Fig. 2 Location plan for the area of the BP Kokoszki

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3. Analysis of the Status Quo

3.1. Energy Consumption

Some of the companies in the Kokoszki Business Park are supplied in heat and steam from the local HOB cased on cola, some use LPG, gas and electricity. Electricity is also used for production processes, ventilation and air-conditioning, interior lighting and street lighting. The demand for energy of particular entities is varied due to their diversified scope of activity and the condition of their buildings.

Tab. 1 BP Kokoszki final energy consumption

Type of energy	Final energy consumption MWh/year
District heating	18 542
Natural gas	39 902
LPG	262
Electricity	44 878
Steam	347
Total	**103 931**

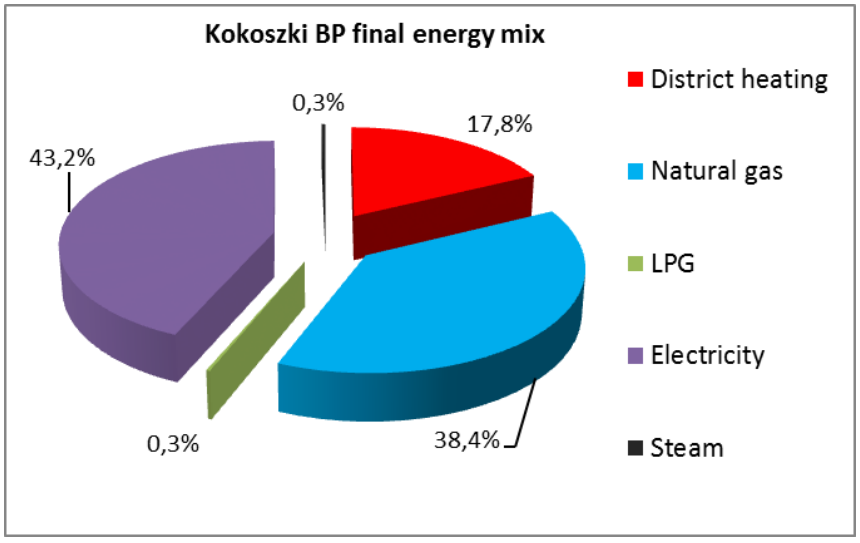

Fig. 3 Final energy mix of the BP Kokoszki

Basing on the preliminary energy audits, the following categories of energy needs have been identified.

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Tab. 2 Energy needs at the audited companies BP Kokoszki1

Energy use category	Consumption MWh/year	Notice
Lighting	795	Internal and external
Heating and ventilation	29 270	District heating
Cooling	N/A	
Compressed air	428	Electricity
Process	1 250	Steam
Heat recovery	88	Natural gas, electricity

3.2. Energy Generation

The main heat supplier for the Kokoszki district is a local utility company. The heat source is the heating plant with high-temperature boilers, which are fired with coal. Currently there are different types of coal boilers in the HOB:

- two water (high-parameter) coal boilers, 11.6 + 6 MW;
- two steam boilers 6.5 + 3 MW.

Total installed capacity is 27 MW.

District heating network has length of 4 500m. There are 40 substations at the end-user facilities. The parameters of the heating network are 125/75 ^{o}C.

Capacity demand is equal to 13 MW. Annual production of heat is equal to 70 000 GJ.

Electricity is not produced in Kokoszki BP, although a small wind turbine of 20 kW is under development. Generally, all the companies are supplied in electricity from the national grid.

3.3. Results of the feasibility studies

A small number of buildings are new ones, constructed with the use of new technologies, thus not requiring substantial thermal retrofitting. Some other building erected several dozen years ago need extensive retrofitting. Some Preliminary Energy Audits (PEAs) and thermovision surveys, as well as feasibility studies for particular technologies have been performed for selected buildings of the park. Possible financing solutions for implementation of measures recommended in the energy audits are under study.

[1] Four Preliminary Energy Audits

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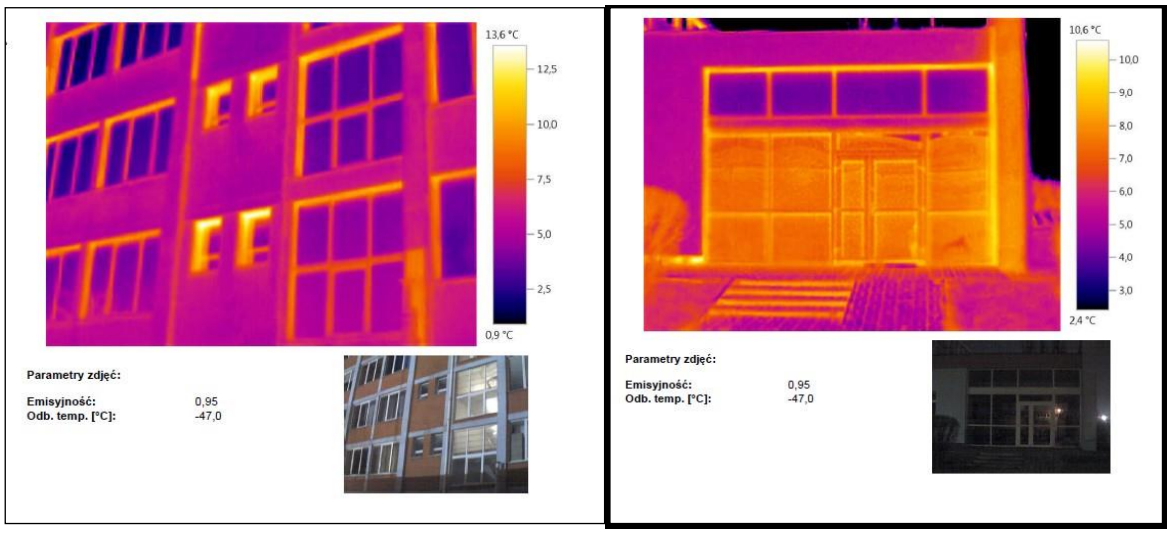

Fig. 4 Kokoszki Office building thermography

The results of ten feasibility studies are summarized below.

Tab. 3 BP Kokoszki comparison of the economy of the analysed projects

No	Technology	SPBT years	NPV kEUR	IRR %
1	Internal lighting office building	6.0	96.9	14.4%
2	Internal lighting production plant building	6.5	105.9	12.8%
3	HOB – fuel switch from LPG to natural gas	1.4	109.9	69.5%
4	Building envelope office building	13.5	2.3	6.1%
5	Building envelope plant administrative building	7.4	265.5	16.2%
6	Compressed air system	2.4	10.2	40.9%
7	Heat recovery for DHW	3.2	42.7	28.6%
8	CHP plant (biomass /gas / biogas)*	>10	-	-
9	PV system	9.5	5.1	6.3%
10	Small wind turbines system	11.6	-4.7	3.5%

** comment: None of the analysed CHP solutions has been recommended at this moment as present support system and price structure on the market do not support considered options of CHP. However increasing costs of heat and electricity from coal are expected, and then the proposed options should have be re-considered.*

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Summing up:

1. There is large potential for improving energy efficiency in production and service facilities covering both energy production technology and the use of heat and electricity for heating, domestic hot water, and lighting technology.
2. Most of the projects will be feasible when special financing is available – grant or preferential loan. However, presently no grant financing is available for business for retrofit projects.
3. There is lack of any incentives for energy end users for investments in connection to the DH.
4. Some projects like modernization of compressed air system are profitable and shall be implemented. However, due to uncertain situation as to further production in the near future, any decision on investment will be not taken at this moment.
5. As to RES implementation - present system of support of small RES does not allow for efficient generation from micro-sources.
6. There are short-term actions (till 2015) recommended to be implemented in BP Kokoszki:
   - Retrofit of transmission pipes of the local DH network
   - Replacement of steam used for technology by hot water from DH network from the same HOB plant
   - Fuel switch in local HOB plant from LPG to natural gas or connection to DH network
   - Modernisation of runway and approach lighting at the Gdansk Airport
7. Other recommended measures to be implemented till 2020 are:
   - Exchange of internal lighting in office and production buildings
   - Conversion of direct DH connections to heat exchanger substations with automatic control
   - Compressed air system optimisation (if present type of production is continued)
8. Implementation of the measures will depend on the individual decision of each company.
9. The measures that can be implemented but have not been considered in the feasibility studies:
   - Modernization of the street lighting in BP Kokoszki
   - Modernization of street surface in BP Kokoszki
   - Heat recovery from the production of pre-fabricated elements
   - Heat recovery in HVAC systems
   - Replacement of internal and external lighting

4. Scenario for the Development till 2020

4.1. Assumptions and general Methodology

4.1.1. Business As Usual (BAU) Scenario

As to BAU scenario it is assumed that all future activities will be performed without any measures analysed within feasibility studies. It is difficult to predict the dynamics of the

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individual companies. It depends heavily on the economic situation on the domestic and European markets. However, existing buildings rather not supposed to be subject of extension. At this moment it seems that only there will be an extension of the Gdańsk airport, which is supplied with heat from the BP Kokoszki local district heating. On the other hand, currently it is observed market recovery and the growing interest of entrepreneurs putting in new facilities in BP Kokoszki. These are mainly warehouses, built in technologies of steel halls or office buildings with light concrete blocks. Most of them will be supplied with heat from the natural gas network, and electricity will be delivered from the national electricity grid. Some of them possibly will be connected to the local DH.

Energy for heating, ventilation and preparation of tap hot water (THW) is typically provided either from natural gas or district heating network. The HOB plant supplying the DH network is coal-fired (chapter 3.2)

Over last years' price of heat from both sources has become similar and there are no incentives to change the energy carrier and invest in the new heat source.

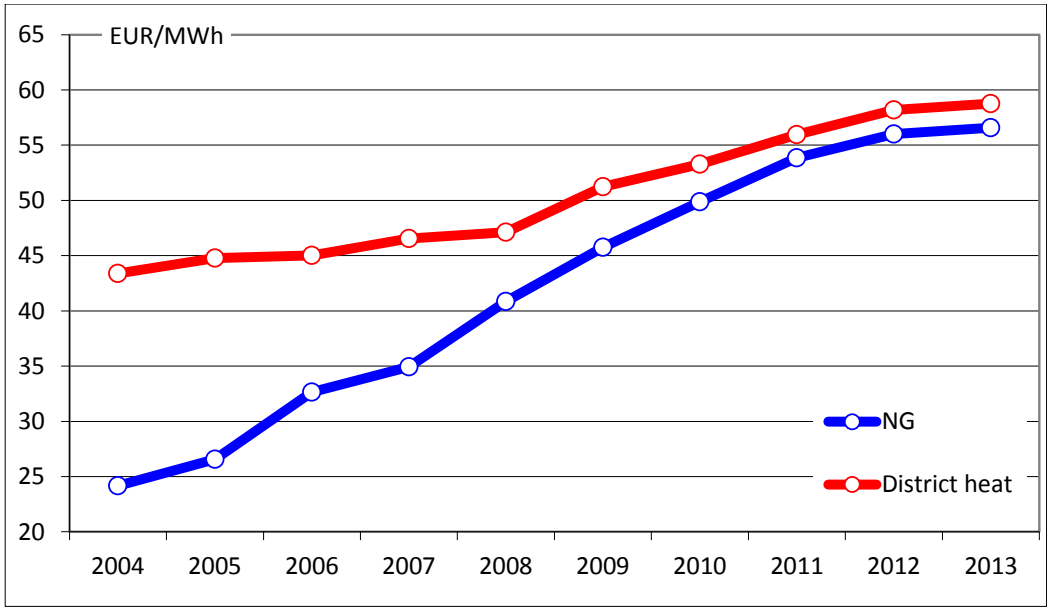

Fig. 5 Evolution of prices of natural gas and district heat

Price of CO2 allowances was expected to reach 20 EUR/t CO2, leading to increase of price of heat generated from coal. However price of CO2 allowances is at the level of 4-5 EUR/t CO2 and this presently is not stimulating replacement of coal by much more expensive natural gas.

Given the above assumptions, it is assumed that until 2020 horizon there will be an increase in demand for energy. It has been assumed that the increase in energy demand comes due to gradual increase in turnover of the companies (higher production level, greater amount of services provided – longer work time in a month/year).

The figures below relate only to those objects for which feasibility studies have been carried out and where increase of energy use has been declared.

New connections shall require 3 900 MWh/a of district heat.

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Tab. 4 Energy use in BAU scenario

	Energy consumption		
Type of energy	MWh/year	MWh/year	MWh/year
	2013	**2015**	**2020**
District heating	18 542	18 542	22 431
Natural gas	39 902	39 902	39 902
LPG	262	262	262
Electricity	44 878	44 878	45 089
Steam	347	347	347
Total	**103 931**	**103 931**	**108 030**

4.2. Assumptions on prices at energy markets and incentives

Prices

Willingness to undertake energy efficiency measures by companies depends on the structure of prices and energy markets and available incentives from different sources.

The most expensive energy carrier, of the highest price is electricity. It has been assumed that the price of electricity for industry sector would follow previous trend and would increase gradually, because of necessary investments in generation capacity and transmission as well as necessity of purchasing CO2 allowances by the power sector. However as the result of the slowing down of economy over recent years the price of electricity during last years has decreased.

The history of electricity prices and prognosis[2] are presented below in the table an in the diagram.

Tab. 5 Comparison of predicted and actual electricity price (for industry)

Energy price	Unit	2006	2010	2014	2015	2020
Predicted	EUR/MWh	55,6	71,6	83,7	86,8	112,9
Actual	EUR/MWh	55,6	61,2	57,2		

[2] Energy policy for Poland till 2030, Council of Ministers, 2009

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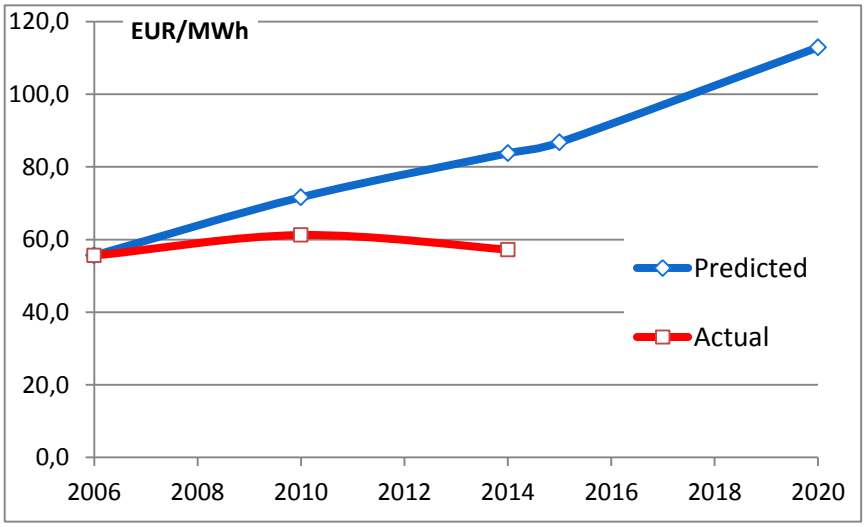

Fig. 6 Comparison of predicted and actual electricity price (for industry)

Development of the DH system and heat source (presently coal HOB plant) depends on situation on the energy and certificates markets.

Price of certificates: 'green' for energy from renewable sources and 'yellow" for energy from cogeneration depends on substitute fees (SF) set by the regulator.

Situation over last years concerning prices at the energy market against the inflation index CPI is shown in the figure below.

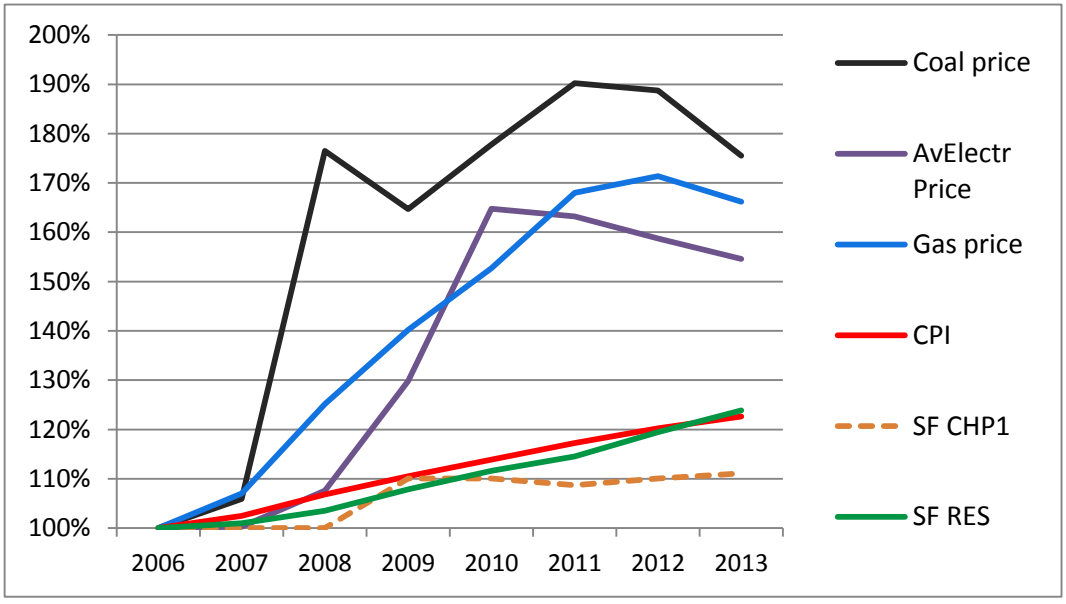

Fig. 7 Evolution of parameters at energy markets; coal, natural gas and electricity price, substitute fees (SF RES and SF CHP1)

Lower prices of certificates do not stimulate installation of CHP plants, supplied with natural gas, biomass or biogas.

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Targets and incentives

The National Action Plan for Energy Efficiency provides that the activities aimed at improving energy efficiency will be implemented in all sectors of the economy, including industry. It was assumed that the level of savings by 2016 will reach 9% compared to the average energy consumption in 2001-2005 (baseline). This means that the average annual domestic consumption of energy should decrease by 1%. However, analysis of national monitoring the implementation of the intended objectives indicate that the actual savings are (so far) higher than planned.

For the industrial sector support for investment activities is PolSEFF program, as well as programs conducted by the National Fund for Environmental Protection and Water Management in the field of high efficiency energy generation and efficient distribution of energy. PolSEFF program is mainly focused on the modernization of technology leading to the purchase of energy-efficient products, but also one can get support for the modernization of buildings. The pre-condition to obtain a support is to get respectively 20% and 30% of energy savings. The program ends in 2014.

In turn, the two above-mentioned activities NFOŚiGW are addressed to large enterprises. There is no market mechanisms to encourage SMEs to invest in energy efficiency improvements. These are usually small projects for the country or region, but expensive for a small entrepreneur. The preferences are given usually to large projects bringing significant environmental effects.

The next budgeting period 2014-2020 will provide support for SMEs at the regional level within the priority 1.2 - improving energy efficiency and 1.3 - Increase the use of energy from renewable sources.

4.2.1. Green scenario

Green scenario takes into account both individual measures implemented by involved companies as well as joint, integrated actions undertaken in the Business Park.

Recommended actions include energy efficiency measures by end users, modernisation of district heating system and installation of base-load CHP plant supplying district heating network.

Development and modernisation of the DH system is the key action of the integrated energy concept for the BP Kokoszki.

Planned modernisation measures

1) Modernisation of the district heating system

   a. Retrofit of transmission pipes of the local DH network

Transmission pipes of the ‘West’ branch of the local district heating network have length of 860 m and have been laid in traditional technology, in concrete channels. Over years their insulation deteriorated and this has resulted in excessive heat losses.

Heat pipes of diameters 250 and 200 mm are to be replaced by preinsulated pipes.

Reduction of heat losses – savings, are estimated at 570 MWh/a (Energy audit performed by the DH company). The payback time is long, the investment is undertaken in order to improve safety of supply of district heat.

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b. Replacement of steam used for technology by hot water

There are plans of replacing steam used for technology (production of concrete elements) by hot water from DH network from the same HOB plant. This is linked with change of technology.

Use of steam has been linked with high energy losses. Periodic use of steam and loss of condensate have resulted in losses in steam system of 70%.

Losses in system supplies with hot water will be much lower.

c. Modernization of substations in DH network

Three users of district heat have direct connection to DH network and supply their internal installations with high-parameter water without control. These connection points shall be converted to heat exchanger substations with automatic control.

Additionally five heat substations do not have functioning automatic control of heat supply to internal network and their technical conditions are bad. These substations shall be modernised.

The results of proposed modernisation of these substations are summarised in the table below.

		2013	**2015**	**2020**
Heat consumption	MWh/a	2 489	0	1 991
Savings				**498**

Taking into account other energy saving measures undertaken by present users of district heating, total savings of present DH users till 2020 can be estimated at 900 MWh/a.

Predicted development of DH system with reduction of consumption by present users and new connections is shown in the table and in the figure below.

Tab. 6 Predicted development of DH system

	Energy consumption		
End users	MWh/year	MWh/year	MWh/year
	2013	**2015**	**2020**
Present users	18 542	18 087	17 187
New connections			3 889
District heating	**18 542**	**18 087**	**21 076**

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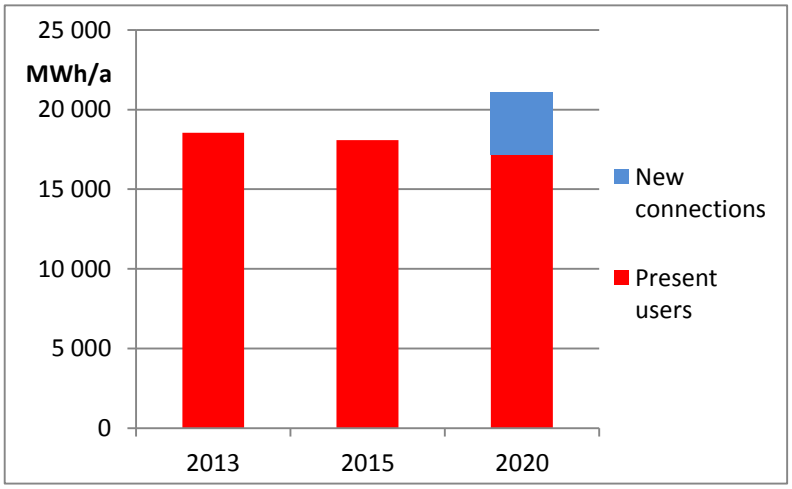

Fig. 8 Predicted development of DH system

2) Modernisation of lighting

a. Modernisation of runway and approach lighting at the Gdansk Airport

Gdansk Airport is planning to upgrade runway and approach lighting. New, energy efficient lighting system will be introduced.

New system shall allow for savings about 60% of electricity against developed traditional system.

b. Other lighting

With development of LED technology there shall be possible to modernise internal lighting in office building and administrative building of a production plant (results of feasibility studies).

Totally about 510 MWh of electricity shall be saved annually thanks to modernisation of identified external and internal lighting.

3) Implementation of RES

Planned new Renewable Energy Law and support to micro-generators (below 40 kWe) shall result in installation at least one PV system of capacity 40 kWe. This shall result in production of renewable energy of 36 MWhe.

4) Modernisation of heat source and installation of CHP

Modernization of heat production process has been analysed as part of the feasibility studies. Several options have been considered:

I. Biomass boiler with thermal oil loop and Organic Rankine Cycle with turbogenerator,

II. Natural gas engine and generator,

III. Biogas engine and generator,

IV. Mixture of natural gas and biogas engine and generator (combination of II and III).

With the present system of support introduction of CHP is not feasible.

Taking into account predicted changes in prices at energy markets possibility of installation of CHP plant based on natural gas engine (Option II) shall be considered.

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The CHP unit of capacity 1.0 MWe/1.0 MWt shall generate heat during low summer demand and operate as the base load during heating season.

Taking into account planned demand for district heating the supply structure and CO2 emission are shown in the figures below.

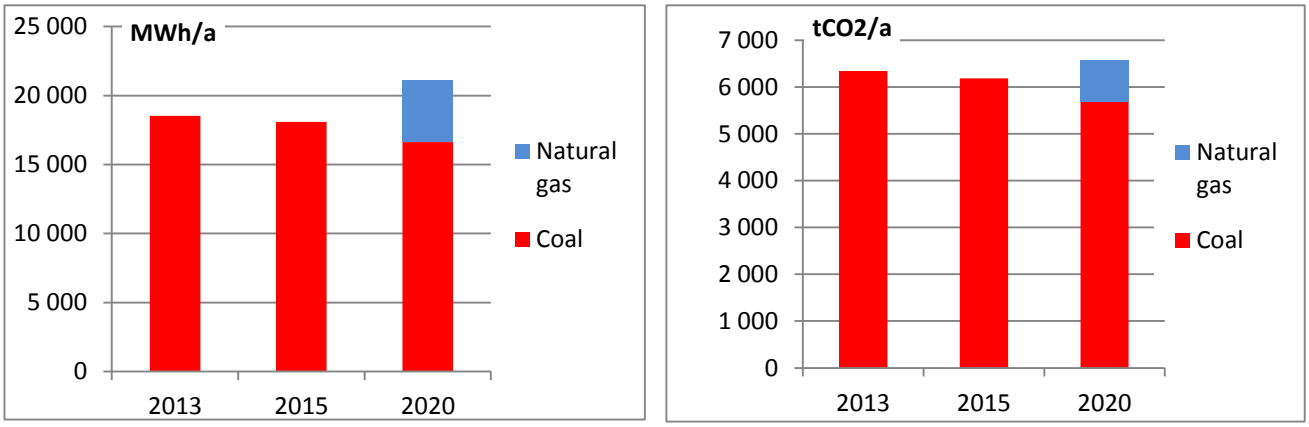

Fig. 9 DH system - supply structure and CO2 emission

5) Other measures - electricity

It is assumed that all companies of the BP shall reduce their electricity consumption, by replacing lighting and other equipment, as well as thanks to introduction of energy management steps.

Summary of measures

It is assumed that in a horizon of 2020 there will be reduction of energy demand and reduction of CO2 emission. The figures below relate only to those objects for which feasibility studies have been done and information on planned measures has been obtained.

Tab. 7 Green scenario – balance of energy carriers

	Energy consumption		
Type of energy	MWh/year	MWh/year	MWh/year
	2013	**2015**	**2020**
District heating	18 542	18 087	21 076
Natural gas	39 902	39 765	38 572
LPG	262	0	0
Electricity	44 878	44 429	39 986
Steam	347	0	0
Total	**103 931**	**102 282**	**99 634**

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Tab. 8 Green scenario – CO2 emission

	Emission		
Type of energy	tCO2/year	tCO2/year	tCO2/year
	2013	**2015**	**2020**
District heating	6 341	6 186	6 581
Natural gas	8 016	7 988	7 748
LPG	59	0	0
Electricity	35 454	35 099	30 954
Steam	119	0	0
Total	**49 988**	**49 273**	**45 283**

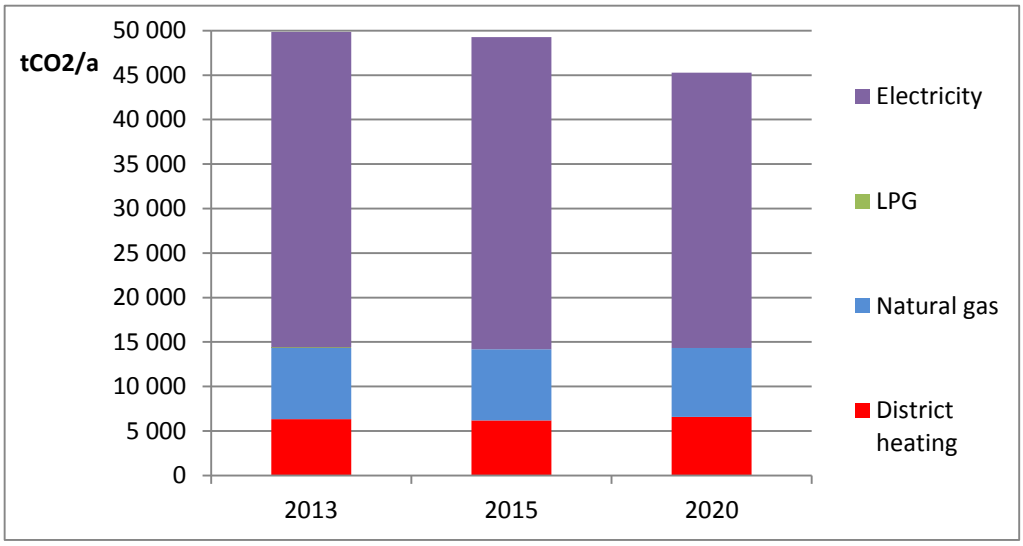

Fig. 10 Green scenario – CO2 emission

The basic tool for making investment decisions here are energy audits, feasibility studies, and analysis of financial support for investments. Both tools were used in the project GoECO. However, at this moment the Directive 2012/27/EU mentions to perform energy audits only at large companies. In Poland, the financial support up to 70% of the energy audit costs is granted only to companies with an annual consumption above 20 GWh.

4.3. Definition of mitigation targets

1) Listing of core measures (BAU and 'Green' Scenarios)

There have been four categories of actions considered within the BP Kokoszki with a goal of energy efficiency improvement and CO_2 reduction to be achieved:

1. Increased energy savings at end users (modernization of district heating substations, internal lighting of an office building and modernization of the heating system, the modernization of the airport runway lighting).

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2. Reduction of heat losses in distribution system, brings 900 MWh/a savings; there will be decreased generation and distribution of steam produced in local HOB, which will bring savings of 210 MWh.
3. Increased energy efficiency in the production processes of heat (this action probably will be implemented till 2020).
4. Increased share of renewable energy sources (by PV installation, installation of small wind turbines). However, these investments due to long payback time will not be implemented until 2015. They will be cost-effective when additional financial or other incentives are available.

Generally, reduction of CO2 emission shall result both from energy efficiency measures and introduction of gas-fired CHP in the DH source.

Additionally, modernization of flue gas cleaning system is going to be implemented to reduce dust emission. The level of particles emission has to be reduced from 400 mg/Nm^3 to 100 mg/Nm^3 until 1st January 2016. So, the investment will start at the end of 2014. The action will not reduce CO_2 emission, neither energy consumption but significantly improve the quality of air in BP Kokoszki.

2) Comparison of outcomes from both scenarios

Considering all the planned actions, an estimated energy efficiency will result in energy consumption decrease and reduced CO_2 emission after implementing investments.

Comparison on both scenarios in term of energy savings and reduction of CO2 emission is shown in the tables and figures below.

Tab. 9 Comparison of scenarios – energy consumption

	Energy consumption		
Scenarios	MWh/year	MWh/year	MWh/year
	2013	**2015**	**2020**
BaU	103 931	103 931	108 020
Green	103 931	102 282	99 635
Reduction		**1,6%**	**4,3%**

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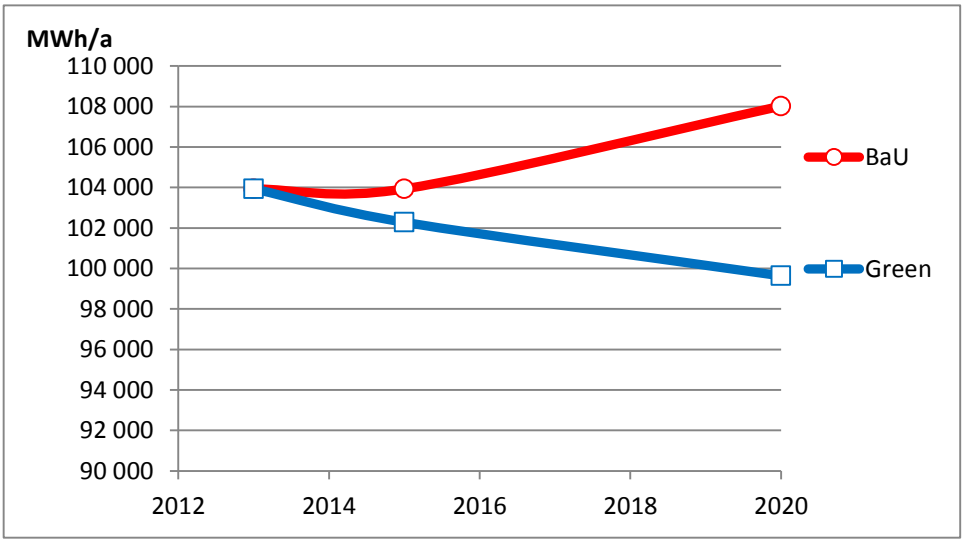

Fig. 11 Comparison of scenarios – energy consumption

Tab. 10 Comparison of scenarios – CO2 emission

	Emission		
Scenarios	tCO2/year	tCO2/year	tCO2/year
BaU	49 988	49 988	51 476
Green	49 988	49 273	45 283
Reduction		**1,5%**	**10,4%**

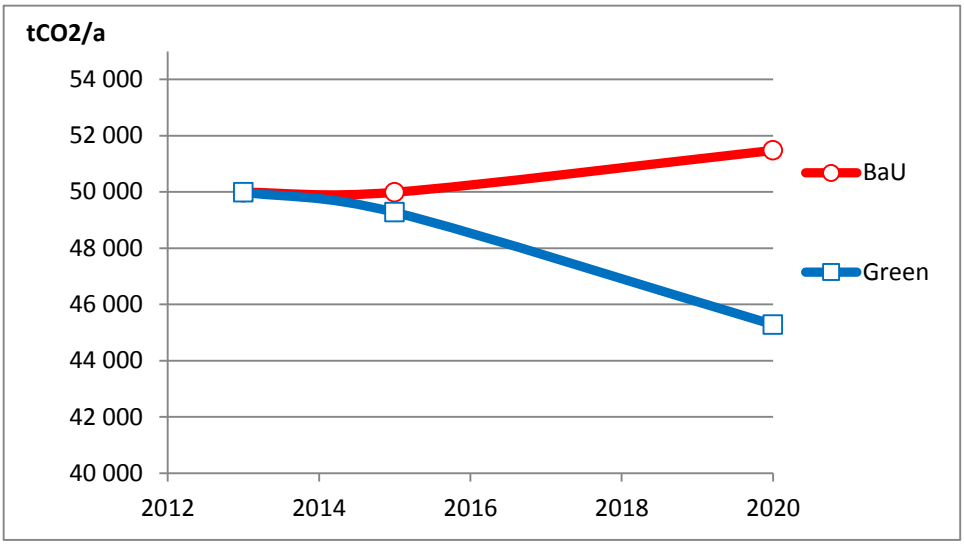

Fig. 12 Comparison of scenarios – CO2 emission

There are no precise plans as to extension of BP Kokoszki. However, if any new companies settle down, there is possibility to increase heat capacity of the heat plant of ca. 6 MW.

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5. Implementation Strategy

Implementation of measures aimed at improving energy efficiency and reducing CO_2 emissions will take place in two ways and independently one of each other. On the one hand, end users will implement activities in their own structure, and on the other - manufacturer of heat will modernize its system. However, for BP Kokoszki as a whole, the most important action will be modernization of heat production process in the local heating plant based presently on coal. In order to make a decision to shift from coal into lower emission fuels there must be in the country more favourable economic conditions for such investment. Today, such investments are not feasible.

In addition, the diversification of companies character in BP Kokoszki (services, logistics, production) as well as the needs of the implementation of measures to improve energy efficiency and install renewable energy sources make it difficult to develop common joint investment projects. On the other hand, it seems, that there is a need for trainings / education such as those organized within the project GoECO that will educate the industrial sector on issues of buildings, technology rehabilitation with a view of energy consumption reduction and the possible use of energy resources from wind or sun. An important element is the availability of advisory services in the field of energy conservation, which can be provided by the energy agency involved in the project.

Suggested time schedule:

Implementation of some measures has been already started e.g. modernization of distribution network. Other proposed short-term measures should start at the end of year 2014 and should be completed till 2015.

Long-term investments like modernization of the heat production is considered to be implemented till 2020. Each company should have different job implementation plan as their type of service and main core technology differs from each other.

6. Monitoring

Currently there is no common monitoring for entities located in BP Kokoszki. In contrast, each of the recipients record consumption of energy on heating, technology, and electricity. Also recorded is heat energy produced in the local heat source. The possibility of joint procurement, such as electricity are currently the subject of studies conducted in the frame of the project. Talks are also carried out on energy management and the creation of such positions in companies. In such informal business park which is BP Kokoszki that is not managed by a single owner it is not possible to create energy management with respect to all entities in one entity.

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