

# Energy Balance

For

# Piaseczno

Poland

## Table of Content

1	Introduction.....	3
2	Description of the Energy Balance programme.....	3
3	Energy Balance 2003 .....	4
3.1	Data .....	4
3.2	Fuel.....	4
3.3	End use.....	5
3.4	Emissions .....	6
3.5	Comparison with national values .....	7
4	Conclusion .....	10
	Appendix 1: Energy Balance .....	12
	Appendix 2: Energy Balance with changes .....	13

## 1 Introduction

In a co-operation between, Green City Denmark, National Energy Conservation Agency, Poland and PlanEnergi, Denmark an energy balance has been made for the Polish municipality Piaseczno.

Piaseczno is an urban-country commune located in the centre of Poland in the direct neighbourhood of the southern part of Warsaw. The commune is made up of the city of Piaseczno and 32 solectwos (Polish smallest administrative units). The area of the commune is 128.2 km<sup>2</sup> and the population is approx. 47.000.

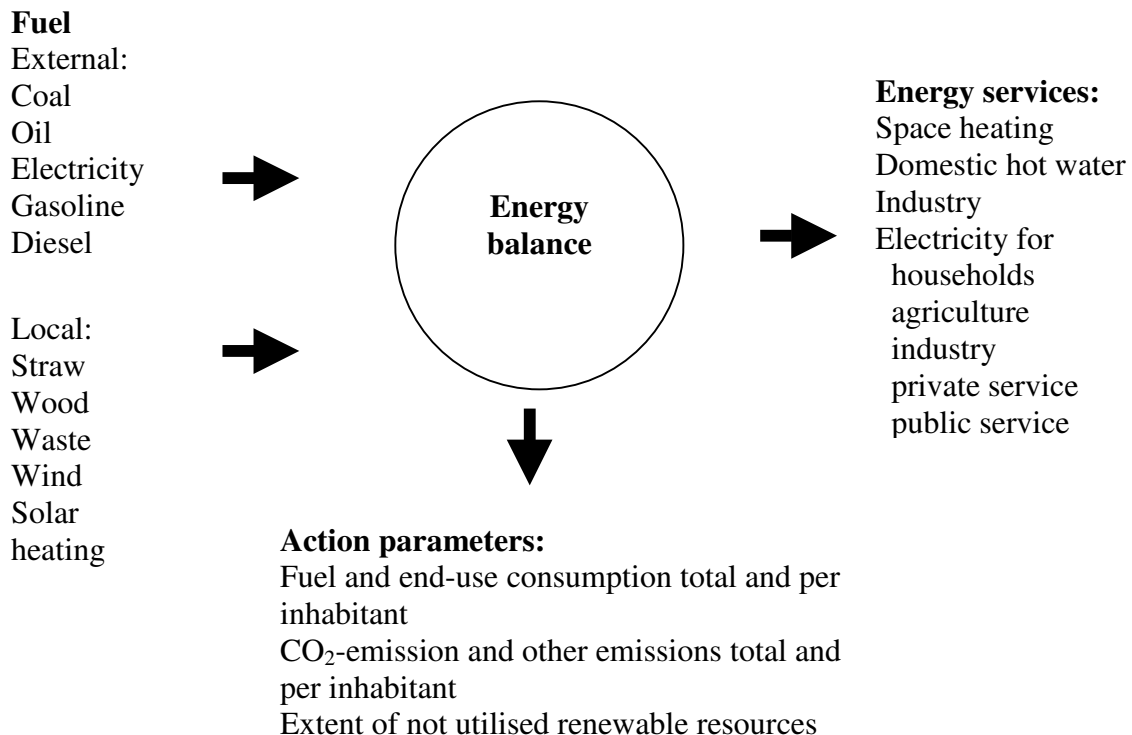
## 2 Description of the Energy Balance programme.

The Energy Balance is an advanced Excel spreadsheet, where you on one page have an overview of the total:

- Fuel consumption
- Energy conversion
- Distribution
- end-use
- Emissions
- Renewable Energy

for at geographical area (city, part of city, municipality or region).

In principle the Energy Balance is constructed like this:



Below is illustrated the overall organisation of the energy balance spreadsheet.

Section 1	Section 2	Section 3	Section 4
Fuel	Fuel conversion technologies	Distribution (electric grid and district heating network)	End-use

Each energy conversion plant (or group of similar plants) is named in section 2 and defined by its efficiencies. To the left, in section 1, is listed the fuel consumption of the plant, and to the right, in section 4, the end-use. The input/output of electricity production to the grid and eventually the same for district heating is calculated in section 3. The spreadsheet model includes one line for each plant. The numbers of plants are defined due to differences in efficiencies and/or end-use production.

### 3 Energy Balance 2003

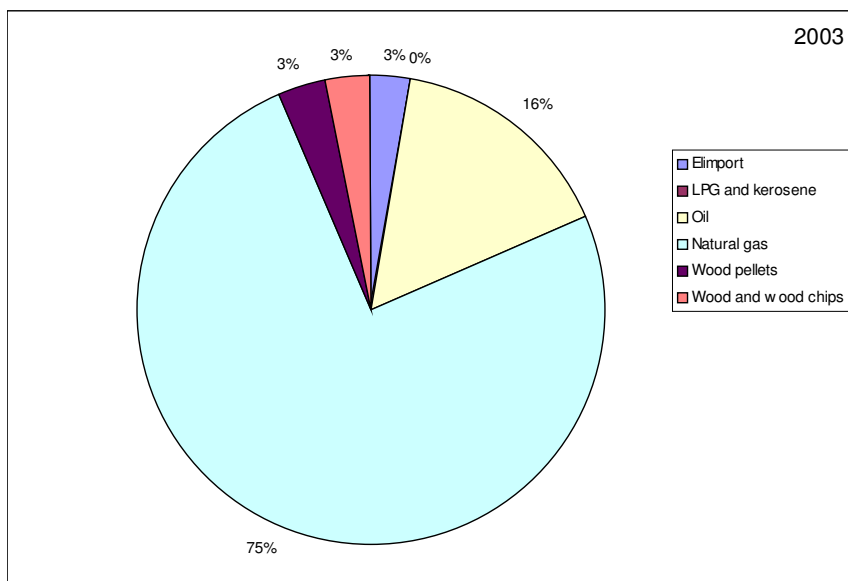
The energy balance for 2003 can be found in appendix 1.

#### 3.1 Data

The data for Piaseczno has been provided by Ms. Malgorzata Popiolek from the National Energy Conservation Agency. The national data has been found the homepage of International Energy Agency.

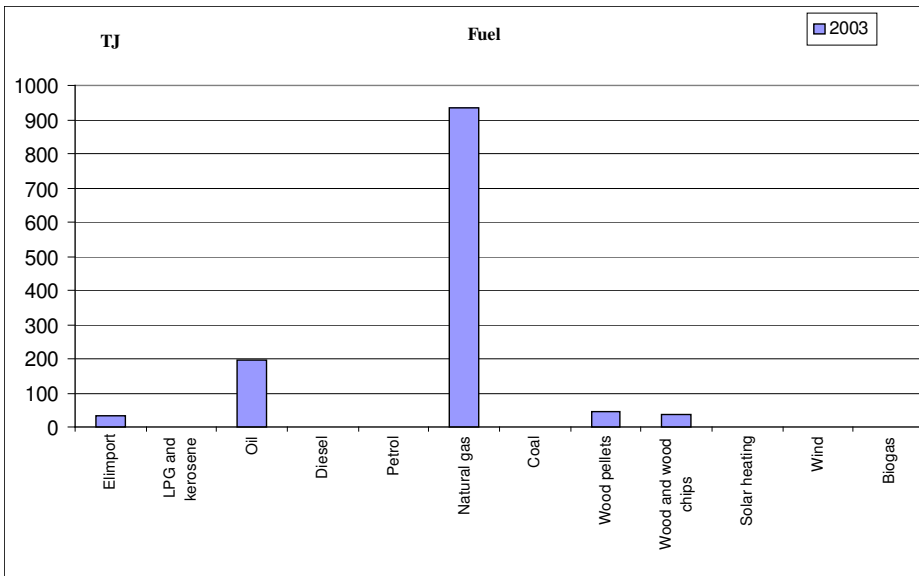
#### 3.2 Fuel

The total consumption of fuel in Piaseczno is found to be 0.0 TJ. In the present energy balance is not included energy used for transportation. The distribution of consumption on types of fuel can be found in Figur 1.



Figur 1 Distribution of fuel consumption

As it appears, natural gas is the main energy source followed by oil and electricity imported to the municipality. The actual figures appear in Figur 2.

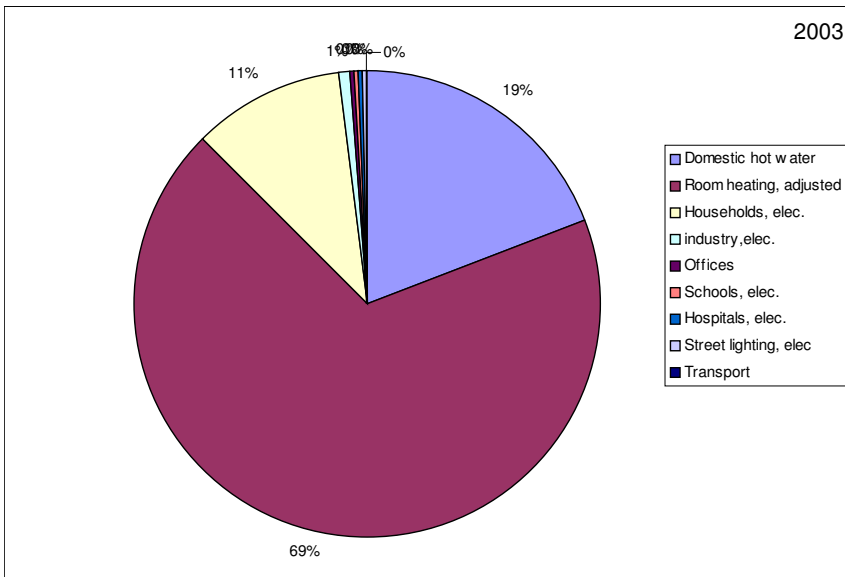


Figur 2 Fuel consumption

### 3.3 End use

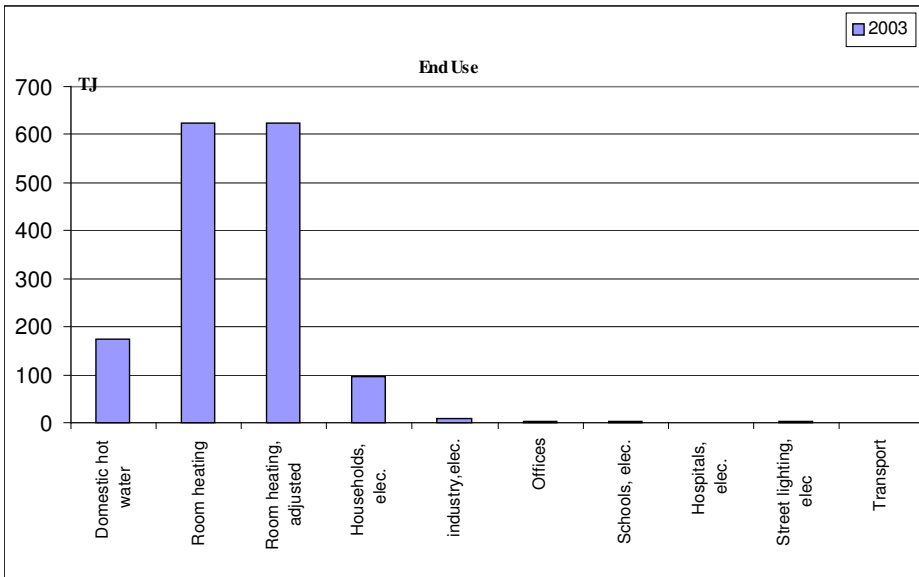
The end use is the utility value of the fuel, i.e. the energy content in the fuel multiplied with the efficiency of the conversion unit.

The distribution of the End use can be seen on Figur 3.



Figur 3 Distribution of End use.

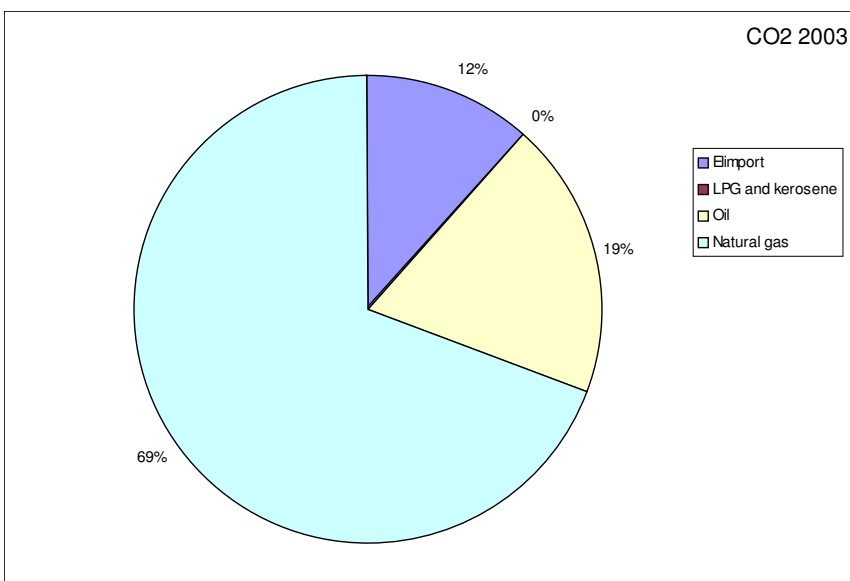
As it appears the majority of the energy is used for space heating, followed by domestic hot water and electricity in households. In actual figures the end use is distributed as shown in Figur 4.



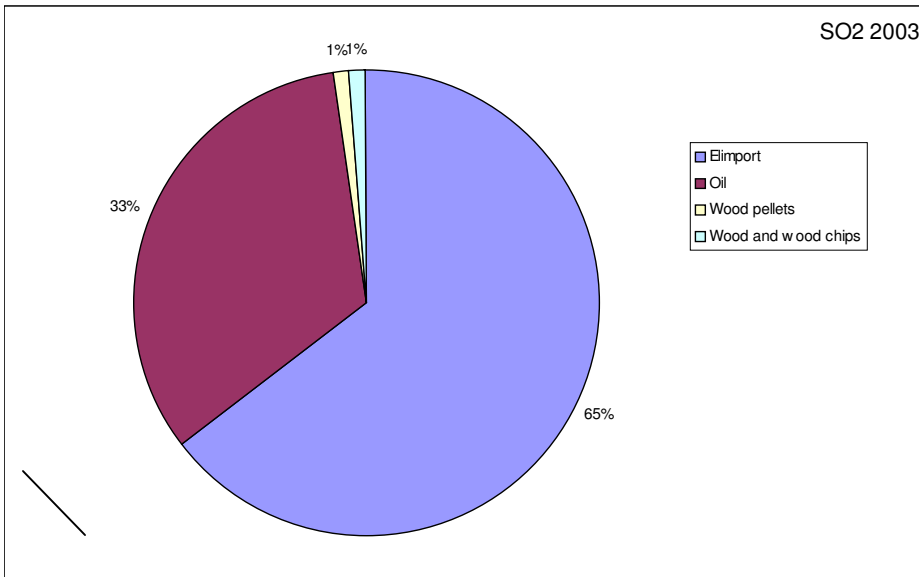
Figur 4 End use consumption

### 3.4 Emissions

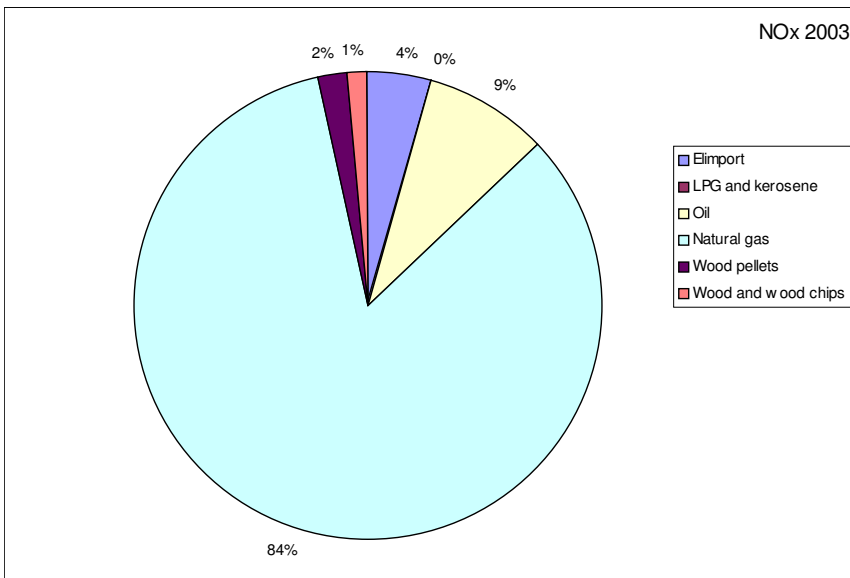
The energy consumption results in emissions of CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub>. Below are tree figures showing the distribution of emissions from the different fuels.



Figur 5 CO<sub>2</sub>-emission divided on fuels



Figur 6 SO<sub>2</sub>-emission divided on fuels

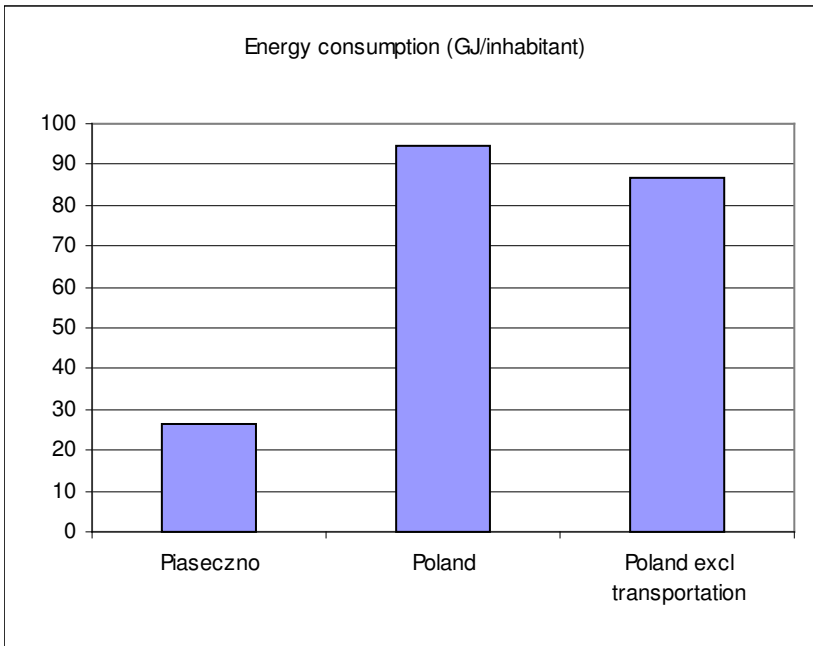


Figur 7 NO<sub>x</sub>-emission divided on fuels

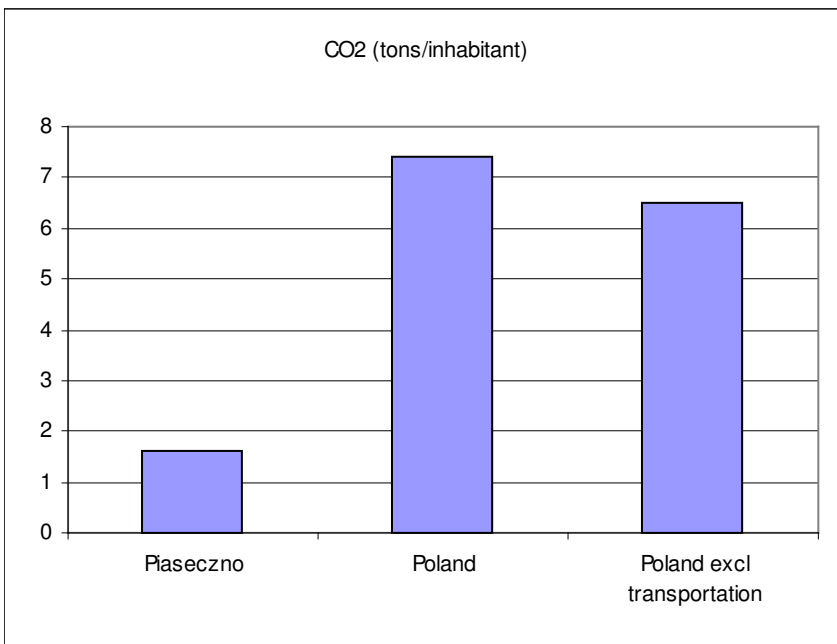
The electricity import and the natural gas are the main sources of emissions, beside SO<sub>2</sub>, where natural gas doesn't contribute.

### 3.5 Comparison with national values

When comparing the numbers from Piaseczno with the national Polish values it comes clear that the values for Piaseczno are low. See figures below.

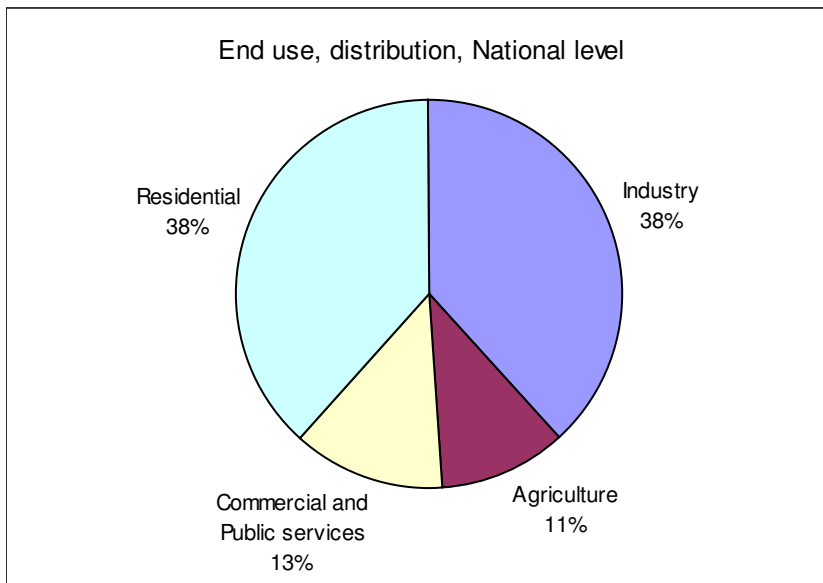


Figur 8 Comparison, energy consumption.



Figur 9 Comparison, CO<sub>2</sub> emissions.

Below is shown the distribution of end use on national level.



Figur 10 End use distribution, national level, except transportation.

Comparing Figur 10 and Figur 3 it becomes obvious that agriculture and industry have a very small role in Piaseczno. Most of the shops and services in Piaseczno City are connected to the district heating network. In Piaseczno residential and commercial and public services consumes about 99% of the total end use, where it on national level is only 51%.

The low figures for industrial energy consumption in Piaseczno are not only due to a small industrial sector, but also due to the fact, that it is not possible to obtain data for the consumption at the industries.

#### 4 Suggestion for goals for Piaseczno

The Energy balance is a starting point for setting up goals for the energy consumption in Piaseczno. These goals can be to improve one or more of the following every year: Energy consumption per inhabitant, CO<sub>2</sub>-emission per inhabitant, percentage of renewable energy, etc.

One way of reducing the CO<sub>2</sub>-emission is by reducing the electricity import. The electricity import accounts for approx. 40% of the CO<sub>2</sub>-emission in Piaseczno. The boilers at Piaseczno main heat plant can be replaced with co-generating gas engines. This will result in higher natural gas consumption, but the electricity import will be reduced significantly and the CO<sub>2</sub>-emission will also be reduced since the natural gas has lower CO<sub>2</sub>-emission than fuel used at the central power plant. The results are summed up in the table below.

	Reference	Co-generation
Electricity import, TJ	157.2	34.4
Natural gas consumption, Piaseczno DH, main boilers, TJ	205.3	350.9
Total energy consumption, TJ	1224.5	1247.2
Total CO <sub>2</sub> -emission, 1000 tons	100.8	80.9

Tabel 1 Impact of implementing co-generation.

Another way of reducing the CO<sub>2</sub>-emission is by replacing coal with a renewable energy source like wood pellets. If for example the local coal boilers connected to Piaseczno district heating network changed to wood pellets the CO<sub>2</sub>-emission will be reduced by 4100 tons per year. That is 4%.

A print out of the energy balance including both the above mentioned changes is attached as appendix 2.

## **5 Conclusion**

The fuel consumption in Piaseczno is dominated by natural gas, oil and electricity produced on coal. Renewable energy (wood) covers only %. At the end use side room heating and domestic hot water heating dominate followed by electricity consumption in households, these three categories cover 99% of the total end use consumption.

Comparing with national Polish figures Piaseczno has very low energy consumption per inhabitant. And when it comes to CO<sub>2</sub> emissions Piaseczno has only 1/3 of the national level. One main factor is the absence of energy consuming industry. Also, it has not been possible to collect information on the energy consumption in the industry.

Even with the low energy consumption and low CO<sub>2</sub>-emission there is room for improvement. Replacing 78% of the imported electricity by co-generation on natural gas and replacing coal at the heating stations in Piaseczno results in a reduction of CO<sub>2</sub>-emission by 24%.



## Appendix 1: Energy Balance

Location: Piaseczno    Inhabitants: 47306  
 Year: 2003  
 Units: TJ    tons    Number of decimals: 1

Klik her for menu,  
eller tryk Ctrl-g

Geographical Energy Balance, Piaseczno, TJ																																					
Fuel											Plant		Efficiency %			Elec. Grid		DH network		End Use																	
Elimport	LPG and kerosene	Oil	Diesel	Petrol	Natural gas	Coal	Wood pellets	Wood and wood chips	Solar heating	Wind	Biogas	Total	name	electricity	process	Heat	Electricity Grid	District Heating network	ex plant	at consumer	ex plant	at consumer	Total	Domestic hot water	Room heating	Room heating, adjusted	Households, elec.	industry, elec.	Offices	Schools, etc.	Hospitals, elec.	Street lighting, elec	Transport				
													0,0	Gas cooker			38,0							0,0													
													0,0	Electric cooker			44,0	89,5						0,0				0,0									
													0,0	Elec. water heaters			90,0	89,5		-12,0	10,7			9,7	9,7												
													0,0	Elec. radiators			100,0	89,5						0,0		0,0											
													0,0	Heat pumps			250,0	89,5						0,0	0,0	0,0	0,0										
													0,0	Lighting		50,0		89,5		-54,4	48,7			24,3				18,3	0,3	0,5	1,5	0,2	3,6				
													0,0	Cooling machines		150,0		89,5		-36,2	32,4			48,6				47,0	1,1	0,0	0,0	0,5	0,0				
													0,0	Motors, etc.		85,0		89,5		-54,7	48,9			41,6				31,1	6,6	2,1	1,1	0,8	0,0				
													0,0	Wind turbines		100,0								0,0													
157,2													157,2	Import, electricity							157,2			0,0													
													0,0	Solar heating plants			100,0							0,0	0,0	0,0	0,0										
													0,0	Wood pellets boilers			70,0							0,0													
													31,8	Oil boilers			70,0							22,3	4,6	17,6	17,6										
													0,0	Coal boilers			60,0							0,0													
													37,1	Wood boilers			60,0							22,3	4,6	17,6	17,6										
													222,7	Natural gas boilers			80,0							178,2	37,1	141,1	141,1										
													205,3	Piaseczno DH, main boilers			94,0						193,0	0,0													
													360,9	Piaseczno DH, local gas boilers			90,0						324,8	0,0													
													43,2	Piaseczno DH, local coal boilers			70,0						30,3	0,0													
													165,6	Piaseczno DH, local oil boilers			85,0						140,8	0,0													
													0,0	Piaseczno DH, consumption									-688,9	564,9	564,9	117,5	447,4	447,4									
													0,5	Piaseczno DH, wood			70,0						0,3	0,0													
													0,0	Piaseczno DH, LPG			90,0						0,0	0,0													
													0,0	Piaseczno DH, Consumption									-0,3	0,3	0,3	0,1	0,2	0,2									
157,2	0,0	197,5	0,0	0,0	788,9	43,2	0,0	37,6	0,0	0,0	0,0	1224,5	Total									0	141	0	565	912	174	624	624	96	8	3	3	1	4	0	
41,3	0,0	14,6	0,0	0,0	44,9	4,1	0,0	0,0	0,0	0,0	0,0	104,9	CO2-emissions (1000 tons)			2,2 tons/inhabitant						2,2 tons/inhabitant, degree day adjusted															
164,3	0,0	18,6	0,0	0,0	0,0	25,2	0,0	0,6	0,0	0,0	0,0	208,7	SO2-emissions (tons)			4,4 kg/inhabitant						4,4 kg/inhabitant, degree day adjusted															
44,4	0,0	19,7	0,0	0,0	157,8	8,6	0,0	3,3	0,0	0,0	0,0	233,9	NOx-emissions (tons)			4,9 kg/inhabitant						4,9 kg/inhabitant, degree day adjusted															
													0,0	Local Resources			3,1 % Renewable						3,1 % Renewable														
													0,0	utilization of local res. (%)			energy						energy														

Elimport	LPG and kerosene	Oil	Diesel	Petrol	Natural gas	Coal	Wood pellets	Wood and wood chips	Solar heating	Wind	Biogas	
262,5	68,6	73,9	73,9	73,1	56,9	95,0	0,0	0,0	0,0	0,0	0,0	CO2-emission values (tons/TJ)
1,045	0,000	0,094	0,094	0,022	0,000	0,583	0,015	0,015	0,000	0,000	0,000	SO2-emission values (tons/TJ)
0,283	0,100	0,100	1,519	0,731	0,200	0,200	0,089	0,089	0,000	0,000	0,200	NOx-emission values (tons/TJ)

## Appendix 2: Energy Balance with changes

Location: Piaseczno changes  
 Year: 2003  
 Units: TJ tons Number of decimals: 1

Klik her for menu,  
eller tryk Ctrl-g

Geographical Energy Balance, Piaseczno changes, TJ																																			
Fuel											Plant		Efficiency %			Elec. Grid		DH network		End Use															
Elimport	LPG and kerosene	Oil	Diesel	Petrol	Natural gas	Coal	Wood pellets	Wood and wood chips	Solar heating	Wind	Biogas	Total	name	electricity	process	Heat	Electricity Grid	Distric Heating network	ex plant	at consumer	ex plant	at consumer	Total	Domestic hot water	Room heating	Room heating, adjusted	Households, elec.	industry, elec.	Offices	Schools, elec.	Hospitals, elec.	Street lighting, elec	Transport		
												0,0	Gas cooker			38,0							0,0												
												0,0	Electric cooker			44,0	89,5						0,0					0,0							
												0,0	Elec. water heaters			90,0	89,5			-12,0	10,7		9,7	9,7											
												0,0	Elec. radiators			100,0	89,5						0,0		0,0	0,0									
												0,0	Heat pumps			250,0	89,5						0,0	0,0	0,0	0,0									
												0,0	Lighting		50,0		89,5			-54,4	48,7		24,3					18,3	0,3	0,5	1,5	0,2	3,6		
												0,0	Cooling machines		150,0		89,5			-36,2	32,4		48,6				47,0	1,1	0,0	0,0	0,5	0,0	0,0		
												0,0	Motors, etc.		85,0		89,5			-54,7	48,9		41,6				31,1	6,6	2,1	1,1	0,8	0,0			
												34,4	Wind turbines		100,0								0,0												
												34,4	Import, electricity		100,0							34,4		0,0											
												0,0	Solar heating plants			100,0							0,0	0,0	0,0	0,0									
												31,8	Wood pellets boilers			70,0							0,0												
		31,8										31,8	Oil boilers			70,0							22,3	4,6	17,6	17,6									
												0,0	Coal boilers			60,0							0,0												
												37,1	Wood boilers			60,0							22,3	4,6	17,6	17,6									
					222,7							222,7	Natural gas boilers			80,0							178,2	37,1	141,1	141,1									
					350,9							350,9	Piaseczno DH, co-generation	35,0		55,0				122,8		193,0		0,0											
					360,9							360,9	Piaseczno DH, local gas boilers			90,0						324,8		0,0											
											43,2	43,2	Piaseczno DH, local wood pellets boilers			70,0						30,2		0,0											
		165,6										165,6	Piaseczno DH, local oil boilers			85,0						140,8		0,0											
												0,0	Piaseczno DH, consumption					82,0			-888,8	564,8	564,8	117,5	447,4	447,4									
											0,5	0,5	Piaseczno DH, wood			70,0						0,3		0,0											
		0,0										0,0	Piaseczno DH, LPG			90,0						0,0		0,0											
												0,0	Piaseczno DH, Consumption						82,0			-0,3	0,3	0,3	0,1	0,2	0,2								
34,4	0,0	197,5	0,0	0,0	934,5	0,0	43,2	37,6	0,0	0,0	0,0	1247,2	Total							0	141	0	563	912	174	624	624	96	8	3	3	1	4	0	
9,0	0,0	14,6	0,0	0,0	53,2	0,0	0,0	0,0	0,0	0,0	0,0	76,8	CO2-emissions (1000 tons)			1,6 tons/inhabitant																			
36,0	0,0	18,6	0,0	0,0	0,0	0,0	0,6	0,6	0,0	0,0	0,0	55,8	SO2-emissions (tons)			1,2 kg/inhabitant																			
9,7	0,0	19,7	0,0	0,0	186,9	0,0	3,8	3,3	0,0	0,0	0,0	223,6	NOx-emissions (tons)			4,7 kg/inhabitant																			
												0,0	Local Resources			6,5 % Renewable																			
												0,0	utilization of local ress. (%)			energy																			

Elimport	LPG and kerosene	Oil	Diesel	Petrol	Natural gas	Coal	Wood pellets	Wood and wood chips	Solar heating	Wind	Biogas	
262,5	68,6	73,9	73,9	73,1	56,9	95,0	0,0	0,0	0,0	0,0	0,0	CO2-emission values (tons/TJ)
1,045	0,000	0,094	0,094	0,022	0,000	0,583	0,015	0,015	0,000	0,000	0,000	SO2-emission values (tons/TJ)
0,283	0,100	0,100	1,519	0,731	0,200	0,200	0,089	0,089	0,000	0,000	0,200	NOx-emission values (tons/TJ)