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Information technology for spatial greenhouse gas emission inventory ready to use for any part of Poland, and any time period

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GESAPU

Geoinformation technologies, spatio-temporal approaches, and full carbon account for improving accuracy of GHG inventories

Deliverable 1.3. Information technology for spatial greenhouse gas emission inventory ready to use for any part of Poland, and any time period

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Work package 1. Spatially resolved greenhouse gas inventory for Poland

Deliverable 1.3.Information technology for spatial greenhouse gas emission inventory ready to use for any part of Poland, and any time period

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1. Geoinformation technology for spatial GHG inventory: electricity and heat production

The energy sector is one of the largest GHG emission sectors, due to energy economic activity. About 90% of carbon dioxide and 75% of the total emissions in the developed countries come from this sector. The enterprises in this sector usually heavily depend on the fossil fuel, which is used as an energy resource. According to the IPCC methodology (IPCC, 2006), the enterprises in the energy sector, specialized in the electricity production (*Figure 1.1*) are the point sources of the GHG emission. Therefore, it is extremaly important to know their exact power/heat locations. The data on fossil fuel consumption in this category in Poland is available only on a regional or the country level. That is whya methodology and geoinformation technology for spatial inventory of greenhouse gas emissions in this sector have to be developed.

Performing the inventory of GHG emissions at the level of every elementary object in the electricity/heat production category, consists of the following main steps:

- creating an input database;
- creating digital maps of emission sources;
- disaggregation of the statistical data ont fossil fuel consumption by the power/heat plants;
- greenhouse gas emission estimation.

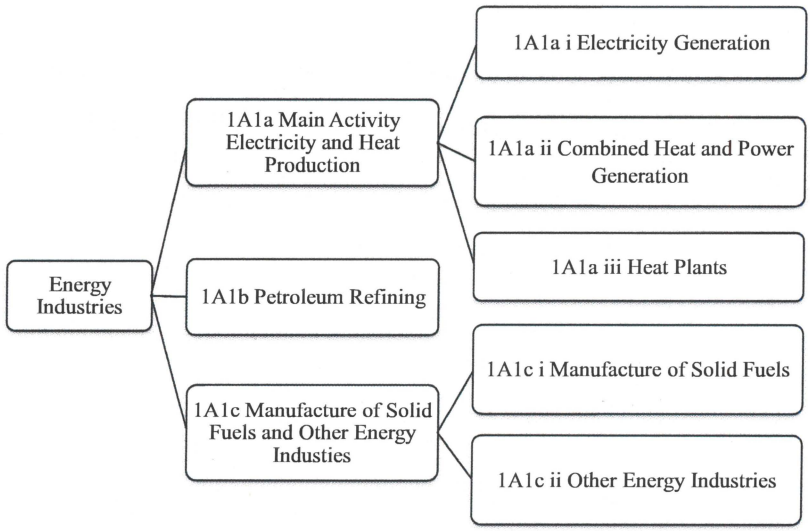


Figure 1.1. The segment structure of the energy sector.

Using the developed methodology of the spatial inventory of GHG emission, the geoinformation technology was built. Its main featureis to use specification parameters that, describe technological processes of the power / heat plants and to createa georeferenced database of GHG emissions. Specific four program modules have been created for each steps of the developed geoinformation technology. Theyinvolvecreation of:(i) statistical input database, (ii) emission sources digital maps, (iii) disaggregation of the statistical data for different levels (country, regional, point source, and square elementary object), and (iv) GHG emission cadasters.

The power / heatproducing is a very specific category. After the analysis of this category it has been decided to split it into two subcategories: power producing, and heat producing. Such subcategories are presented in the statistical data reports (*Table 1.1*, and *Table 1.2*) for each year.

Table 1.1. Consumption of different fuels for power / heat plants ("professional") at the level of voivodeships for the year 2010.

Voivodeships	Number of power plants	Professional (Public)		
		coal, ths tones	natural gas, TJ	brown coal, ths tones
Dolnośląskie	3	997,0	463,0	—
Kujawsko-Pomorskie	4	755,0	0,0	—
Lubelskie	2	355,0	8669,0	—
Lubuskie	2	102,0	13885,0	—
Łódzkie	6	1224,0	0,0	—
Małopolskie	5	3044,0	374,0	—
Mazowieckie	8	9150,0	1057,0	—
Opolskie	3	3265,0	711,0	—
Podkarpackie	5	722,0	8875,0	—
Podlaskie	1	257,0	0,0	—
Pomorskie	3	961,0	337,0	—
Śląskie	24	15588,0	2854,0	—
Świętokrzyskie	3	3626,0	0,0	—
Warmińsko-Mazurskie	1	223,0	0,0	—
Wielkopolskie	6	796,0	368,0	—
Zachodniopomorskie	3	3021,0	0,0	—
Total	**79**	**44087,0**	**37895,0**	**56026,3**

Table 1.2. Consumption of different fuels for the public heat plants at the level of voivodeships for the year 2010.

Voivodeships	Administrative code	Coal, ths tones	Natural gas, TJ	Mazout, ths tones
Dolnośląskie	2	482,0	1033,0	2,0
Kujawsko-Pomorskie	4	469,0	316,0	0,0
Lubelskie	6	330,0	189,0	0,0
Lubuskie	8	43,0	259,0	0,0
Łódzkie	10	342,0	669,0	1,0
Małopolskie	12	342,0	874,0	0,0
Mazowieckie	14	803,0	1767,0	8,0
Opolskie	16	286,0	528,0	0,0
Podkarpackie	18	254,0	343,0	1,0
Podlaskie	20	232,0	195,0	0,0
Pomorskie	22	353,0	866,0	4,0
Śląskie	24	1087,0	1621,0	4,0
Świętokrzyskie	26	283,0	140,0	0,0
Warmińsko-Mazurskie	28	314,0	378,0	2,0
Wielkopolskie	30	298,0	1582,0	3,0
Zachodniopomorskie	32	469,0	810,0	0,0
Total	—	**6387,0**	**11570,0**	**25,0**

The input data includes Excel tables with statistical data and emission factors, and appropriate digital map of the investigated territory. The digital maps of GHG emission sources have been created. The algorithm for constructing the digital maps of electricity generation companies is presented in the block diagram in *Figure 1.2*. The program module that, can build digital map of the point sources (power plants) has been created, using the MapBasic and MapInfo tools. The power plants names and the geographic coordinates are used as input data for this program module. The main part of the program module code is presented below.

```
dim row_id as integer
close all

Register Table "D:\GESAPU_UA\Electricity\EnergyUsing.xls"  TYPE XLS Titles  Range
"EI_Stations!A5:G46"  Interactive Into "D:\GESAPU_UA\Working\E_Station.TAB"
Open Table "D:\GESAPU_UA\Working\E_Station.TAB" Interactive as E_Station
```

```
Select * From E_Station into EI_Station
Commit Table EI_Station As "D:\GESAPU_UA\EI_Station.TAB"

Close Table E_Station

Open Table "D:\GESAPU_UA\EI_Station.TAB" Interactive As EI_Station

Create Map For EI_Station
row_id = 1
Fetch First From EI_Station
While Not EOT (EI_Station)
   Update EI_Station
        Set Obj = CreatePoint( X, Y)
        Where Rowid = row_id
        row_id = row_id + 1
   Fetch Next From EI_Station
Wend

Map From EI_Station
Update EI_Station
Set Obj = CreatePoint( X, Y)
```

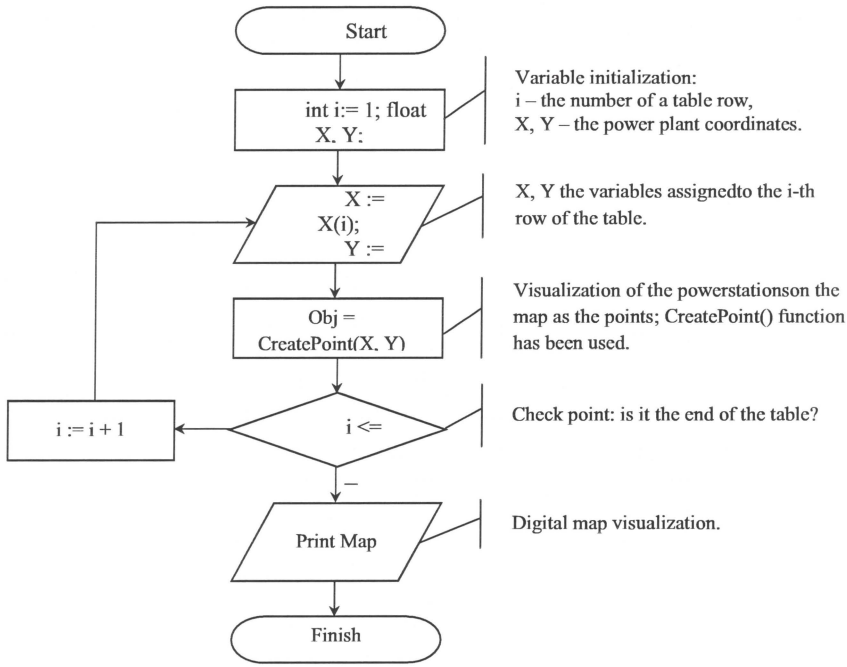
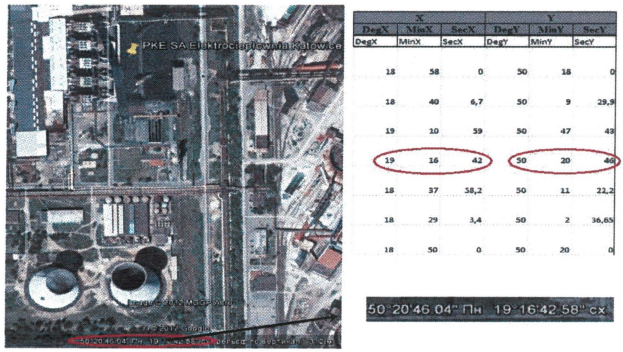


Figure 1.2. Block diagram of the algorithm for constructing digital maps of electricity generation companies.

The power plants producing electricity and heat are considered to be huge point-type sources. We created the database with detailed information on characteristics of these plants. The database includes a set of precise geographic coordinates that, were extracted from web-sources, using the "Google Earth"plug-in. An example of this process is shown in *Figure 1.3*.



X			Y		
DegX	MinX	SecX	DegY	MinY	SecY
DegX	MinX	SecX	DegY	MinY	SecY
18	58	0	50	18	0
18	40	6,7	50	9	29,9
19	10	59	50	47	43
19	16	42	50	20	46
18	37	58,2	50	11	22,2
18	29	3,4	50	2	36,65
18	50	0	50	20	0

Figure 1.3. Extraction of the coordinates of a power / heat plant using the "Google Earth"plug-in.

Naturally, aterritorial distribution of power/heatplantsinPolanddependson economicactivity, and thus it is uneven. For instance, Silesian voivodeship is the main industrial region of the country with numerous power plants.

Based on the coordinates of power plants, a digital map of electricity generation plants was created using the GIS tools (see *Figure 1.4*).

The digital map created (*Figure 1.4*) with information on power plants was the basis for preparation of the georeferenced database of the input data for spatial inventory. Using the digital map, the input statistical data, and thedisaggregation algorithm (*Figure 1.5*), the input database of power / heat plants has been created.

The main feature of the input database created, is the georeferenced data of specific emission sources, which is very important for the spatial GHG emission analysis. Using the created program module,one can create another maps,e.g. on the regional or district level.

The next step is the disaggregation of the statistical data on fossil fuel consumption to the power/heat plants. For this step, it is extremaly important to know the special disaggregation parameters for electricity / heat production category. For example, the plant power and the quantity of generated power are the disaggregation parameters used for the electricity production category. The similar parameters can be used for the heat production category.

The data on fossil fuel consumption was available at a regional level (*Table 1.1* and *Table 1.2*) and was linked with a map of Polish regions. The imported Excel tables contain the important statistical data, which characterize theactivities in power / heat category, and are essential for the greenhouse gas emission inventory.In particular, they involve:

- consumption of fossil fuel for individual administrative units;
- statistical information, such as available power of the electricity generation plant, quantity of the electricity / heat generation;
- table with the data ont net calorific values for various fossil fuels;
- table with greenhouse gas emission factors.

Figure 1.4. Map of power / heat plants of Poland as point-type emission sources.

Fossil fuels are disaggregated from the regional level to the level of elementary objects (power / heat plants) proportionally to their electricity / heat productionorthe power of electricity / heat plants. Information on the amount of fuel consumed by individual electricity / heat generating plants,was also taken into account.

The final step is the GHG emission estimation. The greenhouse gas emissions were estimated, using the disaggregated data on fossil fuel consumption, calorific values, and emission coefficients.

The calorific values of fossil fuels depend on the fuel type and its chemical characteristics, and vary by region.

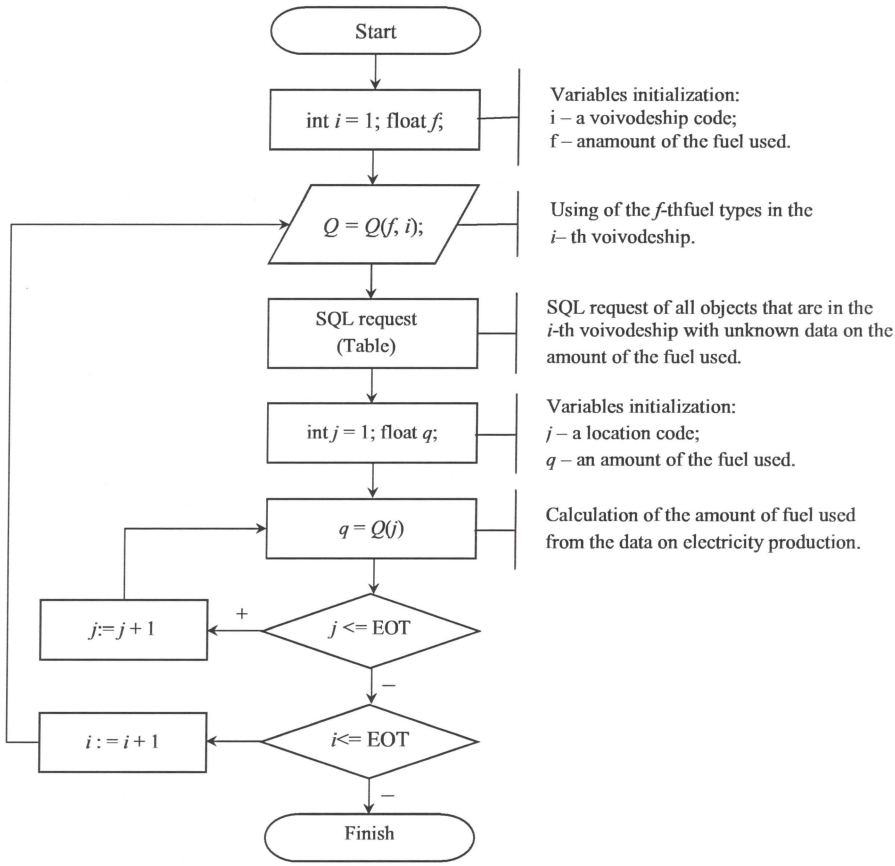


Figure 1.5. Block diagram of the disaggregation algorithm of the statistical data on the fuel used for electricity generation in Poland.

Usingthe statistical data for 2010, we conducted numerical experiments,basing on this information technology. As the result, we obtained the estimation of the greenhouse gas emissions at the level of elementary objects (power / heat plants) for 2010. The georeferenced database contains information about carbon dioxide, methane, and nitrous oxide emissions from burning every kind of fossil fuel in the electricity / heat producing category, as well as the total greenhouse gas emissions in CO_2-equivalent. Every elementary object from the digital map is linked to the

exact row of the georeferenced database, which contains information about greenhouse gas emissions.

The georeferenced database contains the results of the GHG emission inventory, disaggregated fossil fuels consumption, and the emissions of CO_2, CH_4, and N_2O from combustion of each fossil fuel. The results may be presented in the form of thematic maps,using the GIS-tools.

As an example, the results of the spatial inventory of GHG emissions for Silesian (Śląskie) voivodeship, as the main industrial region of the country,are presented in *Figure 1.6*. The geo-referenced database for geographic elementary objects (electricity generating plants) of Silesianvoivodeship contains the amounts of GHG emissions from burning of natural and liquid gas, wood, coal, and other fossil fuels (see *Table 1.3* and *Table 1.4,* as an example, and also Deliverable 1.2).The similar results were obtained for the heat generating plants (see *Table 1.5* for the Silesian voivodeship, as an example).

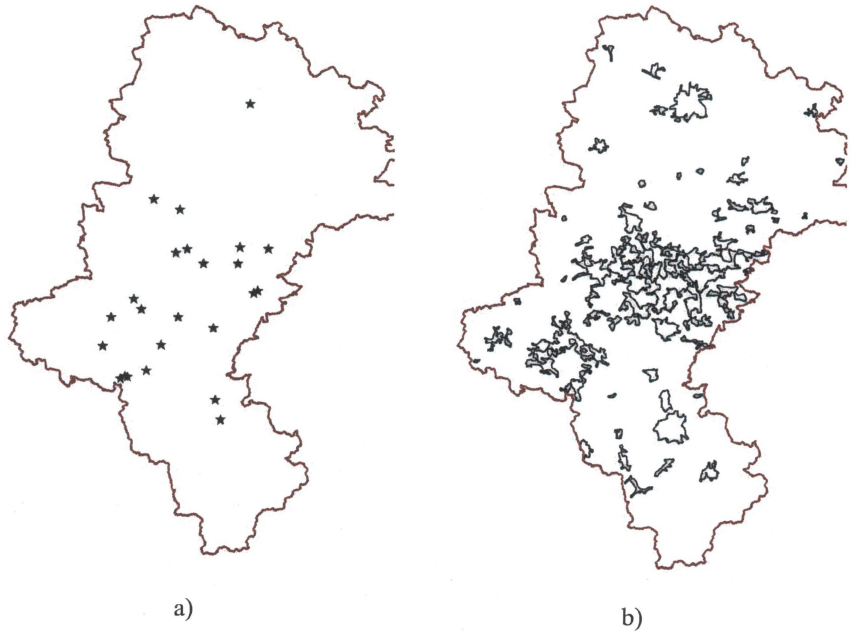


Figure 1.6. GHG emission sources of the Silesian voivodeship (a – electricity generating plants; b – heat generating sources).

Table 1.3.GHG emissions of power/heat stations, using coal as the main fuel ("professional") in Silesian voivodeship.

Power / Heat Station	Voivodeships	Location	Emissions, t			
			CO_2	CH_4	N_2O	Total
Elektrownia Rybnik SA	Śląskie	Rybnik	11 213 269,04	118,15	177,22	11 270 688,16
PKE SA Elektrownia Jaworzno III	Śląskie	Jaworzno	3 602 579,30	37,96	56,94	3 621 026,81
PKE SA Elektrownia Łaziska	Śląskie	Łaziska Grn.	2 748 583,56	28,96	43,44	2 762 658,07
PKE SA Elektrownia Łagisza	Śląskie	Będzin	1 998 969,86	21,06	31,59	2 009 205,87
PKE SA Elektrownia Jaworzno II	Śląskie	Jaworzno	1 236 346,53	13,03	19,54	1 242 677,42
PKE SA Elektrociepłownia Katowice	Śląskie	Katowice	1 092 294,25	11,51	17,26	1 097 887,49
Elektrociepłownia Marcel Sp. z o.o.	Śląskie	Radlin	563 995,07	5,94	8,91	566 883,08
Elektrociepłownia Chorzów "ELCHO" Sp. z o.o.	Śląskie	Chorzów	485 464,11	5,11	7,67	487 950,00
PKE SA Elektrownia Halemba	Śląskie	Ruda Śl.	475 945,20	5,01	7,52	478 382,35
Elektrociepłownia Będzin SA	Śląskie	Będzin	185 618,63	1,95	2,93	186 569,12
PKE SA Zespół Elektrociepłowni Bielsko-Biała EC1	Śląskie	Bielsko Biała	183 238,90	1,93	2,89	184 177,20
Elektrociepłownia Zabrze SA	Śląskie	Zabrze	175 861,75	1,85	2,78	176 762,28
PKE SA Elektrociepłownia Bielsko - Północ EC2	Śląskie	Czechowice Dziedzice	130 884,93	1,37	2,07	131 555,15
Elektrociepłownia Tychy SA	Śląskie	Tychy	95 189,04	1,00	1,50	95 676,47
Elektrociepłownia Szombierki SA, Zespół Elektrociepłowni Bytom SA	Śląskie	Bytom	20 941,59	0,22	0,33	21 048,82
Elektrociepłownia Knurów Sp. z o.o., Przedsiębiorstwo Energetyczne Megawat Sp. z o.o.	Śląskie	Czerwionka Leszczyny	9 518,90	0,10	0,15	9 567,65

Table 1.4.GHG emissions from power / heat plants, using natural gas as the main fuel ("professional").

Power / Heat Station	Voivode-ship	Location	Emissions, t			
			CO_2	CH_4	N2O	Total
Spółka Energetyczna Jastrzębie SA, Elektrociepłownia Zofiówka	Śląskie	Jastrzębie Zdr.	105 044,32	1,22	1,44	105 516,00
Elektrociepłownia Zofiówka SA, Spółka Energetyczna Jastrzębie SA	Śląskie	Jastrzębie Zdr.	89 637,82	1,04	1,23	90 040,32
Spółka Energetyczna Jastrzębie SA, Elektrociepłownia Moszczenica	Śląskie	Jastrzębie Zdr.	78 858,78	0,87	1,17	79 239,28
Spółka Energetyczna Jastrzębie SA, Elektrociepłownia Pniówek	Śląskie	Pniówek	4 340,99	0,08	0,01	4 345,04
Spółka Energetyczna Jastrzębie SA, Elektrociepłownia Suszec	Śląskie	Suszec	3 498,08	0,06	0,01	3 501,34
Elektrociepłownia Dębiensko Sp. z o.o., Przedsiębiorstwo Energetyczne Megawat Sp. z o.o.	Śląskie	Czerwionka Leszczyny	3 108,54	0,03	0,01	3 123,40

Table 1.5. Part of the georeferenced database with the results of the spatial inventory of GHG emissions in the heat producing category (Silesian voivodeship); columns are described in *Table 1.6.*

ID_TERYT	Nazwa	Used_heat	Used_coal	Used_n_gas	Used_oil	Em_CO_2	Em_CH_4	Em_N_2O	Total emissions
2461011	Bielsko Biała	1832516.00	68.6342	102.351	0.252564	148302.85	1.62903	2.26066	149017.26
2414011	Bierun Stary	13095.07	0.490456	0.731398	0.00180481	1059.76	0.011641	0.0161546	1064.87
2404014	Blachownia	34140.93	34140.926	1.90687	0.00470542	2762.98	0.0303498	0.0421176	2776.29
2462011	Bytom	1315449.00	49.2682	73.4717	0.1813	106457.37	1.16938	1.62279	106970.2
2401011	Będzin	366109.03	13.7121	20.4483	0.0504584	29628.67	0.325455	0.451646	29771.4
2463011	Chorzów	37189.00	1.39286	2.07711	0.00512551	3009.65	0.0330594	0.0458778	3024.15
2403011	Cieszyn	137122.77	5.13573	7.65871	0.0188987	11097.15	0.121896	0.16916	11150.6
2402044	Czechowice Dziedzice	98335.19	3.683	5.49231	0.0135529	7958.12	0.0874157	0.12131	7996.46
2401021	Czeladź	214702.58	8.04137	8.041365	0.029591	17375.57	0.190861	0.264865	17459.27
2464011	Częstochowa	4077.00	0.152698	0.227712	0.000561906	329.946	0.00362428	0.00502954	331.535
2465011	Dąbrowa Górnicza	2155222.00	80.7206	120.375	0.29704	174418.98	1.9159	2.65876	175259.19
2466011	Gliwice	2197630.00	82.309	122.744	0.302885	177851.00	1.9536	2.71108	178707.74
2414021	Imielin	5214.39	0.195297	0.291239	0.000718665	421.993	0.00463537	0.00643268	424.026
2467011	Jastrzębie Zdr.	2794149.00	104.651	156.061	0.385099	226126.41	2.48388	3.44697	227215.71

2468011	Jaworzno	855208.00	32.0305	47.7659	0.117868	69210.74	0.760243	1.05502	69544.14
2413011	Kalety	13943.10	0.522218	0.778763	0.00192169	1128.40	0.0123948	0.0172007	1133.83
2469011	Katowice	5843319.00	218.853	326.367	0.805346	472891.30	5.19446	7.20854	475169.31
2405011	Knurów	11066.62	0.414484	0.618103	0.00152524	895.606	0.00983775	0.0136522	899.92
2404064	Koniecpol	21806.07	0.816714	1.21793	0.00300539	1764.73	0.0193847	0.0269008	1773.23
2409024	Koziegłowy	1163.27	0.0435684	0.0649719	0.000160325	94.1415	0.00103409	0.00143505	94.595
2411034	Krzanowice	49.392	0.00184991	0.00275869	6.80738e-006	3.99723	4.39074e-005	6.09319e-005	4.01648
2411054	Kuźnia Racib.	126.055	0.0047212	0.00704054	1.73733e-005	10.2014	0.000112057	0.000155506	10.2506
2407011	Lubliniec	1037.71	0.0388657	0.0579589	0.00014302	83.98	0.000922476	0.00128015	84.3846
2414031	Lędziny	10729.54	0.401859	0.599276	0.00147878	868.326	0.0095381	0.0132364	872.509
2413021	Miasteczko Śl.	11924.34	0.446609	0.66601	0.00164345	965.02	0.0106002	0.0147103	969.669
2408021	Mikołów	111359.22	4.17079	6.21974	0.0153479	9012.14	0.0989935	0.137377	9055.55
2409011	Myszków	15405.70	0.576998	0.860454	0.00212327	1246.76	0.013695	0.0190051	1252.77
2470011	Mysłowice	126075.00	4.72195	7.04166	0.0173761	10203.07	0.112075	0.155531	10252.22
2416064	Ogrodzieniec	20610.21	0.771925	1.15114	0.00284057	1667.95	0.0183216	0.0254256	1675.99
2408031	Orzesze	54346.70	2.03547	3.03542	0.00749025	4398.2	0.0483119	0.0670442	4419.39
2471011	Piekary Śl.	420344.00	15.7434	23.4774	0.0579332	34017.83	0.373668	0.518553	34181.7
2416074	Pilica	8923.92	0.334232	0.498427	0.00122992	722.2	0.00793298	0.0110089	725.678

2416011	Poręba	40350.02	1.51125	2.25367	0.00556118	3265.47	0.0358694	0.0497773	3281.2
2410054	Pszczyna	58117.00	2.17669	3.246	0.00800988	4703.32	0.0516635	0.0716954	4725.98
2415011	Pszów	34110.87	1.27757	1.90519	0.00470128	2760.54	0.0303231	0.0420805	2773.84
2405021	Pyskowice	5327.45	0.199532	0.297554	0.000734248	431.143	0.00473587	0.00657215	433.22
2411011	Racibórz	1305.55	0.0488975	0.072919	0.000179936	105.657	0.00116058	0.00161058	106.165
2415021	Radlin	42952.71	1.60873	2.39904	0.00591989	3476.1	0.0381831	0.0529881	3492.85
2413031	Radzionków	27923.20	1.04582	1.55959	0.00384847	2259.78	0.0248225	0.0344471	2270.67
2472011	Ruda Śl.	1803617.00	67.5518	100.737	0.248581	145964.1	1.60334	2.22501	146667.24
2473011	Rybnik	159762.00	5.98365	8.92318	0.0220189	12929.31	0.142022	0.197089	12991.59
2415031	Rydułtowy	53250.38	1.99441	2.97419	0.00733915	4309.48	0.0473373	0.0656917	4330.24
2474011	Siemianowice Śl.	95498.00	3.57674	5.33384	0.0131619	7728.51	0.0848936	0.11781	7765.74
2401074	Siewierz	34699.91	1.29963	1.93809	0.00478246	2808.21	0.0308467	0.0428071	2821.74
2403104	Skoczów	56137.97	2.10256	3.13547	0.00773713	4543.16	0.0499042	0.069254	4565.05
2475011	Sosnowiec	2187568.00	81.9321	122.182	0.301498	177036.69	1.94465	2.69867	177889.51
2405064	Sosnicowice	491.076	0.0183925	0.027428	6.76817e-005	39.742	0.000436545	0.00060581	39.9335
2403114	Strumień	13082.28	0.489977	0.730684	0.00180304	1058.73	0.0116296	0.0161388	1063.83
2416084	Szczekociny	18122.70	0.678759	1.01221	0.00249773	1466.64	0.0161103	0.0223569	1473.71
2402011	Szczyrk	16385.91	0.61371	0.915201	0.00225836	1326.09	0.0145664	0.0202143	1332.48

2401081	Sławków	42538.60	1.59322	2.37591	0.00586281	3442.59	0.037815	0.0524773	3459.17
2413041	Tarnowskie Góry	99033.35	3.70915	5.53130	0.0136491	8014.62	0.0880364	0.122171	8053.23
2405074	Toszek	1119.85	0.0419424	0.062547	0.000154342	90.628	0.0009955	0.00138149	91.0645
2477011	Tychy	1611577.00	60.3592	90.0113	0.222113	130422.58	1.43262	1.9881	131050.85
2403021	Ustroń	58537.97	2.19245	3.26952	0.0080679	4737.39	0.0520377	0.0722147	4760.21
2402094	Wilamowice	7879.90	0.29513	0.440116	0.00108603	637.709	0.00700489	0.00972095	640.781
2403031	Wisła	43481.01	1.62852	2.42854	0.0059927	3518.85	0.0386527	0.0536398	3535.81
2415041	Wodzisław Śl.	120444.04	4.51105	6.72715	0.0166	9747.36	0.10707	0.148584	9794.32
2401031	Wojkowice	59482.89	2.22784	3.32229	0.00819813	4813.86	0.0528777	0.0733804	4837.05
2407084	Woźniki	188.294	0.00705228	0.0105168	2.59514e-005	15.2384	0.000167385	0.000232287	15.3118
2478011	Zabrze	3078581.00	115.304	171.948	0.424301	249145.08	2.73673	3.79786	250345.26
2416021	Zawiercie	244441.07	9.15518	13.6528	0.0336897	19782.26	0.217298	0.301552	19877.56
2476011	Świętochłowice	182.00	0.00681654	0.0101652	2.50839e-005	14.729	0.00016179	0.000224522	14.7999
2408011	Łaziska Grn.	63904.08	2.39343	3.56923	0.00880748	5171.66	0.056808	0.0788345	5196.58
2416054	Łazy	33176.08	1.24256	1.85298	0.00457244	2684.89	0.0294921	0.0409273	2697.83
2409054	Żarki	2047.03	0.0766685	0.114333	0.000282129	165.663	0.00181972	0.0025253	166.461
2479011	Żory	30652.00	1.14802	1.712	0.00422456	2480.62	0.0272483	0.0378135	2492.57
2417011	Żywiec	144289.00	5.40413	8.05896	0.0198864	11677.1	0.128267	0.178	11733.35

Table 1.6. Explanation of columns in Table 1.5 (heat producing).

Column name	Explanation
ID_TERYT	elementary object ID
Nazwa	name of the locality
Used_heat	amount of heat producing (TJ)
Used_coal	amount of coal consumed (thousand ton)
Used_n_gas	amount of natural gas consumed (TJ)
Used_oil	amount of fuel oil consumed (TJ)
Em_CO2	CO_2 emissions from burning coal, natural gas, and fuel oil (ton)
Em_CH4	CH_4 emissions from burning coal, natural gas, and fuel oil (ton)
Em_N2O	N_2O emissions from burning coal, natural gas, and fuel oil (ton)
Total	GHG emissions from heat producing in CO_2-equivalent (ton)

References

BDL, 2014. Bank Danych Lokalnych, Warszawa, Główny Urząd Statystyczny. Available online at: http://www.stat.gov.pl/bdl/

EMEP, 2007. EMEP/CORINAIR Emission Inventory Guidebook – 2007. Technical Report No. 16, Copenhagen, Denmark: European Environment Agency. Available online at: http://reports.eea.europa.eu/EMEPCORINAIR5/en/page002.html

Galelo F.J., 2010. A population density grid of the European Union. Popul Environ, 31:460–473, DOI 10.1007/s11111-010-0108-y

Gospodarka, 2010. Gospodarka paliwowo-energetyczna w latach 2008, 2009: Informacje i opracowania statystyczne, Warszawa, Główny Urząd Statystyczny, 2010, 369.

GUS (2012) Local database, Central Statistical Office, Poland, http://www.stat.gov.pl/bdl/app/strona.html?p_name=indeks

Hamal Kh., 2008. Carbon dioxide emissions inventory with GIS, Artificial Intelligence (Iskusstvenniy intellekt, Donieck, Ukraine), no. 3, 55-62.

IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Eggleston H.S., Buendia L., Miwa K., Ngara T., Tanabe K. (eds), IPCC, IGES, Japan, 2006.

NIR, 2011. Poland's National Inventory report 2011: Greenhouse Gas Inventory for 1988-2009. National Centre for Emission Management at the Institute of Environmental Protection – National Research Institute, Warszawa, May 2011. Available online at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php.

NIS, 2012. National Inventory Submissions: 2003-2012, UNFCCC, http://unfccc.int / national_reports / annex_i_ghg_ inventories / national_ inventories_ submissions /items/6598.php

Rocznik, 2010. Rocznik statystyczny województw, Warszawa: Główny Urząd Statystyczny, 814.

Transport, 2011. Transport – wyniki działalności w 2010 r.: Informacje i opracowania statystyczne, Warszawa, Główny Urząd Statystyczny, 268.

Zużycie, 2010. Zużycie paliw i nośników energii w 2009 r, Warszawa, Główny Urząd Statystyczny, 15.