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**Analysis of emissions' territorial
distribution for individual
subcategories and greenhouse
gases. Deliverable 1.2**

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

Deliverable 1.2. Analysis of emissions' territorial distribution for individual subcategories and greenhouse gases

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Work package 1. Spatially resolved greenhouse gas inventory for Poland

Deliverable 1.2. Analysis of emissions' territorial distribution for individual subcategories and greenhouse gases

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1. Analysis of emissions' territorial distribution for Energy sector: stationary sources

Analysis of emissions' territorial distribution for Energy sector is based on geodatabases with information on sources of corresponding emissions, and thematic maps of GHG emissions for energy-related activities.

Electricity and heat production

One of the main features of energy/heat production in Poland is its high dependence on coal (*Table 1.1., Figures 1.1., 1.2.*). Śląskie voivodeship is the main industrial Polish region characterized by large concentration of located heat/power plants (*Figure 1.3.*).

Most of the heat/power plants use coal as the main fuel (*Table 1.2.*), less of them use natural gas (*Table 1.3.*), and just few brown coal (*Table 1.4.*). In Tables 1.2-1.4 heat/power plants are sorted by emissions: from the largest to the smallest one.

Table 1.1. GHG emissions (CO₂ equivalent) from electricity and heat production in Polish voivodeships (2010)

Voivodeships	Coal emission		Natural gas emission,		Brown coal emission	
	t	%	t	%	t	%
Dolnośląskie	1 670 759.4	1.7	26 037.3	1.2	0.0	0.0
Kujawsko-Pomorskie	1 565 381.3	1.6	0.0	0.0	0.0	0.0
Łódzkie	2 817 873.5	2.9	0.0	0.0	65 995.2	55.2
Lubelskie	67 285.7	0.1	487 509.9	23.1	0.0	0.0
Lubuskie	227 985.6	0.2	780 836.9	36.9	0.0	0.0
Małopolskie	6 388 681.6	6.7	21 032.3	1.0	0.0	0.0
Mazowieckie	19 140 374.0	20.0	59 441.4	2.8	0.0	0.0
Opolskie	7 426 069.8	7.8	39 983.8	1.9	0.0	0.0
Podkarpackie	1 633 806.6	1.7	499 094.5	23.6	0.0	0.0
Podlaskie	575 028.3	0.6	0.0	0.0	0.0	0.0
Pomorskie	2 083 564.6	2.2	18 951.5	0.9	0.0	0.0
Śląskie	34 913 623.1	36.5	160 497.5	7.6	0.0	0.0
Świętokrzyskie	8 372 863.9	8.8	0.0	0.0	0.0	0.0
Warmińsko-Mazurskie	330 402.7	0.3	0.0	0.0	0.0	0.0
Wielkopolskie	1 685 346.8	1.8	20 694.8	1.0	53 647.0	44.8
Zachodniopomorskie	6 815 242.1	7.1	0.0	0.0	0.0	0.0
Total	95 714 289.0	100.0	2114079.9	100.0	119 642.2	100.0



Figure 1.1. GHG emissions from electricity/heat production, 2010, 10^3 tons of $CO_2eq.$

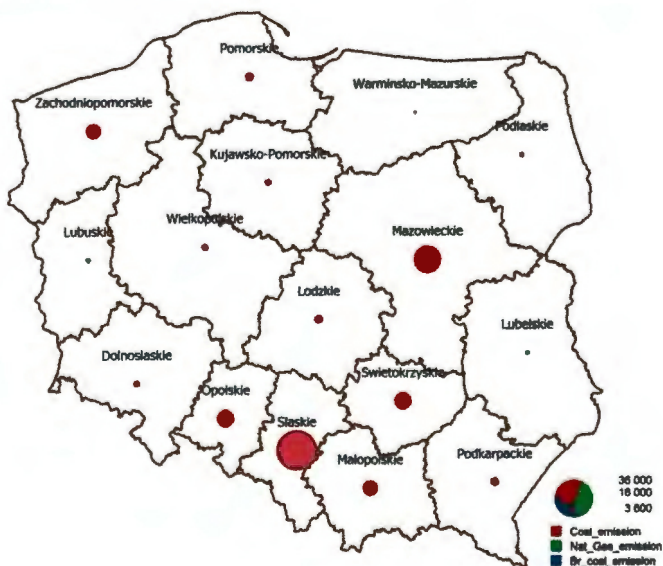


Figure 1.2. GHG emissions from electricity/heat production by fossil fuel burned (coal, natural gas, brown coal), 2010, 1000t of $CO_2eq.$

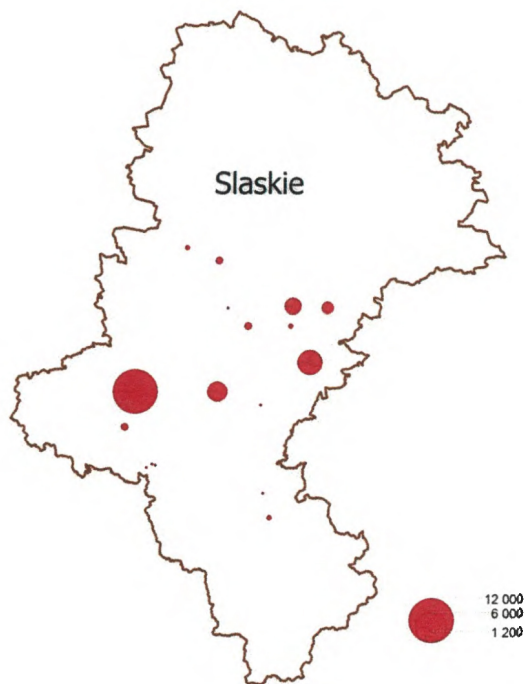


Figure 1.3. GHG emissions from electricity/heat production by fossil fuel burned (coal, natural gas, brown coal) in Śląskie voivodeship, 2010, 1000 t of CO₂.

Table 1.2. GHG emissions of heat/power plants that use coal as the main fuel

Power / Heat Station	Voivodeships	Location	Emission, t			
			CO ₂	CH ₄	N ₂ O	Total
Andropol - Elektrociepłownia Sp. z o.o.	Małopolskie	Andrychów	18 022.38	0.19	0.28	18 114.67
BOT Elektrownia Opole SA	Opolskie	Dobrzeń Wlk.	6 353 724.08	66.94	100.42	6 386 259.22
BOT Elektrownia Turów SA	Dolnośląskie	Bogatynia	518 165.05	5.46	8.19	520 818.39
Elektrociepłownia Będzin SA	Śląskie	Będzin	185 618.63	1.95	2.93	186 569.12
Elektrociepłownia Białystok SA	Podlaskie	Białystok	120 704.86	1.27	1.90	121 322.95
Elektrociepłownia Chorzów "ELCHO" Sp. z o.o.	Śląskie	Chorzów	485 464.11	5.11	7.67	487 950.00
Elektrociepłownia Czechnica SA, Zespół Elektrociepłowni Wrocławskich KOGENERACJA SA	Dolnośląskie	Siechnice	88 575.22	0.93	1.40	89 028.78
Elektrociepłownia Elbląg Sp. z o.o.	Warmińsko-Mazurskie	Elbląg	43 116.37	0.45	0.68	43 337.16
Elektrociepłownia Gdańsk EC2 SA	Pomorskie	Gdańsk	884 665.31	9.32	13.98	889 195.36
Elektrociepłownia Gdynia EC3 SA	Pomorskie	Gdynia	565 142.75	5.95	8.93	568 036.64
Elektrociepłownia Gorzów SA	Lubuskie	Gorzów Wlkp.	21 530.85	0.23	0.34	21 641.11
Elektrociepłownia Huty Częstochowa, Zakład Elektroenergetyczny H. Cz. ELSEN Sp. z o.o.	Śląskie	Częstochowa	0.00	0.00	0.00	0.00
Elektrociepłownia Janikowo, Elektrociepłownie Kujawskie Sp. z o.o.	Kujawsko-Pomorskie	Janikowo	0.00	0.00	0.00	0.00
Elektrociepłownia Kalisz-Piwonice SA	Wielkopolskie	Kalisz	3 349.45	0.04	0.01	3 366.60

Elektrociepłownia Kielce	Świętokrzyskie	Kielce	31 395.72	0.33	0.50	31 556.49
Elektrociepłownia Knurów Sp. z o.o., Przedsiębiorstwo Energetyczne Megawat Sp. z o.o.	Śląskie	Czerwonka Leszczyny	9 518.90	0.10	0.15	9 567.65
Elektrociepłowni Kraków Leg, Elektrociepłownia Kraków SA	Małopolskie	Kraków	663 223.58	6.99	10.48	666 619.71
Elektrociepłownia Łódź 2 SA, Zespół Elektrociepłowni w Łodzi SA	Łódzkie	Łódź	470 749.84	4.96	7.44	473 160.38
Elektrociepłownia Łódź 3 SA, Zespół Elektrociepłowni w Łodzi SA	Łódzkie	Łódź	749 290.39	7.89	11.84	753 127.25
Elektrociepłownia Łódź 4 SA, Zespół Elektrociepłowni w Łodzi SA	Łódzkie	Łódź	684 134.71	7.21	10.81	687 637.92
Elektrociepłownia Marcel Sp. z o.o.	Śląskie	Radlin	563 995.07	5.94	8.91	566 883.08
Elektrociepłownia Mątwy, Elektrociepłownię Kujawskie Sp. z o.o.	Kujawsko-Pomorskie	Inowrocław	232 063.49	2.44	3.67	233 251.81
Elektrociepłownia Miechowice SA, Zespół Elektrociepłowni Bytom SA	Śląskie	Bytom	0.00	0.00	0.00	0.00
Elektrociepłownia OPEC Grudziądz Sp. z o.o.	Kujawsko-Pomorskie	Grudziądz	185 216.10	1.95	2.93	186 164.52
Elektrociepłownia Ostrołęka A Zespół Elektrowni Ostrołęka SA	Mazowieckie	Ostrołęka	68 419.37	0.72	1.08	68 769.72
Elektrociepłownia Pomorzany SA, Zespół Elektrowni Dolna Odra SA	Zachodniopomorskie	Szczecin	299 129.68	3.15	4.73	300 661.41
Elektrociepłownia Poznań – Karolin SA, Zespół Elektrociepłowni Poznańskich SA	Wielkopolskie	Poznań	115 556.15	1.22	1.83	116 147.87

Elektrociepłownia Pruszków SA, Vattenfall Heat Poland SA	Mazowieckie	Pruszków	16 603.10	0.17	0.26	16 688.12
Elektrociepłownia PZL – Mielec Sp. z o.o.	Podkarpackie	Mielec	21 445.29	0.23	0.34	21 555.10
Elektrociepłownia Rzeszów S. A.	Podkarpackie	Rzeszów	89 501.62	0.94	1.41	89 959.92
Elektrociepłownia Siekierki SA, Vattenfall Heat Poland SA	Mazowieckie	Warszawa	1 134 849.27	11.96	17.93	1 140 660.43
Elektrociepłownia Starachowice	Świętokrzyskie	Starachowice	125 165.67	1.32	1.98	125 806.60
Elektrociepłownia Szczecin SA, Zespół Elektrowni Dolna Odra SA	Zachodniopomorskie	Szczecin	196 150.61	2.07	3.10	197 155.02
Elektrociepłownia Szombierki SA, Zespół Elektrociepłowni Bytom SA	Śląskie	Bytom	20 941.59	0.22	0.33	21 048.82
Elektrociepłownia Świdnik Sp. z o.o. Elektrociepłownia GIGA Sp. z o.o.	Lubelskie	Świdnik	14 919.95	0.16	0.24	14 996.35
Elektrociepłownia Tychy SA	Śląskie	Tychy	95 189.04	1.00	1.50	95 676.47
Elektrociepłownia Wrocław SA, Zespół Elektrociepłowni Wrocławskich - Kogeneracja SA	Dolnośląskie	Wrocław	129 418.24	1.36	2.04	130 080.95
Elektrociepłownia WSK – Rzeszów Sp. z o.o.	Podkarpackie	Rzeszów	10 529.60	0.11	0.17	10 583.52
Elektrociepłownia Zabrze SA	Śląskie	Zabrze	175 861.75	1.85	2.78	176 762.28
Elektrociepłownia Zduńska Wola Sp. z o.o.	Łódzkie	Zduńska Wola	7 199.70	0.08	0.11	7 236.57
Elektrociepłownia Zielona Góra SA	Lubuskie	Zielona Góra	48 891.60	0.51	0.77	49 141.96
Elektrociepłownia Żerań SA,	Mazowieckie	Warszawa	638 580.78	6.73	10.09	641 850.72

Vattenfall Heat Poland SA						
Elektrownia Adamów SA	Wielkopolskie	Turek	251 209.02	2.65	3.97	252 495.37
Elektrownia Dolna Odra SA	Zachodniopomorskie	Krajnik	4 083 499.02	43.02	64.54	4 104 409.15
Elektrownia Konin SA	Wielkopolskie	Konin	204 316.67	2.15	3.23	205 362.90
Elektrownia Kozienice SA	Mazowieckie	Kozienice	5 145 136.57	54.21	81.32	5 171 482.96
Elektrownia Ostrołęka B Zespół Elektrowni Ostrołęka SA	Mazowieckie	Ostrołęka	1 180 462.18	12.43	18.66	1 186 506.91
Elektrownia Ostrołęka SA	Mazowieckie	Ostrołęka	1 180 462.18	12.43	18.66	1 186 506.91
Elektrownia Pątnów SA	Wielkopolskie	Konin	502 418.03	5.29	7.94	504 990.73
Elektrownia Połaniec	Świętokrzyskie	Połaniec	6 258 283.71	65.94	98.91	6 290 330.13
Elektrownia Rybnik SA	Śląskie	Rybnik	11 213 269.04	118.15	177.22	11 270 688.16
Elektrownia Skawina SA	Małopolskie	Skawina	829 029.48	8.73	13.10	833 274.64
Elektrownia Stalowa Wola SA	Podkarpackie	Stalowa Wola	307 113.40	3.23	4.85	308 686.01
Energetyka Ciepła Opolszczyzny S. A., Elektrociepłownia Opolszczyzna	Opolskie	Opole	41 473.39	0.44	0.65	41 685.77
Energetyka DWORY Sp. z o.o., Elektrociepłownia Oświęcim	Małopolskie	Oświęcim	937 163.76	9.87	14.81	941 962.63
PKE SA Elektrociepłownia Bielsko - Południe EC2	Śląskie	Czechowice Dziedzice	130 884.93	1.37	2.07	131 555.15
PKE SA Elektrociepłownia Katowice	Śląskie	Katowice	1 092 294.25	11.51	17.26	1 097 887.49
PKE SA Elektrownia Halemba	Śląskie	Ruda Śl.	475 945.20	5.01	7.52	478 382.35
PKE SA Elektrownia Jaworzno II	Śląskie	Jaworzno	1 236 346.53	13.03	19.54	1 242 677.42
PKE SA Elektrownia Jaworzno III	Śląskie	Jaworzno	3 602 579.30	37.96	56.94	3 621 026.81
PKF SA Elektrownia Łagisza	Śląskie	Będzin	1 998 969.86	21.06	31.59	2 009 205.87

PKE SA Elektrownia Łaziska	Śląskie	Łaziska Grn.	2 748 583.56	28.96	43.44	2 762 658.07
PKE SA Elektrownia Siersza	Małopolskie	Trzebinia	1 087 056.09	11.45	17.18	1 092 622.52
PKE SA Zespół Elektrociepłowni Bielsko-Biała EC1	Śląskie	Bielsko Biała	183 238.90	1.93	2.89	184 177.20
Przedsiębiorstwo Energetyczne w Siedlcach Sp. z o.o., Elektrociepłownia Siedlce	Mazowieckie	Siedlce	326 588.45	3.44	5.16	328 260.80
Zespół Elektrociepłowni Bydgoszcz SA	Kujawsko-Pomorskie	Bydgoszcz	118 280.68	1.25	1.87	118 886.35

Table 1.3. GHG emissions of heat/power plants that use natural gas as the main fuel

Power / Heat Station	Voivodeships	Location	Emission, t			
			CO ₂	CH ₄	N ₂ O	Total
Elektrociepłownia Dębieńsko Sp. z o.o., Przedsiębiorstwo Energetyczne Megawat Sp. z o.o.	Śląskie	Czerwionka Leszczyny	3 108.54	0.03	0.01	3 123.40
Elektrociepłownia Energobaltic Sp. z o.o.	Pomorskie	Gdańsk	7 135.34	0.13	0.01	7 141.98
Elektrociepłownia Lublin - Wrotków Sp. z o.o.	Lubelskie	Lublin	142 084.84	2.46	0.42	142 266.65
Elektrociepłownia Nowa Sarzyna Sp. z o.o.	Podkarpackie	Sarzyna Nowa	308 960.70	5.53	0.55	309 248.52
Elektrociepłownia Zofiówka SA,	Śląskie	Jastrzębie Zdr.	89 637.82	1.04	1.23	90 040.32

Spółka Energetyczna Jastrzębie SA						
PKE SA Elektrownia Blachownia	Opolskie	Kędzierzů Kozle Cisowa	80 322.84	1.14	0.71	80 567.66
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
Spółka Energetyczna Jastrzębie SA, Elektrociepłownia Zosiówka	Śląskie	Jastrzębie Zdr.	105 044.32	1.22	1.44	105 516.00

Table 1.4. GHG emissions of heat/power plants that use brown coal as the main fuel

Power / Heat Station	Voivodeships	Location	Emission, t			
			CO ₂	CH ₄	N ₂ O	Total
BOT Elektrownia Bełchatów SA	Łódzkie	Bełchatów	29 055.59	0.27	0.40	29 186.92
Elektrownia Pątnów II	Wielkopolskie	Konin	23 715.65	0.22	0.33	23 822.83
Elektrociepłownia Boruta Sp. z o.o.	Łódzkie	Zgierz	14 900.97	0.16	0.24	14 977.20

Residential sector

According to the obtained results of GHG inventory in the residential sector, the largest GHG emissions are observed in Polish cities, especially in Southern Poland. The largest specific emissions (per square km) are observed in Katowice, the center of the largest conurbation in Poland and one of the largest in the European Union, with a population of about 2.7 million.

The Katowice urban area consists of about 40 cities and towns. However, the whole Silesian metropolitan area consists of over 50 large settlements (both cities and towns). This metropolitan area has a population of about 5 millions. The amount of natural gas burned depends on population density, human needs (cooking, space, and water heating), and access to gas supply network. That is why the GHG emissions in this area are the highest in Poland.

The largest specific GHG emissions from burning coal are observed in Warszawa, Katowice, Kraków, and in the surrounding areas. The liquefied gas burned in residential sector is used evenly all over the territory of Poland; however, the largest specific emissions are observed in the cities with high population.

Around 30% of total GHG emissions in residential sector in Poland are emitted in Śląskie and Mazowieckie voivodeships.

In all the voivodeships the total amount of GHG emissions from burning coal exceeds the total amount of GHG emissions from burning other fuels.

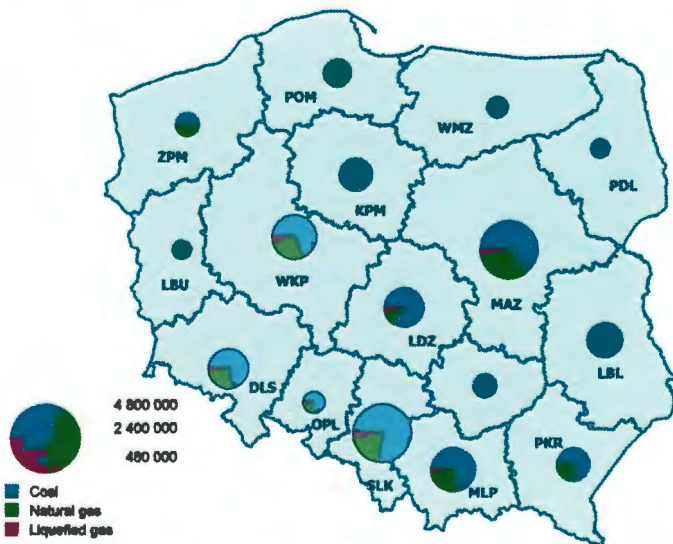


Figure 1.4. Structure of GHG emissions in CO₂eq. by type of fossil fuel burned in residential sector for voivodeships (tons, Poland, 2009).



Figure 1.5. Specific CO₂ emissions in residential sector (ton/sq.km., Poland, 2009).

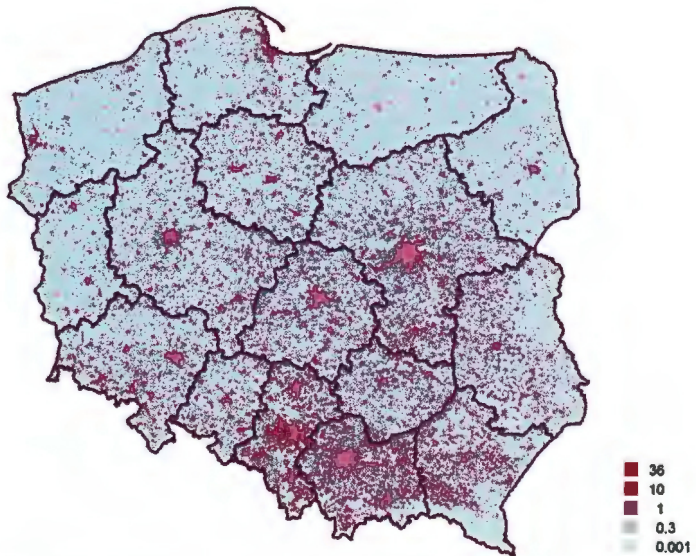


Figure 1.6. Specific CH₄ emissions in residential sector (ton/sq.km., Poland, 2009).

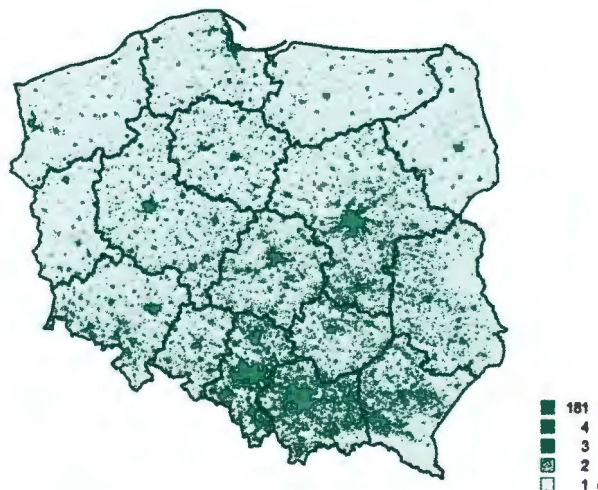


Figure 1.7. Specific N₂O emissions in residential sector (kg/sq.km., Poland, 2009).

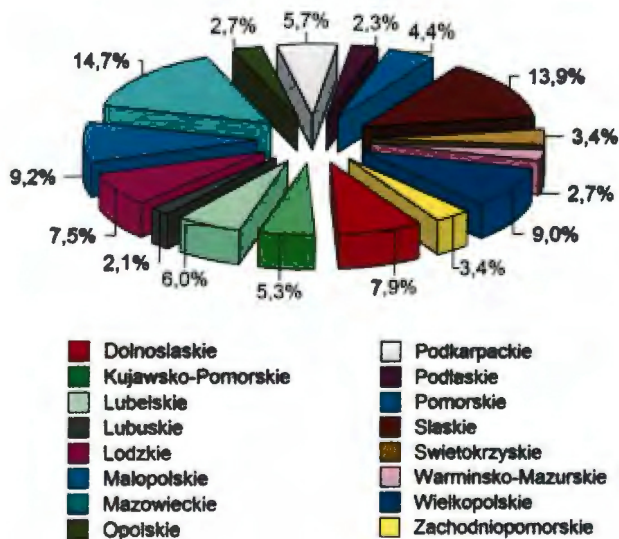


Figure 1.8. Contribution of each voivodeship to the total emissions in residential sector (% of total emissions in residential sector, Poland, 2009).

Manufacturing industries and construction

Emissions from fossil fuel burned in manufacturing industries and construction (iron and steel, non-ferrous metals, chemicals, pulp, paper and print, food processing, beverages and tobacco; products such as glass, ceramic, cement, etc; transport equipment, machinery, textile and leather, construction, etc) can be divided into point sources (large enterprises) and area sources (industrial areas in the city).

Table 1.5. Carbon dioxide emissions from burning fossil fuels for manufacturing industries and construction needs in Podlaskie voivodeship of Poland (kg, 2009)

City	Carbon dioxide (CO ₂) emissions			
	Coal	Natural gas	Liquefied gas	Mazout
Białystok	175035868.2	41896983	2616285.74	9302637.08
Bielsk	18538933.6	4437521.264	277104.049	985289.319
Hajnówka	15167196.3	3630454.548	226706.216	806091.482
Mocki	6809556.7	1629950.952	101783.401	361907.734
Siemiatycze	10492582.5	2511528.372	156834.106	557649.628
Sokółka	11035483.3	2641478.349	586503.196	586503.196
Grajewo	14638119.1	3503813.431	218798.025	777972.599
Kolno	7402643.1	1771913.46	110648.347	393428.516
Wysokie Mazowieckie	6537572.5	1564848.198	97718.0154	347452.581
Zambrów	15708304.6	3759975.468	234794.238	834849.784
Łomża	44523377.3	10657216.74	665497.184	2366285.41
Augustów	19896529.9	4762478.582	297396.23	1057441.53
Sejny	3764350.2	901043.4199	56266.2723	200064.046
Suwałki	45601982.9	10915394.22	681619.253	2423610.1

Table 1.6. Methane emissions from burning fossil fuels for manufacturing industries and construction needs in Podlaskie voivodeship of Poland (kg, 2009)

City	Methane (CH ₄) emissions			
	Coal	Natural gas	Liquefied gas	Mazout
Augustów	2389.7	84.9	4.6	31.9
Białystok	21022.7	746.8	40.8	280.5
Bielsk	2226.6	79.1	4.3	29.7
Grajewo	1758.1	62.5	3.4	23.5
Hajnówka	1821.7	64.7	3.5	24.3
Końno	889.1	31.6	1.7	11.9
Łomża	5347.5	190.0	10.4	71.3
Mocki	817.9	29.1	1.6	10.9
Sejny	452.1	16.1	0.9	6.0
Siemiatycze	1260.2	44.8	2.4	16.8
Sokółka	1325.4	47.1	2.6	17.7
Suwałki	5477.0	194.6	10.6	73.1
Wysokie Mazowieckie	785.2	27.9	1.5	10.5
Zambrów	1886.7	67.0	3.7	25.2

Table 1.7. Emissions of nitrous oxide from burning fossil fuels for manufacturing industries and construction needs in Podlaskie voivodeship of Poland (kg, 2009)

City	Emissions of nitrous oxide (N ₂ O)			
	Coal	Natural gas	Liquefied gas	Mazout
Augustów	345.57	8.49	0.46	52.22
Białystok	3040.10	74.68	4.08	459.42
Bielsk	321.99	7.91	0.43	48.66
Grajewo	254.24	6.25	0.34	38.42
Hajnówka	263.43	6.47	0.35	39.81
Kolno	128.57	3.16	0.17	19.43
Łomża	773.30	19.00	1.04	116.86
Mocki	118.27	2.91	0.16	17.87
Sejny	65.38	1.61	0.09	9.88
Siemiatycze	182.24	4.48	0.24	27.54
Sokółka	191.67	4.71	0.26	28.97
Suwałki	792.03	19.46	1.06	119.69
Wysokie Mazowieckie	113.55	2.79	0.15	17.16
Zambrów	272.83	6.70	0.37	41.23

Table 1.8. Methane emissions from burning fossil fuels for manufacturing industries and construction needs in Lubelskie voivodeship of Poland (kg, 2009)

City	Methane (CH ₄) emissions			
	Coal	Natural gas	Liquefied gas	Mazout
Biała Podlaska	19	1766	2.60	20.4
Bilgoraj	11	1004	1.48	11.6
Chełm	27	2509	3.69	29.0
Hrubieszów	8	761	1.12	8.8
Janów Lubelski	6	547	0.80	6.3
Kraśnik	19	1804	2.65	20.8
Krasnystaw	8	771	1.13	8.9
Łęczna	6	514	0.75	5.9
Lubartów	7	657	0.96	7.6
Lublin	112	10395	15.27	120.1
Opole Lubelskie	5	429	0.63	5.0
Parczew	3	308	0.45	3.6
Puławy	28	2601	3.82	30.1
Radzyń Podlaski	5	465	0.68	5.4
Ryki	6	543	0.80	6.3
Świdnik	13	1176	1.73	13.6
Tomaszów Lubelski	8	777	1.14	9.0
Włodawa	5	423	0.62	4.9
Zamość	25	2343	3.44	27.1
Juków	16	1516	2.23	17.5

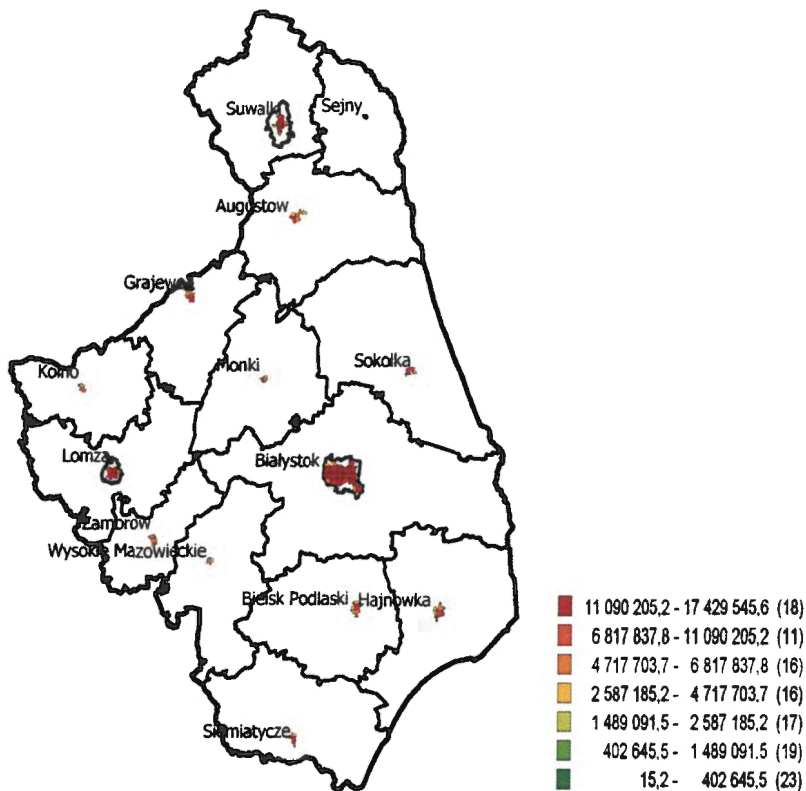


Figure 1.9. GHG emissions from burning fossil fuels for manufacturing industries and construction needs in Podlaskie voivodeship of Poland (tones of CO₂eq., 2009).

