



CERC



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Pilot air quality modelling study for Elektrėnai

Pilot study report

July 31, 2006
Vilnius

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1. Summary

In order to quantify the impact of emissions to air from Elektrėnai power plant, Elektrėnai, situated approximately 50km to the west of Vilnius, dispersion modelling of all emissions from the site was carried out using the ADMS 3 model (version 3.3.1.0). The dispersion modelling and results obtained are fully described in this report.

Emissions to air from all stacks were taken into account simultaneously in the dispersion modelling.

Modelling was carried out using a year of hourly sequential meteorological data obtained from the Vilnius site for 2005. The meteorological site is located approximately 50km east of the power plant site and so these data will give a very good representation of the meteorological conditions at the site.

The modelling was carried out to predict the process contribution (PC) to the ground level concentrations of all pollutants emitted from the site, for comparison with Air Quality Limit values.

1.1 Predicted concentrations of NO₂

There are no exceedences of either of the air quality limit values for NO_x.

The maximum predicted annual average NO_x concentration is 2.5µg/m³, 6% of the 40µg/m³ limit value for NO₂. The maximum predicted 99.79th percentile of hourly average NO_x is 191µg/m³, 96% of the 200µg/m³ limit value for NO₂.

1.2 Predicted concentrations of SO₂

There are no exceedences of the Air Quality Limit values for SO₂.

The maximum 99.73rd percentile of hourly average SO₂ PC is 348µg/m³, 99% of the 350µg/m³ limit value.

The maximum 99.18th percentile of 24-hour average SO₂ PC is 81µg/m³, 65% of the 125µg/m³ limit value.

1.3 Predicted concentrations of CO

Neither the predicted 8-hour average PC of CO nor the maximum predicted annual average PC of CO is significant.

1.4 Predicted concentrations of PM₁₀

Neither the predicted 8-hour average PC of PM₁₀ nor the maximum predicted annual average PC of PM₁₀ is significant.

2. Introduction

A dispersion modelling study was carried out, using ADMS 3.3 (version 3.3.1.0), to assess the environmental impact of all emissions to air from the Elektrėnai power plant, Elektrėnai.

Section 3 presents the air quality standards with which the modelled results are to be compared. Details of the study, including a description of the site, are given in Section 4. Section 5 describes the site layout and emissions. The meteorological data input to the modelling are described in Section 6. Section 7 presents predicted concentrations for comparison with limit values for the protection of human health. A discussion of the implications of all of the modelling results is provided in Section 8.

3. Air Quality Standards

The EU Air Quality Limit values (EQOs) for nitrogen dioxide (NO₂), sulphur dioxide (SO₂) carbon monoxide (CO) and particulate matter (PM₁₀) are summarised in Table 3.1. The year by which each limit value is to be achieved is also shown in the table. The limit values are set for the protection of human health and take into account the effects of each pollutant on the health of those who are most sensitive to air quality.

Many of the Air Quality Limit values are specified in terms of the number of times during a year that a concentration measured over a short period of time (for example, 1 hour or 24 hours, as appropriate) is permitted to exceed a specified value. For example, the concentration of NO₂ measured as the average value recorded over a one-hour period is permitted to exceed the concentration of 200µg/m³ up to 18 times per year. Any more exceedences than this during a one-year period would represent a breach of the limit value.

It is convenient to model limit values of this form in terms of the equivalent percentile concentration value. A percentile is the concentration below which lie a specified percentage of concentration measurements. For example, consider the 98th percentile of one-hour concentrations over a year. Taking all of the 8760 one-hour concentration values that occur in a year, the 98th percentile value is the concentration below which 98% of those concentrations lie. Or, in other words, it is the concentration exceeded by 2% (100 – 98) of those hours, that is, 175 hours per year. Taking the NO₂ limit value considered above, allowing 18 exceedences per year is equivalent to not exceeding for 8742 hours or for 99.79% of the year. This is therefore equivalent to the 99.79th percentile value.

Table 3.1: EU Air Quality Standards for Air Pollutants – Protection of Human Health

Substance	Limit value	Reference period and allowed exceedences	Date to be met
NO ₂	200µg/m ³	hourly mean not to be exceeded more than 18 times a year (modelled as 99.79 th percentile)	2010
	40µg/m ³	annual mean	2010
SO ₂	350µg/m ³	1 hour average (not to be exceeded more than 24 times a year, assumed equivalent to a 99.73 rd percentile)	2005
	125µg/m ³	24 hour average (not to be exceeded more than 3 times per year, assumed equivalent to a 99.18 th percentile)	2005
CO	10mg/m ³	maximum daily running 8 hour mean	2005
PM ₁₀	50µg/m ³	24 hour average (not to be exceeded more than 35 times per year, assumed equivalent to a 90.41 st percentile)	2005
	40µg/m ³	annual mean	2005

4. Study area

4.1 Site location and surrounding area

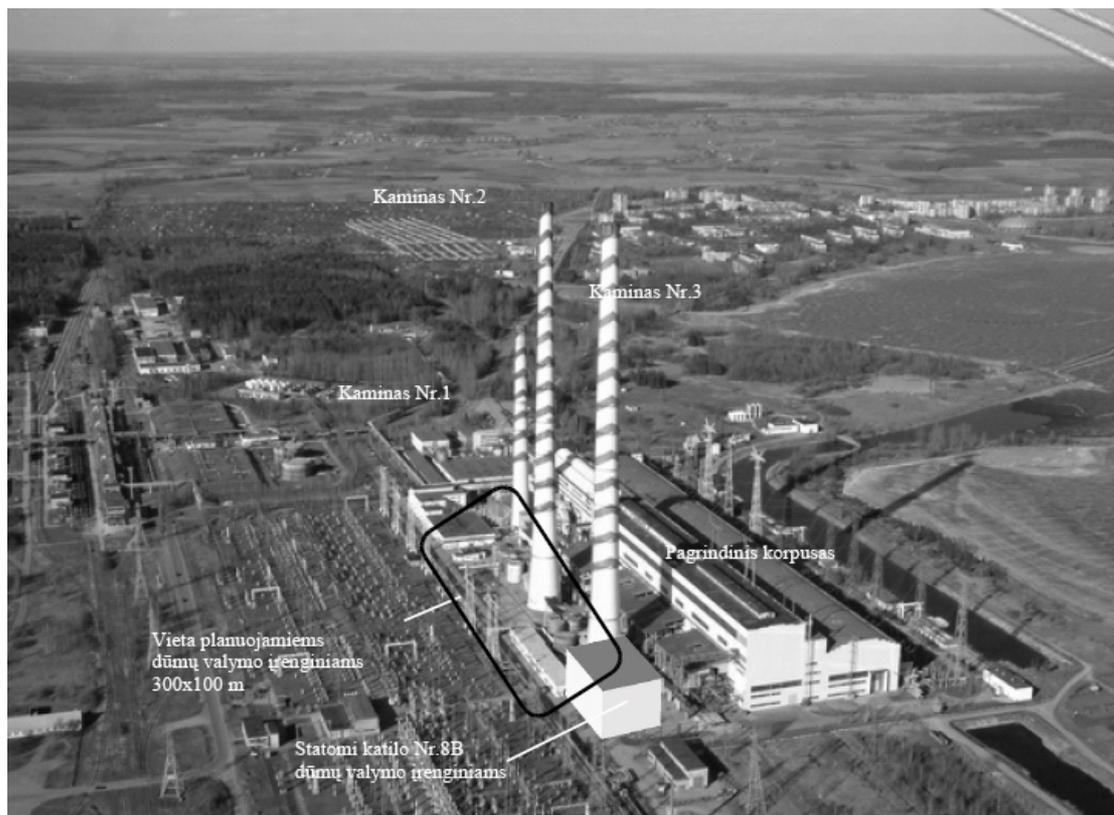
Elektrėnai power plant is located in Elektrėnai, approximately 50km west of Vilnius. Figure 4.1 shows the site location and Figure 4.2 shows the locations of the stacks within the site.

A surface roughness length is used in the model to characterise the surrounding area in terms of the effects it will have on wind speed and turbulence, which are key components of the modelling. A value of 0.2 metres was used in this study, which represents an agricultural area and reflects the land use surrounding the site

Figure 4.1. Location of Elektrėnai power plant



Figure 4.2. Locations of the power plant stacks



5. Power plant site and emissions

5.1 Site layout and modelled stacks

Three sources were included in the modelling. Table 5.1 gives the parameters of the three modelled sources.

Both long and short term impacts were modelled by applying a time varying profile to the emissions from the sources. The emissions vary both throughout the year and diurnally.

5.2 Emissions data

Emissions data were supplied for the following pollutants: oxides of nitrogen (NO_x), sulphur dioxide (SO₂) particulate matter (PM₁₀) and carbon monoxide (CO).

Table 5.2 presents the emissions rates of the pollutants for the three stacks.

Table 5.1: Modelled stack parameters

Stack name	Location (x,y)	Height (m)	Diameter (m)	Efflux velocity (m/s)	Efflux temperature (°C)
Chimney 1	541610, 6070500	150	7	13.8	125
Chimney 2	541610, 6070600	250	6.5	32	125
Chimney 3	541630, 6070760	250	8	20.9	125

Table 5.2: Typical emission rates (g/s)

Stack name	Emission rates			
	NO _x (as NO ₂)	SO ₂	CO	PM ₁₀
Chimney 1	775	2927	121	1.85
Chimney 2	134	506	20.9	1.00
Chimney 3	47.9	181	7.44	1.00

6. Meteorological data

Modelling was carried out using a year of hourly sequential meteorological data obtained from the Vilnius site for 2005. The data were provided as three-hourly values and have been interpolated to give an hourly sequential dataset.

The meteorological site is located approximately 50km east of the power plant site and so these data will give a very good representation of the meteorological conditions at the site.

The hours of meteorological data used in the analysis exclude hours of calm, hours of variable wind direction and unavailable data.

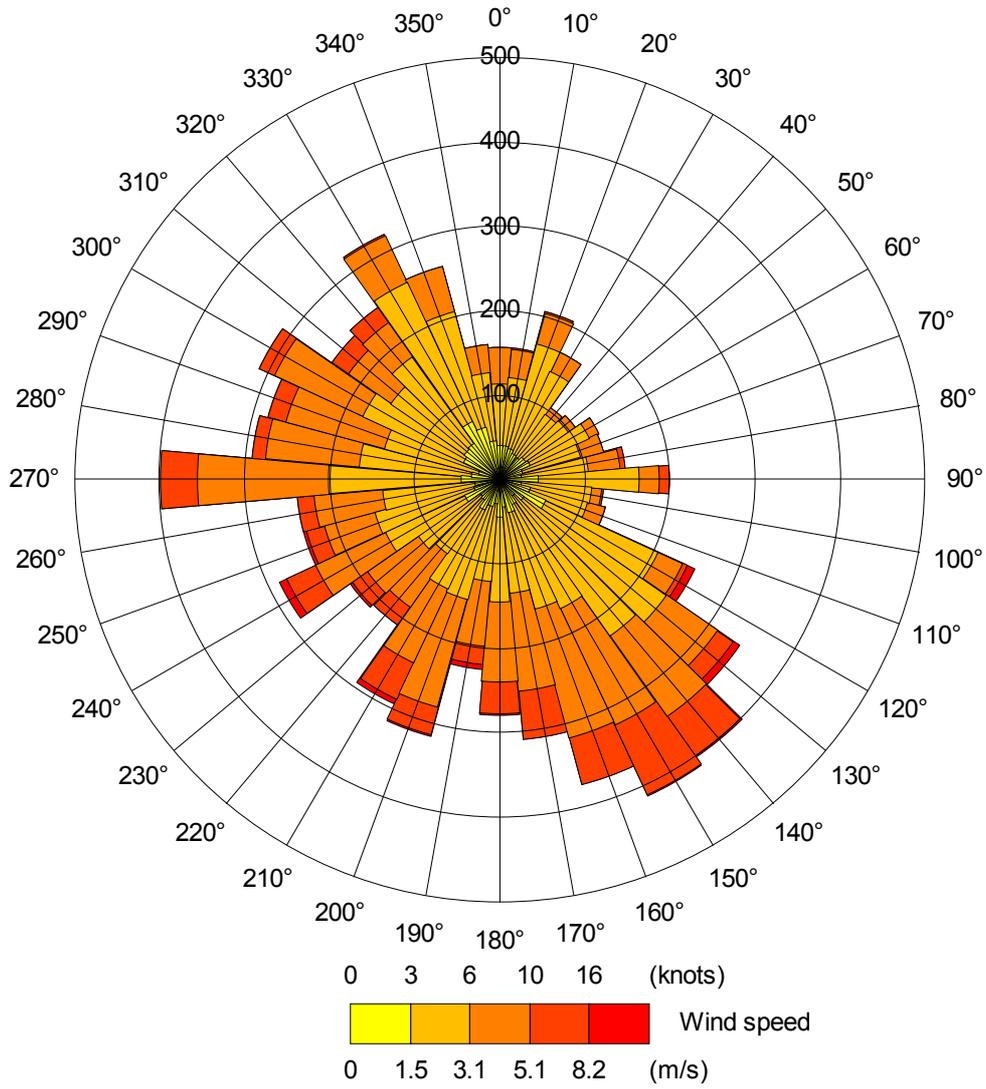
A summary of the data provided is given below in Table 6.1.

Table 6.1: Summary of meteorological data

	Percentage used	Parameter	Minimum	Maximum	Mean
2005	96.0	Temperature (°C)	-22	30.8	6.8
		Wind speed (m/s)	0	13.0	3.0
		Cloud cover (oktas)	0	8	5

The ADMS meteorological pre-processor, written by the UK Meteorological Office, uses these data to calculate the parameters required by the program. Figure 6.1 shows a wind rose for the site giving the frequency of occurrence of wind from different directions for a number of wind speed ranges, for 2005.

Figure 6.1: Wind rose for Vilnius, 2005



7. Consideration of limit values for the protection of human health

Concentrations were calculated on an output grid encompassing the entire area of any predicted exceedences, with a receptor spacing of 800m.

Modelling was carried out to predict the Process Contribution (PC) to the ground level concentrations of each pollutant from the power plant site. The significance of the total pollutant release was assessed by comparing the PC to the relevant Air Quality Limit value (AQO).

7.1 Predicted concentrations of NO_x

NO_x comprises NO and NO₂, and only NO₂ poses a threat to human health.

The PC to NO₂ concentrations cannot be directly calculated, as the NO₂ concentration depends on the concentrations of NO_x due to other sources in the area and the chemical reactions taking place to oxidise NO to NO₂. Instead, the PC to NO_x concentrations has been calculated; when compared against the limit values for NO₂, this value is an overestimate of the true PC of NO₂.

The maximum predicted PC to concentrations of total NO_x are presented in Table 7.1, together with the locations at which they occur.

There are no exceedences of either of the air quality limit values for NO_x.

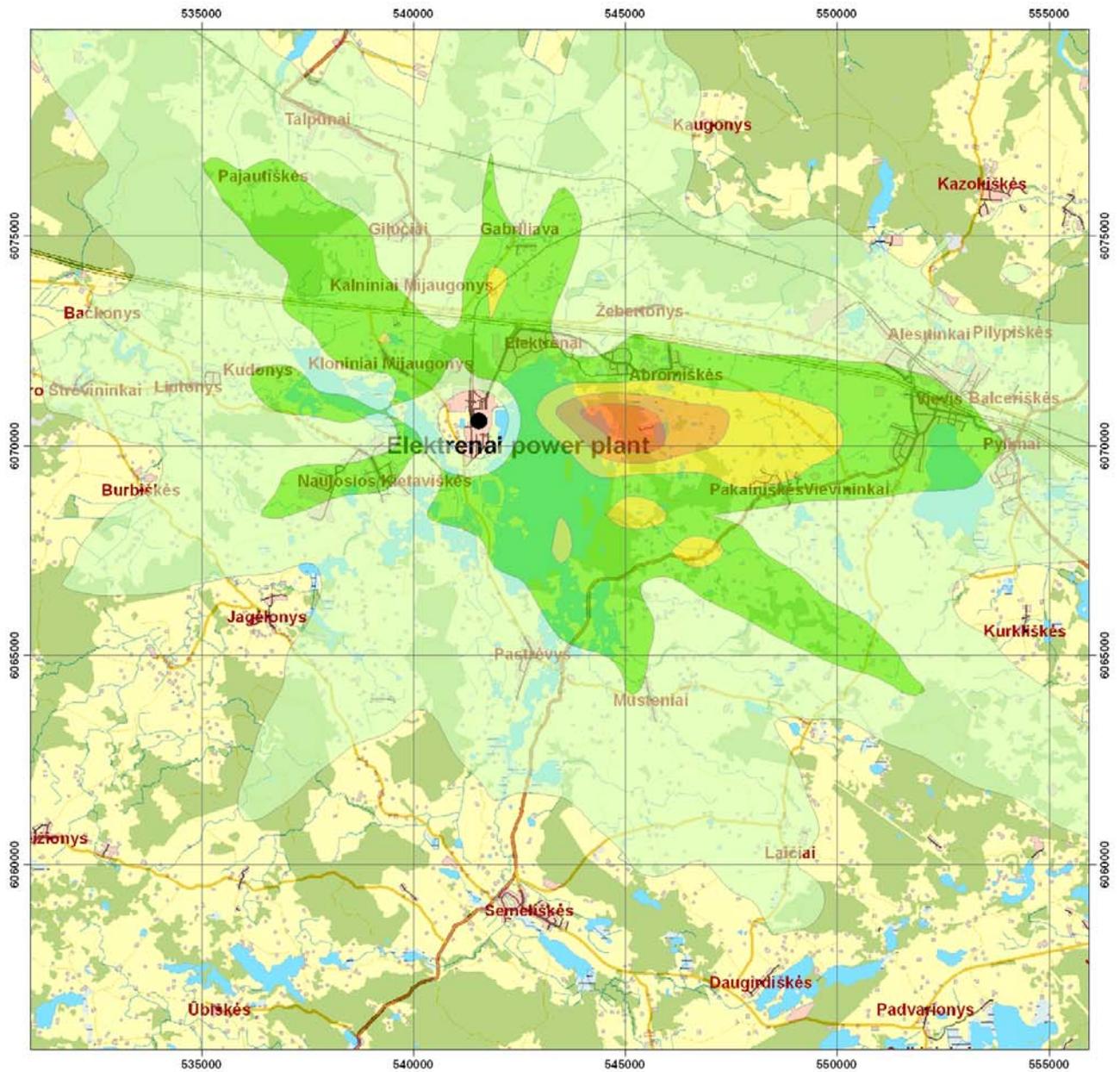
The maximum predicted annual average NO_x concentration is 2.5µg/m³, 6% of the 40µg/m³ limit value for NO₂. The maximum predicted 99.79th percentile of hourly average NO_x is 191µg/m³, 96% of the 200µg/m³ limit value for NO₂. As mentioned above, these values are an overestimate of the true PC of NO₂.

Figures 7.1 and 7.2 show the 99.79th percentile of hourly average PC and the annual average PC of NO_x

Table 7.1: Maximum predicted concentrations of NO_x (µg/m³)

Year	Limit value	Measured as	Limit value value (NO ₂)	PC (total NO _x)	% of limit value	x, y
2005	Short-term AQO	99.79th percentile of hourly averages	200	191	96	545167, 6070834
	Long-term AQO	Annual average	40	2.5	6	544333, 6070000

Figure 7.1: 99.79th percentile of hourly average PCs of NO_x



Legend

Concentration ($\mu\text{g}/\text{m}^3$)



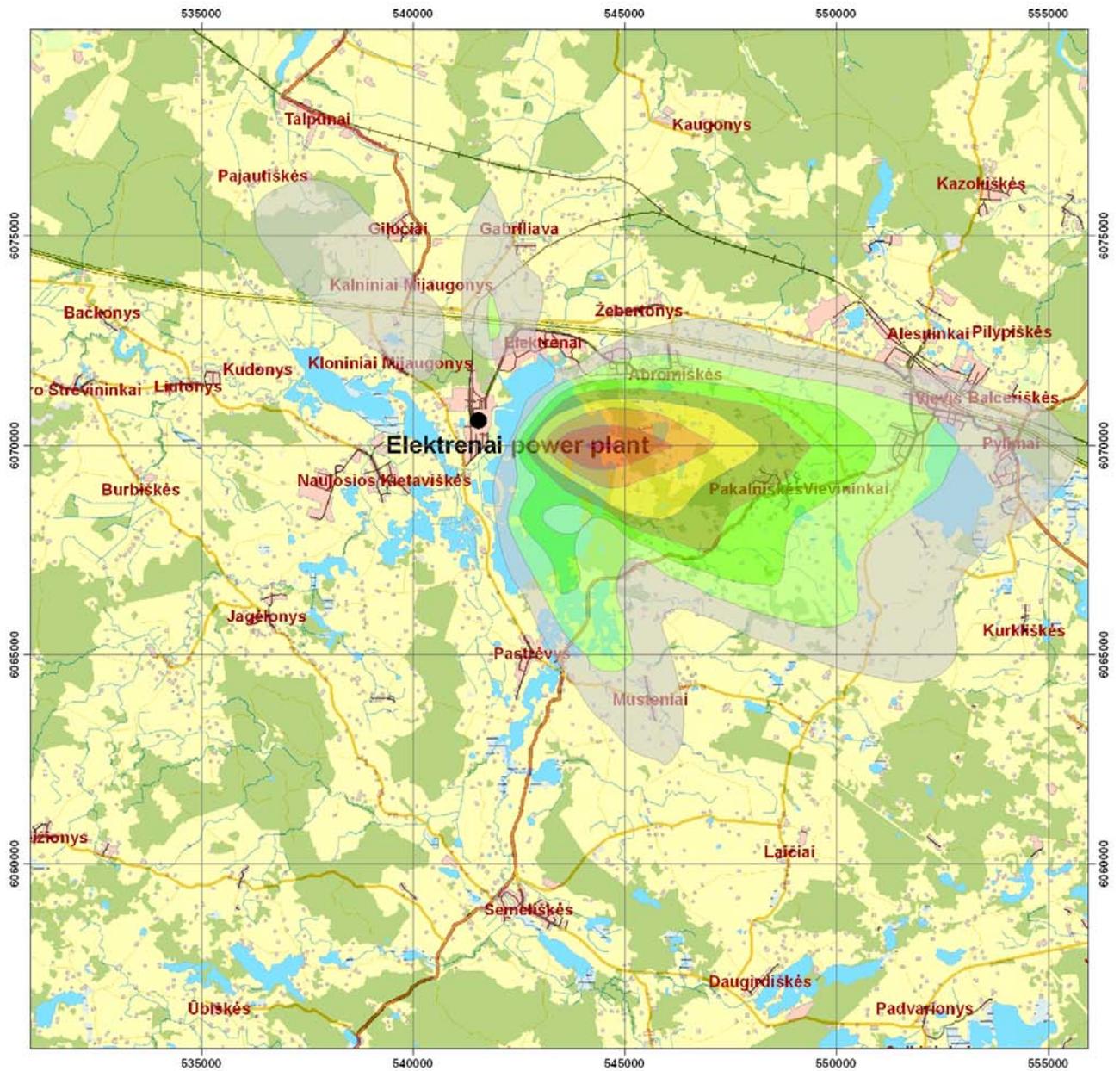
Emission points

Nr.	Coordinates	
	x	y
1.	541610,00	6070500,00
2.	541610,00	6070600,00
3.	541630,00	6070760,00



M 1 : 100 000

Figure 7.2. Annual average PCs of NO_x



Legend

Concentration ($\mu\text{g}/\text{m}^3$)



Emission points

Nr.	Coordinates	
	x	y
1.	541610,00	6070500,00
2.	541610,00	6070600,00
3.	541630,00	6070760,00



M 1 : 100 000

7.2 Predicted concentrations of SO₂

Table 7.4 shows the maximum predicted PC to the ground level concentrations of SO₂, and the location at which the maximum concentration occurs.

There are no exceedences of the Air Quality Limit values for SO₂.

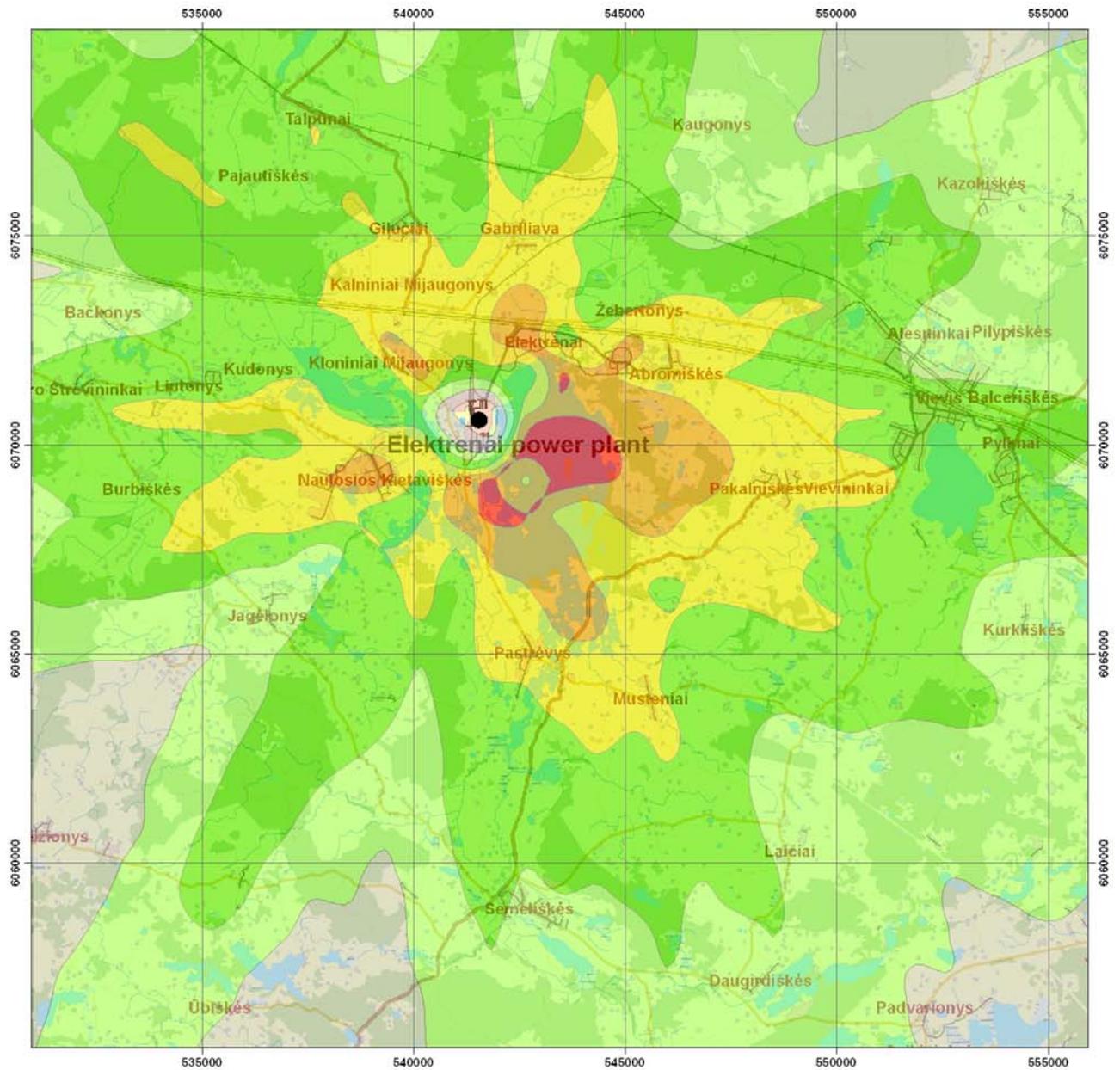
The maximum 99.73rd percentile of hourly average SO₂ PEC is 348µg/m³, 99% of the 350µg/m³ limit value. Figure 7.3 shows a contour plot of the 99.73rd percentile of hourly average SO₂.

The maximum 99.18th percentile of 24-hour average SO₂ PEC is 81µg/m³, 65% of the 125µg/m³ limit value. Figure 7.4 shows a contour plot of the 99.18th percentile of 24-hour average SO₂.

Table 7.4: Maximum predicted SO₂ concentrations (µg/m³)

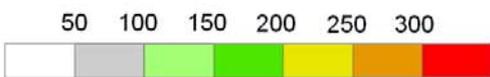
Year	Limit value	Measured as	Limit value value	PC	% PC of limit value	Significant release?	x, y
2005	Short-term AQO	99.73 rd percentile of 1 hour averages	350	348	99	Yes	543500, 6070000
	Short-term AQO	99.18 th percentile of 24 hour averages	125	81	65	Yes	543500, 6070000

Figure 7.3: 99.73rd percentile of hourly average PCs of SO₂



Legend

Concentration ($\mu\text{g}/\text{m}^3$)



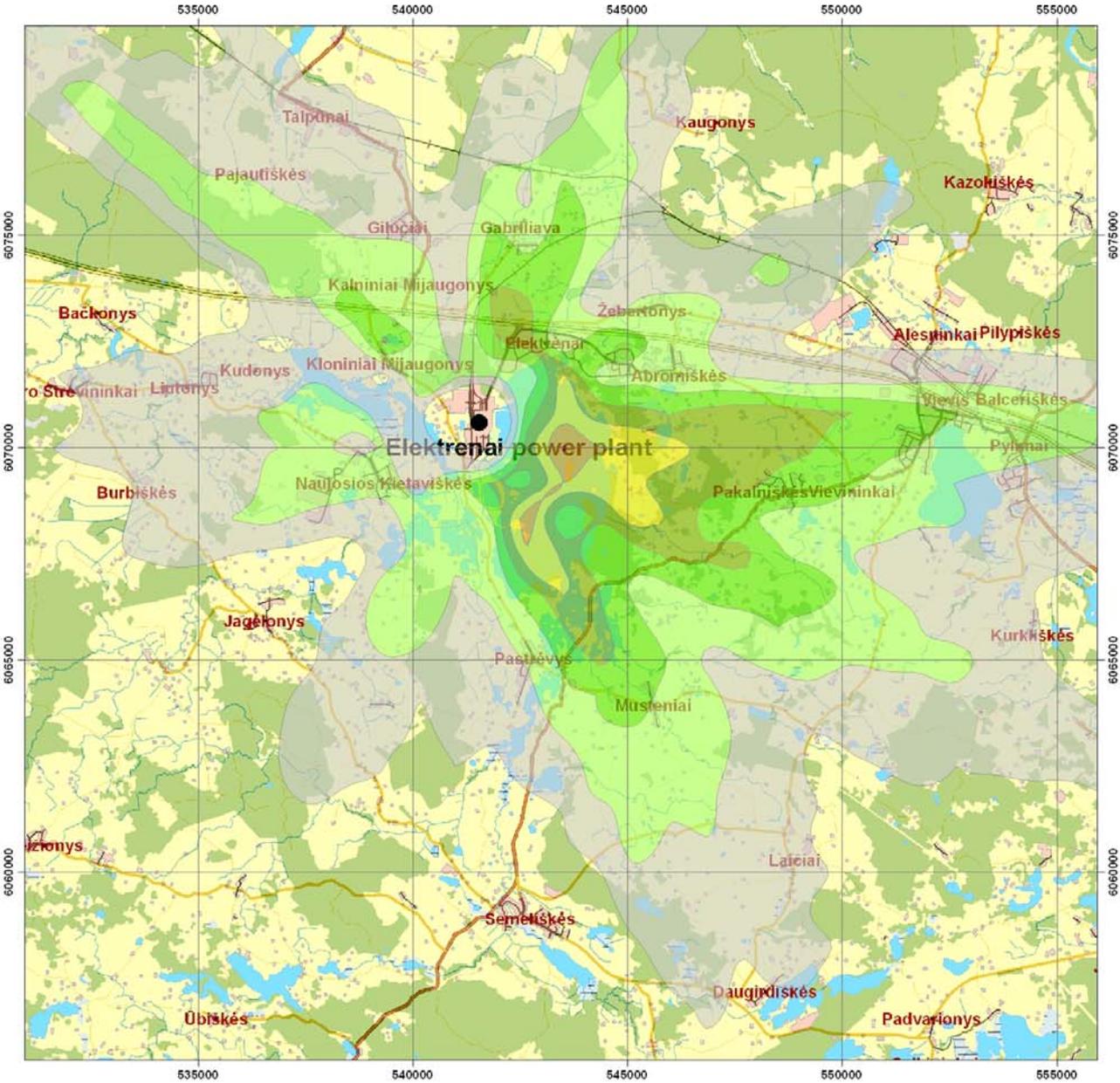
Emission points

Nr.	Coordinates	
	x	y
1.	541610,00	6070500,00
2.	541610,00	6070600,00
3.	541630,00	6070760,00

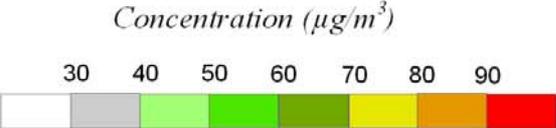


M 1 : 100 000

Figure 7.4: 99.18th percentile of hourly average PCs of SO₂



Legend



Emission points

Nr.	Coordinates	
	x	y
1.	541610,00	6070500,00
2.	541610,00	6070600,00
3.	541630,00	6070760,00



M 1 : 100 000

7.5 Predicted concentrations of CO

Table 7.8 shows the maximum predicted PC to the ground level concentrations of CO, and the location at which the concentrations occur.

Neither the predicted 8-hour average PC of CO nor the maximum predicted annual average PC of CO is significant.

Figures 7.5 and 7.6 show the 99.79th percentile of hourly average PEC and the annual average PEC of NO₂.

Table 7.8: Maximum predicted CO concentrations (mg/m³)

Year	Limit value	Measured as	Limit value value	PC	% PC of limit value	Significant release?	x, y
2005	Short-term AQO	Maximum daily running 8-hour mean	10	0.01	< 1	No	543500, 6070000
	Long-term EAL	Annual average	0.35	0.0003	< 1	No	543500, 6070000

7.6 Predicted concentrations of PM₁₀

Table 7.9 shows the maximum predicted PC to the ground level concentrations of PM₁₀, and the location at which the concentrations occur.

Neither the predicted 8-hour average PC of PM₁₀ nor the maximum predicted annual average PC of PM₁₀ is significant.

Table 7.9: Maximum predicted PM₁₀ concentrations (µg/m³)

Year	Limit value	Measured as	Limit value value	PC	% PC of limit value	Significant release?	x, y
2005	Short-term AQO	90.41 st percentile of 24 hour averages	50	0.02	< 1	No	546833, 6069167
	Long-term AQO	Annual average	40	0.01	< 1	No	545167, 6070000

8. Discussion

In order to quantify the impact of emissions to air from Elektrėnai power plant, Elektrėnai, dispersion modelling of all emissions from the processes on the site was carried out.

NO₂ and SO₂ were found to be significant whereas CO and PM₁₀ were not found to be significant. There were no predicted exceedences of the limit values for NO₂, SO₂, CO or PM₁₀ for the protection of human health.