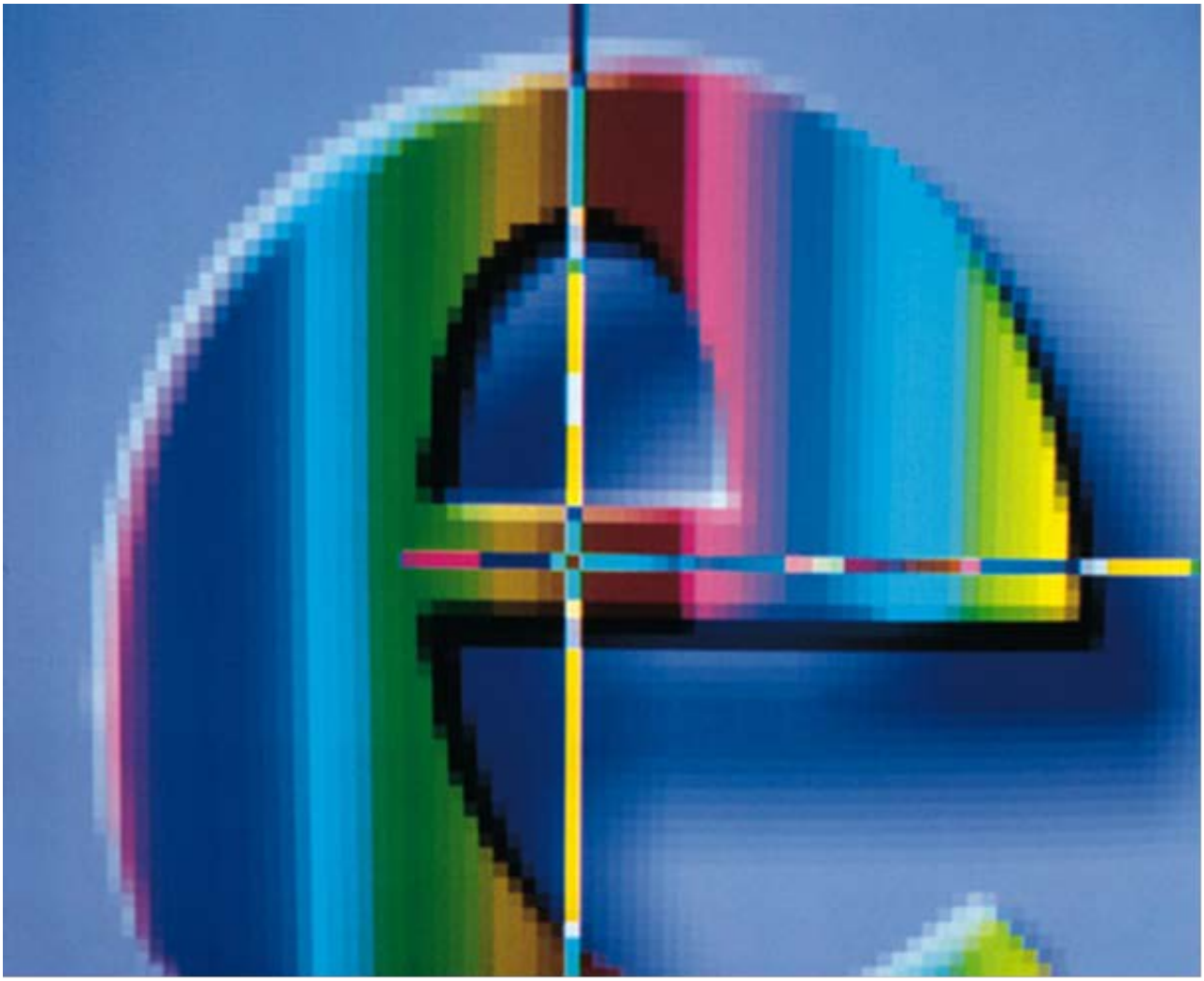
NON – TECHNICAL SUMMARY FOR REPLACEMENT OF UNIT “A“ WITH NEW COGENERATION COMBINED CYCLE POWER PLANT IN EL-TO ZAGREB



EKONERG - Energy Research and Environmental Protection Institute

Zagreb, March 2017

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INTRODUCTION

For the project: “New combined cogeneration plant as a replacement building for Unit A in EL-TO Zagreb”, the Ministry of Environmental and Nature Protection issued Decision on the environmental acceptability with the application of the environmental protection measures and with implementation of the environment monitoring program (CLASS: UP/I 351-03/14-02/24, REF. NO.: 517-06-2-2-2-14-18, from 17 July 2014). The project holder is HEP-Proizvodnja d.o.o., Ulica grada Vukovara 37, Zagreb. Decision is based on Environmental Impact Assessment Study prepared by competent authority EKONERG Ltd from Zagreb.

For the aforementioned project, competent authorities also issued:

- Certificate on project compliance with the physical planning documents of the Ministry of Construction and Physical Planning (CLASS: 350-02/13-02/104, REF. NO.: 531-05-14-2 KM) dated 17 January 2014
- Decision by the Nature Protection Directorate of the Ministry for Environmental and Nature Protection (CLASS: 612-07/14-60/11, REF. NO.: 517-07-1-1-2-14-4) dated 17 February 2014 that the planned project is acceptable for the ecological network

During the environmental impact assessment procedure, the public discussion was carried out from 15 May to 13 June 2014 in Local Office Trešnjevka, Zagreb, Park stara Trešnjevka 2. Notice on the public discussion was published in daily newspaper „Jutarnji list“, notice boards of the City of Zagreb and their website, as well as the website of the Ministry together with the whole Study. A public presentation was held on 29 May 2014. No complaints, proposals or statements from the public or interested public were expressed during the public discussion. Apart from the City representatives, Study creators and project holders, the presentation was also attended by the representatives of the public, i.e. interested public, who had no complaints about the Study.

For the planed project “Multipurpose operation building in EL-TO Zagreb” located on c.p. 561/1 c.m. Trešnjevka in City of Zagreb, Ministry of Construction and Physical Planning issued Location permit (CLASS: UP/I-350-05/13-01/285, REF.NO.: 531-06-1-14-5 KM, from 9 July 2014).

In the Environmental and Social Assessment Report for this project, analysis of compliance with relevant EBRD Performance Requirements is given in detail. Management at EL-TO Zagreb plant comply with PRs related to Environmental and Social Management System and Labour and Working Conditions (also related to Occupational Health and Safety) which will be applied in the construction and operation of planned new CCCPP. Compliance with other PRs is seen through project description, baseline conditions and project’s assessed environmental impact and prescribed protection measures and monitoring programme. With actions listed in Environmental and Social Action Plan (ESAP), planed project will fully comply with EBRD Performance Requirements.

1 PROJECT DESCRIPTION

1.1 DESCRIPTION OF CURRENT AND FUTURE STATE AT EL-TO ZAGREB LOCATION

In EL-TO Zagreb, there are more heat and electricity generation units. EL-TO Zagreb is primarily intended for heat generation, while electricity is generated in combined process – simultaneously with heat generation. The heat is delivered to consumers in two ways. Mostly through the district heating of Zagreb City in form of hot water (for heating and sanitary/domestic warm water) and other part through steam pipeline system for covering process steam and steam heating consumption.

Electricity is generated in back-pressure unit A with nominal output of 11 MW_e, unit B with nominal output of 30 MW_e with heating condenser, as well as in two gas turbine units operating in combination with heat recovery steam generators, making two cogeneration gas turbine units H and J. Besides the aforementioned units, auxiliary units of direct heat generation have been installed in EL-TO Zagreb as well. They consist of one low-pressure auxiliary steam boiler K-7 and two peak hot water boilers VK-3 and VK-4 - **tab. 1.1-1**.

Tab. 1.1-1: Existing units in EL-TO Zagreb

Unit		Fuel	Nominal power	Year of commissioning
UNIT A	K-6	NG / HFO	100 t/h (115 bar / 520°C)	1970
	TA1	-	11 MW_e	
UNIT B	K-8	NG / HFO	100 t/h (115 bar / 520°C)	1980
	K-9	NG / HFO	100 t/h (115 bar / 520°C)	
	TA2	-	30 MW_e	
UNIT D	K-7	NG / HFO	80 t/h (17 bar / 240 °C)	1972
UNIT G	VK-3	NG / HFO	116 MW_{th}	1991
UNIT H	PTA-1	NG	25,2 MW_e	1998
	KU-1	-	7,6 MW_{th} + 64 t/h (17 bar / 240°C)	
UNIT J	PTA-2	NG	25,2 MW_e	1998
	KU-2	-	7,6 MW_{th} + 64 t/h (17 bar / 240°C)	
	VK-4	NG	116 MW_{th}	2013
		HFO	93 MW_{th}	

K-6, K-8, K-9 - high pressure steam boilers, TA1 - backpressure steam turbine, TA2 - condensing steam turbine, K-7- low pressure steam boiler, VK-3 and VK-4 – hot water boilers, PTA-1 and PTA-2 – gas turbines, KU-1 and KU-2 - heat recovery steam generators, NG – natural gas, HFO - heavy fuel oil

Flue gas discharges from units VK-3, VK-4, K-6, K-7, K-8 and K-9 (**tab. 1.1-1**) are connected to common outlet - reinforced concrete 200 m high stack. The CGT (cogeneration gas turbines) units H and J have two separate stacks, each 60 m high.

Locations of existing units and flue gas discharge stacks are designated in **Figure 1.1-1**.

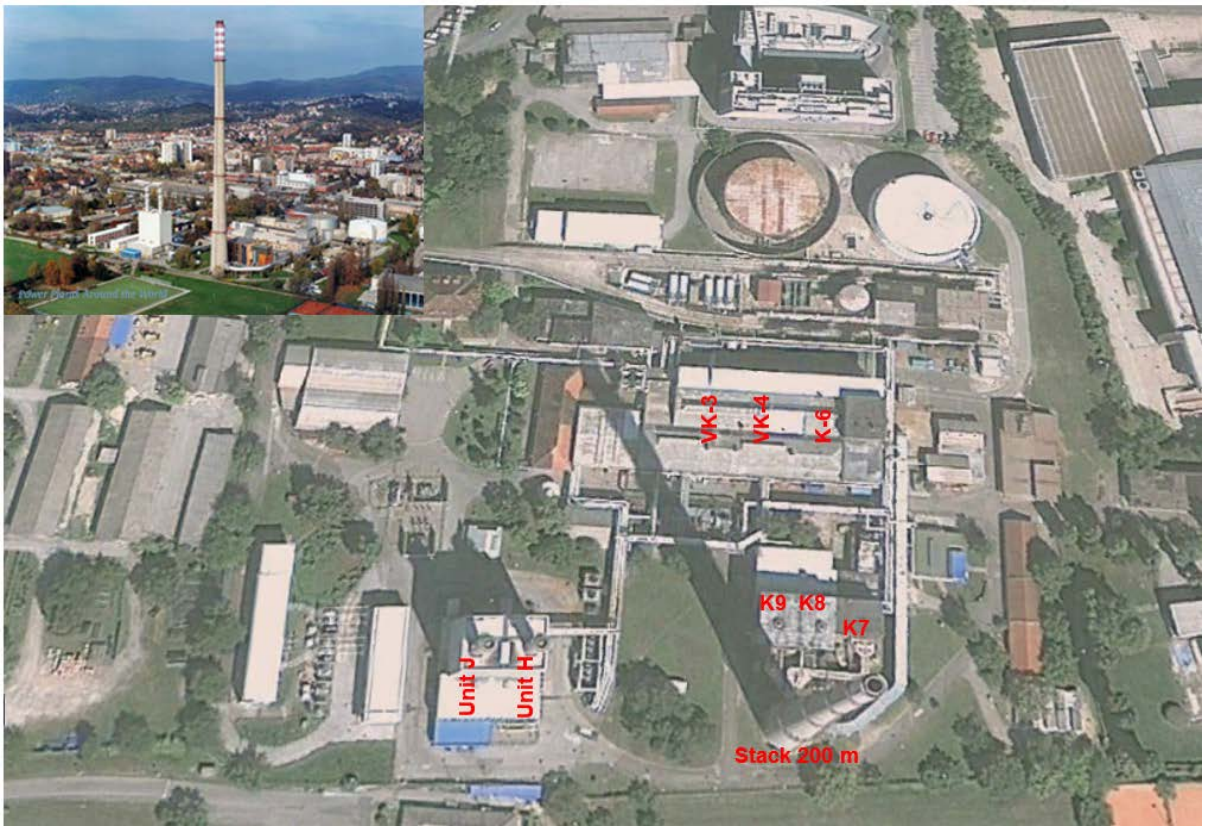


Figure 1.1-1: Existing units and flue gas discharge stacks

New cogeneration combined cycle power plant (CCCPP) was planned to be built and commissioned at the beginning of 2018, but related to the project development, its commissioning can be expected, at best, in autumn 2019. At the time of its start-up, situation in EL-TO will be different in relation to the present situation. Due to unprofitability of investing into reconstructions of existing units (Unit A, Unit B and boiler K-7), they will be shut down on 1 January 2018. At the time of new cogeneration unit start-up, the following units will be in operation in EL-TO:

- hot water boilers VK-3 and VK-4
- cogeneration units H and J.

New CCCPP in EL-TO will represent the basic district heating unit. Electricity generation will be secondary and new unit will be completely adjusted to requirements regarding heat, i.e. process steam supply. Net total efficiency of the CCCPP is 90%. Fuel for the new CCCPP will be natural gas.

During major part of the year, a heat demand will be covered primarily, while process steam demand will be covered in amount left over for extraction (the rest of process steam demand is covered by other units within EL-TO Zagreb).

After EIA procedure for new CCCPP, new projects at EL-TO site were planned and designed with commissioning planned for the second half of 2016: heat accumulator 1000 MWh, 150 MW_{th} and low-pressure steam boiler with nominal thermal power 32 MW_{th} (40,4 t/h steam: 17 bar / 235 °C). Additional steam boiler is also planned. Development plan for EL-TO Zagreb is given in **tab. 1.1-2**.

Tab. 1.1-2: Development plan for EL-TO Zagreb

Unit	
Unit A (K-6), Unit B (K-8, K-9) and boiler K-7	Out of operation 1 January 2018
Unit H and Unit J	Out of operation 1 January 2023
VK-3	Out of operation 1 January 2025
VK-4	No current plans for decommissioning
New CCCPP	Commissioning expected, at best, in autumn 2019
Two new low-pressure steam boilers	Commissioning planned for the second half of 2016, and second half of 2017 respectively
Heat accumulator	Construction planned for the second half of 2017

Heat accumulator consists of: storage tank (aboveground, vertical, atmospheric tank, 30 m diameter, 48 m high), pump station and internal water pipeline for connection to existing EL-TO Zagreb heat system. Tank is planned to be built on the location of existing heavy fuel oil storage tank and the pump station will be located near the existing heating station - **figure 1.1-2**.

Low-pressure steam boiler will be located near K7, K8 and K9 boiler building - **figure 1.1-2**.

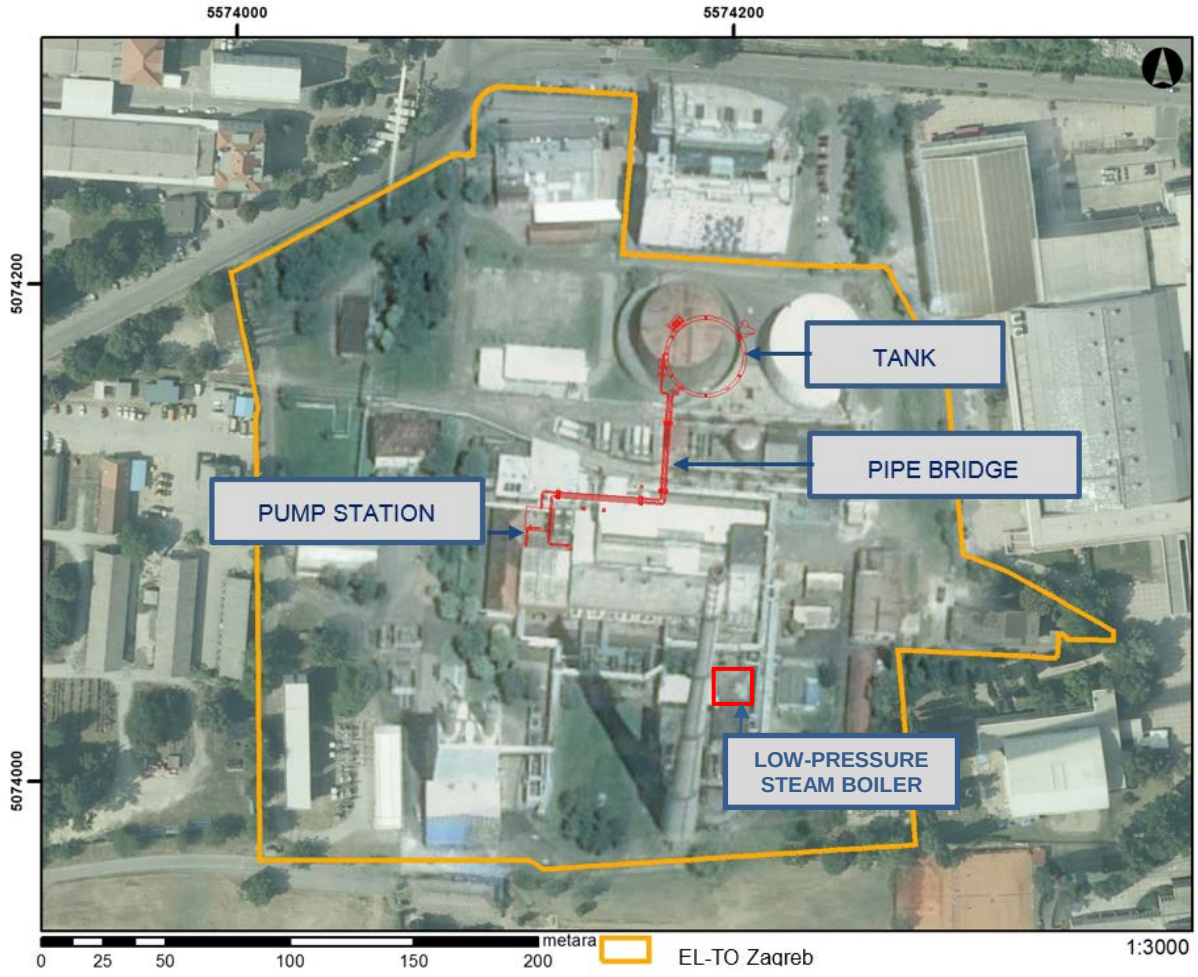


Figure 1.1-2: Locations of additional planned projects

1.2 RATIONALE OF THE PROJECT

The existing technological system of EL-TO Zagreb is complex – **chapter 1.1**.

In addition, the system is characterized by nearing the end of their life of all production units unless of course the newly built hot water boiler VK4. According to the standard technical criteria Unit A, which was built in 1969, expired on the available lifetime. Therefore, an increased maintenance is necessary, until the construction of a replacement unit, respectively by 2018. That time will be a transitional period, until the alignment with emission limit values by applying the principle of common stack.

The same conclusion applies to the peak boiler K7. Life expectancy of Unit B, as regarding the number of hours of operation and the number of start-ups, should expire in 2018. In the first place, due to unprofitability of the reconstruction to achieve the emission limit values. The same life expectancy should be expected for units H and J, but they will stay in operation until 2023, also due to restrictions on the profitability of reconstruction in order to achieve the emission limit values by application of the exemption for district heating. From the above listed data about the remaining operational life of existing generating units, an urgent need for construction of new high-efficiency cogeneration units is evident.

In addition to the replacement of old units, construction of new CCCPP will allow the destruction of ''rigid'' connection between electricity and heat generation, which characterizes the current EL-TO technological system. The new unit will enable higher generation of electricity outside the heating season, which so far has not been the case. By replacing the back-pressure unit A with new CCCPP, installed electrical power will be increased at the site and consequently the generation of electricity.

Construction of new CCCPP is an essential element in the process of harmonizing the EL-TO Zagreb plant with the requirements of obtaining the IPPC (Environmental) permit. IPPC (Environmental) permit for EL-TO Zagreb plant is obtained in December 2016.

At EL-TO Zagreb new CCCPP will be the base district heating unit and its work will significantly reduce the operation of other production units. Electricity generation will be secondary and new unit will fully adapt to the requirements of heat and steam supply.

New CCCPP will use only natural gas as fuel. Total net efficiency of the plant will be 90%. It will be a high-efficient cogeneration unit.

1.3 DESCRIPTION OF PROJECT PHYSICAL PROPERTIES

The project considered in this environmental impact study is planned gas cogeneration combined cycle power plant (CCCPP). The CCCPP will be used for electricity, process steam and heat generation. The CCCPP unit with auxiliary systems and connections to infrastructural systems will be built within the existing EL-TO Zagreb (refer to **figure 1.3-1**). The area intended for CCCPP unit construction amounts 4700 m^2.

The main power connections of planned project are as follows:

- connection to existing gas metering-reduction station
- connection to 110 kV switchyard

- connection to heating system.

Other existing infrastructure to which new CCCPP unit will be connected is as follows:

- chemical water treatment system
- connection to process and sanitary waste water, as well as rainwaters distribution sewage system
- connection to water supply system (for drinking water needs)
- road/transport infrastructure
- external hydrant network,
- and other.

There are four road entries/exits, three on north and one on east side, by which it is possible to access EL-TO (refer to **figure 1.3-1**). The above mentioned four entries/exits along with internal roads are at the same time fire access roads as well.

The main building structures of planned project are as follows:

- main operation building (engine room for placing the gas and steam turbine and generator; boiler plant for placing the heat recovery steam generators; other equipment of water-steam cycle)
- cooling system with auxiliary equipment
- central control room and electric power facility.

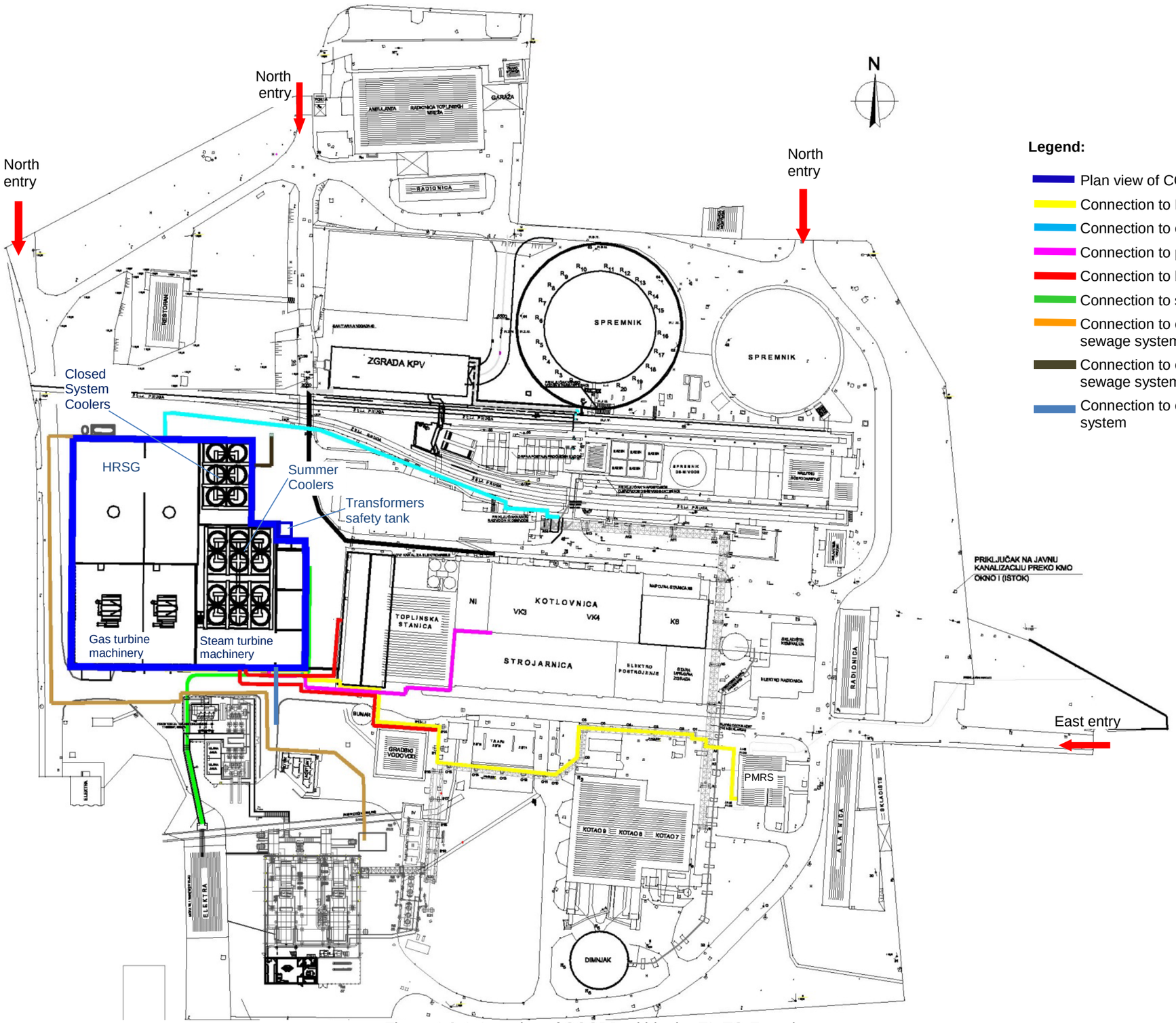


Figure 1.3-1: Location of CCCPP within the EL-TO Zagreb

Spatial arrangement of main building structures and associated infrastructure within EL-TO is indicated in **figure 1.3-1**.

Along with construction of new building structures, the project includes reconstruction of existing gas metering-reduction station, heating station and extension of 110 kV switchyard.

The basic CCCPP operation-generating parts are as follows:

- two gas turbines, one steam turbine, three electric generators
- two double-pressure heat recovery steam generators (HRSG)
- network water heaters
- water-steam cycle equipment
- Instrumentation and Control System (I&C)
- electric equipment (generator transformers and own consumption transformers, medium-voltage and low-voltage switchyards).
- network water pumping station
- air-cooled heat exchangers system
- natural gas supply and treatment system
- heating, ventilation and air-conditioning system
- fire alarm and extinguishing system
- auxiliary power facilities.

The planned CCCPP unit will be connected to the existing EL-TO infrastructure. Existing infrastructure has sufficient capacity to accept the proposed project. All connections will be carried out within the EL-TO. The CCCPP connection infrastructure is indicated in **figure 1.3-1**.

The main operation facility will be located in the western part of EL-TO Zagreb. It comprises engine room of two gas turbines with associated diffusers, boiler room of two boilers (Heat Recovery Steam Generator - HRSG) with their own 60 meters high stacks and steam turbine engine room - **figure 1.3-2**. Equipment of water-steam cycle partially will be placed in a boiler room and partially in the steam turbine engine room. These facilities will be derived from the steel supporting structure, which will be coated with building panels of determinate thermal and acoustic properties.

On the roof of the steam turbine engine room there will be summer coolers (heat exchangers, air-cooled), concealed with vertical barriers - **figure 1.3-2**. Cooling of closed cooling system will be performed by air-cooled heat exchangers, which will be the same type as the summer coolers. Closed cooling system (cooling system of CCCPP auxiliary systems) is used for cooling of oil, generator, feed pumps, etc. Air coolers of closed cooling system will be located on the roof of the central command and electrical plant building - **figure 1.3-2**.

The central command and electrical plant building will be located along the northern part of east side of the main operation facility - **figure 1.3-2**. Three transformers (two for gas turbine generators and one for steam turbine generator) will be placed in a fenced area along the eastern side of the steam turbine engine room - **figure 1.3-2**. Between transformer and adjacent buildings there are designed fire walls. Two transformers of own consumption will be located on the north of block transformers.

Tanks for the wastewater will be located on the north side of the CCCPP, along the boiler room. Tank of 5 m^3 is designed for wastewater that will be transported from the location for external disposal/treatment, while tank of 20 m^3 is designed for wastewater which will be treated at the site and discharged via internal sewage system into the public sewage system.

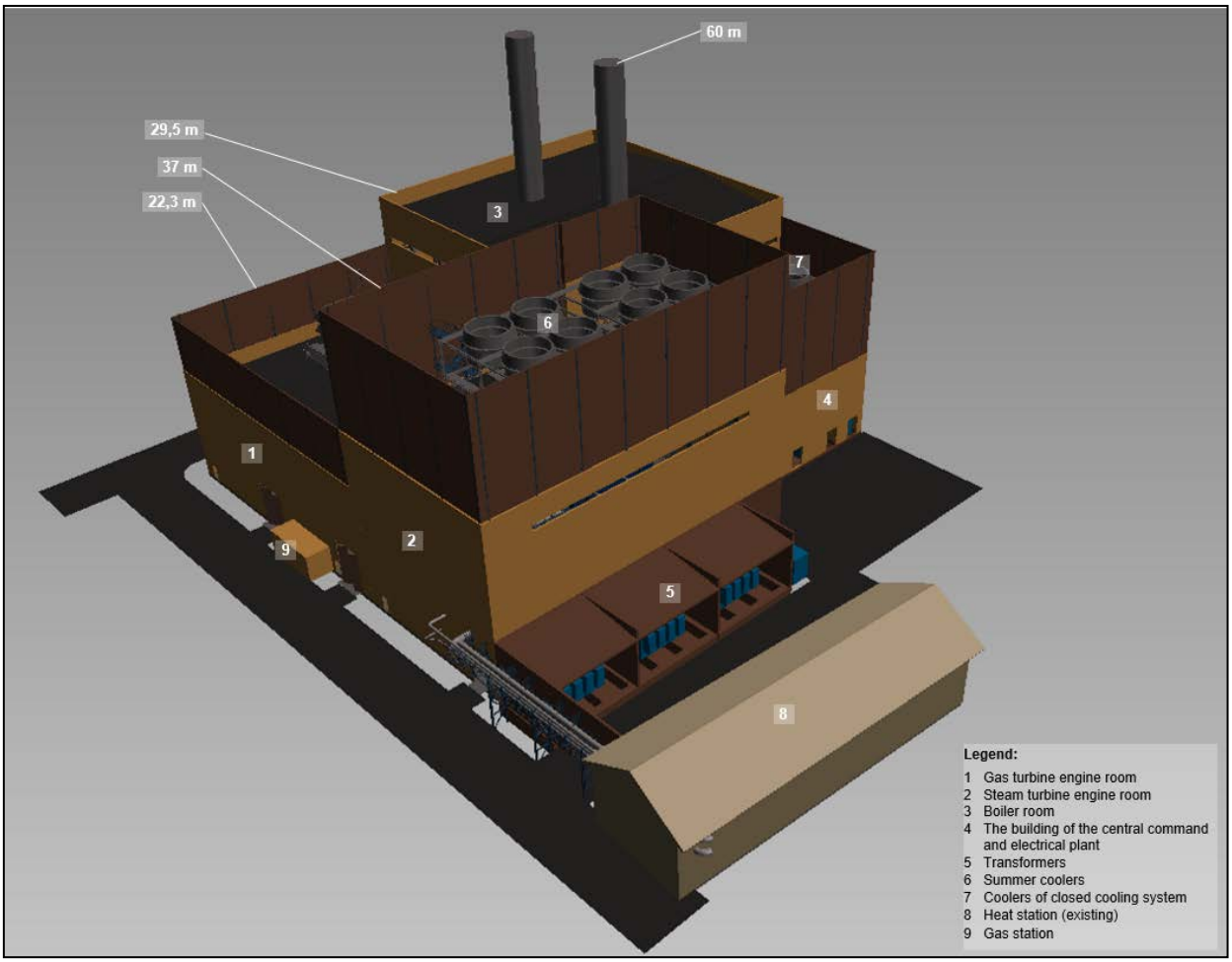


Figure 1.3-2: Three-dimensional display of new CCCPP

1.4 DESCRIPTION OF MAIN FEATURES OF TECHNOLOGICAL PROCESS

New CCCPP unit is configured with two gas turbines, two heat recovery steam generators (HRSG) and one extraction back-pressure steam turbine (refer to **figure 1.4-1**). The main feature of this configuration is high flexibility and availability. Namely, gas turbines are relatively limited as regarding reducing the capacity under 60%, primarily due to increase of specific fuel consumption. In the configuration with two gas turbines in subject, by shutting down one turbine, the load could be reduced even under 50% without increasing the specific consumption.

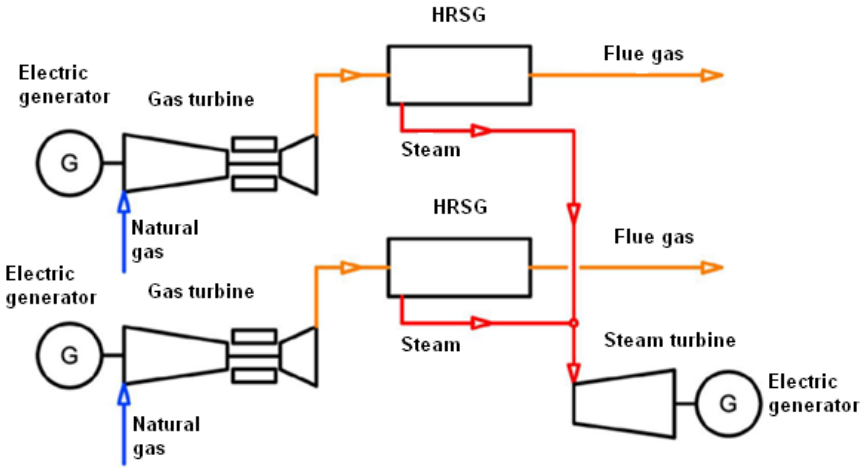


Figure 1.4-1: CCCPP unit configuration

The rated electrical power of new CCCPP shall be up to 150 MW and the heat output up to 120 MJ/s. In the Environmental Impact Assessment Study, CCCPP with rated electrical power of 140 MW and heat output of 110 MJ/s was analysed, so the numbers for inputs and outputs and also specific numbers for turbines power are given for that configuration. Final electrical power and heat output will depend on selected equipment supplier.

Each gas turbine has its own generator. The unit nominal output of gas turbines in standard ISO environmental conditions (15 °C, 1013 mbar, 60 % of humidity) amounts 2×50.5 MW. The CCCPP unit will mostly use natural gas as fuel.

The HRSGs are integral parts of CCCPP unit and their purpose is to generate superheated steam by using hot flue gases at the gas turbine exit. Operating parameters of heat recovery steam generators are selected in order to represent technically approved and acceptable solution of high total efficiency in combined process. The HRSG is of vertical, double-pressure design with two steam superheating systems. Additional HRSG firing is not assumed.

Steam turbine will be back-pressure with two extractions. Accordingly, it will be possible to operate in a mode of only electricity generation, as well as in cogeneration mode. The nominal output of steam turbine amounts 35 MW. The first steam turbine extraction will be carried out for the purpose of process steam generation with characteristics of 245 °C and 11 bar, in the maximum amount of 70 t/h. Uncontrolled extraction (0.4 – 1.15 bar) and back-pressure steam are assumed for heat generation. Total heat output amounts 110 MJ/s.

The CCCPP cooling system will be carried out with air-cooled heat exchangers. Two sections of heat exchangers are assumed. The first one is intended for cooling the steam from steam turbine, so called summer coolers (in the summer operation mode), while the other is used for cooling certain CCCPP systems (electric generators, lubricating oil system, feed pumps).

It is expected that CCCPP unit will generate 825 GWh/year of electricity in average. The planned heat generation is indicated in **tab. 1.4-1**. The plant expected service life amounts to over 25 years.

Tab. 1.4-1: Expected annual heat generation

Heat form	
Process steam generation	289,000 t/year
Hot water generation	465 GWh/year

The generated electricity will be placed to the transmission electric power network via EL-TO 110 kV switchgear. Process steam is assumed for industrial needs, while generated heat will be used in the city of Zagreb district heating system (DHS).

1.5 CONSUMPTION OF ENERGY AND GOODS

1.5.1 FUEL AND ELECTRICITY CONSUMPTION

Natural gas from the Republic of Croatia gas transmission system will be fuel for CCCPP unit. Natural gas consumption at CCCPP unit nominal operation mode (for ISO environmental conditions, 15 °C, 1.013 bar) amounts 2×2.5 kg/s, i.e. 25,348 Nm^3/h.

Electricity consumption varies with mode of operation (from 0.9 MW in cogeneration mode with steam generation and 70% of one gas turbine operation to 3.2 MW in cogeneration mode with 100% of both gas turbine operation.

1.5.2 WATER CONSUMPTION

1.5.2.1 Process water

For the operation of new CCCPP it is necessary to ensure a sufficient amount of raw water which is, after appropriate treatment / demineralization, used in technological process. Raw water will be supplied by the existing supply system and treated in the existing chemical water treatment system.

Existing water supply, treatment and consumption is described in **chapter 3.7.3**.

The CCCPP unit will use demineralized water and required amount depends on operation mode.

The following amounts of demineralized water are required in the operation mode regarding only electricity generation and in cogeneration mode without process steam generation:

- 3.76 t/h for water-steam cycle make-up due to HRSG desludging and desalination losses
- 0.73 t/h for water-steam cycle make-up due to continuous sampling.

In cogeneration mode with process steam generation, needs of demineralized water depend on amount of delivered process steam. The following amounts of demineralized water are required at nominal process steam generation (70 t/h):

- 3.7 t/h for water-steam cycle make-up due to HRSG desludging and desalination losses
- 0.74 t/h for water-steam cycle make-up due to continuous sampling
- 70 t/h for process steam generation.

The prevailing need of demineralized water arises from process steam generation. Depending on the operation mode, new CCCPP will replace/reduce process steam generation in other generating units of EL-TO. After starting up new CCCPP, total annual needs of raw, i.e. demineralized water for EL-TO plant will not be changed. Total annual consumption of raw water for new CCCPP is estimated to 400,000 m^3.

1.5.2.2 Sanitary and drinking water

Sanitary and drinking water for the project purposes will be supplied from the City of Zagreb public water supply system. The construction of new CCCPP will not increase the number of operating personnel, so there will be no increase in consumption of sanitary water in relation to the current situation.

1.5.2.3 Fire fighting water

Within new CCCPP, internal and external hydrant network will be constructed. External hydrant network will be connected to the existing hydrant system at EL-TO. Water for hydrant network will be supplied from the City of Zagreb public water supply system.

1.5.3 CHEMICALS CONSUMPTION

Other substances required for CCCPP operation are oils, hydrochloric acid and sodium lye, sodium phosphate, ammonia water, detergents and glycol.

1.6 PROJECT ALTERNATIVES

During the development of conceptual technical design of new CCCPP, cooling system alternatives were evaluated. Other project alternatives have not been evaluated.

1.6.1 COOLING SYSTEM ALTERNATIVES

The following cooling system alternatives were evaluated:

- Cooling system with dry-wet heat exchangers and
- Cooling system with dry heat exchangers (air-cooled heat exchangers).

Air-cooled heat exchangers cooling system alternative was chosen.

In relation to chosen alternative, alternative with dry-wet heat exchangers differs also in equipment arrangement at EL-TO site - **figure 1.6-1**.

Benefits of cooling system with air-cooled heat exchangers are:

- Avoided creation of water mist in adverse weather conditions (winter season)
- Lower level of noise emission
- Lower process water consumption and emission of process wastewaters
- A higher level of energy efficiency for the proposed plant configuration.

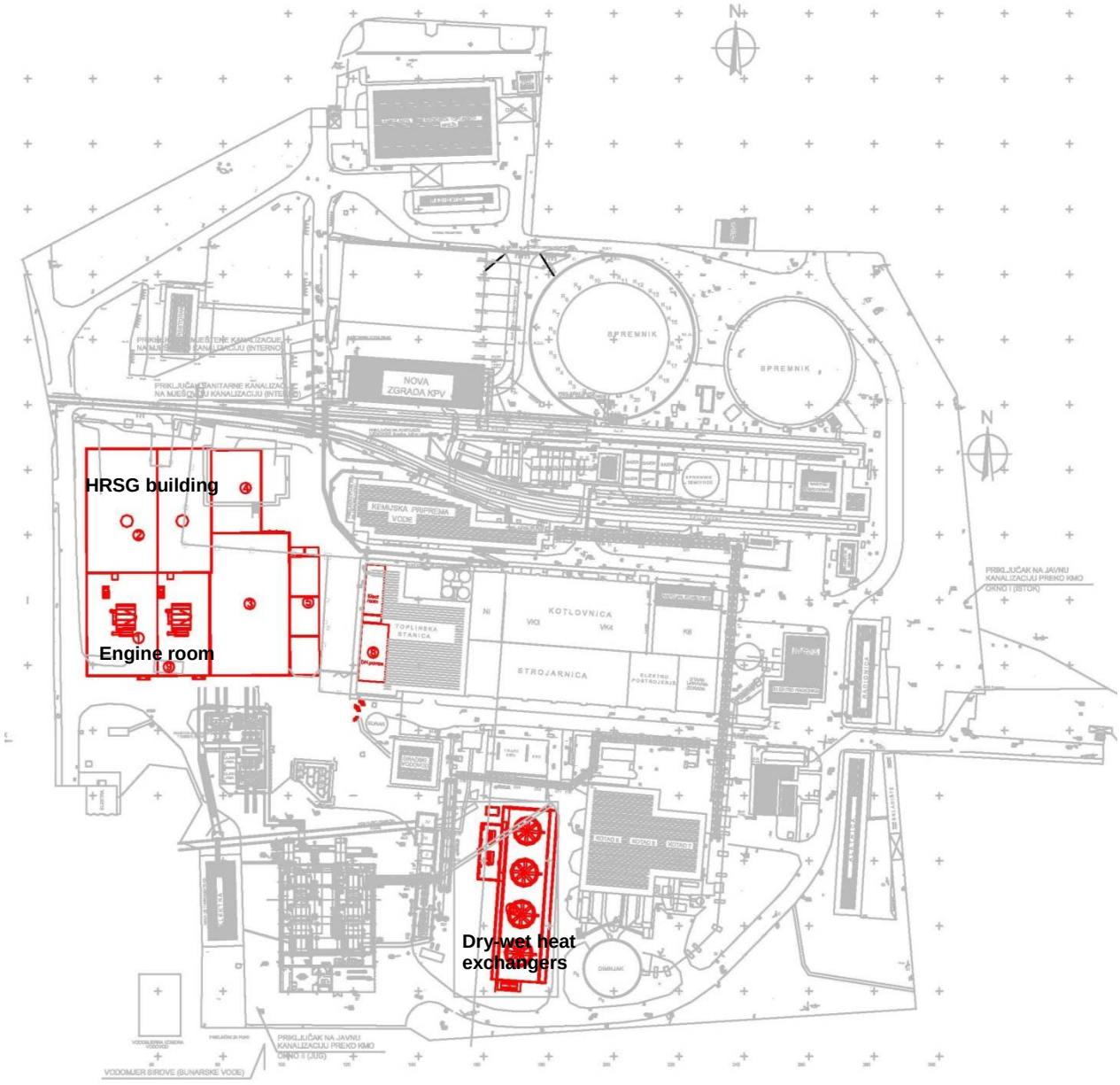


Figure 1.6-1: Layout of EL-TO Zagreb with new CCCPP with dry-wet heat exchangers (A non-selected alternative)

1.6.2 DO-NOTHING ALTERNATIVE

If current consumption of heat and steam is analysed, it can be determined that with the existing units of EL-TO Zagreb security of end users supply is satisfactory. On the other hand, increase in consumption as well as the planned decommissioning of some units in the period from 2018 to 2023, makes supply of consumer severely compromised i.e. ultimately it will be no longer possible.

All this shows that construction of new unit is the necessity because only construction of new production units can meet the long-term environmental protection criteria and enable EL-TO Zagreb to freely fulfil obligations to heat and steam consumers.

1.7 LIST OF TYPES AND AMOUNTS OF SUBSTANCES REMAINED AFTER TECHNOLOGICAL PROCESS

1.7.1 EMISSIONS TO AIR

The basic emission pollutants are nitrogen oxides (NO_x), carbon monoxide (CO) and volatile organic compounds (VOCs) in much small amounts. Other emission pollutants, such as particulate matters PM_{10} and sulphur dioxide occur in almost irrelevant amounts.

The emission limit values for CCCPP are related to two gases NO_x and CO, while for other substances, as it concerns very low emissions, no limit values are prescribed.

According to technical-technological solution, the CCCPP will use dry low NOx combustion system/chamber (DLN). By this technique, the limit values for gas turbines prescribed in Croatian regulation (OG 117/12, 90/14) and in EU Directive for industrial emissions (2010/75 EU) can be achieved, as indicated in **tab. 1.7-1**.

Tab. 1.7-1: ELV for CCCPP (gas turbines) using gas fuels

Plant	**Nitrogen oxides expressed as NO_x**	**Carbon monoxide CO**
Gas turbines (CCCPP), using natural gas as fuel(1) (2)	50(1) mg/m^3	100 mg/m^3

(1) For one-cycle gas turbines, with efficiency higher than 35% - determined in accordance with load conditions according to ISO standards – ELV for NOx is 50×η/35 where η is gas turbine efficiency, determined in accordance with load conditions according to ISO standards, expressed as a percentage.
(2) ELVs are in mg/m^3 and relate to the dry flue gas at temperature of 273 K and pressure of 101.3 kPa, for a given oxygen content of 15%.

For CCGT/gas turbines, ELV for NO_x and CO from **tab. 1.7-1** applies only for loads over 70 %.

At the plant load level of 70 to 100%, NO_x emission will amount to about 31 mg/m^3, while CO emission will amount to 6.5 mg/m^3, according to guarantees of one of the manufacturer.

In **tab. 1.7-2** annual emissions for different operating hours are given. Operation of turbines for 3500, 5000 and 7000 equivalent hours at maximum power per year is assumed.

*Tab. 1.7-2: Annual emissions for planned operating hours**

Pollutant	**h/year (on rated power)**		
	3500	**5000**	**7000**
	t/year		
NO_x	111.55	156.6	219.2
CO1)	223.10	313.2	438.5
CO2)	14.50	20.36	28.5

Pollutant	h/year (on rated power)		
	3500	5000	7000
	t/year		
PM_{10}	2.45	3.45	4.8
SO_2	0.47	0.66	0.9
NMVOC	4.02	5.64	7.9

* Calculation of SO_2 based on measurements of S in natural gas, PM_{10} and NMVOC from EMEP / CORINAIR factors

[1)] Based on ELVs, [2)] Based on expected emissions

Greenhouse gases emission amount from 190,611 t/year (3500 operational hours) to 395,185 t/year (7000 operational hours). In relation to greenhouse gas emissions in the Republic of Croatia in 2013, GGH emissions of new CCCPP represent 0.78% - 1.61% of total national greenhouse gas emissions and 1.05% - 2.18% of emissions from energy sector.

1.7.2 EMISSIONS OF WASTEWATERS

During project usage, rainwater, process and sanitary waste waters will be generated, which after appropriate treatment will be discharged via existing mixed internal sewage system to the city of Zagreb public sewage system. Upon the CCCPP realization, existing amounts and types of waste waters from EL-TO will not be changed.

Process wastewater after being treated in the existing wastewater treatment plant will be discharged via internal sewage system in the public sewage system. Process wastewater contaminated with heavy metals will be delivered to a licensed waste collector, while the process wastewater from HRSG will be injected into hot water system.

Storm waters from paved surfaces (roads, handling areas) will be treated in the precipitator/ separator and then discharged into the existing internal sewage system. Clean storm water will be discharged without treatment in an internal sewage system or on the surface of their own terrain in a way that does not endanger the neighboring plots.

Sludge (if it occurs) from transformer bund (oil sump) will be delivered to a licensed waste collector.

Sanitary wastewater will be discharged into existing mixed internal sewage system.

1.7.3 WASTE GENERATION

The waste will be generated during regular plant maintenance. It concerns waste packaging, various types of waste lubricating oils, waste insulation oils and heat transfer oils, wiping cloths and materials. Various construction waste will be generated as well (metal waste, waste wires and cables, glass insulators and ceramic insulators). The waste management will be carried out, including separate waste collection by types, appropriate temporary disposal and delivery of individual types of waste to collectors with appropriate waste management authorizations.

2 BASELINE CONDITIONS

2.1 PROJECT LOCATION

Location of new CCCPP is the existing plant / power plant EL-TO Zagreb, located on c.p. 561/1 c.m. Trešnjevka. EL-TO Zagreb is located in the City of Zagreb, in the city district Trešnjevka - north. East of EL-TO Zagreb there is Dom sportova (sport hall) and winter swimming pool Mladost, residential buildings and a Four Points Panorama hotel. South of EL-TO Zagreb there are sports and recreational areas, to which are connected residential buildings, mainly family homes. West of EL-TO Zagreb there is recycling yard and facilities of company Water Supply and Drainage Ltd. Further is a space of Zagreb hockey association and Park pravednika među narodima, green areas respectively. North of EL-TO Zagreb there is a business building of Raiffeisen bank (RBA), Magazinska and Zagorska Street and international railway line M101[1], behind which there are residential buildings and commercial buildings and facilities. EL-TO Zagreb location and its surroundings are presented in **figure 3.1-1**.

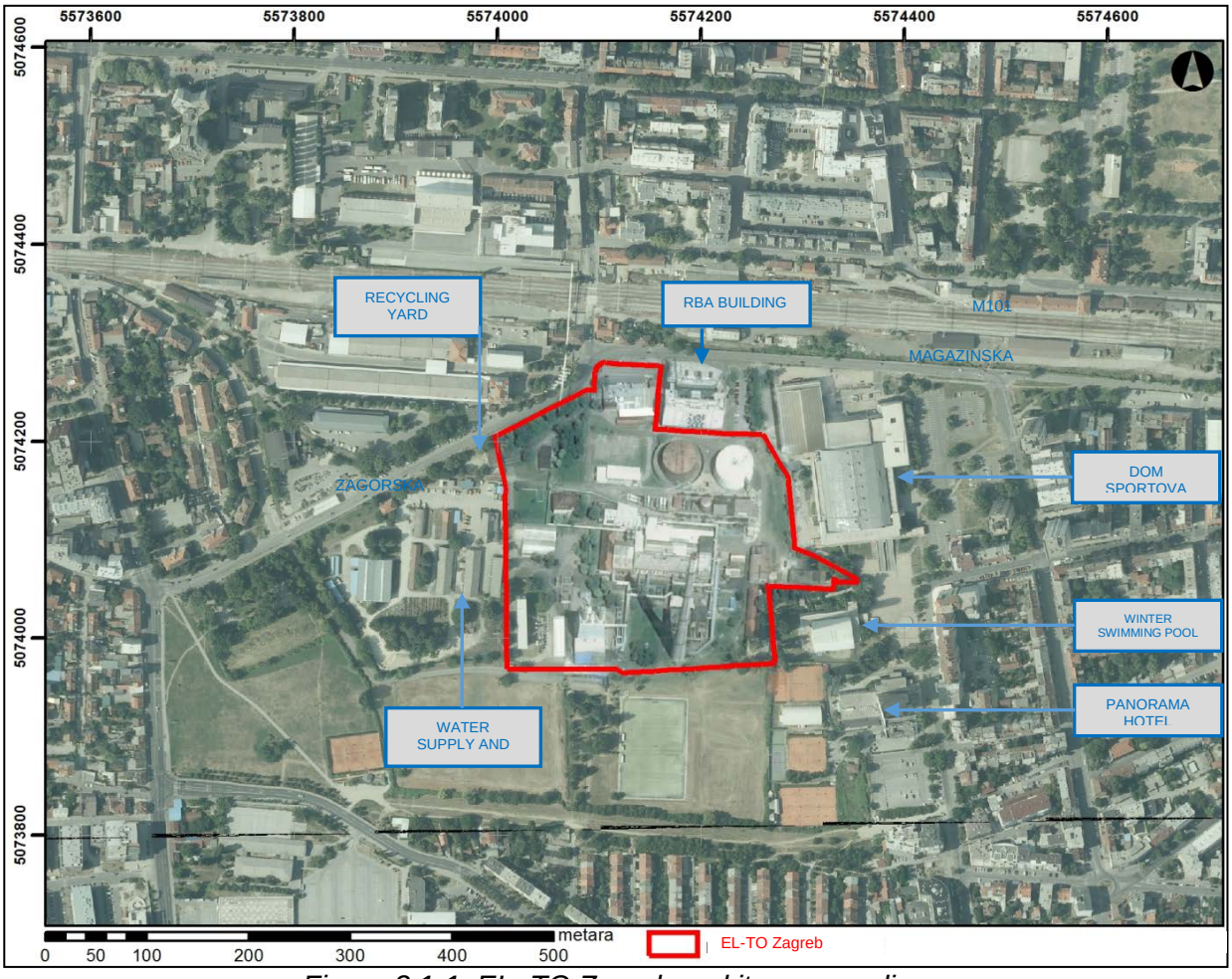


Figure 3.1-1: EL -TO Zagreb and its surroundings

[1] International railway line *(Dobova)* – State border - Savski Marof - Zagreb Central railway station, part of RH1 corridor

2.2 AIR QUALITY

Perennial measurement data indicate that the pollution level of sulfur dioxide, carbon monoxide, benzene, mercury and metals (Pb, Cd, As and Ni) in PM_{10} particles at all Zagreb stations are lower than the limit values.

In the City of Zagreb there is a typical problem of urban air pollution associated with the exceedance of limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$ particles and benzo(a)pyrene in PM_{10}.

Exceeded limit values for ozone concentrations were recorded at the measuring stations in Zagreb as well as other parts of Croatia, whereby there is a significant interannual variability predominantly dictated by meteorological factors.

As regarding the CCCPP air impact, the most concerning condition is NO_2 concentration. In the period from 2011 to 2014, the exceedances of average annual NO_2 concentrations have been recorded on the measuring stations close to the busiest city roads and the most prominent was in the city center (Đorđićeva) due to pollution retention within the street. The number of exceedances of hourly concentrations has not been recorded more than allowed (LV of 200 $\mu g/m^3$ is not allowed to be exceeded more than 18 times in a calendar year), at monitoring stations where the concentrations were measured by automatic measuring devices (Zagreb-1, Zagreb-2, Zagreb-3, Ksaverska cesta, Vrhovec).

The closest monitoring stations to the CCCPP location are Prilaz baruna Filipovića and Vrhovec stations. The distance between mentioned stations is about 800 meters. Average annual concentrations are 20 $\mu g/m^3$ higher at the Prilaz baruna Filipovića station comparing to the Vrhovec station which is in residential area. Due to the distance between stations, the assumption is that they have the same level of "urban background pollution" and that mentioned value of 20 $\mu g/m^3$ is mainly a result of emissions from road transport in the Prilaz baruna Filipovića where tens of thousands of vehicles pass every day.

2.3 CLIMATE AND METEOROLOGICAL DATA

According to Köppen climate classification, Zagreb has a climate type Cfwbx''. This code represents a set of indexes that indicate that Zagreb has a moderately warm rainy climate (C), with no dry periods (f), with less precipitation in cold season, (w), warm summers (b) and rainy periods in early summer and late autumn (x'').

Characteristics of temperature and precipitation regimes are determined according to climate normals for the period from 1961 to 1990 at the meteorological station Zagreb - Maksimir.

Air temperature and precipitation

At the meteorological station Zagreb - Maksimir average annual temperature is 10.3 °C. The coldest month is January with an average temperature of -0.8 °C and the warmest is July with 20.1 °C in average. In the lowland regions of the continental Croatia there is a relatively large

value of annual amplitude of monthly average values for which the station Zagreb - Maksimir is 20.9 °C.

The average annual precipitation at the meteorological station Zagreb - Maksimir is 852 mm. Although most rainfall is in a warm part of the year, which is characteristic for continental type of precipitation regime, the appearance of secondary maximum in late autumn points to the maritime influence. In average, June is the month with the highest (100 mm) and February with the lowest (42 mm) precipitation.

Wind

Specifics of the airflow regime in the wider area of Zagreb is that it is directed southwest-northeast. In Zagreb prevails airflow from the northern quadrant, with prevailing winds in N and NE direction. In overall, winds from the northeast quadrant, directions from N to E, account for half of the cases. Among the winds with pronounced southern component, five-wind directions from SE to SW constitute twenty percent of the data.

At the Maksimir station winds are generally weak to moderate. Average annual wind speed, depending on the direction, ranges between 1 and 3 m/s. Because of channeling the flow in the Medvednica direction, the largest average speed have winds of northeast and southwest direction.

Calm, light winds with speed of less than 0.3 m/s occur in 7.3% of cases. The most frequently occurrence is early in the morning.

2.4 GEOLOGIC AND SEISMIC FEATURES

In the wider area of EL-TO Zagreb dominate deposits of alluvial layers of the first and second Sava terrace (changes coarse gravel and sand in the thickness of 10-25 m), prolluvium (mainly coarse-grained gravel mixed with sand and clay, thickness not exceeding 10 m) and alluvial sediment of recent Sava flows (predominantly coarse-grained sand and gravel), which is with 1-1.5 m high terraced department separated from the first Sava terrace.[2] At EL-TO Zagreb location, in period from December 2013 to January 2014, investigation works were carried out which included three exploration wells. Identified deposits are composed of: (1) black silty clay, sand with a lot of dust on the depth of 0-1 m, (2) brown clay, gravel at depths of 1-5 m, (3) brown clay, gravel, sand at a depth of 5-15 m, (4) blue-gray clay at a depth of 15-20 m (5) powder, sand with fractions of gravel, clay brown and blue-gray at depth of 20-30 m.[3]

In 1987, the seismic map based on so-called probabilistic process was made. Based on a database of earthquakes that occurred in the period 1901 to 1980, the maximum intensity of an earthquake that can be expected for different return periods was determined. According to this map, wider area of the project site is located within two seismic zones of 7 and 8 degrees MCS scale, for a return period of 100 years, within zone of 8 degrees MCS scale, for a return period of 200 years and within zone of 9 degrees MCS scale, for a return period of 500 years.

[2] Source: Basic geological map of the Republic of Croatia (List Zagreb)
[3] Source: The minutes of conducted geotechnical investigation works on the building construction of new combined-cycle cogeneration plant at EL-TO Zagreb site

In 2012, new maps were published, which express seismic risk by acceleration of the soil, not the intensity and for a return period of 95 or 475 years. New maps are made on the basis of modern data and methods and are comparable with maps of European countries that are in line with a set of regulations issued by the EU under the name Eurocode 8. In the wider area of EL-TO Zagreb horizontal peak ground acceleration of type A (agR) for a return period of Tp = 95 years expressed in units of the gravitational acceleration (1 g = 9.81 m/s^2) is between 0.12 and 0.14 g and for EL-TO Zagreb location that is 0.128 g.[4] For the return period of Tp = 475 years expressed in units of the gravitational acceleration (1 g = 9.81 m/s^2) is between 0.24 and 0.26 g and for EL-TO Zagreb location that is 0.252 g.

2.5 HYDROGEOLOGICAL FEATURES AND RELATION TO WATER SOURCE PROTECTION ZONES

The main reserves of groundwater in Zagreb are related to deposits of Quaternary age in the lowland area along the Sava River. These are mostly well-permeable gravel with layers of impermeable or poorly permeable finoclastic sediments. In the background of gravel there are clay - marl deposits of Plio Quaternary age, which limit the extent of an active aquifer to depth. Deposits of Quaternary age were deposited in morphologically very irregular area of separated deep pools. Investigation works carried out in the period from December 2013 to January 2014 at EL-TO Zagreb, determined the level of groundwater at least 5.5 m below the surface[3].

Location of EL-TO Zagreb, as well as the greater part of Zagreb, is in the III. zone of sanitary protection of water sources Stara Loza, Sašnjak, Žitnjak, Petruševec, Zapruđe and Mala Mlaka.

Construction of new units for heat and electricity generation is not prohibited in this zone; however, special attention is needed in plant design and operation in order to protect groundwaters in terms of safe storage of hazardous substances and their manipulation, proper waste management, wastewater treatment, waterproof drainage system and other measures to protect groundwater.

2.6 HYDROLOGICAL CHARACTERISTICS

The main watercourse in the area of Zagreb is river Sava. Next to it, in Zagreb area there are other surface water bodies - lakes and streams. On EL-TO location there are no surface water bodies. The nearest surface water body is a stream located west from EL-TO Zagreb, at a distance of about 1 km.

The Sava River is of great importance for events in the aquifer of area location. In Zagreb Sava river has features of the middle course river with bed cut into alluvial deposits. From the confluence of Sutla to Oborovo total flow length is approximately 73 km and the main river bed has a width of about 100 m. From Zaprešić to Ivanja Reka river Sava is separated from the hinterland by dikes for flood protection. Therefore, for EL-TO location the probability of flooding

[4] Source: Earthquake map of the Republic of Croatia territory

is low[5]. Upstream and downstream of that area Sava is overflowing in a wide area with many blind backwaters.

Rainfall in its catchment area mainly affects water levels of Sava, so high water after snow melting in the Alps mountains is frequent. The largest measured flow of Sava near Zagreb of 3.126 m^3/s was recorded in October 1964. Mean flow of the Sava River for the period 1926-1988 amounted 314 m^3/s, and for the period 1975-1995 - 308 m^3/s. The lowest recorded flow occurred in 1947, 47.5 m^3/s, and in 1971, 53.5 m^3/s. It is a quite large ratio of minimum and maximum flow (1:65). The above mentioned classifies Sava in a group of rivers with very variable flow dependent on hydro-meteorological conditions, which has a direct impact on the change of groundwater level in the impact area of the river.

2.7 WATER

2.7.1 GROUNDWATER QUALITY

According to the Croatian waters' Report of the state of groundwaters in 2013, at stations in Zagreb area groundwater quality is as follows[6]: Given the concentration of nitrates and active substances in pesticides a good chemical state has been determined at all stations on which those parameters were monitored. With respect to specific pollutants - dissolved metals (arsenic, cadmium, lead and mercury), chlorides, sulfates and orthophosphates good chemical state has been determined at all stations on which those parameters were monitored.

With respect to specific pollutants - ammonia and artificial synthetic substance, on two monitoring stations at inflow area of water wells Kosnica bad chemical state with regard to ammonia has been determined, and at two monitoring stations at inflow area of water wells Žitnjak bad chemical state has been determined regarding the sum of trichloroethene and tetrachloroethene. At other stations on which these parameters have been monitored, good chemical state is achieved. With respect to conductivity, good chemical state has been determined at all stations.

2.7.2 SURFACE WATER QUALITY

At monitoring stations of surface waters Sava - Jankomir and Sava - Petruševec, given the specific pollutants and physical-chemical quality elements, good ecological state[7] and good

[5] Return period greater than 100 years (return period of 100 years is for flooding with medium probability of occurrence).

[6] For groundwater only data relating to the quality standards of the Regulation on water quality standards (OG 73/13, 151/14, 78/15), are presented.

[7] Ecological state estimation has the label of intermediate level of reliability since there is no assessment of biological quality elements.

chemical state[8] is estimated in 2013. In terms of quality of cyprinid waters segment, water state at two stations was estimated as good.

2.7.3 WATER SUPPLY

Process water is supplied from separate water intake - water well Knezija with six wells. The EL-TO Zagreb has a water permit to use water from the water well at the Horvaćanska cesta site for technological purposes in quantities of 1,735,000 m^3 per year (4750 m^3 per day). Permissible operating maximum is 55 l/s.

For the abstraction of water for technological purposes in EL-TO Zagreb, HEP d.d. signed with the State Directorate for Water Management a Contract for concession for water abstraction for technological purposes (from 17 March 1999), which, as well as permit, is valid for a period of 20 years.

The extracted water is used as technological/process and cooling water. From water wells water is transported by industrial pipeline of 2.3 km length, to the EL-TO plant (from the south side), to chemical water treatment system. This water is used for preparation of demineralized water.

For the purposes of water preparation, in 2009 a new chemical water treatment plant was put into operation, with the capacity of 3 x 150 m^3/h. It consists of three ion exchange lines with ion exchange resins in a fluidized bed, as well as associated equipment for production of demineralized water and demi water tank (1000 m^3).

In process of raw well water demineralization, ion exchange resins is used (cation, anion and inert), and for their regeneration chloride acid (HCl) and sodium hydroxide (NaOH) solution is used.

Demi water after being heated in the thermal water treatment plant is used for supply of high-pressure steam generator (feed water) to produce process steam and electricity and additionally of hot water pipelines for hot water boilers (for heating the Western part of Zagreb).

For cooling of generators and other parts of plant, closed system of cooling water with air-cooled heat exchangers is used. In the system there is about 150 m^3 of cooling water in recirculation, which is periodically refilled. Eventual surpluses from the system can (after cooling) be discharged into sewer.

For sanitary purposes water from the city water supply system is used via two connections (on average <1% of the amount of well water for process and cooling purposes).

In exceptional cases (in case of long shutdown of well station) for the production of demineralized water, water from the city water supply system can be used. It is supplied through the pipeline Ø 200 mm in amount of about 250 m^3/h. By shut-off valves system, mixing of well's water and water from the city water supply system is disabled.

[8] The chemical state of surface water refers to their load with priority hazardous substances for which at the EU level, in Directive 2008/105/EC are given the standards of quality, which are transferred to our regulations governing water quality standards. The estimation of the chemical state has an intermediate level of reliability, which means that the data are limited or insufficient for some or all priority substances discharged (less than 12 data).

Water from the city water supply system is also used in hydrant network. Water for firefighting is supplied by two connections from the water supply network of the City water supply system of which one is reserve.

2.7.4 WASTE WATER MANAGEMENT

At EL-TO plant location, mixed internal sewage system is constructed, which includes:
- sanitary wastewaters,
- stormwaters from traffic areas and roofs,
- oily stormwaters and
- industrial wastewaters.

Sanitary wastewaters are discharged through a siphon into the existing mixed internal sewage system.

Stormwaters from the asphalt surfaces of roads by longitudinal and cross fall are drained through the sink with precipitator in manholes and by connecting pipes in the existing route of mixed sewage. Roof waters from buildings are collected by horizontal and vertical gutters and through manholes drained into the mixed internal sewage system.

After pretreatment of certain types of wastewaters, they are discharged via mixed internal sewerage system into the public sewerage system.

At EL-TO Zagreb location, wastewaters are discharged via two outlets (**figure 2.7-1**):
- K1 (shaft east – 1) discharge of sanitary, process, cooling and storm wastewaters (cleaned, oiled, potentially polluted)
- K2 (shaft south – 2) discharge of stormwaters in case of overload of K1 outlet.

At EL-TO Zagreb location, two wastewater treatment plants are in operation (see **figure 2.7-1**):
- Plant for wastewater treatment from regeneration of ion exchange resins (wastewaters from chemical water treatment plant). The plant consists of five neutralization basins (with capacity of 100 m^3 each), and two sedimentation basins (150 and 100 m^3) with transitional basin and associated pumps. In the neutralization basins and after the pump, pH value is continuously measured.
- Plant for oily wastewaters treatment from „mazutno gospodarstvo“ (oily wastewater from the fuel unloading station and condensate from the fuel heater). The plant contains oily water separator with two separators connected in series. Capacity of separation basin is nominally 45 m^3/h and maximum 90 m^3/h. In separation basin, rotary cooler of condensate from „mazutno gospodarstvo“ is located as well. In the treatment procedure coagulator of oil is added. The sediments (sludge) from wastewater treatment and from oil-water separator as hazardous waste is handed over to the person authorized for management of this type of waste.

Wastewaters from the restaurant, before being discharged into the sewage, pass through the grease trap. Sanitary wastewaters are not treated before being discharged into the internal sewage system.

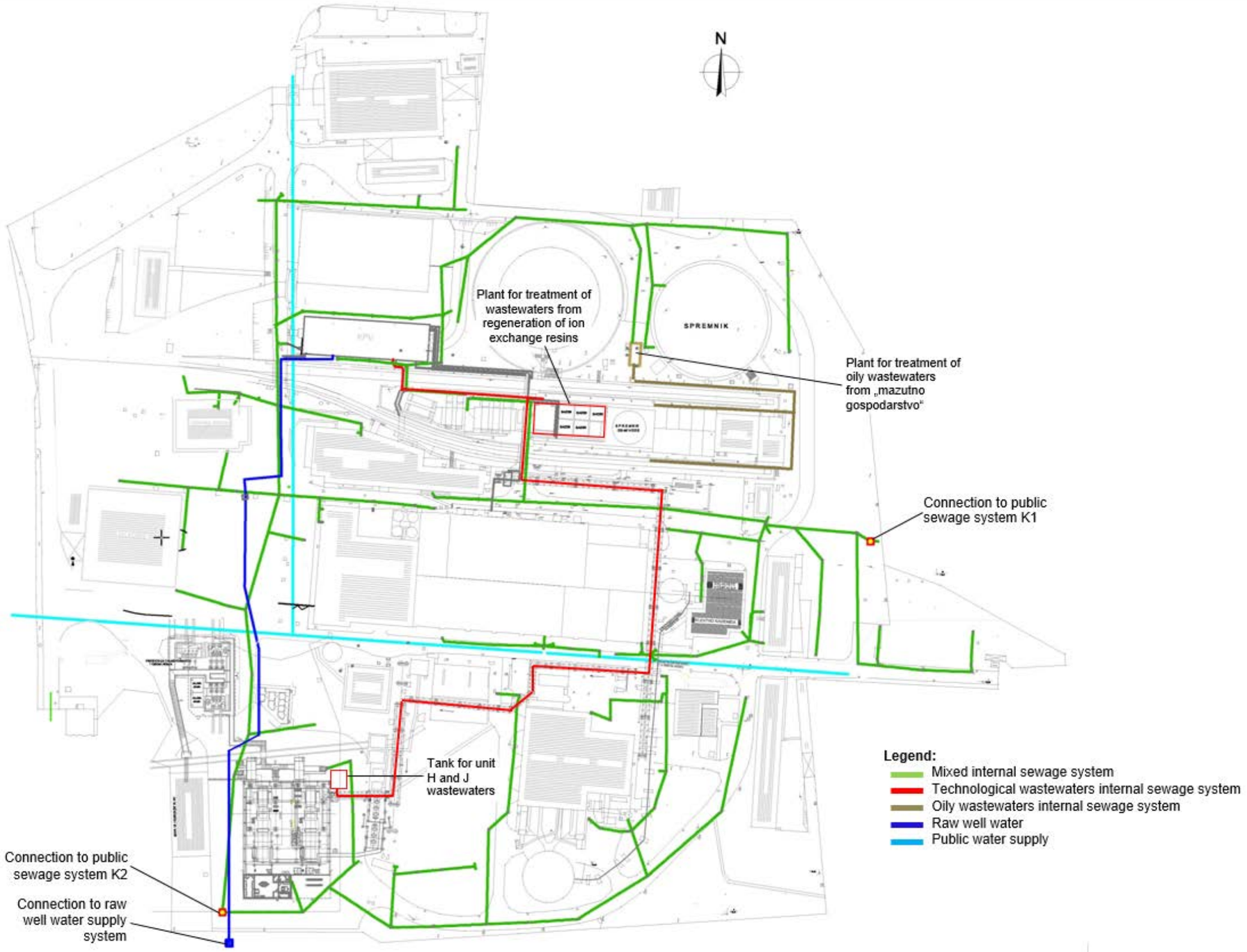


Figure 2.7-1: Water supply and wastewaters sewage system in EL-TO Zagreb

2.8 EMISSIONS TO AIR

In EL-TO Zagreb emissions of air pollutants were decreased in recent years as a result of reduced use of heavy fuel oil as fuel for boilers. This trend is expected to continue due to necessity of using liquid fuel with less than 1% sulfur, as well as complete replacement of liquid fuel with natural gas. Annual emission trend is shown in **figure 2.8-1**.

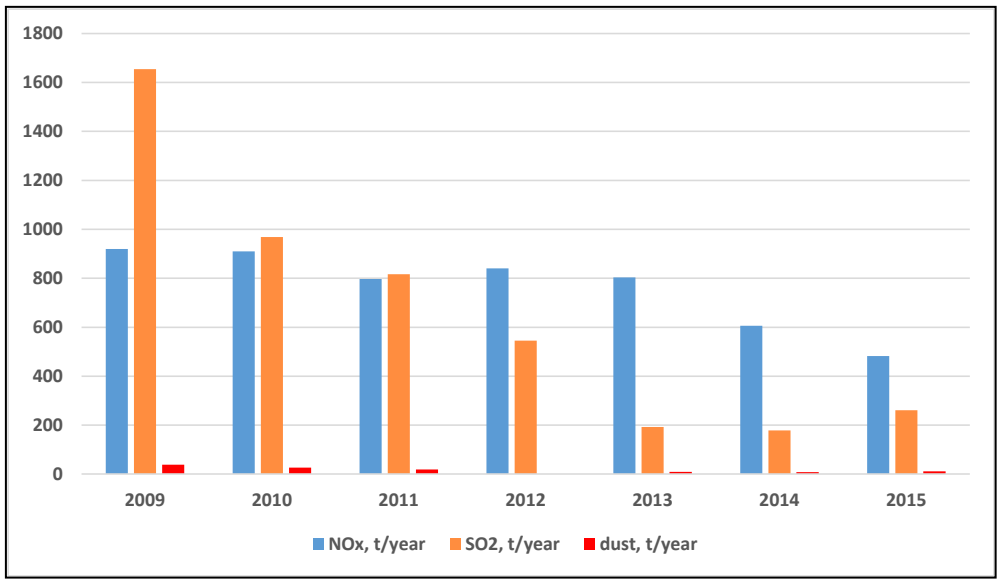


Figure 2.8-1: EL-TO Zagreb annual air emissions trend in period 2009-2015

2.9 NOISE

Noise levels in the open space, related to noise emissions of existing units of EL-TO Zagreb, were measured for the purpose of Environmental Impact Assessment Study for new CCCPP project in January 2014 and for the purpose of IPPC permit obtaining in March 2016[9].

Maximum permissible rating[10] noise levels in open space are given in Ordinance on Maximum Permissible Noise Levels in Areas where People Work and Live (OG 145/04). Those levels depend on noise zone of the project in subject and its vicinity. Noise zones are related to the use of space determined in spatial planning documents (GUP Zagreb).

Measurement in January 2014 is conducted at two measuring points, while measurement in March 2016 at 16 measuring points. Measurements are conducted during, related to noise protection, critical night period. In **tab. 2.9-2** noise measuring results are given.

[9] Report on noise measurement in open space, SONUS Ltd, March 2016
[10] Rating level: each predicted or measured acoustic level with added adjustment.
Adjustment: any value that is added to the predicted or measured acoustic level to take into account some noise features.

Tab. 2.9-1: Measured equivalent noise levels

Measuring point	$L_{A,eq}$ (dB(A))	k (dB)	$L_{RA,eq}$ (dB(A))	Max limit L_{night} $L_{RA,eq}$ (dB(A))
MV1	59			50
MV2	52			40
M01	52.8	-	52.8	45
M02	53.3	-	53.3	45
M03	60.9	-	60.9	80
M04	50.0	-	50.0	80
M05	57.6	-	57.6	80
M06	53.9	-	53.9	80
M07	54.9	-	54.9	80
M08	56.7	3	59.7	80
M09	52.0*	-	52.0*	80
M10	61.3	-	61.3	80
M11	57.2*	-	57.2*	80
M12	48.1	-	48.1	80
M13	53.8	-	53.8	80
M14	46.2	-	46.2	45
M15	46.6*	-	46.6*	45
M16	51.5*	-	51.5*	45

Noise levels measured in points M09, M11, M15 and M16 are dictated by noise from the environment that could not be isolated. In other points, measured noise levels are result of EL-TO Zagreb operation.

Noise levels measured in points MV1, MV2, M01, M02, M14 – M16 exceed maximum permissible levels for the night period and are below the maximum permissible levels for the day period.

GUP Zagreb has changed on 20 June 2016 in which zone west from the plant border has changed to zone 5 (for points M01, M02, M14 – M16). Accordingly, IPPC permit obtained in December 2016 set for EL-TO Zagreb maximum noise limits on the plant border of 80 dB(A) for day and night period.

2.10 HEALTH AND SAFETY

For EL-TO Zagreb a “Vulnerability Assessment” has been prepared, in which risk facilities and possible sources of danger have been identified. The worst-case accident and its effect has also been estimated.

Risk facilities of EL-TO Zagreb are:

1. Risk objects containing heavy fuel oil: storage tanks SG-1 and SG-2, tank wagon loading station, fuel oil station
2. Risk objects containing natural gas: metering-reduction station Botinec, 2 MRSs in EL-TO Zagreb, gas pipelines from MRS to consumers,
3. Chemicals storage,

4. Chemical water treatment and wastewater treatment,
5. Storage of compressed technical gases,
6. Storage of flammable liquids,
7. Transformers,
8. Systems for lubricating (turbine oils),
9. Hazardous waste storage,
10. Production units.

In EL-TO Zagreb many protection measures are applied for prevention of accidents:

- Measures for proper and safe handling and maintenance of equipment, vehicles, installations etc.,
- Monitoring and control of equipment and installations,
- Insurance against unauthorized access and
- Technical (passive) measures: design of equipment and objects/systems according to technical standards and regulations related to:
    - protection against earthquakes and landslides,
    - fire alarm, protection against fire and technological explosions,
    - protection against dangerous properties of substances that are used and stored,
    - protection against the spread of pollutants in soil, water or air in case of accidents (e.g. bunds, safety valves, separators, sewage systems and waste water treatment, etc.).

In each shift, EL-TO has a fire department on duty consisting of one professional firefighter and three employees trained as volunteer firefighters. Fire alarm, obligations and procedures are defined in the Plan of fire and technological explosions protection.

Transport of dangerous goods from the manufacturer/supplier to the warehouses of EL-TO Zagreb, as well as hazardous waste from the plant is carried out by company authorized to manage hazardous substances and possesses the appropriate vehicles, equipment and trained staff. EL-TO Zagreb transports only small amounts of hazardous substances within the site by its own vehicles.

In the event of an accident, collision or rollover, during the transport of dangerous goods from the manufacturer to the warehouse of EL-TO Zagreb, if the consequence is contamination at the plant site or outside it, the driver is obliged to immediately inform a responsible person in the facility of EL-TO Zagreb, company-carrier and the nearest police officer.

Emergency measures to prevent the spreading of hazardous substances into the environment is carried out, if necessary, by external authorized professional companies and in case of major accidents the County 112 center Zagreb is informed.

Emergency plans

EL-TO plant has several internal documents for managing safety issues in terms of accidents prevention and/or activities in case of accident occurrence:

- Operational plan for protection and rescue,
- Safety report,
- Internal emergency plan,

- Plan of fire and technological explosion protection,
- Operational plan of emergency measures in case of accidental water pollution and
- Evacuation plan.

In those documents, a personnel responsible for acting in case of accidents is appointed and notification schemes to responsible authorities (County 112 center – key spot of communication, fire brigade, ambulance etc.) are given.

Operational plan also establishes training plan for personnel education and program of exercises for emergency simulation (minimum ones per year).

Actions outside the EL-TO plant border are also subject of plans of higher order and actions of external service. Plans of higher order, Vulnerability assessment and Plan for protection and rescue for the City of Zagreb have been prepared.

2.11 BIOLOGICAL AND ECOLOGICAL RESOURCES

Project is planned in the urban area of the City of Zagreb, in the center of western part - the city district Trešnjevka and all elements of the project will be situated within the existing EL-TO Zagreb plant. The characteristics of the project's location are conditioned by many years of anthropogenic influence, so on the project site there are no individual protected plants and animal species. The entire location of the project is degraded area related to the aspect of flora and fauna.

2.12 PROTECTED AREAS

According to the spatial data of the State Institute for Nature Protection - Protected Areas of Croatia[11], the project site is not in area protected under the Nature Protection Act (OG 80/13) in the category of strict reserve, national park, special reserve, nature park, regional park, nature monument, significant landscape, park forest and / or park architecture monument.

The project location is not even in the area protected or registered by physical planning documents. The closest protected areas are monuments of landscape architecture that are protected by measures of General urban plan (GUP) of Zagreb. They are at distance of 200 - 300 meters from EL-TO Zagreb site.

2.13 ECOLOGICAL NETWORK (NATURA 2000)

The project location is not in ecological network. The nearest area of ecological network is conservation area important for species and habitat types HR2000583 Medvednica. HR2000583 Medvednica covers an area of 18,531.81 hectares. It is located north of the project location, at distance of about 4.5 km to the nearest point.

[11] http://natura2000.dzzp.hr:6080/arcgis/rest/services/zasticenapodrucja/zasticenapodrucja/MapServer

2.14 CULTURAL HERITAGE

According to data from the Register of Croatian cultural monuments[12], on EL-TO Zagreb location there are no protected, preventively protected and/or registered cultural properties[13]. According to the physical planning documents, in the area of EL-TO Zagreb there is an individual archeological site.

This archaeological site is registered individual archaeological site dated to the period of antiquity[14] because there is a bronze vessel found in the bottom of the antique well, which is now kept in the Archaeological Museum. One pitcher from the well is also mentioned. This well is not in the area where project construction is planned.

2.15 ENVIRONMENTAL MANAGEMENT SYSTEM

EL-TO Zagreb has established and certified integrated system of quality and environmental management in accordance with the international standards ISO 9001: 2008 and ISO 14001: 2004 since 2007.

An integrated system of quality and environmental management is manifested through an integrated policy of quality and environmental management, unified system of documentation and records management as well as through documentation encryption system, unique training system related to quality and environment, joint conduction of internal audits and assessment of the Management Board as well as a unique system of conduction of corrective and preventive actions and more.

Implemented integrated system of quality and environmental management is regularly internally assessed and evaluated by the external authorized certification organizations.

[12] Source: http://www.min-kulture.hr/default.aspx?id=6212
[13] Manifestation of the City Institute for Protection of Monuments of Culture and Nature (CLASS: 612-08/2013-01/761, REF.NO.: 251-18-02-13-2, 30 December 2013)
[14] Manifestation of the City Institute for Protection of Monuments of Culture and Nature (CLASS: 612-08/15-01/360, REF.NO.: 251-18-02-15-2, 15 July 2015)

3 OVERVIEW OF POTENTIAL ENVIRONMENTAL IMPACTS DURING PROJECT CONSTRUCTION WITH PROTECTION MEASURES

3.1 AIR

During construction, the air quality impact is a result of flue gas emissions from vehicles and equipment used during construction, i.e. emissions from trucks and construction machines. This emission depends on site activities, i.e. on types and intensity of activities.

As regarding the air quality impact, a dust fugitive emission could be significant as partly a result of construction works (site cleaning, excavation, earthwork, etc.) and partly due to dust rising during movement of construction machines and vehicles on the site.

Measures implemented on the site should ensure that impact during construction is not noticeable within the closest residential areas.

PROTECTION MEASURES:

- Wheels of vehicles entering public roads shall be cleaned/washed and, if necessary, accessing sections of public roads shall also be cleaned from dust and mud to prevent spreading of mud and dust from the construction site.
- The cargo (bulk, construction) shall be transferred by technically valid vehicles and, if necessary, it shall be damped and covered by a protective cover to prevent dusting.
- Take preventive measures at the construction site to minimize emissions of pollutants into the air during construction:
    - in case filter bags on the drilling rig or cement silo break, works shall be stopped and the bag shall be replaced,
    - unnecessary operation of construction machinery shall be avoided (machines shall be turned off),
    - earthwork and construction work contractors shall be requested to limit dusting to the construction site area by using protective fences or by dispersing water in dry or windy weather at active dusty construction site areas, in line with the type of works performed at individual construction site areas; silos of raw materials in the concrete batching plant shall be equipped with dedusters,
    - bulk materials shall be poured as close as possible to the surface to prevent dusting during loading/unloading of material into stockpiles or cargo vehicles as much as possible,
    - vehicle driving speed shall be adapted to the state of internal roads to decrease or avoid dusting of roads, as well as spilling of bulk material from vehicles,
    - open stockpiles of bulk material shall be damped or covered in dry and windy weather.
- Construction machines made or imported after 13 February 2009, which are used during construction, shall possess a type approval in line with the Regulation on Measures for Prevention of Emissions of Gaseous Contaminants and Contaminants in the Form of Particles from Internal Combustion Engines which are Fitted into TPV 401 Non-road Mobile Machinery (OG 4/14).

3.2 WATER

The waste waters will be generated at the site (potentially oily and conditionally polluted rainwaters, waste waters from mechanization, facilities and equipment washing), collected and treated and then discharged via existing sewer system to the public sewage system.

Sanitary waste waters will be discharged into existing sanitary sewage system.

The impact intensity will depend to a large extent on careful planning of activities, their intensity and particularly on the Contractor's due diligence during carrying out the activities. Critical activities will be carried out under supervision, including the environmental impact aspects as well.

PROTECTION MEASURES:

- During construction, it is required to implement and use a distribution sanitary waste water and rainwater sewage system. The sanitary waste water discharge should be connected to the EL-TO sanitary sewage system. Potentially polluted rainwaters should be treated in oil separator and precipitator/clarifier and discharged to the EL-TO storm water sewage system.
- The wastewater treatment should be carried out until the quality for discharge into the public sewage system.
- It is required to ensure that mechanization and fuel manipulation is placed on water-proof surface with rainwater drainage through oil separator.
- It is required to ensure appropriate absorption agents for treating the polluted soil on the construction site.
- Closed tank of 2 m^3 should be ensured for disposing the excavated earth polluted in case of spilling the fuel, lubricating oil or other substances hazardous for waters.
- The certificates of authorized institutions that used materials have no impact on ground water quality should be submitted on technical inspection. 15 days prior to commencement of these activities, competent authority should be notified on scheduled activities, while as regarding the activities carried out within the ground water zone, it is necessary to require water supervision from competent authority.

3.3 NOISE

Noise will occur during construction works as a result of operation of construction machines and equipment, as well as heavy trucks related to the site operation.

The highest allowed noise levels as a result of site operation are defined in Article 17 of the Ordinance on Maximum Permissible Noise Levels in Areas where People Work and Live (OG 145/04).

During daily period, allowed equivalent noise level amounts 65 dB(A). Within the period from 8 a.m. to 6 p.m., exceeding of additional 5 dB is allowed.

During night period, the equivalent noise level may not exceed values from table 1 of the Ordinance on Maximum Permissible Noise Levels in Areas where People Work and Live (OG 145/04).

Exceeding of allowed noise levels by 10 dB is allowed by exception, in case it is required by technological process lasting up to one night at most, i.e. up to two days within the period of 30 days. The Contractor is obliged to notify sanitary inspection on exceptional exceeding of allowed noise levels in written and to register it into construction journal.

Calculation of noise propagation[15] in the environment is carried out for the worst case – simultaneous work on the excavation of foundations and concreting in which four excavators and three cranes are in operation. Noise of transport trucks is negligible compared to the noise of those working machinery and equipment. The calculation uses the maximum sound power of the working machinery: Lw ≤ 110 dB(A) for the excavators and Lw=105 dB(A) for cranes.

The calculated noise levels that will occur at the reference points as a result of activities of project construction during these operating conditions are given in **tab. 3.3-1**. During all other phases of construction, noise emissions to the environment will be much lower.

Tab. 3.3-1: Noise levels at the reference points during construction

Reference point	**$L_{A,eq}$ [dB(A)]**
G1 - Reiffeisen bank building (north of EL-TO)	52,1
G2 – boundary area with office buildings (northwest of EL-TO)	61,4
G3 – boundary area with residential buildings (south of EL-TO)	53,0

Noise levels are lower than permitted for the entire day period, from 7 a.m. to 11 p.m.. Graphic display of noise propagation from construction site is presented in **figure 3.3-1**.

PROTECTION MEASURES:

- The construction site should be organized in a way to minimize the noise spreading towards the closest residential areas.
- During construction works, low-noise construction machines and equipment should be use.
- Noisy works should be organized during the day and only exceptionally during the night, when required by technology.

[15] Calculation of noise propagation in the environment was carried out by commercial computer software "Lima", the method according to ISO 9613-2 / 2000: Attenuation of sound propagation outdoors - General method of calculation - the noise from industrial sources.

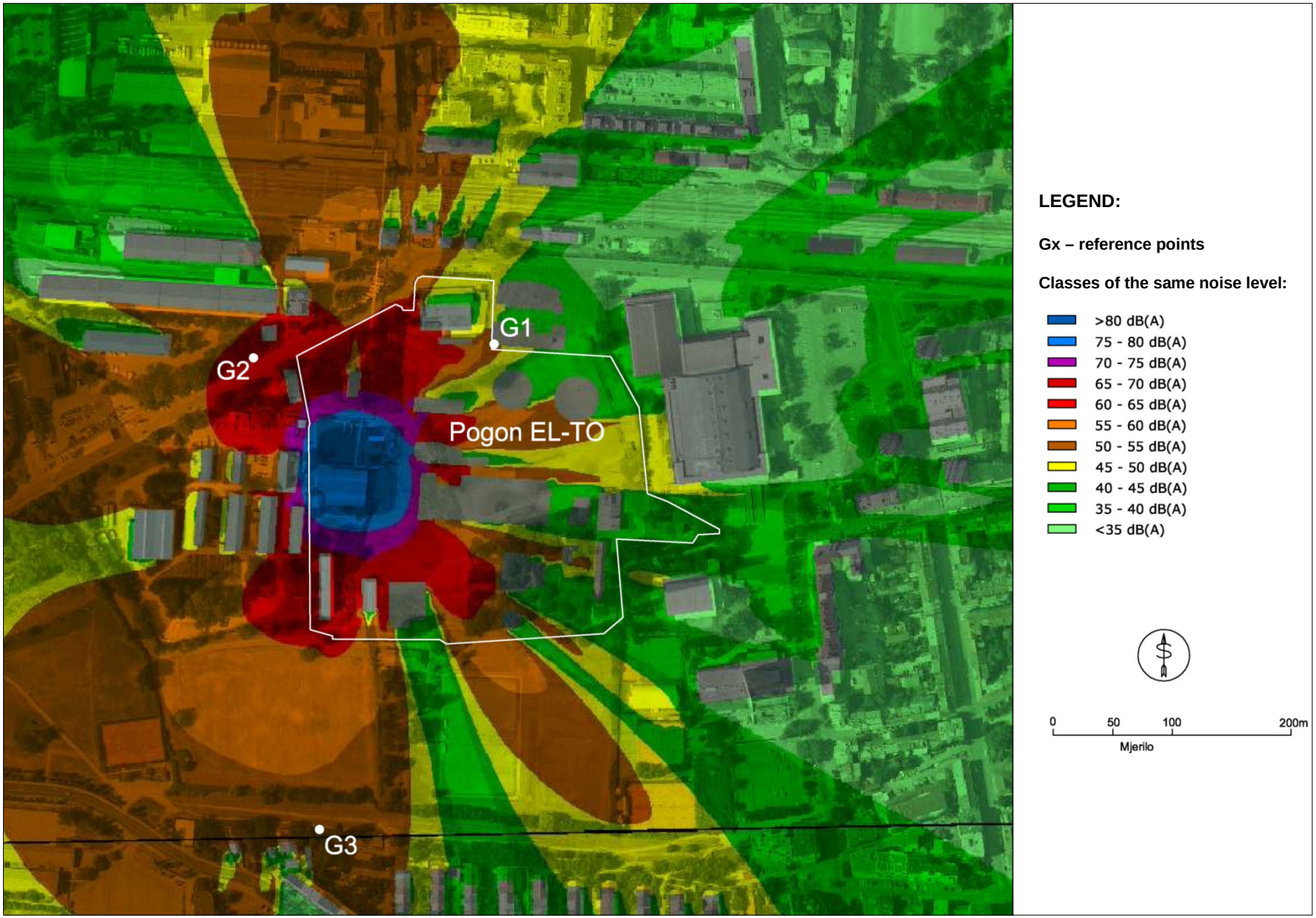


Figure 3.3-1: Graphic display of noise propagation from project construction site

3.4 WASTE

The site preparation, including removal of existing storage building[16] and EL-TO administration building[17], proceeds to the construction of new CCCPP. Buildings removal will be carried out in accordance with prepared projects of storage and administration building removal.

While removing the buildings, large amounts of various types of construction waste will be generated: waste concrete and asphalt, waste iron and steel, aluminium, tiles/ceramics, insulation mineral wool, waste wood, glass, waste plastic, waste wires and cables. Generation of smaller amounts of oily waste is possible as well.

During site preparation, excavation material will be generated and used for terrain landscaping and backfilling where required. Part of unused earth material should be transported and disposed to appropriate location intended for construction waste management.

The management of waste generated during buildings removal and site preparation should be carried out by legal entities authorized for managing individual types of waste. The advantage in waste management is given to recovery procedures in relation to waste disposal procedures.

All waste generated during construction should be collected separately by types and temporary disposed in existing temporary storages of hazardous and non-hazardous waste in EL-TO. The waste transport should be complied with construction dynamics.

PROTECTION MEASURES:

- Waste from storage and administration building removal should be separated at the site.
- Management of waste generated during storage and administration building removal, as well as during site preparation, should be carried out by legal entities authorized for waste management. The advantage in waste management should be given to recovery procedures in relation to waste disposal procedures.
- All waste generated during construction should be collected separately by types and temporary stored in existing temporary storages of hazardous and non-hazardous waste in EL-TO Zagreb.
- Storage tanks with hazardous waste should be designed in a way to prevent the waste scattering, spreading and/or spilling, as well as rainwater entering. The storage tanks should be made of appropriate material, resistant to the temporary stored waste.
- Organize waste removal in line with the dynamics of project construction.
- Management of waste generated during construction should be carried out by legal entities authorized for waste management. Construction waste should be transported to appropriate location organized for construction waste management, except for waste that could be used as secondary feedstock (wood, glass, plastic, iron, steel, mixed metals). Waste generated during mechanization maintenance should be disposed by legal entities authorized for waste management. Municipal waste should be disposed by legal entities authorized for waste management.

[16] Project of storage removal within the EL-TO plant, EKONERG Ltd, 2014
[17] Project of the existing administration building removal, ELEKTROPROJEKT d.d., 2014

- Data on waste and waste management during preparation works and construction should be documented according to regulations. Data on waste management should be reported to the authorities on prescribed forms, i.e. should be submitted to the Environmental Pollution Register of the Environmental Protection Agency.

3.5 LANDSCAPE FEATURES

The planned construction will be a continuation of reinforcing the ambient transformation into industrial subtype of cultural landscape within the area of highly urban tissue of block-type construction in the west part of the City of Zagreb, i.e. it concerns the local impact. The construction of new building structures in EL-TO Zagreb will be carried out within the industrial area preserving its homogenous character. The structure of planned unit is assumed in the area where there is existing administration building and storage building. The landscape structure of narrower area remains unchanged, while landscape impact is indirect, long-term, of minimum power and carried out within the zone already changed by existing impacts of surrounding industrial infrastructure.

PROTECTION MEASURES:

- A construction site arrangement plan shall be prepared, which shall indicate the arrangement of all working surfaces at the least visually exposed locations.
- Upon finalization of construction, repair the surfaces which were used for construction as well as any potential temporary roads and execute landscape adjustment.

3.6 POPULATION AND AREA IN RELATION TO TRANSPORT NETWORK

The existing EL-TO Zagreb location is well connected to the City of Zagreb transport infrastructure, i.e. the Republic of Croatia. On north side, there are quite frequent Magazinska and Zagorska roads passing by the location.

Several types of transport can be selected during preliminary works and construction:
1) Group or organized transport of workers to the site
2) Individual transport of workers to the site
3) Site visits
4) Cargo transport from the site
5) Cargo transport to the site
    - construction materials
    - special cargo

All transport network loads and potential difficulties in transport represent impacts, which will occur mostly during preliminary works and construction and terminate upon the work termination, i.e. their duration is limited and could be minimized by implementing appropriate measures in individual phases of preliminary works and construction. Slightly larger traffic increase is expected in rush hours at maximum loads.

For the purpose of reducing the negative impact of transport load increase, it is required to prepare the project of temporary traffic control during preliminary works and construction, which should define access points to existing transport system and ensuring all potential collision

points during preliminary works and construction. Traffic control can be carried out by placing the traffic signs, occasional slowing down and/or redirecting the traffic on certain roads.

Besides the road network, the railway infrastructure is available as well, thus it is possible to use the railway as alternative, ecological and cost-efficient way of cargo transport to the site.

PROTECTION MEASURES:

- Temporary traffic regulation plan shall be prepared for the period of construction of the planned project, which shall define points of access to the existing traffic system and secure all potential collision points during the project construction.
- All large transports not being technologically conditioned should be planned within the period outside of so called rush hours (6 a.m. to 9 a.m. and 3 p.m. to 6 p.m.) in order to reduce the traffic load.
- In case of damaging existing roads (by using equipment, machinery and vehicles), it shall be necessary to inform the competent authorities to eliminate the damage.
- It is required to clean the access roads of dust and mud and all vehicles should get their tyres washed prior to entering the public roads.

3.7 LIGHT SOURCES

In general, construction works are not carried out during night, but sites are illuminated mostly due to safety reasons, i.e. due to supervision. Since the location of planned project is within EL-TO Zagreb, where the access is restricted and strictly controlled and where external lighting of internal roads already exists, it can be expected that site lighting will be minimum. In case some construction works will be carried out during night in order to fulfil contractual deadlines, the site will be illuminated in duration required for carrying out such necessary works. The site lighting contribution to the City of Zagreb night lighting is irrelevant.

3.8 DANGEROUS SUBSTANCES

During construction, it is possible that fuel storage tanks (canisters and barrels) will be located at the site. Classic petrol and diesel fuels are flammable products, dangerous for water environment and harmful for human health. However, by their appropriate storing – protected against the sun and precipitation in water-proof tank farm, without any sparking or ignition source nearby, by controlled access and using absorption agents for covering potentially spilt fuel in case of fuel leakage or spilling, the environmental impacts are eliminated and/or quickly localized.

PROTECTION MEASURES:

- In case there will be fuel storage tanks on the construction site for the construction purposes, the latter should be located in water-proof bund without discharge. The storage tanks should be protected against the sun and precipitations. Access to the tanks should be strictly controlled. There shall not be any sparking or ignition source nearby. The fire extinguishers should be placed nearby the tanks and appropriate absorption agents for covering potentially spilt fuel should be ensured.

4 OVERVIEW OF POTENTIAL ENVIRONMENTAL IMPACTS DURING PROJECT OPERATION WITH PROTECTION MEASURES

4.1 AIR

The impact of CCCPP is based on the description provided by Environmental Impact Assessment Study for the new CCCPP project. Additionally, new issues related to the future EL-TO emissions and recently adopted Zagreb air quality plan are discussed here.

4.1.1 EMISSION TO AIR

At EL-TO Zagreb location, new CCCPP will be the base load unit of district heating system. CCCPP will use only natural gas as a fuel. The realization of CCCPP project will significantly reduce the usage of existing generating units, as well as total emission of air pollutants from EL-TO Zagreb will be reduced.

Comparison of hourly emissions of Unit A and new CCCPP is given in **figure 4.1-1**. In relation to existing Unit A, new CCCPP will generate significantly more electricity and heat (cca. seven times more).

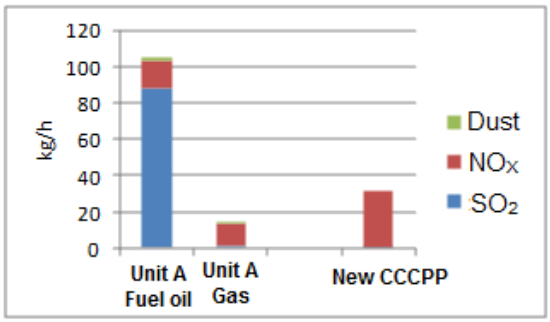


Figure 4.1-1: Emissions of SO_2, NO_X and dust from Unit A (current state) and new CCCPP

New CCCPP is planned to be put into commercial operation, at best, in autumn 2019. The transitional period for compliance with the Directive on industrial emissions[18] will be ended at 1 January 2018. Therefore, certain EL-TO generating units will be put out of operation.

In years after commissioning of new CCCPP, hot water boilers VK-3 and VK-4 and gas turbine units H and J will be still in operation and all generating units will use natural gas as a fuel.

4.1.2 IMPACT ON AIR QUALITY

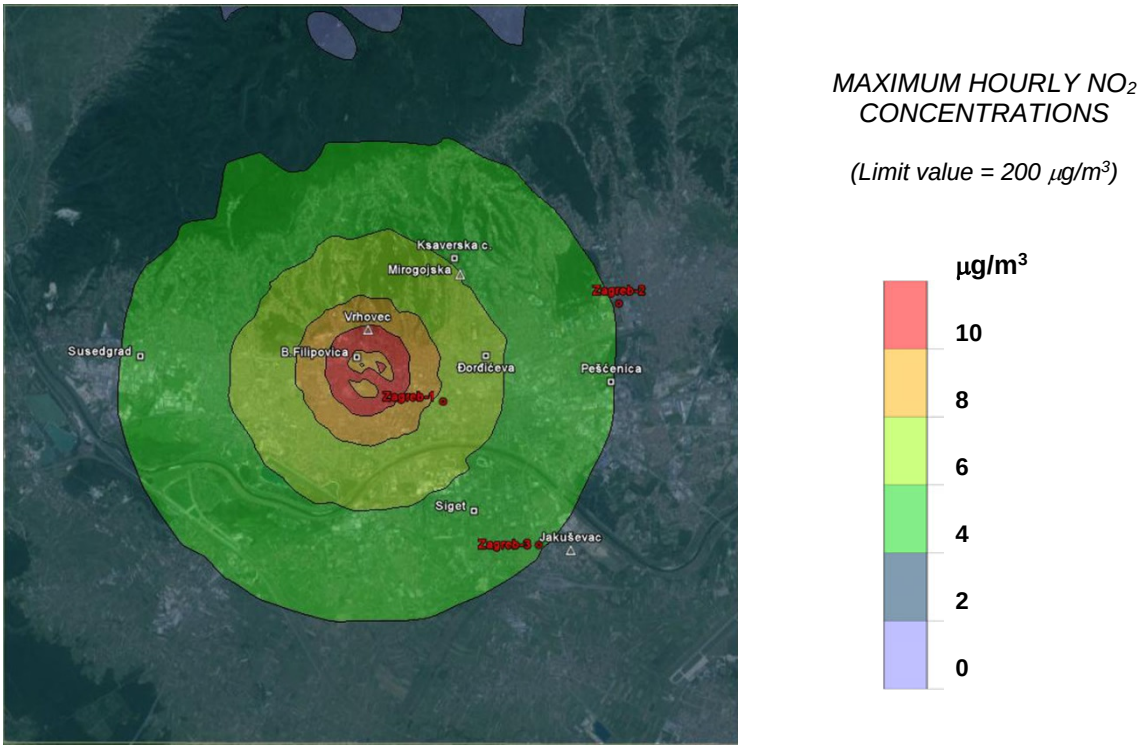
Since new unit uses natural gas as fuel, the impact on air quality is primarily related to an increase in the concentration of nitrogen dioxide (NO_2) in the immediate vicinity of sources.

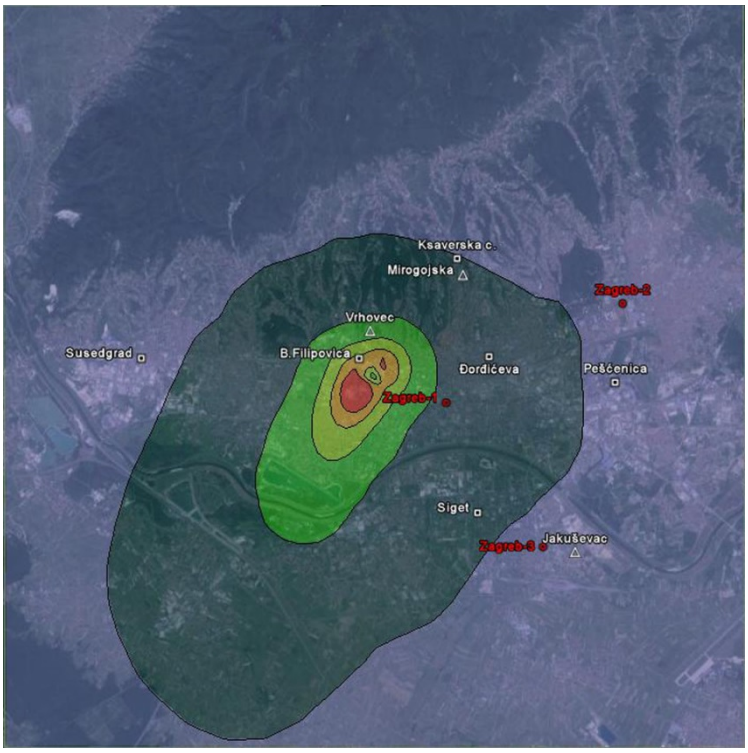
[18] Derogations from emission limit values associated with EU directives is set by the Treaty between member states of the European Union and the Republic of Croatia (OJ L 112, 24.4.2012)

Regulation on Levels of Pollutants in Ambient Air (OG 117/12) prescribes the limits for hourly and annual NO_2 concentrations, and the effect was analyzed with respect to these air quality standards.

The US EPA regulatory model AERMOD is applied for dispersion calculation. The Tier 1 approach that assumes the complete conversion of all emitted NO to NO_2 is applied to estimate ambient concentrations of NO_2 in this study. It should be mentioned that NO_x emissions from CCCPP will consist of the gases NO and NO_2. In terms of environmental impact it is only NO_2 that is of concern. Since NO converts to NO_2 in the atmosphere it must also be considered. The rate of oxidation of NO to NO_2 depends on both the chemical reaction rates and dispersion of the plume in the atmosphere. However, the instantaneous complete conversion of all emitted NO to NO_2 (Tier 1 approach) leads to overestimation of NO_2 concentration near the source.

Figure 4.1-2 shows the dispersion model calculation results: maximum hourly and annual average concentrations of NO_2 under the influence of new unit emissions. The highest hourly concentrations can be expected in any direction relative to the stack within 1 km distance from the stack.





AVERAGE ANNUAL NO_2 CONCENTRATION

(Limit value = 40 $\mu g/m^3$)

µg/m³

0.5

0.4

0.3

0.2

0.1

0.0

Figure 4.1-2: NO_2 concentrations within the area of 20x20 km during the new unit operation calculated by a dispersion model

Dispersion modeling results show that maximum impact of CCCPP on hourly NO_2 concentration is 10.6 µg/m^3. That is less than 5% of the referent limit value (200 µg/m^3). The impact of new unit at the average annual concentration of NO_2 is less than 0.7 µg/m^3 or less than 2% of the referent limit value (40 µg/m^3).

In terms of cumulative impacts, changes in total emissions of EL-TO must be taken into consideration. Before commissioning a new unit, the reconstruction of existing units (H, J) should be implemented and some old units will be shut down, which will significantly reduce total emissions in the future.

In the environmental impact assessment study of CCCPP the dispersion modeling is done for current and future emission scenarios for EL-TO power plant. The current and future emission sources in EL-TO power plant are:

Emission scenario	Units in operation
Current	K6, K7, K8, K9, VK4, H, J
Future	CCCPP, VK4, H(reconstructed), J(reconstructed)

Cumulative impact assessment for current and future emission scenario is modeled for total maximum emission that corresponds with maximum emission during heating season. Dispersion model calculation showed that future impact of total EL-TO emission on air quality will be less than current impact of EL-TO.

Low emission due to compliance with EU Industrial emission directive (2010/75/EC) and 60-meter high stack insures that CCCPP will have very low impact on air quality of surrounding area.

In the future there will be no significant adverse impacts due to CCCPP emission. Overall future cumulative emission of EL-TO power plant will be less since the fuel oil will not be used and old boiler units will be put out of operation.

Comment on emission limit values for existing gas turbines

At the time when process of environmental impact assessment for CCCPP was going on, emission limit values set by national legislation for existing gas turbines were different than they are today.

In the environmental impact assessment study future emission scenario includes emissions of reconstructed gas turbines H and J. That implies that gas turbines H and J will comply with NO_x limit value of 150 mg/m^3 according to the Regulation on Limit Values for Pollutant Emissions from Stationary Sources into the Air (OG 117/12).

However, the "Regulation on Limit Values for Pollutant Emissions from Stationary Sources into the Air" was changed in July 2014 (OG 90/14). Now, NO_x emission limit value for existing gas turbine (> 50 MW_{th}) is 300 mg/m^3. That is higher than actual emission of units H and J so there will be no reconstruction of those units in the future. In addition, there will be no change in H and J maximum hourly emissions in the future, but annual emission should be significantly lower when CCCPP becomes the base load unit of EL-TO power plant.

The existing gas turbines (H and J) are the major source of NO_x emission at EL-TO location for current and future emission scenario. The current and future cumulative impacts of EL-TO power plant are dominantly under the influence of existing turbine emission (units H and J). The future total emission of EL-TO power plant will not be increased because the old boiler units (K6, K7, K8 and K9) will be shut down. Nevertheless, the CCCPP will significantly lower total EL-TO emission any time when it replaces units H and J production.

Recent development in EL-TO power plant

Recent EL-TO development plan includes building of new medium size boiler and heat accumulator.

A project of building up new 30 MW_{th} boiler at EL-TO location started in 2015. The purpose of building a new boiler is to increase security of supply and more efficient heat generation in EL-TO Zagreb. Nowadays, there is irrational production of electricity cogeneration units during low load in the summer and partly in transitional periods the year. The new boiler would be in operation about 1500 hours per year so the annual emission would be 8.6 tons of NO_x per year.

New 30 MW_{th} boiler will increase the safety of heat supply since the Unit A and the Unit K-7 are at the end of their planned life. Unit A, Unit B and boiler K-7 will be out of operation by the end of 2018, but a new combined cycle cogeneration power plants (CCCPP) will not be put in operation by that time. It is planned that the existing gas turbines (Units H and J) will be in operation by 1 January 2023. In the period 2018 - 2022 a new boiler is needed because of the security of heat supply and from 2023 new boiler is necessary to meet the needs for peak heat consumption.

Since new boiler is considered as medium size boiler (< 50 MW_{th}) the environmental impact assessment study was not obliged. Environmental impacts are considered within the process of issuing building permit. Part of the project documentation for issuing building permit was the Environmental report for building a low-pressure steam boiler with connection to the existing plant boilers K7, K8 and K9 at EL-TO Zagreb. Impact of new boiler as well the cumulative

impact of all EL-TO units was analyzed in that environmental report. According to dispersion modeling results, future cumulative impact of new 30 MW_{th} boiler and other EL-TO units (CCCPP, VK4, H and J) will be less than the current impact of EL-TO.

New 30 MW_{th} boiler at EL-TO will not cause the additional burden of NO_2 concentration in surrounding area.

Building permit for heat accumulator at EL-TO site was also issued in 2015. The environmental impact assessment was also part of documentation for issuing building permit. Heat accumulator is not a source of emission to air so there is no direct impact on air quality. Indirectly, heat accumulator has positive effect because it lowers the heat generation as well the air emission of boilers or gas turbines at EL-TO site.

Air quality plan for City of Zagreb

Based on Zagreb air quality monitoring data the non-compliance had been identified for NO_2, PM_{10}, $PM_{2.5}$, benzo(a)pyren and ozone in previous years. The air quality plan for the achievement of air quality standards for named pollutants was adopted in March 2015 (*"Action plan to improve air quality in the City of Zagreb, OG City of Zagreb 5/15)*.

Air quality monitoring stations located near the busy city roads had been reported exceedances of annual limit values of NO_2 since 1990's. There were no exceedances of 1-hour NO_2 limit value at Zagreb air quality monitoring stations. The traffic emission is the main cause of NO_2 non-compliance in Zagreb as is concluded in the air quality plan. The number of monitoring sites with exceedance of annual limit value varies from year to year. There is no clear trend in NO_2 annual concentrations at exceedance monitoring sites.

At Vrhovec air quality monitoring station, from year to year, the annual NO_2 concentrations are well below the limit values and also there is no exceedance of 1-hour NO_2 limit value. Even though the EL-TO power plant is the largest point source in the area, air quality monitoring shows that it does not cause the NO_2 non-compliance.

In the Zagreb air quality plan there are no mitigation measures regarding emission from EL-TO power plant.

4.1.3 IMPACT ON REGIONAL AND GLOBAL SCALE

Impact on regional scale is related to the secondary air pollutants and their deposition hundreds of kilometres from the source. Well-known secondary air pollutants are sulphates and nitrates (constituents of particulates) and ground-level ozone.

Acidification and eutrophication

Air emission of sulphur dioxide and its atmospheric transport lead to the conversion into sulphates, which are deposited by precipitation or in dry form. Precipitations become acidic and have a harmful effect on vegetation and forests. The CCCPP has negligible SO_2 emissions and therefore there is no impact on acidification.

Eutrophication is caused by the excessive deposition of nitrogen compounds. Nitrogen deposition on the Croatian territory generally remained at the same level in the last ten years.

Effect of CCCPP on nitrogen deposition should be viewed in the context of regional pollution or Croatian emission quotas[19] and quotas in the revised protocol to abate acidification, eutrophication and ground-level ozone (Gothenburg Protocol), to the Convention on Long Range Transboundary Air Pollution (LRTAP). The CCCPP NO_x emission in the maximum annual plant operation can reach 150 tons per year that is approximately 0.21% of the Croatian emissions in 2010, and, according to the scenarios for 2020, will represent approximately 0.33% of the emissions in 2020.

Ground-level ozone

Emissions of NO_x from CCCPP, along with other emissions of ozone precursors in Croatia, contribute to ozone formation but it is relatively minor contribution compared to contributions of other countries. It is shown that the emission from CCCPP is about 0.21% of Croatian emissions and the Republic of Croatia contributes to ozone concentrations with approximately 5 - 10 %, which means that the contribution of CCCPP is approximately 0.011 - 0.021 %.

Effect of the CCCPP on ozone formation on a regional scale should be viewed in the context of the existing quotas and new obligations of the Republic of Croatia under the revised Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone (Gothenburg Protocol) (after 2020). The Republic of Croatia has prescribed emission limit values by which it evaluates the ability to meet commitments and which should be in accordance with the Best Available Techniques. The Republic of Croatia has the right to prescribe lower emission ceilings on its territory in the future, if required, and, in this regard, lower emission limit values for NO_x for combustion plants and gas turbines.

Impact on climate change

The combustion of natural gas produces emissions of CO_2 while other greenhouse gas emissions are relatively small. Greenhouse gas emission from CCCPP, will be in range 191 kt (3500 h/year) – 395 kt (7000 h/year) per year. This emission has no impact on the health of population in the area, nor the vegetation. Furthermore, this emission has no impact on local climate change. CO_2 emission from the plant increases the level of concentration in the atmosphere and this has an impact on climate change at regional and global levels. Change in the concentration of CO_2 in the immediate environment due to emission will be immeasurable.

The CCCPP emissions, in relation to greenhouse gas emissions in the Republic of Croatia in 2013 represent 0.78% - 1.61% of total national greenhouse gas emissions and 1.05% - 2.18% of emissions from energy sector.

PROTECTION MEASURES:

- Combined cogeneration plant to be conceived as powered by natural gas with rated heat output of 234 MJ/s, under standard ISO environmental conditions (15°C, 1013 mbar, 60% humidity).
- Two chimneys at least 60 m high to be designed for release of flue gases from exhaust-gas boilers.
- Within the stacks of combined cogeneration plant, plan the implementation of continuous monitoring system of CO and NOx emissions, oxygen volume fraction, emitted mass flow rate and temperature in waste gases.

[19] Regulation on emission ceilings for certain pollutants in the Republic of Croatia (OG 141/08)

- Foresee a design of gas turbines with dry combustion chamber with low NOx burners.
- Natural gas will be used as fuel for combined cycle gas turbine cogeneration unit.
- Maximum heat output (fuel-introduced heat) of the combined cogeneration plant shall be about 300 MJ/s.
- Flue gases from CCCPP should be discharged through two stacks with minimum height of 60 m.
- The emission limit values (ELV) of CCCPP are as follows:

	mg/m^3
NO_X (as NO_2)	50
CO	100

Emission limit values are related to dry flue gases, at temperature of 273 K and pressure of 101.3 kPa, for defined oxygen volume share of 15 %.

- The emission limit values (ELV) for NO_X and CO will be applied for loads exceeding 70 %.
- The ELVs shall be regarded as having been complied with if based on the continuous measurements within calendar year:
  – all validated monthly average values are lower than ELV,
  – all validated 24-hour average values are lower than 1.1 ELV,
  – 95 % of validated hourly average values over the year are lower than 2 ELV.
  The values measured during the start-up and shut-down periods shall be disregarded.

MONITORING PROGRAMME:

DURING TRIAL OPERATION

- At CCCPP, before obtaining the operating licence, it shall be necessary to make first measurements of CO, NO_2, SO_2 and solid particles emissions.
- The first measurements shall also be used to check the nominal heat output of the CCCPP and the efficiency rate at the nominal fuel consumption.

DURING REGULAR OPERATION

- It is required to continuously monitor the emission of CO, NO_2, oxygen volume share, emitted mass flow and temperature in the CCCPP flue gases.
- It is required to ensure continuous data transmission via computer network into the emission monitoring information system managed by the Environmental Protection Agency.
- Monitoring of SO_2 and solid particles emission should be carried out every six months.
- Automatic monitoring system for continuous emission monitoring of CCCPP should be calibrated and tested once a year.

4.2 WATER

During the use of this project, process, rainwater and sanitary waste water will be generated and through the existing internal sewerage system at the EL-TO location, discharged into the public sewerage system of the City of Zagreb.

Process waste water will be generated during desludging and desalting of boilers (waste water from boilers) and drainage of boiler stacks and occasionally from washing fire sides of the

boilers. During regular maintenance, the process waste water from washing the compressor blades will be generated as well.

Waste water from boilers will be introduced into the existing hot water system as a supplement to water losses. Process waste water from washing fire sides of the boiler and from washing the compressor blades will be collected in a new 5 m^3 tank and transported by an authorized institution.

Sanitary waste water will be discharged into the existing drainage system of sanitary waste water.

Rainwater from traffic and maneuvering areas, after being treated in the oil and grease separator, will be drained to the existing sewage system.

Clean rainwater from the roofs will be drained directly to the existing drainage system.

PROTECTION MEASURES:

- A system for injection of boiler wastewaters into the existing hot-water system (boiler blow down and desalting and sampling from water-steam cycle) shall be foreseen.
- For process wastewaters from chimney drainage, a connection to the existing EL-TO plant technological wastewater treatment and discharge system shall be foreseen.
- For process wastewaters contaminated by heavy metals, a temporary storage in an adequate tank on the project location and transfer to an authorized person shall be foreseen.
- For sanitary wastewaters, no-treatment system with discharge into the EL-TO plant's mixed sewage system shall be foreseen.
- For potentially oiled and contaminated storm waters, treatment in precipitator/separator and connection to the existing EL-TO plant's mixed sewage system shall be foreseen.
- Outlets with a trench for drainage of potential oil leakage into the bund (oil sump) shall be provided under the transformer. Sump shall be equipped in such a way so as to allow removal of contaminated collected water/sludge from EL-TO location.
- A connection to the existing EL-TO plant sewage system and release on the surface of own terrain shall be foreseen for clean storm waters in such a way so as not to endanger surfaces of adjacent plots.
- Wastewaters resulting from washing of boiler gas side and compressor blades shall be collected into a 5 m^3 tank intended for that purpose and disposed of via an authorized person.
- Waste water/sludge from transformer sump shall be delivered to an authorized person.
- Wastewaters from project location should be discharged pursuant to the Ordinance on Wastewater Emission Limit Values (OG 80/13, 43/14).
- Structural stability, functionality and impermeability of facilities for wastewater drainage shall be inspected in line with the provisions of the Ordinance on Technical Requirements for Sewage Facilities as well as on Deadlines for Mandatory Controls of Drainage and Wastewater Treatment Facilities Correctness (OG 3/11).

MONITORING PROGRAMME:

DURING TRIAL OPERATION

- In control shaft, prior to connecting to the public sewage system and after wastewater treatment, it is mandatory to measure the flow and to take composite samples for determining the wastewater composition.
- The wastewater sampling should be carried out by own automatic sampling equipment, at least four times a year (on quarter basis), by taking composite samples (every hour during 24-hour period).
- Wastewater composition testing shall be performed via an external authorized laboratory, by taking composite samples every hour during a 24-hour period.

DURING COMMERCIAL OPERATION

- In control shaft, prior to connecting to the public sewage system and after wastewater treatment, it is mandatory to measure the flow and to take composite samples for determining the wastewater composition.
- The wastewater sampling should be carried out by own automatic sampling equipment, at least four times a year (on quarter basis), by taking composite samples (every hour during 24-hour period).

4.3 NOISE

Dominant noise sources are placed in indoor spaces with façade walls and roofs made of thermal panels which sound reduction index equals R_w = 30-46 dB, except for the sources where this is not possible due to technological reasons. Entrance doors of noisy areas must meet the criteria Rw ≥ 30 dB.

Dominant sources of noise during the plant operation are given below[20]:
- gas-turbine unit (noise level in the engine room: $L_p \leq 85$ dB(A))
- air intake for gas turbines (2 air intakes: L_w = 87 dB(A))
- gas turbine ventilation (2 x 2 fans: intake: L_w = 78 dB(A); exhaust: L_w = 77 dB(A))
- engine room ventilation (10 fans: L_w = 76 dB(A))
- stacks (L_w = 85 dB(A))
- transformers (3 block transformers: $L_w \leq 90$ dB(A); 2 self-consumption transformers: L_w = 75 dB(A))
- air-cooled heat exchanger (summer coolers and closed system coolers: $L_w \leq 103$ dB(A))
- feed water pumps.

The area most threatened by noise of the new unit will be a residential area located directly along the western border of EL-TO and the areas with existing residential objects south of the EL-TO complex (south of Munjarski put, within the area planned for mixed – mainly residential purposes (M1) and residential purposes (S), according to the Master Plan) and northwest of the EL-TO complex (north of Zagorska street, within the area planned for mixed – mostly business purposes (M2), according to the Master Plan).

Six specific points were selected as immission reference points, of which three are located along the western fence of the EL-TO complex (border with an area of possible residential building) and one on each border of the other most vulnerable areas (refer to **figure 4.3-1**):
- R1 - R3: M1 zone border along the western fence of the EL-TO
- R4: M1 zone border south of the EL-TO

[20] Data on the dominant noise sources, are based on data from potential vendors, with applied additional noise protection measures.

- R5: S zone border south of the EL-TO
- R6: M2 zone border northwest of the EL-TO.

Based on the measurement of existing level of residual noise at the project location (**chapter 2.9**), in accordance with the provisions of Articles 5 and 6[21] of the 'Ordinance', the maximum permissible noise levels that will be present at the reference points due to noise sources of the project in question, are as follows:

- R1, R2 and R3 (M1 zone border - West): 40 dB (A)
- R4 (M1 zone border - South): 40 dB (A)
- R5 (S zone border - South): 35 dB (A)
- R6 (M2 zone border - North): 45 dB (A).

Calculation of noise dispersion, as a consequence of CCCPP operations, was performed for the worst case, with all sources of noise being in use simultaneously. Maximum values of noise levels or sound power levels listed above were used in calculations.

The expected noise levels, which will occur at the immission reference points due to the operation of the new plant, are given in **figure 4.3-1**.

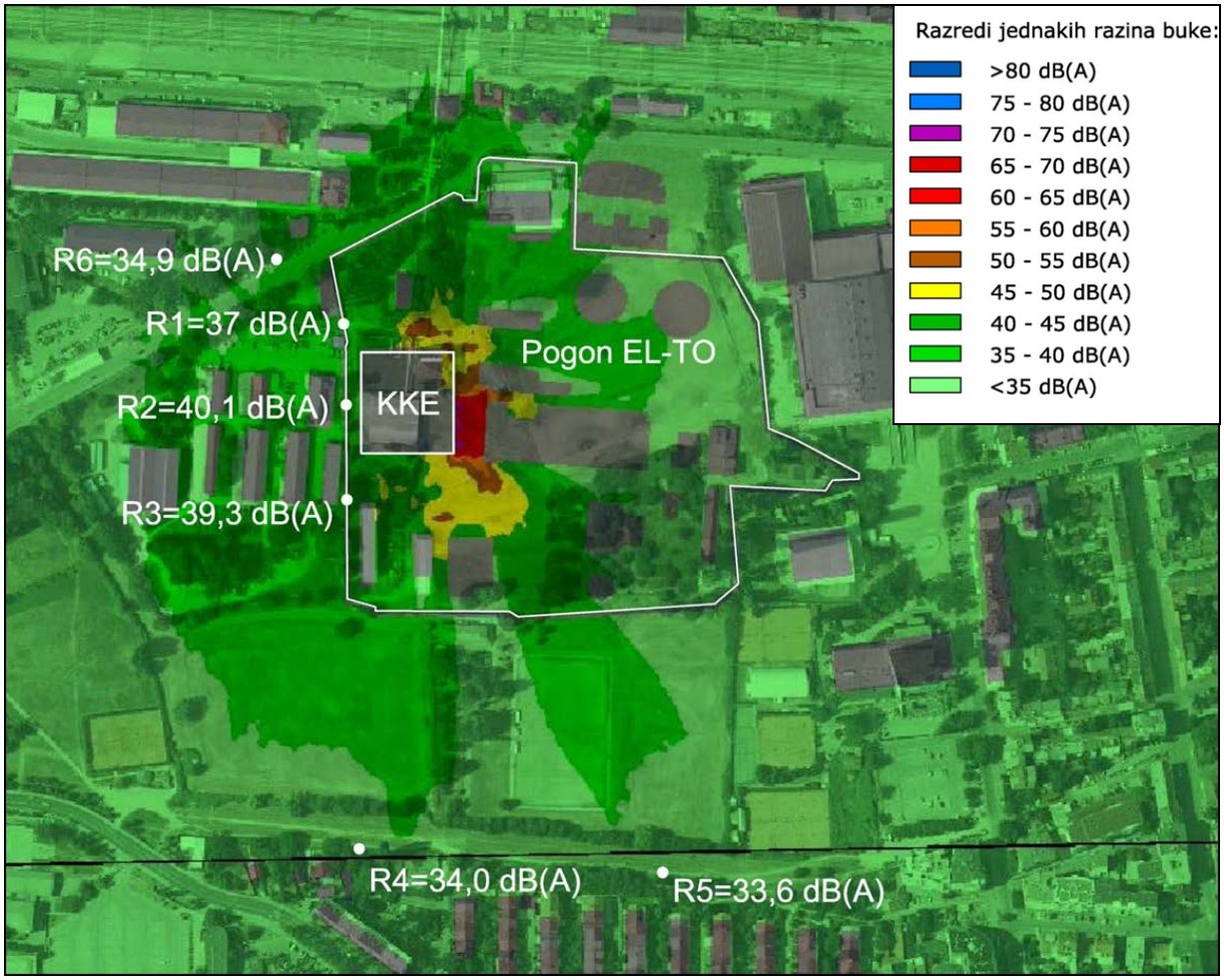


Figure 4.3-1: CCCPP noise dispersion into environment

[21] For areas where the existing level of residual noise is equal to or higher than permitted levels (**tab. 3.9-1**), immissions of noise that would be caused by newly designed, constructed or reconstructed and adapted building with associated sources of noise should not exceed the permissible noise levels minus 5 dB.

The calculation results show that the noise levels that will occur along the border of the EL-TO complex due to the operation of new plant will be significantly lower than the permissible noise levels.

PROTECTION MEASURES:

- A noise protection study shall be prepared, which shall take into account the limitations in relation to allowed noise immission levels, resulting from project operation.
- Elements and equipment of the project should be controlled and maintained on regular basis in order to avoid increased noise emissions.

MONITORING PROGRAMME:

DURING CONSTRUCTION

- In case there is a need for carrying out the construction works during night, it is required to measure the noise outdoors in front of the most threatened residential area south of EL-TO, south of Munjarski put. The monitoring should be carried out during first night works and repeated periodically every 30 days, until the night works are terminated.

DURING TRIAL OPERATION

- The initial monitoring should be carried out during trial run. The noise should be monitored on reference points R1-R6 (**figure 5.3-1**).

DURING REGULAR OPERATION

- The monitoring should be carried out in time intervals of two years and additionally when dominant noise sources are changed. The noise should be monitored on reference points according to the study, points R1-R6 and noise protection study. The monitoring should be carried out during unit operation at nominal capacity.

4.4 WASTE

During the project use, waste will be generated during routine maintenance and repair works.

Oily waste water and waste sludge from the wastewater treatment from washing the floors in the boiler plant and engine room will be generated at the location. These wastes belong to the category 13 05 (hazardous waste). Waste sludge, separated oils and waste water (hazardous waste from the category 13 05) will also be generated during the maintenance of the rainwater drainage system around the new unit (precipitator/oil and grease separator).

Waste water from washing fire sides of the boilers, from washing the compressor blades will be collected at the project site in new tank (5 m^3 capacity) and disposed by an authorized legal entity (KB 10 01 22*). The tank will be located on the north side near the HRS building.

Saturated or spent ion exchange resin from ion exchangers (KB 19 09 05) and used activated carbon (KB 15 02 03) will be present in the existing chemical water treatment plant, but not exceeding the current quantities.

During maintenance procedures, various types of waste lubricating oils for engines and gears (13 02 05*), waste insulating oils and heat transfer oils (hazardous waste from the category 13 03) as well as waste packaging of lubricating oils (15 01 10*), will be generated. During the maintenance of the facilities, waste from liquid fuels or other fuels (KB 13 07 03*) and oily wastes not otherwise specified (13 08 99*) will be generated as well. Waste paint, solvents and thinners (non-hazardous and hazardous waste from the category 08 01) and degreasing wastes containing dangerous substances (KB 11 01 13*) will be generated as well.

The following will be generated also: waste oil wiping and absorbing cloths and materials (15 02 02*), metal waste (non-hazardous waste from the category 17 04), waste wires and cables (17 04 11), glass insulators (17 02 02) and ceramic insulators (17 01 03), waste fluorescent tubes (20 01 21), waste printing toner (08 03 17), waste batteries (16 06 01*), nickel-cadmium batteries (16 06 02*), various other equipment containing hazardous components (16 02 13*), waste paper and cardboard packaging (15 01 01) and used tires (16 01 03).

In addition to the above types of waste, mixed municipal waste will also be generated (20 03 01).

The aforementioned wastes will be temporarily stored at the site in the existing temporary storages for hazardous and non-hazardous waste until their final disposal by authorized legal entities.

Proper management of waste generated during the plant operation involves separate collection of waste by type, its temporary storage and submission to authorized entities. In waste management, recovery procedures have the advantage over waste disposal procedures.

PROTECTION MEASURES:

- Municipal waste shall be collected in municipal waste containers and disposed of by an authorized person.
- Non-hazardous and hazardous waste should be collected in special storage tanks/containers, labelled according to legal requirements and designed in a way to prevent the waste scattering, spilling or evaporation and temporary storage separately by properties, types and physical state.
- Waste sludges resulting from treatment of oiled wastewaters from storm waters drainage system maintenance shall be disposed or recovered by a person authorized for waste management.
- Data on waste and waste management should be documented through register of waste and through prescribed forms.
- Data on waste management should be reported to the authorities on prescribed forms, i.e. should be submitted to the Environmental Pollution Register of the Environmental Protection Agency.

4.5 IMPACT ON LANDSCAPE FEATURES

The structures of existing stacks and units H and J are also the most visible parts of the existing facility from the points located within living spaces and visually most exposed from the intersection of the Krapinska and Selska streets. These are large open surfaces without vegetation volume or built structures which open in-depth perspective on EL-TO at distance of 200-400 meters (distances of greatest potential impact).

The building of the planned unit will be visible from parts of living and traffic areas and intersections of the Selska and Krapinska streets and the southern part of the Park pravednika među narodima.

High vegetation, tree lines and high vegetation areas north of individual housing above Čakovečka street (Križovljanska, Vidovečka, Martijanečka, Ludbreska, Novomarofska, Klenovnička streets) largely obscure the view of the existing EL-TO structures from these residential streets in summer. Existing structures (existing buildings of units H and J) will further almost completely hide the new unit. The planned project will not be spatially dominant.

It is important to note that the structure (by shape and height) of two new stacks of new unit will be very similar to those of the existing units H and J.

The new unit by its volume will be a dominant object in the eastern part of Zagorska street, western part of Magazinska street and southern part of Vodovodna street, near the entrance to EL-TO. This is an area that has no high residential significance but has traffic, transient significance and economic purpose (warehouses), i.e. it is of a low-density housing and degraded visual quality.

In conclusion, the existing structures, buildings and facilities within the existing EL-TO fence, as well as water supply and drainage facilities on the west side of EL-TO site, will for the most part hide the lower parts of the planned unit, while areas of high vegetation that hide the existing EL-TO facilities will also contribute and obstruct the view of the planned unit, especially from the southern, western and eastern sides.

The impact of the planned project on visual quality of landscape has been assessed as low, with application of protective measures related to the concept of coloring (light gray, dual-tone) and construction of the façade, which will not emphasize the contrast of the facility.

PROTECTION MEASURES:

- Low-reflective materials for facade shall be used for new planned EL-TO unit and adequate architectural solutions shall be applied in order to visually reduce the volume.
- Plant cover should be maintained on regular basis.
- The building facades should be kept cleaned, along with regular renovating of painted surfaces, i.e. replacement of worn out/damaged facade panels.

4.6 LIGHT SOURCES DURING THE PROJECT USE

The project is planned in such a way that the largest part of the façade will be non-transparent and light sources from outer spaces will be represented only by window glasses of individual work premises, such as the command room. Given that the project site is located within the EL-TO Zagreb area, with already existing internal roads outdoor lighting, special outdoor lighting for the project is not planned. However, if lighting will be needed, it would have to be the minimum, with a beam of light directed towards the ground or buildings, with minimum dissipation in other directions.

With respect to (1) the position of the project location within the EL-TO Zagreb area, (2) dimensions of the project building, (3) distance between the project and residential areas from which it will be visible and (4) characteristics of the surrounding area of the project location,

where public lighting is dominant at night, the conclusion is that the lighting of the facility will not be a significant new source of light for residential buildings near EL-TO Zagreb. The contribution of lighting of new facility to the night lights of the City of Zagreb is negligible.

PROTECTION MEASURES:

- In case of placing outdoor lighting at the newly planned facilities' micro location, in the design preparation and drafting phase, it shall be necessary to take account of light pollution prevention in order to select adequate lights and prevent unnecessary and excessive illuminance.
- During the night, lighting shall be kept at the minimum level required for safety.

4.7 DANGEROUS SUBSTANCES DURING THE PROJECT USE

The realization of the planned project will not significantly increase the quantity of dangerous substances and products that are already present at the EL-TO site - **tab. 4.7-1**.

Tab. 4.7-1: Additional quantities of dangerous substances related to operation of new CCCPP

Substance	The warning label	Quantity related to new CCCPP	Current quantity in EL-TO	Utilization
Natural gas	Extremely flammable (F+)	~ 0.24 t[22]	~ 0.2 t	Fuel for CCCPP
Turbine oil	-	~ 20.0 t	~ 41 t	Transformers cooling
Transformer oil	-	~ 60.0 t	~ 91 t	Turbine lubricating
Ammonium hydroxide (25%)	Dangerous for the environment (N) Corrosive (C)	~ 0.46 t	2 t	Feed water preparation
Diesel fuel	Harmful (Xn) Irritant (Xi) Carcin. cat 3 Dangerous for the environment (N)	~ 0.50 t	28,200 t of fuel oil	Fuel for reserve diesel engine

Nevertheless, all parts of the project which will include materials and products with dangerous properties should be designed and constructed in accordance with the regulations and in accordance with the properties of these substances and products, with application of good engineering practice and the best safety techniques. The existing documentation related to workers and public health and safety, listed in **chapter 2.10** should be revised and supplemented in regards to the planned project.

By designing and constructing the parts of the project containing substances and products with dangerous properties, the probability of their leakage is reduced to the minimum and through planning the intervention measures and procurement and installation of appropriate safety equipment, the conditions for prompt and effective action are created in case of leakage of substances and products with dangerous properties.

[22] For the purpose of this project a new gas pipeline DN 200 will be constructed within the EL-TO location with length of about 390 m. The pressure of natural gas in the pipeline is about 30 bar.

PROTECTION MEASURES:

- Project parts containing substances and products with hazardous properties shall be designed and constructed in line with the regulations, their properties and good engineering practice, i.e. by applying and/or installing adequate safety techniques.
- Prior to obtaining the building permit, it is required to prepare and submit to competent authorities a revised Form of notice on the presence of hazardous substances at the plant. It shall be necessary to prepare/review and submit to competent authorities other safety documentation of the plant, within the deadlines set by a special regulation on prevention of major accidents including hazardous substances.
- It is required to ensure the implementation of measures defined in the Notification on Small Quantities of Dangerous Substances in any time.
- The amendments to the Notification on Small Quantities of Dangerous Substances should be considered at least once in 3-year period from the day of submitting the Notification to the authorities.

GENERAL PROTECTION MEASURES:

- As a part of the Final Design, prepare a survey evidencing the manner in which the environmental protection measures and environment monitoring program from EIA Decision have been incorporated in the Final Design. The Survey shall be prepared by a legal entity possessing approval for performance of professional environmental protection activities - preparation of environmental impact assessment studies.
- Prepare Elaborate of construction organization and project construction technology.

5 SOCIAL AND ECONOMIC IMPACT

5.1 DURING PROJECT CONSTRUCTION

In providing construction services and goods, advantage will have the domestic enterprises (it is expected that domestic companies will work on civil works and installation of equipment.). During the construction of new CCCPP estimated number of workers at the site is up to 370. During construction, a presence of construction workers will contribute to the increased economic activity that will be also manifested in increase of demand for the activities of tertiary sector (services, trade and transport) as well as secondary activities.

5.2 DURING PROJECT OPERATION

EL-TO Zagreb except heat generation for heating of households and process steam for industry supply of the western part of Zagreb, also generates electricity to the Croatian power system. Although heat generation is the primary objective, the generation of electricity is also important. With an average annual energy generation of about 370 GWh, EL-TO covers over 11% of total energy of the City of Zagreb.

The planned increase in installed electrical power of EL-TO gives a reliable support of secure supply of the western and northern part of the city with electricity. This is particularly important in times of serious disturbances in the power system, as it reduces interruptions in the electricity and heat supply in Zagreb to the minimum.

The economical generation of environmentally friendly energy and developed energy system in the City of Zagreb (location, consumption and well-established supply) represent a major technological, but also general social value.