Final pilot action report

Port of Rijeka Authority

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Table of contents

Pilot action no. 1 : Installation of LED light bulbs

1. Ex-ante situation

Based on the review of the current state of the Rijeka breakwater's external lighting system, we conclude that it is largely neglected, that the public lighting poles pose a danger to the safety of passers-by, and that it does not comply with standardized light technical values.

The estimated mechanical stability of individual columns is very poor, and poses a danger to passers-by. Most of the columns were affected by corrosion to an unacceptable extent. Some of the lamps are broken, and in a large part, due to age and weather effects near the sea, the housing and screen of the lamps have been damaged, and the light intensity is inadequate.

As a result of the previous implementation of partial reconstruction with non-uniform design and technological types of lamps (as many as 7 different types of lamps) that differ in terms of technical parameters that should be harmonized (light colour, power), the current situation is characterized by insufficient, non-uniform and low-quality lighting that visually, especially in the evening hours, spoils the impression of the Rijeka breakwater.

In terms of energy, the lighting is partly satisfactory (LED sources), and mostly outdated and represents an excessive energy load considering the light flux it generates.

In addition to all the above, attention should also be directed to the parameters of light pollution. A large number of lamps at the location in question do not comply with the requirements of the Law on Protection from Light Pollution (OG No. 14/19), i.e. the Ordinance on Illumination Zones, Allowed Lighting Values and Ways of Managing Lighting Systems (OG No. 128/2020).

2. Pilot action description

In order to achieve a higher degree of energy efficiency of the outdoor lighting in question, it is necessary to replace the existing inefficient lamps. When choosing replacement lamps, in addition to energy-saving ones, it is also necessary to meet ecological criteria, in order to achieve a comprehensive solution for the public lighting system.

The designed replacement lamps are based on modern LED technology with the possibility of regulation, with high-quality optics and a higher degree of energy efficiency. Unlike existing lamps, they also meet the ecological requirements of protection against light pollution. The positive effects of the installation of new replacement lamps are manifested through the achievement of the prescribed light technical parameters of road lighting (HRN EN 13201), and the consumption of electricity is reduced, which results in reduced greenhouse gas emissions. Lower consumption will reduce electricity costs, with a 5-year factory warranty, new lamps will have fewer failures, and system maintenance costs will be significantly reduced. Unlike other light source technologies that are predominantly used in lamps of public lighting systems, LED lamps do not contain hazardous substances (eg Hg) and can be considered ecological. The specific lamps with which the analysis of

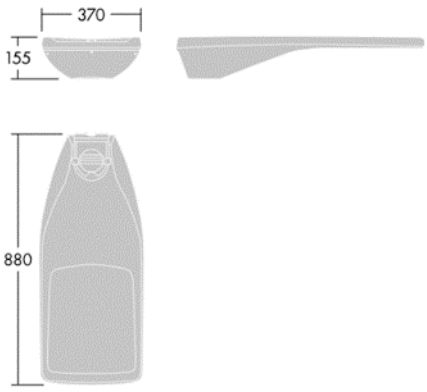
the possibility of replacement was performed are made of recyclable materials, and after the end of their life span they will not represent an environmental problem.
It should be taken into account that energy requirements represent only a part of satisfactory outdoor lighting. Of the other criteria that the lighting system must meet, the most important are certainly the light technical requirements, and the ecological aspects and requirements of urban culture must not be neglected either.
Only the intersection of the above criteria ensures outdoor lighting with sustainability features. This means that by implementing measures of energy efficiency of outdoor lighting, in addition to observing the value of reduction in electricity consumption, all relevant criteria should be taken into account.
The project envisages lamps with a luminous efficacy of a light source of over 100 lm/W. The selected lamps have ULOR=0% (Full cut-off, the proportion of light flux above the horizon is zero). Lamps with a correlated white light shade temperature of 3000K are provided. All lamps have overvoltage protection. The lifetime of the designed lamps is 100,000 hours, which for an average annual lighting operation of 4,100 hours is equal to a lifetime of 24 years.
Existing columns are replaced with new ones and one new column is added. The existing lighting on the walls of the breakwater and on the facades of the buildings will partly be moved vertically, because the current height cannot achieve the standard lighting values. Also, due to incompatibility with the newly designed lamps, some of the consoles are replaced with appropriate new consoles.
The project envisages the preparation for the introduction of an intelligent system of management and regulation of public lighting lamps, as a segment of the Smart City, which will enable additional savings in electricity. A smart city is an urbanistic method of city development in the direction of increasing the comfort and standard of living through advanced solutions made possible by information and communication technologies. In this sense, the lighting fixtures are equipped with drivers (pre-connection devices) with DALI adjustable protocol. In addition, the use of pre-programmed regulating ballasts with self-regulation is foreseen. This regulation system makes it possible to adjust the lighting using different levels of light flux in combination with different time periods of public lighting operation. An independent controller is installed in the lamps, which, depending on the needs of the user, is adjusted to the desired operating mode. The operating modes can easily be adjusted later depending on the needs. The project envisages that the designed lamps will be supplied with an already installed controller with a pre-programmed operating mode. The consequence of using this method of regulation is the reduction of electricity consumption, which contributes to the reduction of electricity costs, and additionally to the reduction of CO2 emissions.

The project foresees four-time intervals of public lighting operation Δt1-Δt4:
Δt1 - time from switching on the lighting until 9:00 p.m.,
Δt2 - time from 21:00 to midnight,
Δt3 - time from midnight to 6:00 a.m.,
Δt4 - time from 6:00 a.m. until lighting is turned off.

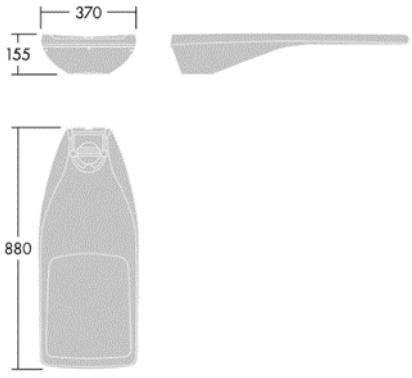
Technical data of the new lights installed on the passenger side and the parking lot:

lamp type 1
R2L2 M 96L90-830 EWR BPS CL2 GY
Light Source: LED
Luminaire luminous flux: 33600 lm
Luminaire efficacy: 128 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10)*:
L90 100000h at 25°C
Luminaire input power*: 262 W Power factor = 0.95
Dimming: PROG
LOR: 1,00 ULOR: 0,00 DLOR: 1,00

lamp type 2
R2L2 M 84L67 830 EWR BPS CL2 GY
Light Source: LED
Luminaire luminous flux: 21070 lm
Luminaire efficacy: 125 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10):
L96 100000h at 25°C
Luminaire input power: 168 W Power factor = 0.95
Dimming: PROG
LOR: 1,00 ULOR: 0,00 DLOR: 1,00

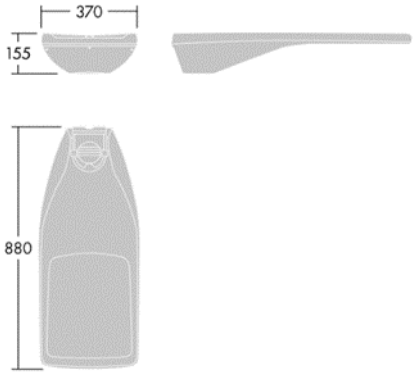


lamp type 3
Philips CitySoul gen2
Light Source: LED
Luminaire luminous flux: 2500 lm
Luminaire efficacy: 125 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10)*:
L90 100000h at 25°C
Luminaire input power*: 20 W Power factor = 0.95
Dimming: PROG

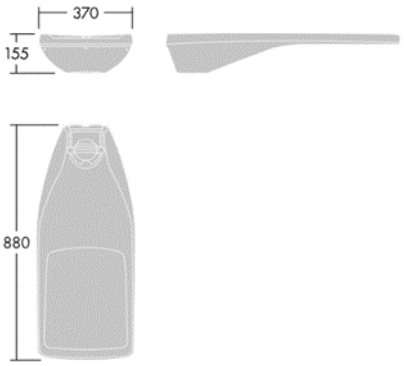


LOR: 1,00 ULOR: 0,00 DLOR: 1,00

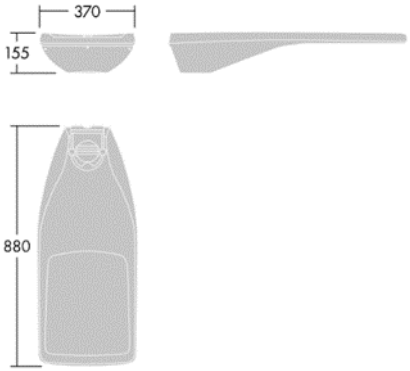
lamp type 4
R2L2 M 84L62 830 EWR BPS CL2 GY
Light Source: LED
Luminaire luminous flux: 20180 lm
Luminaire efficacy: 130 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10):
L96 100000h at 25°C
Luminaire input power: 155 W Power factor = 0.95
Dimming: PROG
LOR: 1,00 ULOR: 0,00 DLOR: 1,00



lamp type 5
R2L2 M 72L62-830 SC BPS CL2 GYLight Source: LED
Luminaire luminous flux: 17410 lm
Luminaire efficacy: 132 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10):
L96 100000h at 25°C
Luminaire input power: 132 W Power factor = 0.95
Dimming: PROG
LOR: 1,00 ULOR: 0,00 DLOR: 1,00



lamp type 6
R2L2 M 96L35-830 NR BPS CL2 GY
Light Source: LED
Luminaire luminous flux: 14020 lm
Luminaire efficacy: 143 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10):
L96 100000h at 25°C
Luminaire input power: 98 W Power factor = 0.95
Dimming: PROG



LOR: 1,00 ULOR: 0,00 DLOR: 1,00

lamp type 7
R2L2 S 36L60-830 SC BPS CL2 GY
Light Source: LED
Luminaire luminous flux: 8820 lm
Luminaire efficacy: 134 lm/W
Colour Rendering Index min.: 80
Correlated colour temperature: 3000 Kelvin
Chromaticity tolerance (initial MacAdam): 5
Rated useful life (B10):
L96 100000h at 25°C
Luminaire input power: 66 W Power factor = 0.95
Dimming: PROG
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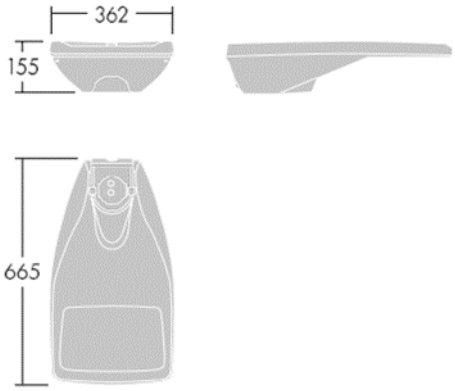


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3. Conclusions

The project saved electricity and reduced annual CO2 emissions, which can be seen in the tables that provide an overview of the energy indicators before and after the replacement of the lighting.

Table 1. Energy parameters of lighting on the breakwater before the implementation of the project

LIGHTING BEFORE PROJECT IMPLEMENTATION	INSTALLED POWER	MEDIUM PEAK POWER	ANNUAL HOURS OF WORK	ESTIMATION OF ANNUAL ENERGY CONSUMPTION	Reduction of CO2 emissions
	kW	kW	h	kWh	kg/ann.
LIGHTING	14,50	13,78	4.380	60.334,50	14.167,14

Table 2. Energy parameters of lighting on the breakwater after the implementation of the project

NEW LIGHTING ON THE BREAKWATER	INSTALLED POWER	MEDIUM PEAK POWER	ANNUAL HOURS OF WORK	ESTIMATION OF ANNUAL ENERGY CONSUMPTION	Reduction of CO2 emissions
	kW	kW	h	kWh	kg/ann.
LIGHTING	12,40	10,54	4.380	46.165,20	10.840,05

It is evident from the tables that annual electricity savings of 14,169.3 kWh were achieved and CO2 emissions were consequently reduced by 3,327.09 kg.

In addition to the above, the new lighting system fully meets the standard light technical values.

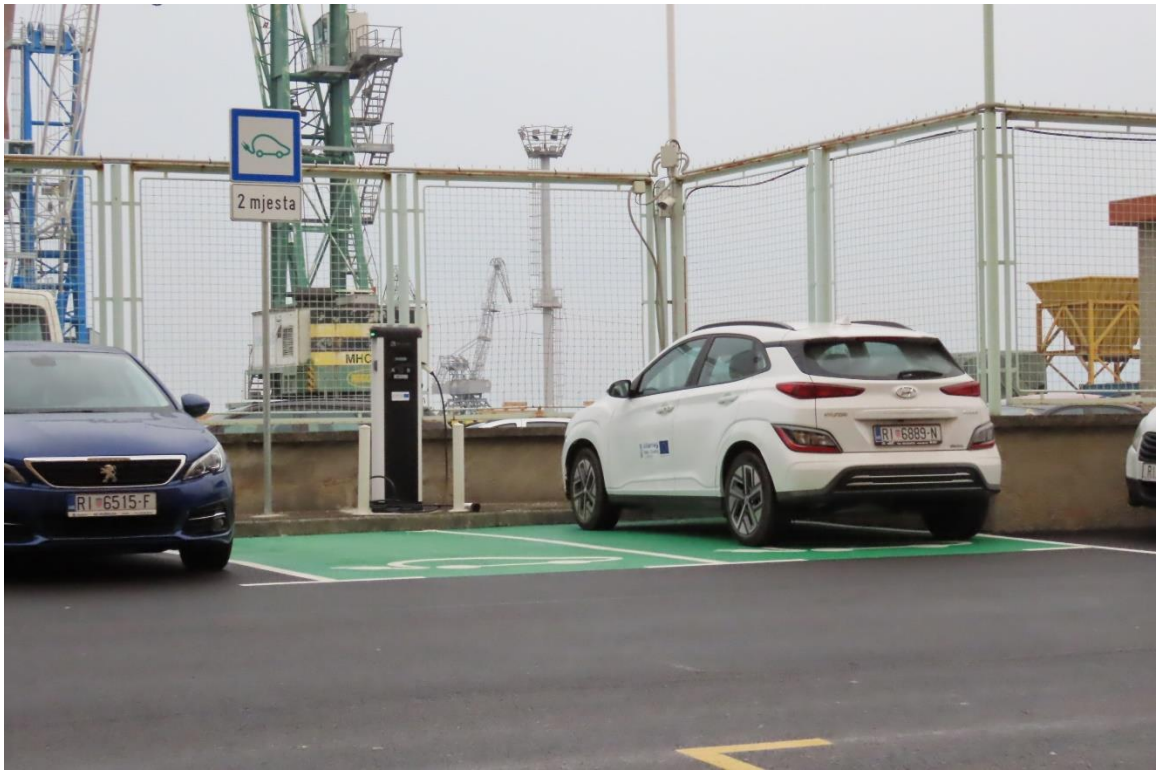
Pilot action no. 2: Purchasing of e-car

Ex-ante situation

Port of Rijeka Authority carries out a monitoring of the state of the environment, which includes, inter alia, testing air quality as well as measuring noise at specific locations in the port area. Monitoring is carried out on an annual basis and the results are publicly available (from 2015) in the form of a special report. Measurements of concentrations of pollutants in the area of measurement stations, relative to the legislation in force, indicate that, according to the concentrations SO2, NO2, and PM10, air quality is the quality of the category I (air is clean or slightly contaminated) and that no exceedance of daily or hourly limit value has been recorded. Still, the Port of Rijeka Authority adopted an Action Plan of energy efficiency and sustainable development. Based on the SWOT analysis and the good practice examples 12 potential and advisable measures have been identified, with them having a positive impact on climate change, air quality, waste, noise and/or light pollution, and focused on the opportunities from the port side. One of the most important measures was purchasing of electric car.

Pilot action description

The electrification of land transport is one of the strategic measures for reducing pollutant and greenhouse gas emissions as well as noise in a given area. It is promoted at EU and national level. Electric car was purchased for the purpose of serving the staff of the Port Authority. As the emission factor for the use of electricity as fuel (kg/kWh) is equal to 0, this vehicle will not generate CO2 or other pollutant emissions (in the exhaust domain). A number of factors are affecting the noise emission of electric vehicles. The results depend on a research approach and goals. Nevertheless, in principle, the results indicate that the use of electric vehicles has a noise reduction potential where average speeds are below 30 km/h. In line with the latter, electric vehicles emit less noise by around 4-5 dB compared to internal combustion vehicles.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Conclusions

A number of policies, both European and national, increasingly promote ports as so-called 'green ports' — centres of sustainable and smart mobility. The advancements are also reflected in the regulation that sets more specific requirements in this regard.

The Port of Rijeka, under the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19), is classified as a port of international economic significance for the Republic of Croatia and as such has a number of positive effects for the national economy. For sustainable development, as a fundamental determinant of today's business of different actors, and also of port authorities, implementation of an efficient environmental management system, including the so-called carbon management, is important since a range of activities, products and services associated with the operation of port authorities has a certain environmental impact and generates greenhouse gas emissions, and the latter must be avoided or at least minimised. Sustainable development offers many opportunities, such as reducing operating costs (in particular considering reduced energy consumption), increasing the quality

of supply, modern equipment of the entire port (machinery, infrastructure, etc.), promotion and development of the port as a sustainable and green one that advocates public interest and the common good, improving the state of the environment at site level and beyond (reducing noise, pollutant emissions and greenhouse gas emissions to air, light pollution, waste, etc.), which contributes to the satisfaction of local authorities and the population, etc.

Pilot action no. 3: Purchasing of two charging stations

Ex-ante situation

Plan proposed construction of two new charging points for electric cars at the pier and in front of the administrative building of Port of Rijeka Authority. The latter represents an important infrastructure project as a contribution to the expected electrification of land transport and thereby to reducing air emissions as well as noise.

Pilot action description

Inland transport also contributes to emissions of pollutants and greenhouse gases, as well as to the noise of the port area and, by the very nature of the measures, which affect this segment, contribute to the port sustainability. A number of factors are affecting the noise emission of electric vehicles. The results depend on a research approach and goals. Nevertheless, in principle, the results indicate that the use of electric vehicles has a noise reduction potential where average speeds are below 30 km/h. In line with the latter, electric vehicles emit less noise by around 4-5 dB compared to internal combustion vehicles. Plan proposes construction of two new charging points for electric cars at the pier and in front of the administrative building of Port of Rijeka Authority. The latter represents an important infrastructure project as a contribution to the expected electrification of land transport and thereby to reducing air emissions as well as noise.


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