Local action plan for the port of Zadar

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Contents

Introduction

Local action plan for the port if Zadar is a result of the analysis of its carbon footprint within the activity D3.2.9 Territorial Needs Assessment (TNA) for the port of Zadar and of the D3.2.13 Best Practice analysis and aims to define the measures that in the medium and long term can solve the critical issues identified within the TNA. Action Plan will comprise the most important medium and long-term energy sustainability actions for the Port of Zadar. Moreover, feasible energy sustainability measures will be identified and evaluated, considering local conditions and the port´s capabilities.

Sustainability and energy efficiency are concepts that are widely used in numerous sectors including transportation with the main objective of preserving environment and the health of all beings by maintaining harmony during the usage of technology in operations. Increasing volumes of both cargo and passenger traffic require new technologies and solutions in order to deal with these changes in a more sustainable way. Ports are becoming busier which increases the risk of pollution in their areas. Therefore, EU supports development of green ports which draws special attention to solving the issues of sustainability and energy efficiency. Transport currently accounts for almost a quarter of the EU greenhouse gas emissions and this figure continues to increase as the demand grows.

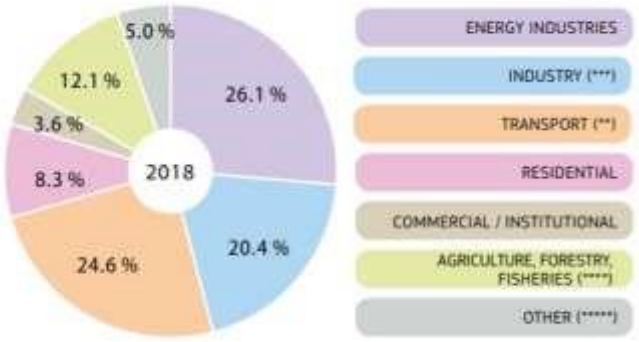

Figure 1: GHG emissions EU-27 by sector (millions of tons CO2 equivalent)
Source: EU statistical pocketbook 2020 available at: https://op.europa.eu/en/publication-detail/-/publication/da0cd68e-1fdd-11eb-b57e-01aa75ed71a1

It is clear that road transportation is still a prevailing mode of transport in the EU countries and wider but is also a prevailing pollutant in the transport sector as shown in the Figure 2. Total navigation counts for 14.1% of the GHG emissions from transportation sector.

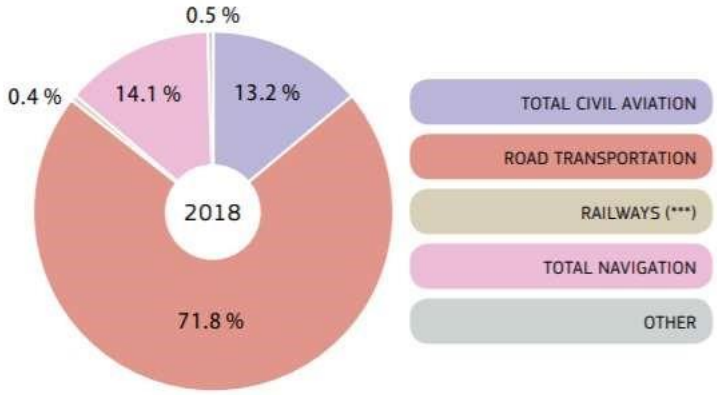

Figure 2: GHG emissions from transport EU-27 by mode (in share %)
Source: EU statistical pocketbook 2020 available at: https://op.europa.eu/en/publication-detail//publication/da0cd68e-1fdd-11eb-b57e-01aa75ed71a1

Therefore, special emphasis should be given to supporting a modal shift in the transport sector from the road transport to more sustainable modes such as maritime and railways including a focus on supporting intramodality in the sector. From the aspect of ports, special focus should be aimed at enhancing transportation within and around the port area by introducing advanced technologies that will support sustainable development of ports and their operations.

In view of the port of Zadar, it should be highlighted that New Port of Gazenica, with an emphasis on the passenger, ferry and RO-RO terminals as the main focus of the study, is located 3,5 km from the Zadar city center which resulted in large relocation and disburdening of the center from the traffic. This relocation can be perceived as an environmental protection action but it is also an introduction to further investigation of energy-efficient solutions and advanced technologies to be implemented within the port and for the port operations. Local action plan for the port of Zadar relies on 3 main findings as a result of the previously issued documents D3.2.9 Territorial Needs Assessment (TNA) for the port of Zadar, D3.2.13. Best Practice Analysis and an analysis of the main needs of the Port of Zadar Authority which are contained within this document. These main 3 steps for the definition of this Action Plan that are stemming from the previously mentioned documents

are: exploration of best practices, calculation of carbon footprint and the results; defining the priorities by the Port of Zadar Authority in line with national/regional/local regulations.

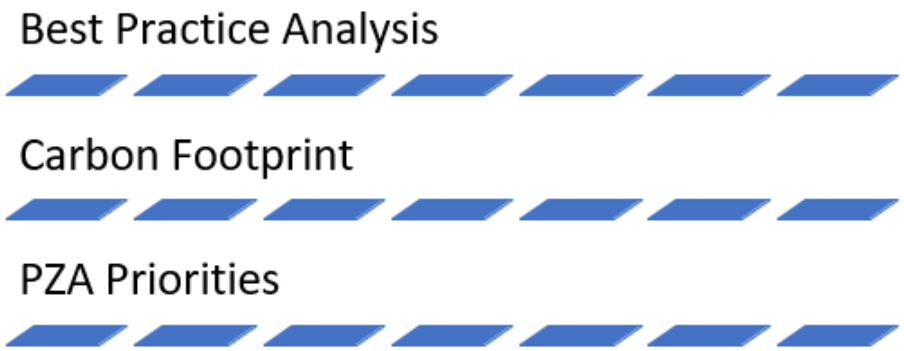

Figure 3: Action plan measures are a result of the 3 previous steps

Weaknesses and Threats of the SWOT analysis included in the TNA tackled by this Action Plan

Main objective of this section is to focus on two specific statements of the SWOT analysis from the TNA. In order to better justify the actions in chapter 3 it is important to provide more details on these points from the SWOT analysis. More specifically, indications regarding weaknesses and threats provided below will be discussed in more detail as the these will be the basis for the pilot actions to be implemented within the SUSPORT project in the port of Zadar but these will also be used for future actions and recommendations.

Weakness

- Electric car and EV charging stations are not available within the port area

Threat

- Increased interest for cruise industry causes more emissions and highlights the need for finding solutions to tackle this environmental dimension

Figure 4: Analyzed SWOT statements

1. Electric car and EV charging stations are not available within the port area

In view of EU policies, strategies and acts which support sustainability and energy efficiency in multiple ways, we can conclude that an important difference among ports and terminals will therefore lie in their ability to make the most of the new technological solutions supporting environmental aspects and these will consequently allow operations within terminals to be optimized and the related costs to be reduced. Electric vehicles (EVs) represent one way of introducing new solutions in ports which support sustainability and can reduce emissions and produce savings in the port area. Electric vehicles produce less emissions that contribute to climate change than the traditional vehicles. Emissions in conventional vehicles are emitted during the fueling of the vehicle, through the pipes and from the fuel system. Many of these are pollutants that are dangerous to both the environment and people (GHGs). On the other side, EVs do not produce such emissions and can therefore support sustainability and environmental quality in the port areas. Even the emissions regarding the production of vehicles and fuel are less significant for the EVs than for the conventional vehicles. In this moment, port of Zadar does not have any EVs in their fleet nor the infrastructure for charging such vehicles. One of the first steps towards the goal of becoming a green port, Port of Zadar Authority has decided to purchase an e-car within the project SUSPORT for the usage within the port area by its employees and a participating charging station. This small EV and a charger for the purpose of daily transport through the port will save additional emissions and this weakness as indicated within SWOT will be elegantly solved and will pave the way forward for the additional infrastructure works to support energy efficient solutions.

2. Increased interest for cruise industry causes more emissions and highlights the need for finding solutions to tackle this environmental dimension

The growth of cruise tourism has resulted in an increasing concern for the environmental impact that this type of tourism may cause. Awareness of the marine and environmental pollution caused by cruise ships is a great issue for all Adriatic cities, and it has increased in the last years since the number of cruise calls has drastically increased. Adriatic Sea attracts numerous cruisers in its semi-enclosed area within the Mediterranean and Zadar has in the last years proved to be a very attractive tourist destination especially since the opening of the New Port of Gazenica in 2015 with a temporary terminal building and even more since 2018 when the New Port of Gazenica was in full operation.

In 2019, Zadar was ranked as a third cruising destination in the Republic of Croatia after Dubrovnik and Split and it was chosen as the world's best port at the Sea trade Cruise Awards 2019 with a tendency to increase the traffic in the following years prior to the breakout of the COVID-19 pandemic. Since 2012 to 2019, the number of cruise passengers has increased from 20.958 passengers to 182.682 passengers (Figure 5). The predictions are that the cruise traffic will continue with its increase after the normalization of the situation with the pandemic. Better facilities, new routes and even bigger ships support the increase of traffic in the cruise industry which is a benefit also to the economic growth but also a disadvantage to the environmental sustainability as cruise ships are well known marine pollutants.

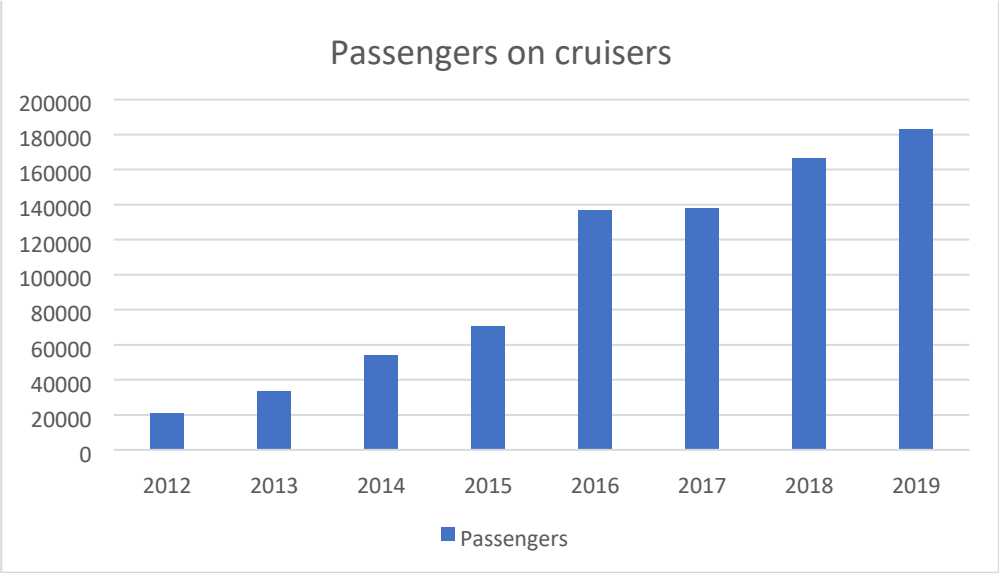

Figure 5: Port of Zadar - Passengers on cruisers from 2012 to 2019
Source: Author based on the data from the Port of Zadar Authority

One of the main challenges in the years to come will be developing cruise industry in line with energy efficient and sustainable principles by preserving natural habitat and port cities. This will have to be enhanced in parallel with development and implementation of technological advances in port areas. Therefore, it is necessary to tackle the issue of increasing cruise traffic in the port of Zadar which consequently causes an increase in the emissions and potential pollution in the port and port-city area. It is necessary to consider environmentally friendly and sustainable solutions in order to create

a better environment for tourist and local residents by reducing greenhouse gas and noise emissions. Proposed actions are listed in the Section 3 of this document.

Actions for environmental sustainability and port energy efficiency

The yellow marked area shown on figure 1 is the scope of investigation in this document.

Emissions calculated in the document Territorial needs assessment for the Port of Zadar represent the actual situation in the port area and clearly indicate potential threats in the future. As estimated, the number of cruisers will increase especially due to the fact that port of Zadar may develop as a home port. Therefore,

Port Authority is engaged in finding a way to establish properly infrastructure in correlation with this growth.

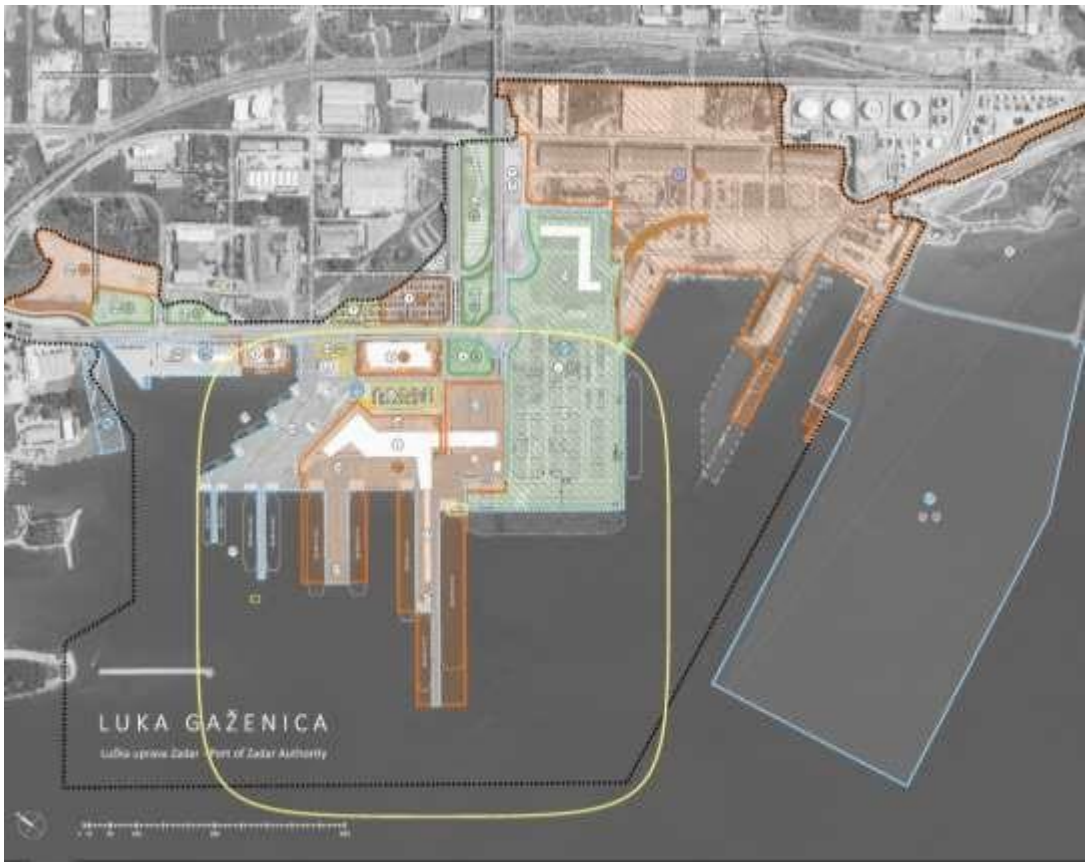

Figure 6: passenger area in the port Gazenica (marked with yellow border)

Results of the carbon footprint performed in the TNA for the port of Zadar have shown the main CO2 emission sources within the New Port of Gazenica – new passenger, ferry and RO-RO terminals and these are indicated in the Table 1.

Summary of contributions to the production of greenhouse gases in the maritime sector, in the port of Zadar, in 2019		
Category	**t CO2eq**	**%**
Electric energy	139.9	3.2
Heating	28	0.6
Service vehicles	0	0.0
Operational port vehicles	0	0.0
Heavy vehicles **and road vehicles**	161	3.7
Naval port service (e.g. pilot/tug)	0	0.0
Railway tractors	0	0.0
Anchored ships	0	0.0
Ships maneuvering	223.6	5.1
Moored ships	3799.1	87.3
TOTAL	**4351.6**	**100**

Table 1: Overall GHG emissions

Furthermore, analyzed terminals have shown different emission levels and these are presented in the Figure 7, indicating that largest percentage of emissions comes from cruisers and the International Travel Terminal.

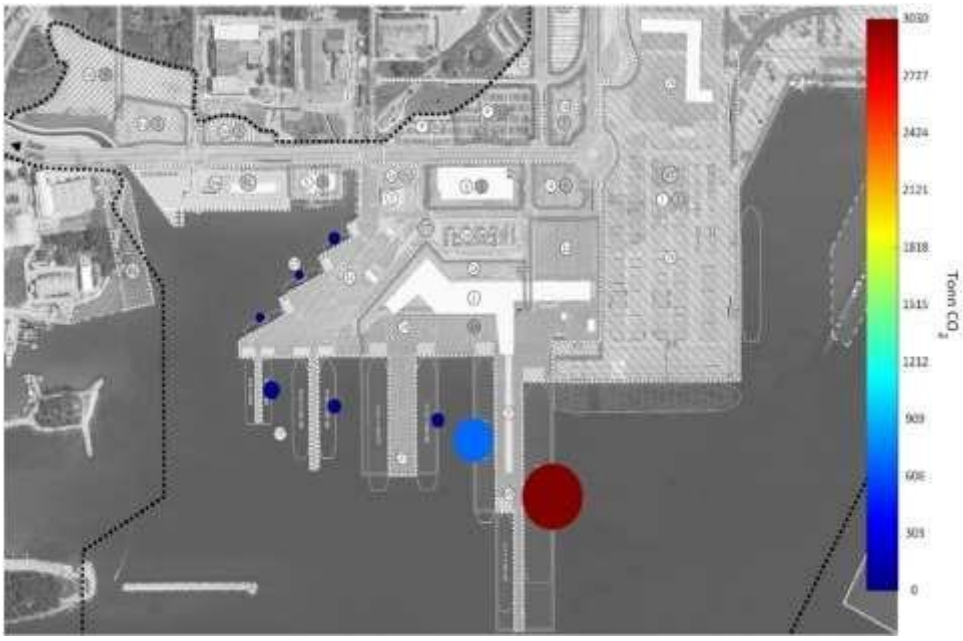

Figure 7: Mapped emissions for all berths
Source: Author

The results of the carbon footprint presented in Figure 7 support the idea of New Port of Gazenica becoming a green port due to the fact that there are no serious emissions found in the port area. These results have been expected since the port has been newly constructed and opened for traffic in 2015 (in full operation since 2018). Nevertheless, Port Authority aims to reach the highest standards in terms of energy efficiency and sustainability and therefore plans to intervene with modern technologies and procedures whenever possible. Following is Table 2 providing a summary of emission sources from the carbon footprint calculation performed within the TNA, its influence today and potential influence in the future with the explanation of main actions to be explored in the short and long-term period.

Emission source	**Influence Today/future**	**Explanation &possible action**	**Focus**

Electric energy	LOW/HIGH	Present emissions from electricity are very small with intention to decrease more because percentage of renewable sources in electricity production on national level will increase what will cause that electricity related emissions will be inevitably reduced following increasing share of renewable energy sources of Croatia power system. But, due to the fact that emobility is rapidly arriving in all kinds of vehicles and boats as well, it could cause a problem because of the limited power from the grid on the area of passenger port. To avoid this problem Port Authority would ultimately need to ensure enough capacity. This could be reached with PV installation and Gazenica could keep small level of emissions from electricity despite predicted growth of traffic. Of course, that could be a trigger for some additional projects: e-chargers and shore to	Energy/ GHG emissions

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		ship for cruisers. Such systems could be installed only for cruise ship arrivals, as ferries produce relatively small mooring emissions. Considering expected raise in ETS pricing towards 65 €/t in 2030, ship operators could find further incentives for welcoming such systems. Crucial for PV systems in the port will be optimization of storage system and balancing with operations through the time.	
Heating	LOW/LOW	Options for decreasing heating emissions are limited due to the fact that heating is currently using natural gas which is very clean fuel. Feasibility of changing heat source from natural gas to heat pump could be investigated as well as the implementation of solar-thermal panels.	Energy/GHG emissions

Heavy vehicles and road vehicles	MEDIUM/MEDIUM	Further electrification of road transport sector will result in decreased emissions from road vehicles. Together with local (nearby island) policy makers Port of Zadar could take actions to support electric mobility infrastructure on nearby islands and further increase share of electric vehicles traveling through the Port of Zadar. Also, multifuel stations with variety of alternative fuels like LNG, CNG, hydrogen will be ultimate in next 5 years.	Energy/GHG emissions
Anchored ships	NONE/MEDIUM	There are no anchored ship emissions associated with Gazenica port but this could become a problem in the future if cruisers remain in Gazenica for more than one day. In	Energy/GHG Emissions
		this scenario, ensuring shore-to-ship should be investigated.	
Maneuvering	MEDIUM/LOW	Optimization of maneuvering patterns, speed and dock location could lead to significant reduction of maneuvering emissions. Education programs for staff with the aim of optimizing maneuvering operations could be very efficient.	GHG emissions

Mooring	HIGH/MEDIUM	Moored emissions are single largest contributor to overall emissions in the port of Zadar. Cruise ships are the source of 85.6% of overall GHG emissions and the best candidate for significant reductions of GHG emissions. In next decade prediction is that part of cruisers and ferries will be driven by LNG as a much cleaner fuel which is the possibility to be explored within the port of Zadar.	Energy/GHG Emissions

Table 2: Summary of emission sources with explanations and actions stemming from Carbon Footprint (TNA) in the port of Zadar

Following (Figure 8) are indications of the identified priorities, current situation and existing practices and proposed future actions in the port of Zadar.

Figure 8: Priority needs and actions in the port of Zadar

Port of Zadar does not have an implemented monitoring system that would be used for monitoring environmental impact in the port area. Therefore, in order to precisely report on emissions there is the need to introduce a monitoring system as a part of an environmental policy within the port. Environmental monitoring is already an integral part in many ports which are using different monitoring equipment (the sensors). It is necessary to define where and how the monitoring should take place (number of sensors and their location), which emissions to monitor (CO2, CO, SOx, NOx, and airborne particulates), and how to analyze the data (reporting, analysis, real-time data etc.).

The aim of implementing these systems is to receive useful information about the levels and distribution of air pollutants in the atmosphere and carbon footprint, as well as to identify the main sources of emissions on regular basis. In general, there are 2 different ways of emissions monitoring: stationary and mobile. Due to the fact that over the last few years mobile monitoring rapidly improved by drone usage this kind of measuring is perfect for implementation within the port areas.

Figure 9: Drone in action
Source: Official website "UAV Drone Environmental Monitoring, Scentroid Flying Laboratory"

A sensor-based system with compact and mobile stations monitors the air quality by receiving real-time data of emissions in the port area. Compact air quality monitoring stations measure real-time emissions of carbon and air pollutants, with a remote data acquisition system. Broadly, mobile air quality monitoring involves deploying instruments for a short period at a temporary location, before moving them to another location.

Within the port and as an extension of the pilot project within SUSPORT project, it is planned to install an air quality measuring device from the container. The air quality monitoring device will be equipped with sensors that automatically measure the concentration of individual pollutants, with pollutants being the following:

Sulphur dioxide- SO2, nitrogen oxides- NO, NO2, carbon monoxide- CO, CO2, O3 and H2S. This system will be autonomous and it will include all auxiliary equipment (air sampling system, UPS, mobile router, data transmission system, air conditioning) that is necessary for autonomy and sending data to external displays.

For the purposes of monitoring the produced and used electricity obtained from the new island system of PV, it is necessary to plan installation of a control meter for electrical energy, and for the purposes of calculation, it will be necessary to move the port lighting circuit on the existing metering station to a separate field.

Main benefits:

- Getting real-time data for the environmental monitoring in different port areas with mobile measuring stations
- Adjusting environmental policy plan in line with the reports
- Completely autonomous work mode

Internal regulative framework and action plans

Port of Zadar Authority does not have a separate environmental policy plan which would consider the European and national environmental legislation, as well as the international environmental regulations and which would be designed for the evaluation of the environmental performance of port activities. However, Port of Zadar acknowledges the importance of environmental protection and issues arising from the port activities and which are related to the port area, sea, noise and air quality. In order to minimize the negative effects on the environment, Port of Zadar Authority implements a series of activities and regulations on the port area under their jurisdiction. In this sense, the main priorities of the Port of Zadar Authority include effective management of waste from ships and operations and procedures with hazardous substances from ships. It also lays down the regulations on the maintenance of order which need to be followed in order to preserve safety and security in the port area.

At this moment environmental issues are tackled within the following internal documents:

- Ship Waste Management Plan (2018)
- Ordinance on determining the class and quantity of hazardous substances from ships (2018)
- Ordinance on determining the class and quantity of dangerous substances that may be handled in the port, that is, that may be carried by a ship entering the port area and places in the port of Zadar where these substances will be handled (2015)

- Regulations on the maintenance of order and terms of using the port area under the jurisdiction of the Port of Zadar Authority also lay down safety and security measures

It would be useful to implement a separate environmental policy plan within the port of Zadar dealing with the issues of monitoring and reporting of environmental impact in the port area and also laying down specific short-term and long-term actions in view of environmental protection. This document would be multipurpose as it would aim at: energy and cost savings, better environmental performance, fulfilling legislative targets on carbon footprint. One of the most important steps for the implementation of this document is development of a monitoring system with sensors as depicted in the previous section.

As monitoring system will identify the main energy and emission sources in port it will be closely related to the proposed measures of an environmental policy plan.

Furthermore, this local action plan developed within the SUSPORT project will be used as a reference point for the future development of such a policy on an organizational level and for sure will be the first step in intention that Gazenica becomes a green port. As part of the environmental policy, Port of Zadar Authority might also explore the need and feasibility of implementing ISO 14001:2015 which could be an additional benefit because this standard specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance. Also, ISO 14001:2015 is intended for use by an organization seeking to manage its environmental responsibilities in a systematic manner that contributes to the environmental pillar of sustainability.

Carbon footprint reduction measures

As shown in Table 3, actual GHG emissions in Gazenica are not causing any environmental problems and do not pose a threat to the area, but Port of Zadar Authority is nevertheless constantly engaged in implementing measures for decreasing these emissions and for improving infrastructure to prepare the port for predicted after-COVID increase of all types of traffic and especially to ensure enough electric capacity for the new era of e-mobility. Therefore, the following sub-sections list possible measures proposed to be implemented in the port of Zadar in order to reduce the carbon footprint.

Summary of contributions to the production of greenhouse gases in the maritime sector, in the port of Zadar, in 2019		
Category	**t CO2eq**	**%**
Electric energy	139.9	3.2
Heating	28	0.6
Service vehicles	0	0.0
Operational port vehicles	0	0.0
Heavy vehicles **and road vehicles**	161	3.7
Naval port service (e.g. pilot/tug)	0	0.0
Railway tractors	0	0.0
Anchored ships	0	0.0
Ships maneuvering	223.6	5.1
Moored ships	3799.1	87.3
TOTAL	**4351.6**	**100**

Table 3: Overall GHG emissions

Port lighting

Terminal building in the port of Zadar is currently using efficient LED lights that do not need any further investments, however, port outdoor lighting uses traditional metal halide lamps which use about 25%-80% more energy than modern LED street lamps and last from 3-25 times shorter than energy-efficient lightbulbs. Therefore, within the pilot action of the project SUSPORT and with the aim of increasing energy efficiency, an island system of operation will be implemented, where electricity from photovoltaics will be used for port lighting and for charging electric vehicles. Canopies are planned to be placed in two or more separate segments on the surface showed in Figure 9. An elegant form of construction is envisaged, and the surface must be resistant to aerosol and other very demanding weather conditions in the port area. Additional lighting is also envisaged in the LED version for new roof surfaces, i.e. shading of canopies. Calculation of port lighting consumption will define a suitable battery pack that is planned to be placed next to existing electricity generator for the supply of the passenger terminal in case of a power failure. When system will be putting into operation test with clutching passenger building will be done to inspect

possibility to avoid start generators in case of stopping electricity supply. That could be an added value for the pilot project and could be proof of concept to avoid diesel generators at all.

Necessary set of batteries is planned to be placed in a 20-foot electricity storage container in which, after the realization of other projects, additional sets of batteries will be placed from renewable sources.

3.2.Water consumption

Currently, fresh clean water is used for the drainage of green surface in the parking area. Within the project SUSPORT, this will be amended in order to achieve greater levels of energy efficiency in a way that canopies used for LED lighting and described in sub-section 3.1. will be used for solving the drainage of rainwater into a suitable reservoir that is planned to be buried in a green area. The rainwater that is collected this way will be used for the central irrigation system therefore it is necessary to provide connection to the existing system with priority use of rainwater.

Plan is to explore the possibility to enlarge this activity to other parts of the port, one of option is to collect all rainwater from passenger building terminal and use it for the purpose of irrigation and roads cleaning.

Figure 9: Canopies with integrated PV are planned to be installed on the parking area shown in
Source: Author

PV

Photovoltaic (PV) power generation systems are plants with solar modules mounted on fixed metal supports at an optimal angle to the horizontal surface and oriented to the south. In accordance with the legal regulations of distribution systems, PV power plants use transformers by means of which solar energy obtained from a photovoltaic power plant is transmitted to the electricity grid.

Practice shows that the energy efficiency of a photovoltaic power plant has decreased annually by 0.5-1%. The lifespan of photovoltaic modules depends on the solar cell technology used. For monocrystalline and polycrystalline silicon solar cells, most manufacturers give a 10/90 and 25/80 warranty which means: a 10year warranty that the module will operate at above 90% of rated power and up to 25 years above 80%. The practical lifespan of silicon-produced photovoltaic modules is expected to be at least 30 years. PV power plants represent environmentally friendly energy source. The components of photovoltaic power plants (solar modules, converters, monitoring system, conductors, etc.) are manufactured with the most modern, environmentally friendly technologies.

PV solar power plants operate silently, do not emit harmful substances and do not emit harmful electromagnetic radiation into the environment. Recycling solar plants is also environmentally friendly.

For each kWh of electricity. energy produced from the PV power plant reduces CO2 emissions into the atmosphere by **0.568 kg**.

In accordance with the Ordinance on simple and other buildings and works NN 34/2018, the procedure for installing photovoltaic modules, implementing projects to improve the energy efficiency of buildings (eg installation of LED lighting) and installing electric chargers for vehicles has been significantly facilitated. In the area of LUZ there are large roof areas suitable for the installation of photovoltaic (PV) power plants.

In the following chapters, positions will be elaborated in order to provide basic information on the potential of each of the positions for the planned publication "Call for expressions of interest for the installation of photovoltaic modules and the use of renewable energy sources in LUZ"- what port authorities plan to do till end of 2021. Within project SUSPORT , PVs will be installed as integrated system into canopies. Energy from this island system electricity production will be stored into the batteries storage container type. This stored energy will be used for the purpose of port lightening and EVs chargers.

A summary of all potential roof surfaces suitable for photovoltaics can be found in the table below.

Roof surfaces	**m^2**	**power (kWp)**
Pasenger terminal	*5315*	*930*
Parking area	*8892*	*1540*
Multifuel station and new commercial center	*2700*	*470*
TOTAL	**16907**	**2940**

Table 4: Possible electric power from PV

Source: Author

Possible yearly savings of CO2 with PVs is **2817 t** and level of investment is around 2,5 mil Eur (detailed calculations in the table below)

Basic data of a solar power plant	
Rated power in kWp	2940
Price in EUR per kW of rated power	850
Cost value in EUR	2,499,000
Annual production 1kWp in kWh	1,687
Annual loss after 5 years in%	2
Percentage of investment financing	50
Loan amount in EUR	1,249,500
Annual interest rate in%	6.5
Loan duration in years	10
sts of loan approval and credit insurance arrangements in EUR	1,000
Investor's own funds in EUR	1,249,500
Operating costs in% on the cost value of the investment	0.5
All risk insurance in EUR per year	13,745
Guaranteed purchase in EUR / MWh	75
Replacement of inverters in EUR	4,500
Market price of electricity in EUR / MWh after 15 years	65
Roof rent in% of electricity sold	3

Table 5: CAPEX for PV
Source: Author

Chargers

There are plenty options for chargers positioning in the passenger port:

- for EV next to the passenger terminal building (for employee vehicles)
- for EV vehicles in the Rent-a-car parking lot
- on new multifuel stations

Within the SUSPORT pilot action it is planned to install two charges for electric vehicles which are predicted to be integrated, one of a lower power, 7-11kW (AC), and one fast charger with power up to 50kW (DC).

Terra multistandard DC charging station 54HV C (8m cable) (Picture is of shorter cable length)	Fast charging station. 50kW DC output power with 1 x 50kW (max) output: 200-920VDC max. 125A **Combo 2 cable + connector, 8.0 m** RFID reader enables RFID Authentication functionality. ISO/IEC14443A/B, ISO/IEC15693, :FeliCa™ 1, NFC reader mode. LEGIC Advant Temperature: -35 degC to +55 degC (de-rating characteristics apply) cabinet size: 565 x 780 x 1900 mm, IP54, powder coated stainless steel housing Support of OCPP interface Support of ethernet & 4G/3G modem	€ 24.000	**Terra HP 175 kW cabinet (not upgradeable to Dynamic DC) 160 kW continuous power, 175 kW peak power; 375 A DC output; 150 - 920 V DC output; galvanic isolation; AC input 400 V ±10%, 50 Hz, 277 A, 3P + PE. CE certified; isolation resistance acc. to IEC 61851-23; DC output ripple IEC 61851-23; EMC Class A acc. to IEC 61000-6-4; EMC immunity acc. to IEC 61000-6-1. IP 54 stainless steel cabinet for outdoor use; -35 °C to 55 °C (with derating). CE certified**	48.550,0 0 €

Figure 10: data & price for common DC charger
Source: budget price from worldwide famous producer ABB

Figure 11: View of the WI-FI ferry charger of the Finnish manufacturer Wärtsilä
Source: Wartsila officel website

Shore to ship

There are variety expressions for shore to ship: “cold ironing”, OPS-onshore power supply etc.

Enabling the supply of electricity to ship, and especially cruisers that stand longer than one day, is of strategic interest to LUZ, which is developing in the direction of maximizing the reduction of emissions in the port area with increasing traffic. The infrastructure for the supply of ships is extremely demanding, but all technical solutions exist and their application is safe and detailed in accordance with the standards and all necessary norms and regulations.

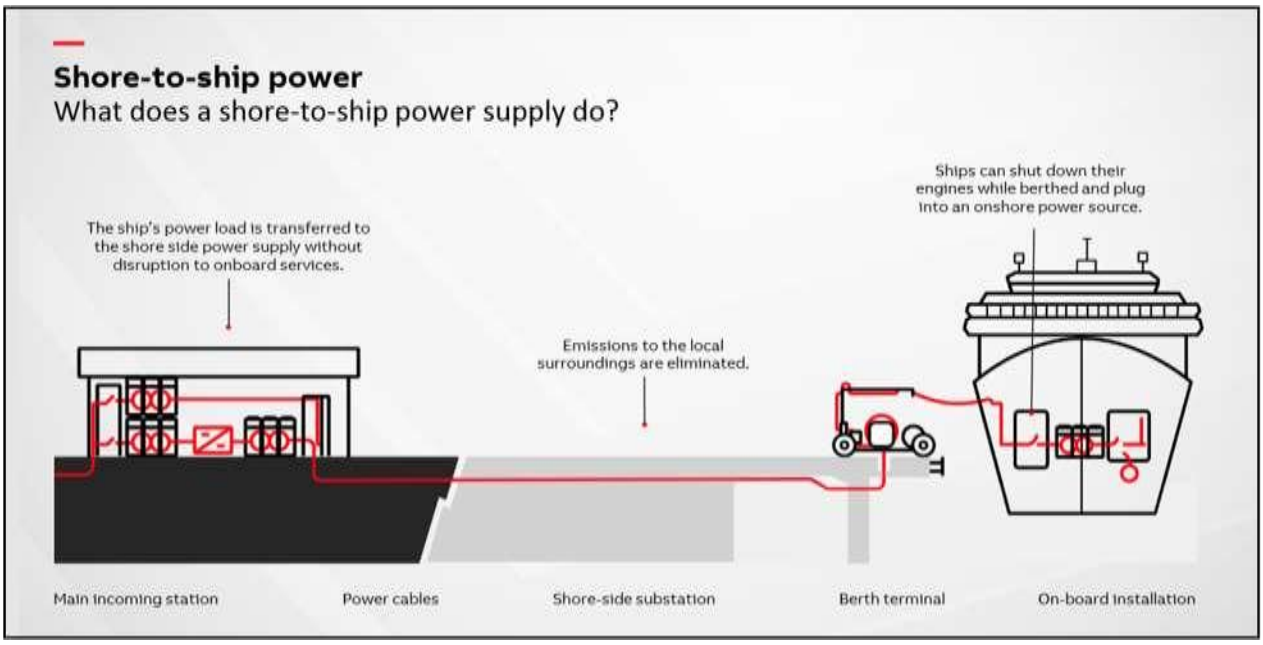


Figure 12: Schematic representation of the “shore to ship”
Source: budget price from worldwide famous producer ABB

The promotion of shore to ship (shore-side electricity for use by ships) started very aggressively since the European Commission adopted various documents related to decreasing emissions. Today it is not strictly an obligation but in a very near future we could expected enormous increasing price of CO2 what will trigger faster implementation. This solution ensures not only low emissions but also with this system the level of noise in port is minimum. Gazenica as all other ports needs to think about ensuring power supply of ships (cold ironing) that are moored in the port for more than 1 day. This will open up the problem of connected power for EE in the LUS area. Currently, shipowners are

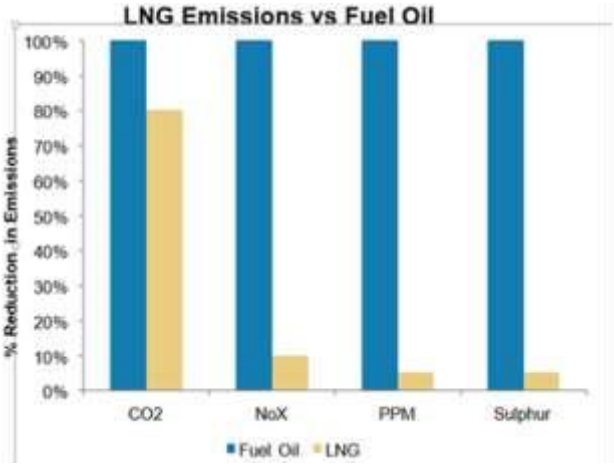
not legally obliged to do so, so ships generally do not yet have the ability to supply EE from the shore and use MGO or HFO to power their generators (this is especially a problem of large cruisers with 3000-5000 guests where the connection power for EE up to 12 MW).

Multifuel station

In correlation to EU and national policy, Gazenica need to ensure variety source of alternative fuel. Depending on progress e-mobility, hydrogen application and LNG usage multifuel station need to be flexible. In extension of such station LNG for filling ships/cruisers need to be ensured.

Figure 13: Position of multifuel station in the port Gazenica

Regarding market trend it seems that LNG could be a great transition fuel which will ensure emissions decreasing represent on figure 14.



Final EU target is to reach zero emissions in energy production. It is possible with renewable source of energy, but because of very volatile production it will be necessary to ensure energy storages on the site. Today trend is to store it into batteries, but because of the problem with after using disposal EU commission strongly support developing of hydrogen (H2) technology. There are many EU funds, like Innovation fund which support H_2 technology. At the moment Croatian national strategy for H2 developing is in progress. For port of Gazenica it is necessary to ensure H_2 availability as soon as it will be available.

Figure 15: Schematic overview of H2 on site production and dispatching
Source: web

Education and training

Some literature sources mention that the way of maneuvering the ship may influence the emission volume up to 15%–18% which is a significant percentage that should be taken into account when planning education of the staff. Seaports, as well as shipping companies, may change their procedures and introduce strict conditions of skill verification during employee hiring and professional work, in pursuit of reducing the volume of emissions at seaports. Companies may organize regular trainings and invest in employee education aiming at improving staff qualifications in supporting decision-making during maneuver operations. These activities may affect development of the environmental policy by the Port of Zadar Authority in order to decrease the costs of ship operation, as well as emission volume. Achieved results also proved that maritime education quality is very important to obtain the necessary qualifications for ships operators. This justifies the need to raise the quality of professional education at the universities and increase the number of practical hours on simulators for seafarers, which will enable an increase in their qualifications and attractiveness on the labor market. Moreover, the presented approach may be useful for seaports and shipping companies and may be implemented to assess the personal qualifications during the selection of staff responsible for ships' steering.

Environmental education and awareness training can help develop and encourage a transition to a greener corporate culture. Also, it seems reasonable to hang pictograms regarding environmental protection inside of passenger building terminal and on visible places within the port. The purpose of pictograms is to motivate drivers to turn off engines during their waiting times for ferries and taking care of proper waste disposal.

Time frame and possible sources of funding

Sources of funding

FZOEU- National Environmental Protection and Energy Efficiency Fund-I n accordance with the provisions of the Environmental Protection Act, the Fund is established for the purpose of securing additional resources for the financing of projects, programmes and similar activities in the field of conservation, sustainable use, protection and improvement of the environment.

- INEA-INNOVATION AND NETWORKS EXECUTIVE AGENCY-INEA's main objective is to increase the efficiency of the technical and financial management of the programmes it manages. There are few different actual program appropriates for Gazenica s actions:
    - Connecting Europe Facility (CEF)
    - Parts of Horizon 2020 – Smart, green and integrated transport + Secure, clean and efficient energy
    - The Innovation Fund
    - Legacy programmes: TEN-T and Marco Polo 2007-2013
- INTERREG Programmes – European Regional Development Fund (ERDF):
    - Cross-border Cooperation Programmes
    - Transnational Cooperation Programmes
    - Interregional Cooperation Programmes

Following is the GANNT chart indicating a timeframe for implementation of listed solutions and measures in the Chapter 3 of the Local Action Plan.

TASKS	2021		2022		2023		2024		2025		2026		2027		2028		2029		2030		2031		2032		2033		2034	
MONITORING ENVIRONMENTAL IMPACT																												
finance closing																												
tendering																												
putting into operation																												
improving system with aditional sensors																												
INTERNAL REGULATIVE FRAMEWORK AND ACTION PLANS																												
environmental policy plan																												
ISO 14001:2015																												
improving system with & recerrtification																												
CARBON FOOTPRINT REDUCTION MEASURES																												
pilot action within Susport																												
PV																												
chargers for Evs&ships																												
shore to ship																												
multifuel station																												
EDUCATION&TRAINING																												

Consistency with environmental sustainability and energy efficiency policies

All actions indicated in this local action plan are consistent with the environmental sustainability and energy efficiency policies followed by the Port of Zadar Authority with a special emphasis on implementing actions in order for the port of Zadar to become a green port.

The EU aims to be climate neutral by 2050 and therefore the European Green Deal provides an action plan to: • boost the efficient use of resources by moving to a clean, circular economy

- restore biodiversity and cut pollution.

It suggests a European Climate Law to turn this political commitment into a legal obligation. Reaching this target will require action by all sectors of our economy, including:

- investing in environmentally-friendly technologies
- supporting industry to innovate
- rolling out cleaner, cheaper and healthier forms of private and public transport
- decarbonising the energy sector
- ensuring buildings are more energy efficient
- working with international partners to improve global environmental standards

Proposed actions are clearly in line with the actions indicated in the European Green Deal since these also aim at investing in environmentally-friendly technologies, support the transport industry to innovate and are supporitn the idea of decarbonisation and making port facilities more enegry efficient.

According to the European Parliament Resolution of 16 January 2018 on international ocean governance: an agenda for the future of our oceans in the context of the 2030 Sustainable Development Goals, maritime transport affects global climate and air quality with CO2 and other emissions. This impact is particularly present in port cities and coastal areas and is important for public health and environmental protection. EU is therefore committed to achieving the protection and sustainable use of the oceans, seas and marine resources, emphasizing the strong maritime dimension of the Sustainable Development Goals within the Sustainable Development Goal 14:

Preserving the aquatic world and marine resources for sustainable development. Actions proposed by this implementation are fully consistent with the SDGs.

In 2018, the International Maritime Organization adopted an initial strategy to reduce greenhouse gas emissions from ships with a vision which aims to phase them out, as soon as possible in this century. The strategy also directly recommends a way to reduce CO2 emissions in line with the Paris Agreement temperature targets (IMO, 2018) which will be supported by the medium and long-term actions that were proposed by this document.

An increasing number of ports in the EU allow liquefied natural gas (LNG) to meet the requirements of reducing CO2 emissions and open up new business opportunities, thus increasing the number of ships that use LNG as a fuel. In the Croatian transport sector, the share of alternative fuel vehicles is still relatively small (less than 3 percent). In December 2016, the Republic of Croatia passed the Act on the Deployment of Alternative Fuels Infrastructure (OG No. 120/2016) transposing into national law the provisions of Directive 2014/94/EU of the European Parliament and of the Council of 22nd October 2014 on the deployment of alternative fuels infrastructure in the part referring to a Member State. Pursuant to the Act, a joint framework of measures for market development regarding alternative fuels in the transport sector and for deployment of adequate infrastructure is defined in the National Policy Framework for Deployment of Alternative Fuel Infrastructure of the Republic of Croatia, which was adopted in Croatia in 2017 (OG No. 34/17). It sets minimum targets for building alternative fuels infrastructure, including filling stations, joint technical specifications for filling and supply stations, user notification requirements, as well as measures needed to achieve national targets. All other issues relating to the deployment of alternative fuels infrastructure not regulated by this Act or the NPF shall be governed by the regulations governing the areas of transport infrastructure, physical planning, spatial data infrastructure, construction, energy, energy efficiency, environmental protection, and laws establishing and defining the scope of activity of the Environmental Protection and Energy Efficiency Fund (Ministry of Environment and Energy, 2019).

National Policy Framework (2017) sets the goal that by 31 December 2030, among other coastal cities and in Zadar, the infrastructure for transhipment and supply of LNG must be available. Alternative fuels should be used to power ships which, by their navigation in any chain of national and / or international navigation, include the Passenger Port of Gazenica as their port of call. By the end of 2021, the Port of Zadar Authority will issue a call for expressions of interest for the construction of a multifuel station that should enable the refuelling of alternative fuels for trucks, buses and personal vehicles. Also, Croatian receiving LNG terminal (FSRU concept) was put into

operation at the beginning of this year (2021) which opens a great perspective for LNG bunkering stations through the Adriatic coast. In some world wide studies it is stated that the usage of more environmentally friendly fuels, like LNG, can decrease emissions from ships up to 30% and SOx emission up to 100%.

Maritime Development and Integrated Maritime Policy Strategy of the Republic of Croatia for the period from

2014 to 2030 indicates within the objective 2.4.1. Port specialisation a measure to Specialise the Zadar port to receive Ro-Ro vessels, passenger ships and cruising vessels, as well as a home port with particular emphasis on port development in terms of attracting new technologies and special cargo. It supports the predictions that traffic within the New Port of Gazenica will certainly increase in the years to come which highlights the importance of sustainability. It is stated that maritime sector is an economic activity which must be based on the principle of sustainability and efficiency as an economic category, but certainly also on sustainability with regard to negative impacts on the quality of life and its environment. Furthermore, objective 3.2.1. supports preventing environmental pollution and the harmful impact of vessels and maritime structures on the Adriatic Sea. Additionaly, Transport Development Strategy of the Republic of Croatia 2017-2030 indicates objectives which are in line with the Maritime Development Strategy and also supports environmental sustainability and reducing climate change impact of the transport sector.

Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20) in the Republic of Croatia determines the area for efficient energy usage, issuing plans on local, regional and national level for improvement of energy efficiency and their implementation, energy efficiency measures and obligations, determining energy savings, consumer rights in the application of measures for energy efficiency and other regulations set down by the Act. Additionally, on the basis of this Act, an Ordinance on the methodology for monitoring, measurement and verification of energy savings (Official Gazette 33/20) has been approved. The main objective of this Ordinance is establishment of a system for monitoring and evaluating the success of the implementation of energy efficiency policy, achieving the goals set out in the Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 and the National Action Plan, methodology for monitoring and calculating energy consumption indicators at national and sectoral level, calculating new energy savings measures as a result of energy improvement measures and the result of the application of energy services, methods for calculating new energy savings, the procedure for verifying new energy savings, as well as the methodology for drafting the an Action Plan, i.e. the Annual Plan. Regarding

the Energy Development Strategy of the Republic of Croatia until 2030 expectation is an enormous decrease of CO2 emissions and increasing of all types of electric vehicles. All producers of electricity need to approve decreasing of emissions in each kWh and this will consequently push them to invest in renewable sources of energy.

Furthermore, Port of Zadar Authority adopted the Ship Waste Management Plan during 2014, and in 2018 the Ordinance on determining the class and quantity of hazardous substances from ships which defined the methods and control of handling hazardous substances in the area of operation. Under the concession agreement for the provision of basic port services and related economic activities in the port of Gazenica, the company Zadar International Port Operations (ZIPO) is obliged to take measures and activities to protect and preserve the marine environment and prevent its pollution.

Also, Port Regulations on the maintenance of order and terms of using the port area under the jurisdiction of the Port of Zadar Authority also lay down safety and security measures which contribute to the abovementioned goals.

International level
Paris Agreement (Agreement on taking urgent actions to fight climate change and its impacts.)
IMO 2020 Sulphur Regulation (2020 global Sulphur limit will be 0,50% m/m (from 3,50%) for marine fuels.)
EU level
European Green Deal (The EU's roadmap for a sustainable economy, striving to make Europe climate neutral in 2050)
Resolution of 16 January 2018 on international ocean governance: an agenda for the future of our oceans in the context of the 2030 Sustainable Development Goals
Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources
Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013
Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action
Directive 2012/27/EU on energy efficiency [Official Journal L 315 of 14.11.2012].
Directive 2009/28/EC on renewable energy sources [Official Journal L 140 of 5.6.2009]

Directive 2014/94/EU of the European Parliament and of the Council of 22nd October 2014 on the deployment of alternative fuels infrastructure in the part referring to a Member State
Directive 2014/90/EU on marine equipment (Safer and less polluting equipment on EU ships)
Directive 2008/56/EC – EU action in the field of marine environmental policy (Marine Strategy Framework Directive)
Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC.
Regulation (EU) No 911/2014 of the European Parliament and of the Council of 23 July 2014 on multiannual funding for the action of the European Maritime Safety Agency in the field of response to marine pollution caused by ships and oil and gas installations.
Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC
Barcelona Convention for the protection of the Mediterranean
Roadmap for moving to a competitive low-carbon economy in 2050 [COM(2011) 112 final of 8.3.2011]
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Energy technologies and innovation (COM(2013) 253 final of 2 May 2013)
Commission Recommendation 2013/105/EC of 9 October 2009 on mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy.
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Energy 2020 - A Strategy for competitive, sustainable and secure energy (COM(2010) 639 final of 10.11.2010)
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Energy roadmap 2050 (COM(2011) 885 final of 15.12.2011).
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank - A framework strategy for a resilient energy union with a forward-looking climate change policy (COM(2015) 80 final of 25 February 2015)
National Regulation
Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20) in the Republic of Croatia
National Policy Framework for Deployment of Alternative Fuel Infrastructure of the Republic of Croatia (OG No. 34/17)
Act on the Deployment of Alternative Fuels Infrastructure (OG No. 120/2016)

Ordinance on the methodology for monitoring, measurement and verification of energy savings (Official Gazette 33/20
Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050
Maritime Development and Integrated Maritime Policy Strategy of the Republic of Croatia for the period from 2014 to 2030
Transport Development Strategy of the Republic of Croatia 2017-2030
Port of Zadar Authority documents
Ship Waste Management Plan
Ordinance on determining the class and quantity of hazardous substances from ships
Regulations on the maintenance of order and terms of using the port area under the jurisdiction of the Port of Zadar Authority
Ordinance on determining the class and quantity of dangerous substances that may be handled in the port, that is, that may be carried by a ship entering the port area and places in the port of Zadar where these substances will be handled

Figure 16: Consulted strategic and legislative framework

Conclusion

Gazenica is a quite modern port with relatively small amount of carbon emissions. To keep this trend, it is very important that projects listed in this action plan are investigated and their potential is explored in the mid-term as well as in the long-term period. It is necessary to trace trends in mobility and adapt plans in correlation with the realistic situation and needs. Vehicles and ships are on the turning point and interplay between electricity, hydrogen and LNG as running fuels exist. Probably this game will never end, so flexibility of ports with an offer of fuel variety will be a crucial advantage for survival.

Alternative fuels are strictly related with electricity and it is very important that renewable sources of energy are explored and installed in Gazenica as a green source of electricity which could be transformed and stored in various energy forms. Monitoring and recording of emissions will also be crucial to recognize potential problems and to be able to react accordingly.

However, it is important to emphasize that this action plan is not an obligatory document for the Port of Zadar Authority but it serves in order to explore the possibilities for energy efficient solutions and advances in the port areas. This plan can be adjusted and adapted in the future, even after the project ends in accordance to the needs that appear within the port.