D.3.1.1 Catalogues of best available technological and organizational solutions

WP3. Nautical marinas framework analysis and investment plans

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Executive Summary

In the last years, alarms sounded by scientists about the climate changes caused by greenhouse gas emissions produced by fossil fuels are more and more frequent. Both these alarms and people own perception is making institutions and public opinion aware of the risk that global warming could reach a critical level leading to an irreversible climate instability.

One of the effect of this awareness is the widespread of renewable energy sources and the request for the development of sustainable transport. In this context the project DEEP-SEA aims to enhance the framework for the development of energy efficient mobility services inside and around nautical marinas with special focus on electric and shared mobility. At the moment, electric mobility is taking shape mainly in the diffusion of electric vehicles (EV). An overview of electric vehicle technologies can be found in [1].

The market is offering an increasing number of hybrid and full-electric car models and, as a consequence, also battery charging stations. For the purposes of the project it is useful to make first of all a brief overview of EV charging technologies [2].

1. Electric vehicle charging technologies

Batteries of EVs can be charged in three different ways: conductive charging, inductive charging, battery swapping. At present, the first one is by far the most diffused and many models are available in the market. Nevertheless, inductive charging is object of increasing research interest, so much so that many laboratory prototypes are documented in the literature, but also some operating prototypes and commercially available wireless chargers [3], [4]. In addition, battery swapping is object of increasing interest, so much so at least one EV builder sells an electric car with the possibility of battery swapping along a route in China served by battery swapping stations [5].

Conductive charging

Conductive charging transfers energy from the supply network to the battery through conductive connection, which implies the connection of the vehicle to the charging station trough a conductor cable.

The battery charger can be on-board the vehicle or off-board. An on-board charger is usually used for slow charging, whereas off-board chargers can be installed at fixed locations to offer rapid charging service.

EV conductive charging systems are the subject of the International Standard IEC 61851, which was approved by CENELEC as the European Standard EN 61851 [6], and the International Standard IEC 62196, which was approved by CENELEC as the European Standard EN 62196 [7].

EN 61851-1 “applies to on-board and off-board equipment for charging electric road vehicles at standard AC supply voltages up to 1000 V and at DC supply voltages up to 1500 V, and for providing electrical power for any additional services on the vehicle if required when connected to the supply network”.

EN 62196-1 “is applicable to plugs, socket-outlets, vehicle connectors, vehicle inlets and cable assemblies for electric vehicles, intended for use in conductive charging systems which incorporate control means, with a rated operating voltage non exceeding

- 690 V AC 50 Hz to 60 Hz, at a rated current non exceeding 250 A,
- 1500 V DC at a rated current not exceeding 400 A”.

EN 61851-1 defines four charging modes and three types of EV connection using cable and plugs. The charging modes are listed in the following.

- Mode 1 charging: connection of the EV to the AC supply network using standardized socket-outlets not exceeding 16 A and 250 V AC single-phase or 480 V AC three-phase, at the supply side, and utilizing the power and protective earth conductors.
- Mode 2 charging: connection of the EV to the AC supply network not exceeding 32 A and 250 V AC single-phase or 480 V AC three-phase using standardized single-phase or three-phase socket-outlets, and utilizing the power and protective earth conductors together with a control pilot function and system of personnel protection against electric shock between the electric vehicle and the plug or as a part of the in-cable control box. The inline control box shall be located within 0.3 m of the plug or the EV supply equipment or in the plug.
- Mode 3 charging: connection of the EV to the AC supply network using dedicated EV supply equipment where the control pilot function extends to control equipment in the EV supply equipment, permanently connected to the AC supply network.
- Mode 4 charging: connection of the EV to the AC supply network using an off-board charger where the control pilot function extends to equipment permanently connected to the AC supply network.

The connection of EVs using cables can be carried out in one or more of three different ways:

- Case “A” connection: the connection of an EV to the AC supply network using a supply cable and plug permanently attached to the EV.
- Case “B” connection: the connection of an EV to the AC supply network using a detachable cable assembly with a vehicle connector and AC supply equipment. Case B1 corresponds to a connection to wall mounted socket. Case B2 corresponds to a specific charging station.
- Case “C” connection: the connection of an EV to the AC supply network using a supply cable and vehicle connector permanently attached to the supply equipment. Only case “C” is allowed for mode 4 charging”.
- *Inductive charging*
- Inductive charging is carried out by charging systems where a transmitting section transfer power to a receiving section by means of a variable magnetic field [8]. The two sections are galvanically isolated, so that this way of charging is also known as wireless charging.
- Advantages of inductive charging are safety also under adverse weather conditions, increased user comfort and possibility of recharging the vehicle while running, thus avoiding time-consuming recharging stops and contributing to reduce the so-called “range anxiety”. Drawbacks of the present inductive charging technology are lower efficiency and higher power losses with respect to conductive charging.

Battery swapping

- This recharging method is based on the presence of battery swapping stations (BSS) [9], where users can swap their empty batteries with fully charged ones. Advantages of battery swapping are short charging time (similar to the present refueling time for vehicles with internal combustion engine), long battery life, low managing cost tanks to collection and management of batteries in centralized locations and increased possibility to operate as vehicle-to-grid (V2G) systems [10], i.e. to exploit the power electronic apparatus connecting the BSS to the electric network also to provide it with ancillary services. As a counterpart realization of battery swapping stations require the availability of large spaces and high amount of money for the initial investment.

Battery charging techniques

- At present most of the EV are equipped with Lithium-ion (Li-ion) batteries, because, among the well-established technologies, they are the ones with better performances in terms of power and energy densities. For the future, researches of universities and research centers are exploring new promising technologies, such as Lithium-Sulphur (Li-S) batteries.
- Among the different possible charging techniques, most of the commercial chargers for Li-ion batteries use a constant current – constant voltage (CC – CV) technique. CC charging is faster than CV charging but it could lead to overcharging conditions, which would reduce the battery life. For this reason, with the CC – CV method the battery charging is started in CC mode and, when a set battery voltage level is reached, it is switched to CV mode until a termination condition is reached.
- Reduction of battery charging time is one of the key issues to help the diffusion of EVs. As a result, in order to reduce the charging time and increase the battery capacity, many improved CC – CV methods and pulsed-current methods have been proposed in the scientific literature. Nevertheless, other studies are required to further enhance battery charging performance.

Battery chargers for plug-in electric vehicles

- Battery chargers for EV can be unidirectional or bidirectional [11]. Unidirectional chargers allow electric energy to flow only from the supply system to battery to be charged. In most cases, they are composed of a diode rectifier, a filter and a DC/DC converter with or without high frequency transformer.
- Typical bidirectional chargers have two stages: an AC/DC PWM converter and a bidirectional isolated or non-isolated DC/DC converter. The first one is connected to the power network and can absorb electric energy in order to charge the battery or supply electric energy to the power network in order to play the role of a V2G system. Usually, V2G-enabled power electronic systems can also perform ancillary services to the power network not requiring an exchange of electric energy, such as reactive power compensation, active filtering, load balancing.
- The DC/DC converter stage is in charge of controlling the electric energy flow through and from the battery by regulating its current or voltage.

- Bidirectional battery chargers can be built also using two unidirectional converters, one to charge and the other to discharge the battery. However, thanks to the recent advancements

2. Commercially available electric vehicles and charging stations in Europe

At present, new car makers specialized in the production of EV are entering the market; for example, the well-known Tesla or a number of other less known producers such as the American Fisker, producing a luxury sports plug-in hybrid EV, or the Italian Estrima, a producer of light EV from Pordenone. In addition, the product line of many of the traditional car manufacturers, namely Audi, BMW, Chevrolet, Citroen, Ford, Hyundai, Honda, Jaguar, KIA, Land Rover, Mercedes-Benz, Mini, Mitsubishi, Nissan, Opel, Peugeot, Porsche, Renault, Smart, Toyota, Volkswagen, Volvo, includes one or more plug-in hybrid or full-electric car models.

Usually, EV are sold together with specific domestic chargers. Nevertheless, the offer of EV is growing together with the offer of charging stations. At present, a number of charging stations for EV are made available by well-known multinational companies, such as ABB and Siemens, and other companies such as the German Mennekes, the Swiss Repower and the Italian Gewiss, bTicino, Scame, Enel X, e-Station, Lampionet.

Unfortunately, there is still no common standard for EV charging and the situation is rapidly changing, both as regards charger technologies, roaming protocols and connectors for conductive charging [13], and there is a big difference between Asia, USA and Europe [14].

Types of charging stations in Europe

Charging of EV is usually divided in two power levels [15]:

- normal power charging, also known as slow charging, for power $\leq$ 22kW,
- high power charging, also known as fast charging, for power > 22kW.

Types of charging stations which can be found in Europe are listed in the following. They are classified according to the type of connector [15], [16].

- *Type 1*: also named Yazaki connector, uses 5 pin connectors and allows AC slow charging.
- *Type 2*: also named Mennekes connector, uses 7 pin connectors. At present, it is the most diffused charging type in Europe and is indicated by the European Union as the standard for slow charging. Nevertheless, there are charging stations, at least some by Enel X, which have type 2 connectors allowing 43 kW fast charging.
- *Type 3*: also named Scame connector, allows slow charging in Italy and France. According to [15] it is not installed anymore since 2012; however it is still diffused in Italy, moreover Scame and other Italian companies still produce it.
- *Type 4*: better known as CHAdeMO, uses 10 pin connectors and allows fast DC charging, up to 200 kW.

- *Combined Charging System (CCS Combo 2)*: it allows both type 2 AC slow charging and DC fast charging. It is indicated by the European Union as the standard for fast charging.
- *Tesla destination charger* and *Tesla supercharger*: they use a type 2 connector, but they can be used to charge only Tesla vehicles. Tesla destination charger allows AC slow charging and Tesla supercharger allows DC fast charging up to 120 kW. Tesla superchargers have been now updated with CCS Combo 2 connector, used for Tesla Model 3, while Model S and Model X need an adaptor.

a) b) c) d)

Figure 1: connector of the different types of charging stations: a) type 1,b) type 2, c) type 4, d) CCS Combo 2.

The majority of plug-in hybrid EV are equipped with a type 2 connector for slow charging; nevertheless, a number of them is equipped with a type 1 connector.
The situation is more diversified for full EV. Some of them are enabled only for slow charging, therefore they are equipped with a type 1 or, more frequently, especially for new models, a type 2 connector. On the other hand, many of them are enabled both for slow and fast charging; as a consequence, some of them, mainly the new models, are equipped with a CCS combo 2, while other are equipped with two connectors, i.e. type 1 or type 2, increasingly widespread in new models, plus CHAdeMO or, in one case, CCS combo 2 (together with type 1).
The previously listed companies offer different charging stations with the listed types of connectors and different power levels. However, among them, only ABB, Siemens, Scame, Enel, e-Station, Lampionet offers stations enabled for fast charging.
Typical nominal currents of slow charging are 16 A and 32 A which correspond respectively to 3.7 kW and 7.4 kW in case of single phase power supply or 11 kW and 22 kW in case of three-phase power supply. At present, the typical power level for fast DC charging in Italy (both by CHAdeMO and CCS Combo 2) is 50 kW, apart from the 120 kW of Tesla superchargers.
For instance, within the Interreg project Italia Slovenija MUSE, at the University of Trieste a Scame charging station is being installed with two type 2 connectors allowing 22 kW charging. Other examples in Trieste are two charging stations available at Area Science Park. One is an Enel X charging station equipped with a 43 kW type 2 connector, a 50 kW CHAdeMO connector and a 50-kW CCS Combo 2 connector. The other is an Emobitaly charging station equipped with two 22-kW and two 7.4-kW type 2 connectors. For the rest, apart from two 22-kW Tesla destination chargers, in Trieste and its surroundings there are several charging stations installed by the utility company Hera equipped with one 22-kW type 2 connector and one 3 kW type 3 connector.

E-roaming

The absence of protocols and standards for interoperability and e-roaming has so far hindered the development of cross-border EV travel within the EU [13].

Charging stations are often equipped with proprietary billing systems. The usage of these charging stations is thus reduced to customers who made a contract with the charging station operator. E-roaming is defined as the possibility for EV drivers to charge their vehicles at all charging stations, regardless of any contracts concluded with operators. The billing occurs subsequently via the customer's own contractual partner [16].

A roaming hub offers the possibility to charge a vehicle at stations of different charge point operators connected to that roaming hub. Currently, multiple roaming hubs for electric mobility exist in Europe, each one using its own proprietary protocol. Only one independent protocol exits, it is called Open Charge Point Interface Protocol (OCPI) and is proposed by [13] as the possible standard protocol for e-roaming in Europe.

"In essence, all roaming protocols have the same goal: to offer roaming to EV drivers across Europe. However, the hubs that use their own proprietary protocol do not communicate with each other and do not exchange data. A service provider or charge point operator who wants to achieve maximum roaming will need to reach an agreement with all major hubs. OCPI can change this. In an ideal situation, the different protocols should be united and converged into one independent and open protocol that can connect both via hubs as well as peer-to-peer. This will reduce the need to connect to every hub, as OCPI offers alternative ways to connect (e.g., peer-to-peer)" [13].

Examples of practical information about three full electric car models and their charging

As an example, practical information about connectors and endowments for charging, battery size and time required to bring the battery state of charge (SOC) from 0 to 100% (unless otherwise specified) of a small car, Renault Zoe, a medium car, Nissan Leaf, and a large car, Tesla, are given in the following table.

CAR MODEL	CONNECTOR	ENDOWMENTS	BATTERY SIZE	CHARGING TIMES	
				SLOW	FAST
Renault Zoe	Type 2	- On board adaptive single / three phase battery charger from 2 to 22 kW for 68 kW and 80 kW motors and to 43 kW for 65 kW motor.	41 kWh	From data sheet	
				Single-phase - Household outlet (10A): 25h. - 3.7 kW: 15h. - 7.4-kW: 7h25. *Three-phase* - 11-kW: 4h30.	Charging station 43 kW (*): - 65 min. for 65 kW motor, - 100 min. for 68 kW and 80 kW motors.

<table>
<tr><td></td><td></td><td>- Cable for type 2 - type 2 connectors.
- Optional cable for schuko household outlet.
- Optional wall box to be installed at home.</td><td></td><td>22-kW: 2h40.</td><td></td></tr>
<tr><td rowspan="2">Nissan Leaf</td><td rowspan="2">- Type 2
- CHAdeMO</td><td rowspan="2">- 6.6-kW on board AC battery charger.
- 32-A cable for type 2 – type 2 connectors.
- 10-A cable for type 2 – schuko connectors.</td><td rowspan="2">- 40 kWh (110 kW motor),
- 62 kWh for e+ Tecna (161 kW motor).</td><td colspan="2">From Nissan website
(in brackets time for e+ Tecna)</td></tr>
<tr><td>- Household outlet: 21 h (32 h).
- 7-kW: 7h30 (11h30).</td><td>- 50-kW (**): 60 min. (90 min.).</td></tr>
<tr><td rowspan="2">Tesla</td><td rowspan="2">- Type 2 in Model S and Model X
- CCS Combo 2 in Model 3</td><td rowspan="2">- On board battery charger: 11 kW for Model 3, 16.5 kW for model S / model X.
- Tesla mobile connector + domestic adapter (2.3 kW) and blue industrial adapter (3.7 kW).
- Type 2 cable.</td><td rowspan="2">- Model S and Model X: 100 kWh.
- Model 3: 50 kWh or 75 kWh.</td><td colspan="2">Estimated by calculation (***)
(in brackets time for Model 3, 75 kWh battery)</td></tr>
<tr><td>- Household outlet (2.3 kW): 45h
(34h)
- 3.7-kW: 28h (21).
- 11-kW: 9h30 (7h).
- 16.5-kW: 6h20.</td><td>- 50 kW: 2h (1h30).
- Tesla supercharger (120 kW): 50 min. (40 min.).</td></tr>
</table>

		- CCS Combo 2 adapter (up to 120 kW) for Model S and Model X (no need for Model 3). - Optional Tesla wall connector to be installed at home. - Optional CHAdeMO adapter (up to 43 kW) compatible with Model S and Model X.			

(*) SOC 0 – 80%, as from data sheet.
(**) SOC 20-80%, as from Nissan website.
(***) SOC 0 – 80%. Since no data by the manufacturer are available (in Tesla website gives the travel miles per charging hour) they have been roughly estimated dividing the battery capacity by the charging power and increasing it by about 30% in order to take into account the time required by the battery to warm up, the charging efficiency, the charger efficiency and other non-idealities. Charging time has been estimated for charging from 0 to 80% of the battery capacity because charging slows down as the state of charge is getting closer to 100%.

3. Plug-in electric boats and their charging systems

Even if talking about electric mobility our thought goes immediately to electric cars, electrification is greatly progressing also in the marine sector, spanning from hybrid ships to full-electric small boats [17].
At the beginning of July 2019 MS Roald Amundsen, the first hybrid expedition cruise ship, owned by the Norvegian company Hurtigruten, sailed from northern Norway for its maiden voyage. MS Roald Amundsen has a length of 140 m, a gross tonnage of almost 21000 GRT and can take more than 500 passengers plus 150 crew members. The battery pack enables the ship to run with fully electric propulsion for 45-60 minutes under ideal conditions. The second hybrid cruise ship Hurtigruten has

on order, to be delivered later this year, will have battery pack with twice the capacity of the Roald Amundsen. The company expects infrastructure will improve on its traditional routes along the Norwegian coast, while currently charging services are only provided in Bergen. "We expect batteries to be an important part of shipping in the years to come, but of course we don't expect our ships to be able to operate only on batteries, because the ship can sail up to 18-20 days in areas where there are no charging points", Hurtigruten Chief Executive Daniel Skjeldam said [17].

While propulsion of cruise ships cannot rely only on batteries, ferries conceived for short routes can be fully electric. One of the first examples are the two 110 m-long ferries Aurora and Tycho Brahe, which since November 2018 have being crossing more than 20 times a day each the 4 km between Helsingborg in Sweden and Helsingor in Denmark. Their lithium battery pack can store up to 4.1 MWh and they are recharged in a fully automatic way for about 5 minutes in Denmark and 9 minutes in Sweden. The charging system is supplied with 10 kV AC and during charging it absorbs 600 A. The voltage is reduced to 750V by a step-down transformer and then rectified [19]. Another example is the fully electric ferry Ellen, baptized on 1st of June 2019 and built with the support of the European Commission's research and innovation Horizon 2020 initiative. It is 60 m long, thus being smaller than Aurora and Tycho Brahe, but with its 4.3 MWh battery pack it will be able to cover the 40 km between the Danish island of Ærø and Fynshav [20].

The previous examples show that the technology is ready for plug-in hybrid mega yachts, which could be accommodated by the best marinas together with smaller hybrid and full electric yachts. Actually, each berth in marinas is already equipped with a shore power connection used for instantaneous supply of loads of moored boat and charging of their auxiliary batteries.

One of the first examples of hybrid yacht is the model Long Range 23 (Mochi brand), produced by Ferretti Group [21] only from 2009 to 2011 for a total of five units. Two 70-kW synchronous machines supplied by a lithium ion battery pack can sail the more than 20-m long yacht in the so called “zero emission mode”. The batteries can be charged both by the synchronous machines driven by diesel engines during navigation and standard shore power connections when moored.

If the Long Range 23 is no more in production, WIDER 165 is a much larger hybrid yacht currently in production by Wider [22]. It has a total length of about 50 m, four 350-kW gen-sets, two 531 kW electric propulsion motors and a 544 kWh battery pack for zero emission mode cruising. All onboard energy sources are controlled by the Power Management System**,** a smart and fully integrated system which controls the power supplied by the shore connection, the gen-sets and the battery packs, distributing it between the hotel requirements, the propulsion system and the recharging of batteries, as required.

An example of medium size yacht is the 18 m-long Tag 60 catamaran [23]. Its propellers are moved by two 18-kW permanent magnet electric motors. Electric energy is stored into a 144-V lithium ion battery pack, which has an energy capacity of 46 kWh. When the catamaran is under sail the propellers spins in the wake turning the 18-kW permanent magnet machines, which charge the batteries with renewable energy. When there's not enough wind for recharging, two 22-kW diesel generators kick in automatically, together or individually as needed. The generators are 144-V DC units that recharge the batteries directly. The batteries can be charged also with a 144-V charger that plugs into both 110 V, 60 Hz or 220 V, 50 Hz shore power. The charger is also designed to handle

a wide range of voltages and frequencies, a big advantage in out-of-the way ports with erratic supplies of electricity.
Another producer of yachts is the Slovenian Greenline Yachts [24]. The Ocean Class of its fleet includes two medium-size yachts (around 20 m long) which can be equipped with a hybrid propulsion system. They produce also small-size yachts (from 10 m to 15 m long) which can be equipped with hybrid (the Greenline line) or full electric propulsion (the NEO and Greenline lines). All the Greenline yachts are equipped with an on-board charger for battery charging by a standard shore power connection.
Against a few examples of large and medium-size hybrid yachts, it is possible to find a number of small-size hybrid and full electric yachts.
For instance Cantieri Navali Vizianello produces hybrid boats for passenger transport in the Venice lagoon and the water limousine, the first hybrid taxi in Venice delivered on 18th of June 2019 [25]. The water limousine is equipped with a diesel engine combined with a 12 kW permanent magnet machine, powered by a 10 kWh battery pack.
Other examples can be found in the catalogue of Ecoline Marine, a company from Sarnico (Iseo Lake) producing only electric and hybrid motorboats and two models of small hybrid yachts [26].
Both the boats produced by Vizianello and the ones produced by Ecoline Marine have an on-board battery charger which gives the possibility to charge the batteries through a 16-A or 32-A standard shore power connection. This is the most common solution for hybrid and full electric boats.
An exception is Repower^e [27], a 10-m long full electric boat produced by Repower, which can be charged by the same charging stations used for electric cars. Repower^e has two electric motor rated 11 kW or 20 kW depending on the model. The battery pack capacity can range from 20 kWh to 100 kWh.

4. Examples of electric mobility in coastal areas

Repower^e is the cabin evolution of Reboat [28], an open full electric boat active for passenger transportation since 2016 on Lake Garda. In addition to Lake Garda, Repower^e can be found as a water-taxi on Varese Lake, where two local businessmen donated a charging station for boats to the public docks in the town of Cazzago [29].
Another example of charging stations for boats can be found at the Yacht Club de Monaco (YCM), where on May 2019 were installed speedy superchargers designed specifically for electric powerboats [30]. The charging stations at YCM are the first of a planned network along the French Riviera. Each station supports AC and DC charging. With a maximum power output of 150 kW, they allow DC compatible powerboats to half recharge in under an hour.
An example of initiative for electric mobility in the coastal areas is “Como – The Electric Lake” [31], started in the summer 2017 with the installation of 17 charging stations for electric cars covering the 170 km around the lake and aimed at developing a charging network for e-bikes, cars, boats. Electric boats can be rent at least at Econoleggio Como Lake at Colico. Electric boats are also produced and introduced in the lake by Cantiere Nautico Matteri and Cantiere Ernesto Riva. An example is Elettra, the electric version of a traditional 10-m boat endowed with two 100 kW electric

motors and a 180 kWh battery pack [32]. In the Como Lake a fast charging point will soon be installed at the historic site of the Ernesto Riva shipyard [33]. It will allow continuous services to the shipyard's electric boats and not only.

5. Renewable energy sources

Nowadays, two energy transition are occurring: the first one is from fossils fuels to renewable energy sources, the second one is the unification towards the energy carrier electricity, where distributed generators and electric vehicles are the leaders.
Development of renewable energy sources is driven by a real boom, shown by the histogram in Fig. 2 [34], were power capacity of renewable energy sources (excluding large hydro power plants) worldwide increased from 7.5% in 2007 to 19% in 2017, while the European target is 32% by 2030. Such a boom is testified also by the fact that 61% of new installed energy sources in 2017 worldwide (82% in Europe) were renewable (excluding large hydro) and the largest investments are in renewable energy sources.
The main factors contributing to this significant increase are:

- target for emission reduction,
- iincreased public awareness of the risks related to climate change,
- reduced availability and consequent price increase of conventional energy resources,
- deterioration of air quality in urban areas,
- low installation time of distributed generators,
- low cost of electric energy from wind power and photovoltaic plants.

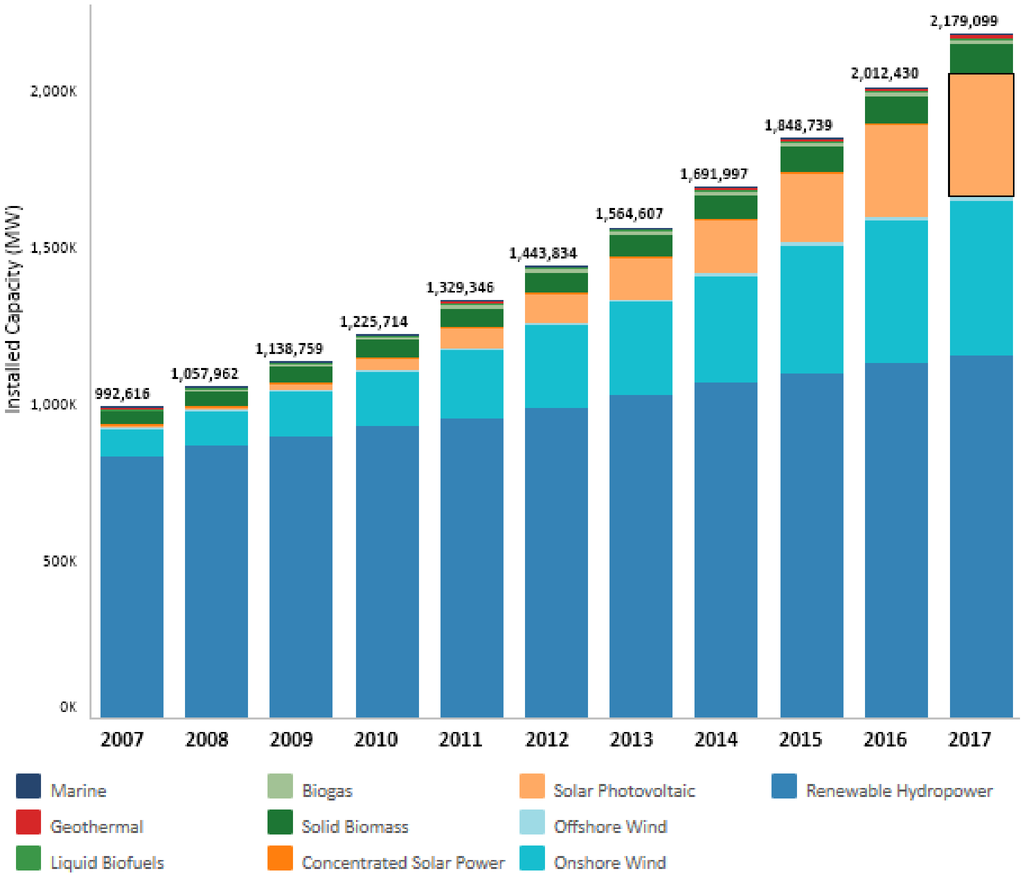

Figure 2: histogram showing the total installed capacity for the different renewable energy sources.

Photovoltaics

Photovoltaic energy has a leading role in the aforementioned energy transition. This statement is proved by the histograms of Fig. 3 and Fig. 4 [35].

Advantages of photovoltaic systems justifying such a leading role and making them very attractive for installation in Marinas are:

- fuel source is free, vast and essentially infinite,
- the lowest operation and management costs,
- high reliability and durability,
- easy and quick installation,
- modular technology, which means that photovoltaic plants can be expanded,
- no moving parts and therefore no noise,
- no polluting and smelling emissions,
- possibility of integration in existing and under construction buildings,
- high public acceptance.

The so called grid-parity occurs when the generation cost from photovoltaic systems is lower than the price the end customer pays for the electricity. Nowadays, grid-parity is achieved for any condition and type of customer.

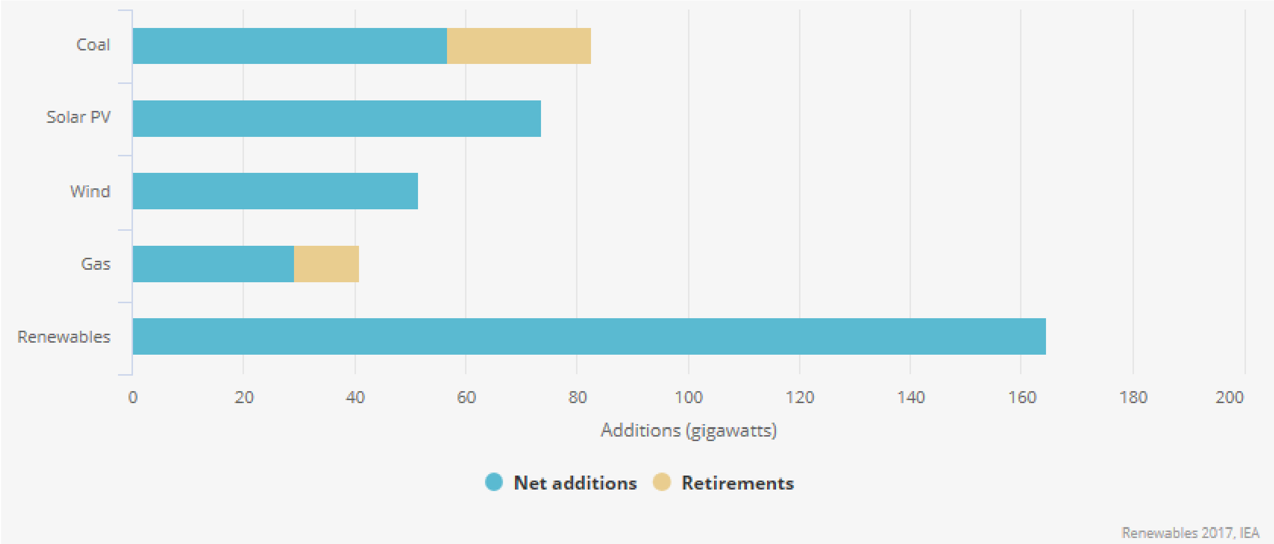

Figure 3. histogram showing the electricity capacity additions by fuel in 2016.

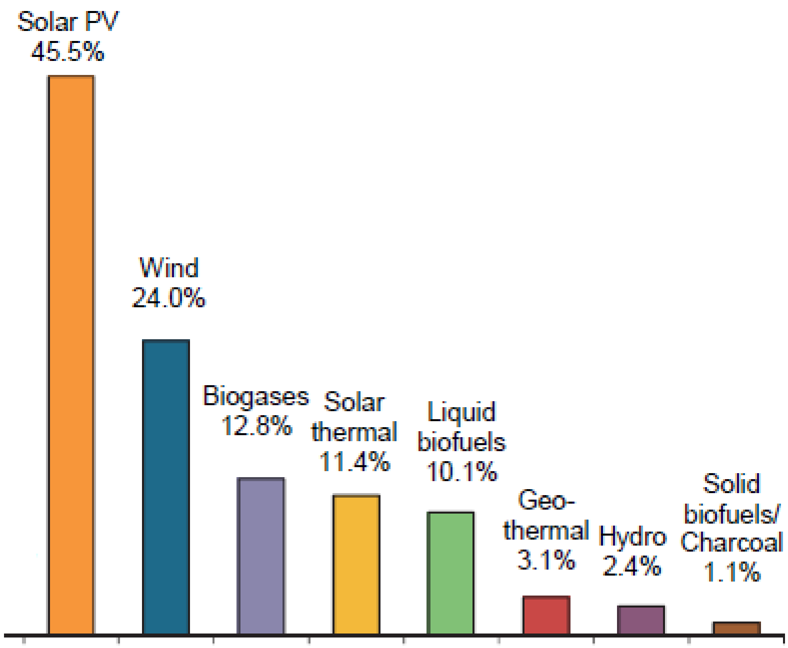

Figure 4: histogram showing the annual average growth rate of renewable energy sources in the world from 1990 to 2015.

As an example let's consider a 20-kW "commercial & industrial" photovoltaic plant in Rome, which is a rather small size plant in an average latitude with respect to the different locations of the partners involved in the project DEEP SEA. For such a photovoltaic plant the cost of produced electric energy is calculated in 0.07 € / kWh without incentives, which is much lower than the price which would be paid to the utility by a commercial or industrial customer both in Italy and Croatia. The pay-back time is 7.5 years and the Internal Rate over Return (IRR) is 11.5%. This is considering no any tax deduction that is often applicable.

6. Microgrid solutions

The realization of active distribution networks within the ongoing energy transition requires the implementation of radically new system concepts. In this context microgrid (the "building block of smart grids") are the most promising network structure. This type of implementations can intelligently integrate the actions of producers (photovoltaic plants owners), consumers (who have the need to supply their charging stations), prosumers, and Distribution System Operators (DSOs) in order to efficiently deliver sustainable, economic and secure electricity supplies. Microgrid consist of a Distributed Energy Generator (often based on the use of renewable energies such as for example photovoltaics), a storage device (often a lithium ion battery) and a load (that can be flexible). Such systems can be operated in a non-autonomous way, if interconnected to the grid, or in an autonomous way, if disconnected from the main grid. The operation of microgrid in the network can provide distinct benefits to the overall system performance, if managed and coordinated efficiently.

7. Specifications of components for the pilots

The microgrid installed at the University of Trieste within the MUSE – Cross-border collaboration for a sustainable and energetically efficient university mobility, a project co-financed by the European Regional Development Fund via the cross-border cooperation program Interreg Italy-Slovenia has been taken as an example for the specification of the components that could be used in this project. At this stage of the Deep Sae project, the following description should be taken as a general example until specific case-studies (i.e. the specific Marinas) will be chosen.

The microgrid consists of the following main parts:

- A 4kWp PV generator. The PV modules are based on an m-Si technology, while the azimuth and tilt angles have been optimized in order to minimize the Levelized Cost Of the produced Energy (LCOE) that in this case is 7.6 eurocent/kWh. The yield of the plant is 4,400 kWh/year, while the maximum daily production is 20 kWh;
- An inverter that guarantee a Maximum Power Point Tracking (MPPT) capability together with the management of the energy stored inside the Li-ion battery;

- A 10 kWh Li-ion battery that stores energy when the sun shines and there is no load. The Levelized Cost Of the Storage energy (LCOS) is 17 eurocent/kWh that is still cheaper than the price of electricity bought from the grid (circa 20 eurocent/kWh). The maximum number of cycles for this type of battery is 10,000;
- A charging station with two charging points (connectors type 2) with a power of 22 kW for e-cars;
- A charging station for e-bikes and e-scooters;
- An energy management systems working in real-time using a dSPACE-based controller;
- A LAN connection with the web from where the system can take a number of references such as for example the electricity market price and exchange all the data;
- The system is connected through an Interface Board (IB) with the Low Voltage (LV) campus electrical grid.

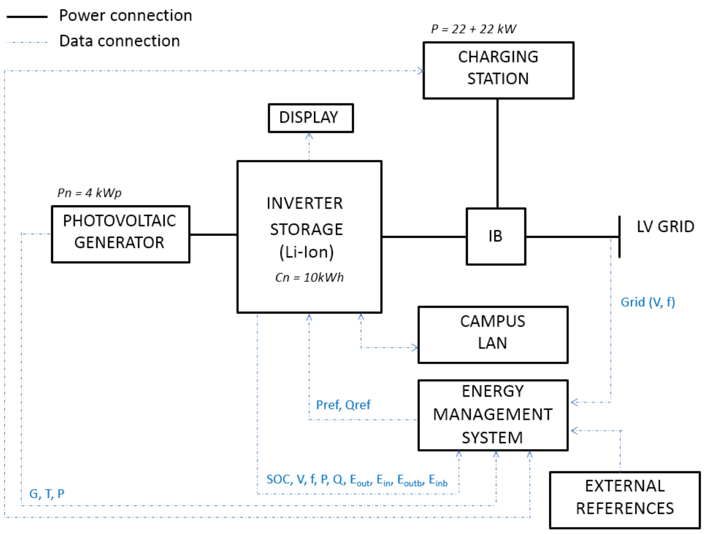

Figure 5. : block scheme of the microgrid installed at the University of Trieste

8. Business cases

Firstly, it is crucial to define the terminology as precisely as possible. In fact, some of terms for these mobility innovations are often used in a loose and confused manner. The notion of shared mobility might involve sharing a ride or a vehicle. Both are forms of shared mobility that reduce the number of cars on the road but the economic and organizational requirements are very different. Sharing a ride might take place in a family or with friends or take a more open and commercial nature, such as ride-sharing (also called carpooling) as made popular by BlaBlacar in Italy or Carpool World in Croatia. Public transport is essentially also a form of ride-sharing since the vehicle is accessible to all people interested to use it on pre-specified routes and paying the fare. Sharing a vehicle concerns who owns, manages and uses the vehicle. Leasing or renting a vehicle for months, weeks or days has been popular since many years. More recently, it has become widespread, especially in large urban areas to rent a vehicle for hours or minutes. Depending on the vehicle rented, one defines it car-, van-, bicycle- or scooter-sharing. If the vehicles happen to be electric, than the term becomes e-car-, e-van-, e-bicycle- or e-scooter-sharing.

Car-sharing and bike-sharing date back to several decades ago. In large cities such as Milan and Rome, the supply of carsharing services has gained momentum in the last decade, with millions of users and thousands of cars available. Similarly, bike- and scooter- sharing are widespread in many cities. In all cases, both conventional petrol and electric vehicles are offered, the electric ones representing about 25% of the total supply. In the last months, electric kick scooters have become popular. They represent an evolution of the tradition kick or push scooter with an added electric motor and a battery. They are usually two-wheeled, light, foldable, recently with a swappable battery, allowing up to 15 km at speed of 15-20 km\hour. Many business models and cases are possible to offer vehicle sharing (VS) services and have different characteristics as illustrated in the following table [36, 37].

Who owns and maintains the car	Profit-oriented VS firm	University-sponsored VS	Municipally-owned company	Rail or public transport operators	Non-profit-oriented private community	private person
Aims	Profit, advertising	Environmental, parking, accessibility, transportation goals	environmental, economic and social	increase public transport attractiveness	environmental, economic and social	economic
Operational model	roundtrip or one-way (station-based or free-floating)	Station-based roundtrip	Station-based roundtrip	Station-based roundtrip	Station-based roundtrip	roundtrip
Targeted users	everybody	Students and employees	everyone	public transport users	community members	friends
Known examples	Car2Go, Enjoy, Autolib, Share&Go, DriveNow	e-vai (Univ Padua); Io-guido (Univ. Parma); Zipcar (Yale, Stanford, Berkeley)	ICS (Italy), Coop. Car Sharing Trentino	e-vai (Milan), Flinster DB (Germany)	Selbstfahrer-genossenschaft (Zurich, 1948)	P2P

Different providers have different aims. The modern large sharing providers operating in large towns view sharing as a commercial activity, which should generate profits. Non-profit oriented, State-supported organizations pursue wider environmental, economic and social aims. For instance, these organizations might pursue specific transportation goals, such as reducing parking needs or increasing rail or public transport attractiveness, which is typically the case when VS is offered by transport operators.

Operationally, VS is of two main types: roundtrip or one-way. Roundtrip VS means that the user has to collect the vehicle from a VS station (on-street or off-street parking place) and return it to the same station. One-way VS does not require it. One-way VS can be station-based or free-floating. The former requires that the car is left in a parking place belonging to the VS organization. Free-floating VS allows the user to leave the car in any parking place within a given area. The flexibility, the managing difficulty and costs, and the technological requirements differ largely among these operational models. Free floating systems are definitely the ones most preferred by the users, since a vehicle can be localized via an app, used, left at any location within a pre-defined area with a payment transaction taking place via a credit card[1].

A third feature which can be used to differentiate among business models are the targeted users. A VS service provider might offer the VS service to everyone that is interested (neighborhood residential). It might set the tariffs targeting specific community members such as low-income families or business employees, acting as a substitute to the firm's own fleet by providing group tariffs or specific cars. It might tailor its service to specific groups (tourists, students, hotel guests); or, finally, it might set up a service specifically designed and offered to rail or public transport users. Of course, there might be an overlap among the various users.

On the basis of these analysis, let us know focus on the role that shared mobility, or more specifically shared e-mobility can be in the transport to and from a Marina. Although both ride sharing and vehicle sharing are possible, the latter is probably the most innovative. Two types of users might be identified:

1. People living the in area and in need of reaching the Marina;
2. People not living the in area and in need of using a vehicle to reach destinations outside the Marina.

The demand for shared mobility is most likely very different among these two groups and needs to be investigated according. It is likely that the first group owns a vehicle and will use the same vehicle to return home. The second group on the contrary is most likely in need of a vehicle.

As for the question of whom should organised the VS service, several options could be evaluated: the company supplying sharing services for the whole city\regions (when existent); the Marina itself

[1] In fact, when Car2Go started suppling a free-floating CS service in Milan in August 2013, in few months, 60,000 members enrolled. In 2014, Car2Go introduced the same service in Rome and in Florence. Other companies followed suit: Enjoy, a joint company by Fiat, Trenitalia and Eni, started a free-floating CS service in Milan, Rome, Florence, and Rimini. Twist offered a competing service in Milan and, recently, the city of Turin is serviced by Car2Go, Enjoy and Blue Turin (by Bollorè with electric cars). More recently, Share'ngo, an Italian new comer, supplies free-floating CS service with electric cars in Milan, Rome, and Florence.

with owned vehicle and management service; a commercial company who wins the tender to provide the service. The number of vehicles and the service fees might vary greatly depending on the demand characteristics and the vehicles offered.

9. Regional and local policies achievements

Energy supply chain in Friuli Venezia Giulia Region

Figure 6 depicts the energy flow in the FVG region in 2014, the last officially available year. It appears that the main energy source is the natural gas (1559 ktep), used in civil residence heating, industry and to generate electricity. The second largest energy source is oil (818 ktep), consumed mainly by the transport sector. Renewables make up the third largest source (629 ktep), used in electricity production and for civil uses. Electricity is imported in a large amount (464 ktep). Solid fuels are equal to 406 ktep and are used for electricity production. Non-renewable waste plays a very marginal role. Since natural gas, oil and coal are imported, the FVG relies strongly on foreign states for the energy needs. This conclusion is further strengthened by the direct import of electricity.

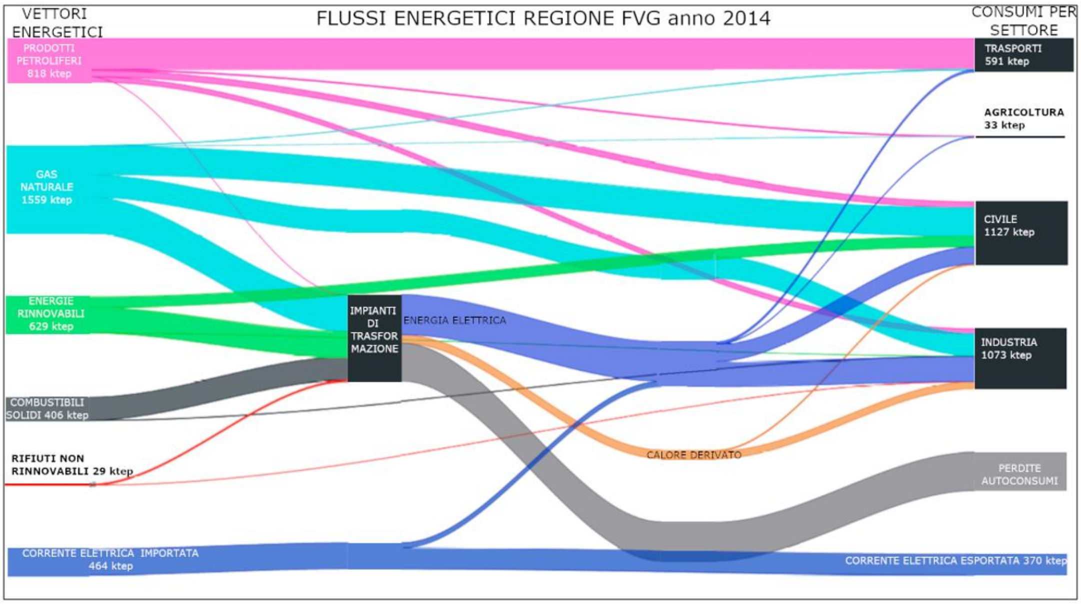

Figure 6: Energy supply chain in FVG (2014).

Focusing more closely on electricity production, the following tables report the energy sources used in absolute values and in percentages. As it can be seen, the FVG electricity mix has changed considerably over the last three decades. The main change is that the natural gas has fully substituted oil, with the almost disappearing. Such a trend does not characterize only the FVG region, but it is a national (if not international) trend of the main industrial economies, aiming at reducing their CO2 emissions. Consequently, the coal share has been also reduced from 47% to 30%. Hydro has slightly grown. It also deserves to be stressed that bioenergy and more recently photovoltaic provide together 12 % of the energy needs, testifying the effort of the FVG region to achieve a more sustainable energy balance. Wind source, however, are not present in the FVG energy mix.

Year	Coal	Natural gas	Oil	Hydro	Bioenergy	Photovoltaic	Total
1988	564	26	493	114	9	0	1206
1990	498	22	533	82	9	0	1144
1995	526	174	626	102	4	0	1432
2000	658	217	269	132	14	0	1290
2001	703	285	218	139	26	0	1371
2002	736	261	355	141	35	0	1528
2003	666	267	598	102	31	0	1664
2004	624	276	376	148	43	0	1467
2005	624	317	294	111	49	0	1395
2006	680	666	384	108	77	0	1915
2007	648	983	292	112	74	0	2109
2008	530	908	176	151	64	1	1830
2012	541	907	13	306	53	75	1895
2013	618	760	4	335	92	91	1900
2014	578	645	4	475	118	95	1915
2016	601	885	4	299	138	97	2024

Table 1: Energy sources for power production (MW)

1988	47%	2%	41%	9%	1%	0%	100%
1990	44%	2%	47%	7%	1%	0%	100%
1995	37%	12%	44%	7%	0%	0%	100%
2000	51%	17%	21%	10%	1%	0%	100%
2001	51%	21%	16%	10%	2%	0%	100%
2002	48%	17%	23%	9%	2%	0%	100%
2003	40%	16%	36%	6%	2%	0%	100%
2004	43%	19%	26%	10%	3%	0%	100%
2005	45%	23%	21%	8%	4%	0%	100%
2006	36%	35%	20%	6%	4%	0%	100%
2007	31%	47%	14%	5%	4%	0%	100%
2008	29%	50%	10%	8%	3%	0%	100%
2012	29%	48%	1%	16%	3%	4%	100%
2013	33%	40%	0%	18%	5%	5%	100%
2014	30%	34%	0%	25%	6%	5%	100%
2016	30%	44%	0%	15%	7%	5%	100%

Table 2: Energy sources for power production (%)

Regional Energy Plan (REP) in the Friuli Venezia Giulia Region

The Regional Energy Plan is the strategic tool the Region uses, in compliance with the European, national and regional guidelines, to ensure an orderly correlation between the energy produced, its efficient and effective use and the territorial and environmental ability to consume such energy. The basic strategy of the REP aims at a sustainable development, protecting the historical and cultural environmental heritage. The plan completes the actions and the financial economic vision of the regional law 3/2015 “Relaunching business”, directing the economic system to “clean technologies” and encouraging companies to create new “green jobs” with the promotion of the new skills that the energy sector requires.

The REP identifies the objectives and the measures for the development and strengthening of the regional energy system and implements it within the global vision of the reduction of climate-altering emissions, as outlined on December 12, 2015 by the Paris Agreement of COP21 (Conference of the Parties of United Nations Framework Convention on Climate Change - UNFCCC).

The main goals of the REP are:

- build more sustainable energy production plants, networks and storage systems;
- increase energy efficiency;
- promote sustainable mobility;
- encourage responsible use of regional resources;
- raise public awareness on environmental sustainability;
- draft the guidelines to grant financial incentives for the use of renewable sources;
- reduce greenhouse gas emissions;
- develop cross-border infrastructures.

To reach the abovementioned aims, the Plan includes regulatory and authorization actions and purely economic measures.

In particular, starting from the vision of the European system (environment, growth, competitiveness and security) the regional energy vision is composed of six key points:

- Bio-Region and “green belt”: a cross-border carbonsink to mitigate the climate. It is about the creation and the implementation of a green belt along the borders with Veneto, Austria and Slovenia, which covers forests, arable land, river basins and ponds for the protection of biodiversity and natural carbon storage. A “green belt” to be enriched with border smart grids in the name of cross-border and inter-regional cooperation and with shared protocols on the development of renewable energy, on the sustainability of energy connections and on the reduction of CO2 emissions.
- Renewable energy sources: consumption and production. Its aim is to develop the use of renewable energy for citizens and businesses by redefining the "green" non-recourse regional incentives, to favor the most disadvantaged members of the company, with loans dedicated to companies that implement efficiency measures.
- Energy requalification: efficiency and optimization. This objective is carried out by directing the building activity to the recovery and restructuring of the existing constructions with the

increase of energy savings. A special attention is given to the urban building heritage, both public and private.

- Environmental sustainability (houses, production facilities, agriculture, tourism and transport).
- The innovations for sustainability in order to improve the quality of homes and production facilities are essential for achieving high environmental standards that at the same time lead to economic and employment growth. With reference to the transport sector, the strategy focuses on incentives for the replacement of obsolete vehicles. Electric mobility will be favored, proposing a different range of service cars available to the regional administration and promoting the use of electric public transport.
- Infrastructural, plant and smart grid interventions. These entail infrastructural interventions on the electricity grid as well as for the energy production in order to make the energy produced available to local industrial uses with networks of internal users.
- Increase in the technological and information applications deriving from scientific research to make the best use of the skills of universities, research centers and incubators, with the aim of setting up programs and defining concrete projects in the energy field.
- According to the 2014-2020 ROP ERDF, 57.5 million are also planned for the energy requalification of school buildings and hospitals and health facilities.

Regional Energy Plan (REP) in the Friuli Venezia Giulia Region

As requested by the PNIRE, the assessment of the most suitable modalities for the implementation of recharge infrastructures must aim to meet the needs of current and potential recharge demand, ensuring complementarity between public and private infrastructure. To this end, it is considered that the charging infrastructure should be based on multiple descriptive indicators of the private and public reloading demand, including:

- the vehicle fleet;
- the number of electric vehicles;
- the availability of garages \ residential density;
- the consistency of input flows estimated on the basis of origin / destination matrices and inclusive of both systematic mobility (home-work commuting / study), and non-systematic mobility (business, tourism, leisure);
- tourist attractiveness;
- commercial attractiveness.

10. Model for mobility scenario and e-mobility planning

To give substance to these principles, for the planning and localization of the infrastructures for the recharge of vehicles powered by electricity, the Friuli Venezia Giulia Region [3] has elaborated two distinct models developed:

1. A model that identifies the charging stations required along the highway / road network, taking into account the daily traffic flows;
2. A second model that estimates the charging stations needed at the municipal level based on the potential charging demand.

On the basis of the data provided by the Directorate General for the Motorization of the Ministry of Transport - Department for Transport, Navigation, General Affairs and Personnel, in February 2017, 45 electric vehicles were present in the FVG. There were also more than 3 thousand vehicles classified as gasoline hybrids \ electric or hybrid \ diesel oil. The Friuli Venezia Giulia Region has elaborated the hypothetical scenarios (2030) shown in the following table 4.

	CURRENT SCENARIO	SCENARIO 2020	SCENARIO 2025	SCENARIO 2030
Automotive Park	725.063	725.063	725.063	725.063
Total registrations	33.919	33.919	33.919	33.919
Registrations of electric cars	9	678,4	1526,4	2374,3
Hypothesis of% registration of electric cars (variation of + 0.5% per year starting from 2017)	0,006%	2%	4.5%	7%
Eletric cars park	45	1.741	7.677	17.852
% of electric cars on the park	0,006%	0,240%	1,059%	2,462%
% of tourists' electric cars	0,1%	2,1%	4,6%	7,1%

The scenarios have the following characteristics:

- Current Scenario:
    - the most recent data on registrations are used (data for 2016 equal to 725,063 cars) and the fleet of electric cars present in FVG in February 2017 (n ° 45);
    - for tourists it is assumed that the percentage of electric cars is equal to 0.1%.
- Scenario 2020:
    - the car park is assumed to be constant at the 2016 value (that is to say, it is assumed that the divestments are equal to the registrations);
    - the registration rate of electric cars is supposed to reach 2%, thanks to the following progression: 0.5% in 2017, 1% in 2018, 1.5% in 2018, 2% in 2020. These assumptions are

optimistic, but not unrealistic, given that the rate of registration of electric cars in Austria in 2016 amounted to 1.3%.

  - it is also assumed that the rate of presence of electric cars among tourists will be 2.1%.

- Scenario 2025:
  - the car park is supposed to be constant at the 2016 value;
  - the registration rate of electric cars is expected to reach 4.5%, thanks to the following progression: 2.5% in 2021, 3% in 2022, 3.5% in 2023, 4% in 2024, 4.5% in 2025. These assumptions will be reviewed in the next updates based on real trends.
  - It is also assumed that the rate of presence of electric cars among tourists will be 4.6%.

- Scenario 2030:
  - the car park is supposed to be constant at the 2016 value;
  - the registration rate of electric cars is expected to reach 7%, thanks to the following progression: 5% in 2026, 5.5% in 2027, 6% in 2028, 6.5% in 2029, 7% in 2030. These assumptions they will be reviewed in the next updates based on real trends.
  - It is also assumed that the rate of presence of electric cars among tourists will be equal to 7.1%.

An estimate of charging demand

Residents

The starting point assumed in the model is that those who have a private garage, will be equipped with a slow charging socket from which to charge their own electric car. The data on the availability of a private garage per municipality is taken from the 2011 Census of Housing. ISTAT has made available data on the car park and the number of parking spaces available for each municipality of the FVG. On average, 8 cars in 10 have their own garages. The Municipality with the least availability is Trieste (5 out of 10).

The demand for recharge therefore comes from residents who do not have their own garages. It is hypothesized that 50% of these require an accelerated recharge and 50% a fast recharge.

Commuters for work or study purposes

The starting point is that the commuters will probably leave home with the electric car charged. A recent study by Monte and Danielis (2015), based on commuting data taken from the 2011 census, showed that 95% of the daily routes for work or study reasons of this category of users is less than the autonomy of a electric vehicle and therefore the need for recharging can be satisfied with a single daily recharge at home. As a precautionary measure it has been assumed that 20% of commuters need accelerated charging points at the destination of the journey and 10% of fast recharge points.

Tourists

Since the tourist destination may be very distant from the place of residence, it has been assumed that all tourists submit a recharge request to the municipality visited. It is hypothesized that 50% of tourists' electric cars require an accelerated recharge and 50% a fast recharge.

Users of commercial activities

In some cases the commercial activities may be distant from the place of residence. It has been hypothesized that 40% of users present a recharge application at the visited business activity. It is assumed that 50% of users' electric cars require an accelerated refill and 50% a fast recharge.

An estimate of charging sockets / charging stations needed at the municipal level

Each category of user expresses an accelerated or fast reload application. It was assumed that the slow top-up is mainly used at home (or hotel) or at the workplace. Taking into account the average recharge time, respectively for accelerated recharge (assumed to be equal to 2 h on a total of 10 h day) and for fast recharge (assumed to be 30 min on a total of 10 h day), it has been estimated the request for sockets for each municipality. The hypothesis is that a charging station has at least 2 sockets, by regulation, it follows the number of charging stations.

The following tables lists the accelerated and fast charging stations by province in the 2020, 2025, and 2030.

province	**Accelerated charging sockets**	**Fast charging socket**	**Accelerated charging stations**	**Fast charging stations**
GO	19	4	9	2
PN	21	4	11	2
TS	26	6	13	3
UD	67	15	34	8
Totale	**133**	**30**	**67**	**15**

province	**Accelerated charging sockets**	**Fast charging socket**	**Accelerated charging stations**	**Fast charging stations**
GO	61	13	30	7
PN	110	25	55	13
TS	86	17	43	8
UD	219	47	110	24
Totale	**476**	**103**	**238**	**51**

province	Accelerated charging sockets	Fast charging socket	Accelerated charging stations	Fast charging stations
GO	125	27	62	14
PN	196	38	98	19
TS	250	58	125	29
UD	451	94	225	47
Totale	**1021**	**217**	**511**	**108**

Legend:

- Charging socket: cable and socket for an electric car;
- Charging station: column with 2 sockets;
- Accelerated charging: about 2 hours (required power up to 22 kWh);
- Fast charging: about 30 minutes (required power up to 44-50 kWh).

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Annex I: SWOT analysis

This Annex presents the SWOT analysis to give evidence of the most prominent trends and opportunities in tourism and e-mobility sectors and to anticipate technological and organizational solutions with adequate investments, as a basis for the Investment Plans to be developed in Activity 3.4.

The analysis also includes a description of model for the definition of the passengers and tourists flows and scenario elaboration on transport volume in the coastal zones.

Introduction

The SWOT analysis is conducted among DEEPSEA partners in order to reveal the strength and weaknesses of best available solutions identified in task 3.1, with the aim to identify current trend and opportunities and identify the best solutions for each DEEP-SEA pilot area, thus informing the development of the investment plans.
Each DEEP-SEA partner performed the SWOT in relation to their implementation areas and their wider regions. Results were aggregated and are summarized in the following chapters.

1. SWOT Analysis

According to Pickton and Wright (1998), SWOT analysis consists a simple and practical analytical tool used widely and for many purposes and it reveals key issues affecting business development and growth. SWOT Analysis has been extensively used for evaluating electromobility and electric vehicles (AUTOCLUSTERS project, 2009 and 2011, Knez et al., 2014, Raslavicius et al., 2015, Yu and Pettersson, 2014, ELMOS project, 2014, SAGE project, 2013, Dano and Rehak, 2018).

In general terms, the following simplification may be applied to identify the SWOT elements: Strengths and Weaknesses can be seen as internal factors, i.e. related to the organization, its assets, processes, and people, while Opportunities and Threats as external factors, arising from the wider context:

- Strengths: endogenous/internal positive;
- Weaknesses: endogenous/internal negative;
- Opportunities: exogenous/external positive;
- Weaknesses exogenous/external negative.

Figure 7: SWOT analysis model

The strengths can refer to advantages, potential synergies and coherence with local needs and objectives and future development scenarios for marina sites, the weaknesses include disadvantages or gaps; opportunities can be defined as overall impacts on mobility and the environment, quality of life, innovation and technology, human resources potential, urban and regional development and mobility policies while financial instruments, cost of development, cost of deployment and maintenance, legislation, complexity of communication between stakeholders, political impacts belong to the last category.

On this basis, each compiler of the SWOT questionnaire should cross their context and critical issues with the opportunities represented by the technological and operational solutions identified in deliverable 3.1.

Strengths
S1.
S2.
S3.
..
Weaknesses
W1.
W2.
W3.
…
Opportunities
O1.
O2.
O3.
…
Threats
T1.
T2.
T3.
…

Figure 8: SWOT analysis table

Results

The results of the SWOT analysis from the local contexts here considered, as reported by each Marina, are detailed in a Master Table (Annex 1) and outlined in the paragraphs below by providing an overview of the main outputs.

Sustainable mobility services

Sustainable mobility services consist primarily of the sustainable technological solutions described in D3.1.1, such as electric vehicle charging technologies, commercially available electric vehicles and charging stations, plug-in electric boats and their charging systems.

Strengths:
In the local contexts analysed, the main strengths identified in the implementation of these technologies are energy savings due to high levels of efficiency in the energy consumption and consequent reduced costs, combined with substantial reductions of pollutant and acoustic emissions, as well as reduced traffic thanks to a more equal distribution of vehicles in the traditional ways of transport (UniSpliT, Malinska, Puglia), a well-developed traffic network and the possibility to have comfortable, quiet and cheaper ride with electric vehicles.

The nautical e-mobility is an attractive instrument to users and businesses, as well as to public institutions, for increasing the use of ecological vehicles and environmentally friendly initiatives overall, contributing to the economic development of the sector in the trade market. In fact, more and innovative infrastructures, facilities, and services are a source of environmental, economic, and social added value, thanks to the increased number of available berths connected to electricity, which could also originate from renewable sources (Puglia, UniRijeka, Maslinica). This could contribute to promote and valorise the port as a destination for sustainable tourism. In Puglia, some existing initiatives already contribute to this, such as a Pass that allows you to moor in all Apulian marinas, started in an experimental phase in the ports of Vieste and Rodi Garganico during 2020, several ongoing EU and other projects for environmental sustainability and for the development of intelligent systems to improve the quality of life of citizens. The large number of companies in the marine economy recorded in the project areas and the positive trend of hybrid cars registered in Italy in 2019 should be also a strength in this respect.
The deeper knowledge, the quality and availability of IT specialists, and the experience transfer between marinas and users on sustainable mobility, combined with the possibility to use financial resources dedicated to the sector, are other positive outcomes identified (UniRijeka, Maslinica).

Weaknesses:
There is still a general limited knowledge of environmental sustainability and management issues in the nautical sector. The improvement of ports is in fact inconsistent among marinas, and generally focused more on quantity of the infrastructures built, rather than the quality of the services offered (UniRijeka, Puglia). The overall costs remain high, followed by high and limited battery life of electric vehicles, and incentives are not enough to support the development of battery technologies, as well as the implementation of more infrastructures and e-services, combined with the lack of investments to give structural modifications to already existing boats, powered by traditional fuels (Malinska, Maslinica, Puglia). The necessity to evaluate the feasibility, effectiveness, and sustainability of certain measures is critical, particularly regarding the cold ironing technologies, the capacity to provide enough energy as demanded, and the overall difficulties which could be encountered in the management of energy services for electric boats (Venezia Giulia).
Still a low number of users prefer e-mobility, and this also leads to inconsistent changes in demand between seasons, as well as between ports and recharging infrastructures, with the consequent necessity to keep using fossil fuel-based vehicles to comply with the peak demand in summer seasons, increasing CO_2 emissions substantially in those periods (UniRijeka, UniSpliT, Malinska, Maslinica) and a lack of norms and standards for electric vehicles. Finally, a lack of

adequate communication on services available in ports on the web and the limited availability of profiles with specialized technological skills for boating are also identified (Puglia).

Opportunities:

Globally, there is an increasing interest in sustainable business. New business cases for SMEs are appearing, as well as new opportunities to further develop the economic capital of existing companies, particularly in the hybrid and electric boats world market (UniRijeka, Puglia). This is caused by, and is also leading to, better access to information and communication technologies, higher environmental awareness, acceptance, and attention to reduce energy consumption and emissions among public, private institutions, and citizens, increasing the global demand for e-vehicles (UniSpliT, Malinska, Maslinica, Puglia) and implementing the development of more powerful batteries. This also constitutes an opportunity for a competitive development of less advanced regional territories or islands, as well as for enhancing further collaborations between port authorities, public administrations, and third entities (Puglia).

Nevertheless, multisectoral cooperation is one of the key aspects in the growing of sustainable mobility services. The development of the sustainable nautical mobility does not only come from voluntary initiatives, but also due to policy restrictions to traditional and pollutant mobility at national or local levels, such as the „national framework on infrastructure and market development policy for alternative fuels" in Croatia, and the national strategic framework to implement nautical mobility (D.Lgs 257/2016) in Italy, which both transpose the EU Directive on the deployment of alternative fuels infrastructure (2014/94/EU) (Maslinica, Puglia). This is combined with existing EU directives, funds, standards, and protocols which support the harmonisation of charging methods and technologies, as well as regional political initiatives to encourage locals to use more innovative and sustainable ways of transport (UniRijeka, Malinska, Venezia Giulia, Puglia).

The high touristic attractiveness of the coastal areas where project pilots are located and their strategic position and mild climate are also big opportunities for developing low carbon mobility, due to the high tourist demand for mobility and quality services. There is a huge opportunity for job creation associated to this transition in these areas. The presence of well-known universities in the project supporting this process and also of active environmental NGOs represent also the opportunity for high quality and innovative results.

Threats:

Projections of climate change, more extreme weather events, natural disasters and demographic trends (decline in the number of inhabitants, outflow of young highly educated poeple) may be

a fundamental threat in the future for nautical mobility (UniRijeka). This is also limited by a stronger international support to the fossil fuel market, in comparison with sustainable businesses and services (UniRijeka). In addition, international, EU, and national standards and requirement for manufactures and charging methods still need to be totally harmonised (Maslinica, Venezia Giulia). It is also important to mention the necessity to conduct feasibility studies for the implementation of the project to understand costs and benefits and reduce distrust towards electric vehicles, since costs could be very high and unsustainable in the case of a total electrification of all ports in a specific area and in a limited time period (Puglia).
The vulnerability of national and international tourism to economic depressions and health crises could also substantially obstacle the development of e-nautical mobility (UniRijeka, UniSpliT, Maslinica). In addition, lack of communication and possible negligent behaviour of users and owners limit the support given to the sector (UniRijeka). The lack of planned networks for charging stations and coordinated solutions across regions is also a possible threat, often followed by the relatively high initial investments.

Renewable energy sources and smart grid solutions

Strengths:
Renewable energy options, energy efficiency and smart grid solutions, described in D3.1.1, are key to substantially reduce emissions in the energy production and consumption processes. Renewable energy systems (RES) consist of a local, reliable, infinite, efficient "free source of energy", with low costs needed for the infrastructures (UniRijeka, Malinska, Puglia).

In addition to the environmental sustainability of RES, these contribute to economic development for their low costs for energy production, particularly in favour of local communities which could provide themselves with local energy, but also to increase the market of electric vehicles, charged by renewable energy produced at home or in the local marinas for what concern nautical mobility (Malinska, UniSpliT, Maslinica).

The renewable energy system is also socially sustainable for the higher transparency of energy production and consumption, compared to fossil fuel-based energy (UniRijeka). It could also enhance collaboration and networking opportunities between charging stations managers, marinas, and energy service providers (Maslinica). Incentives for the use of alternative energy sources and existing experimentations and research on solar boats by Universities, such as the University of Bari, are also a strength, combined with the high projected electricity demand growth and the definition of a healthy macroeconomic environment.

Weaknesses:
Renewable energy systems require high initial investments and wide, specific, and suitable places for energy storage technologies (batteries) and infrastructures (charging stations, solar PVs) (UniRijeka), which are still under development overall, and present several gaps in the potential to meet energy demands, and in the capacity of academia and research institutes to transmit technical knowledge into applied technologies (UniSpliT, Maslinica, Puglia). Renewable energy systems and smart grid solutions also require high and complex management standards such as constant monitoring and cyber security (Malinska). All this is worsened by a lack of political and economic support, of investments in renewable energy, of technical and commercial skills, of investment programs in the renewable sector, particularly in the local contexts. Further weaknesses are represented by the size of companies (mainly micro and small) in the nautical sector, leading to long production times and also the low availability of profiles with specialized skills for boating.

Opportunities:
RES and smart grid solutions may be a fundamental measure to implement in order to improve the availability of electricity in coastal territories and islands, also increasing the attractiveness of those areas for new inhabitants (UniRijeka, Malinska), and increase the diversification of energy supply. In addition, private electric cars and boat users will be attracted by the general availability of renewable energy resources and of charging stations and services to visit the areas in question (Malinska). In Croatia, where the National Energy Strategy was recently approved, there are already investment plans and project initiatives (FIRESPOL, ADSWIM, AdriAquaNet, Project eMOBILNOST) to deploy renewable energy systems, with a focus on the islands, also thanks to EU funds (UniRijeka, Maslinica).

The importance of spreading awareness and education among citizens and businesses about climate change and the need to reduce emissions is increasingly leading people to consider smart grid and renewable energy solutions, to support the research and development of the sector (UniSpliT, Malinska). Further development of high-quality touristic services, job creation and development of the mechatronics sector also thanks to the collaboration between research and the industrial sector are also opportunities to consider, as well as the use of IT technologies in monitoring energetic consumption and logistic control of fuels supply.

Threats:
Despite the optimistic views regarding renewable energy and smart grid opportunities and outputs, these could sometimes be too simplistic, since there are still many obstacles to the achievement of high energy standards, compared to the ones available nowadays with the use of fossil fuels technologies (UniRijeka).
There are still knowledge gaps regarding the benefits and co-benefits of renewable energy and smart grid solutions, as well as the consistency of renewable energy availability, particularly in situations of emergency, due to their intrinsic variability and intermittency characteristics (Malinska, UniSpliT). These are also followed by the doubts of decision makers regarding the potential of renewable energy and smart grid solutions, related also to subsidized energy prices. It is also not certain whether people and local citizens would be totally aware of environmental and economic reasons behind political choices to invest in this sector, and of the benefits that they could obtain from them (Maslinica). This creates situation in which renewable energy sources find difficulties to penetrate into the energy market.

Policies

This section analyses strengths, weaknesses, opportunities, and threats of the local policy and planning context in relation to sustainable mobility solutions, renewable and smart grid development. The chapter on policy from D3.1 is used as a basis, as well as wider policies and incentives available/required according to the marinas, in relation to DEEP SEA pilot implementation and future investments.

Strengths:
Local policies are focused on developing objectives and strategies regarding public transport services, to improve sustainable mobility and renewable energy production and consumption, with the aim to render the transport system in certain areas more sustainable and carbon neutral (Malinska island, Puglia), by accessing national and regional funds, and building strong partnerships and collaboration opportunities between port authorities, Adriatic, Croatian and Italian universities, developing agencies, and businesses (Maslinica), reducing the imports of natural gas, coal, etc and boosting the conservation and preservation of natural resources.

The positive outcomes are given by an increasing attention from policy makers to sustainable mobility solutions, powered by renewable energy and smart grids and bringing a positive impact on the economic development. These consist primarily of the development of an intelligent mobility system through innovative infrastructures, technologies and services (Puglia), higher awareness among citizens, businesses, nautical infrastructure managers regarding the sustainability and levels of emissions reduction from renewable and efficient energy consumption (Malinska). All this contributes to promote the areas of interest as green, eco-friendly regions, toward tourists and citizens by providing a higher accessibility to these services (UniRijeka, Puglia), and at the same time to the rise of various industries and suppliers, meaning job creation.

To be highlighted in Puglia, the "Porti di Puglia" initiative, launched in 2020, conceived by Assonautica Italiana with the Department of Property and Heritage of the Puglia Region, in collaboration with Unioncamere Puglia and the Chambers of Commerce of Puglia, whereby a single card the „MED PASS PORT“ offers the opportunity to move across the region marinas and discounts or free passes to a series of services onland (such as restaurants, shops and transfer to and from the main airports, car and e-bikes rental). The initiative is now starting with two marinas (Vieste and Rodi Garganico), in the view for all marinas of the region to join.

Weaknesses:

The outcomes of these policies, however, are not communicated and spread enough to provide a consistent public awareness. This could be partially due to poor and undeveloped performance indicators and public reports to monitor the results, which increase the gap between the project planning process and the achievement of the results (UniRijeka).

Usually, local policies tend to favour short-term measures that fit in the administration period, rather than consistent long-term strategies, also privileging the necessities of selected stakeholders, instead of attempting to meet the needs of the overall population (UniRijeka, UniSpliT). All this leads to the lack of clear, synergistic and effective strategies and targets, of climate policies, inconsistency among marinas, inter-regional and cross-border areas, but also the lack of specific financial resources for the e-infrastructure, e-service projects, incentives for end-users (UniSpliT, Malinska, Maslinica). This is reflected in a general lack of local strategies and their compatibility with other local and national strategies. If national policies do not provide effective guidelines and support to local authorities, this local political intermittency could worsen (Malinska).

In the Foggia Province, weaknesses exist in terms of transport infrastructures: Lack of connecting infrastructures between coastal municipalities, both road and railways, which makes tourist ports inaccessible, Lack of a comprehensive sustainability strategy and lack of integration with the urban context, ie between the ports and the rest of the community. Furthermore, companies tend not to work in groups.

Opportunities:

Local policies in coastal areas and islands aimed at improving sustainable electric mobility, powered by renewable energy and smart and efficient grid solutions, should take advantage from EU and national Energy and Sustainability strategies, guidelines, funding opportunities and profitable investments in renewable energy, in order to start the transition to renewable energy and smart grid systems, also to increase their green, eco-friendly reputation (UniRijeka, UniSpliT, Maslinica). For example, in the Republic of Croatia, the National Energy Strategy aims to build a sustainable energy system in the country, while the Tourism Development Plan for Split-Dalmatia County at a regional level includes the development of sustainable tourism on the promotion of energy efficiency, reduction of waste and energy consumption (Maslinica). An existing programme promotes the procurement of electric and „plug-in" hybrid vehicles for citizens, companies and trades. Under the „Green line" programme, regional (county) public institutions, national and natural parks will be able to apply for grants for electric vehicles, vessels and hybrid vehicles within the Ministry of environmental protection and energy efficiency (Maslinica). In Split-Dalmatia County, renewable energy infrastructures are already existing (Maslinica).

The same opportunities occur for SMEs and local businesses which could benefit from technological developments and renewable energy deployments (UniRijeka).

In addition, end-users could be incentivised to choose renewable and sustainable energy solutions, by following Clean Energy Cooperatives', national and local authorities' standards and guidelines, but also ecological financial incentives on purchasing e-vehicles (Malinska, Maslinica). Environmental taxes are also used to restrict the use of pollutant and less efficient vehicles, combined with restrictions to those vehicles in traffics (Maslinica). Overall, there is a wide opportunity for increasing cooperation between the public and the private sector and to improve the sustainability and corporate social responsibility across companies, that could have a positive impact in the economic development of the region.

Threats:

Political barriers, complicated system of obtain incentives and permits, frequent changes in incentives and systems may obstacle the implementation of environmental and sustainable policies, such as political instability in the current administration and among following administrations, as well as between regions with different levels of development. Corruption phenomena, bureaucratic and legal procedures could delay or impede the achievement of the

projects, creating resistance against sustainability and systemic change. In addition, national, regional, or local strategies may not present dedicated sections to the development of on- and off-shore e-mobility, lacking national funds, regulations and standards (UniRijeka, UniSpliT, Malinska, Maslinica, Puglia). Lack of support by citizens and other stakeholders, led by low awareness of environmental and sustainability concerns, could also limit the implementation of those policies (UniSpliT, Malinska).
From a technical perspective, there are still technological gaps in the renewable energy sector, particularly for what concern energy storage batteries in the vehicles, and on-shore e-infrastructures such as electricity charging stations, which disincentivise the investments in the field. Lack of financial incentives and the financial crisis also constitute threats to this transition, now worsened by the COVID emergency.

2. Recommendations based on marina features and priorities

Based on the results of the previous chapters here recommendations for DEEP SEA marina pilot sites are drawn, which can be useful for the development of the investment plan for each site. These recommendations can help support the diffusion of e-mobility and in general energy sustainable solutions in the marinas of the Adriatic Sea.

Table 3: Key recommendations from DEEP SEA partners on e-mobility

e-mobility	Key Recommendations
Business: adoption of services and technology related to e-mobility	- In order to spread electric mobility, a charging infrastructure needs to be developed in order to have, using electric vehicles, a comfortable and easy experience. Priority objective is to build a high-power charging network for electric vehicles along the major marinas in Europe. - Start by offering free of charge charging bicycles and scooters and offer them to business for testing; - Promotion of the marina as a modern, ecological, and e-friendly destination; - Further education of human resources on the benefits of e-mobility is needed; - Installation of a charging station with the latest technology and OCPI protocol for e-vehicles

	- Purchase of e-vehicles and e-bicycles for renting and carpool service.
Governance: request of policy from the decision makers to support e-mobility diffusion	- Continue enforcing existing climate/energy strategies, (such as "Krk 0% CO_2 emissions" strategy) and push for better implementation among businesses by incentivising them to use smart mobility solutions. - Advocating for: • The promotion of e-mobility between residents with the local authorities. • The development of local polices on e-infrastructure. • The development of a local strategy on sustainable tourism. • Definition of clean and more sustainable forms of transport through new laws and developments. • The reducing ferry fees for e-vehicles with the port authorities. • The construction of charging stations with the local and regional authorities. • The implementation of a universal e-roaming system in the EU with the national authorities. • The procurement of e-vehicle for carpooling services on the island. - Public authorities should facilitate business-to-supplier relations with economic aids, to develop a more effective service. - Activation of communication campaigns for the dissemination and knowledge of the e-mobility service using social media and multimedia. - Developing models and example of good practice from the EU and using EU funds.
R&I: cooperation and alliance to support knowledge transfer and strategy	- Advocating for the implementation of e-infrastructure across other marinas beyond DEEP SEA. - Forming alliances for promotion purposes with other marinas in the area that have charging stations. - Cooperation with universities, local authorities, port authorities, and tourist communities.

	- Promotion of the marinas as touristic destinations with the possibility of personal privacy (guests spend most of their time on boats). - Cooperation on advocating the construction of charging stations in and outside marinas. - Cooperation on establishment of a universal e-roaming system in the EU. - Focus on the concept of interoperability, through agreements between operators and sustainable service providers. - Activation of communication campaigns for the dissemination and knowledge of the e-mobility service using social media, multimedia and newsletter.

Table 4: Key recommendations from DEEP SEA partners on reneables and smart grids

Renewable energy and Smart Grid	**Key Recommendations**
Business: adoption of services and technology related to removable energy and microgrid	- Encourage business to use renewables in their daily operations providing them actual figures and incentives to incorporate energy index. - Further education of human resources on the benefits from renewable energy sources and the microgrid concept. - Construction of a plant for obtaining electricity from renewable energy sources and implementing the microgrid system. - Promotion of marinas as a sustainable and eco-friendly destination. - Implementation of a sustainable tourism concept. - Identification of best practices, innovation-based project action plans, know-how and transfer of knowledge acquired in the project.
Governance: request of policy from the decision makers to support e-alternative energy solutions	- Establish a body in charge of promoting and encouraging the switch to renewable energy. - Incentivise switch to clean energy. - Advocating for: • the development of a local energy strategy. • the education of residents on the benefits of renewable energy resources with the local authorities.

	• the implementation of microgrid systems. • the education of residents on the necessity of environmental protection and advantages of electrification. - Public authorities must develop action plans associated with improved energy management, for promotion, research and development of energy efficiency initiatives and for a better control and monitoring of energy consumption in ports.
R&I: cooperation and alliance to support knowledge transfer and strategy	Encouraging other marinas in the transition towards sustainability and the implementation of Smart grid systems. - Forming an alliance with other marinas in the area for the purpose of joined promotion (sustainable and “clean” marinas). - Cooperation with universities, touristic communities, and travel agencies in order to promote sustainable tourism. - Multinational bodies with expertise in energy efficiency and renewable energy management technology should also be involved.

3. Model for estimation of passenger flows from and to Adriatic marinas

Approach and methodology for estimation of passenger and mobility flows is here summarized, as a model that can be used for estimation of flows across all Adriatic marinas.

Definition of the methodology

The estimation of passenger flows from and to Adriatic marinas will be based on the most recent data available (2019 if available) from the marinas in terms of traffic volumes and energy consumption on annual basis.

The analysis will comprehend energy consumption from berths and offices inside the marinas, as well as on-shore (inland) and off-shore (seaside) mobility:

ON-SHORE (inland) mobility analysis includes traffic flows to access and leave the marinas: the number of users which arrive to each marina in a year by road in order to start their cruise; the

type of vehicle used; the total distance covered by starting location up to the marina and return; total consumption per fuel.
The analysis includes also road traffic flows generated for on-site touristic visits (generally passengers disembarking in the marina and visiting the nearby sites before setting off again). Number of visitors, vehicles used, distance covered, total consumption per fuel.
OFF-SHORE (sea side) mobility analysis includes the energy consumption of boats docking in the marinas; traffic flows of boats around the marinas: analysis of number of boats, divided by main usage (long distance/short distance journeys, chartered/private), type of boats (sail/motorboat), fuel type, total distance covered per year/journey; total consumption per fuel and consequent emissions.

Methodology for the estimation of traffic volumes and energy consumption

The Table below, from *1.A.3d Navigation shipping 2016*, defines the main criteria for distinguishing international or domestic navigation.

Table 5: Criteria for defining international or domestic navigation (applies to each segment of a voyage calling at more than two ports – Source: Navigation shipping 2016)

Journey type between two ports	Domestic	International
Departs and arrives in same country	Yes	No
Departs from one country and arrives in another	No	Yes

Most shipping movement data is collected on the basis of individual trip segments (from one departure to the next arrival) and do not distinguish between different types of intermediate stops (in line with the IPCC Good Practice Guidance). Basing the distinction on individual segment data is simpler than analysing the complete trip and it is likely to reduce uncertainties. It is important to note that this table relates to all water-borne vessels, whether they operate on the sea, on rivers or lakes.

Covenant of Mayors BEI parameters to estimate energy consumption from transport:

Road transportation

It can be challenging to account for road transport activity sector emissions in urban areas given the nature of the road transport, which contains numerous mobile sources moving within but also across the boundaries of the urban territory, according to various patterns. Depending on the aim of the inventory, the energy consumption and associated emissions could be accounted for in different ways. Among the most common methodologies are: fuel sales method, territorial method.

The “territorial approach” requires more data collection and analysis than the fuel sales method, but also provides far more useful information to guide local policy and planning. There are relatively simple to more sophisticated ways to apply to this method, but all are usually based on the following parameters:

— The modal share and distribution of trips to different types of vehicles (fleet distribution), describing the portion of trips by different modes. In urban areas the most important mode relates to road passenger, which can be further disaggregated into vehicle types (e.g. passenger, light-duty or heavy-duty for road vehicles);

— Fuel carbon intensity relates to the emission factors of the fuels (e.g. diesel, motor gasoline/petrol, electricity, hydrogen etc.);

— The Vehicle-Kilometres Travelled (VKT) as a measure of traffic flow, determined by multiplying the number of vehicles on a given road or traffic network by the average length of their trips measured in kilometres; it can be measured as passenger- kilometre (a unit of measure = 1 passenger transported a distance of 1 kilometre) and tonne-kilometre (a unit of measure: 1 tonne transported a distance of 1 kilometre);

— Energy intensity as a measure of the fuel consumption (actual in-use or alternatively average) assessed as the product of the average fuel consumption of vehicle, the type [l fuel/km], and the Net Calorific Value (NCV) of the fuel [e.g. in Wh/l];

The method to be used in the frame of the Covenant is the territorial method (44). Reasons for recommending the use of this bottom up approach is that it is the only one fully in-line with the scope and principles of the Covenant (see section 2.3): it is based on the mileage driven within the local territory and it can be relatively simple to apply, while allowing identifying and quantifying mitigation actions (45). Using a territorial approach is also a good compromise in terms of accuracy and needed resources concerning the data collection, the estimation of the CO2 emissions and the analysis of the impact of local actions, which can therefore be done by all CoM signatories, including small local authorities.

4. Scenarios of traffic volumes along Adriatic coasts

TOURISM TRENDS IN ITALY:

That 2020 is going to be a bad year for the global economy now is more than clear. In Italy, and all over Europe, economies have been hit very hard and the touristic sector seems to have the worst effects form this pandemic. In Italy, a country where this sector represents almost 26 billion of euro every year (7% of the national GDP), the situation is dramatic: 35 million visitors less and 119 million fewer overnight stays, losing 23.3 billion euros in incoming tourism spending[2]. Nonetheless, even if the sector has been significantly affected by the crisis, in the last few weeks a slight recover has been observed. After weeks (when Italy was in the middle of the Covid-19 pandemic) in which the foreign governments had discouraged their citizens to book holidays in Italy, now it seems that there is an opposite trend; in the last week alone, Italian tourism has recorded a +43% increase in international reports[3].

Enit (Italian national tourism Entity) has confirmed the new trend. Probably this will be the worst touristic season in decades, but things have started to change. The national body foresee that in less than 3 years, even more tourists will return in the country. Enit has calculated that for the end of the year there is a potential 300 million of possible new guests (demonstrated by the data and the intention of over 300 million people, who take information on the web about a possible holiday in the country). The turning point should come after mid-August. The Head of ENIT has also spoken about the actual crisis, underling that is important to make people feel safe; but he added this is the opportunity to implement a change in the way in which tourism has been defined in the last decades. All citizens, and tourists should think to their holiday places like a hub of sustainability. Generally, tourism in the city can also start up again by combining parks, adventures in open spaces and culture". At the beginning of June, the international arrivals were -85% from China and -82.7% from the USA. However, the negative sign came to a halt. In the meantime, reservations for flights from abroad to Italy have risen to 300,000, the foresee increase is great: -96.3% in June, -86.2% in July, -79.2% in August[4].

For what concern the sea tourism forecasts are negative like in all the other sector of tourism. The BlueMonitorLab Study Centre has estimated 125 billion less turnover on the sea economy. This is the projection on the value of the Covid-19 damage that the sea economy will suffer in

2 https://www.repubblica.it/cronaca/2020/06/19/news/turisti_stranieri_tedeschi-259594062/;
3 Ibidem;
4 Ibidem;

Italy (i.e. everything that in industry, services, logistics, craftsmanship, is attributable to the sea factors). These are the indications that emerge from the first data reported from surveys from 25 business associations and institutions concerning the consequences of the virus emergency on the 2020 turnover of the entire maritime economy. In the traditional maritime cluster, the ranking of damages due to a real zeroing of turnover is headed by cruises that, in comparison to a forecast of 13 and a half million passengers, have already confirmed in the first half of the year the loss of 6 million 886 passengers, and the cancellation of 2,709 calls in Italian ports[5]. The negative impact on cruises should at the end of the year, amounting to over EUR 3 billion. In the tourism sector (in Italy about 70% of which is sea tourism), the hypothesis at the end of the year will be a net loss of turnover between 55 and 60 billion euros[6]. Today the hope is that July and part of August can save part of the season. Heavy the consequences on the commercial ports, which are losing from 20 to 30% of the traffic also in the container sector.

Another point is related to the shipbuilding industry. The sector is facing a real risk, mostly for the SME (small and medium enterprises) of the sector, and this is partially caused by a series of issues related to non-updated regulations and policies that hamper the uptake and full implementation of new technologies in sustainable mobility, followed by persistent social preconceptions (vessels owners and operators are sceptical about the need of turning to sustainable alternative fuel vessel). It is impossible at present to formulate a forecast of the damage and recessionary effect that will hit the economy of the major islands (Sardinia and Sicily) and the smaller ones, as well as a reflection on the activity of the ferries that until now have recorded a reduction in transport activity, and that also in the second part of the season will face defined costs with a certain contraction in turnover determined by the rules on the prevention of contagion that will force (to date) ships to travel to about 60% of their transport capacity[7].

Blue Economy in Italy is made of ports and ships carrying goods and passengers. Nonetheless, this is an extensive sector that includes all the 'marine' tourism that in Italy represents about 70% of the total flow of tourism in the country that has direct repercussions on the hospitality industry, catering and beach management[8]. But the sector absorbs issues related to the protection of the environmental and economic heritage of the seacoasts, marine biotechnology, energy produced with high tech blue; it concerns all industrial activities directly connected with the sea, first and foremost the shipbuilding industry.

5 https://www.sardiniapost.it/economia/covid-mazzata-sulleconomia-del-mare-sono-125-miliardi-di-fatturato-in-meno/;
6 Ibidem;
7 https://www.sardiniapost.it/economia/covid-mazzata-sulleconomia-del-mare-sono-125-miliardi-di-fatturato-in-meno/
8 Ibidem;

However, looking beyond the COVID crisis, a recovery is expected and increasing volumes of tourists especially towards small marinas and related services, compared to cruises, favoured by higher safety and environmental performances. This should also support the small naval electric nautical mobility and shared inland e-mobility solutions.

TOURISM TRENDS IN CROATIA:

According to existing data (half of July) more negative impact on tourist demand is on southern than northern Adriatic coast of Croatia. Demand is between 30% (south) and 60% (north) of the last year total for the same period.
Croatia's economy will probably suffer significantly from this pandemic, due to the country's dependence on the touristic sector, which accounts almost a quarter of its GDP.
Chartering is more popular in southern part but highly depend on arrival of tourists by airplanes, and air traffic is still almost suspended. However, there is no impact on Covid-19 crisis on mega yachts arrivals. Even better results is expecting than last year in terms of income (longer staying in port). The situation for this mode of nautical tourism may be significant for estimation of future direction of nautical tourism development. On the other hand, cruising ship industry has practically shutdown and will be difficult to recover in next years.

A gradual recovery to the demand is expected, but a few years will be needed to reach the pre-crisis numbers, depending also on overall mobility constraints and recovery of airborne industry.

A positive trend is that the Croatia government continuously and very seriously monitor the situation and is acting to facilitate the situation. One of the results is upgraded e-Nautica service for tourists arriving from EU countries. With this service all fees and taxes are integrated and can be paid online and electronically through the card issued. Nautical tourists coming to Croatia marinas from several EU countries included Italy, Spain, Belgium, Slovakia and Baltic states are already able to use this e-vinjette system.

In the last years, the regional and national authorities of Croatia have invested a lot in strategies for sustainable tourism and diversification of touristic products, with an increased nautical activity and number of boats (both private and chartered) demand the construction of additional berths both on sea and land (dry docks). Within the national Action plan for Nautical Tourism Development the construction of new marinas with additional 15 000 berths are planned. With the raised awareness on the importance of environmental protection and renewable energy sources both new and existing marinas are keen to implement "green" technologies and to become more sustainable. On the other hand, if the pandemic continues it will result in a significant drop in touristic and nautical activity and demand, which may also have an impact on the implementation of sustainability within the marinas.

Concerning the sustainable development of the touristic sector it is necessary to mention the Interreg Excover project[9] that from 2014 to 2020 has worked in order to promote the increase of tourism and of a sustainable tourism in the Adriatic sea, both for Italy and for Croatia. One of the results of this project could be found in the city of Duvbronik, as example of sustainable tourism in Croatia. The report of the Global Sustainable Tourism Council (GSTC)[10], the international organization that verifies the sustainability of tourist destinations based on - cultural heritage management, environmental protection, local community benefits and long-term planning – has promoted the work of the Croatian city for what concerns sustainability. The indicators used by GSTC to verify the sustainability of tourism are 105. The GSTC has stated that 12 of that (11.4%) are excellent, 47 (44.8%) are good with the necessary improvements, 37 (35.2%) are at medium risk and 9 (8.6%) are at high risk. The project in order to change tourism in the city has been supported by CLIA, the International Association of the Cruise Industry, which has contributed to making the Croatian town a sustainable destination[11].

Another example of EU project funded by the Italy-Croatia programme towards sustainability of ports in the Adriatic is SUSPORT "Sustainable ports" project, that will see the collaboration between the principal ports of Italy and Croatia. The main goal of SUSPORT is to improve the environmental performance and energy efficiency of the Adriatic ports involved by implementing pilot activities in several sectors, such as noise reduction, air quality, and CO2 emissions[12].

These examples show the efforts implemented in Croatia in order to make its touristic and sea-industrial sectors more sustainable.

This crisis may however also impact on investment and the availability of funding for e-mobility & smart grid solutions and infrastructures, as those type of investment may be suspended or postponed after the sector fully recovers from the current situation.

THE AUTOMOTIVE SECTOR:

9 https://www.italy-croatia.eu/web/excover;
10 https://www.gstcouncil.org/wp-content/uploads/GSTC-Destination-Assessment-Dubrovnik-2019-Final-Report.pdf;
11 Ibidem;
12 https://www.porto.trieste.it/wp-content/uploads/2020/05/202005_SUSPORT.pdf

The sector of mobility has been affected like others in 2020, and the sustainable mobility one has been smacked like at the same level. Analysing the issue, it is possible to go down in details and study how this sector of economy will respond to the crisis; in particular how electric cars will face coronavirus crisis? Deloitte asked the question, and the answer cannot be the most predictable. As for the general crisis of the worldwide economy, it seems that the sector of e-mobility will slow down too, and in particular the sales of electric cars will decrease with it.

Deloitte's analysis[13] of the car market is in line with all the forecasts. In Italy, like in all the rest of the world, there has been a collapse in the sales (-85% in March for Italy). Deloitte foresee a -2.219 million cars produced in North America and -2.956 million in Europe in 2020[14]. The study does not foresee a good 2020 for electric cars as well. The well-known problems due to the blockage of Chinese factories of batteries and other components, must have been added to the complexity of technology related to the development of electric mobility, that requires huge investments over many years. This need of investment is not compatible with the contraction of profit margins and the liquidity crisis of companies. It is necessary also to consider the effects of the postponement of the launch of new electric models. In parallel to these issues, it is should be considered also the lack of cooperation and networking among municipalities, PAs, often caused by a not well-developed long-term planning and deficiencies of DATA and technical knowledge, that it also involve a not-proper SHs engagement.

For the automotive sector, and in particular the sustainable one, the possible solutions indicated by this study are not compatible with the goals to increment sales of e-cars and enhance its infrastructure (i.e. e-columns). To relaunch the car market according to Deloitte, there will be two key factors: reducing environmental limits on CO2 emissions and encouraging the purchase of diesel or petrol cars. In practice, according to this report, to save electrics, diesel and gasoline cars must be saved first, otherwise car manufacturers will not have enough money to invest in electrification. It is reasonable to think, always according to Deloitte, that a postponement will be necessary of at least one or two years of the entry into force of the new European limits on CO2 emissions. This is the only way foreseen by Deloitte in which companies will be able to find the oxygen they need to return to invest in innovation, a conclusion that is certainly not in line with the EU Climate Strategies and policies and DEEP-SEA project objectives.

The fall of the electric vehicle market is expected to bring with it a drop in the spread of charging stations. Worldwide, the electric car charging market and infrastructures is developing rapidly

13 https://www2.deloitte.com/it/it/pages/consumer-industrial-products/articles/l-impatto-del-coronavirus-sull-auto-elettrica---deloitte-italy--.html;
14https://www.gazzetta.it/motori/la-mia-auto/mobilita-sostenibile/08-04-2020/auto-elettriche-coronavirus-cosa-ci-attende-37061707742.shtml;

thanks to government support. Policies in China, North America and Europe have led to the rapid development of the sector, but in 2020 there will be a real slowdown. In 2019 there were about one million charging points each in Europe and China and 1.3 million in North America. According to experts, the number will continue to grow, albeit much more slowly than previous foresee. By the end of 2030, there should be 8.6 million charging points installed in Europe, 9.8 million in China and 10.8 million in North America[15].

SUSTAINABLE TOURISM:
Even if the national and international trend about tourism and e-mobility is not good, or better, is very negative, there are also positive exceptions. In Italy, where the pandemic has hit harder, there are situations that bode well.

An example could be found in the Adriatic region of Abruzzo, where in one of the most popular touristic cities, Francavilla al Mare, the local government has rethought the entire touristic season. Ecological vehicles will be available in sharing mode and manageable through Apps. In order to meet the new necessities, bring by coronavirus, resorts have thought about the reorganization of events with less seats, modular, to meet the needs of interpersonal distance, and itinerant, to promote the development of tourism in different areas. The city has a bike path of about 6 km (out of 7 of coastal extension), but the central part is still missing[16]. The Municipality informs that the missing part of the cycle way will be completed shortly in order to allow people to enjoy their holidays through ecological and safe transport modes.

A focus on the touristic sector in the Italy-Croatia area cannot but consider the nautical tourism sector. Even if also this economic area has been hit by the crisis, data revealed by the Tourism Responses report are in contrast for what concerns the 2020 season. According to the report, more than 89% of marinas predict that 2020 will close with drops in traffic; but 32.9% of companies in the sector believe that for this summer period alone there will be a growth in demand[17]. A halo of uncertainty is spreading over nautical tourism in 2020 as a result of the Covid-19 emergency and the consequent long lockdown that has been imposed.

15 https://www.rinnovabili.it/mobilita/veicoli-ecologici/ricarica-auto-elettriche-colonnine/;

16 https://www.rete8.it/cronaca/4567estate-2020-francavilla-al-mare-lancia-la-mobilita-green/;

17 http://www.risposteturismo.it/Public/RisposteTurismo_SpecialeCrociere2020.pdf;

Surveys[18] from the society Risposte Turismo, carried out through an online questionnaire, analyzes the impacts of the health emergency and shows that 52.6% of the sample has negative traffic expectations for 2020 and believes that it will remain below the 2019 volumes throughout the year. A further 36.8% expect a decline "with a recovery in the second half of the year" but "not sufficient to compensate for the initial losses". 7.9% expects the year to end "in line with the previous year" and only 2.6% anticipates "a recovery in the second part" that will "offset the initial losses"[19].

Considering the trends in the dockyard/yacht industry in the next years and the shift towards electric nautical mobility, DEEP SEA partners foresee two possible scenarios, based on the evolution of the pandemic. Firstly, we consider the situation where it does not continue. In such case, we assume that in the next few years the number of marinas and berths will grow, especially when taking into consideration the new docks for cruise ships, large (+12 m) and mega (+20 m) yachts. This is the result of increased nautical activity and popularity of the Croatian sea and coastline. Such positive trends and profit gained from tourism will increase purchasing power and will produce a higher life standard. As a result, more charter agencies could open which could lead to the purchase of new vessels both by them and the people willing to invest in their own boats. On the other hand, if the pandemic continues, we assume that the decrease of nautical activity will result in sale drops in the nautical and yachting industry. Following the trends in the automobile industry and its grown electrification we assume that the technology will find its application in the yachting industry on a world scale. There are already several manufacturers with different concepts of e-vessels which could, if produced widely, lead to cheaper sea transportation and which would have a positive impact on sea and marine ecology. The biggest obstacle towards that is still the high price of such technology and production as well as the necessity of upgrading the existing dockyards to meet the needs of e-vessels. This is also followed by a decrease in the economic welfare caused by the pandemic situation and by a low level of security and safety, especially fires, mostly connected to electric installations, and stealing. Still we do not believe that, in the next few years, a big change will happen regarding electric nautical mobility in Croatia regardless of the pandemic situation, mostly due to the high price and underdeveloped awareness on e-mobility in general.

During the last couple of years, thanks to EU initiatives on energy transition, environmental protection, greenhouse gas emissions etc. an adaptation was made to Croatia’s legal and

18 Ibidem;
19 Ibidem;

strategic framework in order to implement sustainable mobility. Therefore, numerous charging stations were built which at the moment still provide free electricity. Also, the Ministry of Environment and Energy has developed several programmes in order to promote e-mobility and cofounding of e-vehicle purchases. However, in relation to the interest and propension to pay for sustainable services (e-boats, microgrids, e-mobility/cycling on land, etc) by passengers/tourists, DEEP SEA partners believe that the interest in sustainable services has not increased much mostly due to low awareness on sustainability in general, both from citizens and tourists. A minor increase in e-mobility application such as commercial e-bicycles and e-Vespas (mostly used during the tourist season) which can be rented at low prices is present. Unfortunately, the same cannot be said about e-vehicles, which are still too expensive and for which a sufficient e-infrastructure is still lacking. There are also “green” taxies which provide their services at the same price as the taxis with a combustion engine.

Thus, increasing demand for these services is a need, and must go hand in hand with a proper and efficient long-term planning, based on further development of a sufficient e-infrastructure, characterized by costs reduction of sustainable services, improved communication and awareness raising towards citizens and tourists, SHs engagement. This needs to be followed by the monitoring of the environmental factors (noise, congestions, water, etc.), by the boost of incentives and by the definition of an efficient legal framework. These elements could increase the number of project proposal for alternative energy and solutions, manage better funds for e-boats, offer a wide range of boat typology and accessible to all users, from big yacht to small boats. New incentives could open the possibility to test new technologies at a wider scale, to ensure scalability and marketability and to make possible the definition of an asset of specific regulations and ad-hoc financial scheme, able to support a gradual transition towards sustainable transports.

Into the Nautical sector a common vision and a wide-spread idea seems to move towards a circular economy model, considering environmental, economic and social aspects in a well-integrated system, to speak about marinas as energetic HUBs. HUB as emblematic element and concept for sustainable mobility structured around correct communications, long term planning, flows of DATA, knowledge and SHs engagement, able also to be a spatial and conceptual link between sea and the inland.

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Annex 1: SWOT Analysis Master Table

Sustainable mobility services

	Strengths
UniRijeka	S1. Attraction of new users/boats with high ecological standards S2. Improvement of existing market position S3. New added value services – vehicle/ride sharing, batt charging… S4. High acceptance on political level, existing spatial plans for marina dev. S5. Public awareness and concerns for environment, especially along coastline
UniSpliT	S1. High efficiency S2. Quiet driving S3. No gas emissions S4. Lower expenditures
Malinska	S1. Encourages people to use environmentally friendly transport S2. It will allow better (and carbon and noise neutral) mobility on the island S3. Using sustainable mobility services can help decrease congestion during summer season S4. Increased road safety (fewer casuialtie) S5.Reduced air and noise pollution
Maslinica Solta e RERA	S1. Existing marine infrastructure with 50 berths connected to electricity and water supply S2. Broad knowledge and experience of the marina's human resources on e-vehicle management S3. Existing financial resources within Project DEEP-SEA for the purchase of e-bicycles, e-vehicles, and electrical grid/charging station construction S4. Ability to host boats that use wind and solar energy to meet power needs
Puglia	S1. promotion of the port for sustainable tourism, valorization of the territory, economic development given by the electrification of the berths (Punta delle Terrare, porto di Brindisi and darsena di Ponente, porto di Bari) (https://www.giornaledipuglia.com/2020/07/bari-progetti-per-collegamenti-citta.html) S2. extended services and facilities available in the ports (https://www.giornaledipuglia.com/2020/07/bari-progetti-per-collegamenti-citta.html) S3. energy efficiency
Chamber of Commerce of Foggia	S1. Existence of a Skipass that allows you to moor in the Apulian marinas, started in an experimental phase in the ports of Vieste and Rodi Garganico during 2020

	S2. High craftsmanship skills S3. Numerous cross-border Interreg's are underway for environmental sustainability and for the development of intelligent systems to improve the quality of life of citizens S4. In 2019, the "Plastic free beaches campaign" was launched S5. Numerous projects on environmental issues are being launched S6. Large number of companies in the marine economy recorded in the "Business Register" of the Italian Chambers of Commerce S7. Positive trend of hybrid cars registered in Italy in 2019 S8. The Polytechnic of Bari is carrying out studies and research on solar boats
Ponikve eko otok Krk	S1. Comfortable, more quiet and cheaper ride with electric vehicles S2. Contribution to lower emission of harmful gases into the atmosphere and reduced noise S3. Developed traffic network S4. Close to important markets S5. Quality and availability of IT specialists
	Weaknesses
UniRijeka	W1. In some cases, low knowledge of green port concepts on port management level W2. Ports very much oriented toward civil infrastructure construction (more berths) rather than toward quality of existing services (in Croatia) W3. Negligible number of e-vehicles and e-boats users in Croatia W4. Seasonal characteristic of port-service demand W5. Some marina has low level of transit traffic (long-term berthing) that means less demand for fuel/charge supply
UniSpliT	W1. The trend is still weak W2. High cost W3. Low battery duration W4. Insufficient use and lack of infrastructure for the use of e-bikes
Malinska	W1. Possible fluctuation in usage (summer/winter) W2. Locals not tasking advantage W3. Lack of bicycle infrastructure W4. No incentive to use this way of transport W5. Initial high cost of infrastructure
Maslinica Solta e RERA	W1. Non-existent charging infrastructure for e-vehicles and e-boats in the marina W2. Increased emissions of CO2 in the marina caused by using fossil fuels due to a large number of boats during the peak summer season W3. Non-existent e-carpooling services in the marina

Puglia	W1. inconsistency among electrification projects in different ports (file:///C:/Users/arian/Downloads/SIA_011-ALL_01-Elettrificazione.pdf) W2. necessity to give structural modifications to old boats (file:///C:/Users/arian/Downloads/SIA_011-ALL_01-Elettrificazione.pdf)
Chamber of Commerce of Foggia	W1. High costs for the production of the structures W2. Lack of infrastructure W3. Lack of adequate communication on availability in ports via internet W4. Low availability of profiles with specialized technological skills for boating
Venezia Giulia	W1. necessity to evaluate applicability, sustainability and effectiveness of cold ironing measures, capacity to provide demanded energy, difficulties in the management of the energy service to boats (https://www.consiglio.regione.fvg.it/export/sites/consiglio/hp/eventi/eventi_allegati/PORTO-TS-TS-CR-09.03.2018.pdf)
Ponikve eko otok Krk	W1. High prices of electric vehicles compared to the conventional ones W2. Limited battery life of electric vehicles W3. High battery production costs W4. Lack of norms and standard for electric vehicles W5. Relatively low investment in research and development associated with electromobility
	Opportunities
UniRijeka	O1. Increasing interest for business O2. Potential for small business companies development O3. Existing service providers can upgrade their business O4. Broad public awareness for environment problems O5. Possible even higher modal-share of nautical tourism due to mobility restrictions
UniSpliT	O1. Raising awareness O2. Lifestyle change O3. Reducing fuel consumption
Malinska	O1. Implement smart mobility initiatives and encourage locals to use it even during winter O2. Encourage wider implementation on whole island (green island initiatives) O3. Create island wide network for car/bike sharing and charging stations O4. Local policy measures to ensure better acceptance O5. Include wide options of smart mobility services to ensure higher rates of acceptance
Maslinica Solta e RERA	O1. Adopting the national framework on infrastructure and market development policy for alternative fuels which encourages the use of electric energy in mobility

	O2. Existing EU directives and standards for different charging methods which encourage their standardization and unification O3. Increased global demand for e-vehicles O4. Introduction of e-boats in the yachting industry O5. Existing OCPI protocol for e-roaming in Europe O6. On-board chargers on e-boats enable charging to an EU standard current in the marinas O7. Existing EU funds for e-infrastructure implementation O8. Rapid development of new chargers and charging methods that enable the installation of the latest technology O9. E-catamarans introduced in the nearby National parks Krka and Mljet O10. Cooperation and networking with other marinas in the nearby area that have introduced charging stations for e-vehicles (ACI, Baotić)
Puglia	O1. political incentives on the use of public transports, e-bikes to promote sustainable mobility (http://mobilita.regione.puglia.it/index.php/descrizione-joomla) O2. competitive development of less advanced regional territories in South Italy, better access to information and communication technologies O3. build collaboration between port authorities, public administrations and third entities (file:///C:/Users/arian/Downloads/SIA_011-ALL_01-Elettrificazione.pdf) O4. EU 2014/94 Directive regarding infrastructures for alternative fuels, transposed to D-Lgs. 257/2016: national strategic framework to implement electric nautical mobility (https://www.port.taranto.it/attachments/article/1055/Taranto_POT_Vision%202030_Redacted.pdf) O5.hybrid and electric boats world market is increasing and expanding (https://www.port.taranto.it/attachments/article/1055/Taranto_POT_Vision%202030_Redacted.pdf) O6. EU recommendation and promotion of harbour emissions monitoring and techniques for emissions reduction
Chamber of ommerce of oggia	O1. High tourist attraction of the coastal area O2. Strategic position and mild climate O3. Public awareness of the risk of global warming O4. Increased requests for services in the sector O5. New job opportunities O6. Increased interest and attention to sustainable means of transport O7. Incentives from European funds for the study of new sustainable technologies

	O8. Development of the mechatronics sector also thanks to the collaboration between the world of research and the industrial sector O9. Presence of good level university centres O10. Presence of very active environmental NGOs in the area
Venezia Giulia	O1. take advantage from EU projects funding opportunities such as EALING (https://www.ansa.it/friuliveneziagiulia/notizie/2020/07/18/portitrieste-vince-2-progetti-ue-cofinanziati-programma-cef_0543f241-c135-47bb-912e-948a1f0e8caf.html)
Ponikve eko otok Krk	O1. Increasing production and use of electric vehicles O2. Access to Eu and other support funds for procurement of electric vehicles O3. Use of electric vehicles for official (public) purposes O4. Development of more powerful batteries for electric vehicles O5. Multisectoral cooperation
	Threats
UniRijeka	T1. Extreme climate conditions, natural disasters T2. Deviant behaviour T3. Control of oil prices T4. Economical crisis in tourism sector T5. Other priorities with higher visibility
UniSpliT	T1. Poor infrastructure T2. Economic crises T3. A small number of charging stations for electric vehicles
Malinska	T1. Usage beyond island T2. Post programme usage T3. Communication T4. Different car sharing systems at the island T5. No clear expansion plan
Maslinica Solta e RERA	T1. Decline in tourism and nautical activity due to the COVID-19 pandemic and its possible prolongation T2. A lack of charging stations outside the marina area (regional and national) T3. Non-existent universal charging standard (different standards used by different manufacturers, as well as the differences in the standards used in Europe, Asia and USA) T4. Lack of e-roaming standards and protocols that complicate cross-border traveling T5. Lack of clearly defined requirements for connecting charging stations to the electro energetic grid

Puglia	T1. costs could be very high in the case of a total electrification of all ports. Necessity of effectiveness study for the implementation of the project to understand costs and benefits (file:///C:/Users/arian/Downloads/SIA_011-ALL_01-Elettrificazione.pdf)
Chamber of Commerce of Foggia	T1. Climate change caused by greenhouse gas emissions T2. Insufficient incentives, even for electric motors T3. Financial crisis and crisis in the tourism sector following Covid T4. Long battery charging times T5. Lack of planned networks for charging stations
Ponikve eko otok Krk	T1. Insufficient familiarity and use of electric vehicles T2. Distrust towards electric vehicles T3. Unrealistic expectations of end users that cause possible disappointments T4. Demographic trends (decline in the number of inhabitants, outflow of young highly educated people) T5. Relatively high initial investment
Venezia Giulia	T4. lack of uniformed standards for implementing environmental policies in a specific area (https://www.consiglio.regione.fvg.it/export/sites/consiglio/hp/eventi/eventi_allegati/PORTO-TS-TS-CR-09.03.2018.pdf)

Renewable energy sources and smart grid solutions

	Strengths
UniRijeka	S1. Reduction of emissions - no polluting and smelling emissions S2. Free source of energy (RES) S3. Improvement of local energy solutions & energy efficiency S4. Transparent and social friendly integration of energy production & consumption S5. Reliability in energy supply S6. Lower cost of electric energy from wind power and photovoltaic plants S7. Infinite “fuel” source
UniSpliT	S1. Ensures economic development S2. Close cooperation between science and industry S3. Technically skilled labor
Malinska	S1. Provides low cost clean energy

	S2. With average of 260 sunny days[20] it can become energy supplier to local communities S3. Charging cars and bikes could potentially be free or cheaper than charging at home S4. Cleaner air/less polution S5. Variety of cars that might be charged thanks for clean renewable energy sourced at micro grid charging stations
Maslinica Solta e RERA	S1. Suitable climate and geographical position S2. Large number of sunshine hours per year S3. Possibility of utilizing wind and wave power S4. Existence of a small solar power system within the "Solar Academy" project on the island of Šolta S5. Other marinas in the nearby area self-sustained by renewable energy sources, which facilitates networking
Chamber of Commerce of Foggia	S1. Cross-border Interreg for environmental sustainability and for the development of intelligent systems to improve the quality of life of citizens S2. Launch of numerous projects on environmental issues S3. High number of companies in the sea economy recorded in the RI of the Italian Chamber of Commerce S4. Incentives for the use of alternative energy sources S5. Studies and research on solar boats of the Polytechnic of Bari
Ponikve eko otok Krk	S1. Health macroeconomic environment S2. Well-developed general infrastructure S3. High projected electricity demand growth S4. Substantial grid capacity S5. Energy efficiency
	Weaknesses
UniRijeka	W1. Area requirements for energy storage (batteries) W2. PV plants requirement W3. Battery lifetime W4. Still no common standard for EV charging (big difference between Asia, USA and Europe)
UniSpliT	W1. Weak technical infrastructure W2. Lack of investment policy W3. Lack of promoting of renewable energy W4. Weak technology transfer from academia and research to applied technologies

20 https://www.visitmalinska.com/o-malinskoj/klima-i-polozaj/

	W5. Limited market deployment programs
Malinska	W1. Regulatory issues / cyber security for smart grid solutions W2. Requires constant monitoring W3. Not so widely accepted as standard in Croatia W4. Weather dependent W5. Requires back-up plan in case it fails (connection to other power system)
Maslinica Solta e RERA	W1. Non-existent Microgrid infrastructure W2. Non-existing systems for obtaining electricity from renewable energy sources
Puglia	W1. necessity of wide spaces for implementation of solar Pvs knowledge gaps regarding the potential to meet energy demands (file:///C:/Users/arian/Downloads/SIA_011-ALL_01-Elettrificazione.pdf)
Chamber of Commerce of Foggia	W1. High costs for the production of the structures W2. Lack of infrastructure W3. Size of companies (micro and small) in the nautical sector, from which the mainly artisanal production and long production times derive W4. Low availability of profiles with specialized skills for boating
Ponikve eko otok Krk	W1. Lack of investment in renewable energy and smart grid solutions W2. Lack of technical and commercial skills in renewable energy and smart grid solutions W3. Need for initial investment W4. Subsidized electricity tariffs
	Opportunities
UniRijeka	O1. Improvement of electricity supply on Island O2. Possibility of development new attraction in unpopulated area (small islands) O3. Usage in emergency and back-up power supply solutions to maintain vital services O4. Existing investments and plans for PV construction on Croatian islands O5. Raising awareness of the harmfulness and the risks related to climate change caused by emissions
UniSpliT	O1. Educate people with renewable energy and smart grid technologies O2. Enhance public support and take advantage of support programmes for experimentation, development and implementation O3. Exploit expertise in engineering's fields O4. Exploit market penetration in renewable technologies
Malinska	O1. Potential to attract electric car/boat owners (people who did not visit due to lack of charging stations) O2. It has opportunity to spread to entire island (all counties) O3. It can drive greener economy on the island

	O4. Experiences gained in this project can be base for wider implementation O5. By enforcing renewable energy incentives local governments have opportunity to switch to clean energy
Maslinica Solta e RERA	O1. An increase in investments in renewable energy sources during the last 10 years O2. Financial resources from EU funds O3. Development of a solar photovoltaic technology which is applicable in marinas and which produces cheaper energy compared to other sources O4. Microgrid system can act independently to the rest of the grid which makes it applicable for isolated and islandic systems O5. Adopted Energy Strategy of the Republic of Croatia that includes guidelines for sustainable energy implementation O6. Existing different project initiatives (FIRESPOL, ADSWIM, AdriAquaNet etc.) for renewable energy sources use O7. Project eMOBILNOST developed by the HEP group for building "clean energy" charging stations based on the Microgrid concepts on a national level
Puglia	O1. wind energy for clean alternative power system for boats (https://www.port.taranto.it/attachments/article/1055/Taranto_POT_Vision%202030_Redacted.pdf)
Chamber of Commerce of Foggia	O1. High tourist attraction of the coastal area O2. Mild climate O3. Presence of good level university centres O4. Presence of very active environmental NGOs in the area O5. Public awareness of the risk of global warming O6. Increased diffusion of renewable energy sources in all sectors O7. Incentives from European funds O8. New job opportunities O9. High long-term savings O10. Increase in the prices of conventional energy sources O11. Development of the mechatronics sector also thanks to the collaboration between the world of research and the industrial sector
Ponikve eko otok Krk	O1. Substantial renewable energy resources O2. Diversification of energy supply O3. CO2 emissions reduction towards global responsibility O4. Development and modernization of the local industry O5. Use of IT technologies in monitoring energetic consumption and logistic control of fuel supply
	Threats
UniRijeka	T1. To high expectation – tendency toward extreme estimations of results T2. Simplification of the concept development

	T3. Non-systematic and non-consistent development and life-cycle management T4. Oil price reduction T5. Extreme climate conditions, natural disasters
UniSpliT	T1. Oppositions and different issues dues to the lack of knowledge and understanding T2. No taking advantage of current expertise T3. Electricity theft
Malinska	T1. Change in regulations T2. Not encouraged nation wide T3. Usability during emergency situation T4. System stability
Maslinica Solta e RERA	T1. Low awareness of citizens regarding the necessity of environmental protection and the advantages of electrification T2. Low awareness of visitors and business subjects on the advantages of renewable energy sources T3. High investment costs of renewable infrastructure construction T4. Low awareness of the island's residents and municipal administration on the importance of investing in renewable energy sources
Chamber of Commerce of Foggia	T1. Climate change caused by greenhouse gas emissions T2. Inadequate legislative framework T3. Insufficient incentives also for the use of electric motors T4. Financial crisis and crisis in the tourism sector following Covid
Ponikve eko otok Krk	T1. Subsidized energy prices T2. Lack of awareness of technology learning effects of renewable energy and smart grid solutions T3. Lack of awareness of benefits and co-benefits for renewable energy and smart grid solutions T4. Difficult to penetrate into the energy market T5. Doubt of decision makers regarding the potential of renewable energy and smart grid solutions

Policies

	Strengths
UniRijeka	S1. More sustainable planning oriented policy

	S2. Public awareness of building eco friendly ports S3. Image of the local community and the region, promotion of green-blue region S4. Minimize the negative impact of tourism, especially nautical tourism S5. Promotion of the region
UniSpliT	S1. Preserved natural environment S2. Potentials of geo-traffic position and development S3. Quality experts
Malinska	S1. Island is already part of initiative to become carbon neutral S2. Clearly sets directions for renewables implementation S3. Encourages green energy implementation S4. Allows for businesses to adopt clean energy
Maslinica Solta e RERA	S1. Participating in the DEEP-SEA project which presents a cross-border Adriatic network of marinas and shareholders in the sustainable nautical mobility field S2. Strong partnership within the DEEP-SEA project (port authorities in the Adriatic, Croatian and Italian Universities, Developing agencies, and others)
Puglia	S1. Action Plan (AP) of Regional Transports Plan (RTP) 2015-2019 identifies infrastructures and related policies aimed at achieving objectives and strategies defined in the RTP. TSP (Triennal Services Plan) implements the objectives and strategies regarding public transport services at regional and local level, identified in the RTP and considered most fundamental (http://mobilita.regione.puglia.it/index.php/trasparenza/itemlist/category/60). These are fundamental instruments for regional policies for sustainable mobility, needed to access national and regional funds S2. promotion of intelligent mobility: innovative infrastructures and technologies and services, use of Intelligent Transport Systems (ITS), education and information given to operators and users (http://mobilita.regione.puglia.it/index.php/trasparenza/itemlist/category/60). S3. sustainable mobility: promotion of public transport and good practices; emissions reduction; preference for efficient solutions in terms of financial and management issues. Social sustainability for promotion of a territorial network for a higher accessibility to services in the region and in the European Mediterranean space (http://mobilita.regione.puglia.it/index.php/trasparenza/itemlist/category/60)
Chamber of Commerce of Foggia	S1. The "Porti di Puglia Project" was launched, conceived by Assonautica Italiana with the Department of Property and Heritage of the Puglia Region, in collaboration with Unioncamere Puglia and the Chambers of Commerce of Puglia S2. Strategic position and mild climate S3. Large number of companies in the sea economy recorded in the Business Register of the Italian Chambers of Commerce

Ponikve eko otok Krk	S1. Opportunity to implement a resource preservation policy S2. Positive impact on the economic development S3. The rise of various industries and suppliers, meaning job creation S4. An important role in decreasing the imports of natural gas, coal, etc S5. Conservation and preservation of natural resources
	Weaknesses
UniRijeka	W1. Outcomes should be more precisely defined and disseminate to public W2. Performance indicators monitoring and public reporting poor or non-established W3. Pipeline between projects planning and achieved results should be established W4. Short-term interest rather than real strategic orientation W5. Favouring interest of particular stakeholders
UniSpliT	W1. There are no clear strategies or goals W2. Political opportunism W3. There is no synergy between strategies W4. Lack of financial resources W5. Interregional (dis) connection
Malinska	W1. Can potentially draw to renewables as only source W2. No clear guidelines implemented nation-wide and can slow down local implementation W3. Not enough incentives from counties to engage end-users W4. Planning and implementation timeframe
Maslinica Solta e RERA	W1. Lack of networking between the other marinas (under port authority of Split-Dalmatia county) on the island regarding e-infrastructure and e-services
Chamber of Commerce of Foggia	W1. Low tendency of companies to work in groups W2. Lack of connecting infrastructures between coastal municipalities, both road and railways, which makes tourist ports inaccessible W3. Lack of a comprehensive sustainability strategy W4. Lack of integration with the urban context, ie between the ports and the rest of the community
Ponikve eko otok Krk	W1. Lack of a steady national policy that could promote sustainable exploitation of renewable energy W2. Lack of energy policy and mechanism W3. Lack of climate policy W4. Lack of local strategies and their compatibility with other local and national strategies

	Opportunities
UniRijeka	O1. Impact of common regional (across Adriatic) and EU strategy O2. Opportunity for small companies and entrepreneurship development O3. EU funding opportunities O4. New technology development can change the existing paradigm and direction of local business O5. Make the risk-return equation more favorable for renewable energy investors, for example by increasing the returns for renewable energy investment
UniSpliT	O1. Developing models and examples of good practice from the EU O2. Brand itself as a city of ecological and sustainable development O3. Use of EU funds
Malinska	O1.By instating 'Clean Erergy Coorperative' help end-users to switch O2. Encourages people to switch to clean and renewable energy by engaging them O3. Increase energy efficiency O4. Cleaner energy can drive better life quality t the island O5. Potential to enable energy -independent island
Maslinica Solta e RERA	O1. An existing programme which promotes the procurement of electric and "plug-in" hybrid vehicles for citizens, companies and trades, as well as the "Green line" programme under which regional (county) public institutions, national parks, and nature parks will be able to apply for grants for electric vehicles, vessels and hybrid vehicles within the Ministry of environmental protection and energy efficiency O2. EU guidelines within the EU Strategy for Mobility and Transport which promotes the transition to renewable energy sources O3. Implemented Bill on the promotion of clean and energy efficient vehicles in road transportation, and the Bill on energy efficiency O4. Stimulation of purchase of e-vehicles by introducing ecological measures ("clean" vehicles pay less toll) O5. Adopted Energy Strategy of the Republic of Croatia which aims to build a sustainable energy system in the country O6. EU initiatives for sustainable island development which encourage the application of "clean" energy O7. Existing Main Tourism Development Plan for Split-Dalmatia County (regional level) includes the development of sustainable tourism on the promotion of energy efficiency, reduction of waste and energy consumption O8. Existing renewable energy infrastructure in Split-Dalmatia County
Chamber of Commerce of Foggia	O1. Wide spaces for possible cooperation between institutions and companies O2. Survey of the training needs of companies in the nautical sector O3. Increased prospects for expansion of the nautical sector

	O4. Development and promotion of a culture of corporate responsibility
Ponikve eko otok Krk	O1. Positive impact in the economic development of the region O2. Opportunity to implement a resource preservation policy O3. Multi-products approach for cost-competitiveness O4. Access to EU and other support funds
	Threats
UniRijeka	T1. Potential political instability T2. Corruption T3. Long lasting legal procedures and bureaucracy T4. National funding T5. A lack of appropriate standard and legal regulations
UniSpliT	T1. Resistance to change T2. Lack of awareness and education about e-mobility T3. Centralized development, regional inequalities T4. Slow bureaucracy T5. Conflict with tourism development goals
Malinska	T1. Sun collectors limit to 10kWh T2. Not enough storage capacity T3. Missing policy at country level T4. Missing residents' participation
Maslinica Solta e RERA	T1. Non-existent national strategy for the development of e-vehicles and e-boats T2. Lacking and unclear legal framework T3. Non-existing local (island-based) policies regarding the development and implementation of e-infrastructure T1. Absence of a national industrial policy T2. Inadequate legislative framework T3. Financial crisis and crisis in the tourism sector following Covid
Ponikve eko otok Krk	T1. Sustainability and systemic change resistance T2. Conflicts with nature protection in terms of national policies T3. Complicated system of obtaining incentives and permits T4. Frequent changes in incentives policies and systems