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The Viability of Short-Sea Shipping in Croatia

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This paper analyzes the advantages of short-sea shipping (SSS) in Croatia as well as the environmental concerns related to shipping in general and short-sea shipping in particular. A comprehensive strengths-weaknesses-opportunities-threats (SWOT) study was undertaken with regard to the strategy of SSS development in Croatia. The study shows that strengths and opportunities largely diminish the significance of weaknesses and threats, provided that the emphasis in policy-making is placed on wider public, economic and environmental interests, as well as on the internalization of external costs. The impetus for conducting this study comes from new regulations within MARPOL Annex VI, oriented towards the reduction of GHG emission. They encourage the application of new technologies in existing ships as well as the development of new vessels that are able to fulfill new ecological demands. The a authors believe that with its long-lasting high-quality shipbuilding tradition and prestigious maritime education institutions, Croatia can respond to the need to protect its environment. A concept of a ship that meets these new criteria is proposed. The ship is intended for shuttling people and goods between local coastal communities in an environmentally friendly and socially and economically relevant way. The example demonstrates that what had at one time been considered as being remote future in SSS became a reality and a topic of great interest and importance.

Keywords: *EEDI, energy efficiency, environmental protection, short-sea shipping*

Mogućnosti razvoja priobalne plovidbe u Hrvatskoj

Prethodno priopćenje

U ovome su radu analizirane prednosti priobalne plovidbe u Hrvatskoj, kao i utjecaj pomorskog prometa na okoliš, s osobitim osvrtom na priobalnu plovidbu. Provedena je i sveobuhvatna SWOT studija (snaga-slabosti-prilike-prijetnje) u odnosu na strategiju razvoja priobalne plovidbe u Hrvatskoj. Studija je pokazala da snaga i prilike uvelike nadmašuju slabosti i prijetnje. Preduvjet za to je stavljanje naglaska u donošenju odluka na širi javni, ekonomski i ekološki interes. Poticaj za provođenje ovakve studije su nova pravila u okviru MARPOL-a Prilog VI, usmjerena k smanjenju emisije stakleničkih plinova. Ta pravila potiču primjenu novih tehnologija kod postojećih brodova, kao i osmišljavanje novih brodova koji mogu udovoljiti strogim ekološkim zahtjevima. Autori smatraju da Hrvatska sa svojom stoljetnom tradicijom u visokokvalitetnoj brodogradnji i prestižnim obrazovnim institucijama može odgovoriti potrebi zaštite vlastitog okoliša. Predložen je i koncept broda koji udovoljava navedenim kriterijima. Brod je predviđen za prijevoz putnika i dobara između lokalnih obalnih zajednica na ekološki prihvatljiv, ekonomsko isplativ i socijalno koristan način. To je primjer koji pokazuje da je nekad daleka budućnost u priobalnoj plovidbi postala stvarnost i tema od velikoga interesa i značaja.

Ključne riječi: *EEDI, ekološka prihvatljivost, energetska učinkovitost, priobalna plovidba*

1 Introduction

Croatia is often presented as a maritime country with well-indented coast and numerous islands, but also with inappropriate connections between coastal communities of the mainland and the islands and maritime liner services which are undergoing continuous decline. Such services were in operation until some 50 years ago when they ceded their way to road transport on the far from perfect road infrastructure. Ferries were in such transport mode used only to carry vehicles across channels interrupting the roads, preferably pending the construction of road bridges.

The grounds for abolishing maritime services were their low profitability (high subsidies). That is certainly not a specific feature for Croatia only. Namely, with the advent of the automobile and truck leading to the development of national highway systems in many countries since the 1950s, coastal shipping entered a new phase, that of a decline. The combination of governmental subsidies and reduced transit time for road transport shifted cargo movement from water transport. Recently, increased road congestion, recognition of extraordinary expenses of road construction and maintenance, and technological advances of containerization and cargo handling have led many to view coastal shipping in its new incarnation called short-sea shipping (SSS) as being an attractive complement to road and rail transport [1].

This paper discusses the possibilities of SSS. Special attention is given to environmental concerns related to shipping in general and short-sea shipping in particular in light of the new regulations oriented towards the reduction of green-house gas (GHG) emissions. New demands encourage the application of new technologies in existing ships and the development of new innovative and energy efficient vessels. The authors believe that Croatia, with its long-lasting high-quality shipbuilding tradition and prestigious maritime education institutions, can respond to the need to protect its environment and therefore they propose a concept of an energy efficient and environmentally friendly ship.

2 Advantages of sustainable short-sea shipping

A sustainable transportation system is the one that allows the basic access needs of individuals and society to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations, the one that is affordable, operates efficiently, offers choice of transport mode, supports a vibrant economy, and limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise [2].

SSS, which is the subject-matter of this paper, is defined by the European Commission as the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe. Short-sea shipping involves domestic and international maritime transport, including feeder services, along the coast and to and from islands, rivers and lakes [3]. The European Commission is trying to revive SSS as a new, alternative, and sustainable mode of freight transportation and has actively supported SSS through funding of short sea projects since 1992, under its common transport policy.

In many cases SSS is more energy efficient and more environmentally friendly. It also shows better safety record than other types of transport. Maritime transport uses so to say a no-cost infrastructure, the sea. With investment in this mode being less substantial, maritime transport can adjust more easily to fluctuations in traffic. Also, maritime transport and ports take up less unspoiled land and require much less impervious surface. It is the way of mitigating highway congestion and reducing highway noise. It rescues the communities from being split by roads, orienting them towards their waterfronts. Additional advantages of SSS are expansion of transportation network capacities, port productivity improvement, revival of maritime sector, intermodal integration, door-to-door, just-in-time practices, modern logistics and allowing a better integration of islands.

Also, SSS generates work for European shipyards. In 1995, the European Commission estimated that 50 per cent of the ships built in the EU were for short-sea shipping. It is essential for island maritime transport to provide services both for passengers and freight. If these two aspects are considered separately, neither of the two sources of demand appears to be large enough to support a satisfactory maritime transport service. But if they are considered jointly, they can give rise to a more substantial volume of traffic, which thus becomes more attractive from an economic point of view [4].

3 Environmental impact of SSS

Climate change presents an enormous challenge for the transport sector. SSS is unfortunately associated with greater quantity of negative externalities as compared to long-range maritime transport on account of the need to use a greater number of small ships and a greater number of ports called at. Furthermore, sulfur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter (PM) emissions are typically very high for shipping – especially when no abatement technologies are applied. Besides atmospheric pollution, the share of SSS in the environmental impact is also through routine or accidental water pollution, noise emissions, as well as underwater noise and collisions with marine mammals.

Today, shipping accounts for about a quarter of the world's nitrogen oxide emissions, which causes smog, and the shipping emissions are growing significantly as the marine transportation increases.

3.1 Bunker fuel quality

The transport of goods by vessels, including SSS, is generally more fuel efficient on a per ton-mile basis than trucks and comparable to rail. Nevertheless, fuel efficiency per ton-mile of cargo does not guarantee that the emissions from shipping will be less harmful than landside transport. In fact, since many years heavy duty road transport is engaged in an on-going improvement of air emissions performances, while maritime transport is very late and slow in this change. Ships use one of the dirtiest fuels on the planet – heavy fuel oil. Thus, while relative carbon dioxide production from SSS as compared to trucking and even rail may be less because of economies of scale, air emissions of particulate matter, SO_x and NO_x are greater. That depends on key inputs like fuel type, route, speed of the vessel, the amount of drayage trucking involved post shipping, and ancillary emissions. For instance, annual deposition of sulfur in the amount of 9.16 kg/ha in Dubrovnik [5] is by far the highest in Croatia and is probably the result of its being a popular port of call for cruise ships. Rijeka is the second most polluted site measuring 6.68 kg/ha, with others ranging from 2.61 to 5.70 kg/ha.

Regulations concerning air pollution were introduced to the global regulatory regime through Annex VI of the IMO MARPOL Convention in 1997. Lately, MARPOL Annex VI regulations have become stricter, especially in Environmental Control Areas (ECAs) such as the Baltic Sea or the North American coasts where sulfur content in the fuel is currently limited to 1.0% and will be further tightened to 0.1% from 2015. The regulation for NO_x is also gradually tightened, although through another regulatory instrument - the NO_x code, applying to marine engines.

Black carbon is a component of particulate matter and is produced by ships through the incomplete combustion of diesel fuel. The substance is especially pernicious because it is responsible for severe public health and climate change impacts. There is evidence showing that its emissions from shipping are worse than previously thought. Large cargo ships, for example, emit more than twice as much black carbon (otherwise known as soot, which is thought to be the second largest contributor to global warming, after CO_2) than was estimated in earlier studies. It is estimated that commercial shipping releases around 130,000 metric tons of black carbon a year, or 1.7 per cent of the global total – with much of it pumped out near highly populated coastlines [6].

Black carbon contributes to global warming by absorbing solar energy not only when suspended in the atmosphere but also when deposited on snow and ice, which leads to accelerated melting. It is estimated that over 80% of the warming caused by black carbon deposited on snow comes from black carbon emitted by burning of fossil fuels. There are still no specific regulations for particle emissions implemented for marine engines.

Shippers could further improve their environmental performance by lowering ship emissions while at port, where most of their external costs occur. All types of vessels engaged in short-sea shipping should use shore power (cold ironing) while at berth. Ports also play a key role on the environmental friendliness of the transport system. Being the interface between sea and land they are central to ecosystems and consequently must meet the environmental challenges to achieve sustainability.

3.2 Greenhouse gas emissions

International aviation and shipping are the only GHG emitting sectors which are not covered by the Kyoto Protocol, reportedly due to lack of reliable emission data and lack of an agreed approach for defining responsibility by country. The IPCC reported that the vast majority of marine propulsion and auxiliary plants on-board ocean-going ships are diesel engines, which typically have service lives of 30 years or more. Thus, the IPCC concluded that it will be a long time before technical measures can be implemented in the fleet on any significant scale [7]. In 2009, a report on the GHG emissions of the shipping industry which was commissioned by the IMO stated that mid-range emissions scenarios show that by 2050 in the absence of policies ship emissions may grow by 150 to 250 per cent, compared to the emissions in 2007, as the result of the growth in shipping [8]. The report found that a range of technical and operational measures could increase efficiency and reduce emissions rate by 25 to 75 per cent below the current levels.

The report was also the basis for the introduction of the first formal CO_2 control regulations. They were adopted by IMO in July 2011 with the amendments to MARPOL Annex VI and the inclusion of a new chapter 4 intending to improve energy efficiency for ships through a set of technical performance standards. The amendments entered into force on 1 January 2013 [9]. They require that every ship has International Energy Efficiency Certificate (IEEC). In order to obtain IEEC a ship has to comply with Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP). EEDI is mandatory for new ships and SEEMP for all ships. They present the first ever mandatory global GHG reduction regime for an international industry sector.

It has to be noted that these regulations apply to all ships of 400 GT and above, but not to ships solely engaged in voyages in waters subject to the sovereignty or jurisdiction of the State the flag whereof the ship is entitled to fly. This is of particular importance for SSS since many ships intended for SSS do not leave their State. Also, EEDI formula does not apply to diesel-electric, turbine or hybrid propulsion system. Adoption of the amendments represents a significant step towards regulating the GHG emissions by IMO.

4 Challenges to SSS development in the EU

Schengen is considered a major reason for the low competitiveness of rail and sea transport against road. Today, trains and ships have to undergo lengthy procedures at borders between Schengen countries whereas trucks may pass without even stopping [10]. Thus, the EU enlargement has introduced a new challenge for SSS and intermodal growth, although it cannot be held accountable for the decline of SSS's share, as the decline had started before the enlargement. According to the European Sea Ports Organization (ESPO), since Latvia, Lithuania and Estonia became EU members the maritime transport in the Baltic Sea decreased 10 per cent, while the road transport increased almost 50 per cent. This is due to the reduction in bureaucracy and administrative procedures for road transport. At the same time the legislation on shipping has not been transposed, meaning that an inverse modal shift (from sea to road) is taking place as the result of the enlargement. The same applies with regard to more recent EU entrants as well [11].

The use of fuel with lower sulfur content within designated ECAs may have a reverse impact on the policy goal to shift cargo from land to sea as it is making SSS less favorable to road transport. In such a manner, the reduction of pollution at sea could be offset by pollution increase inland.

5 Present Croatian approach to SSS

A successful SSS program offers an opportunity to add value to a national and international transportation network and thus improve economic efficiency and ultimately the societal standard of living. The Republic of Croatia has enormous potential to reap benefits from developing the sector. The priorities in written and non-written development strategies in the Republic of Croatia are either associated with integrations into international organizations and thereby the projects of international and fully economic interest or with the development of tourism which is not always subject to proper regulation and control. Croatia rarely defends its sustainability and environmental interests within the framework of global development projects that it participates in and the authors consider that a major drawback.

The interests of Croatian citizens, Croatian precious natural resources, or so to say general public interest are given neither due attention nor priority. Similarly, at the EU level, the interest in expanding SSS was heralded at first as promising an improvement in inter-island links. It now appears that this is unlikely to occur in the near future. The islands are only briefly mentioned in no more than a very few definitions of SSS, and they are given no attention at all in sea motorway (SM) designs, despite the fact that many of the proposed SM pass just a few miles from important Mediterranean islands. With a minimum variation in routes and timetables, and with some additional costs, the liner shipping companies could include the islands in their legs, if necessary making use of public financial support. This would be justified by the fact that delivering a transport service should not be based exclusively on economic criteria: certainly, it must be profitable from an economic point of view, but it should also be acceptable in an ecological perspective and socially fair. It must reconcile the developmental strategy devised for a given area with overall economic development, lasting growth and a quality public service for the entire population [4]. Likewise, the Pre-Accession Maritime Strategy of the Republic of Croatia has identified SSS as one of the key measures of shipbuilding development. On the other hand, Croatia is phasing out its shipbuilding industry and thus the centuries-old tradition of the region.

In 2005, the Short Sea Shipping Promotion Centre was established in Croatia, the official task of which is placing an emphasis on the advantages that the short-sea shipping may provide at Trans European and Pan European level and in facilitating integration processes in logistics chaining of intermodal transport by providing support to members of the

Association in finding and preparing concrete projects. However, apart from international transit and tourism, there is no mention of projects intended for transporting passengers and goods locally.

With regard to SSS and its inherent intermodality, general situation in Croatia is not as developed as in other regions in Europe. The infrastructure for freight management and equipment that supports the efficient, rapid and low-cost modal shifting procedures is underdeveloped. The existing transport system is not fully adapted to the SSS utilization (Table 1). Difficulties occur in the following: administrative, organizational, technical, technological and infrastructure shortcomings as well as inappropriately trained staff. On the other hand, considering the indent of the northern part of the Adriatic Sea in European mainland, it is and will remain the object of interest for various forms of maritime transport.

Croatia has a long-lasting tradition in quality maritime education and should engage its potential in re-developing its SSS services in an environmentally friendly manner and in shifting the traffic from roads to the sea [12]. Italy was pursuing the idea of a "Med ECA" limited to the Adriatic Sea, but it was dropped for the foreseeable future according to the Italian Environmental Ministry. Croatia should adhere to high environmental standards in transportation and strive in its own long-term interest to proclaim the Adriatic the Emission Control Area.

Table 1 **Present maritime services by areas**
Tablica 1 **Postojeće brodske linije po područjima**

Area of	Ferry service	Ship service	Fast ship service
Rijeka	5	2	1
Zadar	6	3	5
Šibenik	1	2	1
Split	8	2	4
Dubrovnik	4	1	2
Along the coast Rijeka-Dubrovnik	1, twice weekly seasonal only		
Notes: non-ferry services are mostly daily and one-time according to official data there is no liner service on the Istrian peninsula nor to the south of Dubrovnik, not to mention cross-border coastal services			

In Table 2 a strengths-weaknesses-opportunities-threats (SWOT) study is presented for the strategy of coastal shipping development in Croatia. Major tasks and concerns ensuing from this study are as follows:

- strengths and opportunities largely diminish the significance of weaknesses and threats, provided emphasis in policy-making is placed on wider public, economic and environmental interests, as well as internalization of external costs;
- major threat comes from bad policy, which is a result of own insufficient organizational capacity, and unfavorable arrangements in international negotiations;
- strict environmental regulations should be pursued for ships, ports and maritime procedures;
- own shipbuilding and innovation skills should be preserved despite the official policy of phasing out big shipyards;

- emphasis should be placed on investing in domestic academic and technical knowhow of greening the shipping industry in general and SSS in particular.

Table 2 **SWOT analysis for the coastal shipping strategy development in Croatia**
Tablica 2 **SWOT analiza za razradu strategije razvoja priobalne plovidbe u Hrvatskoj**

Strengths geography coastal population density and tourists orienting communities toward waterfronts historical ports in city and town centers takes up less unspoiled land than roads requires less impervious surface rescues communities from being split by roads requires less public expenditures on infrastructure service for passengers and freight adjusts more easily to fluctuations in traffic shows better safety record than other transport modes road traffic congestion mitigation reduced highway noise intermodal integration adds value to national and international transportation network available knowhow in shipping and shipbuilding available knowhow for greening energy efficiency in energy crisis revival of maritime sector	**Weaknesses** inappropriate public transport connections between coastal communities of the mainland and the islands with low coverage, low frequency, few ports of call, ferries prevail phasing out of own shipbuilding industry administrative and organizational shortcomings underutilized ports existence of aged, unsafe and high-emitting ships greater number of new small ships and access nodes necessary emphasis on road traffic financing and subsidizing policy disregard for SSS and railway transport badly defined national maritime strategy insufficient negotiating capacities and skills coastal shipping in decline elsewhere lengthy procedures at borders air pollution by sulfur oxides, nitrogen oxides (smog), soot EEDI, SEEMP not yet developed for passenger ships and applies only to ships above 400 GT water pollution underwater noise, collisions with marine mammals
Opportunities better integration of the islands with regard to education, health care, markets to own agriculture and other products lesser island depopulation improving standard of living urban infill in coastal cities better coping with energy crisis investment in creating more jobs revival of shipbuilding skills maintaining of tradition facilitating the access to insular heritage for visitors export of ships and knowhow green innovation information technology innovations exploiting solar energy strict environmental laws and ECAs abatement technologies for air pollutants quality benchmarks for emissions, fuel sulfur cold ironing in ports public health protection standards in port communities EEDI and SEEMP development and application routes avoiding sensible marine areas marine spatial planning contribution to turnover of insurance, brokerage and freight forwarding sectors	**Threats** geopolitical interests unfavorable national and EU legislation, trade agreements public procurement rules emphasis on larger SSS projects non-internalization of externalities basing transport service exclusively on economic criteria uncontrolled development traffic in sensitive areas unregulated ports (ports as interface between sea and land are central to ecosystems) tourism not always subject to proper regulation and control ECAs reversing effect

6 Proposed concept of a small ship

A small passenger ship intended for shuttling people and goods between local coastal communities in an environmentally friendly and socially and economically relevant way is proposed. The main particulars of the ship are given in Table 3 [13].

Table 3 **Ship's main particulars**
Tablica 3 **Glavne značajke broda**

Length over all	L_{OA} = 37.3 m
Breadth	B = 9.4 m
Draft	T = 2.3 m
Displacement	D = 340 t
Speed	v = 15 kn
Number of passengers	N = 240

As described in [13], the ship's resistance power at 15 knots is about 570 kW. Electric power consumption while in port amounts to about 20 kW, and during maneuvers around 37 kW (without propulsion power). The ship has a hybrid power system consisting of two diesel engines, a fuel cell and a battery. The ship's fuel cell described therein was of a proton exchange membrane (PEM) type and had rated power sufficient to maintain cruise speed at 8 knots. The fuel cell for this ship would have lower rated power, but still sufficient to cover operations in port (maneuvering, mooring, accommodation, etc.). Diesel engines would be operational only during sailing in open sea. The fuel cell could also be active in open sea to achieve higher propulsion power and speed, or to decrease consumption of fuel oil while maintaining the speed.

Hybrid system, as described in [13] and shown in Figure 1, is a series hybrid type. The electric power is produced by two diesel engines driving electric generators, a fuel cell and a battery. The electric power is then converted to AC and distributed from the main switchboard to the propulsion system consisting of two propellers and a boat thruster, and other auxiliary systems. Compared to the conventional ship power system, this system has many drawbacks, but certain advantages make it competitive, if not now, then certainly in the near future. The main drawback is its higher initial cost. Also, transmission losses in hybrid systems are greater and amount to 8-12 per cent, as compared to the losses in mechanical transmission which amount to 2-4 per cent. But while losses in transmission are greater, hybrid systems are able to reduce losses at the beginning and at the end of the propulsion chain. Engines and propellers in hybrid systems can operate at their optimal performance. That is due to the versatile operational characteristic of the electric motor which is highly adaptable to changes in propeller load. This feature is particularly pronounced for ships which often change speed, or sail at a reduced speed, i.e. when approaching and maneuvering in port.

In addition, if well designed, hybrid systems are able to turn off their diesel engines while in port. Since frequent port operations are typical for SSS, the overall energy efficiency of a hybrid system would be even higher than that of a mechanical system. This is particularly pronounced in some ports, for example in the port of Mali Lošinj, where the maximum allowed speed is 2 knots, and so sailing in and out of that port takes more than an hour. During that time, there would be no need to have diesel engines running. This would save fuel and be beneficial for the environment.

The main advantage of hybrid systems is the so called "green benefit". Considering ship operation only, hybrid systems are more energy efficient and environmentally friendly than conventional systems. They produce less CO_2, SO_x and NO_x and are able to achieve zero emission in ports. This is very important since, as mentioned before, pollution in port areas is particularly pronounced. And this is not limited to air pollution only, but also to noise pollution which is also greatly reduced. However, the greatest obstacle to the application of fuel cell technology is financial. When "the green benefit" becomes measurable in terms of money saved, only then will the ship owners consider it. It is up to the government to recognize advantages of innovative energy efficient technologies and financially encourage their use.

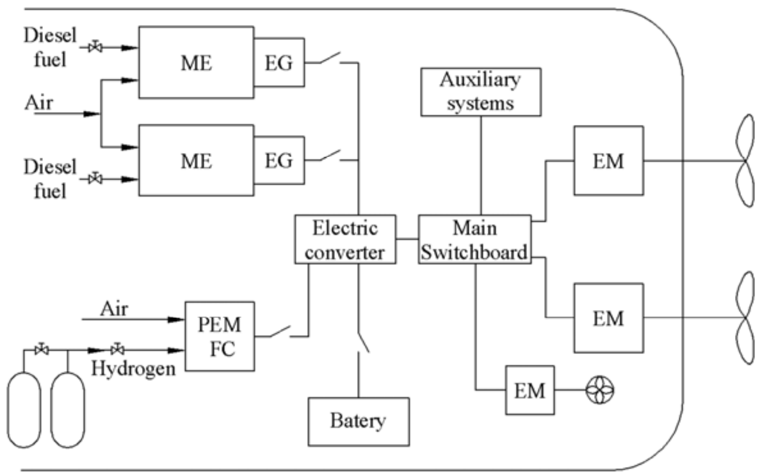

Figure 1 **Hybrid power system configuration (ME – diesel engine, EG – electric generator, EM – electric motor, PEM FC – proton exchange membrane fuel cell)**
Slika 1 **Konfiguracija hibridnog energetskog sustava (ME – dizelski motor, EG – električni generator, EM – elektromotor, PEM FC - gorivni članak s membranom za razmjenu protona)**

Instead of a series, a parallel hybrid system could be used. In that case, increased fuel efficiency could be achieved while sailing in the open sea at a constant design speed, because the energy conversion from the mechanical to the electrical, and then back to the mechanical energy would be eliminated. During port operations diesel engines could be detached by means of a coupling and turned off. But if the power from the fuel cell would not be enough while sailing at lower speed, then diesel engines would have to be used and the desirable fuel saving effect would not be achieved. This could be counteracted by using a series-parallel hybrid system, which on the other hand increases system complexity and initial cost.

The analysis of energy efficiency of various types of power systems is required. Energy efficiency of this ship is hard to calculate using EEDI, because its benefit for the society is hard to measure. A much more appropriate tool would be Energy Efficiency Operational Indicator (EEOI). By using EEOI, various conditions that this ship encounters during its service could be pursued. This would allow precise comparison with conventional designs and more realistic cost estimates. A further and much more detailed analysis on this subject is required.

Another challenge with regard to the fuel cell technology involves problems related to the use of hydrogen. Price of hydrogen production, difficulties in storage of hydrogen and the lack of the supply network hinder the development and wider use of the fuel cell technology. But again, since this ship is designed for SSS, it would call at ports more often and these problems would be easier to deal with.

7 Conclusion

In the authors' opinion, the environmental concerns described in this paper should be dealt with proactively in order to ensure environmental, social and economic benefits for the society. In Croatia there is still enough knowledge and skill available to design and build innovative energy efficient small ships. The proposed concept of a hybrid power system for small ships operating in SSS service complies with the most stringent environmental standards. It produces less CO_2, SO_x and NO_x and achieves zero emission in ports, that being vital for public health in port communities. With further development of the concept, the "green benefit" it could provide would not only be reflected in the environment preserved, but also in the money saved.

Existing ports in small coastal communities would be sufficient to accommodate smaller ships meaning that intervention in the space would just concern some environmentally friendly communication route between the port and the town in case the very port is not already a part of historical centre of such a town or village. The cities such as Rijeka have already built passenger terminals which, while waiting for some future cruise ships, could and should service small Quarner Bay liners.

Croatia should therefore introduce/intensify its domestic SSS liner services while also reviving and modernizing its rail infrastructure and services adhering to high environmental standards and strive in its own long-term interest to proclaim the Adriatic the Emission Control Area (ECA). The SWOT study for the strategy of the SSS development in Croatia shows that strengths and opportunities largely diminish the significance of weaknesses and threats, provided emphasis in policy-making is placed on wider public, economic and environmental interests, as well as internalization of external costs. Major threat is the bad policy making resulting from insufficient organizational capacity and unfavorable arrangements agreed in international negotiations. Strict environmental regulations should be pursued for ships, ports and maritime procedures. At the same time, own shipbuilding and innovation skills should be preserved despite official policy of phasing out big shipyards. Emphasis should be placed on investing in domestic academic and technical knowhow of greening the shipping industry in general and SSS in particular.

A similar SWOT analysis could apply for other coastal states, subject to respective variations of individual factors outlined in this study.

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