Environmental protection as a crucial policy aspect for port of Hamburg sustainable development

1. IMPORTANCE OF ENVIRONMENT PROTECTION IN THE PORT OF HAMBURG

The Port Development Plan to 2025 from October 2012 was prepared for the first time in dialogue with all parties which may have interest in or be dependent on port development like associations representing port companies and transport industry, representatives of local economy (e.g. chamber of commerce), trade unions and, last but not least, environmental associations. The result was identification of strategic guidelines, which Port of Hamburg Authority should follow: value creation, handling, quality and environment.

Thus, protection of the environment became one of the most important goals for HPA combining its actions in this area under the headword “green port”. But it is not only the port strategy and expectations of business partners that mark a path towards greener port development. For many years the port of Hamburg has been developing together with the city of Hamburg and that co-existence puts additional constraints on that part of port business which may impact local community. Like in many other places including Gdynia or Szczecin, port of Hamburg is namely located in the very heart of the city, which means that the usual activity within the port affects directly and indirectly most of citizens of Hamburg – sometimes in positive, but sometimes in negative way. The only possibility for sustainable development under these circumstances is to take responsibility for ecology and to shape the future port development in symbiosis with the city, its inhabitants and the environment.

The economic impact of the port of Hamburg on the metropolitan region is enormous. In fact, giving about 133 thousands work places in Free and Hanseatic City of Hamburg and some 22 000 thousands more in surrounding areas depending directly and indirectly on the port, it is the biggest employer in the region [1]. It creates high added value (EUR 12,6 billion in Hamburg and additional EUR 1,5 billion in the metropolitan region) and brings to the city of Hamburg tax revenues of EUR 751 million (according to Planco, all data refer to 2010) [1]. In 2013 the port handled 139,1 million tons, most of which in containers. The container throughput reached last year 9,3 million of TEUs, of which 3,9 million of TEUs were transshipped to other ports in Northern Europe and 5,4 million of TEUs were transported to/from Hamburg by land (Fig. 1).

In its newest study on container volume development in the port of Hamburg, Bremen Institute ISL expects that by 2025 box handling shall reach 15,4 million TEUs and 18,6 million TEUs in 2030 [4] i.e. twice as much as in 2013. To handle such enormous volumes Hamburg needs not only efficient infrastructure and handling facilities or well-developed links with the hinterland, but also – what becomes more and more obvious - special policy to protect port’s natural environment, its employees as well as citizens of Hamburg from harmful effects of shipping and usual port activity.

This huge amount of cargo poses a potential threat to the environment as a source of noise (not only during day but in nighttime as well), pollution and congestion – just to name basic externalities only. It may probably be enough to put some rudimentary restrictions on emissions to fulfill legal requirements of environmental protection. Nevertheless, the Senate of Free and Hanseatic City of Hamburg has put in the Port Development Plan much more ambitious goals for HPA to acquire a top profile among ports “by pursuing ambitious environmental and climate objectives and actively promoting and applying innovative technologies and ideas” [1].
2. RISING IMPORTANCE OF ENVIRONMENT PROTECTION IN MARITIME TRANSPORT

Environment protection is more and more visible (especially in the Northern Europe) as a strategic goal for business units as well as local governments and countries. An example of how good practice can be spread among enterprises is a so called Clean Shipping Index, introduced by leading world shippers (including ABB, Akzo Nobel, Alfa Laval, KappAhl, Stora Enso Logistics and others) to evaluate performance of carriers providing transport by sea. Clean Shipping Index has been created by two Swedish scientists, Ulf Duus and Jan Ahlbom, who checked a number of ships calling Gothenburg and - basing on this investigation - listed several technical solutions reducing adverse effects of shipping on air and water pollution. By comparison of performance of selected vessels to a reference ship in five areas (level of emission of carbon dioxide, nitrogen oxides, particulate matter and sulphur oxides as well as use of chemicals and handling of ship’s waste, sewage and ballast water), Clean Shipping Index enables an environmental ranking of ships. It is understandable for cargo owners and easy and inexpensive for shipping lines. Carriers have to answer online simply 20 questions per vessel and eventually have their ships verified by a renowned organization including Bureau Veritas, Germanischer Lloyd, DNV and others. The driving force is preferential treatment of carriers and their ships by shippers looking for environmentally acceptable shipping.

But it’s not only shippers that actively support climate protection. A similar initiative of some key ports including Hamburg, Rotterdam, Los Angeles, Busan and others concerned by greenhouse gas emissions by shipping is called World Port Climate Initiative (WPCI). A major project of WPCI is an Environmental Ship Index (ESI) which identifies ships performing better in reduction of air pollution than current emission standards. The ESI Index can be used by shipping lines as promotion tool of their environmental policy actions, however, the main idea of the index is to use it as a tool for ports to identify ships contributing to environment protection and to reward relevant shipping lines by purely economic incentives. Thus, carriers will enjoy some economic benefits as well as good reputation which eventually be reflected in growing provision of services. Shippers receive a tool to implement sustainable goals as well as positive consumer experience and, last but not least, ports enjoy cleaner air and increased acceptance.

Introduction of European Sulphur Emission Control Area (SECA) in the Baltic Sea as well as the North Sea and in English Channel (La Manche) is a predominant legal initiative of European countries as well as European Commission and UN Organization which will shape the shipping in near future. According to the European Commission, shipping is a source of substantial air pollution, especially in dense traffic areas and, eventually, contributes to poor air quality. Annex VI to MARPOL Convention (IMO), revised in 2008 and
confirmed by directive 2012/33/EU of the European Parliament and the European Council in November 2012, sets new standard for air pollution in ECA in respect of sulphur emission and requires that from 2015 sulphur content in marine bunker shall not exceed 0.1% (1% in North Europe and 3.5% at high seas today).

Both Senate of Free and Hanseatic City of Hamburg, as a legal and controlling body, as well as Hamburg Port Authority governing the port, acknowledge rising consciousness and higher standard of environment protection in both the industry and local community and – in consequence - aim at sustainable port development in harmony with the city of Hamburg and environment to offer sustainable job and service quality around green supply chain and eventually gain public acceptance. The dialogue among all actors engaged in creation of port development plan revealed that following actions are considered to be important:

- Improvement of environmental performance and increase in efficiency,
- Reduction of emissions and consumption,
- Strengthening of railway and inland waterway connection at expense of trucking,
- Support to nature preservation areas in the port and around the port.

3. MODAL SHIFT TO ENVIRONMENTALLY FRIENDLY TRANSPORT MODES

A good way to protect environment in a port is to shape its modal split in favour of low-emission transport modes like rail or inland waterway transport. It is not realistic to eliminate or limit trucking of goods to and from the port by administrative restrictions or by putting additional burden on road transportation in form of public tax or levy to diminish its attractiveness. Also, it wouldn’t be wise to cumber trucking by not developing road infrastructure and thus allowing congestion to build up on port roads over the long time, due to the role which road transportation is playing for many cargo owners. On the other hand, road transport is a source of high external costs which are even more important in densely populated area like Hamburg. A reasonable solution is support to green transport modes which would help to reduce emissions, congestions and accidents. Also the European Commission is determined to foster modal shift in transport of goods: it plans in its White Book published in 2011 that by 2030 some 30% of cargo transported over routes of 300 km or longer shall be shifted from road transport to alternative transport modes.

The type of cargo has a substantial impact on modal split. In 2013 the port of Hamburg handled 139.1 million tons of cargo, of which 42.0 million tons of bulk cargo and 97.6 million tons of general cargo (95.7 million tons in containers). One of the reasons of Hamburg’s success is high percentage of local cargo. Some 20 percent of imported or exported goods, especially in containers, are delivered or produced locally. In this case road transport offers the best possible solution over other transport modes. On the other hand, bulk goods are transported mainly by rail or by barge whereas containers delivered over long distances to or from port’s hinterland use all possible transport modes. Price is always a crucial factor to decide on which mode of transport is to be used. In case of containers on short distances up to 150 km trucks are hard to beat, but on distances of 300 km or more some 70 percent of all boxes are transported by rail (Fig. 2.). Road transport is often more expensive than rail but flexibility and speed of trucks is important for some port customers. Nevertheless, in the last ten years rail improved its share in modal split by ca. 10 percent points.

This positive trend is supported by the main outside factors. It is for instance development of Central European countries like Czech Republic, Poland or Austria and growing demand for stable and reliable hinterland connections or increased cost of road transportation (oil price, road toll, taxes and legal regulations). Nevertheless, efficient rail infrastructure within the port is basic mandatory condition to sustain the growth of rail traffic, therefore HPA is determined to complete a number of infrastructural projects and maintenance works in the port to achieve this goal. On the other hand there are bottlenecks in German rail network outside the port and the federal government that has to be engaged to solve it. The five north German countries including Hamburg have prepared a list of necessary infrastructural projects known as list of Ahrensburg in 2008.

Energy efficiency and optimized carbon footprint are definitely one of the most valuable advantages of rail. But the port is coping to improve other emissions (except CO2) as well and some good examples of HPA activity in that field are use of soot filters by railroad engines, noise-reduced brakes and – last but not least – telematics and IT tools for planning transportation of goods.
4. BETTER INFRASTRUCTURE AND OPTIMIZED CARGO FLOW WITH SMARTPORT LOGISTICS

In order to increase the efficiency of the port in supply chain, HPA has started a project called smartPORT logistics, which is based on three pillars: intelligent infrastructure, efficient traffic flows and optimizing trade flows.

Intelligent infrastructure is a system which consists not only of road or rail tracks or fairway channels for ships, but also of information, which has to be gathered and processed. The information processing infrastructure is not fully completed yet, but the plan foresees creation of an intermodal Port Traffic Centre which shall combine all transport modes and help to increase the capacity of the whole port infrastructure. In the future it will control road and rail networks, manage the available parking places as well as movement of vessels within the port.

Some elements of the system have already been built. In case of road network, the system provides automatic collection of data on traffic flow thanks to detectors installed throughout the port. Various detectors (inductive loops, video detection, Bluetooth), which are currently being installed on port roads, gather information on traffic density, average speed of vehicles, traffic jams and disturbances etc. and convey the data via fibre optic cables or radio to Port Road Management Centre which merges it with inputs from all other available sources and analyzes to make a short-term prediction which is consecutively passed to truck drivers and to other services as well. PRMC provides:

- Real-time traffic information,
- Dynamic traffic management via information tables located on port’s roads,
- Incident management system,
- Car park management,
- Traffic management on roads leading to port terminals.

Communication with truckers has been provided since 2011 via LED message boards called DIVA (dynamic traffic volume information system), which inform on congestion, accidents, maintenance works and times when collapsible bridges are closed for road traffic etc. Thus optimized traffic limits emission of CO2, noise and time spent in traffic jams which in consequence lead to optimized trip planning and savings of money and time.
The next step in road traffic management is a Smart Road project which will use to even larger extent all options which the IT technology can offer to monitor road network better and provide more accurate picture of the actual situation (inclusive traffic, environmental pollution, wind direction and force, road lighting etc.).

A problem in a busy port like Hamburg can be created by trucks looking for a parking place. As space in the port is expensive, it is not possible to provide excess parking space to accommodate all truckers in all possible locations. Eventually, it may lead to additional and unnecessary traffic caused by drivers looking for an appropriate parking. HPA is creating a comprehensive parking management system that will assist truckers and ensure that existing facilities are optimally used. Truckers will be communicated via mobile app with functions like available bay detection and administration.

As already mentioned, not only road infrastructure is in focus of HPA. In case of port’s railway network there is already a dedicated IT management system (HABIS) which supports management of rail traffic in Hamburg. To manage the rail infrastructure better, critical railway points (switches) will be equipped, under a pilot project, with versatile sensors which will measure various parameters whenever the point is switched or crossed. Thanks to information on actual conditions in major points, the operational management will be able to make better decisions and it will be easier to plan maintenance measures.

Along with roads and rail tracks also the river Elbe and port channels and basins are used for traffic. In March 2014 a dedicated IT system for planning ship movements in the port and in the estuary of the river Elbe (PRISE) was introduced after one year trial. This task is getting on importance as in Hamburg the number of big vessels navigating in narrow time-frames is growing constantly. The system gathers information from terminals, pilots, shipping companies, tugs and Harbour Master Authority as well as from German Federal Maritime and Hydrographic Agency (e.g. actual water level) and processes it to enable berth planning, provision of status information on ships’ positions, communication with relevant parties (tugs, terminals etc.) and more.

Reduction of emissions is one of priorities for HPA, therefore HPA engaged itself in World Port Climate Initiative (WPCI). The group has developed a special measure of ships performance in environment protection in form of Environmental Ship Index (ESI). To support shipping line investing in low-emission technology, HPA uses financial incentives in form of discounts on port tariff rates. The WPCI members are convinced that in the future more ports will join the initiative thus giving even more reasons to shipping lines to deploy “green ships”.

5. REDUCTION OF EMISSIONS WITH SMARTPORT ENERGY

A milestone in Hamburg’s green policy is an important project smartPORT energy which HPA has been carrying out since 2012 together with administration of Free and Hanseatic City of Hamburg (Fig. 3.). The idea of smartPORT energy project is energy transition in the port towards renewable energy as well as lower energy consumption by increasing energy efficiency and by promotion of ecologically friendly mobility. The expected result shall be better use of available resources thanks to general reduction of energy consumption and reduction of harmful emissions.

The renewable energy in the port comes from three different sources: wind installations, solar panels and biomass. Wind installations in Northern Germany are more and more important. In the port they are also present but the number of installations is limited – currently there are six wind turbines generating power of 20 MW. HPA is currently inspecting potential wind plant sites within the port and plans to construct seven of them by 2015. In this year HPA has prepared a list of available roofs in the port, where solar panels could be installed. Biomass should be obtained as waste from green areas (e.g. lawn etc.) in the port.

In fact, many companies operating within the port area have already implemented some energy saving measures after joining voluntarily an environmental program “Enterprises for Resource Protection” run by city authorities. The program, in which port companies receive both consulting and financial support to implement energy saving investments, encompasses such activities as preparation of footprint analysis, introduction of energy management system or reduction of emissions by modernization of existing buildings.
Substantial potential is seen in co-generation (production of electric energy and heat), cross-company use of waste heat (i.e. waste heat produced in excess by one company could be used by another company as well) and intelligent grid management. Another very promising project within this program is connected to use of hydrogen produced from renewable energies as storage of energy. Hydrogen could then be used to power motors or in fuel cells.

Innovative mobility concept is focusing on emission reduction through reduction of unnecessary traffic, modal shift of traffic from road to rail and/or inland waterways and through avoidance of harmful emissions which include air pollution, noise and also light. Especially air pollution is being criticized by the public. According to Lutz M. Birke, Enterprise and Port Strategy Manager at HPA, nitrogen oxides (NOx) and particulate matter (PM10) arising from ship traffic contribute to 38% and 17% of total emissions in Hamburg respectively. Huge sources of harmful emissions are diesel generators on ships running during ships’ stay in the port. To address this problem, HPA will build a shore power supply installation (“cold ironing”, see Fig. 4) for cruise ships in Altona which should be completed by 2015.

Fig. 3. Energy transition in the Port of Hamburg

Fig. 4. Onshore power supply for ships
By the same time external electric supply installation for container ships shall be made available. As part of a pilot project “Green Shipping Line” between ports of Hamburg and Shanghai, which is supported by Federal Ministry of Transport and digital Infrastructure, external power supply for cargo ships will enable the latter to switch off their generators thus contributing to improvement of air quality in the port.

Moreover, HPA is planning provision of a number of alternatives to onshore power supply including mobile generators operated with natural gas, barges with generators operated with LNG or fuel cells. An LNG generator on a barge seems to be a highly interesting option due to its flexibility. Hamburg-based Hybrid Port Energy GmbH, a subsidiary of Becker Marine Systems GmbH & Co. KG, designed a LNG Hybrid Barge which will act as low emission electrical power to cruise ships mooring in a port [6]. The idea of LNG Hybrid Barge is based on use of LNG to generate electric energy which can be delivered to lighter’s propulsion unit or fed to other vessel as external power supply. For its innovative approach, in 2013 the project won the Baltic Sea Forum’s prize “Baltic Sea Clean Maritime Award” in Infrastructure Development. The first vessel shall be constructed already in September 2014 [5] and will stay in Hamburg to provide power supply to AIDA Cruises ships.

Fig. 5. Examples of different power outlets used in different ports worldwide, which are considered for implementation in Hamburg (up left: installation for cruise ships in Los Angeles (11 kV), down left: installation for smaller container ships in Shanghai Waigaoqiao (440 V), right: installation for big container ships in Kaohsiung, Taiwan (6,6 kV))


Introduction of sulphur emission regulations in the North Sea and in the Baltic Sea started some projects on usage of LNG as propulsion system on ships as well as alternative power for trucks. Today LNG as fuel for ships is of negligible importance, but it will definitely rise soon as it solves problems of future restriction compliance to regulations concerning emissions of oxides of nitrogen and particulate matter (e.g. MARPOL Annex VI). Port Development Plan foresees investments in LNG bunker installations as a factor which will strengthen Hamburg’s competitive position as a regional container hub, due to anticipated growing role of LNG powered feeder ships.
6. SUSTAINABILITY ENHANCEMENT AND INCREASED EFFICIENCY ON TERMINALS

HHLA, the biggest terminal operator in Hamburg, is an excellent example of how seriously companies in Hamburg are committed to environment protection. Actually, the environment is one of the pillars of company’s sustainability strategy and its performance in this area puts it as one of the industry leaders. For instance, HHLA issued a declaration of compliance with the German Sustainability Code, which is still unique in the maritime industry. The company is in following fields of environmental activity:

- Ecological transport chains,
- Space conservation,
- Nature conservation,
- Climate protection [7].

A good measure of climate protection is reduction of CO2. HHLA undertakes a number of actions in this area and, moreover, publishing its carbon footprint since 2008. Although the absolute emission of CO2 by HHLA is rising, the emission per container is falling down and the target is reduction of CO2 emission per box by at least 30% by 2020. In 2013 emissions per container were lower by 24.9% already, therefore a set target seems to be achievable easily.

In order to fulfil the set goal, HHLA is undertaking a number of measures e.g.:

- Use of company’s own locomotives with electric engines,
- Electro mobility - conversion of handling equipment to electricity instead of diesel encompassing:
  - Cars,
  - AGVs\(^2\),
  - Container and rail gantry cranes,
- Improvement of energy mix by bigger share of electric energy from renewable sources (two large dimensioned solar power panel implementations mounted on roofs of HHLA produce approx. 570,000 kWh solar power electricity p.a.),
- Reduction of travelled distances of containers on terminals thanks to real-time optimization (IT support) [7],
- Emission-free heating by using biological gases (fermentation gases of the sewage plant Köhlbrandhöft are used for production of heating in the building of CTT Terminal - reduction of CO2 by approx. 1,000 tons p.a.) [2],
- Reduction of container handlings by quad-spreaders (spreaders able to handle 4 TEU at once) and dual cycle (explained later).

HHLA is operating battery electric AGVs since 2011, when first two vehicles was delivered to CTA by manufacturer (Gottwald Port Technology). Thanks to the newest technology, an 11 ton battery pack ensures uninterrupted work of the AGV for ca. 20 hours (up to 60 t payload) whereas exchange of battery takes only about 5 minutes and proceeds fully automatically. Recently HHLA together with partners (Gottwald, Vattenfall, Universities of Oldenburg, Göttingen and Clausthal) has initiated a so called BESIC project (Battery Electric Heavy Goods Transports within the Intelligent Container Terminal Operation), supported by the Federal Ministry of Economics and Technology. BESIC project assumes a broader use of fully electric AGVs at terminals and investigates coordination of battery charging times with terminal operations requirements and with available renewable energy in electricity grid. For the purpose of the project a fleet of battery electric AGVs is being enlarged to 10 vehicles. Ideally, all batteries shall be charged with electric energy made from renewable energy sources, which eventually shall be produced by HHLA itself at own solar plants or wind farms. A potential success of the BESIC project will initiate a process of transferring all vehicles to electric energy at HHLA terminals which eventually shall ensure that all machines used between quayside and delivery zone shall be free from CO2 emission (powered exclusively by electric energy). At the same time the level of noise at a terminal shall be reduced significantly as well [3].

Higher efficiency of operations, which eventually also improves environmental impact of HHLA’s container terminals, means also more TEU per handling or less handlings to load and unload a ship.

\(^2\) Automated Guided Vehicle – automatic vehicles (without driver) which transport containers between STS gantry cranes on quayside and container yard
recently HHLA testing quad-spreaders, which are able to lift even 2 x 40 ft containers at once (in so called tandem mode), and dual cycle, which reduces a number of spreaders’ empty runs (Container Terminal Altenwerder is the first terminal worldwide to implement dual cycle into its production system) as well as optimized way for AGVs and van carriers between a STS gantry crane and container yard.

**Fig. 6. Conventional operation vs. dual cycle**
*Source: own graphic based on materials of HHLA AG*

7. **CONCLUSION**

Environment protection as a path leading to sustainability is never ending process which has to be consequently followed. The city of Hamburg has gained an honourable title of the European Green Capital 2011 for its pro-active attitude. The actions initiated by the city of Hamburg as well as by Hamburg Port Authority in following years including projects smartPORT energy and smartPORT logistics projects as well as other activities, prove that Hamburg is intending to stay on a road to ecologically friendly development. The scope of undertaken activities is very broad: from protection of the river Elbe and Natura 2000 areas along the river between the port and the North Sea (not only in favor of endangered species, but also in view of salting, dikes’ protection and silting), through emission control incentives for shipping and railways, to optimization of road traffic and wider use of renewable energy and eventually to many other smaller or bigger measures to boost port’s environmental performance. Today we stand in front of an LNG revolution, which will make shipping in the Northern Europe even more environmentally friendly and further increase advantages of maritime transportation compared to trucking or even to rail transportation. In a port like Hamburg a key to success is wider use of LNG in ports combined with e-mobility and smart grid powered by renewable energy.

**Streszczenie**

Ekologia jest coraz bardziej istotna dla coraz większej liczby firm, a także dla władz lokalnych i wszystkich krajów. Większość władz portowych w północnej Europie działa jako organ publiczny ale pracuje w prywatnym otoczeniu, co oznacza że muszą przestrzegać zasad ustalonych zarówno przez sektor publiczny jak i prywatny. W tych okolicznościach, nie jest zaskoczeniem, że znaczenie ochrony zasobów naturalnych wraz ze zmniejszeniem obciążeń związanych z ładowaniem i obsługą towarów dla społeczności lokalnej to jeden z punktów centralnych władz portowych. W artykule przedstawiono działania podjęte przez port w Hamburgu mające na celu ochronę środowiska naturalnego, jak również mieszkańców Hamburga z powodu szkodliwych emisji z działalności gospodarczej portu.
Ochrona środowiska jako kluczowa zasada polityki na rzecz zrównoważonego rozwoju w porcie w Hamburgu

Abstract

Ecology is more and more important for ever broader number of companies as well as local authorities and whole countries. Most of port authorities in northern Europe act as a public body but work in private environment which means that they have to follow rules set by both public as well as private sectors. Under these circumstances it is no surprise that significance of protection of natural resources along with diminishing of burden which ships and handling of goods at port terminals create for local community are one of focal points of port authorities. This article presents actions taken by the port of Hamburg aimed at protection of natural environment as well as of citizens of Hamburg from harmful emissions due to port economic activity.

Key words: ecology, environmental protection, maritime ports.

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