BRE REVIEW

BALTIC RIM ECONOMIES

DECEMBER 2021
ISSUE NO. 5

SPECIAL ISSUE ON MARITIME SECTOR

ELSI KATAINEN

Reducing emissions in the maritime sector will bring challenges and opportunities for Finland

KARIN ANDERSSON

Emission free propulsion for ships

MARJUKKA PORVARI

Focus and courage are needed for saving the Sea

ELISA ARO

The European Union supports sustainable and digital maritime processes

pan-european institute

To receive a free copy,
register at www.utu.fi/pei

BALTIC RIM ECONOMIES

BRE REVIEW

The Pan-European Institute publishes the Baltic Rim Economies (BRE) review which deals with the development of the Baltic Sea region. In the BRE review, public and corporate decision makers, representatives of Academia, as well as several other experts contribute to the discussion.

Pan-European Institute

ISSN 1459-9759

Editor-in-Chief | Kari Liuhto
(responsible for writer invitations)

Technical Editor | Elias Kallio

University of Turku
Turku School of Economics
Pan-European Institute
Rehtorinpellonkatu 3
FI-20500 TURKU, Finland
Tel. +358 29 450 5000

www.utu.fi/pei

bre@utu.fi

Data protection description

pan-european institute

EXPERT ARTICLES

EXPERT ARTICLES

ELSI KATAINEN

Reducing emissions in the maritime sector will bring challenges and opportunities for Finland

Expert article • 3092

Finland's northern location, the Russian border and 1100 kilometers of shoreline on the Baltic Sea make us, in practice, an island nation within the European Union. Functioning maritime transport is vital for Finland's economy and competitiveness, since 90 % of our exports and 80 % of imports are transported by sea. At the same time, currently around 98% of the fuels used in vessels are fossil fuels, which underscores the necessity of a green transformation in the sector.

The EU's Fit for 55 -legislative package includes 12 ambitious proposals to reduce emissions to reach climate neutrality in 2050. Many of these proposals affect the maritime sector, the most impactful being the expansion of the EU Emission Trading Scheme (ETS), the FuelEU Maritime proposal and the Alternative Fuel Infrastructure Regulation (AFIR). The ETS aims to steer the sector toward a low-carbon path by putting a price on carbon, whereas the FuelEU Maritime seeks to increase the demand for alternative fuels and decrease emissions by 75% by 2050. AFIR's objective is to ensure adequate infrastructure for alternative fuels. All of these legislations intertwine and therefore it is of utmost importance to have a holistic approach ensuring that their objectives align. An impact assessment of the cumulative impacts on the maritime sector is necessary to understand the overall consequences.

The upcoming policy shift includes both challenges and opportunities for export-driven Finland. As the negotiator of Renew Europe group in the Committee on Transport and Tourism, my priority is to create a stable legal framework for companies to operate in as well as a future-proof legislation, which will encourage investments and innovations in the energy and infrastructure sectors. It is crucial to safeguard Europe's global competitiveness and key position in global trade to avoid carbon leakage. To facilitate this, technological neutrality should be ensured in both FuelEU Maritime proposal and AFIR. Furthermore, to unlock the full potential of the biofuel sector, the raw material feedstock base should be broad enough to ensure a sufficient supply of biofuels to meet the increasing demand created by the FuelEU Maritime proposal. When considering the obligations for vessels to use shore-side electricity while at berth, the legislation should ensure infrastructure compatibility between vessels and ports as well as adequate grid capacity.

Maritime shipping is a highly competitive sector and the green energy transition will pose some challenges and raise costs at least in the short run. It must be ensured that the maritime sector in the remote northern parts of Europe maintain their competitiveness at both EU and global levels. It has been estimated that in Finland, the FuelEU Maritime proposal would increase the cost of maritime transport sector around 100-300 million and the ETS extension around 210 million euros, which is alarming. Moreover, the remote location, harsh winters and arctic conditions of, for example Finland, Sweden and Estonia, pose extra challenges not felt in other parts of the EU. Vessels must navigate through ice many months of the year, which increases fuel consumption anywhere from 20% to 60%. The vessels must be ice-strengthened for safety reasons and these structures will inevitably make them heavier than other vessels. This will also increase fuel consumption not only when sailing through ice but also on the open seas all year long. If ice navigation is not properly taken into account, extending the ETS to shipping can create a considerable competitive disadvantages and will pose barriers to the functioning of the single market.

Due to its huge transport capacity, maritime transport is the least emitting mode of transport per product, even though total emissions are high. There is a danger that rising costs will shift transport from the seas to the roads, leading to an increase in transport emissions. This should be avoided by creating a balanced and coherent legislative package to ensure cost-effective greenhouse gas emission reductions from the maritime sector without hurting its competitiveness. On the other hand, this transition will also create opportunities for Finland, as we are a pioneer in the production of sustainable biofuels and renewable hydrogen. Demand for these will rise sharply with the FuelEU Maritime regulation as the target level for emission reductions gradually increases. This can also bring about new jobs in the field of renewable fuels and pave the way for a global energy transition towards a sustainable world for next generations. The ambitious target set in the Green Deal needs reasonable steps done together with stakeholders and industry. New innovations need to be at the centre of the transition while no one should be left behind. That is the way EU should reach the world's most aspiring climate targets. ■

ELSI KATAINEN
Member of European Parliament (the Centre Party of Finland, Renew Europe)
Renew Europe's negotiator of FuelEU Maritime regulation in the Committee on Transport and Tourism

THOMAS L. BREWER

The Baltic Maritime Emission Control Area (ECA) - Precedent for a Mediterranean ECA?

Expert article • 3093

The Baltic Sea's maritime Emission Control Area (ECA) was the world's first regional agreement to establish limits on international shipping emissions below those set globally by the International Maritime Organization (IMO). The Baltic ECA was agreed by the nine Baltic governments in 1997 and entered into force in 2005; it sets lower limits on sulfur oxide (SOx) and nitrous oxide (NOx) emissions by ships while in the Baltic Sea, as compared with the global limits of the IMO. The Baltic limits on the two emissions are similar to those of the other three ECAs – namely North Sea/English Channel, North America (Atlantic and Pacific coasts) and US-Caribbean Territories.

In recent years, the Baltic ECA and other ECAs have received increased attention within Europe because of the possibility of establishing a Mediterranean ECA of nearly all of the coastal countries, with ports in southern Europe, northern Africa and the eastern Mediterranean. As many as 200 million people in coastal zones – including those in urban areas near major ports - are thus exposed to SOx, NOx and other emissions from tankers, container ships and others passing through in East-West routes on their way to ports in northern Europe and from cruise ships in North-South and North-North routes connecting major tourist areas.

The national governments of France, Italy and Spain have endorsed the creation of a 'Med ECA,' and the European Commission has sponsored research on the issues posed by the design and establishment of such an ECA. Of the many issues, one is the kinds of emissions that could be covered. As noted above, the Baltic ECA covers both SOx and NOx – as does the North Sea/English Channel ECA – though the other two ECAs do not. There are significant differences between SOx and NOx emissions, but there are cost-effective advantages of reducing both.

Another issue about the kinds of emissions that are covered concerns black carbon (BC). The Baltic ECA does not include BC, though it is technically included in the North American ECA. BC is an extremely potent climate change forcing agent; its Global Warming Potential compared with carbon dioxide is on the order of thousands of times greater per tonne at 20 years and hundreds of times greater at 100 years. In its totality, BC is thus one of the three principal contributors to global warming, along with carbon dioxide and methane. BC is also a major contributor to global public health problems. Because of its small size compared with other air pollutants, it can penetrate human lungs and cause lung cancer and other pulmonary diseases, including asthma, as well as cardiovascular disease. Although BC poses different regulatory issues because it is particulate matter, not a gas, there are widely used technological means to limit emissions of them.

Yet another issue is about enforcement of regulations once they are in effect. Members of the Baltic ECA have developed and deployed several monitoring systems, which can measure ships´ emissions from land-based equipment near ports, from other systems attached to bridges that ships entering and leaving the Baltic Sea must pass under, and from airborne systems carried by drones that can fly through ships´ emission plumes. Technological monitoring systems are thus available to prove factual records of individual ships' compliance or non-compliance with the emission limits.

The situation concerning enforcement processes is more complex. Enforcement mechanisms applied to ships in the ECAs – as well as those outside the ECAs but still covered by IMO limits - are established in the context of a system of Memorandums of Understanding (MOUs) signed by 145 national governments and territories. Altogether, the MOUs cover tens of thousands of ships that enter hundreds of ports each year. The Baltic ECA ports are included among the ports in the Paris MOU, which includes the ports of most European countries.

In short, the Baltic ECA provides a potentially useful precedent for the establishment of a Med ECA, which would significantly reduce ships' emissions in heavily populated coastal regions. Although the Baltic and other ECAs are not yet comprehensive in their coverage of the types of emissions or comprehensive in their enforcement procedures, they can serve as useful precedents for the design, creation and operation of a Med ECA. ■

THOMAS L. BREWER
Emeritus Faculty
Georgetown University
USA

SAVITRI JETOO

OECD governance indicators for a resilient Baltic Sea Action Plan 2021

Expert article • 3094

The word 'resilient' has been at the forefront of the recently concluded COP26 negotiations and has been widely used in environmental conservation as a means of adapting to stressors, crisis, disasters and more widely, the impacts of climate change. It is also a word used frequency by the Baltic Sea Marine Environmental Protection Commission (HELCOM) in its recently released and updated Baltic Sea Action Plan 2021. This update comes with the goals of a Baltic Sea unaffected by eutrophication, hazardous substances and litter and supporting environmentally sustainable sea-based activities, which will all lead to a healthy and resilient Baltic Sea. What does the word resilient mean in relation to the Baltic Sea? This does not refer to the traditional engineering resilience that sees a system rebounding to its original state after withstanding the maximum disturbance. This is indeed useful in the design of suspension bridges that links the archipelago in the Baltic Sea, flexing with the disturbance of high winds and returning to their original shape without breaking. A resilient Baltic Sea is more referring to the concept of ecological resilience, where the system bounces forward under stressors whilst retaining its core function and purpose. As defined in the Baltic Sea Action Plan update 2021, 'a healthy and resilient ecosystem is one which can maintain its species and communities over time, despite external stress'. This is consistent with the original definition coined by Holling in 1973, with resilience being a measure of the ability of the system to persist after disturbances and still maintain the same relationships between populations. Inherent in this definition is the idea that a resilient system may adapt and be different due to stressors but core relationships should persist.

This concept holds widespread appeal as it addresses the concern that Baltic Sea governance is challenged by entrenched policy regimes and rules that are not flexible to change and adaptive to new stressors. In order to bridge the shortcomings of the previous Baltic Sea Action Plan, the architects of the updated plan have positioned resilience and adaptive management as a way to achieve the overarching goal of good environmental status. As a solution, adaptive governance calls for regimes that stimulate learning in the face of uncertainty and complexity, and that engage and connect stakeholders in a coordinated and flexible manger. Alongside this discussion of more adaptive governance, international organizations such as the World Bank and the Organization for Economic Cooperation and Development (OECD) have called for diagnostic tools such as 'governance indicators' that can assess the presence of attributes of adaptive water governance. The OECD have consulted water governance experts, stakeholders and water practitioners to develop twelve principles focused on the three dimensions of effectiveness, efficiency and trust and engagement in water governance. The effectiveness driver relates to the contribution of governance to define, implement and meet set goals and includes the principles of capacity, policy coherence, appropriate scales and clear roles and responsibility. The efficiency driver looks at governance that maximizes the benefits of sustainability with the least cost and includes the principles of data and information, financing, regulatory frameworks and innovative governance. The trust and engagement driver examines the contribution of governance to building public confidence through the inclusion of stakeholders and include principles of monitoring and evaluation, tradeoffs, stakeholder engagement and integrity and transparency. These principles represent key policy issues highlighted in the academic literature as underpinning the governance of transboundary water systems. The OECD developed three indicators for each of these twelve principles to assist in their implementation. These indicators are based on voluntary self-assessment and stakeholder dialogue in order to assess how water governance systems are performing at a given moment in time.

This OECD water governance indicators can be a useful tool for the implementation of the Baltic Sea Action Plan 2021. Governance indicators can be seen as aggregation of variables that describe the system or process in such a way that it has more significance than the face value of its components. In the Baltic Sea context, governance indicators are not outcome indicators, as these focus on monitoring the state of the Baltic Sea. They can be useful in the implementation of the Baltic Sea Action Plan 2021 as they can provide knowledge on the transboundary capacity to support the aims and objectives for the Baltic Sea ecosystem. They can be used as tools for continuous diagnosis, reflection and improvement, as they provide a way of isolating and assessing specific aspects of governance. The scholarly literature on the Baltic Sea governance has agreed that there is a highly developed multilevel governance framework but that stakeholder engagement is a key weakness. As an illustrative example, the OECD governance principle 10, promote stakeholder engagement for informed and outcome oriented contributions to water policy design and implementation is measured by three indicators. These are. i. the presence of transboundary legal frameworks to engage stakeholders, ii. Structures to engage stakeholders and iii. Mechanisms to diagnose/ review stakeholder engagement. These assessments can be done by twinning countries, where they take turns at assessing the other and then discussing the results in an open and transparent manner. They can bring more objectivity to the self reporting of progress under the BSAP 2021. These indicators can shed light on e.g. the engagement of farmers in nutrient abatement measures in each case and then comparatively, at one point in time and then at another later time. They can be a valuable point of departure for generating policy dialogue and for diagnosis and assessment of the current state of stakeholder engagement and adaptive governance in the Baltic Sea Region. There is need for more research to be done on the use of these indicators in transboundary regime. This does not reduce the overall value of the governance indicators as a tool to motivate transparency, openness and forward looking dialogue across countries and with stakeholders on best practices and governance gaps. These indicators can be

useful in the Baltic Sea region to trigger BSAP 2021 implementation actions which can bridge Baltic Sea governance gaps for a more resilient ecosystem. More empirical studies are needed on how they can be most effectively applied, but these studies can be done through partnerships with scholars and practitioners which the OECD governance indictors framework support. ■

SAVITRI JETOO
PhD, Adjunct Professor
Åbo Akademi University
Turku, Finland

LENA NERHAGEN

A tale of an island – on changing circumstances and the need for adaptive governance

Expert article • 3095

There is one place in the Baltic Sea that is very special to me. It is the island of Tjärö on the coast of Blekinge. 50 years ago, I spent the best summer ever in my childhood there. That summer my mother was the manager of this island tourism lodge. For me and my siblings, it was a summer of lazy days in the sun, mostly spent on "our" cliff where we would dive into the sea and see fish swimming in front of a steep slope covered in rockweed. Rowing boats were the means to get out onto the sea. It was a very quiet place compared to what it is today. One reason for this was the military presence in Blekinge which prevented foreigners from visiting this coast and it islands. This ban lasted until 1997.

Since it is a special place, in 1976 Tjärö was declared a nature reserve. In the summer of 1983, I came back to work, and did so for two summers. There are many memorable encounters from these stays; cows having slipped out of pastures during the night, a badger being trapped in one of the old houses, the captain who had a designated place in the dining room and the fisherman who came to sell a pike almost as long as he himself was tall. More importantly however was getting to know a sailor instructor, Joakim, that was to become associate professor in meteorology and researcher at the Swedish Meteorological and Hydrological Institute. Little did we know then that we were going meet again and work together.

At this point in time, we were not involved in any discussions about problems with algal bloom. It was only in 1980 that the foundation of HELCOM, the Convention on the Protection of the Marine Environment of the Baltic Sea Area, had entered into force. In Sweden, the problem with algal bloom was addressed several years later in the government bill 1988/89:10. According to the 1989 yearbook of the Swedish Society for Nature Conservation, the main polluting sectors to the seas were agriculture and traffic. The latter since the nitrogen emissions from the burning of fossil fuels contribute to the eutrophication. Despite this, looking back I can conclude that the focus in this international work has been on reducing the impact of land-based water borne sources. An example is the list of significant pollution sites around the Baltic Sea established in 1992 – HELCOM Hot Spots. Today 25% of the sites remain on the list.

Over time, shipping has increased and is now said to be: "among the largest sources of airborne NOx ending up in the Baltic Sea, e.g. more important than the combined airborne NOx load from on-land sources in Sweden". This is an interesting statement since it actually says nothing about if air pollution from shipping is or isn't an important environmental problem. For many years, after having met Joakim Langner again at a conference, I have had the possibility to do multidisciplinary research with SMHI. The lessons I have learnt is the complexity in modelling air pollution and the importance of assessing the influence from many different sources over larger geographical areas. In one recent study, we estimated the impact of Swedish shipping in the Baltic Sea (Nerhagen, 2016; SMHI, 2016). We compared its impact with that from other emission sources and concluded that emissions from shipping only make a marginal contribution to the total deposition in the area. This conclusion is supported by the results in a study by Geels et al. (2021). Of an estimated total of 9900 premature deaths in 2015 in the Nordic countries, about 850 can be attributed to shipping. Another finding in our study was that, as expected, there is an important geographical variation in the impact from shipping. Since we did not include leisure boating, a potential problem locally due to the emissions being released closer to land, I am pleased to see that this issue has been addressed in more recent research.

Another lesson I have learnt from my work on air pollution is that it can be difficult to influence policy. For me, the tale of this island is the need to develop adaptive governance that accounts for geographical differences and changes over time in complex socio-ecological system. Having followed the development on and around Tjärö for 50 years, it is clear that circumstances change in important ways. Geo-political developments, emissions from distant sources and changes in ownership of the island have all influenced the conditions for its development as a tourism destination. Maybe now the tourism development itself is a cause for concern. I noticed, when returning in 2019 after 35 years, that the island is now a popular destination for leisure boats from near and far. With the Blekinge Archipelago having been designated an UNESCO Biosphere Reserve in 2011, this might be one of the conflicts that needs to be addressed in the future. To solve conflicts, I believe there must be a common understanding of what the problems are. Hopefully, this coast now being a biosphere reserve can contribute to a planning process where researchers and policymakers work together in closer cooperation also involving other concerned parties. ■

LENA NERHAGEN
PhD in Economics, Researcher and Senior Lecturer
Högskolan Dalarna
Sweden

SAKARI KUIKKA

Use of ecosystem models in marine governance

Expert article • 3096

Barcelona held, during Novemeber 2010, the MARIFISH-ICES Joint Workshop on Integrated Ecosystem Modelling with the aim of building capacity to understand and manage marine ecosystems in a changing world. A good representation of ecosystem models aimed at simulating an end-to-end representation of the ecosystem was shown at the workshop. Slide by slide, these presentations summarized years of intelligent thoughts by some of the brightest minds in the field of marine ecosystem research.

In a workshop structure that was unusual, the organizers also gave the floor to the clients of this work, those who pay the research for its development. The European Commission is a big actor for this role in Europe through funds provided by DG Research, including the E4 Unit in charge of fishing and aquaculture. An officer from this unit offered a more pessimistic view. In fact, the analysis by Philippe Moguedet was rather devastating. His sharp criticism was not on the internal structure or the logic of the models but on the fact that he could not identify who was implementing these tools for the managing porpoises that justified their creation.

To cut the head of the messenger is an option since Tigranes war against Rome and the words of the officer, despite being valid in the scientific arena by its internal consistency based on facts, was followed by a vivid reaction of the room. The discussion evidenced that part of the failure was coming from the final-user side and their (lack of) willingness to incorporate innovative concepts in their decision-taking process. It is also unbalanced to expect from marine-ecosystem modeling more capabilities than it is presently requested to other areas of research not dealing with the complexities of living being. Meteorology was mentioned as an instance where huge model-implementation and data-gathering programs only allow a prediction time of the order of days. Marine-ecosystem models cannot count on these massive investments to better constraint their outputs. However, it was also obvious that many of the models developed ad hoc to manage resources under the ecosystem approach had problems to perform that function.

An interesting set of debates cascaded in the following days of the workshop from this, rather chocking, initial picture. Without denying its limitations, part of the workshop members advocated for the understanding that can be gained by knitting the details of ecosystem functioning into mathematical complex structures. Without denying its heuristic value, a smaller portion of the participants was more sensitive to the perils this design involves for managing purposes. Dr. Moguedet's words were seen as evidence of their inherent potential to be used for transmitting a too optimistic view of science and its capacity to predict precisely the outcomes of management actions on ecosystems. Although both positions were by no mean exclusivist the emphasis in either view was present along the intensive exchanges held during these days.

A very first and basic question to consider is what was wrong? Why an officer from the European Commission with an unquestionable experience in managing programs of fishery research has reached to the conclusion that tools developed so far to implement the ecosystem approach might be nice to the scientist eye but useless to the rest of the society.

Some context may help to analyze this unreasonable divorce. Stock collapses along the 20th century evidenced that statistics alone are not a reliable tool to provide scientific support for the management of living resources. The first collapse of a fish stock cannot be predicted by modeling its statistical behavior in the past.

At the present state of this heuristic path, the structure of these models can accommodate the variables needed to apply the ecosystem approach for the management of marine resources. The models use spotless mathematics to construct the equations that simulate these variables and the interaction among them. These equations demand a large number of variables but these are incorporated in a fashion coherent with the existing knowledge of ecosystem functioning, a knowledge that still needs development but certainly is not small.

Therefore, it seems that we have models able to focus the problem and to focus it with a firm basis constructed over decades of scientific thought. Being this the case, why these tools that look solid are not widespread used for knowledge-based decision-making? A non-negligible part of this lack of transfer comes from the honest position of the model developers and the limitations they perceive in their own tools. Projecting a wrong diagnose or prognose in the taking of decisions may have societal consequences beyond those of hypothesis fencing in scientific journals. This is a challenging arena when the dynamics of the conceptual representation under operation by models is perceived only as an approximation to the real ecosystem functioning. In words of the famous modeler George E. P. Box: "…all models are approximations. Essentially, all models are wrong,… ; the practical question is how wrong do they have to be to not be useful"

Alternatives exist to avoid projecting the ecosystems over a mechanical-universe determinism where they hardly fit. The modern implementation of the Bayesian approach is able to cartography over mathematical structures not only our knowledge but also our uncertainties on ecological processes. In doing so, they do not produce point but probabilistic estimates to compute uncertainty and risk that are crucial to decision making. They offer us a consistent frame to describe the uncertainties of our diagnoses and prognoses given the available data and hypotheses, a strategy considered as superior both to model nature and to represent the uncertainties associated to this modeling. These techniques can also consistently compute not only parametric but structural uncertainty by analyzing together several alternative theories (causal structures) to describe the natural phenomena. This is a major advantage to model mid and high trophic levels where data can be used to learn about the several hypotheses that scientific literature proposes to describe their dynamics. ■

SAKARI KUIKKA
Professor
FEM –group, Environmental Change and Global Sustainability -research program,
University of Helsinki Finland

sakari.kuikka@helsinki.fi

LAURA UUSITALO

Marine monitoring in transition

Expert article • 3097

Human activities both on land and at sea affect the marine ecosystems and drive them towards new states and configurations. Land use changes affect the release of nutrients and other substances to the seas. Climate change alters the temperature, seawater stratification, and rain patterns. Coastal developments change habitats, and introductions of new species on one hand and the exploitation of established species on the other hand change the interactions between species.

Marine environments support human societies by offering a multitude of ecosystem services from climate control and carbon sequestration to food provision and recreational, cultural, and spiritual values. The provision of these services depends on the biodiversity and the state of the marine environment. Therefore, societies have established legislation to ensure the protection and restoration of the marine environment, such as the Clean Water Act and Oceans Policy in the USA, the Oceans Acts of Canada and Australia, and the Water Framework Directive, the Marine Strategy Framework Directive, and the Biodiversity Strategy for 2030 of the European Union.

Effective protection and restoration of the seas require an understanding of the status and development trends of the ecosystem, which in turn requires monitoring. While the economic benefits of monitoring are hard to see directly, leading to attempts to save monitoring expenses, research has shown that monitoring costs are a minimal part of the management and that sufficient monitoring can help direct the use of resources in the most efficient way. Good information on the status of the environment will help focus the restoration measures where they are needed, and therefore help improve the status of the seas cost-efficiently and safeguard or restore the provision of the ecosystem services. Further, information gained from monitoring is needed to make informed decisions about permitting new activities on the coast and sea, and to create models of the marine environment that can be used for future projections and scenario evaluations.

Marine monitoring is in transition. Increased pressures threatening to change the marine ecosystems, together with the recognition of the human dependency on them, have created a need for more monitoring data both in terms of spatial and temporal coverage and for aspects of the ecosystem that have not been monitored before, such as contaminants, microplastics, food web functioning, and many aspects of biodiversity. Modern monitoring methods such as satellite imagery, automated monitoring stations, stable isotope and eDNA techniques, biomonitoring, and underwater imaging, together with machine learning and other new data analysis methods, offer the means to acquire and handle these data. Old monitoring methods can be complemented with and even replaced by these new methodologies to gather a wealth of data that can help us manage and protect the seas. Yet, dismantling the old, more traditional monitoring systems needs to be approached with caution. In the Baltic Sea, the international monitoring has been coordinated by the Baltic Marine Environment Protection Commission (HELCOM) since 1979, while some time series go back much further. Long, uninterrupted time series are priceless in helping to understand the changes of the ecosystem, a critical issue under the current, global changes.

The monitoring transition needs to be managed carefully. To be as useful as possible, monitoring data need to be comparable across time and geographical areas, meaning that the methods need to be standardized between different actors such as nations performing the monitoring in their parts of the sea. International coordination is needed to agree the new monitoring protocols to guarantee their comparability. Further, if the modern method aims to eventually replace an old monitoring method, there needs to be a thorough and proper, multi-year research programme to establish the correspondence and possible differences between the old and new results, so that the continuity of the time series will not be hampered by the change. This being taken care of, the technological improvements in monitoring and data analysis offer an unprecedented opportunity to increase our understanding about the marine ecosystems and their changes, and to ensure the well-being of both the seas and the human societies around them. ■

LAURA UUSITALO
PhD, Leading Researcher
Finnish Environment Institute
Finland

ANDERS BERG & JOHANNES BETZ

LISA: Linking Sea & Land – A Flagship process

Expert article • 3098

A Flagship process. These processes are operational concepts that take initiative and responsibility for elaborating and implementing measures aiming to the realization of one or two objectives of the Policy Area Transport Action Plan. As ongoing initiatives and projects often overlap, and projects run over several years there is a need to establish networks to increase coordination. Lack of coordination and fragmented approaches run the risk becoming a bottleneck for further development and improvements in efficiency. A more harmonized and coordinated approach would make it possible to offer streamlined services throughout the region, make better use of current project results and give these results a chance to become adopted and scale.

By engaging stakeholders from port related businesses, logistics businesses along the supply chain, administration and policy, LISA aims to create a large partnership around the Baltic Sea Region (BSR). The focus lies within the facilitation of innovative technologies and solutions, digitalization and optimization of port calls linking sea and land and serving the stakeholders as a creative platform for projects, initiatives, and dialogues with other relevant stakeholders. The overall goal is to steer and manoeuvre towards the realization of EUSBSR Policy Area Transport Action Plan and its three actions: to improve connectivity of the region and cooperation with third countries, developing measures towards a climate-neutral and zero pollution transport, and the facilitation of innovative technologies and solutions in the Baltic Sea Region. Through that, LISA will help to help the EUSBSR goals of increased prosperity and affordable, sustainable cross-border connections, and in the long run increased global competitiveness.

LISA focuses on these areas to support the cross-sector harmonization process towards a European Maritime Single Window (e-MSW) and other digitalization processes along the logistics- and supply chain that optimise the port calls and link land and sea. A stakeholder workshop LISA held provided feedback suggesting that the LISA process should focus on digitalisation topics such as: digital port assets, port call standards or maritime informatics more generally, just to name a few. The idea with LISA is to establish a long-term Flagship Process to support these cross-sectoral digitalization efforts in transport and logistics in the BSR. All under the consideration of TEN-T interconnectivity, the Motorway of the Seas Detailed Implementation Plan, and the EUSBSR Transport Action Plan goals. This process will help to facilitate joint initiatives and joint project applications linking land and sea in the BSR, utilising multi-level-governance (MLG) stakeholder networks and through that help uplift EU co-financed project activities beyond their project- and beyond the upcoming multi-annual financial framework lifetime. This will help to increase connectivity and intermodality and thus support a greener and more efficient transport system in the Baltic Sea Region.

There is a fragmentation among the Baltic States as well as in industry and shipping in how digitalization best can be used to assist effective, seamless, and secure transport flow through Baltic ports and the linking of shipping with connecting rail and road transports. This fragmentation can be de-fragmentized with the assistance of suggested Flagship process by contributing with the neutral platform that supports and guides stakeholders, projects and initiatives. To steer stakeholders clear to avoid becoming isolated digitalized islands.

The European Commission also points to the need for coordinated and optimized port calls. Alongside the introduction of e-MSW, other possible efficiency gains need to be carefully examined which favours freight and passenger transport at sea. LISA the Flagship process would function as a network for coordination and discussion of present and future joint endeavours.

The Flagship process is not limited in time and is expected to continue until the specific challenge has been satisfactory solved. The Flagship process should especially be characterized by inclusiveness, flexibility, and endurance. The Flagship's nature of inclusiveness, flexibility and endurance ensures that the Flagship can adapt to policy change, especially since one of its core values is the actual impact on macro-regional policy. The co-funded projects are focusing on aspects that are part of the cooperation programmes, adopted for the relevant multi-annual financial framework.

Processes on the other side, can react to changes in policy focus or developments, outside of the cooperation programmes. Therefore, a more agile response to technological-, environmental-, societal changes can take place. This agility also helps to consider aspects for the Baltic Sea Region and the EUSBSR Action Plan, that may be considered under other EU co-funding programmes such as Horizon Europe or Connecting Europe Facility II. Through that, aspects such as the electronic freight transport information legislation or developments within the EU Green Deal or React-EU can be included into the activities and policy support of Flagship Processes. This in turn will help Baltic to stay at the forefront of being a sustainable, advanced-, and well-developed Baltic Sea Region. ■

ANDERS BERG
Innovation Manager
Swedish Maritime Administration
Sweden

JOHANNES BETZ
Project Manager
Hafen Hamburg
Germany

PÄIVI HAIKKOLA

International regulation for autonomous maritime

Expert article • 3099

Autonomous maritime traffic, or MASS (Maritime Autonomous Surface Ships), as it is also called, has been a popular topic in recent years. Maritime actors hope that adapting these technologies, would enable maritime traffic to decrease their GHG (greenhouse gas) emissions in the future. Both the European Union and IMO (International Maritime Organization) have set ambitious reduction goals, and they cannot be reached by adapting merely one set of tools. IMO has adopted an initial strategy on the reduction of GHG emissions from ships and set a goal to reduce the total annual GHG emissions by at least 50% by 2050. The European Commission intends to achieve climate neutrality in the EU by 2050.

To be able to apply these technologies more widely, however, the use of these technologies needs to be regulated on an international level. There are currently several projects around the world that aim to use autonomous and related technologies in ships, but without international regulation, the vessels can only be approved nationally. Vessels using these technologies, that have been approved by the national authorities, can be held up to different standards and are difficult, if not even impossible to sell internationally. For the ship owners to be ready to invest in these technologies, the international rules and regulations need to be known.

The Maritime Safety Committee (MSC) of IMO did their first foray into Maritime Autonomy already in 1964, where agenda item 11 of their 8th session was Automation in ships. The committee started with the basics, namely a definition of automation *"automation refers to those processes in which machines – often including electronic controls – adjust and control their own performance with little or no human intervention once the operation is started. A distinction is generally made between a fully automated system, a partly automated system and remote control."* (MSC VIII/11, 9 March 1964).

It took a few decades, until in 2017 at MSC 98, when the issue of automation in ships was taken up again. MSC was the first of the IMO main committees to plan to undertake a scoping exercise. The purpose of the exercise was to go through the instruments under the purview of the MSC, to find out where one could expect problems, when going towards increased automation and remote operations. The work they decided to undertake, was indeed massive. MSC had to develop a framework for the regulatory scoping exercise (RSE), that would include among others the objectives, methodology, instruments, and provisional definitions. They also had to agree upon plan on how to do the RSE.

A MASS (Maritime Autonomous Surface Ships) working group was formed at MSC 99 and under the leadership of its chairman, Henrik Thunfors from Sweden, the working group started its work by clarifying what they were about to do. Again, the work started with some definitions that were necessary to complete the work, but it was clearly stated that the definitions were created for the RSE, not for anything else.

When all the preliminary work was done, the working group set out to do the actual work, namely, to go through the IMO instruments that were determined by MSC. Several member states volunteered to go through the instruments. It was impressive how the representatives where able to find the time to go through these individual instruments, despite having to complete their normal jobs at the same time. The IMO Secretariat also had to work overtime preparing the tools for the storing and commenting of RSE results on a short notice. A correspondence group and an intersessional working group were needed, so that the work could be completed on time.

The MSC had the most instruments to go through for their RSE, but other main committees of IMO initiated their RSE: s soon after MSC. The Legal Committee (LEG) and Facilitation Committee (FAL) started their work soon after MSC. LEG finalized their RSE at their 108th meeting in July 2021. FAL also finalized their work in an intersessional working group in October 2021, although it needs to be approved in the next FAL meeting. This leaves only the Marine Environment Protection Committee (MEPC) of the main committees, as not having started their work on MASS regulation. As the MEPC is quite overwhelmed by the work regarding reduction of CO2 emissions, it is possible, that they will not complete an RSE, but rather follow the lead of the other committees in the creation of rules and regulations for MASS.

At MSC 103, which ended 14th May 2021, the regulatory scoping exercise for MSC was finalized, a year later than originally planned, due to the COVID-19 pandemic. The next question was naturally, how to go forward? There were four output proposals for MASS at MSC 104 in October 2021. The proposals were merged into one and with the help of that output, MSC will start the regulatory work for MASS at MSC 105 in April 2022. The first step will be to create a roadmap for the regulatory work and in the following committee meetings (and possible intersessional working groups) the actual work on the new regulation will be started.

After the RSE, the suggestion was that the issues should be handled in a holistic manner through the development of a goal-based MASS instrument. A liaison is to be appointed to improve the coordination of the MASS issues between the different IMO committees. As it stands today, it seems that instead of making changes to several regulations regarding MASS, there will probably be a new MASS instrument that will be anchored to major IMO conventions, such as for example SOLAS (Safety of Life at Sea). In the output proposals there were suggestions that the new instruments could be finalized by 2028, but I do not expect to have them ready before 2032.

The original work of the MSC in 1964 did not result in much else than the report, that is surprisingly on point over 50 years later. This time it seems that we will be able to create regulation for the vessels utilizing these technologies. The delegates and IMO personnel, that were responsible for the report in the nineteen-sixties, would probably be both surprised that it has taken us so long to come where we are today and happy at the same time, to see IMO and the maritime community finally tackle these questions. ■

PÄIVI HAIKKOLA
Senior Ecosystem Lead, One Sea – Autonomous Maritime Ecosystem
DIMECC Ltd
Finland

paivi.haikkola@dimecc.com

NANI PAJUNEN & ONA VASSALLO

Carbon-neutral circular economy in the marine sector

Expert article • 3100

The need for systemic change

Humankind is in a transition phase. We are facing huge challenges, such as biodiversity loss and climate change. Our current global economy is based on overusing the natural resources of the planet. Urbanisation, industrialisation, global trade, transportation operations and energy production all have huge impacts in nature worldwide. The sourcing and processing of natural resources is responsible for approximately half of global greenhouse gas emissions and for 90% of biodiversity loss (The International Resource Panel, 2019).

We need to understand that the lifestyles of humankind today are not sustainable. Some parts of this planet are already uninhabitable. Therefore, there is a dire need to make changes in every sector of society as well as in our everyday life. We urgently need to transition from a linear economy towards a circular economy. (Sitra, 2016; European Commission, 2020) In this article, our approach to the sustainability crises is the perspective of marine nature and marine industry, global trade and maritime transport.

Why the perspective of marine nature is important?

Oceans regulate our climate by absorbing a quarter of all the carbon pumped into the atmosphere. Over 90% of the additional heat caused by global heating is stored in the Oceans. Conserving, protecting and restoring marine nature directly help the oceans' ecosystems. The pressure on marine ecosystems and the resources they provide is increasing as biodiversity is threatened. Healthy marine ecosystems are important for society since they provide services including food security, feed for livestock, raw materials for medicines, building materials from coral rock and sand, and natural defence against hazards such as coastal erosion and inundation.

Significant proportion of the world's population depends on the oceans and coasts for survival and well-being. The Food and Agriculture Organization (FAO, 2016) predicts that the global Sustainable Development Goals (SDG) will have a strong influence on aquaculture sector, as more and more fish, shellfish, algae and other organisms are being cultivated and harvested in water environments. According to FAO, fish alone provide 20% of animal protein to about 3 billion people.

Biggest threats to marine nature: pollution, waste plastics, tourism, fossil fuels and fishing

Pollution, waste plastics, tourism, oil and gas exploitation and fishing, especially bottom trawl fisheries are probably the best-known threats to marine nature. However, all our actions, such as mining and extraction; coastal infrastructure and construction on the coast; offshore wind farms; eutrophication based on agriculture; and shipping have huge environmental impacts. The consequences of climate heating effect the oceans, as well. Storms, not so common weather phenomenon and climate patterns (e.g. El Niño), the spreading of new species, diseases and overharvesting of invertebrates all present risks for nature and humanity. Researchers also raise attention to the threat underwater noise poses to mammals. Not so well-known risks also come from abandoned ships and uncontrolled large-scale ship-dismantling activities. (Korpinen et al., 2021)

The "Merikartta" ecosystem

International trade is still largely based on transport by sea: according to estimates, about 90% of world trade travels by sea. The marine sector is also a large employer in the EU, providing jobs to more than five million people. In Finland, we have a long tradition in shipbuilding and shipping. Finnish maritime expertise is strong, supported by research and construction of ships to shipping operations. Therefore, we believe the Finnish marine sector can be part of the solution, not the problem.

A year ago, we launched the "Merikartta" ecosystem, starting from an online workshop with nearly one hundred marine professionals. The aim is to build a collaborative network that will help the marine sector move towards a carbon-neutral circular economy, while addressing the challenges of both climate heating and biodiversity loss. Results, know-how and technological solutions of earlier projects are gathered for everyone's use, and novel ideas, actions and organisations are welcome. The ecosystem follows a multidisciplinary and collaborative working method.

The next nautical miles

We need a common understanding of the value of nature. However, this is not enough. Without real actions, from strategy level to the operational level, the marine nature will continuously deteriorate. Our prosperity and welfare are based on global industrial value nets. The single most important driver for the transition from a linear economy towards a carbon neutral circular economy is that it makes economic sense. (Pajunen, 2015) Therefore, we strongly believe business can be a global tool for the necessary change towards a more sustainable future, in the marine sector as well.

The adoption of circular economy business practices and solutions will open a wide range of opportunities for companies in the industrial marine sector, via product design, improving material efficiency, energy solutions or selling products as a service. And the best incentive is this: promoting circular economy business tends to improve the company´s financial performance, as well. ■

NANI PAJUNEN
Leading Specialist (D.Sc.)
The Finnish Innovation Fund Sitra
Finland

nani.pajunen@sitra.fi

ONA VASSALLO
Research Assistant
Turku University of Applied Sciences
Finland

EEMIL RAUMA

Can circular economy of mobility help Baltic Sea region countries achieve their CO2-reduction targets?

Expert article • 3101

Transport sector is responsible for around 20 % of Baltic Sea region CO2-emissions1 and is one of the largest final energy consumption sectors. Transport sector is also one of the most important sectors affecting Baltic Sea regions economic development. Prices of vehicles and gas play large role in household consumption and heavily effect regional economy, as Germany and Sweden are traditional automotive powerhouses and Finland is rising as such due to electric mobility revolution. In short sector`s role in achieving the ambitious climate goals of Paris agreement while at the same time ensuring social and economic welfare is fundamental.

At the 26th UN Climate Change Conference automotive sector announced various electrification and zero-emission targets stating that the last internal combustion engine (ICE) vehicles are to be sold between 2035-2040. Electric vehicles reduce vehicle life-time emissions between 30 and 80 % in the Baltic Sea region countries2 so these news sound good.

However, many residents of Baltic Sea region economies do not afford electric vehicles by 2030 even though their prices are expected to be lower than equal ICE-vehicles then3. How can we then enable socially and environmentally just transition for the citizens?

One answer is circular economy, that can be described as following:

A) Economic model meaning a simplified version of reality that allows us to observe, understand, and make predictions about economic behavior

B) Which does not focus on producing more and more goods, but in which consumption is based on using services

C) Sharing, renting and recycling – instead of owning

D) Materials are not destroyed in the end, but are used to make new products over and over again

Above noted principles of circular economy can also be applied to transport sector in which they have fundamental effects on how societies prepare to reduce transport sector CO2-emissions while simultaneously providing just transport service level for all.

Figure 1: By applying principles of circular economy to transport sector, we receive holistic model describing, how circular economy principles change mobility.

Circular economy is foremost about changing ineffective and wasteful business models towards sustainable ones, that enable green mobility for all. Great example is making better usage of vehicles through services. On approximate privately owned cars are used only 4-5 % of their time while rest of the time they sit idle, but with mobility services, such as car sharing, usage rate of vehicles can be increased substantially while at the same time replacing several private cars. Based on Finnish study published by Ministry of Transport and Communications in 2021, diverse transport services could decrease greenhouse gas emissions in Finland by 260,000–300,000t by 2030. This alone is more than 15% of the required additional CO2-emission reductions from transport sector that Finland is facing. All while simultaneously saving space in cities, freeing capital from privately owned vehicles to other more lucrative and environmentally sustainable investments, reducing transport poverty, supporting local businesses4 instead of foreign OEM`s and employing residents.

What is needed then from societies in order to move towards circular economy of mobility? Most important way is to support services. Services are a must in order to effectively reduce emissions while simultaneously securing mobility needs of consumers at an adequate price. Mobility services ranging from e-scooters to MaaS applications to shared vehicles are all based on constant iteration and optimization, which is not the case with private owned vehicles. For example, micromobility company TIER managed to reduce their life-cycle CO2 emission per km by scooter type by more than 60% in just three years5. All thanks to data that can be gathered from services, that are all based on intelligent platforms that constantly develop. Service support can come in many ways from taxation to positive (de) regulation to procurement methods and everything between.

Moving towards circular economy in mobility is a long journey, that will take years. But we owe it to future generations. ■

EEMIL RAUMA
Chief Impact Officer (CIO)
ITS Finland ry
Finland

VESA MARTTINEN

Data and circular economies in European short seas

Expert article • 3102

Traditionally maritime economics has four markets. Operations as “eye on the cash flow” shipping activity, while the earnings have been made with correct timing of the asset sale. To create these assets the new building market must yield, and to balance supply/demand the demolition market is the volatile drain. About ten years data market was introduced and some few years ago we started to talk about circular economy as well. Both are justified, having a growth role in maritime. Data market is on one side about optimizing the activity with increased customer satisfaction and sales with e-commerce, social media channels, artificial intelligence supported purchasing behavior analysis etc. More often it is the others part of equation e.g. cost and risk management with optimized operation to decrease operational expenses, smarted designs to speed-up the time to market and reduce financial cost, automated production to cut the capital expenditures and mitigation of business risks with use of machine learning to support decision making.

Circular economy is a way to turn inefficiencies of linear value chain into business value. These should be seen further from traditional waste, and more as underutilization of assets, short lifecycles, questionable materials, amortized end-of-life value, and underutilized market opportunities. In other industries the circular supply chain is already operating. Sharing of cargo space is daily business for intermodal cargo vessels while expansion into cargo units them self and to break bulk market remains. Lifetime extension with converting the assets is underestimated opportunity and recovery of ship systems is also limited. The “as a service” business model has been tested in some countries, so framework so that is already existing.

Above mentioned are seen in basic level at “perfect market” of global deep-sea shipping, where demand is often in hands of American consumers, supply comes from Chinese yards, technology has European roots and scrapping takes place in South-Asia. In European short sea business we have opportunity to lift maritime among lead industries of data and circular economies thanks to high education level, cost pressure, development ecosystem and responsible societies. This corner of the world is the heart of maritime innovation. The local operation can and should take advantage of these new market opportunities. Thus, following the markets in maritime economics in a matrix with data and circular economies. To dive deeper following is few examples of these opportunities.

	DATA MARKET	CIRCULAR ECONOMY
OPERATIONS	cargo tracking, energy analysis, safety predictions	door-to-door logistics, shared cargo space
CHARTER, S&P	alternative mission-based valuation	lifetime extensions, mission renewal, ship as a service
NEW BUILDING	fleet design, door-to-door optimized	use of circulated materials and equipment’s
DEMOLITION	material and equipment traceability	responsible circulation to users

Moving into data and circularity driven business, we have to appreciate the dynamics and interaction between traditional markets, but at the same time, especially in the European short sea operation, the new approach will be more independent, and disruption happens across old markets. Intermodal cargo operation is a classic example of door-to-door optimized logistics where ecosystem of trucks, ports and ships has learned to operate smoothly. This means that less material and energy is used to accomplish the transportation in the right time. Here the individual cargo units can be tracked for their location, temperature, humidity, and other business critical data. Having said that the fast-moving goods generate higher amount of GHG emissions as the time and predictability is of essence and transportation “gears” are loaded with-in each other causing low load factor for the volume in use. What need to be emphasized is the vital role of maritime ecosystem, with ship owners, ship operators, port authorities, port operators, shippers/cargo owners, agents, authorities, infrastructure services etc. all heading for mutual target. If these same goods would be transported without modular thinking, the material used to accomplish the same transport work would be significantly higher, more empty return voyages with unnecessary use of energy would be seen and form that point of view also the GHG emissions are not saved. Having a shared situational awareness including insight of carried goods and assets is the tool for ecosystem to operate on most responsible way.

Chartering, Sale & Purchase and also conversion market as part of it, finds new opportunities in data and circular economy by valuating exiting assets for alternative mission. With shared capability understanding of existing maritime assets in the market, the time to value creation for new businesses will be very short. Also, the extension of lifetime for underutilized fleet is a valid alterative to save resources into something more valuable. Change of business model from current owner & operator (both by same entity) or owner vs. charterer into “vessel as a service” is not too big of a leap and would bring actors from different maritime markets closer to each other. Here for example a yard and finance institute together with a ship manager can bring vessel for the end-user with less burden. At the same time the public-private collaboration could find new innovative ways of working.

New Building market in Europe has lost its global position from 80% to 5% market share during one generation. The remaining business is knowledge based naval architecture, equipment engineering and operational excellence. There are also some high operational value

ship types like yachts and cruise ships, where the value is created by multiple companies with concurrent approach and the entry to this business requires value network with thrust and it takes many decades to create it. Also, much of the supply to the local infrastructure demand is made by Europeans. In a responsible society, we should see that maritime fleet of the future has smart sustainable solutions and use circulated materials. Total environmental and societal impact should therefore be a part of every new project, especially if the public sector is involved directly as buyer, with support to operator or with credit guarantees. This way the demolition market would also be directly connected to new buildings. ■

VESA MARTTINEN
CEO and Partner
Yepzon
Finland

VALERIE DE LIEDEKERKE

Can the Baltic Region harbour a Sustainable Blue Economy?

Expert article • 3103

A healthy Baltic Sea can provide blue natural capital for our economy, our societies, and future generations – yet if financial flows in the region continue to follow current business-as-usual pathways, the Baltic Blue Economy (BBE) will remain at peril. Recent research, done by WWF and 3Keel, mapping financial flows and their environmental and social impacts on the Baltic Sea region revealed that the BBE is currently some distance from being sustainable where nature can thrive, and resources are available in perpetuity. Governments, industry, and financial actors are in a position to steer future investments towards nature and climate positive outcomes; while guidelines, guardrails, and accountability frameworks relevant to the ocean context are coming on stream and are applicable to support current and future decision-making in the Baltic Sea region. Will they be employed to accelerate the transition to a Sustainable Blue Economy (SBE)?

Significant value at stake

The total turnover of the BBE is approximately €1.17 trillion per year, with an estimated Gross Value Added (GVA) of €263.5 billion – one and a half times the GVA of the entire agricultural sector within the EU. The average annual growth in the BBE, based on Eurostat data from 2016-2018, was estimated at 6.5% and driven largely by increased turnover from non-living resource-related activities. Extraction and renewable energy generation had the highest per-sector growth rates at 10.1% and 8.4%, respectively. Tourism and recreation also saw 7.5% annual growth.

Extraction sector poses a challenge

The extraction sector is the largest of all in terms of turnover, commands the largest share of financial flows and stocks, ranks worst in terms of environmental and social impact, and employs 23% of the entire BBE workforce. While small in terms of total turnover, the fossil fuel sector is of particular concern as it had an average year-on-year growth of 33%. If sustained into future years, such a high growth trend in this sector would prove an obstacle for the transition to a SBE. Furthermore, it highlights the disconnect between national net-zero commitments and fossil fuel plans, calling on an urgent need to align national environment, climate, and finance government agendas.

Renewable sector poised for growth

The rise of renewables in the Baltic as the lead profit generating economic sector is cause for optimism and a potential source of examples for other sectors. The highly intentional coordination of resources and creation of support mechanisms for renewable energy demonstrate that short-term change is possible. The challenges for renewables are reducing or eliminating negative environmental impacts associated with infrastructure placement and noise pollution, and reliance on natural mineral resources. Investment is needed to support innovative, sustainable, and circular flow solutions to address these, as well as effective marine spatial planning and stakeholder engagement processes to ensure development occurs in appropriate areas to avoid known impacts and potential conflicts with other sectors.

Marine circular economy offers potential

The marine circular economy in the Baltic represents a significant opportunity as it is not matched to the value of goods flowing through the current 'take-make-waste' system. Although circular activities can and do take place in many sectors, the only defined economic sector that is dedicated to circular resource use is the 'resource and material recovery' sub-sector. This sub-sector generates approximately €9 billion, a mere 3% of the €286.4 billion generated by all extraction sectors.

Stakeholders have tools to accelerate the transition

Adopting and implementing UNEP FI's SBE Finance Principles can transform the way in which ocean assets are used and managed, ensuring that investment decisions deliver long-term value without having a negative impact on marine ecosystems or on efforts to reduce carbon emissions. The EU Taxonomy can support achieving both EU Environmental and Biodiversity Directives and the HELCOM Baltic Sea Action Plan by establishing a list of environmentally sustainable economic activities via its classification system. It also could play an important role in helping the EU scale up sustainable investment and implement the European Green Deal.

It is critical that public and private finance and investment actors take leadership and redirect finance towards sustainable development pathways that will build environmental, social and economic resilience to secure the needs of present and future generations across the Baltic Sea region. Likewise, strong government leadership is needed now to create the enabling conditions through supporting measures and setting common standards, regulations, carbon pricing and a clear net zero transition roadmap. To avoid a more difficult and costly transition in the future, the time to act is now. ■

VALERIE DE LIEDEKERKE
Baltic Ecoregion Programme Manager & Interim Director
World Wide Fund for Nature
Sweden

Valerie.deLiedekerke@wwf.se

HELI HAAPASAARI

Baltic Sea marine pollution response

Expert article • 3104

At any given moment about 2000 vessels sail in the Baltic Sea and 25% of them have oil or chemical cargo. About 200 ships sail in the territorial waters of Finland every day. Baltic Sea is semi-enclosed brackish-water sea, it is narrow and quite shallow. It has specialised flora and fauna which are vulnerable to pollution incidents. In the northern Baltic Sea the archipelagos are large and shores rocky, we have ice cover annually and in wintertime the daylight hours are very limited. All these environmental conditions have to be taken into account when building the preparedness to respond to marine pollution incidents.

In Finland the backbone of the marine pollution response capacity is a fleet of 12 multipurpose response vessels. These vessels are owned and manned either by the Finnish Border Guard (FBG), Finnish Navy, private companies contracted by FBG or the Government of Åland. In addition, the Regional Rescue Departments have about 150 boats suitable to oil pollution response in the coastal waters. The offshore patrol vessels as well as the patrol boats of the Finnish Border Guard operate in constant readiness 24/7 throughout the year.

The response vessels need to be supported by aerial surveillance, as thickness of the oil spill can be reliably detected from aircraft and thus the experienced and well trained aircraft crew can guide the response vessels to the thickest parts of the oil slick. The FBG has two aircrafts that are equipped with specialised oil detection equipment. The planes are already over 20 years old and need to be replaced.

In addition to the ships, Finland has significant amount of different response equipment: about 150 kms of open sea and coastal oil boom, skimmers, absorbents etc. The FBG has an ongoing process to setup four regional central response equipment depots. In addition, we will place rapid response containers with 800 metres of inflatable boom with anchoring equipment in the Coast Guard Stations along the Finnish coastline.

The trainings and exercises are important means in building the knowledge and testing the existing procedures as well as the capabilities and restrictions of equipment. A good example of this are the recently developed ChemSAR and HELCOM procedures regarding the response to the hazardous and noxious substances (HNS) incidents. The ChemSAR procedures are tested, trained and evaluated during exercises to enhance the HNS response capability. Also new HELCOM HNS manual guidance will be adapted to the existing procedures. Several national and international oil and HSN response exercises are arranged annually. Finland hosted the HELCOM BALEX 2021 exercise and the exercise was considered to be successful. To make sure that all the Baltic Sea states learn from this exercise, an international evaluation team identified some issues that should be tested in the coming HELCOM exercises.

A clear legislation that defines the roles and responsibilities of different authorities and other actors in marine pollution incident is vital. Legislation should give to response commander enough power to take the necessary measures without undue delays. Legislation should be transferred to plans, practical guidelines and procedures which the different actors follow in their exercises and in real incidents.

Common situational picture which is shared among the different authorities as well as the volunteer organisations is of highest importance as it caters up to date information exchange between different actors – from the Command Centre staff all the way to an individual responder as well as to the assisting actors. Common situational awareness picture builds the basis for correct decisions that are taken at correct timeframe and can also be used to deliver the decisions to the actors on the field.

The cooperation under the HELCOM umbrella

In the Baltic Sea area, the Helsinki Convention is the legal framework for the international cooperation in marine pollution response. HELCOM has decided that mechanical oil recovery is the preferred pollution response method. Use of dispersants should be limited and use of sinking agents is prohibited.

HELCOM Response Manual defines the principles, rules and operational procedures for joint response operations, including pollution reporting system, requesting and providing assistance as well as solving related financial aspects. The competent response authorities of the Baltic Sea states and EU meet annually and develop the cooperation further. In addition, expert working groups share experiences and best practises in aerial surveillance of pollution, on the shore response and oiled wildlife response. In addition, the environmental threat by wrecks and by sunken ammunitions is discussed by an expert group.

Good, well defined and frequently exercised cooperation forms the basis for successful pollution response operations. ■

HELI HAAPASAARI
Pollution Response Expert
Finnish Border Guard HQ
Finland

I. STALMOKAITĖ, F. SAUNDERS, J. JOHANSSON & B. HASSLER

Sustainability transformations – research in the Baltic and beyond

Expert article • 3105

Understanding and promoting sustainability is one of the key concerns across research, policy-making and everyday lifestyle choices. At the same time, there is growing acknowledgement that responding to sustainability challenges such as biodiversity loss, climate justice and decarbonisation, among others, is rife with differences about what sustainability transformation means and implies across different settings, including the Baltic. The multifaceted character of the sustainability conundrum highlights a range of interrelated questions. For example, what repercussions the promotion of local solutions may have for long-term sustainability paths at national, regional and global levels? How to value ethical, political, social and scientific views on which problems to prioritise and whose knowledge counts? In response, universities are increasingly partnering with stakeholders in solution-oriented sustainability research projects. We understand sustainability transformations as fundamental to how societal, institutional, and technological domains interact towards just, legitimate and enduring arrangements. This perspective provides opportunities to reflect on the complexities of societal change towards sustainability, including who should be involved in partnering for change, what constitutes positive change in particular contexts, how change could come about as well as who benefits and who loses. We relate to these questions with illustrations from research projects undertaken in the Baltic and beyond.

Transformation of ocean conflicts for sustainability

A case study on the offshore wind farm planning process in Hiiumaa, Estonia is part of the OCEANS PACT research project which conceives conflicts over the sea space as avenues for social learning and as potential catalysts for sustainability. The study has identified two competing sustainability paths: i) a blue growth pathway aimed at climate change mitigation via the deployment of renewable offshore wind energy, and ii) a blue justice pathway reflecting local community voices speaking for cultural, social and environmental values of sea space (e.g. migratory seabird habitat areas at sea). Although both pathways represent opportunities for sustainable change, one of the challenges to be addressed concerns how to balance different knowledge claims of what is conceived as a positive transformation. While this project aims to open up a space to imagine different sustainability futures, it recognises that existing problem framings are refracted in such futures.

Transformation of forestry

In forested countries, such as Sweden, forests are considered key elements in reducing greenhouse gas emissions and tackling climate change. This has resulted in two competing sustainability pathways: one claiming the supremacy of storing carbon in the forests by significantly reducing timber harvests, and the other – promoting a continued intensive management to substitute fossil-fuel products with products originating from renewable resources. Policymakers and key actors are thus facing several important choices, particularly the challenge to increase carbon sequestration and secure biodiversity and other values in the forest. The project “On the road to a bio-based economy: Governance pathways and policy design for sustainable forest use (GOVFORBIO)” will evaluate effectiveness of current policy strategies as well as elaborate on and recommend changes. Further, in close collaboration with key actors, acceptable changes will be discussed, given present knowledge gaps and uncertainties of outcomes. Thus, the project recognises the need for a broad discussion on the various values that forests bring to society, and how policy conflicts and power are understood in the process of knowledge co-production underpinning change.

Transformation of small-scale fisheries

JUSTMAR Network (Global Marine Governance Network-co-Constructing a Sustainable Fisheries Future) researchers worked closely with small-scale fishers in global North (Poland) and South (Chile, South Africa and Vietnam) settings with a goal to examine transformation strategies and envision (radical) ideal fishing futures. In the Chilean context, this proved challenging as fishers were more concerned to redress immediate problems rather than discuss abstract future imaginaries. This posed ethical challenges, while also illuminating the differing rationales between researchers and practitioners who are more immersed in real world problems. Upon encountering ‘this problem’ an explorative forward-casting approach was adopted, where strategies were identified that sought to address current problems. This approach lacked an idealised vision of a sustainable future yet supported an incremental edging to a future state that the fishers envisaged would be ‘free’ of current (unsustainable) problems. As part of this work, researchers in partnership with the fishers were able to enact strategies such as writing local histories to increase women fishers’ visibility as fishers and explore relations with local social entrepreneurs on ways to add value to local catch.

Transformation through cluster development initiatives

Researchers in cooperation with the funding agencies established Triple Helix (i.e. academia, business firms and government) cluster activities in Tanzania. The research project “Fostering innovation” was initiated to develop a new cluster monitoring program aiming to enhance decent work and economic growth possibilities while contributing to climate change mitigation and poverty alleviation. For example, researchers in partnership with local community devised strategies to facilitate women empowerment through seaweed farming cluster activities. Scientific knowledge on how to expand seaweed farming from shallow to deep-sea waters as well as experiential knowledge on how to add value in seaweed farming proved important for the expansion of farming into product selling (e.g. seaweed soap). In addition, researchers informed local communities that seaweed

can compete with other types of marine vegetation which could in turn affect fish breeding. Therefore, scientists and seaweed farmers developed monitoring tools to count the marine species at sea, as an early warning citizen science initiative.

Insights from these research practices in the Baltic and beyond show that transformation invariably involves a plurality of visions and means for sustainable change accross different contexts. The quest for radical change towards sustainability may pose ethical dilemmas, where the careful consideration of power relations underpinning knowledge claims is essential. Reflective and engaged research partnerships are thus paramount to ensure a pluralistic sustainability transformation agenda is promiment in future research practice. An important avenue for future research not only includes sustainability transfromations in specific contexts, but also deepening the understanding of potential implications at higher levels and in varying contexts.

ACKNOWLEDGEMENTS

The research projects discussed in this article are a part of the broader research theme, “Sustainability challenges and pathways” at the Department of Environment, Development and Sustainability Studies at Södertörn University, Sweden. For this article, the funding support was provided by the internal call for *“Research and writing collaborations for the advancement of the research themes 2021”* at the Department of Environmental studies, Development and Sustainability Studies at Södertörn University, Sweden.

We are especially grateful to Gloria L Gallardo Fernández, Tomas Kjellqvist and Ralph Tafon for sharing insights from their research projects, which are funded by the following funding agencies: Belmont Forum’s Collaborative Research Action on Ocean Sustainability (OCEANS PACT), FORMAS (GOVFORBIO, OCEANS PACT), Swedish Research Council (JUSTMAR), the International Social Science Council (JUSTMAR) and Swedish International Development Agency (Fostering Innovation). ■

IGNĖ STALMOKAITĖ
PhD in Environmental Science, Project Researcher
School of Natural Sciences, Technology and Environmental Studies, Södertörn University
Sweden

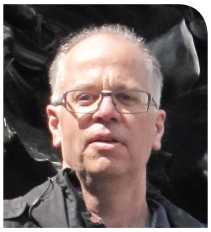
igne.stalmokaite@sh.se

FRED SAUNDERS
Associate Professor in Global Development Studies/Environmental Science
School of Natural Sciences, Technology and Environmental Studies, Södertörn University
Sweden

fred.saunders@sh.se

JOHANNA JOHANSSON
Associate Professor in Political Science and Senior Lecturer in Environmental Social Sciences
School of Natural Sciences, Technology and Environmental Studies, Södertörn University
Sweden

johanna.johansson@sh.se



BJÖRN HASSLER
Professor in Environmental Science
School of Natural Sciences, Technology and Environmental Studies, Södertörn University
Sweden

bjorn.hassler@sh.se

EERO HOKKANEN

Reducing greenhouse gas emissions from maritime transport – a northern Baltic perspective

Expert article • 3106

Shipping is vital for all countries around the Baltic Sea. Especially for Finland that is located a long distance away from its main European markets and very dependent on sea connections to the large European transport hubs in the south. Therefore, in the midst of the ongoing combat against climate change, it is essential for Finland to balance the measures that reduce emissions from ships on one hand, and their economic impacts on the industry and economy on the other.

This balancing act has characterized Finnish transport policies in the International Maritime Organization (IMO), the EU, and international cooperation around the Baltic Sea for years when it comes to Sulphur and other pollutants, and will likely continue to do so. Winter navigation, ensuring a level playing field for ice-classed ships, will also remain the exotic twist of Finnish environment and climate policy positions in the domain of shipping. There is no escaping the fact that all ports on the Finnish coast may freeze during the winter months, and that the northernmost ports around the Bothnian Bay face conditions comparable to the Arctic. There is no escaping the fact that this incurs additional costs to Finnish foreign trade.

How, then, should we look at the challenge of reducing greenhouse gas emissions from maritime transport here in the north? What is the role of public policy and regulation, and that of charterers? I will try to answer these questions based on the Finnish Government Resolution on reducing greenhouse gas emissions from maritime and inland waterway transport published this May. As a Government official and the ministerial rapporteur for this Resolution I will take the liberty of quoting it in the midst of my answer.

Public policy and regulation

The primacy of and preference for global regulation negotiated in the IMO is a cornerstone of maritime transport policy both in Finland and its Baltic neighbors. This is natural considering the inherently international nature of shipping. One cannot expect optimal results from any regional regulation, if there is a chance the regulation can be avoided by, for example, visiting a port outside the said region. However, effective global regulation is hard and often very time-consuming to achieve in the IMO, where negotiations among 175 states can continue for years on end, and the results watered down in the last minute. But as said, global regulation for a global industry is still preferable and should be pursued.

Finland and other EU Member States have advocated for effective global measures to reach the goals set in the Initial IMO Strategy on reduction of GHG emissions. At the 76th session of the IMO's Marine Environment Protection Committee (MEPC) in June 2021, Finland joined other EU Member States in opposing the inadequate level of carbon intensity cuts in the negotiated short-term reduction measure. At the same session, Finland proposed to the said measure an exemption, which would apply to ice-classed ships moving in ice conditions. This would avoid imposing additional burdens on Finnish competitiveness due to winter navigation. Work on this continues in a technical Correspondence Group. Finland is not the only country supporting effective overall measures while also advocating national or regional interests.

Unfortunately, the MEPC has not yet sent a sufficiently strong signal to shipowners and the entire maritime cluster about the urgency of climate action. Enforcement of the short-term measure is weak, and negotiations on the more effective mid- and long-term measures, such as a global carbon levy or tax, will take years. Therefore, pressure is growing in the EU for large-scale regional emission reduction measures. In July 2021, the European Commission published a broad Fit for 55 climate package, which includes regulation for EU-wide alternative fuel distribution infrastructure, measures to increase the use of alternative fuels in shipping (FuelEU Maritime), and most notably a proposal to broaden the scope of emissions trading (EU ETS) to include maritime transport.

By and large, the Government of Finland views the Commission proposals favorably. However, much remains to be negotiated. Taking into account the demands of winter navigation remains a particular challenge for Finland and its northern Baltic neighbors on the EU side regulation as it does on the global level in the IMO. In addition to EU and IMO level negotiations, this challenge needs to be considered in national policies, as well as public funding for research and innovation. The Finnish Government Resolution published in May includes several measures to this end.

Charterers

There has been much discussion on the responsibility of shipowners in the midst of climate crisis and the flurry of building regulation on all levels. Many Finnish shipowners are already pioneers in testing and taking into use green shipping solutions. Yet the rapid decarbonization of Baltic Sea maritime traffic, especially scheduled short-sea shipping and the roro and ropax sector, while at the same time ensuring safe winter navigation, is a huge challenge.

Perhaps more attention should be paid to the responsibility and influence of charterers. Agreements on maritime transport are made between the charterer and the shipping company under charter parties or contracts of carriage. In some charter types, such as time chartering, the charterer is responsible for the ship's commercial operation and travel costs instead of the shipowner. Consequently, the charter party templates underlie many decisions that affect shipping emissions.

Charter parties may make it more difficult for shipping companies and shipmasters to seek emissions reductions by operational means. For example, the clauses of the charter party may result in

some vessels being empty on return voyages. The IMO, the EU or individual sovereign states have little or no possibilities to influence the content of commercial charter parties. The main responsibility for concluding charter parties that support the attainment of emissions reduction targets lies with the charterer, and the largest charterers in the northern Baltic Sea could play an important role in reducing greenhouse gas emissions from maritime transport, should they so wish.

I would like to encourage all charterers to include not only speed- or schedule-related targets, but also emissions reduction goals in their charter parties. Chartering ships, which run fully on non-fossil fuels, should be competitive in short-sea shipping in the Baltic Sea by no later than 2045. ■

EERO HOKKANEN
Ministerial Adviser
Ministry of Transport and Communications
Finland

ELINA ANDERSSON

Finnish maritime industries and Baltic Sea area green transition

Expert article • 3107

Green transition is a must for all industries. Finnish marine industry is targeting to be a forerunner in the maritime sector transition. There are large opportunities, a lot has been done already but also many steps to be taken, so that Baltic Sea area could be a leading hub for green maritime technology in the future. Time to act is now.

Finland has a long history and thorough understanding of delivering smart and environmentally friendly high-tech maritime solutions. Finnish marine industry consists of marine equipment manufacturers, turnkey suppliers, design companies, system suppliers, software providers and shipbuilding, ship repair and offshore yards. Our internationally known maritime network's expertise ranges from icebreakers and ice going vessels to cruise ships, ferries, specialized vessels, and offshore renewable energy solutions as well as port technology. Finland also has one of the most diverse marine system supplier and subcontractor networks in the world.

Baltic Sea region countries have remarkable opportunities to make Baltic Sea a green hub of maritime transport and green energy. We have the know-how from our top of the range maritime and energy industries, we can use digital solutions to design vessels and systems and optimize energy consumption or routes, for instance. With the know-how we could build a hub for green maritime fuels produced with offshore wind energy, store it near by and use it for clean maritime transport, clean steel, or green heavy transport. We have short routes that would be optimal for instance testing new fuels like hydrogen, since hydrogen is hard to store without loss.

Actions needed for maritime green transition in the Baltic Sea area

The first prerequisite is that there is enough RDI activities in place to develop new technologies. RDI funding is essential to promote cooperation and reduce the risk of developing new technologies with ambitious targets. Companies are now investing in developing for instance technologies that make it possible to use hydrogen, ammonia, and methanol as a fuel. Electrification and hybrid solutions are suitable for some routes. Electricity used directly is the most efficient way, but for long routes it is not an option, at least not yet. Energy saving is the key and all possible technologies to reduce energy consumption will be needed to establish zero emission waterborne transport. Wind propulsion is one technology that is already available.

Regulation is needed to promote development and investments in green technology. EU's FuelEU Maritime and Emission Trading System (EU ETS) for shipping will, when working as planned, accelerate investments to new technology and fuels. IMO's Carbon Intensity Indicator CII enters into force in 2023. Discussions for market base measures will also continue. Global regulation is crucially needed.

In Baltic sea area ice is one special issue that must be handled. New regulation might guide shipowners to order less ice-going vessels. Need for icebreaking would then rise. This is one reason why Baltic Sea countries should prepare and go rapidly forward with ordering new icebreakers to replace those that are in the end of their lifecycle.

Pilot projects are needed test new solutions, to make them better and proof that the technology works. Without pilots and references it is hard to sell new solutions. Finnish companies have been piloting many green technologies with Finnish shipowners and also with foreign shipping companies. Many pilots have also been made in public procurement projects. For instance, the famous Azipod propulsion was invented in public and private cooperation. If Finland wants to accelerate the transition, there is a need for more pilots. For instance, road ferries have been and could be an optimal test bed for new solutions. Baltic sea region with tight regulation and harsh conditions is also a good test area itself.

Green energy is key in production of P2X fuels. There are plans to establish more wind power to the Baltic Sea. With more wind power the area would have more clean energy to produce for instance green hydrogen, that should be produced near the use. In the future there could be even sea hubs for production and bunkering of green hydrogen.

Infrastructure is of course essential for new fuels like hydrogen, methanol, or ammonia, including production, transportation, storage and bunkering infra. Building the infra is a large commitment so it ideally should be usable for multiple fuel types. LNG infra is a good start that could help the transfer to other new fuels. In any case, large investments will be needed at the Baltic Sea region.

Investments can happen when technological solutions are in place. Also, there must be reliable plans for the infra and new fuels available. Chicken-and-egg-problem is the main factor that is causing delay; there should be technologies and infra ready so that there would be major investments. And major investment in sight accelerates RDI and infra construction. It is important to have enough predictability for the players. Countries should share the risk with the first ones that use new technologies.

Collaboration for the future

Collaboration of Baltic Sea region countries is essential since no country can solve for instance infrastructure issues alone. The countries should have common understanding how the future looks like. Business Finland and for instance the funding instrument for Leading companies as well as EU's Horizon Europe funding programme will hopefully be in key roles accelerating the RDI activities.

European Waterborne stakeholders have established Zero Emission Waterborne Transport partnership targeting to provide and demonstrate zero-emission solutions for all main ship types and services before 2030, which will enable zero-emission waterborne transport before 2050. Finnish marine industry is investing a lot of effort

to develop green technologies; propulsions systems and engines for new fuels, energy efficiency of ship concepts and the systems, wind propulsion and other technologies to save energy or recently also to capture carbon. Lately for instance engine manufacturer Wärtsilä has announced “the world’s first long term, full-scale, testing of ammonia as a fuel in a marine four-stroke combustion engine” and cooperation to build ammonia-fueled ammonia tanker.

Collaboration of maritime industry, shipowners and ports is of course important for development and testing of new technologies. Due to the country’s isolated geographic location, Finnish maritime cluster has always been important for the security of supply of Finland. If we use our maritime know how together with our know how of green energy and new fuels, we could make our security of supply even better at Baltic Sea area. ■

ELINA ANDERSSON
Secretary General
Finnish Marine Industries
Finland

KARIN ANDERSSON

Emission free propulsion for ships

Expert article • 3108

The global shipping sector contributes to a large part of the transport work, but it also contributes to the total CO2 emissions by almost 3 %. With the existing plans for decarbonisation only around 20 % of the shipping will be fossil free in 2050 and increased future transport may even lead to an increase in emissions. There are also several other ship emissions to air that influences both human health and the environment and the Baltic Sea is also designated as a Particularly Sensitive Sea Area, PSSA, by the IMO as well as being one of the "special areas" in the MARPOL convention, emission control areas, ECA.

Some emissions are subject to regulations, like nitrogen and sulphur oxides. For CO2, however, only data collection on the fuel oil consumption is compulsory globally today, but the goal of the International Maritime Organisation, IMO, is "to peak GHG emissions from international shipping as soon as possible and to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008".

Thus, "zero emission" can refer to different emissions, although greenhouse gases (GHG), including CO2 and methane, are most in focus. The decision maker faces a multicriteria situation with both short- and long-term aspects and the decision on a new fuel and/or energy conversion technology is not only an environmental one, but health impact, technology, economy, logistics, availability, public acceptance, ethics, and political issues also are of importance.

Some things to note when making a fuel choice:

- Emission regulations and reporting today relate only to the ship, but sustainable solutions need to include the production and distribution chain.
- Alternative fuels are in general more expensive than the traditional, and the incentives for increased energy efficiency become stronger.
- Liquified natural gas, LNG, fulfils sulphur and nitrogen oxide regulations. However, being fossil, it gives only a marginal decrease in GHG in combustion and possible emissions upstream.
- Since the lifetime, including the design, construction and use phase of a ship is very long (30 -50 years), also retrofitting of older ships provides improvement potential

Available and future energy conversion technologies discussed today include:

- Combustion engines (Diesel or Otto)
- Dual fuel engines (Diesel/gas)
- Gas turbines
- Fuel cells
- Electric motors

These can all be used with fossil as well as renewable energy carriers.

In addition, sail aided propulsion is also under development and can be attractive for some applications.

The combustion engine with low emitting, non-fossil fuel has a potential to be used also in coming years. Biofuels (HVO, LBG, lignin based fuel etc) provide a potential, although the availability of biomass is limited compared to the fuel use in global shipping.

Synthetic liquid or gaseous fuel, "e-fuels", like methanol or ammonia can be used in combustion engines but also in fuel cells. These can be produced from renewable electricity via electrolysis to hydrogen and adding CO2 or N2 . The technology for production is more complicated and the energy efficiency "from sun to fuel" is lower than when using electricity or hydrogen. This will also influence the cost of production.

Hydrogen, made from renewable electricity, can be directly used in fuel cells or combustion engines. It yields only water in fuel cells, nitrogen oxides may be formed in combustion engines. This is a very efficient energy carrier and many initiatives for production and use are on-going. The present lack of infrastructure and the low level of technology readiness makes the time scale for large scale introduction longer than for biofuel or e-fuel but it has the potential to become an attractive alternative with time.

From energy efficiency as well as total emissions point of view, the direct use of renewable electricity is a preferred choice. There are many applications where it is possible to use electricity stored in batteries, or even to connect ferries to the grid and there is lot of development. However, battery weight well as capacity issues need to be handled and battery production sets demands on scarce elements and new mines.

Summing up:

The main primary sources of non-fossil energy for shipping are biomass or renewable electricity.

Electricity is very energy efficient, but it needs to be distributed and stored. Battery storage can be used for some applications. Conversion of electricity to gaseous or liquid fuels makes present logistics and fuel handling possible, but it is less energy efficient and has higher production cost, as does conversion of biomass to fuel. The most energy efficient of liquid and gaseous electricity derived fuels is hydrogen.

Thus, there is no "one solution for all applications", but there will be many alternative fuels and technologies used in the coming years depending on application and local conditions. ■

KARIN ANDERSSON
Professor
Maritime Environmental Sciences,
Department of Mechanics and Maritime Sciences, Chalmers University of Technology
Gothenburg, Sweden

Karin.Andersson@chalmers.se

TIINA TUURNALA

Towards zero-emission through cooperation

Expert article • 3109

Up to 90 per cent of all the goods in the world are transported by sea, such as consumer products, medicines and industrial raw materials. At the same time, shipping is undergoing a major transition, as digitalisation, automation, the increasingly stringent environmental requirements and changing services are reshaping the industry.

Approximately 2.9 per cent of global emissions are generated by shipping. While carriage by sea is an environmentally friendly and energy-efficient mode of transport, the fight against climate change concerns us all and calls for a major effort. Shipowners are fully committed to reducing shipping emissions to achieve carbon neutral sea transports. The entire sector is fervently looking for achieving zero emissions.

Global solutions for maximum impact

In 2018, the International Maritime Organisation (IMO) adopted a greenhouse gas strategy to reduce absolute carbon dioxide emissions from international shipping by 50% by 2050. In autumn 2021, the International Chamber of Shipping (ICS), the global umbrella organisation for shipping companies, called for a drastic tightening of the global maritime emissions reduction target: to make all global shipping carbon neutral by 2050.

What the shipping industry is trying to do leaves no room for doubt. The current proposal to the IMO to tighten the target is a clear indication that the shipping industry as a whole is determined to move towards zero-emission shipping and to take action to mitigate climate change. In an international industry, the greatest impact can be achieved through global regulation.

To attain the objective, cutting-edge technology and novel fuels are needed. At present, low-carbon fuels are not commercially available on the scale required by the global merchant fleet. In the future, the availability of low-carbon fuels will be of key importance. Major investments in research and development are called for. Expediting the adoption of new concepts calls for new mechanisms to finance green investments, both nationally and internationally. The ICS has also proposed the creation of an R&D Fund and the introduction of a global carbon levy. They would make it possible to channel funding to develop new marine technologies.

Europe wishes to lead the way

In July 2021, the European Commission published the Fit For 55 climate package. As part of it, the Commission proposes to extend emissions trading to maritime transport, and to promote the use of alternative fuels through the Fuel EU Maritime initiative. Swift progress on climate change mitigation measures is essential. Fit for 55 is a comprehensive climate package that seeks to push progress in the right direction. However, the effectiveness of the legislative package, the risks of carbon leakage and the combined impacts of the various initiatives, together with global regulation, need to be carefully examined before final decisions are taken. What is particularly difficult for Finland is that the legislative package proposed by the Commission does not in any way take into account the special conditions in the North and the challenges of winter navigation.

Towards zero-emission shipping through cooperation

With an annual turnover of EUR 14 billion, the Finnish maritime cluster is one of the most important industries in Finland. It gives work for over 50,000 people across the country. Its indirect impact on employment is over half a million jobs. In Finland, there are shipping companies carrying passengers and goods, specialised shipping companies, maritime industries ranging from shipyards to software houses and start-ups, as well as ports that handle up to 90% of Finland's foreign trade. Passenger transport is also of great importance. Helsinki is the busiest passenger port in Europe, with over 12 million international passengers passing through the port of Helsinki in 2019. One of Finland's special strengths is the exceptionally transparent cooperation between actors, which permits innovative experiments.

The shipping industry is engaged in close cooperation with its European counterparts, and this cooperation is notably active and transparent between Nordic countries. The Swedish and Finnish maritime clusters organise an annual Fairway Forward seminar, where key industry representatives from both countries meet, hear and discuss best practices and technologies for reducing emissions and harnessing digitalisation.

Cooperation is also intense between the authorities and industry in the Baltic Sea region in the framework of HELCOM cooperation. The authorities and representatives of the maritime industries in the Baltic Rim countries convene regularly for Green Team meetings to find ways to boost green shipping and overcome bottlenecks that slow down progress.

In Northern Europe, we are leading the way on environmental maritime issues; here, our special strength lies in transparent cooperation. Making the world's shipping carbon neutral by 2050 is a joint and collaborative effort. ■

TIINA TUURNALA
CEO
Finnish Shipowners Association
Finland

ANITA MÄKINEN

Looking for a Silver Bullet to reduce GHG emissions from maritime transport - is there a one?

Expert article • 3110

While writing this, the political leaders, representatives of civil society and industry are gathered in Glasgow for Climate negotiations. There are challenges, e.g. how to keep us on a truck to achieve the temperature goal decided in Paris in 2015, and solve, how to financially support Small Island Developing States (SIDS) and Least Developed Countries (LDCs) in mitigating the impacts of climate change. However, the biggest challenge is, if we are ready to switch from fossil fuels to alternative sources of energy. Fingers crossed that decision makers finally find a balanced solution and that nobody will be left behind.

According to the 4th IMO GHG Study, the International Shipping is in charge for about 3% of all GHG emissions in the world and the trend is increasing. However, as International Shipping was excluded from the Paris Agreement, shipborne emissions were not directly discussed in Glasgow. The measures to tackle these emissions are in focus both at global level in the International Maritime Organization (IMO) and in EU.

Shipping is a global business and the IMO can provide a global level-playing field for the industry. After Paris, IMO adopted the Initial GHG Strategy in 2018, and since then a couple of short term measures have been adopted. From 2023 onwards, all existing ships must meet new energy efficiency standards: Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII). The EEXI measures CO2 emissions per transport work, considering the ship's design parameters only without any measurement or reporting of factual CO2 emissions.

According to the Initial GHG Strategy, we have also started discussions both on alternative fuels for maritime transport and carbon pricing. The latter one through e.g. the International Maritime Research Board and Fund (IMRB, IMRF), initiatives by the Industry, levy or cap and trade. All these measures are under consideration in the Marine Environment Committee (MEPC) of IMO. Worth of noting is that industry side does not consider their proposal to be a market based measure but a short term measure to be adopted as soon as possible to facilitate research and technological development in the field of shipping.

Many are of the view that low and zero carbon fuels and sources of energy are the key in decarbonizing of shipping. However, to assess the overall climate impact of new fuels, it is important to develop a common framework for the lifecycle assessment (LCA) of the GHG intensity of marine fuels, covering both the upstream and the downstream parts i.e. from well-to-wake. Accordingly, we have started the debate on the LCA guidelines in IMO. For the deployment of alternative fuels, we need to consider also other issues such as safety, regulation, pricing, infrastructural availability, supply chain constraints, barriers to adoption etc. and this is not going to happen in a night.

IMO is about to start to update its Initial GHG Strategy for adoption in 2023. There are already proposals to strengthen the goals of the Strategy to reduce GHG emission from international shipping to be zero already in 2050, i.e. in 30 years. According to the Initial GHG Strategy, emissions should be phased out as soon as possible during this century. Thus, these proposals, initiated both by industry and a number of member states from different corners of the world, are progressive.

In parallel to IMO developments, the European Commission has taken an action to reach the European Green Deal objectives by launching the Fit for 55-package in June this year. Therein are proposals e.g. to include shipping in EU Emission Trading Scheme (ETS) and to develop a legally binding regulation for the use of alternative fuels and sources of energy, including mandatory onshore power. The aim of the Fit for 55 package is that "the price of seaborne transport should reflect the impact it has on climate change, in line with the "polluter pays" principle and in line with the objective that all key EU economic sectors should face carbon pricing".

Digitalization and automation of the maritime sector has also been of great interest in recent years for achieving enhanced efficiency and environmental sustainability. Digitalization and further optimization of shipping activities have also major economic benefits. According to some estimates digital enhancements of shipping operations can save up to EUR 100-300 billion annually in operating costs for EU industries. Furthermore, it has been evaluated that the benefits of digitalization in the logistics sector as a whole will globally be about EUR 1 400 billion by 2025.

However, there are challenges as different actors are approaching digitalization from their own angles instead of considering how the entire industry should be transformed by digitalization. Development of overlapping systems, which do not interact, creates yet another challenge to overcome. Unfortunately, according to our findings, the industry is strongly guarding the status quo.

To conclude, there is no single Silver Bullet to reduce GHG emissions from Maritime Transport but more like a basket of measures, which all are needed in decarbonizing of shipping! ■

ANITA MÄKINEN
Adjunct Professor, PhD, Chief Adviser
Finnish Transport and Communication Agency TRAFICOM
Finland

anita.makinen@traficom.fi
Twitter@AnitaMakinen

JUSSI MÄLKIÄ

Lessons learnt from greening of shipping

Expert article • 3111

In shipping, greenhouse gas emission reductions are now being discussed more than anything else. The pressure is on to extend emission reduction targets and emissions trading to logistics and sea transport.

I have a bad habit of hypothesizing, and looking too much into the past, but as wise men say; history helps us determine how to approach the future. What has gone wrong when trying to meet the environmental and climate challenges in shipping?

About ten years ago, roughly a dozen new goals in environmental regulation were announced to be coming into force within the next decade. No breakthrough solution has been found even for the smallest problems. The one that most of us probably remember the best is the Sulfur Directive. In the preparation a lot of money was spent, and other efforts made, but the overall impacts on the climate and environment were not taken into account. Open loop sulfur scrubbers have transferred sulfur from the air to the sea, which significantly increases the local load, especially in port use. This has led to deterioration of water quality in certain sea areas.

When solutions for environmental problems are looked for one at a time, it is a long and winding road. The hype for LNG began as a solution to cut sulfur emissions. It was also believed to be a more climate-friendly fuel with lower CO2 emissions. Research data on methane slip and its harmfulness to the climate already existed back then, but was ignored by the industry, politicians, and officials. Moreover, it seemed to be forgotten that natural gas is a fossil fuel, that humankind sought to get rid of in the fight against climate change. Now large investments have been made in fossil technology that can be even more harmful to the climate than the “old fashioned” oil-based technology. In addition to the financial side, we have wasted also other resources and precious time in the fight against climate change. There’s hardly any more scientific debate about the benefits of LNG. The balance gets even worse when the whole life cycle is taken into account: there are significant leaks throughout the LNG production chain. Besides the ship engines, methane slip occurs also during the production and transport. We are now tied to this climate-damaging technology and infrastructure, and that is why it is apparently so difficult to admit the mistake. Perhaps that is why greenwashing in the marketing of LNG continues.

All this has resulted in costs and investments for the industry and ship owners, but only little environmental benefit has been achieved. In addition, both, scrubbers and investments on LNG technology were moderately supported by public funds. Therefore, policy makers should understand the big picture, and not solve problems case by case. If we aim to achieve the goals we have set ourselves for carbon neutrality, no more public subsidies, direct or indirect, should be given for solutions based on fossil energy.

CO_2 emissions were on the earlier mentioned list of environmental regulation goals ten years go. But this probably the most significant environmental problem for the future of mankind was left last to solve. Shipping is considered one of the most difficult sectors to eliminate greenhouse gas emissions from. We should have started with the largest problem and the smaller ones would have been solved on the side.

The industry has anyway announced a goal of carbon neutrality by 2050. On the large scale there are not yet enough carbon-neutral fuels available. However, bio-oil, biodiesel, hydrogen and its derivatives (i.e. ammonia and methanol) and, as a black horse, nuclear power for large scale ships are already available. An interesting combination worth trying is the hybrid propulsion system that combines bio-oil and batteries, especially for small tonnage on regular routes. We are preparing such a concept in our company, and we have tentatively planned feeder traffic out of Saimaa to seaports. This would provide a carbon neutral green shipping corridor in accordance with the recently signed Clydebank declaration in COP26.

Currently, the most sustainable fuels among the existing renewables are bio-oil and green hydrogen. In principle, biogas could be on this list as well, but methane slip in marine engines also applies to biogas. Biogas, like natural gas, is better suited for other energy production where it burns cleaner.

We need careful consideration whether interim solutions are needed. On the next round we should adopt only near-100% GHG-free solutions, rather than investing in temporary solutions that solve one problem regardless of the overall environmental impact. The time frame in shipping is long, we are tied for decades to the investments. Mankind cannot afford that, not from the ecological nor economical point of view. By now, we should have learned our lesson.

It seems that low-sulfur diesel, existing and commonly in use, is the most viable solution before future technological innovations can be put into practice. At present, with existing equipment and infrastructure and by optimizing resources, we can achieve significant emission reductions in terms of tonne-mile performance: ships sailing utilizing full cargo capacity, slower, and on optimized routes, minimizing ballast voyages. Port operations would require reorganization. It is absurd that at the moment our ships are rushing at sea (that is consuming more fuel and causing more emissions) to get to port to wait.

More sustainable solutions and holistic, ambitious thinking are needed now.

The Clydebank Declaration also recalls fully decarbonized propulsion technologies that should have the capability not to add additional GHGs to the global system through their lifecycle, including production, transport, or consumption. Other factors to consider when planning future shipping are automation, digitization and reviewing and maybe redesigning the whole chain.

Emissions trading and a sufficiently high carbon price will accelerate investments and the advancement of technological innovation. In addition to being supported by governments, fossil energy is far too cheap. Emissions trading for shipping needs to be global, it needs consider not only CO_2 but all GHG emissions and it should include all sizes of commercial trading vessels. ■

JUSSI MÄLKIÄ
President
Meriaura Group

jussi.malkia@meriaura.fi

ELINA KARI & HERMANNI BACKER JOHNSEN

Economic incentives for sustainable shipping?

Expert article • 3112

The recent 26th UN Climate Change Conference of the Parties in Glasgow highlighted again the pressing need to reduce greenhouse gas (GHG) emissions from transport, including international shipping. The share of shipping emissions in global anthropogenic emissions is about 3% and the emissions are predicted to increase in a business-as-usual scenario. This figure appears small but corresponds to nearly six times the combined total emissions of the Nordic countries of Denmark, Finland, Iceland, Norway, and Sweden - countries with a high standard of living and a total population of 27 million people. In 2018 International Maritime Organization (IMO) agreed to reduce the total annual GHG emissions from shipping by at least 50% by 2050 compared to 2008 levels.

The European Commission launched in July 2021 the 'Fit-for-55 package' of proposals to reduce the EU's total GHG emissions by 55% by 2030 as a step towards the full EU decarbonization by 2050. As a part of the package, shipping will face new stringent EU regulation and there will be an ambitious target to cut emissions. Shipping is proposed to become subject to the European Emission Trading Scheme (ETS) from 2023 onwards. The new FuelEU Maritime regulation drives decarbonization of international shipping as well as fuels and energy sources used onboard. Alternative Fuels Infrastructure Regulation will require onshore power supply in the ports. Further, the ongoing revision of the Energy Taxation Directive is proposing to remove the tax exemption for conventional fuels. Reaching these targets will require investments in innovative technologies and alternative energy sources in maritime transport.

Within our own Baltic Sea region, the maritime traffic is intense with further growth predicted – but here, the industry is also the world leader in sustainability. Despite increasing shipping activities, the CO2 emissions have, according to research, decreased by more than 6% during the past decade. This increase in energy efficiency of the Baltic Sea fleet indicates that the actors in the maritime transport sector of the area are motivated to reach the emission targets. The positive developments in the Baltic Sea region are also the result of the relatively diverse palette of economic incentives for sustainable shipping available in the region. A broad definition of such economic incentives includes governmental and EU support for environmental technology development and deployment as well as environmentally differentiated operational fees (e.g., reduced port or fairway fees, taxes, and emission trading).

A key role of economic incentives is to secure R&D funding and financing for new environmentally advanced ships. While operational measures and retrofits have a significant role in reducing emissions of existing ships, the overall environmental impact of maritime transport is mainly determined by the choices made at the design and commissioning phase. As ships tend to have long life spans (25-35 years), it is crucial to incentive the most efficient choices to be able to meet the global environmental targets. When incentivising the decarbonization of maritime transport, the focus should be on long-term solutions, such as on new innovative and more sustainable propulsion systems of newbuilds.

The deployment of innovative technology on a large scale requires investing in solutions which may be promising but high-risk for financiers. Investment risk is often defined as the probability or uncertainty of losses rather than expected profit from investment. Business operators, as well as commercial banks and international financing institutions tend to view these profits and losses purely in terms of monetary value. However, regulators should also see risks of investments to modern ships in terms of how likely they are to deliver the desired policy outcomes, such as reaching the Fit-for55 targets.

The current EU Multiannual Financial Framework 2021-2027 provide several funding programmes to support the R&D, innovations, and investments in sustainable shipping. For example, the Horizon Europe is the research and innovation framework programme, the Connecting Europe Facility supports the trans-European networks and infrastructure and the Innovation Fund, with a budget coming from ETS, focuses on the demonstration of innovative low-carbon technologies. Regional funds such as Interreg or the NDPTL Support Fund provide opportunities for preparatory steps and pilots.

Major transitions in the history of shipping (sail to coal/diesel, containerization) have required substantial leaps of faith. In our times the field of EU, regional, and national co-funding for maritime transportation should look beyond modulations of old ways of doing things - by testing innovative concepts in practice. ■

ELINA KARI
Specialist
Wega Group Oy
Finland

elina.kari@wega.fi

HERMANNI BACKER JOHNSEN
Seconded Expert
Northern Dimension Partnership on Transport and Logistics (NDPTL)
Finland

EVA-LOTTA SUNDBLAD

Manage shipping in harmony with marine ecosystems

Expert article • 3113

Ecosystem-Based Management (EBM) is a strategy, recognized by the UN member states to ensure that ecosystem structure and function are sustained for the benefit of present and future generations. EBM means that human activities are to be managed in an integrated and cross-sectoral way and based on the best understanding of the ecological interactions. The UN states have also adopted the sustainability goal Life Below Water (no 14) as the oceans and coastal seas are under severe environmental pressure with an urgent need to reduce the negative impacts. A healthy marine ecosystem is in the interest of all individuals. Our rainwater, drinking water, weather, climate, much of our food, and even the oxygen in the air, are all provided and regulated by the sea. EBM may seem good and reasonable, but the implementation is complex. Sectors and authorities meet many challenges such as how to get knowledge of the varying aspects of the ecosystem, how to handle conflicting societal goals and trade-offs, how to clarify who can decide and how to reach stakeholder acceptance for measures.

Shipping is one of all sectors that needs to adapt as vessels need to operate at the same time as environmental pressure needs to be reduced. Ships have several on-board systems that releases hazardous, acidifying and eutrophicating substances, noise. Ships also contribute to the spread of invasive species.

It is the responsibility of the shipowner to reduce their environmental impact, but it is not easy to know what to prioritize and how to consider the state of the ecosystem at each place. As a help, obliging regulations and guidelines are provided by authorities and actors. With increasing awareness and knowledge new legislation arises. Today, ships need to limit their pressure within the limits of the aggregated environmental pressure at each place. Hence, ships travelling far can meet many different requirements which also may vary over time.

The Baltic Sea is an example of an ecosystem which is sensitive and differ from the neighboring Atlantic. Baltic Sea is brackish with severe problems of eutrophication, toxic substances and overfishing. The nine nations around the Baltic provide a whole puzzle of decisions aiming at a reduction of marine pressures from many sectors. Local authorities and ports have the mandate to decide within their mission. HELCOM and EU also deliver cross-national measures to steer towards Good Environmental Status in the marine waters. The ambition by politicians to transport more goods and people with ships provides a goal conflict with marine environmental ambitions if shipowners and their regulators do not take more action to reduce pressures from ships.

The global regulator for shipping, IMO (International Maritime Organization), within the UN, has decided and implemented rules to reduce some pressure, such as sulphur air emission and TBT in antifouling paint. However, the regulations and processes are not yet coherent with the 17 UN sustainability goals, targeted between 2020 and 2030. IMO processes are extremely slow and need to adapt to meet requirements of marine ecosystems as well as the service to mankind.

One example from IMO rules that seems out-of-date, is that each substance/emission is handled separately regarding the pressure on marine waters. Consideration in regulation is not taken to that there are more than one type of emission from each ship and how these may interact with each other. In addition, consideration is not taken to that ships operate in fleets, or that there are pressures from other sectors. This contrasts with EBM which advocates a wider perspective.

National authorities also need to adapt in how they cooperate with UN. A worrying recent example from Sweden concerns a decision of one authority to establish a marine protected area in line with the UN goal to protect 10 % of the ocean to the benefit of marine mammals, fish and birds, at the same time as another authority establishes a new international shipping lane through the same area (finally decided by IMO). Implementation of EBM requires more understanding and coordination between authorities to handle trade-offs.

Despite a growing concern for the sea and ocean the environmental status is deteriorating rapidly, while processes to act in favor of the ecosystems are slow. This is especially valid in the shipping sector for which the global regulatory process is very slow. Nations need to work more intensively towards EBM to overcome these challenges. However, the results are also dependent on the cooperation between many of us. ■

EVA-LOTTA SUNDBLAD
Scientific Coordinator
Swedish Institute for the Marine Environment
Sweden

eva-lotta.sundblad@havsmiljoinstitutet.se

ULLA TAPANINEN

Six steps to reach carbon-free shipping

Expert article • 3114

Year 2021 was very important for European shipping in its path to zero-emission targets. This year, in June 2021, International Maritime Organisation (IMO) decided on measures to reduce the carbon intensity of shipping by 11% between 2019 and 2026, and that total annual greenhouse gas (GHG) emissions from international shipping should be reduced by at least 50% by 2050 compared to year 2008.

Furthermore, in July 2021, European Commission presented the Fit for 55 package, which included proposals for the inclusion of shipping in the carbon trading, the carbon content of fuels, the abolition of duty-free treatment of bunker and the distribution infrastructure for alternative fuels. In practise, these actions driven by EU put more pressure on shipping that those decided by IMO.

There are three approaches to reduce emissions from shipping: (i) low-carbon fuels, (ii) improved ship design and (iii) operational solutions, i.e., ship type selection and ship speed choices. Energy companies are currently in an accelerating debate about fuel solutions and ship designers about new technological solutions, but the operational solutions can still bring the biggest emission reductions at the lowest cost.

It is estimated that trillions of euros will be needed to achieve the carbon neutrality in shipping. This is calculated by using the currently commercially-available technology as the assumption. The question in the whole shipping area is – as we do not know what kind of technologies there will be available for shipping in a decade or two – how can the shipping companies prepare themselves for the coming new regulations?

There are six important steps how the maritime sector can prepare itself for the carbon-free future. First four actions are for shipping companies, one for shippers, and one for regulators.

1. First, shipping companies should improve the energy efficiency in their newbuildings. The service life of a vessel is practically always more than 20 years, up to 30 or more. It is therefore very important that the ship designs on the table are as energy-efficient as possible. This action has already decreased substantially shipping companies' emissions, for example bulk vessels being built today can use 50% less fuel compared to the ones being built 10 years ago.
2. Second, shipping companies should pilot various technical solutions to increase their energy efficiency. These include rotor sails; smart IT- solutions to manage data for maintenance, bunker optimization and safety; air lubrication systems; use of batteries in ports and fairways; information for port arrivals, etc. There are multiple solutions for energy efficiency of vessels being developed around the world, and shipping companies should be active to get them to everyday use. Their effect might be only a few procent in decreasing the carbon emissions, but they are always worth to test. It is the total effect what counts.
3. Third, shipping companies should reduce their speed and port companies improve their operations. One of the most efficient ways to decrease greenhouse gases of vessels is to reduce vessels' speed. With the fastest vessels, a drop of few knots can decrease the emissions by one third. In many cases, the improvement of data operations and cargo handling in ports save time that can be used at the sea without increasing the total transport time.
4. Fourth, shipping companies should prepare themselves for the new low or zero carbon fuels. We do not know what is the fuel of tomorrow – is it hydrogen, ammonia, biofuels, methanol, or even electricity? Or them all? However, some of them are coming and shipping companies should increase their knowledge of various alternative fuels suitable for their own business models.
5. Fifth, shippers cannot solely rely that maritime sector will change their operations. Shippers should also re-evaluate their full transport chains. Are there possibilities to use slower speed vessels instead of high-speed, or use containers instead of trucks, or rail instead of road, or have more cargo transported at the same time, or more precise cargo tracking to give better estimations for the time of arrival? Should there actually be more inventory and not to rely on fast transports? These decisions have to start by analysing the needs of the final customer, e.g. are they actually wanting high speed or just to have the products when needed.
6. Finally, authorities and regulators have to introduce rules and support mechanisms and carbon taxes to help shipping industry to move towards carbon-neutrality. It is very important that these rules and mechanisms treat shipping companies in a fair way, so that they really focus on carbon reduction and do not make unfair situations in competition.

By following these six steps, there is a way for shipping sector to achieve carbon neutrality in a balanced way and make the shipping companies even stronger in the future. ■

ULLA TAPANINEN
Associate Professor Maritime Transport
Estonian Maritime Academy, Tallinn University of Technology
Estonia

ulla.tapaninen@taltech.ee
Twitter: @UTapaninen
Blog: ullatapaninen.net

NIINA KUITTINEN

Shipping remains a crucial airborne particle source

Expert article • 3115

Freshly emitted airborne particles from ship engines are born during combustion in the marine engine cylinders or during dilution of the hot exhaust gases into the surrounding atmosphere. These particles can include various compounds – light absorbing black carbon, metals, as well as semi-volatile sulfuric and organic compounds.

The amount of airborne particles can be expressed by different quantities – the most common measure being the particle mass. The mass of the particles is highly dependent of their size, and for that reason, air quality measures such as PM2.5, indicating the mass of particles smaller than 2.5 micrometers are commonly used.

Particles emitted from modern combustion sources are generally significantly smaller and thus their mass may be low, but number high. In our latest study considering six different marine fuel options, it was found that, in all cases, the majority of the particles were in the ultrafine particle (UFP) size range, having diameters below 0.1 micrometers. Particles of this size can penetrate deep in the alveolar region of human lungs and evidence exists of their ability to translocate to other organs.

From the climate change perspective, information of particle number emissions rather than mass is needed for detailed climatic models, considering for example, the effects of particles to the formation of clouds and their radiation balance.

Also, as particle mass is widely measured in the air quality observation stations of the world, it has so far been in the focus of the epidemiological studies that connect particle concentrations in air to human morbidity and mortality. However, new studies suggest that particles' number or surface area may be more relevant for understanding their health effects. In the recent air quality guideline update by the World Health Organization, a good practice recommendation for ultrafine particle number was introduced for the first time. High particle number concentration in outdoor or indoor air is considered to be more than 10 000 particles in one cubic centimeter of air, while less than 1000 is a low value.

Our recent study focused on quantifying the particle number emission factors for freshly emitted exhaust in the case of six different marine fuel options. The particle numbers corresponding the freshly emitted exhaust were in the order of 16-50 billiard particles for each kilogram of fuel burned. Applying a scrubber could bring these levels down to 3-7 billiard particles per kilogram of fuel. Despite the extremely high numbers of particles being produced, due to dilution to ambient air, the observed concentrations in the plumes of the ships followed by aircraft were in the order of 10 000 to 60 000 particles in one cubic centimeter of air, 7 to 10 minutes downwind from the stack.

When combining the information of particle number emission factors to STEAM ship emission assessment model, which uses satellite data for modelling of the global ship traffic, the global particle number emission from shipping could be assessed. The global emission was estimated at 1.2×1028 in the year 2016, which is of similar magnitude with an earlier estimate of total anthropogenic particle number emissions in the continental areas. While bringing significant environmental and health benefits on its own, the global sulfur cap of 0.5% introduced in 2020 doesn't significantly reduce the emission if use of residual fuels continues. Replacing high sulfur heavy fuel oils with cleaner marine diesel or gasoline oils could reduce the global particle number emission by 25-44% and introduction of natural gas or scrubbers by 61-67%. In the Baltic and North Sea emission control areas, fuel sulfur content is limited to 0.1%, favoring the use of cleaner fuel types, but desulfurized residual fuels can also still be used.

Our study also presented the global distribution of particle number emissions from shipping around the world, where emission levels were elevated on the main oceanic shipping lanes but, importantly, also near densely populated port cities. The importance of particle number emissions from shipping is emphasized by the trend in continental emissions that are dominated by on-road vehicles; for these, exhaust particle filters, leading to a decrease of particle number by orders of magnitude, are becoming mandatory. Therefore, the relative contribution of particle number from ship emissions may become higher in the future. At the moment, particle number emissions are not limited by the International Maritime Organization, but regulation has been discussed for specific particles such as black carbon.

Question also remains whether the new emerging fuel technologies such as methanol and ammonia can be used to reduce particle emissions in addition to helping the shipping sector to reach the carbon dioxide targets. Ships are currently undergoing a technology shift and it would be important to make sure that in addition to reaching the carbon targets, the climate and air quality effects of the co-emitted species are continuously considered. ■

NIINA KUITTINEN
PhD Researcher
Tampere University
Finland

SELMA BRYNOLF

Solutions for zero-emission shipping

Expert article • 3116

There are several initiatives and a growing momentum in the transition towards fossil free shipping at the moment. Policy and regulations are key to make the transition faster and possible for all the involved actors. Discussions are ongoing at many different levels, nationally, the European level and globally by the International Maritime Organization (IMO).

LNG was introduced as an alternative fuel as a response to the sulphur and nitrogen oxides regulations introduced by IMO in certain emission control areas (a limit of 0,5% sulphur in the fuel now also applies globally) in the 2000s and are now an established fuel. While LNG can reduce particles, nitrous oxides, and sulphur dioxide - it is still a fossil fuel and have a very limited possibility to reduce the climate change impact from shipping. Thus, there is need for other types of alternative fuels - produced from renewable primary energy sources such as solar and wind energy and biomass. It is possible to produce several different types of energy carriers from renewable energy sources including electricity, hydrogen, ammonia, methanol and methane. When produced from electricity, water and carbon or nitrogen they are typically called electrofuels, while fuels produced from biomass are typically called biofuels - both production pathways may complement each other.

In combination with renewable fuels there is a need for new ship technology, and there are several initiatives coming from the Nordic countries with examples including Stena's conversion of a RoPax ferry to run on methanol, Maersk's order of 8 large ocean-going vessels to operate on carbon neutral methanol, Nordled's hydrogen-powered ferry, DFDS's concept ferry using hydrogen and electricity, ForSea's battery-electric ship to name a few. There is also development of ammonia engines and fuels cells.

For existing ships, renewable fuels that can be used without any extensive retrofit will be needed. Ships running on LNG can shift to renewable liquefied methane, ships running on diesel can shift to hydrotreated vegetable oil or be retrofitted to run on renewable methanol. For newbuilding's several technology pathways are possible and the choice may be dependent on what type of ship segment and operational pattern. For short sea shipping and costal shipping, we see an increase in battery-electric ships. Battery-electric ships are already cost-efficient for some ships in these segments. For ships carrying energy carriers as cargo, there is a trend toward using the cargo as fuel - for instance for methanol, ammonia, and liquefied petroleum tankers. Previously, this was mainly the case for liquefied natural gas (LNG) carriers.

Another decisive factor is how regulations will be formed. There is a strong push towards zero-emission ships sometimes without considering the life cycle perspective. A regulation that limits emissions from the ship will push for carbon free energy carriers such as electricity, hydrogen and ammonia and disqualify carbon-based energy carriers such as methane and methanol. From an environmental and also wider sustainability perspective it is not known which types of energy carriers that will be beneficial in the long run.

Direct electrification is with present technology not possible for long distance shipping. That leaves hydrogen and ammonia, neither of these technologies are mature and even if they are promising, we do not know their performance compared to other renewable fuels such as methanol and methane. Furthermore, there is a risk of introducing a shift of environmental burden from the ship to the fuel and/or ship production if only ship emissions are regulated.

Another option is to consider the entire fuel and ship life cycle and regulate the life cycle performance. Close to zero-emission ships from a life cycle perspective could enable a smooth transition towards fossil free fuels and avoid dead ends. ■

SELMA BRYNOLF
Researcher
Department of Mechanics and Maritime Sciences, Chalmers University of Technology
Sweden

BEATRIZ GARCIA & HECTOR GUTIERREZ-BOCAZ

Decarbonizing shipping: national action and the challenges ahead

Expert article • 3117

In 2018, the International Maritime Organization (IMO) announced a greenhouse gas (GHG) emission reduction target for international shipping. This target – to reduce emissions by at least 50% by 2050 compared to 2008 – marked a milestone in global climate change regulation. It is the first sector-wide target established for the shipping industry. The roadmap to achieving this goal is the Initial IMO Strategy on Reduction of GHG Emissions from Ships, which proposes implementation measures for the short, medium and long term. In the short term, IMO member States must develop National Action Plans (NAPs) defining domestic policies to meet emission reductions in shipping. We argue that NAPs can play a key role in guiding national action and meeting international obligations. We also discuss some of the challenges in ensuring that the NAPs are effective and the goals of the Initial IMO Strategy are achieved.

Current national action plans

So far, only five countries – India, Japan, the Republic of the Marshall Islands, Norway and the United Kingdom – have completed their NAPs. The strategies in these NAPs include increasing the energy efficiency of ships and ports, investing in research and development for alternative bunker fuels and green technology, and improving infrastructure and logistics.

The UK's NAP commits to zero-emission ships by 2050 and proposes non-tax incentives and a Green Finance Initiative for shipping. The UK will measure emissions from vessels operating domestically, extend North Sea Emission Control Areas in internal waters, and encourage ports to develop Air Quality Plans. The Clean Maritime Council is the agency expected to implement these commitments. The UK also aims to explore alternative fuels (such as hydrogen, ammonia, batteries and electric engines) and improve port infrastructure for the transportation and bunkering of these fuels.

Norway's NAP establishes a 50% reduction of emissions from domestic shipping and fisheries by 2030 and proposes low/zero-emission solutions for all types of vessels. It establishes specific measures for different categories of vessels. For example, cruise ships and ferries sailing in the West Norwegian Fjords are expected to be emission-free by 2026. The government envisages renewing the cargo fleet with funding from various domestic sources. The NAP focuses on technological innovation for the uptake of alternative fuels and improving port infrastructure, with ports expected to be emission-free by 2030.

Japan's NAP proposes meeting the IMO target through energy efficiency improvements to existing ships. Japan champions the use of alternative fuels and other technological solutions, including concept designs for ultra-low or zero emission ships that would reduce 90% of GHG emissions. In its NAP, the Marshall Islands aims very generally to reduce domestic shipping emissions by 40% by 2030 and 100% by 2050. The NAP proposes a framework in which the Micronesian Centre for Sustainable Transport will prepare and implement a low-carbon strategy for the transport sector. India's NAP focuses on managing the growth and development of port operations with the aim of achieving a safe, sustainable and green port sector.

It is probably too early to tell if the NAPs will help achieve the sector's new emission reduction and decarbonization goals. However, if well-designed and fully implemented, NAPs could indeed give effect to international commitments. For example, research and development measures proposed under current NAPs can contribute to the development and deployment of alternative fuels envisaged under the Initial IMO Strategy. Moreover, if NAPs are designed to align with IMO targets and guidelines, they can also be an instrument of coordination among IMO member States to help achieve common goals. While current NAPs signal the direction of the sector's decarbonization, they tend to set mostly general goals and define areas where further work is required. To achieve real outcomes, NAPs should provide tangible and measurable actions accompanied by regular evaluation and monitoring. Countries should be able to tell whether the measures proposed in their NAPs are achieving the desired outcomes.

There is substantial room to argue that, although the current NAPs do target decarbonization, the overall strategies that are being proposed do not include targeted short-term measures that provide a clear path to reducing GHG emissions from shipping. It may be that some countries are tackling the problem in a more general sense in order to pursue specific measures at a later stage, but detailed commitments are crucial in adhering to national (and international) GHG emission reduction goals.

What are some of the challenges ahead?

IMO member States may design innovative and comprehensive NAPs and targeted measures, but the key issue is whether they will have the technical and financial capacity to implement them. While some large shipping companies are investing in low-carbon fuels and green technology, most shipowners are small family-run businesses that are unable to do the same. Likewise, IMO member States have varying capacity to introduce the large and costly changes required to decarbonize the industry, including improvements in technology, infrastructure and logistics. Who will pay for this? Will the financial burden be on individual States? How much support can be expected from shipping companies, developed countries, financial institutions, and the IMO? The IMO recognizes this challenge and has made efforts to address the needs of developing countries through various resolutions and through projects such as the Global Maritime Energy Efficiency Partnerships Project (GloMEEP) and GreenVoyage2050.

Will the IMO be able to drive the changes required to decarbonize the industry within a limited timeframe? As the sector's regulator, the IMO plays the role of "orchestrator", engaging diverse actors towards common goals. But, even if the IMO effectively engages key stakeholders, there are limits to what it can do. The authority

to enforce IMO regulations and standards rests with member States, which have varying capacity and political will to do so. Even established legal instruments, such as the International Convention for the Prevention of Pollution from Ships (MARPOL), have uneven ratification and implementation records. The Initial IMO Strategy and future GHG regulations may face similar challenges.

In the short term, IMO member States should consider NAPs as an opportunity to design plans of action that can deliver tangible outcomes. Going forward, NAPs should aim at designing precise and measurable activities, which can be assessed and adjusted through regular evaluation and monitoring. The IMO, but also shipping companies and financial institutions, should support the design and implementation of NAPs to ensure that national actions can drive the much-needed greening of ships and ports. ■

BEATRIZ GARCIA
Dr., Senior Lecturer, Nationally Accredited Mediator
School of Law, Western Sydney University
Australia

b.garcia@westernsydney.edu.au

HECTOR GUTIERREZ-BOCAZ
Lieutenant – Royal Australian Navy
Sea Power Centre-Australia, Royal Australian Navy – Department of Defence
Australia

hector.gutierrez-bocaz@defence.gov.au

MAGNUS GUSTAFSSON & HENRY SCHWARTZ

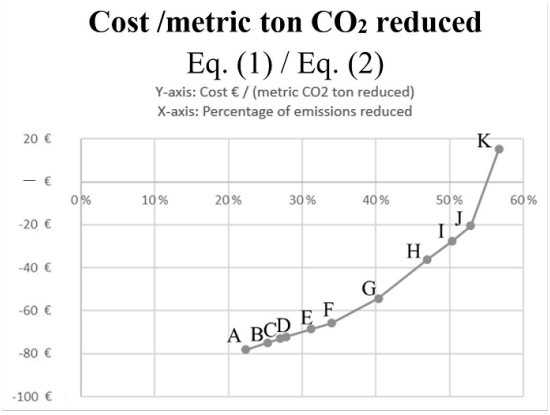
The business opportunity of reducing emissions in shipping

Expert article • 3118

Shipping is a key industry in international trade and emits one billion tons carbon dioxide per year – two percent of global emissions. For the shipping industry reducing its emissions and doing its fair share in helping to avoid global warming constitutes a significant challenge. Ships have long lifespans, often over 30 years and some analyses show that for the shipping industry to achieve net zero by 2050 all newbuilt ships would have to be zero-emission starting today – no small feat.

However, the picture is not completely dark. Analyses show there are numerous technologies that could help reduce emissions from operational measures optimizing the utilization of existing capacity, new technologies that reduce energy consumption and renewable fuels (figure 1). In fact, analyses show many of these could provide quite profitable investments. Optimizing logistic flows and especially cargo flows would not only reduce the fuel consumption per ton of cargo but also increase the utilization rate of ships while energy-saving technologies not only reduce emissions but also reduce costs by reducing fuel consumption.

Figure 1. Cost of reducing emissions €/metric ton CO2 reduced. Adapted from Schwartz, Gustafsson & Spohr (2020)



A. Operational solutions	+E Ballast water reduction	+I Waste heat recovery
+B Cold ironing	+F Optimized propeller	+J Hybridization
+C Solar cells	+G Slender hull	+K Fuel cell
+D Efficient lights	+H Wind	

Why is it then that the needed investments into reducing emissions are proceeding much too slowly? Take the example of ships rushing to wait at the anchorage point in front of the port leading – in some cases tens of ships waiting for weeks. In a time when any normal person can check their smartphone and inform their friends, they will be five minutes late and ask them to order in their place, ships still steam full ahead to get a place in the queue to the port. Analyses show eliminating this rush-to-wait would reduce global ship fuel consumption by 10% thereby reducing both fuel costs and emissions. On a global scale the ICT investment needed would amount to perhaps 100 million USD – a paltry sum in an industry that spends around 90 billion USD on fuel annually.

Rush to wait has been debated for a long time in the shipping industry. Many software companies have also proposed brilliant technologies with which the problem could be solved. New contract models have also been developed since it turned out that one key reason for ships rushing to wait was that contract models were still from the time when you would scan the horizon through binoculars to spot ships approaching ports. Yet still the problem remains and the reason for the persistence is to be found in the last point – old-fashioned business models.

The shipping industry is an old industry with well-established routines and traditions. Some of these are codified into regulations and standard while others are part of the established way of working and culture. These routines, regulations, standards, and traditions reduce uncertainty and provide stability in a challenging business. However, over time they can become outdated and hinder the introduction of new technologies that could improve the performance and sustainability of the industry – leading to the persistence of phenomena like rush-to-wait, which can only be described as lose-lose. Rush-to-wait is far from the only lock-in plaguing the shipping industry.

Lock-ins like rush to wait are wicked problems. They are embedded throughout the value chains. They emerge and are validated every time a freight contract, an investment or similar decision is made the traditional way and are perpetuated by the silofication and fragmentation that characterizes the shipping industry and its stakeholders. This means investments often have difficulty achieving profitability because they are constrained by the established business models of other stakeholders in the value chain.

However, therein also lies the business opportunity. By identifying the lock-ins and incumbent business models constraining the investment solutions can be devised that enable profitability and scalability. The next step is to outline how the technology could change the roles of different stakeholders, the division of roles and responsibilities and information flows and based on that identify how they should be engaged in the new value-creation process. This can include new value propositions, partners, risk-sharing mechanisms and incentives.

The shipping industry is a value-creating ecosystem that provides valuable services to society. It is an old industry that has gone through many changes and metamorphoses. There is still a lot of room for improvement and there are many companies bringing promising technologies to the market that can increase the sustainability of

the industry. By developing and changing the business models of the industry, technology can be introduced that not only reduces emissions and increases sustainability but does so profitably. After all, for something to be sustainable it is not enough that it is environmentally and socially sustainable, it needs to be economically sustainable too. ■

MAGNUS GUSTAFSSON
PhD, Research Leader
Åbo Akademi Laboratory of Industrial Management
Finland

Partner
PBI Research Institute
Finland

HENRY SCHWARTZ
Doctoral Student
Åbo Akademi Laboratory of Industrial Management
Finland

ERIK YTREBERG

Importance of including the marine perspective in assessments of ship emissions

Expert article • 3119

International shipping is essential to the world economy and the International Maritime Organization (IMO) estimates 90% of the world's trade to be carried by sea. Shipping is however causing multiple pressures on the atmosphere and the marine environment via engine exhausts and emissions from different waste streams containing chemicals and nutrients. The methodology on how ship emissions impact air quality and human health are well established and used in cost-benefit analysis of policy proposals. However, the knowledge base is not equally established for the marine environment. This risk policies to be biased towards air pollution whilst trading off impacts on the marine environment.

A current example is the wide-scale use of exhaust gas cleaning systems, also known as scrubbers. Globally, over 4000 ships are equipped with scrubbers, which is an abatement technology to reduce sulphur oxide emissions to air. Scrubbers can be operated in open or closed loop mode. Open loop systems, which is the most popular chose by shipowners, use seawater to wash sulphur oxide out of the exhaust, and the resulting washwater is discharged back to the sea. Closed loop systems recirculate the washwater and produces a lower volume of discharge water. Scrubbers were introduced on the market as an abatement method to meet the global cap of maximum allowable sulphur content in marine fuel which in 2020 was reduced from 3.5% to 0.5%. To comply with the stricter regulations and reduce the atmospheric emissions of sulphur oxides, the ship owner can either

- switch from high sulphur fuel oil (HFO) to distillates e.g. marine gas oil
- retrofit vessel to use alternative fuels, such as liquified natural gas and methanol
- install a scrubber and continue the use of the relatively cheaper HFO.

While all three options reduce the sulphur oxide emissions to air, the third option is causing additional pollution to the marine environment. This is particular true for open loop scrubbers which produces large volumes of acidic wash water (about 13,000 m3 per day for a medium size Roll-on/Roll-off vessel), and while regulations are focused on sulphur oxide removal from the exhausts, other pollutants e.g. cancerogenic polycyclic aromatic hydrocarbons (PAHs) and heavy metals are transferred to the acidic wash water and discharged to the marine environment.

In the recent publication by Ytreberg et al (2021), we developed a comprehensive framework to analyze how different pressures from shipping degrade marine ecosystems, air quality and human welfare. By adding knowledge from marine ecotoxicology and life-cycle analysis to the existing knowledge from climate, air pollution and environmental economics we established a conceptual framework that enabled a valuation of the damage costs associated with specific types of environmental and human health degradation. The results for a Baltic Sea case showed the total annual damage costs of Baltic Sea shipping to be 2.9 billion €. The damage costs due to impacts on marine eutrophication (800 million €) and marine ecotoxicity (600 million €) were in the same range as the combined damage costs associated with reduced air quality (800 million €) and climate change (700 million €).

The results highlight the importance to include the marine perspective in future socio-economic studies of ship emissions. However, solutions already exist to reduce the input of chemicals and nutrients which are the main pollutants causing marine ecotoxicity and marine eutrophication. The three most important are:

- installing a selective catalytical system (SCR) which reduces the level of nitrogen oxide in the exhaust gas from the engine
- changing antifouling system from toxic copper-based antifouling paints to biocide-free paints
- operate scrubbers in closed loop mode.

These three measures would reduce emissions of chemicals and nitrogen, and the corresponding damage costs due to marine ecotoxicity and marine eutrophication, by 95% and 70%, respectively. Moreover, the efficacy of biocide-free foul-release paints to prevent organisms to attach to the ship hull has increased substantially in the last couple of years. For example, several studies in the Baltic Sea region have shown these paints to be as effective as toxic copper-based paints. Despite this, only a handful of ships in the Baltic Sea use foul-release paints and as long as copper-based paints are allowed to be used, biocide-free strategies have difficulty in gaining market shares.

The results also showed the use of open loop scrubbers to be a major source of several metals and PAHs to the Baltic Sea. By switching to closed loop mode, which 85% of the Baltic Sea scrubber fleet has the possibly to do, the input of PAHs and metals from scrubbers could be reduced with up to 90%. Based on all these findings we strongly recommend the legislators on global (IMO), EU and national level to include the marine perspective in future socio-economic assessments of ship emissions. ■

ERIK YTREBERG
Associate Professor in Maritime Environmental Science
Department of Mechanic and Maritime Sciences, Chalmers University of Technology
Gothenburg, Sweden

erik.ytreberg@chalmers.se

KIRSTEN Å. ØYSTESE

Can Norway's electric ferries pave the way for zero-emission shipping?

Expert article • 3120

In 2015, the world's very first electric car ferry started to operate in Norway. Now, six years later, more than 40 are in operation in the Norwegian fjords. Reaching zero-emission shipping globally by 2050 will be much more challenging, but perhaps there's something to be learned from Norway?

Shipping means trade. More than 80 per cent of goods in cross-continental trade are transported by ship. In the last decade, the growth in global trade has led to both more and bigger ships sailing the seven seas. These almost exclusively run on fossil fuels and shipping accounts for 2-3% of global CO2 emissions.

Climate goals for shipping

Along with international aviation, international shipping is the only industry not included in the Paris Agreement. It is not the responsibility of any one country to cut emissions from vessels that sail from one country to another.

On Friday 13 April 2018, the International Maritime Organization (IMO) adopted a resolution containing an ambition to reduce emissions from international shipping by at least 50 per cent by 2050. This is a good start. However, halving emissions by 2050 is far from enough.

To achieve the goals of the Paris Agreement and limit global warming to well below 2 degrees and preferably down to 1.5 degrees, it is essential to rapidly reduce and eventually eliminate anthropogenic greenhouse gas emissions. Emissions must be halved by 2030 and reach net zero by 2050.

Norway has taken the lead

In Norway, the path towards zero-emission shipping began with the electrification of car ferries. Car ferries form part of Norway's road network by connecting islands to the mainland. They bring different areas closer together, allowing people to live on one side of the fjord and work or go to school on the other. National and regional authorities are responsible for the ferries, represented by the Norwegian Public Roads Administration or the regional county councils.

Ambitious policy and clear climate and environmental requirements have played a decisive role in replacing diesel-run ferries with battery-run ferries.

In 2010, the Public Roads Administration saw the possibility of using competitive tenders to achieve more energy-efficient and eco-friendly ferries. It announced a tender competition containing the requirement of 15–20 per cent lower energy consumption and emissions.

This competition stirred the interest of the ferry operators, shipyards and the maritime industry as a whole. As it turned out, the market delivered far beyond the Public Roads Administration's requirement. The result was Ampere – the first fully-electric ferry, which could transport 120 cars and 360 passengers completely emission free.

In 2015, the same year that Ampere started to operate, the Norwegian Parliament requested that the Government ensure that all upcoming ferry tender competitions contained a requirement for low or zero emission technology where possible. As a result, more than 40 battery-run ferries currently in operation, and more are expected in the coming years.

Norwegian car ferries unlike any other vessels

Norwegian car ferries are relatively small vessels. They run over short distances at moderate speed and on fixed routes. This differs significantly from the types of vessels and types of marine transport used in international shipping, characterised by large container ships, bulk carriers and tankers which sail all around the world.

Batteries are not the solution to achieving zero emissions across the entire international shipping sector. Large vessels will need other energy solutions, such as green ammonia, green methanol or other carbon-free and carbon-neutral fuels.

This is possible to achieve. Shipping companies, shipyards and engine manufacturers are aspiring to design and test energy systems and new green fuels. The problem is that it is taking much too long. Political ambitions are weak. The minimal requirements that do exist are far from adequate to ensure the right tempo. And without putting a price on emissions, conventional fossil fuels are near impossible to compete against.

Ambitious goals and clear requirements have been decisive to Norway having the highest density of battery-run ferries in the world. Ambitions and requirements generated new, innovative solutions.

Equally clear climate targets and emission requirements can also generate a green transition in shipping in the rest of the world.

The requirements must come from the IMO and heads of state. They must come from companies that use shipping as a means of transporting their goods. They must come from the finance sector that grants loans and makes investments in shipping, and they must come from us, as consumers, who buy the goods that in one or another part of the production chain have been shipped.

When the requirements are clear enough, the necessary solutions will be developed to achieve zero emissions by 2050. ■

KIRSTEN Å. ØYSTESE
Project Manager
Norwegian Climate Foundation
Norway

EUNICE OLANIYI

Impact of SECA regulations on clean shipping in the BSR

Expert article • 3121

Establishing the Sulphur emission control (SECA) areas was a good step undertaken by the International Maritime Organisation (IMO) to reducing sulphur emissions from shipping. The current 2020 global sulphur shows that the energy transition outlook in the maritime sector is spreading across the globe - there is no going back.

Since SECA, ship-owners in the BSR explored economically viable options for the SECA and the global sulphur law post-2020. So far, compliance measurement of air emission on the Baltic waters has had an impressive record of 95% and 85% around its borders. Ship-owners adopted a different strategy for compliance. Some went for the strategy of a specific compliance method, others adopted a hybrid strategy that combines two or more of the compliance methods. The favourite choice for most ship-owners is switching to the low sulphur fuel because it only slightly increases the cost of operations for a voyage, and the ship-owners do not necessarily have to make any investment decisions or risk undertakings. Other hybrids of low sulphur fuel are growing in demand because they are less expensive than traditional distillates.

There are both public and private costs of environmental governance in the maritime sector, and the orchestration of green shipping initiatives to activate regulatory policies reveals some gaps in the development of such regulation compliance. A pertinent question is what are the expected hurdles of a complete transition to a clean maritime transport industry? Can the world achieve total integration of this policy to contribute to environmental protection?

There is no doubt that the implementation of the SECA regulations has been successful. The general economic effects are negligible for most ship-owners due to the significant reduction in fuel price since 2014. So far, the SECA regulation impact on costs, pricing, FDI, cargo flows and modal splits were low while innovation and the branding of the BSR were positively impacted by SECA.

However, it was also revealed that regulatory compliance can be costly and risky not just for the ship owners but for small and medium fuel-producers who must make heavy investments in their production plants to produce compliant fuel. Besides, because there are different fragments of tasks to fulfil, it is hard to notice the administrative burden of SECA – except for the maintenance – because each of these tasks take only a little time on a normal operation but in sum could be time-consuming.

The total annual cost of administrative burden for ship-owners in the BSR is around 2.7 million €. However, if the annual administrative burden per ship is calculated, the resulting costs would be less than 2000€ per ship every year, which can be considered as a negligible cost-block compared to other cost categories in the shipping sector. The total SECA-related administrative burden annually for all EU maritime authorities which mostly include compliance checks of ships in national ports is 260 000€. By adding up both administrative activities we have approximately 2.96 million € as the annual total cost of administrative burden in the BSR.

The total additional costs for SECA compliance from consumed fuel in BSR in 2015, 2016, 2017 and 2018 were 615.616, 500.641, 502.608 and 563.940 respectively. Considering the median value between 2015 and 2018, the average cost is about 550 million € for the BSR.

It is important to note that these findings are lower than the pre-SECA report on the ex-ante expectations of SECA impact on maritime business, which implies that the numbers were overestimated when compared to the trifling effects noticed after 2015.

The introduction of sulphur regulations in the BSR was seen to have influenced the maritime companies established after 2010 in the BSR. Aside from maritime and offshore sectors, many of the new entrants offer ranges of emissions reduction technologies for both power plants and maritime engines. Although some of these companies have about 10 staff or less, they can serve global markets.

So far, the world have witnessed how the BSR and North Channel became successful test labs for the world since 2015 January. Now, the world must look into what was done, how they were done to enable and trigger a sustainable future for the sulphur law and clean shipping in general globally. We were expecting that bunker fuel supply and availability will change after the 2020 global sulphur cap and that this change will spur demand for drastic and cost-efficient technological solutions. However, the advent of the COVID-19 pandemic seems to have put a slight delay.

The design features of the SECA rules in combination with other current and upcoming environmental rules may not be enough to make the shipping industry shift entirely to clean shipping technology. A radical or systemic innovation would require a different set of regulatory requirements that is efficient and sustainable. There is still a lot of room for improvement, policymakers must seek to integrate and adopt a potentially high-cost effective compliance option/approach for all actors and stakeholders. ■

EUNICE OLANIYI
PhD, Research Fellow
Centre for Maritime Studies, University of Turku
Finland

eoolan@utu.fi

PENTTI KUJALA

Future cruise ships and the environmental challenges

Expert article • 3122

Finland has a long history, which dates back to the 1960s, in the development and construction of new cruise ship concepts. Most major innovations in the field have been developed in Finland. Before the corona pandemic, cruise traffic grew steadily by more than 10% per year and this is expected to continue after the pandemic.

Cruise ships account for less than 1% of the world's merchant fleet. The total emissions to air caused by maritime transport are about 3.0% of all air emissions, so cruise ships account for 0.03% of the total emissions. During the construction phase, less than 5% of emissions are generated, and significant development work has been done in this sector to streamline ship design and construction processes and to develop lighter and more recyclable materials, such as the development of high-strength special steels.

In the case of cruise ships, improving energy efficiency and renewable fuels in particular are related to reducing greenhouse gas emissions and other harmful emissions. The energy consumption of cruise ships has been optimized for years and it can be estimated that ships developed in Finland have been able to improve energy efficiency by up to 50% over the last 20 years. In addition to fuels, other important developments to reduce emissions include improving the ship's hydrodynamics, which involves e.g. optimized hull shape and alternative propulsion systems, new technologies related to air conditioning and refrigeration equipment, improved heat recovery systems, modern waste treatment methods with sorting stations and investment in the circular economy. Improvements in waste management require close development cooperation with cities and ports. The new cruise ships are designed so that there are no emissions to the water when, for example, all biowaste is treated on board and stored on board

The Finnish maritime cluster has been a pioneer in many developments related to the ship's energy efficiency and new fuels. The world's first LNG-powered passenger car ferry (Viking Grace, 2013) and a cruise ship (Costa Smeralda, 2019) have been developed and built in Finland. The cruise ships, which will be completed in the next few years, will also be the first in the world to apply new hydrogen-based fuel cell technology. In recent years, the large cruise shipowners have invested significantly in the so-called closed-loop sulfur scrubbers for the installation on its fleet. The development of digital monitoring systems is estimated to contribute to the monitoring and decrease of emissions.

Taking into account the cruise ship's more than 30-year life cycle and the new strict IMO and EU requirements in coming years, technologies, materials and operating methods are being developed today more rapidly in cooperation with the entire maritime cluster and the scientific community. The leading shipyards in Finland aim to be carbon neutrality before 2030. The future will require development and investments in ships with zero emissions through revolutionary machinery and propulsion concepts. This can be achieved for example through new fuels like ammonia and hydrogen to be used on the ship machinery, increased number of electrical batteries onboard, utilizing solar and wind energies. The complicated systems onboard have to be integrated to gain optimum efficiency and safety. The company organisations have to be developed further for the new era of communications and automation demands.

Digital transformation will change the entire business and used practices. The ship and passenger performance can today be monitored by a number of ways and a lot of data gathering methods are available. The challenge is that typically there is even too much scarce monitored data without a clear picture what should be measured and why and how to properly analyse data and use it in the design, production and operation principles of future ship concepts. New analytics, AI and machine vision-based tools are rapidly emerging, but there is no clear picture what approach to be used for various applications in the marine field and this will require joint efforts by the whole maritime cluster to develop the proper and in practice useful tools. Sustainable development goals are important on all activities today.

The new, urgent topic is how to design and operate the ships taken into account the new health requirements. After the Covid-19, the cruise ship fleet is planned to be back in business in full power at early 2022 and the ship owners have developed new processes onboard the vessels to guarantee the safety of passengers. All future scenarios forecast that the growth of cruise ship market will continue to grow. The new environmental demands and health requirements can have major effects on the future ship concepts requiring again that Finnish maritime cluster has to show the way forward for the whole international arena of the maritime community. ■

PENTTI KUJALA
Professor, Vice Dean
Aalto University, School of Engineering
Finland

pentti.kujala@aalto.fi

DANIEL METZGER & ORESTIS SCHINAS

The challenge of financing green shipping

Expert article • 3123

Rising sea levels and recent extreme weather events made global warming visible for everyone and put the fight against climate change on the agenda of international politics. In the past, the majority of the members of the United Nations (UN) committed themselves to treaties, such as the Kyoto Protocol and the Paris Agreement, while the latter explicitly excludes maritime shipping. The Member States of the International Maritime Organization (IMO), a body of the UN, agreed on their own emission reduction goals and a strategy to achieve those. According to a study prepared for the European Parliament in 2017, shipping is projected to account for approx. 17% of the global carbon budget available in 2050, if no material counter measures are applied. This makes the maritime sector essential for the fight against climate change.

The IMO strategy foresees to half the greenhouse gas emissions by the sector in 2050 against 2008 levels. In the light of expected global economic growth, these goals are ambitious and inter alia require substantial investments into new technologies, new ships, and retrofitting of existing ships.

Some of these technologies require further research, such as ammonia and hydrogen, while other technologies, such as innovative wind propulsion devices are ready for deployment and have already started to gain momentum. Depending on the wind-assisted technology installed, the annual emission reduction potential of CO2 ranges from the encouraging 8-14% to the promising of 30-35%. Considering that North Sea and Baltic regions have abundant wind potential, the WASP (Wind Assisted Ship Propulsion) project, funded by the Interreg North Sea Europe Programme, part of the European Regional Development Fund (ERDF), aims at bringing together researchers and the industry with the goal of testing in actual conditions and of promoting wind-assisted technologies to lessen the carbon footprint of local sea trade.

While many feasible technologies are ready for installation, the access to financial resources became increasingly difficult since the top 40 lending banks decreased their shipping position by c. 34% from 2010 to 2019 while the world fleet was growing. Consequently, the industry needs to find alternative financing sources.

One solution could be to charge a greening premium on top of the usual charter rates (Solution A). This way, customers with the respective environmental awareness would finance the additional costs for greening technologies. However, market experience suggests that the customers are yet not willing to pay for such a green shipping premium. Another solution would be to use export credit agencies to accelerate the installation of greening technologies by way of technology-linked financing (Solution B). This way, States fill the financing gap, which would not only accelerate the greening of shipping but also support innovative companies that develop greening technologies. Hence, a shipping company that acquires a technology developed in, say, Norway, would get access to the respective financing by the Norwegian export credit agency. Nevertheless, export-credit based solutions have usually limited visibility in the international market.

The third solution are financing schemes that build on sharing economy models (Solution C). These models foresee that the economic benefits as well as risks of a capital-intensive investments are shared. The Pay-as-You-Save Model for green shipping technologies is presented in the literature and considered in actual business cases. This approach assumes that the economic benefits of a greening technology are shared between the shipowner, and the technology provider, or another party who provides bridge finance. Thereby, the shipowner carries 20-30% of the upfront costs (technology costs) while she gives away a certain percentage of the profits for a negotiable period of time. The profits achieved by the respective technology are fuel savings and carbon offset revenues minus maintenance costs, while the carbon offset revenues depend on the pricing of carbon emissions, which is expected to come in the next years. As a side effect, the incentives of buyer and supplier are further aligned since the majority of the supplier's remuneration depends on the performance of the respective technology. The model can be customized to fit for special needs of supplier and ship owner as well as various technologies.

Afterall, if the banks' appetite for shipping does not increase, the greening of shipping depends on alternative financings solutions such as the ones presented. Most likely, the optimal solution is a mix between premiums paid by the ultimate customers (Solution A), national support such as export credit schemes (Solution B) and innovative sharing economy schemes (Solution C). Whatsoever the solution will look like, if the targets set under the Paris Agreement shall be met, there is not much time left for the shipping industry to substantially decrease its carbon footprint. ■

DANIEL METZGER
External Doctoral Candidate
Hamburg School of Business Administration & Helmut Schmidt University
Germany

Associate
Aquila Clean Energy EMEA
Germany

ORESTIS SCHINAS
Dr-Ing, Professor of Shipping and Ship Finance
Hamburg School of Business Administration
Germany

Founding Partner
HHX.blue
Germany

ANGELA KRUTH & JENS WARTMANN

Green ammonia technologies for zero-emission shipping

Expert article • 3124

Our economy relies heavily on shipping containers and an estimate of over 90 percent of world's goods are transported by sea. The shipping sector with one billion tons of CO2, accounting one-quarter of all emissions from the global transport sector and 3 percent of global CO2 emissions, faces intense pressure to decarbonize in the coming decades. Short-term measures such as the Energy Efficiency Existing Ship Index (EEXI) as a technical measure looking at design of the ship as well as energy-efficiency measures and energy harvesting will be put into force by 2023. Other fundamental key drivers for decarbonisation of shipping are a new regulatory framework for assessing carbon risks for companies by the Task Force on Climate-related Financial Disclosures as well as commercial pressure and expectations of cargo owners, consumers and investors. In order to meet the targets, utilization of new fuels is necessary.

Although there has been an increase in the uptake of alternative fuel in shipping of nearly 12 percent over the past two years, new fuels are still fossil-based and dominated by liquid natural gas (LNG). To really tackle shipping's contribution to climate chance, synthetic fuels derived from abundant renewable sources must be utilized large-scale. Green hydrogen is announced as the key solution to large volume storage of renewable energy. It maybe used directly as a carbon-free fuel but exhibits low energy density, high storage cost and is extremely flammable. Implementation of synthetic fuels such as methane, methanol or dimethyl ether (DME) that are produced from green hydrogen and CO2 is currently discussed as a possible pathway to decarbonisation of global shipping. To account for the greening potential of synthetic fuels, availability and sustainability of the CO2 source as well as method and cost of its production must be critically assessed.

Recently, there has been high motivation to explore green ammonia as a maritine fuel that offers a great opportunity to truly decarbonise shipping. It is carbon-free and synthesized from abundant atmospheric nitrogen and water by means of an entirely carbon-free process. It possesses a high gravimetric density of hydrogen of around 18 percent, resulting in a high energy density comparable to that of methanol. Ammonia is easily liquefied and transported at -33 °C or, alternatively, under a very modest pressure of around 9 bar. As a feedstock for fertilizer production, around 180 million tons of ammonia are today produced annually and transported globally by an established infrastructure per pipeline, rail, road and ship. Ammonia storage and distribution is highly cost-efficient and has the advantage that there is no CO2 emission at the users end. It may be used directly in marine propulsion or back-converted to pure hydrogen on-board for utilization. A key step in the realisation of ammonia as a marine fuel is the development and implementation of suitable propulsion technologies. Ammonia marine internal combustion engines (ICE) are intensively developed by major marine engine manufacturers. Because of poor combustion characteristics of ammonia, dual fuel operation with diesel or hydrogen as accelerant is applied. In dual fuel ammonia hydrogen zero-carbon ICE propulsion, an ammonia cracker supplies around 10 percent of hydrogen accelerant into the fuel stream. For control of NOx emissions and ammonia slip, effective catalytic conversion must be implementated in the exhaust gas system of the ICE. Fuel cells are a class of new marine propulsion technologies. Solid oxide fuel cells (SOFC) maybe operated directly with ammonia and offer high efficiencies with the possibility of combined heat and power production. The cycleability of the SOFC must still be improved to allow for maneuvering the ship. Polymer exchange membrane fuel cell (PEMFC) exhibit a better cycleability but must be supplied with hydrogen by means of an ammonia-cracker. Thermal cycling of the cracker as well as purification of the hydrogen stream in the feed gas are still highly challenging and large efforts in development of catalysts and membranes are required. Since ammonia is highly toxic, adapted safety systems on board of ships are required. In addition to classic methods such as hydro-shielding, systems must enable safe enclosure of ammonia in compartments. Finally, global supply chains of green ammonia including bunkering structures must ensure a secure supply of ammonia as a marketable fuel. It is important not only to import ammonia but also to produce regional ammonia in the Baltic Sea region. For this purpose, a suitable infrastructure and ammonia production plants are to be established with the neighboring countries. Also, public acceptance must be achieved by safe regulations and appropiate community engagement. ■

ANGELA KRUTH
Dr., Speaker and Coordinator
CAMPFIRE Alliance

Head of Materials for Energy Technologies
Leibniz Institute for Plasma Research and Technology
Greifswald, Germany

angela.kruth@inp-greifswald.de

JENS WARTMANN
Strategy and Technology
CAMPFIRE Alliance

Head of New Materials and Technologies
The Hydrogen and Fuel Cell Centre
Duisburg, Germany

j.wartmann@zbt.de

JONATHAN LEWIS

Maritime sector needs zero-carbon fuels, not LNG

Expert article • 3125

The global maritime sector puts more than a billion tonnes of climate-warming pollutants into the atmosphere every year, accounting for 2-3 percent of total anthropogenic greenhouse gas emissions. The United Nations' International Maritime Organization (IMO) took a halting first step toward reducing the sector's emissions in 2018 when it announced a commitment to reduce greenhouse gas emissions from marine vessels by at least 50% by 2050.

The ambition gap between the IMO target and the 2015 Paris Agreement, which in effect requires every major sector of the economy to eliminate its greenhouse gas emissions by midcentury, is stark. Bringing the IMO target into alignment with broader climate change mitigation obligations has emerged as a major priority within civil society, and dozens of countries, including those in the EU-27 bloc, United States, and Japan, have called on the shipping sector to target either zero or net-zero greenhouse gas emissions by 2050.

Multiple options for reducing emissions are available to the shipping industry, from optimized route planning to reductions in cruising speed to the use of modern wind-assist technologies, but the strategy that offers the largest impact is a switch from heavy fuel oil (HFO) and marine diesel oil (MDO) to fuels with lower carbon intensity.

Until recently, many in the shipping industry assumed that the successor fuel would be natural gas compressed and cooled until liquefied (LNG). Natural gas emits about 30% less carbon dioxide than fuel oils when burned. LNG is mainly comprised of methane, however, a greenhouse gas that is 84 to 86 times more potent than carbon dioxide over a 20-year period, and the natural gas supply chain as currently operated is leaky. The climate impact of LNG depends strongly on the amount of methane released during extraction, processing, and transport of the natural gas feedstock as well as the energy and emissions from the liquefaction stage.

Numerous studies have shown these emissions to be substantial. When the upstream methane and CO2 emissions that occur along the LNG supply chain are added to the methane and carbon dioxide released directly from LNG-fuelled ships to calculate the lifecycle well-to-prop emissions, the case for LNG as a climate-friendly alternative to conventional marine fuels breaks down. Depending on the leak level for upstream methane, shifting marine vessels from MGO or HFO to LNG delivers between a 10% reduction and a 9% increase in lifecycle GHG emissions. Plainly, the maritime sector cannot achieve Paris Agreement-aligned reductions in greenhouse gas emissions over the next three decades by shifting to LNG.

Eliminating greenhouse gas emissions and conventional air pollution from the maritime sector instead requires a shift to zero-carbon fuels, namely hydrogen and ammonia (which is made by combining hydrogen and nitrogen atoms). Reciprocating engines and fuel cells can convert hydrogen and ammonia into propeller-spinning energy without emitting carbon dioxide. Zero-carbon fuels can be produced at mass-scale in ways that minimize lifecycle greenhouse gas emissions: one such process uses electricity generated by renewable or nuclear power stations to electrolytically decompose water into oxygen and hydrogen; another extracts hydrogen from methane molecules in machines called reformers, and manages the associated greenhouse gas releases with methane leak controls and carbon capture equipment. ■

JONATHAN LEWIS
Director, Transportation Decarbonization
Clean Air Task Force
USA

EVELIINA KLEMOLA

Options for low or zero carbon maritime fuels

Expert article • 3126

Reduction of greenhouse gas (GHG) emissions from transport is vital for mitigating the climate change. Replacing existing vessels with newbuilds is an effective method to ensure deployment of latest environmental technologies. It is also possible to significantly decrease emissions without premature scrapping by combining operational and technical efficiency measures, such as slow steaming and switching to low-carbon fuels, with required retrofitting. However, for each fuel, the whole life cycle must be assessed.

There are several alternatives for shipowners, and the fuel choice is always a compromise between the benefits and drawbacks of each fuel. The most significant factors are the price of the required equipment, the expected price and availability of the fuel, as well as safety. The emission reduction objectives of shipowners, their customers, and financers also play a role.

In the short term, emphasis is expected to be on fuels which can be used in existing powertrains and with proven potential to reduce or even eliminate GHG and other emissions. Liquid biofuels, e.g., ethanol and methanol produced from biomass, fatty acid methyl esters (FAME), and hydrotreated vegetable oils (HVO), have so far been used in the maritime sector mostly as a demonstration or blended with conventional fuels. Their future availability for maritime transport is uncertain, as also road transport and aviation have their needs and may be able to pay higher prices.

Liquefied natural gas (LNG) is a widely available option to reduce the local emissions and, to some extent, carbon dioxide (CO2) emissions. Many of the newbuilds operating in the Baltic and North Seas run on LNG today due to regional regulation on sulphur and nitrogen oxide emissions. Even as LNG, a fossil fuel, cannot be considered a long-term solution, it is building a bridge toward decarbonization. Its clear advantage is that the infrastructure is directly suitable for liquefied biogas (LBG), which is chemically identical but carbon neutral. LBG has been piloted to replace LNG in ships in the Baltic Sea, and its availability is expected to increase in the next few years. Sustainable feedstock and sufficient production volumes are key issues for all biomass-based fuels. LBG is mainly produced from waste streams with relatively large potential production volumes.

In future, the same infrastructure will be suitable for liquefied synthetic methane as well. Synthetic fuels are produced from CO2 and water, with electricity as the main source of energy. If the CO2 is biomass-based or captured from the atmosphere, and the electricity is produced from renewable sources, synthetic fuels can be considered renewable as well. The Power-to-X methods can be utilized in the production of methane, diesel, petrol, methanol, and other alcohols. However, these synthetic fuels are not expected to be commercially available in large scale before the next decade.

In addition to new fuels for combustion engines, new propulsion systems are emerging also in the maritime sector. They have a large potential to reduce emissions, and the first applications, such as fully electric or battery-diesel hybrid vessels, already operate in environmentally sensitive sea areas, such as the Baltic Sea. Their wider deployment depends on further technological development and cost-efficiency from scaling-up. Whereas direct electrification has potential for vessels operating on fixed routes and short distances, hydrogen and ammonia fuel cells are potential solutions for international maritime transport. Their emissions consist only of heat and water, and in the case of ammonia fuel cells, also nitrogen. The yield of fuel cells is superior compared with traditional combustion engines.

So far, the challenges have been the price of hydrogen, the energy required to produce hydrogen and the related GHG emissions, and the space requirements of the fuel cells. Both hydrogen and ammonia also require larger storage space onboard, with novel safety architecture, than traditional fuels, due to their lower energy intensity. However, due to fast technological development and decreasing price of renewable electricity, hydrogen could be available for a commercially competitive price as soon as in 2025. Large-scale investments are expected to promote the use of zero-emission hydrogen, produced with solar or wind power, in the transport sector.

In addition, vessels directly powered by solar and wind energy are being developed, each technology with their own drawbacks and limitations. The current spectrum is wide, and it is difficult to predict the option which will prevail. There is no one-solution-fits-all toward low and zero emission maritime transport. Most likely, a mix of fuels and propulsion methods will be utilized, with tailored solutions for the different needs of various fleets. The composition of the mix will depend on the regulation, availability, speed of technology development, and price of the alternatives. ■

EVELIINA KLEMOLA
Senior Specialist
Wega Group Oy
Finland

eveliina.klemola@wega.fi

KIRSI SPOOF-TUOMI

Fuel choices for short sea shipping in the Baltic Sea

Expert article • 3127

The climate crisis is one of the greatest environmental, economic and humanitarian challenges facing our society. There is a global understanding that significant reductions in greenhouse gas (GHG) emissions are needed to avoid the worst impacts of climate change, and various laws and regulations have already been implemented to combat global warming. In July 2021, the European Commission (EC) adopted an extensive legislative package, "Fit for 55," to reduce the economy-wide GHG emissions by 55 % by 2030 compared to 1990 levels. This level of ambition for the next decade is expected to set Europe on a balanced pathway to becoming climate neutral by 2050 – an economy with net-zero GHG emissions.

Climate strategies will inevitably affect the design of maritime energy solutions. The main technology development and deployment must happen by 2030 to prepare for the more rapid change in 2030–2050. Although internal combustion engines are still undergoing further improvements with, e.g., advances in combustion technologies, improving the energy efficiency of conventional technologies alone is not enough to achieve the targeted emission levels, and a switch from conventional marine fuels to low- and zero-carbon alternatives is imperative. For maritime stakeholders, the EC wants to see renewable and low-carbon fuels account for 6–9 % of the bunker fuel mix by 2030 and 86–88 % by 2050.

There is increasing focus on gas as an alternative to traditional marine fuels. So far, there is also a strong economic argument for LNG in shipping. In addition, numerous studies have shown a significant emission benefit of LNG in terms of NOx, SOx, and particulate emissions. However, progress towards decarbonization appears more difficult. This is because the overall GHG impacts of LNG are highly dependent on methane leakage rates within the LNG supply chain and especially on methane slip rates, i.e., unburned methane released from an engine's combustion process during vessel operation. Approximately 2.5 % methane slip from fuel combustion may cancel out the decreased emissions of CO2, leading to global warming potential equal to diesel fuel's. It, therefore, appears that LNG does not offer the significant reductions in CO2-equivalents needed to sustain EC's GHG targets.

Indeed, reducing total annual GHG emissions from shipping in line with the EC's target seems possible only by introducing fuels produced from renewable sources into the fuel palette. For example, liquefied bio-methane (LBG) exhibits, in principle, a neutral recirculation loop for CO2, which is one of the main causes of global warming. Major CO2 savings are based on the fact that producing bio-methane from organic waste material results in fuel that contain only biogenic carbon, and combustion of such fuel releases only biogenic CO2, which is, unlike CO2 from fossil fuels, not considered to contribute the climate change. The use of LBG produced from organic waste could reduce life cycle GHG emissions from short sea shipping by 60–75 % compared to marine diesel. It would also significantly reduce the impact of ship emissions on local air quality, an important feature for short sea vessels with regional operations near coasts and populated areas.

The major challenge facing LBG today is fuel availability in volumes needed for shipping. However, the production of LBG is steadily increasing to meet growing demand. For example, in November 2020, the Finnish gas major Gasum opened the first plant in Finland (in Turku) to produce LBG for transport, industry, and maritime sectors. In Sweden, the new LBG plant in Nymölla has just started, and the first delivery of liquefied biogas was in May 2021. Gasum and other industry players are also working on LBG projects not yet in the public domain.

Another main barrier to the broader deployment of LBG is the large price cap between LBG and fossil LNG. A major policy push is needed to address this barrier. Eliminating fossil fuel subsidies and implementing carbon pricing are necessary measures to increase the competitiveness of low-carbon renewable fuels. Moreover, specific blending mandates could guarantee the demand for renewable fuels and secure the necessary investments. Adequately high carbon prices, a predictable regulatory framework, and investment certainty are the key enablers in establishing a market for low-carbon marine fuels.

LNG distribution infrastructure can support the gradual shift towards LBG, as LBG can be easily and cost-effectively stored and distributed through precisely the same fuel infrastructure. Introduction of LBG on the market is also possible through blending with LNG. Hence, LNG could be seen as a part of a long-term solution for short sea shipping, providing a bridge technology to lower carbon shipping. Having infrastructure already in place enables a smooth transition to LBG in the long term. ■

KIRSI SPOOF-TUOMI
Project Researcher
University of Vaasa, School of Technology and Innovations, Energy Technology
Finland

KJELL LARSSON

Reducing discharges from chemical tankers

Expert article • 3128

Several million tons of chemicals, in addition to crude oil and mineral oil products, are transported by tankers each year in the Baltic Sea. The transportation of chemicals by specialised chemical tankers or combined chemical/oil product tankers is growing worldwide, both in respect to the number of substances and the total volume transported. A diversity of chemicals are carried by chemical tankers in the Baltic Sea, including acids, bases, alcohols, ammonia, vegetable oils, biofuels, fuel additives and a large number of different hydrocarbons including benzene, styrene, xylenes, acetone, phenols etc.

The majority of the chemicals carried by chemical tankers will have detrimental effects on the marine environment if discharged or spilled to the sea. The safety standards on chemical tankers are usually very high, but accidents leading to large discharges do sometimes occur. However, a more common pathway by which noxious chemicals from the ships' cargo tanks enter the marine environment is through the recurrent tank washings.

Because chemical tankers after unloading of a tank usually will load a different non-compatible substance in the same tank, meticulous tank washing operations are needed after unloading for safety and commercial reasons. How washing operations should be performed, and if, when and where the contaminated wash water could be released back to sea is regulated by the MARPOL Convention Annex II, named "Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk", and by the IBC code, as well as by the approved ship specific manual. Note that whereas discharges of noxious chemicals from chemical tankers to some extent actually are allowed in the Baltic Sea outside 12 nm from land, discharges of oil cargo residues from oil and oil product tankers is completely prohibited in the whole Baltic Sea and North Sea according to regulations in MARPOL Annex I.

Noxious chemicals carried by chemical tankers are divided into four categories, that is, categories X, Y, Z and OS, other substances. Category X-chemicals are deemed to present a major hazard, Y-chemicals a hazard, and Z-chemicals a minor hazard to the marine environment and human health. Chemicals in OS category are considered to present no harm.

A tank from which a category X-chemical has been unloaded shall be prewashed before the ship leaves the port of unloading and the resulting wash water and residues shall be discharged to a reception facility. The same rules applies when a tank has contained Y-chemicals which are highly viscous, solidifying or are persistent floaters. There are, however, a large number of noxious or harmful chemicals in the Y and Z categories which are transported by chemical tankers and where the unloaded tanks are not prewashed in ports but washed legally at sea. Such tank washings at sea occur regularly and according to the Swedish Coast Guard the number is increasing. Tank washing and release of residues of noxious chemicals from chemical tankers are today even legal in marine protected areas and marine Natura 2000-sites in the economic zone.

In addition to the legal discharges of tank residues, illegal discharges do also occur. Recently, several slicks of large quantities of tall oil and biodiesel, classified as Y-chemicals, have been detected along the Swedish coast and in offshore marine protected areas. For example, in March 2021, a slick of fatty acid methyl ester, FAME, which covered 25 square kilometres of sea surface was detected within a protected Natura 2000-site east of Öland, that is, in an area which hosts large numbers of threatened waterbirds and Baltic harbour porpoises.

As a measure to reduce climate change, larger volumes of biofuels will in future be produced and transported by chemical tankers in the Baltic region. It is important to realize that biofuels and vegetable oils, when released to the sea, have similar effects on the marine life as chemically similar fossil fuels. Vegetable oils and biofuels can form noxious degradation products, damage the plumage of waterbirds, create anoxic environments or absorb other toxins.

To reduce the legal and illegal discharges of noxious chemicals from chemical tankers, and the associated negative effects on the marine environment, the chemical industries in the Baltic region must take full responsibility for the transport of their chemical raw material and products. It is now also the time for authorities to strengthen the regulations regarding discharges of noxious chemicals from chemical tankers. A first step should be to make it mandatory to perform a prewash procedure at the port of unloading when the tanks have contained any of the Y-categorised chemicals. A total ban to discharge residues of noxious chemicals from chemical tankers in marine protected areas should be uncontroversial and could be adopted immediately by the countries around the Baltic Sea. ■

KJELL LARSSON
Professor Emeritus in Maritime Science
Kalmar Maritime Academy, Linnaeus University
Sweden

kjell.larsson@lnu.se

OLGA SARNA

Shipwrecks: the ticking bombs at the bottom of the Baltic Sea

Expert article • 3129

There are numerous environmental pressures caused by human activity that can negatively affect the marine environment. Shipwrecks containing various types of fuels and other hazardous substances are one of them. In case of a spillage they may contaminate both the water column and the seabed, having a negative impact on the entire ecosystem. It is a global problem that is particularly acute in the case of enclosed sea basins, such as the Baltic Sea.

HELCOM estimates that there are between 8 to 10 thousand shipwrecks in the Baltic. The location of most of them has not yet been identified or confirmed, and at least 100 are considered to be high priority wrecks posing a potential threat to the marine environment. To be classified as "dangerous to the environment" a wreck must contain in its tanks (or any other enclosed space) fuel and/or other hazardous substances in quantities greater than 10 m3 and be located less than 10 nautical miles from the coast that is a sand beach, a rocky beach or a cliff.

There are two reasons why the greatest potential threat is posed by wrecks sunk during the two World Wars. Firstly, due to the progressing corrosion, 75 years after the end of the WWII, it can be assumed that the "expiration date" of these wrecks is quickly approaching. Secondly, in most countries, there are no legal provisions explicitly defining legal responsibility for monitoring and examining these wrecks, as well as for carrying out preventative oil retrieval operations.

We speak of "a potential threat" only because it is deferred in time. It does not mean that it is not real. There is a high risk that leakages will take place in the near future. Once it happens, a significant area surrounding the wreck will be contaminated and all living organisms will be affected. As a result of such event, people and economies of coastal regions will also be impacted. Primarily because of the costs associated with cleaning of the affected areas and measures to minimize environmental losses. Also, in case of a significant oil spill, the tourism sector may be hit especially hard – since some of the potentially dangerous wrecks contain also light fuel that will float to the water surface and consequently may contaminate not only the seabed but also the coastal areas, including beaches, nature reserves, and coastal infrastructure.

There are multiple examples confirming the growing urgency to take measures to minimize this threat. In 2018, the US Navy had pumped out nearly a million liters of heavy oil (mazut) from the Prinz Eugen shipwreck located near the Marshall Islands at the Pacific. A year later, in August 2019, one hundred years after sinking of the shipwreck of "SS Mopang", about 100 tons of fuel leaked from its tanks into the Black Sea. The contaminated are at the Bulgarian waters was 2 km wide and 400 meters long.

There is also an important example in the Polish waters of the Baltic Sea, where over 41 hectares of seabed are contaminated by the fuel from the passenger ship "Stuttgart" sunk in 1943. The wreck is located in the Puck Bay in the Natura 2000 site, two nautical miles from the port of Gdynia. The leakage was first confirmed in 2009 and despite numerous reports and toxicological data presented to the marine and environmental administration in Poland, no steps have been taken to stop the oil spread or to remediate the contaminated area.

The growing awareness of environmental risks and potential damages caused by oil spills has mobilized many countries to undertake institutional measures aimed at studying and removing oil from old wrecks. Multiple countries around the world have a separate, fixed budget to carry out systemic activities aimed at reducing the potential threat posed by shipwrecks. Those countries include: United States of America, United Kingdom, Australia, Norway, and in the Baltic Sea region – Finland and Sweden.

In Sweden, the Chalmers University in Goteborg developed the VRAKA risk assessment methodology to classify the wrecks, manage the risk and collect data. As a result, the Swedish Agency for Marine and Water Management carries out between 2 and 3 oil removal operations each year. In Finland, the Environmental Institute (SYKE) conducts a comprehensive programme for studying and cleaning the wrecks, which also leads to cleaning of 2-3 wrecks per year. In Poland, between 1999 and 2016, the Maritime Institute in Gdańsk carried out research on the threats posed by wrecks as part of the Finnish Review of Wrecks (on behalf of HELCOM). The project did not lead to cleaning of a single wreck, despite the fact that risks posed by at least 4 wrecks in the Polish EEZ have been documented.

It is of great importance that this issue is addressed as quickly as possible and that dedicated Wreck Management Programmes are introduced in all Baltic countries. At the MARE Foundation, we have been conducting activities aimed at highlighting the issue of oil remaining in the WWII wrecks in the Baltic since 2018 and we strive to implement measures to manage wrecks in Poland as soon as possible. ■

OLGA SARNA
CEO
The MARE Foundation
Poland

https://fundacjamare.pl

AXEL MERKEL

External costs of maritime transport in Sweden

Expert article • 3130

The use of maritime transport is associated with external costs, a high share of which is related to greenhouse gas emissions and air pollution. Shipping is subject to less incentive-based regulation than e.g., road transport, but proposed new regulation at the EU level hints at a much more stringent regulatory strategy going forward. Sweden represents a unique regulatory case with its national system of fairway dues, which are differentiated according to the environmental performance of ships. Can more than two decades of attempting to incentivize the reduction of external costs from maritime transport in Sweden teach us anything about the preferred policy path going forward?

Amid increasing attention paid to shipping's environmental impacts, a tripartite agreement to reduce emissions of NOX and SOX from shipping was reached by the Swedish Maritime Administration, the Swedish Shipowners Association, and the Swedish Ports Organization. To achieve this aim environmentally differentiated fairway dues – 'green' infrastructure charges levied on commercial traffic calling Swedish ports – were introduced in 1998. In short, this meant that shipowners were given a rebate on charges based on the intensity of NOX emissions and the use of low-sulphur fuel (the subsequent implementation of the sulphur directive in 2015 made the latter part obsolete). In addition, refunds on fees were given to co-fund the installation of catalysts and other abatement equipment on vessels, though this measure was discontinued in 2001.

The environmental differentiation of fairway dues was significantly reformed in 2018, when a new system entered into force. Under the system, shipowners can qualify for environmental rebates if vessels score high enough on an index called the Clean Shipping Index (CSI). The CSI is an equally weighted composite of different factors, including the emissions of CO2, NOX, SOX and PM, as well as chemical use and water/waste management.

Evaluations of the various environmental policies built into the infrastructure charging regime have found mixed results. Previous research has found that while the uptake of measures enhancing vessels' environmental performance increased during the policy regime in place prior to 2018, it is difficult to establish to what extent this was driven by the policies. It has been acknowledged that the potential rebates that could be earned by shipowners were too low to create sufficient incentives for investments in emissions-reducing measures. An evaluation of the current system has shown that while the reform has succeeded in increasing the uptake of environmental incentives, the incentives to reduce NOX emissions have been weakened. The economic incentive for shipowners to undertake measures to enhance vessels' environmental performance are still weak in relation to the costs involved. Under the current system, analysis shows that the Swedish national policy measures only lead to an external cost internalization rate of roughly ¼ - meaning that the majority of external costs caused by shipping are left unchecked.

An important outstanding issue concerns the harmonization of policy measures across countries and ports. Many large ports in Sweden and in neighboring Baltic countries apply some form of environmental differentiation in the setting of port fees. However, the basis for rebates and environmental incentives is not uniform, rather it varies from port to port. There is a marked risk that differing indices weaken the incentives for shipowners to take urgent steps to reduce the environmental impact of operations. Harmonization ought also to occur to a greater extent between the Swedish national charging system and the charging systems of individual ports to maximize the effect of differentiated charging. 'Green' pricing must not only reward those who have already complied with higher standards but also accelerate transition among laggard shipping segments. For this to happen, we need coordinated, and sufficiently strong policy measures.

A second issue concerns the transparency of measures. Evaluations of the current scheme for environmentally differentiated fairway dues in Sweden are made difficult by the fact that the system is not sufficiently transparent. That is, it is difficult for any outside actor to establish what environmental effects can be expected to follow from the implementation of the rebates system. By contrast, the EU mandate enforcing Monitoring, Reporting and Verification of carbon emissions from shipping, which constitutes the basis for including maritime emissions in the European Trading System, ensures a high level of transparency regarding the effectiveness of policy.

In summary, Swedish experiences of implementing monetary measures for the reduction of maritime emissions are encouraging but also show that much work is needed in terms of getting policy right. ■

AXEL MERKEL
Researcher (PhD)
Swedish National Road and Transport Research Institute
Sweden

axel.merkel@vti.se

O. DE ANDRÉS GONZÁLEZ, H. KOIVISTO & M. KEINÄNEN-TOIVOLA

Efficient maritime logistics in the Baltic Sea area

Expert article • 3131

Essentially Finland could be seen as an island in respect of logistics. The efficient logistical solutions are extremely important at the Baltic Sea region, especially at maritime logistics.

Digitalization can typically be initiated at the port managing and automating information flows within the port and between the port and the vessels. Intermodal sharing of information is crucial when managing logistics. The main goals for the maritime sector could be described as becoming safer, more efficient and environmentally friendly. Same as all improvements to the efficiency of the operations aim eventually to become economically more profitable.

In order to optimize maritime transportation between Finland and Sweden the Interreg Central Baltic Efficient Flow project created a Port Activity Application for the transport corridor between Port of Rauma and Port of Gävle. The application means to improve Just-in-Time approach with a practical solution and increased shared situation awareness of the operations. Value added is behind the improved business cases of the stakeholders. Rauma & Gävle Port Activity Application has to be attractive to the point of economy and time efficiency, same as reducing environmental impact. Only by doing so, it could reach user quantities that are on the level of creating a meaningful impact on the overall pool of individual port activities.

Maritime pilots are local experts guiding the vessel through the congested fairways safely and efficiently to the port for loading and unloading of the cargo and passengers. Pilots are crucial for the safe and efficient conduction of maritime safety-critical operations, for which Port Activity App provides an up to date tool.

Vessel crew can download the Port Activity Application (PAA) as a smart phone application. A timestamp is representing activity in the sequel of actions when the vessel is closing to a port or departing from it. From the vessel crew perspective, the decision making, and related reporting activities are mostly related to the schedule of the vessel, as in, when is the vessel expected to arrive to port. This again reflects the adjustment of the vessel speed and maintaining awareness of effects to the schedule, and finally forwarding that information to whom it may concern. The crew has an import role to play to apply for a vessel specific slot time.

The development of the Port Activity application is definitely a prominent step forward on the port digitalization roadmap. From the view of managing the whole intermodal flow efficiently this is a good start and need to be extended to managing information flows with the hinterland and between ports connecting all the logistics operators handling the goods and other stakeholder including both shipping parties. Port Activity Application provides new data in the form of queuing system and recommended Time of Arrival. It gathers readily existing data and presents it in collated format under a single application. Certainly, even though the communication would be flawless, there will be some events in the logistics chain that could lead to unwanted outcomes.

The value which the Port Activity Application adds to the logistic chain mainly lies with the enhanced communication and contributes to long-lasting real hands-on changes in the functioning of the transport corridors and improve their digital maturity. Fintraffic VTS took ownership of the developed application in Finland in the future, and proves credibility of the application and secures the future evolvement of the application and port digitalization. The port application in Finland is already in use in more than sixteen ports and amount is increasing.

OLENA DE ANDRÉS GONZÁLEZ
Researcher, Ph.D.
Satakunta University of Applied Sciences
Finland

HEIKKI KOIVISTO
Project Manager, Captain
Satakunta University of Applied Sciences
Finland

MINNA M. KEINÄNEN-TOIVOLA
Head of Research, Adjunct Professor, Ph.D.
Satakunta University of Applied Sciences
Finland

OSKARI LÄHDEAHO

New reality and opportunities of Baltic Sea supply chains

Expert article • 3132

Modern logistics companies face pressures to transform towards improved sustainability. These pressures originate from global, regional, and national legislation, as well as stakeholder demand. In other words, companies from their own perspective are experiencing "top-down" and "bottom-up" pressure simultaneously. While they are busy in complying with tightening legislation and regulation, they must please their clientele and other external stakeholders. Therefore, companies in logistics industry are more often recognizing possible competitive advantages attainable by improving sustainability performance of their operations. Some have even assumed a strategy to position as forerunner in sustainability related issues in the industry.

During the past two years, Covid-19 pandemic has had immense impact to supply chains globally. Baltic Sea is not an exception. Incumbent supply chains experienced shocks during the early days of the pandemic, and the after-effects are still visible today. Resilience of supply chains has been forced as a subject for rigorous stress-testing due to the pandemic circumstances. While this situation has had its negative impacts, it has also exposed weaknesses and illuminated possible improvements to status quo. One such improvement is in transport mode selection. As traditional supply chains are stretched to their limits, new ones are studied, piloted, and implemented. For example, majority of freight globally is transported by sea. However, after the pandemic, sea transportations have been congested and their prices have soared. Due to this, railway transports have gained popularity, for example between Europe and Asia.

For smaller logistics companies, turbulence during pandemic times have posed as a challenge for survival. While larger companies often have some cushion to fall back on temporarily, smaller companies usually lack this privilege. Also, reportedly smaller companies face difficulties in acquiring governmental aid. Unfortunately, survival mode in smaller companies has led to less focus to afford for improving environmental sustainability. Nevertheless, modern societies depend on small and medium enterprises as employers. Moreover, large corporations' business practices heavily rely on subcontracting from these smaller actors. In logistics, this means that smaller actors usually perform the transportation itself. Thus, economic sustainability of Baltic Sea societies can be seen as depended on small and medium enterprises. In addition, supply chains and logistics operations in the region are powered by these enterprises via subcontracting.

Sustainability can be divided into three dimensions: economic, environmental, and social. Past two years has tested economic sustainability of businesses. Amid the challenging times, practices and managerial mindsets have improved in this regard. However, as market activity returns, it is important to apply the lessons in change resilience to other dimensions of sustainability. We are still facing steepening uphill battle for environmental sustainability. During the worst times of pandemic, companies did not settle for simple trade-offs in conducting business. Instead, those who performed best were able to find new opportunities amid the challenges. Similar mindset is needed to navigate through environmental challenges in business. Those who can adapt to the changing surroundings, turn challenges into competitive advantages, will prosper the most in coming decades. This applies to all sectors, but especially logistics.

While transportation is accountable for a significant share of negative environmental impact, it is also vital for modern societies. Fluent supply chains offer necessities and commodities required to lead normal living. Thus, societies are reliant on these supply chains and furthermore the transportation services enabling them. Environmentally sustainable societies are only achievable through environmentally sound transportations. Subsequently, environmental advances in transportation are realized by subcontractors in collaboration with large corporations. It seems that economical stability of subcontractors and the surrounding logistics systems is critical for further improvements in sustainability of Baltic Sea supply chains.

A possible solution for increasing stability and sustainability of Baltic Sea supply chains would be development programs in the region. These programs should involve consortiums with smaller companies, large actors, public sector, and academia. Also, cross-border collaboration is important, as it has been decreasing during the pandemic times. Programs of this sort have been successful in the past, for example Cross-border cooperation program between South-East Finland and Russia. Green InterTraffic was a project in this program, where Finnish and Russian partners collaborated in measuring environmental impacts of road transportation between these countries. ■

Green InterTraffic project website: https://en.greenintertraffic.ru/

OSKARI LÄHDEAHO
Junior Researcher
LUT University, Kouvola unit
Finland

oskari.lahdeaho@lut.fi

JARKKO TOIVOLA

Sustainable icenavigation in Northern Baltic Sea

Expert article • 3133

Writer hold the position of Head of Maritime unit in Finnish Transport and Infrastructure Agency (FTIA), the authority responsible to organize icenavigation for merchant maritime traffic to and from Finland. This role includes arranging and management of icebreaker services, setting of ice restrictions, co-operation with neighboring countries icenavigation authorities and participating to development of related regulation.

History

Icebreaking services to Finland has existed since 1890, providing active assistance to passage of merchant vessel through ice into Finnish ports. Initially only in lighter ice conditions and only to more southern ports, but from mid-seventies, even to the northernmost ports of Bay of Bothnia and Eastern Bay of Finland were kept open year around. This development based also to ice class of merchant vessels, which provided more regulated risk management and possibility of insurance coverage to ship owners.

Fundamentals of Northern Baltic Sea Icenavigation system and related challenges

- **Varying winter on first year ice regions.** In order to assure safe, reliable and efficient maritime trade, the whole system must be dimensioned also for harder ice conditions, even with large and even heavily ridged ice areas and ice coverage down to Central Baltic Sea.
- **Ice and other METOCEAN information.** The severity of any ongoing winter can only be judged at end of February or even later. On the short, operational term reliability and accuracy, the ice and METOCEAN information is adequately accurate only for 3-5 days ahead, which is too short for any commercial decisions, but assures frontline safety of maritime traffic.
- **Ice classes of Merchant vessels, including independent ice going capacity and strength to tolerate iceloads.** These are different things, first being an issue for the icenavigation system performance and second a pure safety issue. Independent ice going capacity of merchant vessels is constantly deteriorating due to merchant vessels adaptation to tightening emission regulation. By the laws of physics, everything to improve ice going is contrary to fuel efficiency in open water.
- **Icebreaker capacity.** Number and type/size of icebreakers especially suited to Baltic operations is one of the key factors. Fleet of icebreakers used in Baltic Sea is ageing. Due to trend of wider merchant vessels with lesser and lesser independent ice going capacity, even with the general trend of lighter winters, lack of adequate icebreaking capacity is a high risk to reliable and efficient maritime transport system to Northern Baltic Sea ports.
- **Management of assistance operations, information flow for all related parties.** Efficient management of data and information via FIN-SWE common online IBNet icebreaking management system assures optimization of assistances. Biggest potential, but also challenge for further improvements, is the accuracy and reliable lengthening of ice and METOCEAN predictions.
- **Size of merchant vessels, traffic flows, required accuracy of shipping schedules.** All these set higher and higher requirements to icenavigation system, to assure economically and environmentally efficient and competitive maritime transport.

"Golden age" of icenavigation in Baltic Sea and present trend

From seventies until millennium, new IB's and optimization towards better ice going capability of merchant vessels were the main trend and fuel consumption was not an issue.

Since then, the slow deterioration of system performance versus competitiveness required by industries, has taken place. One of the main drivers, even before environmental regulation, was the increasing of fuel costs as part of the total freight cost. Merchant fleet renewal rate is slow, as lesser cargo carrying capacity and worse fuel economy, compared to pure open water vessels, diminish resale value of high iceclass vessels to other regions.

Development trends and possible solutions to maintain system performance and improve sustainability

Although the winters are getting milder, the variation between winters remain. To assure efficient and sustainable transport system, admitting reducing independent ice going of merchant vessels, an adequate icebreaking capacity has to be maintained.

To make right decisions related to icebreaker renewal, icebreaking authorities and Aalto University are further developing icenavigation simulation that can model changing trade patterns, different ice conditions and realistic ice going performance of different vessels. Results will also help to minimize total emissions from maritime transports.

Availability of alternate fuels and implementing them to vessels used to icenavigation, is also a solution, though challenged by the slow renewal rate of both icebreaker and merchant fleet increases. On a long-term, only e-fuels provide adequate volumes of energy, but the needed amount of fossil free electricity at reasonable price is yet in the quite distant future. ■

JARKKO TOIVOLA
Head of Maritime Unit
Finnish Transport Infrastructure Agency
Finland

M. RAMACHER, M. QUANTE, M. KARL, V. MATTHIAS & J. MOLDANOVA

Future shipping and air quality in the Baltic

Expert article • 3134

Shipping and air quality in the Baltic Sea

In the Baltic Sea region, shipping played a major role in trade for centuries and is expected to grow in the future. However, ships emit a variety of gases and particles into the atmosphere, among them carbon dioxide (CO2), nitrogen oxides (NOx), sulphur oxides (SOx) and soot particles, which are known to negatively impact human health and the environment. It is estimated that shipping contributes a substantial share of air pollution in the Baltic Sea areas. Especially, close to the coastlines in the Southern Baltic Sea, air pollution from shipping can be substantial, leading to health problems and connected costs. In order to prevent and reduce such negative effects, the International Maritime Organization (IMO) applied regulations globally to all ships and more rigid local rules to certain emission control areas, such as parts of the North and Baltic oceans, the US/Canadian coast as well as the Chinese coast. Targeting different pollutants, such areas are called nitrogen emission control area (NECA) or sulphur emission control areas (SECA), respectively.

The BONUS SHEBA project

In the European BONUS project SHEBA (www.sheba-project.eu) lead experts from different fields of environmental, technical and societal sciences were brought together to tackle different negative aspects arising from shipping activities and emissions in the Baltic Sea e.g., air, noise and water pollution and the associated effects on people, the environment and costs. Besides an in-depth analysis of current impacts from shipping, a set of scenarios to describe the emissions from shipping to water, the atmosphere and underwater noise in the years 2012, 2030 and 2040 under assumptions of different policy measures and regulations were defined.

Scenarios for atmospheric emissions from shipping

First, a busines as usual (BAU) scenario was developed, which takes into account technological (size, fuel, etc.) and economic (transport work, development of trade and sectors, etc.) trends in the future development of shipping in the Baltic Sea. The BAU scenario takes into account already decided and/or implemented policy, for example the emission control areas NECA and SECA. Besides the BAU scenario, other scenarios address different aspects under discussion, for example the realization of the Energy Efficiency Design Index (EEDI), which is introduced by the IMO to reduce fuel consumption of newly built ships, but does not take into account any emission control area.

Air quality modelling results

The developed scenarios were applied in air quality modelling systems to identify shipping impacts in the year 2012 and in all future scenarios. The simulations revealed that shipping emissions are the main contributor to atmospheric NO2 concentrations over the Baltic Sea in the year 2012. In the BAU scenario, the projected NOx emissions from shipping in the Baltic Sea can are reduced by almost 80% in 2040, which is mainly an effect of the NECA. An even higher reduction of emissions and connected high reduction of air pollution from shipping was simulated for sulphur dioxide due to an already decided strengthening of the regulations of the SECA in 2015. When it comes to particles smaller than 2.5 µm diameter (PM2.5) the air quality simulations show a decrease by 35% – 37% between 2012 and 2040 in the Baltic Sea region, with reductions by 50% – 60% along the main shipping routes, but smaller reductions over the coastal areas.

Exposure and urban air pollution in Baltic Sea harbor cities

In addition to the identification of the regional impact of shipping, in the SHEBA project the shipping impact on air quality and population for current and future scenarios in different Baltic Sea harbor cities was simulated. Taking into account that about 70% of the ship traffic takes place close to coastlines from where air pollutants can easily be transported (by wind) towards urban areas and that port cities are major sources of air pollution in general (industries in harbor areas, various machinery in ports, large number of trucks, etc.), it is of major importance to look at the urban population exposure to air pollution from shipping. In an urban-scale air quality and exposure modeling chain it was simulated that in the Baltic Sea harbor cities Rostock (DE), Riga (LV), Gdansk-Gdynia (PL), shipping contributes 5-15% to NO2 exposure in the year 2012. Simulations with future scenarios for the city of Gothenburg identified reduction potentials of up to 30% for PM2.5 and up to 60% for NO2 for the BAU scenario in the year 2040. Moreover, the simulated impact of a wide use of shore-side electricity for ships at berth in 2040 leads to an additional local reduction potential of up to 3% for PM2.5 and up to 30% for NO2 in the proximity of the port area. ■

Acknowledgement: We gratefully acknowledge the extremely valuable contributions of our colleagues Erik Fridell (IVL), Lasse Johansson (FMI) and Jukka-Pekka Jalkanen (FMI) to the air quality research within BONUS SHEBA.

Expert article • 3134

MARTIN RAMACHER
Researcher
Helmholtz-Zentrum hereon, Coastal Environmental Chemistry
Geesthacht, Germany

MARKUS QUANTE
Professor
Helmholtz-Zentrum hereon, Coastal Environmental Chemistry
Geesthacht, Germany

MATTHIAS KARL
Researcher
Helmholtz-Zentrum hereon, Coastal Environmental Chemistry
Geesthacht, Germany

VOLKER MATTHIAS
Researcher
Helmholtz-Zentrum hereon, Coastal Environmental Chemistry
Geesthacht, Germany

JANA MOLDANOVA
Researcher
IVL Swedish Environmental Research Institute
Gothenburg, Sweden

ANNALEENA MÄKILÄ

Digitalisation alone is no longer enough: Ports are electrifying

Expert article • 3135

The development of digitalisation has in recent years taken a large step forwards in ports, as in other transport modes. An understanding of its uses has been cultivated by working together to solve its weak points, alongside meeting the needs of individual customers – but far-reaching digitalisation and information sharing systems, which have the potential to reach across the entire transport chain, await still their time in the spotlight.

The port is a mosaic, in whose arena work countless service providers, and which combines different methods of transport: shipping, and land-side tracks and fairways. The port authority, in Finland the port company, is undoubtedly the higher power which as a neutral party can bring together different service providers to share data and information. A partial optimisation is not in the best interests of the port company, better a full optimisation that assures the fluidity of an integrated transport system. In this time of digital change, port managing bodies are offered the chance to take up new roles and business models.

In Finnish ports, the development of digitalisation has progressed specifically in the management of waterborne traffic. In practice, national maritime traffic management has been digitalised, and the ports themselves have many different solutions in use now that utilise operative real-time data, for example on the height of the water, wind, and other weather conditions and how these are changing, the condition of port structures, the timetable ships will arrive by, and information with which we can guarantee fluent turn-around times in ports. The development phase currently leading digital development in ports, is concentrated on merging existing service solutions to make multiple layers of simultaneous data easier to manage.

The first 5G networks are now in use in Finnish ports. Digital Twin understands where each transport unit is and keeps track of the status of goods handling. In the port area, full digitalisation allows faster through-times. This also solves the continuing difficulties ports have with developing productivity in what is often a physically limited space. The fluidity of traffic is undeniably significant for port authorities and port areas reducing their carbon footprints.

The electrification of passenger transport is seen in the development of a contactless customer experience in terminals and passenger traffic, as well as on cruise ships.

This digi-leap is only in the initial phase in some of Europe's ports, while views have already turned towards considering the more long-term electrification of ports. In July, the EU Commission published a proposal of methods for the reduction of greenhouse gases within the EU, in the form of climate package Fit for 55. The proposal includes the focused reduction of emissions in several industries. Transport will play a central and critical role in Europe's reduction of greenhouse gases.

European ports recognise that they must take care of their own roles in reducing maritime emissions. For ports, it is a question of connecting ships to shore-side electricity while they are at berth. The proposals in the climate package require ports to invest in shore-side electricity for both goods and passenger transport, as well as cruise transport, and in turn the ships are required to use the facilities.

The carbon dioxide emissions of ships in port comprise only a small part of the total maritime emissions produced during navigation, which is why the EU Commission's Fit for 55 package includes a proposal to convert ships to clean energy, as well as the inclusion of sea travel in the EU's Emission Trading System.

In the future, considerably more electricity will be needed in ports, compared to current demand. We also need more robust electricity grids, so that a comprehensive electrification, automation, and digitalisation is possible.

In Europe, a previously unseen race has started for the production, transport and use of hydrogen. In this too, a new landscape is opening up for ports: offshore wind power and water combining to produce hydrogen for use in industry and in transport could not be better placed than in the natural home of ports.

In the next few years, we will come to see a new digi-leap; this time accelerated by climate goals, the reduction of greenhouse gases, energy changes and with that the transfer to new energy sources. All in all, from a port perspective, the digitalisation of traffic continues to be a relevant solution to reducing the greenhouse gas emissions of port areas. ■

ANNALEENA MÄKILÄ
Managing Director
CEO
Finnish Port Association
Finland

www.satamaliitto.fi

Chairman
European Sea Ports Organisation, ESPO
www.espo.be

IVEN KRÄMER

OPS just one option to reduce emissions in ports

Expert article • 3136

For both, shipping and ports emissions and air quality have become an issue of highest priority and with latest decisions from the International Maritime Organisation (IMO) at the UN Climate Change Conference in Glasgow, a pathway to net zero is clearly set. There are stricter regulations in combination with ambitious goals for a zero emission future that drive the shipping lines and the charterers. At the same time, there is an increasing pressure by local communities to tackle the existing problem of air pollution in urban ports. Therefore, numerous actions and projects are under way for the uptake of sustainable ports and shipping and there is one technical option that promises to be an easy and fast solution Onshore Power Supply or OPS. To date in some 60 global port's OPS-projects and installations have already been made and more are in planning, but is this the one size fits all solution for the overall emission problem in seaports? No, OPS is just one option to reduce air emissions in ports that furthermore requires power from pure renewable sources.

Onshore power supply as a high voltage shore connection is synonymous with cold ironing, a term used by the US Navy when ships were using coal-fired iron engines, which cooled down during port stays. It requires intense and expensive fixed or mobile installations within the ports and at the same time technical installations and adjustments on the vessels. The investment costs are directly related to the type and size of the ships and thus to the specific power demand. Container ships for example have a power demand between 4 to 8 MW whereas large cruise vessels need more than 12 MW. The power demand is furthermore depending on the individual time spent at berth and the frequency of ship calls. Technical challenges are the cable connectivity especially at berths with a high tidal range. This often requires the implementation of additional cable troughs and shafts, crane arms, lifting platforms, cable management systems and so on. Furthermore, depending on the capacity of the port network and the needed additional OPS-capacity there might be extra investments into substations and new cables necessary. Once realised and operational OPS installations prove to have a positive impact on closed to berth housing areas and the people, which are living and working nearby. Especially in ports with a high frequency of ship-calls and berth locations closed to or even within the city-centre (urban ports), measurements demonstrated the effectiveness of these installations.

These generally positive results in combination with intense marketing efforts for those already existing installations have led to an overwhelming public and political support for OPS. Often it is therefore not mentioned that OPS shifts the responsibility to reduce emissions from the shipping sector towards the ports and that only a smaller proportion of ships is OPS ready yet. As of 2021, not more than ten percent of the global seagoing ships are equipped with on-board OPS installations whereof the majority are full container ships and ferries and the segment with the highest rate are cruise vessels.

For the reduction of emissions from ships, there is the option to improve the vessel-design to reduce specific fuel consumption. There is the upcoming and most promising shift from fossil to synthetic fuels and alternative means of propulsion. And, there is the option for improvement practices during docking periods. The last option focusses on the time spent in ports that is typically not more than 20 percent of a ships lifecycle. As such, OPS is not a solution, which is addressing the overall target of the reduction of shipping emissions. Some shipping lines therefore asses OPS as being negative for the industries plans towards a full zero emission shipping and regard this as a solution for richer countries only.

Even if politically favoured OPS installations remain in most ports high-risk investments since there is so far no legal requirement for the use of the available installations once provided. As a result, so far all existing OPS installations could only be realized by public investments or with a high-rate public subsidy. Based on this only few shipping companies and ports are pushing forward towards a 100 percent distribution of OPS to all berths and those ports that are already providing OPS for seagoing ships typically have only one and none of them has more than ten berths equipped. Taking the still very high and so far in most places uneconomical investment and operational costs into consideration OPS is will in the nearer future be not more than a solution for specific shipping markets like large container vessels, cruise ships and maybe ferries.

To take action against air emissions from ships in general European ports have created an goal-based approach called Zero Emission at berth, though which any technologies available to achieve the gradual emission reduction standards should be accelerated and encouraged. These technologies include not just OPS but also hybrid solutions, hydrogen, ammonia or synthetic fuels. This would give guidance to the shipping sector on the objectives while providing necessary flexibility on the choice of technologies allowing choosing the most effective solutions. For ports, this would be even more beneficial than OPS, as these solutions could also be operational and emission saving while manoeuvring within the ports and on the passageways. The positive effects would not be restricted to the short time at berth and not to just some ports in the western hemisphere. ■

IVEN KRÄMER
Dr., Head
Unit of Port Economy, Infrastructure and Shipping, The Ministry for Science and Ports
Bremen, Germany

TOMMI INKINEN

Baltic ports benefit from collaboration and planning in waste management

Expert article • 3137

Collaboration is one of the key-enablers in the pursuit of efficiency and enhanced operation performance. This holds true also in the case of Baltic Sea ports, on which we wrote a scientific paper with Irina Svaetichin (2017) some years ago. The article focused on waste management in four main ports located in Denmark, Estonia, Finland, and Sweden. The paper was to consider collaborative and legal arrangements of waste management and port profiles. We asked what kind of wastes and dischargeable items they process and accept. We focused on cruise ships as they produce extensive amounts of different types of waste and their popularity was on continues upswing at the time.

Our study indicated that ports have clear and distinct profiles on what types of waste they handle and how they see the future. We also looked at the pricing options for different waste types and their discharge volumes. Ports have of course several tools to influence the types of waste that ships leave. They may require specific recycling and support specific methods of waste handling. This can be motivated with fee reductions e.g. with proper sorting of passenger generated waste.

Wastewater discharging is the most unevenly distributed waste fraction in the Baltic ports. There are clear and identifiable differences in the discharging of black and grey waters. Ports can determine the fee rates and amounts that they accept to receive causing variations. In our study, ports of Helsinki and Stockholm received the largest amounts of wastewater and the main reason was in port policies (e.g. no extra charging for larger volumes). Both ports have also sophisticated system integration to municipal wastewater system enabling efficient wastewater management at berth.

Port statistics verify the differentiation between ports in their waste handling volumes and contents. Specialization is one of our main recommendations. This is important, as the Baltic Sea is a small and shallow sea with very high traffic volumes. The broadness of the mix of different shipping companies, vendors, and other operators is extensive. The diversity of business combined with the ever-increased demand (before the outbreak of Covid-19 pandemic) for cruise shipping and leisure travel in the Baltic Sea created a continuous need for improving the waste handling, both in ships and in ports.

The small physical size of the Baltic Sea causes that all major ports are relatively close to each other. Thus, the time of accumulating waste in ships is rather limited and the vessels are not holding their waste amounts for excessive periods. In the near future, when the pandemic subdues, these demands continue to increase. Waste and other forms of environmental management has to keep up with the future waking travel volumes after the pandemic. As such, IMO regulations have implemented in order to tackle and at least maintain the delicate condition of the Baltic Sea. Fundamentally, environmental and cost efficiency bring in the need for the mentioned collaboration. Small distances aid efficient formation of different modes of collaboration.

The future demand for port specialization is likely to increase. This entails several interesting topics, on which there already is some empirical research. At the University of Turku, we have conducted specific qualitative studies on Finnish ports and their short and long-term perspectives on digitalization and open data potentials (e.g. Inkinen et al. 2019; 2021). Particularly, environmental improvement and the simultaneous development of blue and green technologies to support livable Baltic Sea. These developments have also an impact on waste and environmental management.

To conclude, waste management is a tangible and well justifiable example of a port operation that requires smooth and well-functioning sea-port-land integration. Forthcoming studies need multidisciplinary approaches and purposeful methodological mixes. Qualitative and quantitative methods and their innovative combinations are in high demand in order to obtain a colorful, versatile, and meaningful picture of the future development of the Baltic Sea. ■

TOMMI INKINEN
Professor of Economic Geography
Department of Geography and Geology,
University of Turku
Finland

tommi.inkinen@utu.fi

MARJUKKA PORVARI

Focus and courage are needed for saving the Sea

Expert article • 3138

In 2007 the countries belonging to the Baltic Sea Marine Protection Commission HELCOM agreed to return the Sea in good ecological status by 2021. Despite good intentions, the launch of the new HELCOM decade in October 2021 had to be started by admitting the failure in reaching the needed nutrient reductions, and the new time limit was set to 2030. It was a pity, as the climate change ridden Baltic Sea is suffocating in high nutrient loads which are also the main threat for its fragile biodiversity.

Striving for a more successful outcome in 2030, there are lessons to be learned for the next ten years. Some of the past policy approaches and areas of HELCOM have been more successful than others. The Hot Spot list with 162 main pollution sites, established after the collapse of the Soviet Union in 1992, has certainly been one of the success stories. Coupled with financing from countries and international financing institutions, it has enabled major reductions in pollution load. The power of the Hot Spot list has stemmed from its strong policy focus and message which have effectively steered national decision making among various political priorities and resource needs.

HELCOM is often described as a regional policy setting institution. After the former Eastern Bloc countries joined the EU, HELCOM lost some of this significance - especially as its policy instruments, on the contrary to the EU directives, are not legally binding. However, the fact that Russia is a part of HELCOM has provided added value. Also, although non-binding, the HELCOM recommendation on wastewater treatment which is stricter for phosphorus discharges than the EU directive has been important policy-wise and driven nutrient reductions in the whole Baltic Sea region.

The John Nurminen Foundation has been an active player in improving wastewater treatment in the Baltic Sea region since 2005 and has financed investments in several former Soviet countries. Our experience confirms that the HELCOM wastewater recommendation and international financing were for many years important drivers of wastewater investments especially in Russia and Belarus. Phosphorus is the main challenge for the eutrophied Sea, and therefore the achieved reductions in phosphorus load have been essential for its survival.

On the verge of the new decade, the questions of focus and impact become decisive for HELCOM's legitimacy. After the Crimean conflict cooperation with Russia has changed its nature. Russia formally participates in HELCOM but the active and impactful years of sweeping Hot Spots jointly with westerners are gone. This is due to sanctions which prevent financial support from the West, and the new political distance between Russia and Europe.

Another issue hindering the progress has been the status and fate of the Hot Spot list, considered for several years an instrument which had outlived its political relevance. Ending the name-and-shame business would have been short-sighted, as it has certainly been the most successful and operational part of the HELCOM cooperation. Luckily, the Hot Spot list was rescued in the Baltic Sea Action Plan's renewal and will be updated in 2025.

Apart from the successes in municipal wastewater treatment, there have been major challenges. HELCOM has been unable to deal with some of the largest industrial pollution sources in the region. Fertiliser industry and especially its waste handling have proven to produce significant risks for the Sea. This was understood in 2012, when a phosphorus leakage from the Phosphorit fertiliser factory to the Luga River was revealed in Kingisepp, Russia. Before it was directed to treatment, the estimated discharge was nearly 10% of the total phosphorus load to the Sea. The magnitude of the discharge shows that the phosphogypsum waste stacks should have been immediately addressed in the whole region. Unfortunately, 10 years after the Luga incident phosphogypsum still seems to paralyse HELCOM. No coherent and comprehensive up-to-date information and monitoring data has been provided, and no environmental investments have been realised to prevent leakages of the high-risk stacks on the Polish coast.

The other paralyzing theme is agriculture which has become the largest source of nutrients to the Sea. The most wicked problem is legacy phosphorus in soils, coupled with concentrated animal production. High animal numbers induce more phosphorus accumulation, as phosphorus-rich manure is dumped into soils. This keeps the high agricultural phosphorus load up and running.

Manure phosphorus is regulated in the Annex III of the Helsinki Convention which sets a limit of 25 kg/ha for manure phosphorus application. However, although the Convention and its annexes are legally binding for the contracting parties, a recent review revealed that Sweden is the only HELCOM country implementing the manure limits.

The key problem is that industrial scale animal husbandry has separated plant and animal production. And when transported away from animal production regions to plant cultivation areas, manure phosphorus easily becomes 10 times more expensive than mineral phosphorus. The price disparity turns manure nutrients into waste which is left to pollute soils and waters in the areas of intensive animal husbandry. The efforts to change the situation by making nutrient recycling strategies and roadmaps are bound to fail if the root problem – the fact that the value of transported nutrients is way too low to cover the processing and transport costs – remains unsolved. Legislative whips and economic carrots are urgently needed to solve the issue.

The clock is ticking and 2030 approaches soon. The old paralyzing challenges remain ahead of the HELCOM community, and its credibility depends on the ability to respond. It will require persistence and courage to raise the same difficult issues on the table, and it would certainly be tempting to switch to something fresh and diplomatically lighter. That, however, would not get far in terms of results and legitimacy. Nutrients remain the life and death question for the Sea, and climate change just adds our urgency to reduce the load.

MARJUKKA PORVARI
Director / Clean Baltic Sea projects
John Nurminen Foundation
Finland

marjukka.porvari@
jnfoundation.fi

GUNNAR PRAUSE

Culture for post-COVID recovery

Expert article • 3139

Cultural and Creative Industries (CCIs) have been intensively studied within the last decade due to high economic growth potential and positive impact on innovation and regional development. Baltic Sea Region (BSR) enjoys a prospering CCI sector with a large number of agile creative hotspots around the BSR deploying directly their innovation energy or in cross-sectoral cooperation with traditional companies. Consequently, EU Strategy for the Baltic Sea Region (EUSBSR) recognises the CCI sector as an important contributor to smart regional transformation and sustainable development. Meanwhile, some EU-projects like "CTCC" project or "Creative Ports" project investigated the CCI clusters within the BSR and contributed to the facilitation of creative-traditional and the transnational cooperation.

This prospering development has been interrupted with the appearance of COVID-19 pandemic where the CCI sector together with tourism industry suffered most under the anti-COVID measures mainly based on lockdowns and social distancing. However, the CCI sector proved its creativity by launching innovative ideas and new channels to distribute cultural products and to meet their clients. Special importance devolved on digitalization strategies where the number of virtual concerts, exhibitions and other cultural offers exploded during COVID times but in parallel, also the demand and consumption of culture and cultural products via digital media increased significantly. A well-known case concerns the museum world where despite the fact that 95% of the museums closed their doors during lockdowns, the number of accesses to online museum websites increased by 200% showing that the cultural demand during Corona times increased and the clients used new channels to consume cultural products. Hence, social distancing and isolation seem to drive the demand for culture.

This observation seems to be in line with results from other science disciplines. A detailed analysis of COVID impacts from the psychological perspective highlights that social distancing and isolation measures caused severe mental health problems within the population representing a topic that have been neglected in the public discussions until now. Surveys from several countries revealed that COVID-19 measures are responsible for growing number of depressions and even suicide due to anxiety, unemployment fears, family aggressions, and social isolation. A representative German online-panel from this year with 5000 persons in the age between 18 and 69 years pointed out that the lockdowns had in general a significant negative mental impact on the normal population and that nearly half of those people who suffered already before COVID-19 from depressions indicated a worsening of their mental situation even up to suicide ideas.

These observations motivated OECD to reflect about an extension of the traditional role of the CCI sector by advocating cross-sectoral cooperation between CCI and health institutions since the experiences of lockdowns made evident the importance of arts and culture for people's mental well-being "and possibly, through the increasingly documented psychosomatic effects of cultural access" also to health. The OECD approach tries to tackle simultaneously two challenges by supporting the CCI economy after the pandemic and at the same time by facilitating and accelerating the recovery of post-COVID mental problems of the society. By doing so, new opportunities can be established to capitalize the role of arts and culture in the prevention and treatment of illness across the lifespan, contributing to solutions for health and welfare systems with the consequence to reduce hospitalization or medication rates. As a side effect, such approaches contribute to accelerate digitalization for regional development.

Meanwhile, first cities and regions recognized the advantage of CCI potential for post-the COVID recovery as well as a driver for social-economic regional development. Beyond the in issue of post-COVID recovery, CCI involvement in cross-sectoral innovation projects with traditional companies seems to be prospering also in issues related to climate change, aging society or the support of creative and cultural tourism. The BSR with its long Hanse history and its common Baltic cultural background can play the role of a test lab for whole Europe in the development of successful inter-cultural COVID recovery concepts as well as for trans-regional smart development. ■

GUNNAR PRAUSE
Professor
Tallinn University of Technology
Estonia

Professor
Wismar University Business School
Germany

gunnar.prause@taltech.ee
gunnar.prause@hs-wismar.de

ELISA ARO

The European Union supports sustainable and digital maritime processes

Expert article • 3140

The maritime industry in the Baltic Sea Region has experienced reforms in recent years. For example, digital development has taken real leaps forward and various parties are working together to develop operations and processes that are more sustainable for the business and the environment. Regulation has played a significant role in this development. New regulations and emission targets, set by the IMO and the EU, both demand and encourage organisations towards more environmentally-friendly maritime operations. At the same time, more and more national and EU funding programmes are supporting R&D projects with environmental targets without disregarding how to boost the regional economy. The Pan-European Institute at the University of Turku has been able to contribute to the development of the maritime sector in various development projects due to these funding programmes.

The Pan-European Institute is a research unit which specialises in several research areas, including the economic and business development of Europe with its bordering countries in the East. The maritime industry of the Baltic Sea Region has been a key research area for close to 10 years. Several maritime projects co-funded both by the EU and national funders have been implemented, such as SmartComp (Interreg Central Baltic), DigiPro (Business Finland) and CSHIPP (Interreg Baltic Sea Region). The latest example is the EU-funded Interreg Baltic Sea Region project titled 'Expanding efforts to bring eco-efficiency to maritime industry processes in Baltic Sea Region via digital tools' (EXOPRODIGI), which was put into action this year. EXOPRODIGI benefitted from the outputs of an earlier project with almost an identical name, ECOPRODIGI (2017-2020), by making more mature versions of several digital tools as well as broadening their purpose and deployment within target groups.

To be more specific, EXOPRODIGI focused on the development and implementation of digital tools within three maritime areas 1) shipping, 2) cargo stowage and 3) shipbuilding. As drafted in the application form, the objective was to support business processes by making operations more transparent, enhancing decision-making and reducing working hours. Ultimately, the project aimed at cutting energy consumption, waste materials and emissions in the industry. In other words, the project targeted at making maritime operations more sustainable both environmentally and business-wise. This was done through international collaboration between different actors from four countries: Finland, Denmark, Sweden and Lithuania. The project partners represented universities, a local authority, expert organisations specialised in the maritime sector and the Baltic Sea Region, as well as a great number of private enterprises. The group of enterprises consisted of established shipyards, shipping companies and solutions providers in the Baltic Sea Region. EXOPRODIGI was able to reach a large part of its objectives by its finish date in September 2021. Now is a good time to reflect on what was behind the success.

The support from the European Regional Development Fund, the Interreg Baltic Sea Region Programme and national funders enabled the establishment of networks and transnational collaboration, which would have been impossible to achieve on such a large scale without this support. Sharing the know-how and expertise between experts from different fields yielded new ideas and led development forward within organisations. Problem sharing and solving can often be easier and more productive in teams. Furthermore, the funding made it possible to gain access to and dig deeper into the maritime processes and the challenges within these processes. The funding further enabled the testing of tools and engagement of specific target groups, which is essential in order to receive feedback to the development work and to make sure that the tools work well when actually used in business operations. The results and best practices of the project could also be communicated to larger target audiences through multiple channels thanks to the funding.

The maritime industry in the Baltic Sea Region is in the midst of a sea of opportunities and challenges created by digitalisation and need for environmental sustainability. The EU-funded collaborative projects serve as bridges between actors in different countries around the Baltic Sea, bringing them together to ponder over common goals and to initiate innovative solutions. ■

Please see an animation summarising the achievements of EXOPRODIGI (video by Tussitaikurit Oy / Marker Wizards Ltd. and Centrum Balticum Foundation): https://www.youtube.com/watch?v=BfN41qn4L7U
For more information on the project, please visit: https://ecoprodigi.eu/exoprodigi

ELISA ARO
Research Manager
Pan-European Institute,
University of Turku
Finland

THOMAS DOEPEL

Securing National Emergency Supply in a sustainable way

Expert article • 3141

For more than 70 years, Finnlines has played an essential role in integrating Finland with the rest of the Europe and Russia and increasing the prosperity in our country. With good seamanship and long-term focus, the company has navigated through several economic storms during the years. In fact, thanks to these challenges, Finnlines is today in better shape than ever.

The current world crisis due to the Coronavirus pandemic has taken the world by surprise and challenged governments, societies and economies globally. Whilst ensuring the safety of its citizens, it is just as important to safeguard the supply of food, medicine and other consumer goods to each country. Finland's island-like location, and its dependence on sea transportation require frequent and regular liner traffic services. This is nothing new to Finnlines, being the most important player providing maritime transport of rubber-tyred vehicles, i.e. lorries and trailers to and from Finland. In fact, Finnlines alone transports more than one third of the roughly one million trucks moving over the three main sea bridges, Finland–Estonia, Finland–Sweden and Finland–Germany, which are connecting Finland to the rest of Europe.

Maritime vessels specialized in transporting rubber-tyred vehicles, or commonly called rolling cargo, all form part of the RoRo segment. When focusing on freight or non-passenger transport, the short sea RoRo segment can either be served by Ferries, RoPax vessels or RoRo. Thus, it is justified to say that Ferries, RoPax vessels and RoRo vessels are competing within the same market. Ferries, which base their main income on passenger transports and onboard entertainment have quite limited capacity for freight and have a much heavier cost structure than RoPax and RoRo vessels. When referring to the RoRo segment, the difference between pure RoRo vessels and RoPax vessels or Ferries is that they are not allowed to carry more than 12 passengers.

Since the beginning of the Coronavirus pandemic, the Finnish state has granted close to 100 million Euro of aid through imposing public service obligations to existing Ferry operators, and additional state aid is still expected. In Finnlines' view it is very important to secure the security of supply in Finland. However, the decisions made only to support Ferry operators is not optimal for the security of supply, they are extremely expensive for the society, they discriminate operators in the field and treat them unequally, they distort competition and thus, violate EU State aid rules.

How should the Finnish state instead have secured the security of supply in Finland? The answer is quite simple. While the total sea transport fell by 6 percent in 2020 vs 2019, the number of passengers in foreign shipping fell by as much as 65 percent. If we consider only the maritime link between Finland and Sweden, the drop in rubber-tyred vehicles was around 2 percent, whereas numbers of passengers fell by 73 percent. It is evident that the critical supply should have been secured by suitable tonnage, designed to generate its income from freight, and by utilizing the unused capacity that already existed on the routes.

The inefficiency of supporting the Ferry traffic between Finland and Sweden can easily be translated into environmental figures. The four ferries that had the public service imposed on the route Turku – Stockholm emitted appr. 170 000 tons of CO_2 during the nine months that the Coronavirus pandemic affected the traffic in 2020. At the same time, the combined passenger capacity utilization rate was only around 6 percent, meaning that they were practically running empty. If the Finnish state instead would have let the market work or have time chartered a suitable RoPax vessel instead of these four Ferries, securing the same freight capacity, the overall CO_2 emissions would have been 81 percent less.

So what can we learn from all of this? First, it is important to recognize that Finland is dependent on sea traffic, its fluency and competitiveness. Almost 90 percent of exports and 80 percent of imports to Finland are transported by sea. Thus, maritime transport services are considered as critical infrastructure for Finland's security of supply.

The Finnish public-private cooperation is exceptional from an international point of view and the National Emergency Supply Agency plays an important role in securing the security of supply in Finland. Finnlines again, being the market leader in rubber-tyred maritime traffic in the Baltic Sea area and providing cost-efficient regular high frequency traffic to both private and public sector, with the lowest CO_2 emission per transported rubber-tyred vehicle, will continue to safeguard the National Emergency Supply in a sustainable way. With its EUR 500 million investment programme for ultra green vessels, Finnlines will not only meet the needs of today but also safeguard the interest of tomorrow. The five new vessels due for delivery in 2021-2023 will help Finnlines strengthen its role of Finland's critical infrastructure and security of supply. In addition, the environmental footprint of each carried passenger or truck will reduce significantly from current level, being already the smallest footprint of all available options. Sustainable operation equals financially sound operation. Therefore, the Finnish government can rest assured that Finnlines will remain in its role safeguarding the National Emergency Supply during the Pandemic or any other crisis in a sustainable way. ■

THOMAS DOEPEL
Chief Operating Officer (COO)
Finnlines Plc
Helsinki, Finland

Thomas.Doepel@finnlines.com

TADEUSZ SZELANGIEWICZ

Unmanned vessels - maritime transport in the 21st century

Expert article • 3142

There are currently about 100,000 ships over 100 GRT floating the seas and oceans. These are diesel-powered ships (there are few electric-powered ships). Further development of sea transport based on traditional manned ships may be limited due to problems related to: crews (e.g. pandemic, lower interest in the seafaring profession), shipping safety (currently about 80% ÷ 90% of maritime accidents and disasters are caused by humans) and environmental protection (further use of combustion engines and oil-based fuels will increase CO2 emissions and other toxic exhaust components).

One of the new technological solutions that can improve the situation in maritime transport and stimulate further development are unmanned ships. Ongoing analysis suggests that allowing unmanned ships to operate will:

- reduction of the number of marine accidents and disasters,
- reduction in operating costs (the cost of building a prototype unmanned 100÷300 TEU container ship will be about 3 times that of a manned container ship of this size, the cost of building an autonomous serial ship ~10% lower than a traditional ship, operating costs 30÷50% lower, travel costs ~40% lower energy consumption, total operating cost reduction ~80%),
- improved protection of the marine environment (all ongoing projects and research on autonomous ships have electric, zero-emission drives),
- better planning and optimization of the ship's route, improving punctuality of arrival at the destination port,
- better protection of the ship against maritime piracy.

Along with the construction and operation of unmanned vessels, land-based centers for monitoring, supervision and possible remote control of these vessels must be established - ultimately, unmanned vessels will be controlled autonomously (on-board computer with control software along with the entire system of sensors for measurement, navigation equipment and radio communications) or remotely from a land-based center (change in the level of autonomy or in emergency situations).

The design, construction and operation of unmanned autonomous vessels, especially in international waters, requires solving many legal and technical problems.

The major legal and administrative issues to be addressed are:

- developing regulations to allow unmanned vessels to operate in international waters (such work is ongoing in IMO),
- clarify whether an unmanned vessel will be allowed (required ?) to take part in a rescue at sea (SOLAS Convention),
- whether it will (can) have to take survivors on board,
- how the control of port services or other institutions would be carried out on an unmanned vessel,
- what should be the procedures and protocols for information exchange between vessels (manned and unmanned) at sea,
- what role (captain, navigator, first engineer) and responsibility will the operator of the unmanned vessel have from the land – based center,
- who will be responsible for damaged cargo or sinking of the unmanned vessel (shipowner, land operator),
- how the seaworthiness of the unmanned vessel will be determined and how the liability of the vessel's insurer will be defined (if the vessel is unseaworthy, the insurer will not be liable for damages).

The most important technical and technological problems need to be worked out:

- construction and operational regulations for unmanned ships (Classification Societies), adaptation of the ship's structure and equipment to the legal regulations concerning e.g. participation of an unmanned ship in rescue operations,
- new materials for the ship's hull structure to reduce its weight, resulting in lower propulsive power and increased transportation efficiency,
- new structural solutions of the ship's hull and its equipment,
- propulsion systems, zero emissions for long range or autonomy of the unmanned vessel (currently tested electric propulsion systems with batteries allow for short range, about 200 Mm),
- maintenance-free electric drive systems and electrical supply systems, in the long term with high power and high voltage,
- global remote control and monitoring systems and radio communication systems with very low latency and resistance to various interferences, including cybercrimes,
- port infrastructure adapted for unmanned ships (mooring, unloading, loading, port power supply).

For about 20 years, research on the construction and autonomous control of unmanned ships (the first prototype of an unmanned ship, the Yara Birkeland, began trials in late 2021) has been conducted on models or on existing small, manned vessels (e.g. ferries) operating in internal waters or designated, for research, shipping routes. In order for unmanned vessels to operate regularly in international waters, legal and technical issues must be resolved. The involvement of many countries with large maritime traditions and research and industrial institutions in conducting research gives reason to believe that in the near future unmanned ships will be widely used, initially on shorter sailing routes. ■

TADEUSZ SZELANGIEWICZ
Head
Department of Naval Architecture and Shipbuilding, Maritime University of Szczecin
Poland

t.szelangiewicz@am.szczecin.ol

CÉLINE VANEECKHAUTE

Ship-generated nutrient discharges on the Baltic Sea

Expert article • 3143

Nutrient discharges into the Baltic Sea and the resulting phenomenon of eutrophication have caused environmental issues in the area for decades. Eutrophication is characterized by the proliferation of harmful algae blooms and low-oxygen (hypoxic) waters, all affecting ecosystem diversity, aquaculture activities and tourism, to name a few. The increase in maritime transportation and the resulting increased production of ship-generated wastes contribute to the devastating environmental impact on maritime ecosystems worldwide. Due to its important ecological and socio-economic character, the Baltic Sea has been designated as Particularly Sensitive Sea Area (PSSA) by the International Maritime Organization (IMO) in 2005. This involves the application of strict discharge regulations provided by the International Convention for the Prevention of Pollution from Ships (MARPOL), as well as the need for specialized equipment on board of ships.

Ship-generated nutrient discharges into the Baltic Sea mainly include food waste and sewage. Regarding food waste, its discharge after grinding or comminution at more than 12 nautical miles from the nearest land is still allowed and common practice on the Baltic Sea. Nevertheless, a more sustainable approach may include its valorisation through, for example, anaerobic digestion or composting, either on board of ships or following delivery at port reception facilities. This would allow recovering valuable nutrients as a fertilizer product, all while producing bioenergy in the case of anaerobic digestion. These products could be used on board of ships (for example, for ship-based food production), at the port, or marketed elsewhere. It should be emphasised, however, that priority must still be given to the reduction of food waste production at the source, mainly in the case of cruise ships.

Ship-generated sewage includes black and grey water. Black water includes sewage generated by toilets, urinals and medical facilities, while grey water comes from showers, baths, sinks, laundry and dishwashers. Typically, less water is used on board of ships as compared to land-based applications; hence, sewage on ships is typically two to three times more concentrated as compared to its land-based equivalent. The discharge of untreated black water on the Baltic Sea is prohibited, but no special limitations exist to date for grey water discharge. Since 2019, advanced treatment systems treating nitrogen and phosphorus are required on all new passenger ships in the Baltic Sea area, or the black water must be delivered to port reception facilities for treatment. Although multiple advanced treatment systems are available today that meet the required discharge regulations, further improvement regarding the sustainability of these systems is possible. Current research at the BioEngine research team on Green Process Engineering and Biorefineries (Université Laval, Canada) looks at the recovery of these nutrients instead of their removal. This would allow for their valuable reuse, for example as mineral fertilizer products. Reuse of the valuable resource, water itself, is also being looked at. Moreover, wastewater treatment also typically produces a residual sludge stream, which should be disposed of properly. The latter could be valorised through anaerobic digestion or composting, along with food waste as indicated above. All of this could help to further reduce the environmental, economic and social impact of ship-generated wastes on the Baltic Sea.

In order to facilitate decision-making regarding the selection of the most sustainable waste management option, research has been initiated at the BioEngine research team aiming at the development of a decision-support system for ship-based organic waste valorisation, including food waste and sewage. The software tool should allow determining, comparing and optimizing the economic, environmental and social benefits of various waste valorisation strategies. ■

CÉLINE VANEECKHAUTE
Canada Research Chair in Resource Recovery and Bioproducts Engineering

Director
BioEngine Research Team and Laboratory on Green Process Engineering and Biorefineries (BioEngine)

Associate Professor
Department of Chemical Engineering,
Faculty of Science and Engineering,
Université Laval
Québec, QC, Canada

celine.vaneeckhaute@gch.ulaval.ca

NICOLE WERMUTH

Large engines for sustainable shipping solutions

Expert article • 3144

Since the IMO adopted a resolution in 2018 to decrease the emissions of greenhouse gases from marine transportation by 50 % by 2050, the focus of ship emission reductions shifted from sulfur oxides and particulate matter to carbon dioxide emission reduction. The Large Engines Competence Center (LEC GmbH) in Graz, Austria, works towards this goal and develops sustainable shipping solutions for medium- and high-speed engines. Together with a consortium of 12 major players from the shipping sector, the European research project HyMethShip is currently being completed.

The carbon dioxide emission reduction goals are far beyond what efficiency increases alone can deliver. Innovative concepts and changes in fuel or energy supply are required. Large engines are well proven, reliable and efficient prime movers in maritime shipping and—in principle—can be operated with almost any kind of e-fuel. While the use of hydrogen as a carbon-free fuel in land-based applications seems straightforward, logistics, safety requirements and most of all space constraints on board of vessels strongly favor the use of liquid fuels with high energy density. E-fuels such as methanol and ammonia are strong candidates but currently there is no clear favorite solution in sight. Thus, various viable solutions need to be examined in depth and approved. This technology qualification process requires participation of numerous stakeholders, including shipbuilders and classification societies.

Over the last two decades the LEC developed advanced combustion systems for a wide range of different fuels, applications and emission legislations using a combination of simulation-based and experimental methods and applying specialized measurement technologies to investigate in detail processes in the combustion chamber. Today the LEC is taking aim at large engine applications using renewable fuels – methanol, ammonia and hydrogen in particular.

The LEC introduced the novel HyMethShip concept for sustainable ship propulsion that features a methanol-based closed-loop carbon cycle combining the benefits of liquid fuel bunkering and storage with carbon dioxide-emission free hydrogen combustion in a large bore internal combustion engine. The concept uses on-land methanol synthesis using hydrogen plus recycled carbon dioxide and onboard methanol decomposition to hydrogen used for propulsion and carbon dioxide. The advantages of this concept are its use of established reciprocating engine technology, bunkering of a liquid fuel that does not require high pressure or cryogenic storage, and the recovery of engine waste heat for the precombustion carbon capture process.

The onboard setup consists of two interconnected subsystems: the fuel producing and carbon capture subsystem and the fuel consuming subsystem that provides the propulsion power. The first subsystem consumes methanol and water and produces hydrogen via methanol steam reformation in the catalyst portion of the membrane reactor. After hydrogen and carbon dioxide are separated in the membrane section of the membrane reformer, the carbon dioxide is liquefied and transferred to the tank system, while hydrogen is released to the fuel consuming subsystem. The two subsystems exchange the hydrogen fuel and the engine exhaust gas enthalpy; the latter energizes fuel production, which consists of methanol reforming (an endothermic process that requires heat to be sustained) and absorption cooling used for carbon dioxide liquefaction. Only little electric energy is required on top,

The LEC developed a flexible hydrogen combustion system on a single-cylinder research engine and transferred it to a full-scale engine demonstrator in the 1–2 MW power range. In cooperation with its project partners, the LEC also built the fuel production subsystem and integrated it together with a full-scale engine into a technology demonstrator. The project also included the design of a case study for a full-scale ship to demonstrate the integration of the complete system into the vessel. Based on this design, a classification society conducted a comprehensive risk and safety assessment of the design and operation strategies.

The technology demonstrator was built at the LEC facilities and commissioned in September 2021. It constitutes the development platform for the evaluation of subsystems, the implementation of identified improvement measures and the development of additional technology components for fuel pre-treatment and carbon dioxide capture. The main research questions that remain to be solved beyond the project's duration are the quality of the carbon dioxide separation, the optimal cascading use of the waste heat from the engine, and the best possible maintenance-friendly design of the entire plant. There are still a few hurdles that need to be removed before the system can go into series production on a ship in probably a few years. ■

NICOLE WERMUTH
HyMethShip Project Leader
Area Manager at Large Engines
Competence Center (LEC GmbH)
Graz, Austria

ALESSANDRO SCHÖNBORN

Looking for pathways to decarbonise shipping

Expert article • 3145

As the World Meteorological Organization announced that the global mean temperature for 2020 was 1.2 ± 0.1 °C above the 1850–1900 baseline, while at the same time the International Energy Agency reported that in 2021 global carbon dioxide emissions are expected to rise by around 5%, the challenge which climate change poses to our current way of life is clear.

The Baltic Rim Economies are traditionally relying on their strong maritime industry, hosting many household names of the maritime industry. As this sector is looking to free itself from greenhouse gas emissions, companies and institutions in the Baltic Rim are looking to take the global lead in decarbonizing shipping.

Shipping is an important contributor to the world's anthropogenic greenhouse gas emissions, at around 3%, and the International Maritime Organization (IMO) has already laid out 'The Initial IMO Strategy on Reduction of GHG Emissions from Ships'. With discussions ongoing, and its revision planned for Spring 2023, is likely to become more ambitious rather than less. The recent 77th session of the IMO MEPC discussed proposals from several parties aiming to revise the GHG reduction strategy to reaching zero net greenhouse gas emissions from international shipping by 2050. Assuming that the life-time of a vessel is of the order of 25 years, this yields some indication about the technological actions needed by 2025.

The aim is clear, but we are still looking for suitable pathways to decarbonise shipping.

The prevalent source of energy in international shipping is chemical energy stored in fossil fuels such as fuel oils and liquefied natural gas. Phasing out greenhouse gas emissions from shipping consequently requires the reduction of energy needs, or replacing the fossil fuels with a climate neutral alternative.

The trivial solution of removing energy needs is impossible, assuming that we wish to move ships at some speed, but energy needs may be reduced. The simplest way is reducing sailing speeds. While this may be a smart option for commodities that can endure longer transit times, it may not be practical for others, such as fresh produce needing to reach their markets. Energy saving without reducing speed, is possible by reducing friction via hull air lubrication systems and optimized hull shapes, more efficient propellers and rudders. Increasing engine efficiency or replacing engines with fuel cells or electric drivetrains may help further, but overall efficiency improvements are inherently limited. Even if drivetrains approached 100% efficiency, the need for energy and the associated emission of greenhouse gas emissions would remain considerable, unless the source of energy ceases to be unabated fossil fuels.

Replacing the remaining fossil energy with renewable energy is thus necessary; assuming that safe and abundant nuclear energy is still some way out of reach.

Using renewable energy can be achieved in two ways: The first option is using renewable energy directly to propel ships in the form of sail power, or solar power captured onboard. This is the most direct and efficient option, since the problem is solved in situ. In the case of wind power, forces propelling the ship are applied directly to the ship, and thus they conveniently avoid the losses of the propeller. The second option is to harness renewable energy elsewhere, on land or at sea, and to store it either in the form of electricity (using batteries) or in the form of the energy contained in fuels, such as hydrogen, ammonia or synthetic natural gas (SNG) or methanol. Such chemically-stored energy needs to be converted back into propulsive energy on a ship using an engine or motor driving a propeller. This option has the advantage of being available on demand, but it inevitably transfers the problem from international shipping to the world's renewable energy production, rather than solving it where it occurs. It is also associated with significant energy losses when converting renewable energy to fuels and then reconverting converted back into movement in the ship engine or fuel cell via a propeller. It is widely accepted that at the current state of development in battery design, storing energy in batteries is not yet a viable option for intercontinental shipping, because batteries cannot store enough energy.

Looking for pathways to decarbonise shipping also requires consideration of the social, and economic dimensions, and the challenge is thus significantly more complex than suggested above.

From an environmental perspective, however, even clean fossil fuels are a red herring. And although they are widely discussed and arguably necessary to some extent, zero-carbon renewable fuels, will apply further pressure on climate neutral energy production occurring 'elsewhere', rather than shipping taking responsibility for its renewable energy production. The most sustainable pathways to decarbonise shipping lead clearly to the production of renewable energy in situ, as much as possible. ■

ALESSANDRO SCHÖNBORN
Assistant Professor, Maritime Energy Management (MEM)
The World Maritime University

PAULA KANKAANPÄÄ

Ecosystem based management in the core of science and environmental diplomacy in the Baltic Sea and the Arctic Ocean

Expert article • 3146

The arctic sea ice is melting due to the warming climate. Less attention has been paid to the fact that the winter sea ice cover of the Baltic Sea has also decreased. The marine ecosystems in both regions are expected to dramatically change.

The world nations share the responsibility for the seas and their ecosystems. As virtually all human activities affect the seas, the effective protection of the seas and oceans requires wide-ranging cooperation. There, interdisciplinary research must support cooperation of different sectors of society and the work must be done together from the local, regional, and national levels to international cooperation. At the same time, different sectors of governance need to see the importance of multidisciplinary research and be able to invest in it together.

The seas are distant from everyday lives of many people, and there is less experiential knowledge than on land. The sea can often only be experienced from the surface, although the average depth of the world oceans is almost four kilometers (the Arctic ocean is on average 1.2 km deep, and the Baltic Sea is 54 m). Indeed, the seabed is less known that the surface of the moon. That is why research and monitoring of the seas are so important. Only science can assess the state of the seas and the need for societal action to protect them. Exploration of the seas is expensive because it requires demanding infrastructure. Therefore, research is carried out in cooperation networks and usually funded by states.

Both the Baltic Sea and the Arctic Ocean are examples of successful large-scale and fruitful cooperation between government officers and researchers. The Arctic Council, and especially its Protection of Arctic Marine Environment Working Group (PAME) work for environmental cooperation and sustainable development for the Arctic Ocean. Established in 1996, the Arctic Council is a forum for international cooperation between the eight Arctic states.

The Convention on the Protection of the marine Environment of the Baltic Sea Area entered into force as early as 1980. Later, this so-called the Helsinki Agreement that is coordinated by Helsinki Commission (HELCOM) and participated by all nine Baltic Sea states and the EU, has adapted to promote regionally the younger EU Marine Strategy Framework Directive from 2008 and the even newer Maritime Spatial Planning Directive from 2014.

The core of international environmental cooperation in the Baltic Sea is so called ecosystem-based management, which is an advanced cooperative decision-making tool. The method has been implemented it the Baltic Sea for over decade, but not that much is known about it outside expert circles.

In the first phase of this systematic approach, the state of sea is monitored based on internationally agreed scientific methods and indicators. The focus is on functioning of entire ecosystems instead individual species or substances. National monitoring results are stored in the databases of the International Council for the Exploration of the Sea (ICES). Then, based on this commonly used data, each country complies an assessment report on the ecological state of its seas. The Finnish Environment Institute, together with other government research institutes, has the national responsibility for monitoring and reporting on the state of the sea for Finland.

Finally, based on the results of the assessment reports, national action plans for good state of the sea are prepared in cooperation by several sectoral ministries. The preparation includes wide-ranging participations and societal consultations. In Finland, the Government will approve our latest action plan in December 2021. After that, the measures will be implemented through national and international funding programs.

Implementation of national action plans take also into account the joint Baltic Sea Action Plan prepared by HELCOM. Its update was recently approved at the HELCOM Ministerial in October.

What is essential in ecosystem-based decision-making is that the work does not end with the adoption of the operational action plan. As the cost of the implementation Finland's action plan, for example, is hundreds of millions of euros, it is absolutely essentials to monitor scientifically whether investments are influential and can be detected as an improvement of marine ecosystems. Then, based on the new monitoring results, the action plans will be updated again.

All the stages of the whole process are carried out in six-year cycles. The national works are reported internationally in accordance with both the EU -directive and the HELCOM -cooperation.

For some years ago, a large group of researchers published an article "The Baltic Sea as a time machine for the future coastal ocean (Reusch et al., 2018). It describes how the Baltic Sea is a pioneer in both bad and good. Over hundreds of years, human pressures have led to unprecedented pollution of our small sea. But the Baltic Sea is also a forerunner in international research and environmental cooperation that includes all different sectors of governance. Successful science-based decision-making has produced significant results for example as reduction in the amount of nutrients and harmful substances discharged into the sea, recovering fish and bird

stocks, improving the quality of some coastal waters, and thus shifting societies towards so called sustainability transformation.

Unlike Baltic Sea co-operation, the Arctic Council is not based on an international agreement but is political by nature. Its work is based on a statement issued by the Foreign Ministers at their regular biennial meetings. Like in the case of the Baltic Sea co-operation, the declarations of the Arctic Council ministers are based on scientific assessments and recommendations.

The ministerial of the Arctic Council in last May agreed the strengthen the council further. Among other thigs, the importance of the Arctic Marine Strategic Plan and ecosystem approach to management was highlighted. The Baltic Sea cooperation has potential to serve as an inspiration for the development of the ecosystem based management in the arctic, while the research on ecosystem effects of melting sea ice in the arctic is of interest also in the Baltic Sea.

All in all, although the Arctic Ocean and the Baltic Sea differ greatly in terms of both natural and social conditions, there are many similarities in their international cooperation. It should be noted that, in view of geopolitical tensions in the world, environmental cooperation in these strategic regions has continued to be smooth. This is supported by the diversity and breadth of collaborative networks of both researchers and administrators for decades, which is the idea and the prerequisite for ecosystem-based decision-making. In addition to advanced international cooperation on the marine environment and its interdependent research activities, both areas can be considered examples of successful environmental and scientific diplomacy. ■

PAULA KANKAANPÄÄ
Professor, Director
Marine Research Centre,
Finnish Environment Institute
Finland

BRE REVIEW BALTIC RIM ECONOMIES

Pan-European Institute

TURKU

CENTRUM BALTICUM

TURKU CHAMBER OF COMMERCE

JOHN NURMINEN FOUNDATION

PORT OF TURKU FINLAND

Co-funded by
the Centrum Balticum Foundation,
the City of Turku, the John Nurminen Foundation, the Port of Turku and the Turku Chamber of Commerce