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Sustainable maritime shipping and climate action

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Author: Prof Rainer Durth, phone +49 69 7431-3607, Rainer.Durth@kfw.de

International shipping plays an important role in climate action. The sector releases more CO_2 emissions than all of Germany. These emissions can actually be reduced quite significantly by using existing technologies. But applicable legislation is weak, global cooperation is difficult and at least part of the climate impact of ships that will be sailing in 2050 is already being determined today. The current trend is heading in a completely different direction and an obvious goal conflict exists between trade, which is per se desirable (because it increases prosperity), and necessary climate action, given that ships, after all, transport 90% of the international flow of goods. As a result, the expected environmental impacts of shipping continue to be significant. Shipping is interesting for (at least) two reasons.

First, climate action in shipping has a lot in common with global climate action but is much less complex. This also means that an approach that is found – and works – in the relatively less complex maritime shipping industry may potentially be applicable to the significantly more complex problem of global cooperation on climate action. The main issues relate to how innovation emerges in the first place and how it spreads across the sector. Second, maritime shipping is by no means a large, homogeneous bloc. Rather, it is composed of segments that can also be regarded as very diverse environmental conditions for innovation. Sometimes, a close examination of the individual segments can even reveal new potential solutions. This is visible in the cruise market, where environmentally friendly vessels have become an important competitive factor and driver of innovation.

International shipping is relevant for the climate

Around 50,000 deep-sea vessels ply the world's oceans. Ships carry 90% of international freight. This is reassuring because shipping is relatively environmentally friendly.[1] However, shipping will increase as trade expands and wealth grows. Besides, many ships run on particularly polluting heavy fuel oil. In 2015 they released 932 million tonnes of CO_2 – 2.6% of global emissions. International shipping accounted for the bulk of these emissions (2.3%, cf. Figure 1).[2] Valued at the current cost rate applied by the German Federal Environment Agency[3], these emissions cause environmental damage of around EUR 170 billion each year – more than the market capitalisation of 11 German DAX companies.[4] The internationally operating ships alone release a greater share of global CO_2 emissions than all of Germany.[5] Around the world, ships cause roughly the same amount of CO_2 emissions as aircraft. From a climate policy perspective, their impact is therefore already anything but negligible.[6]

In addition, however, it is estimated that ship emissions may increase three and a half fold by 2050 in a business as usual scenario.[7] The contribution of maritime shipping to global CO_2 emissions would then rise to 17%.[8] Although these estimates are fraught with many uncertainties (economic growth, trade expansion, transport efficiency, etc.), this would obviously require much more ambitious national climate action efforts.

Figure 1: CO_2 emissions from shipping

In millions of tonnes of CO_2

Source: ICCT 2017

The good news is that in shipping, many low hanging fruit have not yet been picked; that is, relatively simple measures can reduce CO_2 emissions by relatively high amounts. Numerous technological options are already viable today. The bad news is that a solution to CO_2 emissions from shipping is so difficult to bring about because of the many challenges at micromanagement level that also characterise global climate action efforts. But this is precisely what makes maritime shipping so interesting from an analytical point of view. Moreover, CO_2 emissions in maritime shipping are highly concentrated. Only three types of vessels (container ships, tankers and bulk carriers) account for 55% of emissions, while 53% are released by ships that are registered in only six flag states (Panama, China, Liberia, Marshall Islands, Singapore and Malta).[9]

The basis for an international regulatory law is thin

The simplest solution would probably be to impose CO_2 emission limits on all the world's ships. In reality, shipping companies can choose the state under whose flag their vessel sails. And switching to a different state is quick and easy.

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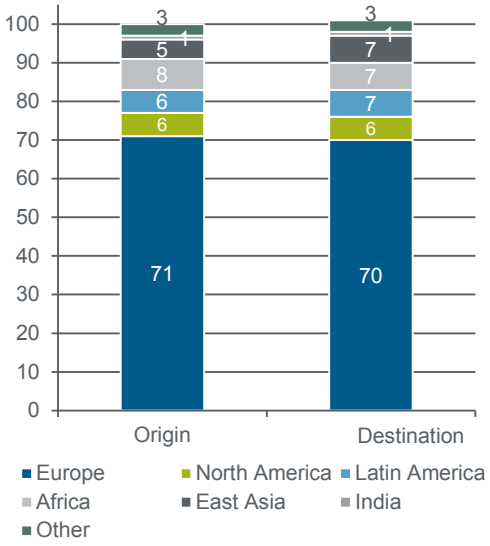
This means that nearly 200 states around the world are generally vying for revenue from maritime shipping. In addition to the direct financial cost for shipping companies, providing generous environmental legislation is an important competitive factor for these states.[10]

The International Maritime Organization (IMO) of the United Nations works on the basis of international law and has been operating globally since 1959. It has 174 member states with voting rights and includes numerous organisations without voting rights.[11] The IMO usually makes decisions based on consensus, that is, each member state has blocking power.[12] In 1973 the members developed the International Convention for the Prevention of Pollution from Ships (MARPOL). Annex VI to the Convention entered into force in 2005 and regulates air pollution from ships, especially from sulphur dioxide emissions.[13] Since 2018, however, the IMO has been pursuing an own strategy for reducing greenhouse gas emissions from ships under which ship emissions are to be reduced by 50% by the year 2050 against the baseline year 2008.[14] Although MARPOL is generally implemented by the flag states, compliance with the Convention is in fact now being monitored by the port states.[15] Around the world there are today nine regional conventions under which the signatory states commit to inspecting the safety and pollution control measures on merchant ships in their ports without prior notification. The ships are classified on the basis of the inspections: 'Good quality ships' are inspected less frequently in future, while 'high-risk ships' are required to be inspected at the same intervals as now. Moreover, White, Grey, and Black lists are prepared each year, among other things for the flag states, on the basis of the inspection results.[16]

Regulation (EU) 2015/757 also addresses the monitoring function of seaports. After all, it is estimated that CO_2 emissions from European ships account for around one quarter of global CO_2 emissions from ships.[17] Of these, roughly 70% come from ships that originate directly from or sail to European ports (cf. Figure 2).[18] The CO_2 emissions from European maritime shipping are therefore primarily a European problem, so the important role played by European seaports can be harnessed. As a result, all ships in European ports now have to report their emissions to the European Commission.[19] This allows the ports to identify possible departures from local environmental regulations and enforce the requirements.[20] As a result of this emphasis on the principle of the port state, the EU is able to not only substantially reduce the number of states that have to cooperate with each other[21] but also limit cooperation to those states that are willing to pay relatively high sums for climate action. Both approaches make intergovernmental cooperation much easier. Of the greenhouse gas emissions in the EU, 4% are actually caused by maritime shipping and only 3% by air transport, which makes maritime shipping even more important for climate action in the EU than it is globally.[22] Even so, international maritime shipping remains the only type of transport that is exempt from the European Union's greenhouse gas reduction requirements.[23]

Figure 2: CO_2 emissions from European ships by origin and destination

In per cent



Source: TNO (2015). Greenhouse emission reduction potential of EU related maritime transport and its impacts. p. 19.

As an export nation, Germany is particularly dependent on competitive maritime shipping. In addition, the Federal Government estimates that around 400,000 jobs depend on the maritime economy in Germany. Furthermore, new technologies are to be developed and harnessed for the energy turnaround in a targeted manner. The Federal Government therefore adopted the Maritime Agenda 2025 in the year 2017.[24] The key building blocks of the agenda are new fuels and new drive technologies for ships, the promotion of sector coupling of energy, transport and industry and a greater use of digitalisation in the maritime industry.[25]

Most solutions are already technically viable

There has long been debate about how greenhouse gas emissions in shipbuilding and shipping can be reduced. The debate essentially centres on the following approaches:[26]

- Operation: The most important proposal is to save fuel in maritime shipping by reducing the speed of vessels (slow steaming).[27] In addition, maintaining hull smoothness through regular removal of molluscs etc. reduces drag resistance and new routes – now navigable year-round – shorten travel distances.

- Design: Greenhouse gas emissions can be reduced with lighter building materials, larger vessels, slimmer hulls / modified bow shapes and improved propellers and by installing filters / catalytic converters or enlarging vessels.

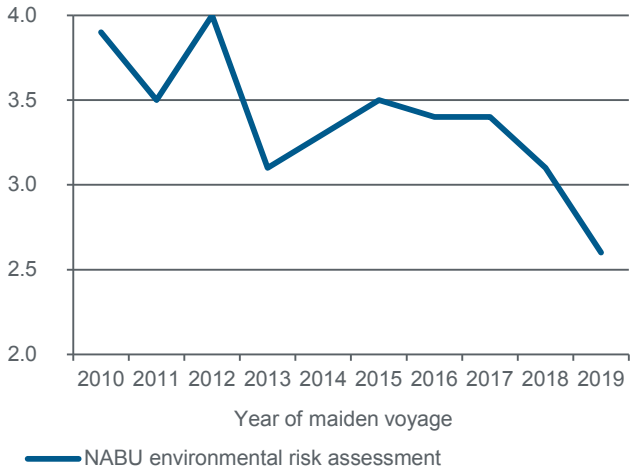
- Fuels: Most maritime vessels run on heavy fuel oil, a by-product of refineries that would have to be disposed of as hazardous waste. The mere conversion to diesel fuel would greatly reduce emissions. Liquefied natural gas is often debated and already in use but is difficult to transport and carries the danger of releasing methane, which is particularly harmful to the climate (methane slip).[28]

– Drive technologies: Efforts are currently underway to make alternative drive technologies available to the maritime shipping industry. In addition to wind energy (sails) and solar energy (photovoltaics), these technologies involve mainly electric drivetrains (e.g. fuel cells) and the generation of liquid fuels from renewable electricity (e-fuels).[29]

Taken together, these approaches generally enable considerable reductions in CO_2 emissions from maritime shipping. And although research is ongoing, the necessary technologies are already available, so reducing emissions is not a technological problem. Based on reasonable estimates, maritime shipping could be climate-neutral using existing technologies by the year 2035;[30] and besides, transport costs on average make up less than 3% of the total cost of a product.[31] Nonetheless, both the current and expected emissions from maritime shipping and the official targets of the IMO (see strategy above) are in obvious conflict with the need to limit the global temperature increase to 1.5 to 2°C, as agreed in Paris in 2015.[32]

Cruise liners make up less than 1% of ships around the world but account for 4% of CO_2 emissions from maritime shipping (among other things because of their above-average size and onboard hotel operation).[33] Moreover, they have a special responsibility, as they often berth in ports and fjords or call at particularly vulnerable locations (e.g. Venice). Many promise dream holidays based on an experience of unspoiled nature.[34] Cruises are therefore usually viewed with a critical eye.[35] Precisely because of this, however, protecting the environment has now also become an important competitive factor, especially in the German market.[36] Many cruise lines act as trailblazers for the rest of the maritime shipping industry.[37] Funding innovations of this sort in premium segments is definitely a tradition in environmental protection. The assessment undertaken by Germany's Nature and Biodiversity Conservation Union (NABU) impressively demonstrates how the environmental impacts of cruise liners have improved over time (cf. Figure 3).[38] NABU gave the environmental quality of European cruise liners newly built from 2001 to 2010 a poor rating (average score: 3.9[39]; after all, this figure represents one third of all cruise ships currently in service). The ships newly built for the European market in the ten years that followed have already shown gradual but significant improvement (3.4; three fifths of cruise liners). However, NABU gave the ships built in the year 2019 the highest score (2.6; almost one fifth of the fleet). Despite all criticism, the cruise industry is thus helping to develop, trial and diffuse practices and technical solutions that are better for the environment in a scantily regulated international context. Examples include the provision of electricity to cruise liners berthed in port – which is now often climate-neutral thanks to renewable sources – and the construction of modern ships with cleaner drive technologies.[40] In this sense, the cruise industry can be understood as an important laboratory. What is also interesting is that increasingly more cruise passengers have begun to offset their CO_2 emissions on a voluntary basis.[41]

Figure 3: Reduction of environmental impacts of cruise liners for the European market according to NABU



Source: Own calculations and rendition using data from the Nature and Biodiversity Conservation Union (2019). Methodology: NABU assesses each cruise liner individually under environmental aspects and also states its maiden voyage. There are four traffic lights for each ship that may be shown as red (1 point), amber (0.5 points) or green (0 points). So the maximum score achievable is 4 points. The lower the sum of all four traffic lights, the more environmentally friendly the ship is.

Climate action in shipping is very similar to global climate action

Some similarities to global climate action emerge. However, international shipping is slightly less complex, which makes it easier to penetrate analytically. Their CO_2 emissions are already high and the expected increase in the absence of countermeasures is simply no longer sustainable. The main similarities:

– The **technology** for reducing CO_2 emissions is already available and the main challenge probably lies in how these approaches can be broadly disseminated.[42] In particular, the targeted use of public policies will probably be required as well to support the transition to greener shipping. In addition, legal and institutional innovations will be necessary, for instance in the formulation and enforcement of environmental regulations. Particularly with a view to these innovations, the segments of maritime shipping which are subject to diverse framework conditions could be of general interest as well..

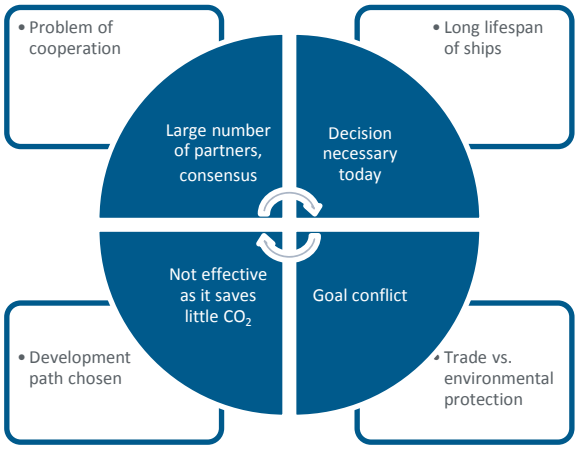
– All cooperation between states is being hampered by the fact that they are in **close competition** for shipping companies which can switch to another state at any time, quickly and without significant cost. This exacerbates the challenge of getting states to cooperate in **taking action on climate change mitigation as a public good**.

– Ships have a **lifespan of approx. 30 years**. Decisions on construction measures, viable fuels or alternative drive technologies are therefore made for a very long period of time (as in the case of power plants or buildings). So first of all, there is the danger that a path embarked on is pursued for the sole reason that it was chosen some time in the past (lock-in). For another, the long lifespan increases

the time pressure: CO_2 emissions in the year 2050 will therefore be heavily determined by the decisions taken today and tomorrow – and less by the decisions taken the day after tomorrow.

– The **development path** taken in maritime shipping currently does not provide for a reduction in CO_2 emissions and would have to be changed to achieve this. That would require a fundamental rethink and would require great effort. This is being hampered by international law and maritime law but particularly by the **goal conflict** between more environmental protection on the one hand and global trade and prosperity on the other hand. A reduction in CO_2 emissions means higher transport costs and lower prosperity levels.

Figure 4: Similar problems as in global climate action



Source: own rendition

Figure 4 sums up the problems once again. At first sight, the similarities are not directly encouraging. Apparently, there are limits to the otherwise customary international law regulations (here, through the IMO). But the similarities also illustrate how important it is to use 'competition as a discovery procedure'[43]. Independent developments in the cruise business could provide a particular advantage here. The same would apply to EU legislation based not on flag states but port states. Finally, what makes this sector especially interesting is the fact that it can be examined not just for the ways in which it generates new solutions but also for how they are spread and how they can be spread faster.[44]

Conclusion

Shipping is indispensable for our prosperity but unfortunately has a negative impact on our climate. This is even more relevant if we look at the predictions. Without appropriate action, CO_2 emissions from maritime shipping may potentially increase several times over by the year 2050.

Although the relevant basis under international law is thin, the technologies required to effectively reduce CO_2 emissions from ships already exist. There is a similarity here to the challenge faced by global climate action: Everyone knows what needs to be done, and could do it in principle, but the specific conditions prevent them from acting. So there is merit in taking a closer look at maritime shipping, which is by no means a homogeneous bloc. Rather, it is composed of different segments which pursue diverse approaches to controlling pollution, for instance in the form of inspections by port states, under EU law, or in cruise voyages.

The major advantage of maritime shipping here is that it is far less complex than the global economy as a whole. This makes it easier to identify successful approaches and examine whether they would be applicable to global climate action. In this sense, maritime shipping can serve as a testbed for global climate action.

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[1] Shipping releases 10–15 g of CO_2 per tonne-kilometre into the atmosphere. For comparison: the same transport by rail releases 19–41 g CO_2, by road 51–91 g CO_2 and by air 673–867 g. Cf. OECD (2019). OECD Observer. Sea fairer: Maritime transport and CO_2 Emissions.

[2] International Maritime Organization, IMO (2015). Third IMO Greenhouse Gas Study 2014, p.1 ff. The percentages vary depending on the source. They are generally estimated at 2–3% of global greenhouse gas emissions (e.g. EU (2019): Reducing emissions from the shipping sector). Brookings (2019, see below) puts them at a significantly lower 1.6%; the IFC, on the other hand – 2019 Setting Sail towards Zero Emissions in Shipping, p. 1 – currently estimates them at 1 billion tonnes or 2.5% of global greenhouse gas emissions. CE Delft (2019) provides a further update of important figures. Update of maritime greenhouse gas emissions projections. See also German Bundestag (2019). Document 19/2019. Maßnahmen für mehr Klimaschutz im internationalen Seeverkehr (*Measures for more climate action in international shipping* – our title translation, in German only).

[3] The officially recommended cost rate is current as at February 2019 and amounts to EUR 180 / t CO_2. German Federal Environment Agency (2019). Methodological Convention 3.0 for the Assessment of Environmental Costs. Cost rates. Cf. e.g. p. 9.

[4] The companies Continental, E.ON, Fresenius Medical Care, RWE, Deutsche Bank, Merck, MTU, Wirecard, Heidelberg Cement, Lufthansa and Covestro have a combined stock market value of approx. EUR 163 billion. Cf. Finanzen.net. Last retrieved on 27 December 2019.

[5] ICCT (2017). Greenhouse Gas Emissions from global Shipping, 2013–2015. p. iv.

[6] Cf. IMO (2015), p. 6.

[7] Ibid.

[8] See inter alia ICCT (2017), p. 2.

[9] ICCT (2017), p. 14f.

[10] The shipping companies' decision is, of course, a complex one. In addition to economic and environmental factors, they also take into account other competitive factors such as the different service quality of registers and the independence of countries that may potentially be involved in a trade war.

[11] IMO Homepage

[12] European Parliament (2016). Decision-making processes of ICAO and IMO in respect of environmental regulations, p. 14

[13] MARPOL Homepage. Major achievements here include the establishment of Emission Control Areas (ECAs) and the reduction in the sulphur content of ship fuel from 3.5% to 0.5% from 1 January 2020 (for comparison: the limit for car fuel is 0.001%). For more on the new regulations and, in particular, the commercial calculations of shipping companies see, for example, Frankfurter Allgemeine Zeitung of 23 July 2019, p. 22 'Reeder und Spediteure zittern vor neuen Abgasregeln' ('*Shipping companies and freight forwarders tremble at new emission regulations*', or Süddeutsche Zeitung of 23 December 2019, p. 17 'Der Geruch des Schwefels' ('*The smell of sulphur'* – our title translations, all articles in German only).

[14] IMO (2018). Initial IMO Strategy on Reduction of GHG Emissions from Ships.

[15] See Douvier (2004) for more details. MARPOL Technische Möglichkeiten, rechtliche und politische Grenzen eines internationalen Übereinkommens (*MARPOL Technical possibilities, legal and political limits of an international convention* – our title translation, in German only), p. 104ff.

[16] For more details (for Germany) see Federal Ministry of Transport (https://www.deutsche-flagge.de/de/sitemap; last retrieved on 28 January 2020). All six flag states mentioned above, incidentally, are on the White list. Their common average ranking would immediately follow Italy.

[17] TNO (2015), p. 19.

[18] TNO (2015), p. 19.

[19] In Germany this is done through the German Emissions Trading Authority (DEHst). Vgl. https://www.dehst.de/DE/Als Betreiber teilnehmen/Schifffahrtsunternehmen. Retrieved on 4 July 2019.

[20] Failure to act means that ports risk a discrepancy being addressed by other parties – such as local environmental groups.

[21] By definition, this now affects only the 28 EU member states instead of the 174 members of the IMO.

[22] European Parliament (2015). Reducing CO2 Emissions from Transport, p. 5.

[23] German Bundestag (2018). Paper by the Research Services. Einschränkung des Schifffsverkehrs auf der Grundlage von Emissionswerten (*Limits to shipping on the basis of emissions* – our title translation, in German only). p. 9.

[24] German Federal Ministry for Economic Affairs and Energy (2017). Maritime Agenda 2025.

[25] Bundesbank (2018). Monthly Report 02-2018. Maritime Energiewende gewinnt an Fahrt (*Maritime energy transition is gathering steam* – our title translation, in German only).

[26] A good overview on this is provided in OECD/ITF (2018). Decarbonising Maritime Transport. Or TNO (2014).

[27] In actual fact, however, many ships appear to be sailing at higher speeds. Large oil tankers increased their speed by 4% from 2013 to 2015, and large container vessels by as much as 11%. Cf. ICCT (2017), p. 23.

[28] The IMO anticipates a great deal of research on alternative fuels for merchant vessels and cruise liners. It intends to establish an international development fund for this purpose. For more details on this see e.g. Die Welt of 18 December 2019. 'Sauber für fünf Milliarden' ('*Clean for five billion'* – our title translation, in German only). The debate over liquefied natural gas, which many regard as particularly green while others consider it to be even more harmful to the climate than conventional heavy fuel oil, shows how difficult the topic is. Cf. e.g. Die Welt dated 7 February 2020. 'Schädlicher als gedacht' (*'More harmful than expected'* – our title translation, in German only). The potential of what are referred to as e-fuels – liquid fuels obtained from the conversion of 'green electricity' (from renewables) – is also interesting.

[29] Electric drives are already being used on short ferry routes and for heavily protected destinations such as fjords.

[30] OECD/ITF (2018).

[31] Nature and Biodiversity Conservation Union – NABU (2014). Luftschadstoffemissionen von Containerschiffen (*Air pollutant emissions of container vessels* – in German only).

[32] German Federal Ministry for Economic Affairs and Energy (2015). Paris Agreement. For assessment, cf. e.g. CE Delft (2019). Update of maritime greenhouse gas emissions. p. 27.

[33] IMO (2015), p. 6.

[34] Nature and Biodiversity Conservation Union (2015). Mir stinkt´s! – NABU-Kampagne für eine saubere Kreuzschifffahrt (*It stinks to high heaven! NABU campaign for a clean cruise industry* – our title translation, in German only).

[35] Cf. e.g. Der Spiegel dated 10 August 2019 (2019) S.O.S. – Wahnsinn Kreuzfahrt – die dunkle Seite des Traumurlaubs (*SOS – Cruise madness – The dark side of the dream holiday* – our title translation, in German only), p. 44–53. Or German Consumer Foundation Stiftung Warentest (2019). Dicke Luft, aber sicher (*The air is thick but you're safe* – our title translation, in German only). Edition 1/2019, p. 76-88.

[36] The importance of this topic is highlighted, for example, by FAZ article dated 12 September 2019, p. 19: 'Kreuzfahrer wollen Image retten. In Hamburg diskutiert die Branche über saubere Seereisen.' (*'Cruise operators want to salvage their image. In Hamburg the industry debated clean ocean cruises'* – our title translation, in German only).

[37] For details see Energy and Environmental Research Associates, EERA (2017). Evaluation of Cruise Industry. Global Environmental Practices and Performance. The German Federal Government confirms that this is not an isolated opinion (2019): Kreuzfahrten. Umweltschutz ist mit an Bord (*Cruises. Environmental protection is onboard as well* – our title translation, in German only). (https://www.bundesregierung.de/breg-de/aktuelles, retrieved on 22 July 2019), NDR (2018). AIDAnova: Das graue unter den schwarzen Schafen (*The grey one among the black sheep in the family* – our title translation, in German only) (https://www.ndr.de/nachrichten/AIDAnova-ist das-graue-unter-den-schwarzen-Schafen, retrieved on 22 July 2019), Kreuzfahrtport (2019), Umweltschutz: Kreuzfahrtschiffe sind Vorreiter (*Environmental protection: cruise liners are trailblazers* – our title translation, in German only) (https://kreuzfahrtport.de/umweltschutz-kreuzfahrtschiffe-sind-vorreiter, retrieved on 22 July 2019)

[38] Nature and Biodiversity Conservation Union (2019). Cruise liner ranking 2019. Overview of the vessels for the European market. Incidentally, the same figures do not show a clear trend in average passengers per ship. While ships were built for an average of approx. 2,500 passengers after the turn of the millennium, in 2019 it was only 1,600 passengers (at a total number of 17 vessels in 2019).

[39] Own finding on the basis of the NABU traffic light scoring system. Cf. methodology under Figure 4.

[40] These and other examples were obtained from the newspaper Die Welt of 24 September 2014. 'Deutsche Reedereien sind führend beim Umweltschutz' (*German shipping lines are leaders in environmental protection* – our title translation, in German only). Cf. also FAZ dated 11 September 2019, p. 19. 'Aida-Schiff bekommt 10-Megawatt-Batterie' (*'Aida ship to receive 10 Megawatt battery'* – our title translation, in German only).

[41] For an overview cf. Finanztest (2018). Über den Wolken (*Above the clouds* – in German only). In issue 3/2018, p. 12-17.

[42] Brookings, Energy Transition Commission (2019). 'Accelerating the Low Carbon Transition, The case for stronger, more targeted and coordinated action', London. E.g. p. 15

[43] Hayek, Friedrich August von (1968): Der Wettbewerb als Entdeckungsverfahren (Competition as a Discovery Procedure). In: International Institute 'Austrian School of Economics' (ed.): Austrian School of Economics. Texte – Band II von Hayek bis White. Vienna: Manz'sche Verlags- und Universitätsbuchhandlung, 119-137.

[44] Brookings (2019), p. 82.