

Strategic impact of efficient supply systems and alternative fuels

Safety, standards and guidelines, work IMO

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Why Fuel cell Systems?



e4ships is the most serious, most advanced, and largest FC development initiative world wide!



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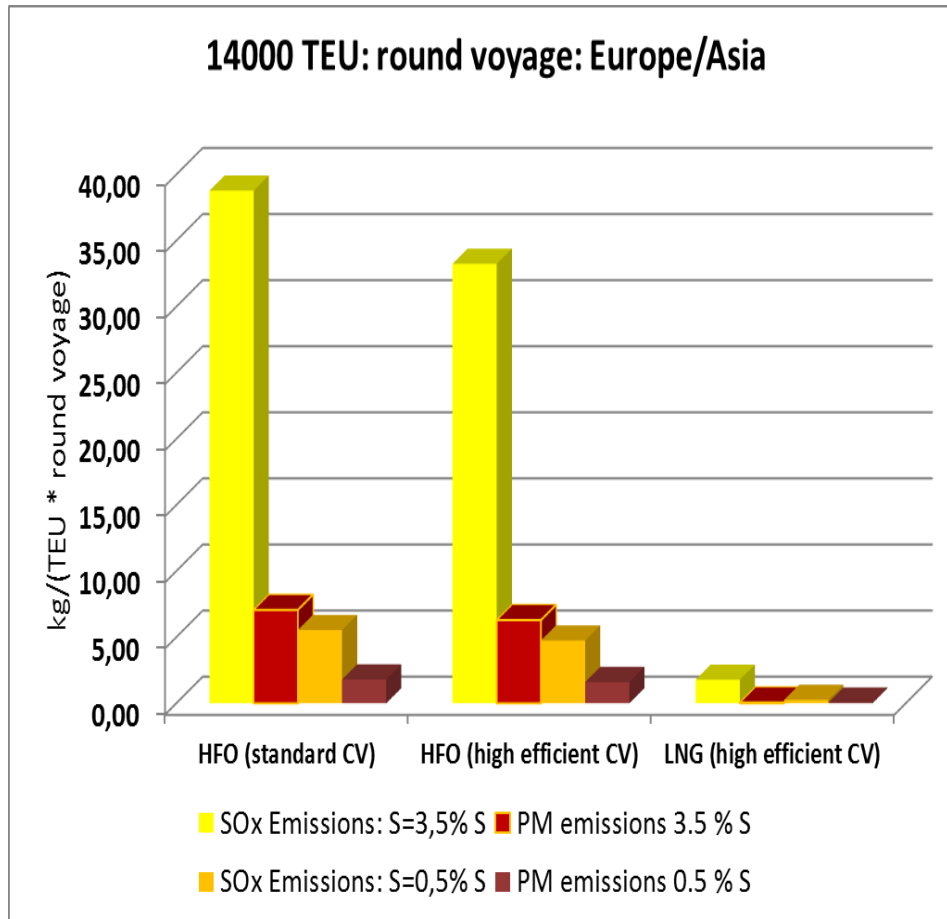
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The potential of clean fuels

- e.g. SOx and particles (LNG in 2-stroke ship engines)



emissions gewue April 2016.xlsx



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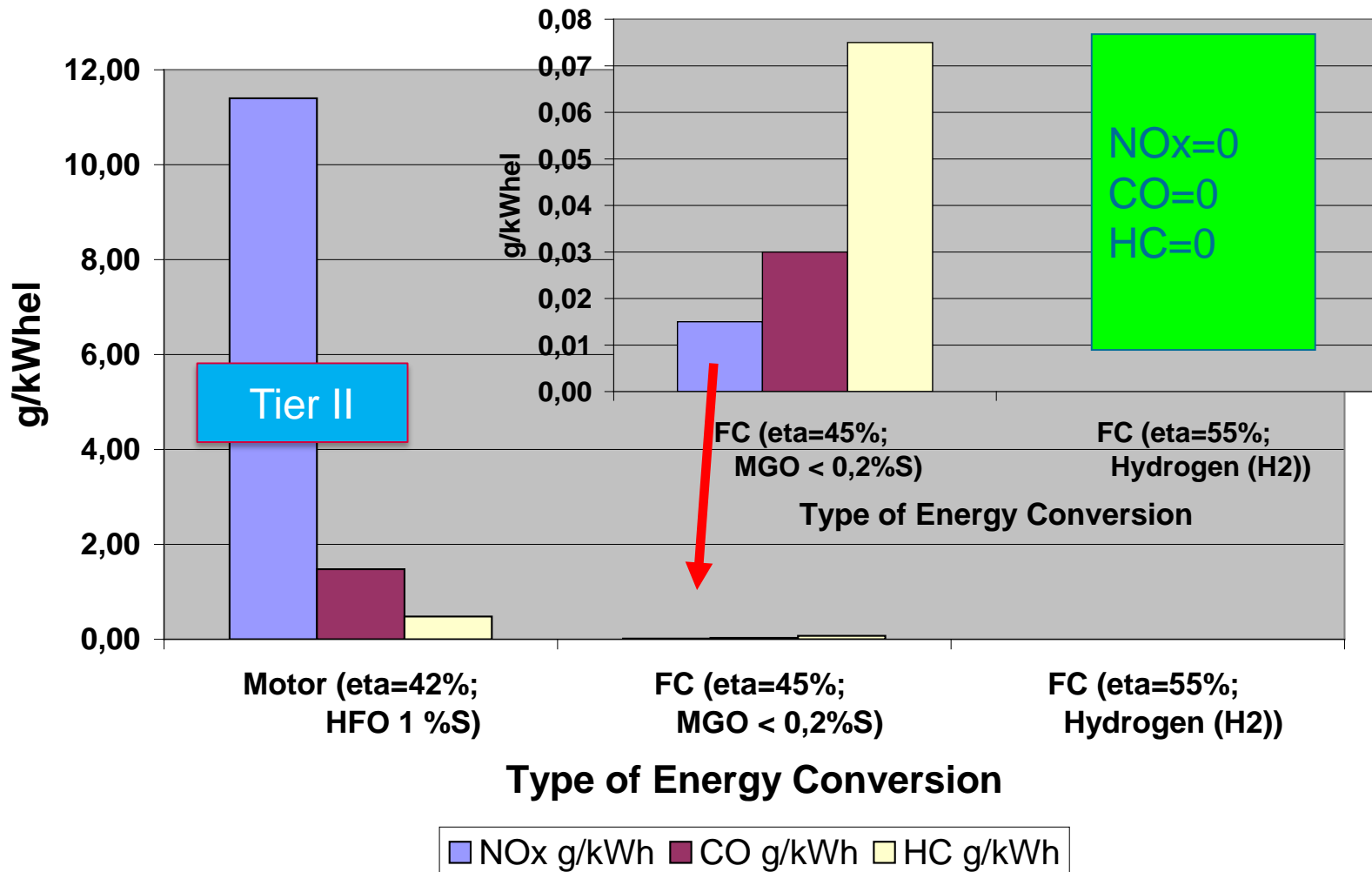


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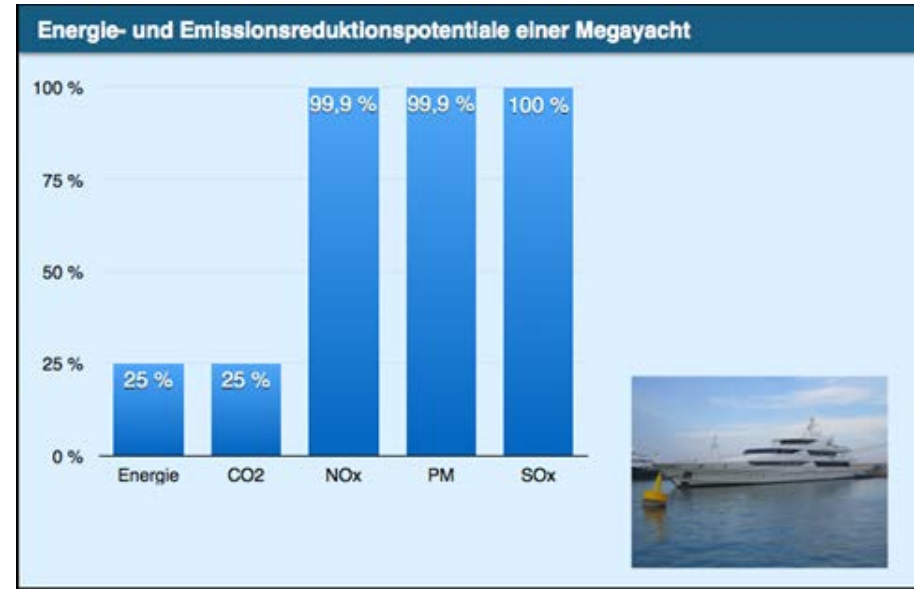
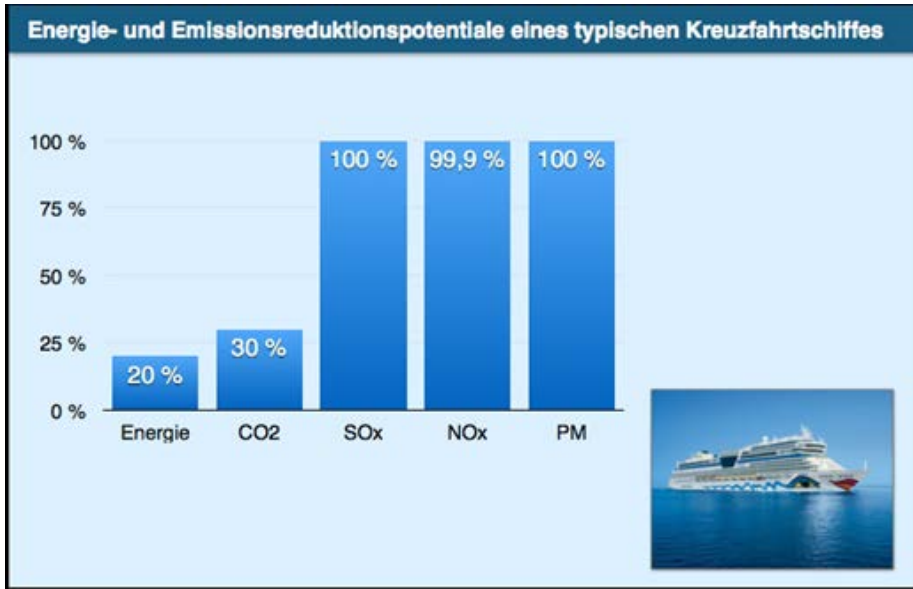


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FC-Systems: Significant Reduction of Air Pollution from Ships Operation



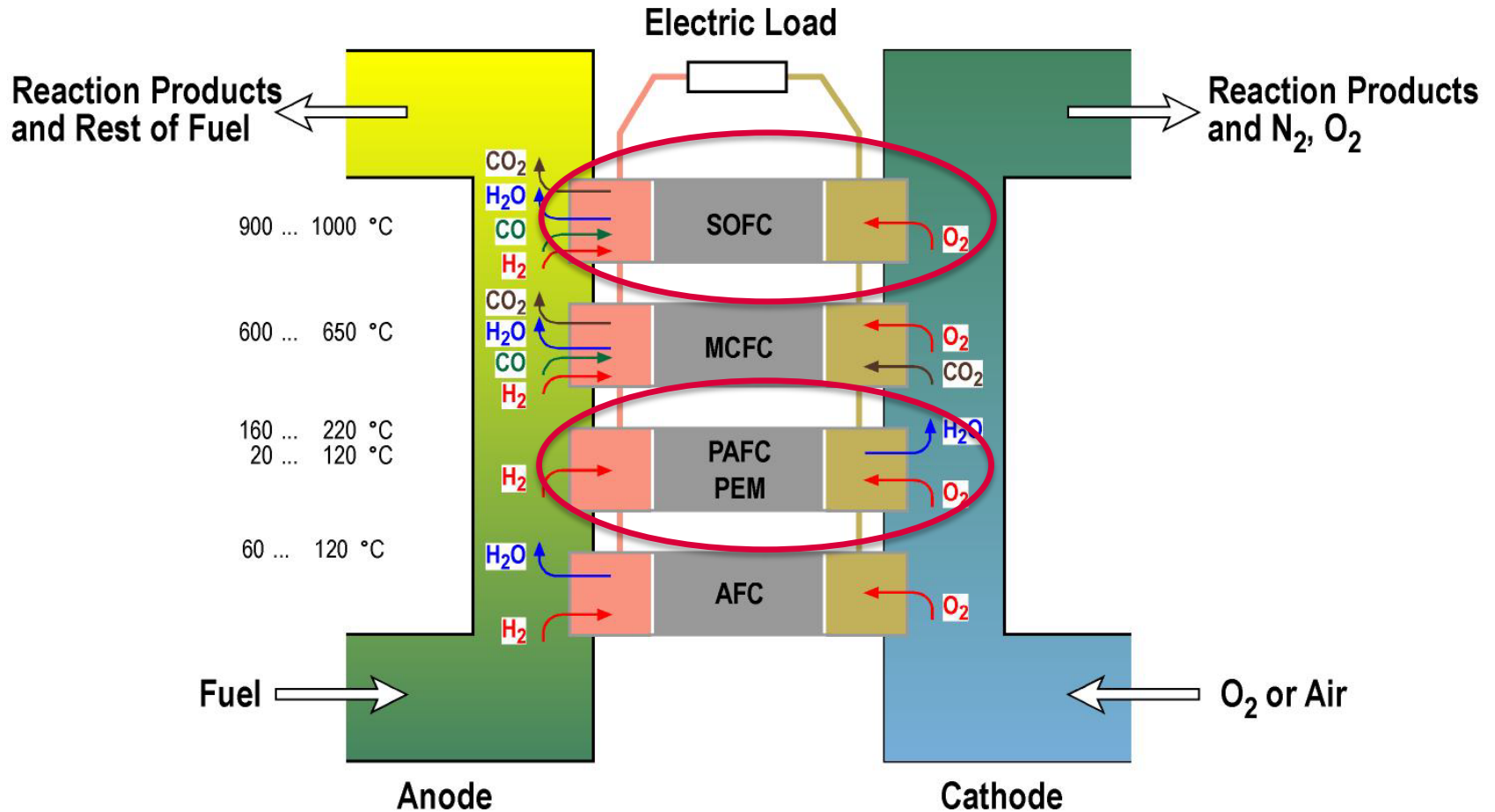
E4ships – emission reduction potential -



- ≡ CO2 emissions depend on efficiency and carbon content of fuel
- ≡ FC systems have high efficiencies at all loads!



FCs – nearly always Hydrogen in and water out - needs clean fuels!! -



Fuel Cells and the IMO IGF Code

(International Code of safety for ships using gases and other low-flashpoint Fuels
(IGF CODE))

- ≡ With FC systems an environmentally friendly, high efficient technology becomes available
 - ≡ This technology needs clean fuels!
- ≡ IMO IGF Code introduce new, clean, environmentally friendly fuels for shipping
- ≡ e4ships provides input for the IMO rule development of alternative fuels since 2009
- ≡ Reliable international regulatory framework is needed ensuring a level playing field and planning reliability



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International Maritime Organization (IMO)

- ≡ UN Special Agency
- ≡ 171 Flag States, 76 NGOs
- ≡ 6 languages, 1000 opinions



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International mandatory rule setting by IMO:

- ≡ Segregation of ships
- ≡ Equipment of ships
- ≡ Loading of ships
- ≡ Operation of ships

- ≡ Emissions from ships
- ≡ Scrapping of ships

- ≡ Building of ships,
- ≡ Requirements for rule development



Continuous work on IMO regulations needed

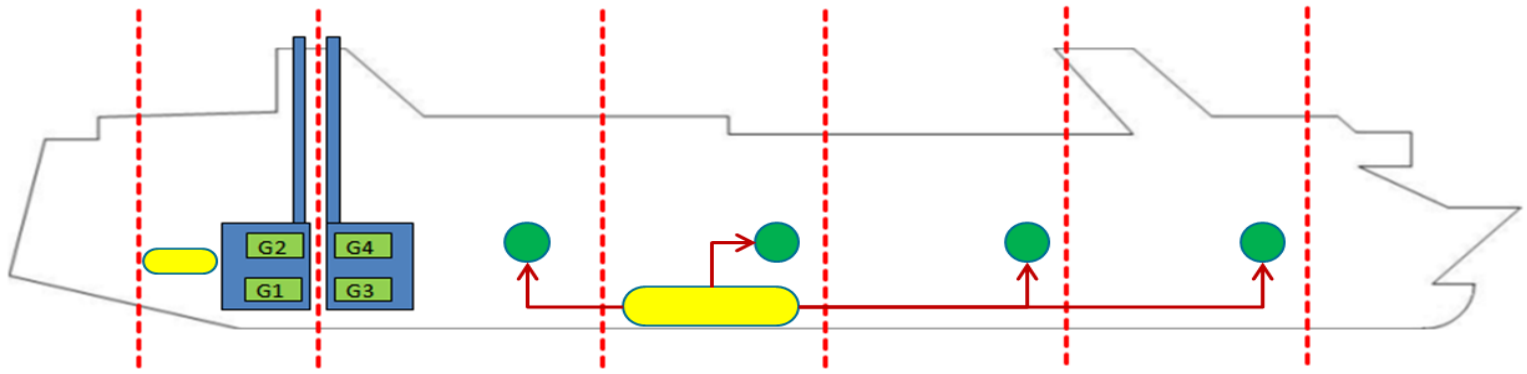
- ≡ 2009 to 2015 – Development of the IGF Code for LNG and CNG as fuel
 - ≡ 2004/2019 develop the IMO Interim Guidelines for LNG as fuel (IMO MSC.285(86))
 - ≡ 2009/2015 first stage of the development of IMO IGF-Code: International Code of safety for ships using Gases or other low-flashpoint Fuels (adopted by MSC 95 on 12th of June 2015, in force January 2017)
- ≡ FC systems are allowed “in principle” by the IGF Code
 - ≡ More detailed requirements needed
- ≡ work on Methanol and low flashpoint diesel is ongoing/proposed
- ≡ Requirements for distributed power networks are needed.



Next steps for IMO rule development – Phase 2 and 3 -

Regulatory aims for e4ships 2.0:

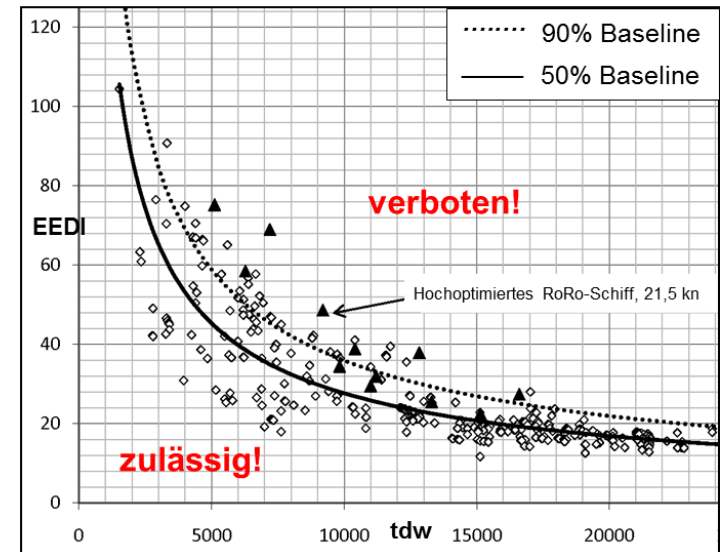
- ≡ Integration of FC systems and relevant alternative fuels into MARPOL Annex VI – Energy Efficiency Design Index (EEDI),
 - ≡ Methanol, low flashpoint diesel, hydrogen
- ≡ SOLAS-requirements for distributed power supply:



Energy Efficiency Design Index (EEDI) - the IMO way to reduce CO2 emissions -

$$EEDI_{att} \approx \frac{C_F \quad SFC \quad P}{Cap \quad V_{ref}} \leq EEDI_{req}$$

- ≡ numerator – „burden for the environment“
- ≡ denominator – „benefit for society“
- ≡ Ship speed is included as a factor but not as quality measure
- ≡ Implementation is not clear



Energy Efficiency Design Index (EEDI)

- ≡ Reference Lines will be lowered
- ≡ Phase II of the EEDI reductions can not be met without alternative fuels and high efficient energy converters
- ≡ Fuel cells and Hydrogen offer the highest reduction potential



What can policy do to promote alternative fuels and FC technology?

- ≡ Support of new technologies by support research and development project
- ≡ Give clear boundary conditions for the reductions of emissions (MARPOL Annex VI, EU and IMO Sulphur requirements)
- ≡ Support innovations by IMO work on challenging and innovative safety requirements for newbuildings and retrofitting of ships (SOLAS (IGF Code))
- ≡ Support the introduction of technology by support of pilot projects, support of investments into “Green Shipping“

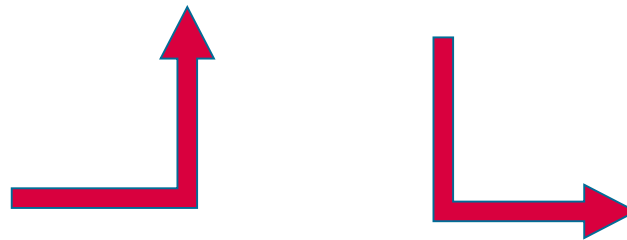


Ship fuel beyond the age of fossil fuels

-You can make any fuel from CO₂ and H₂-

- ≡ $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$: Methane
- ≡ $CO_2 + 3H_2 \rightarrow CH_3OH$: Methanol
- ≡ $n \cdot CO_2 + n \cdot 3 \cdot H_2 \rightarrow (-CH_2-)_n + n \cdot 2 \cdot H_2O$
(Synfuel)

You only have to have CO₂ and H₂
(on a world wide competitive price!!)



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Thank you for your attention

www.e4ships.de

