FC-Systems on Board of Watercrafts
An Early Market ? (Part 1)

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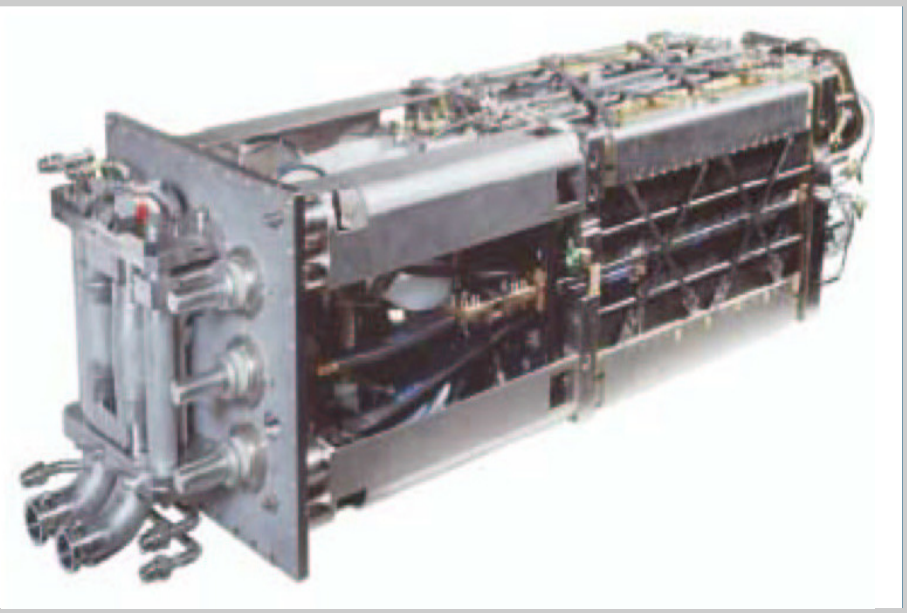


Germanischer Lloyd

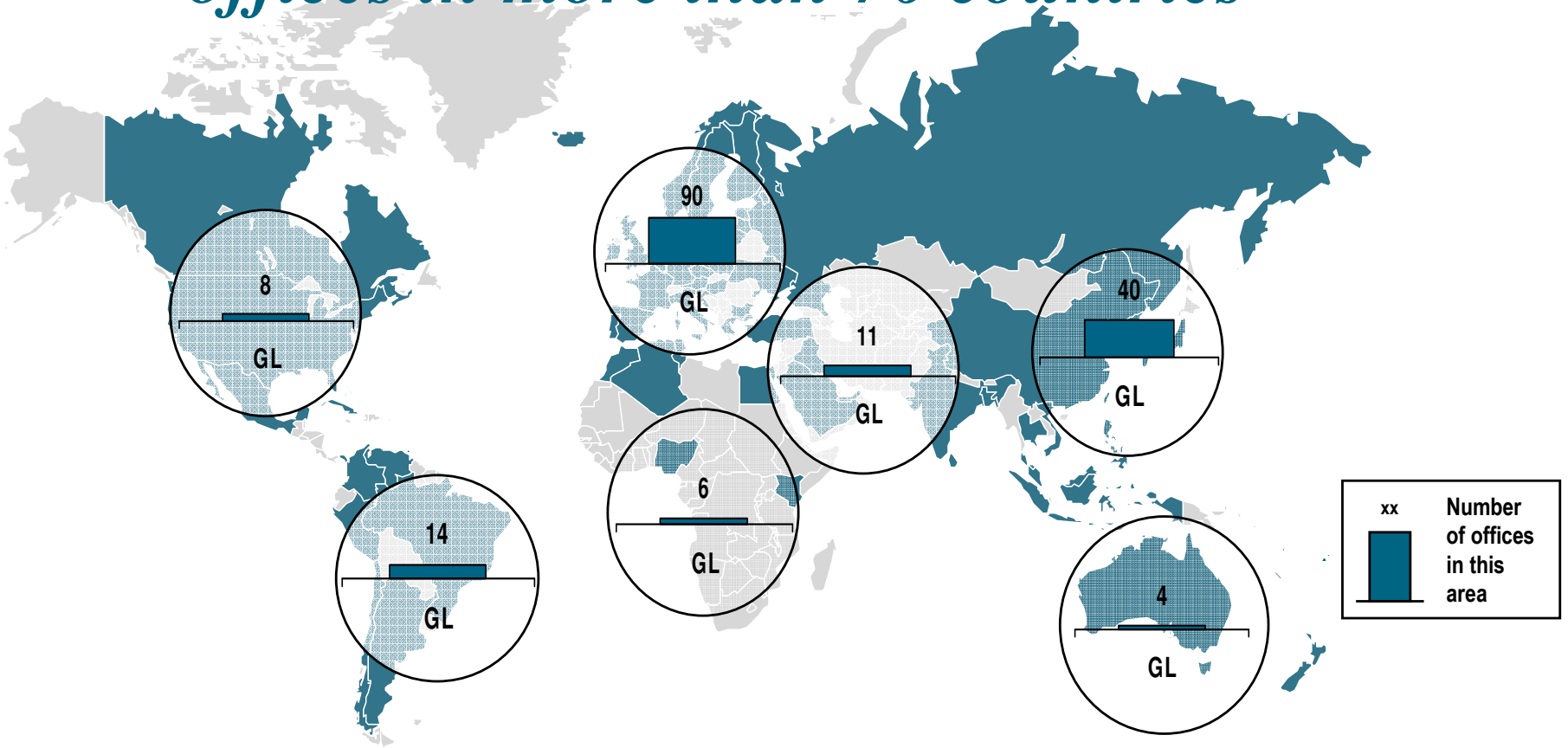
Content

- Over 100 years of Germanischer Lloyd
- Emissions from Shipping
- Legislative overview
- Possible Solutions
- The Fuel Cell
- Benefits of the fuel cell
- What is the price for FC-systems?
- Market Introduction – How?
- Possible Market
- Examples

Over 100 years of Germanischer Lloyd

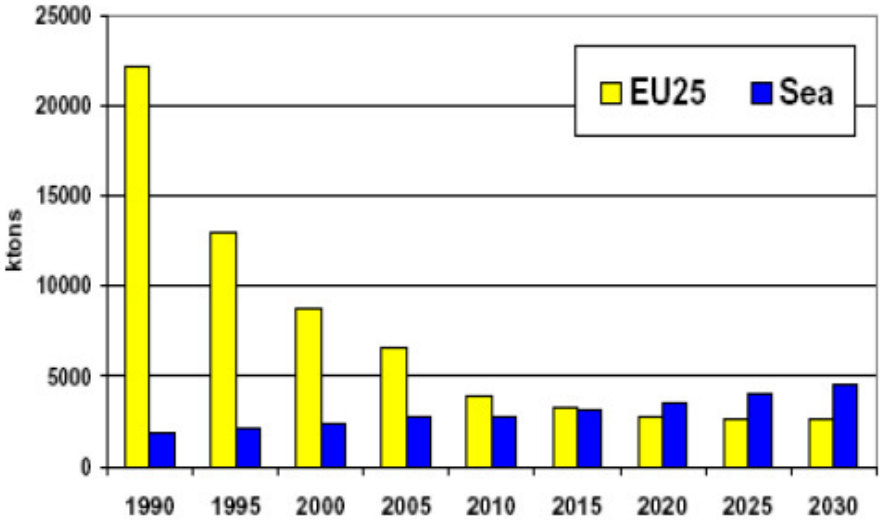
- **Founded in 1867, GL is one of the world‘s leading technical surveillance societies**
- **We develop authoritative standards for technology, safety and quality in the most varied fields**
- **Unlike others, we write our own rules and guidelines**
- **We guarantee that our rules and guidelines are in line with the newest technical developments**

Over 2,700 employees - thereof 1,890 engineers – are working for you in over 170 offices in more than 70 countries

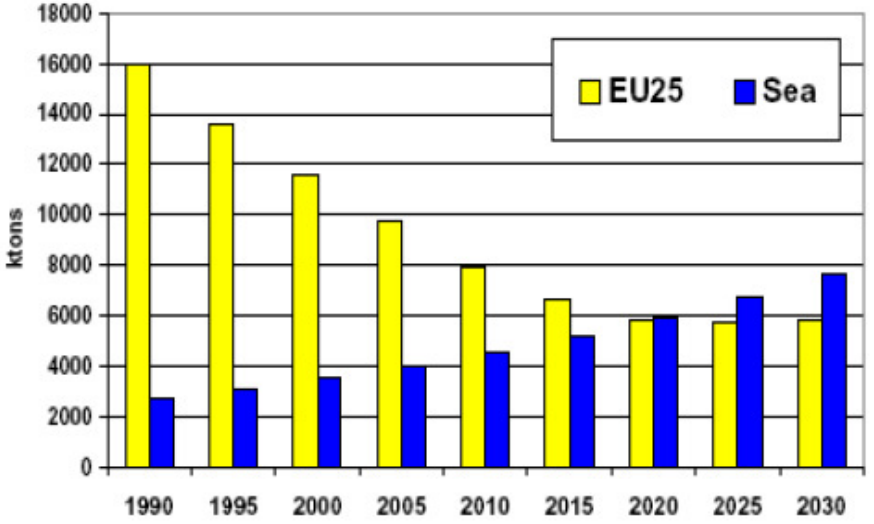


Emissions from Shipping

The Problem



Emission of SOx 1990-2030 (ktons)



Emission of NOx 1990-2030 (ktons)

Source: http://europa.eu.int/comm/enviroment/air/transport.htm#3

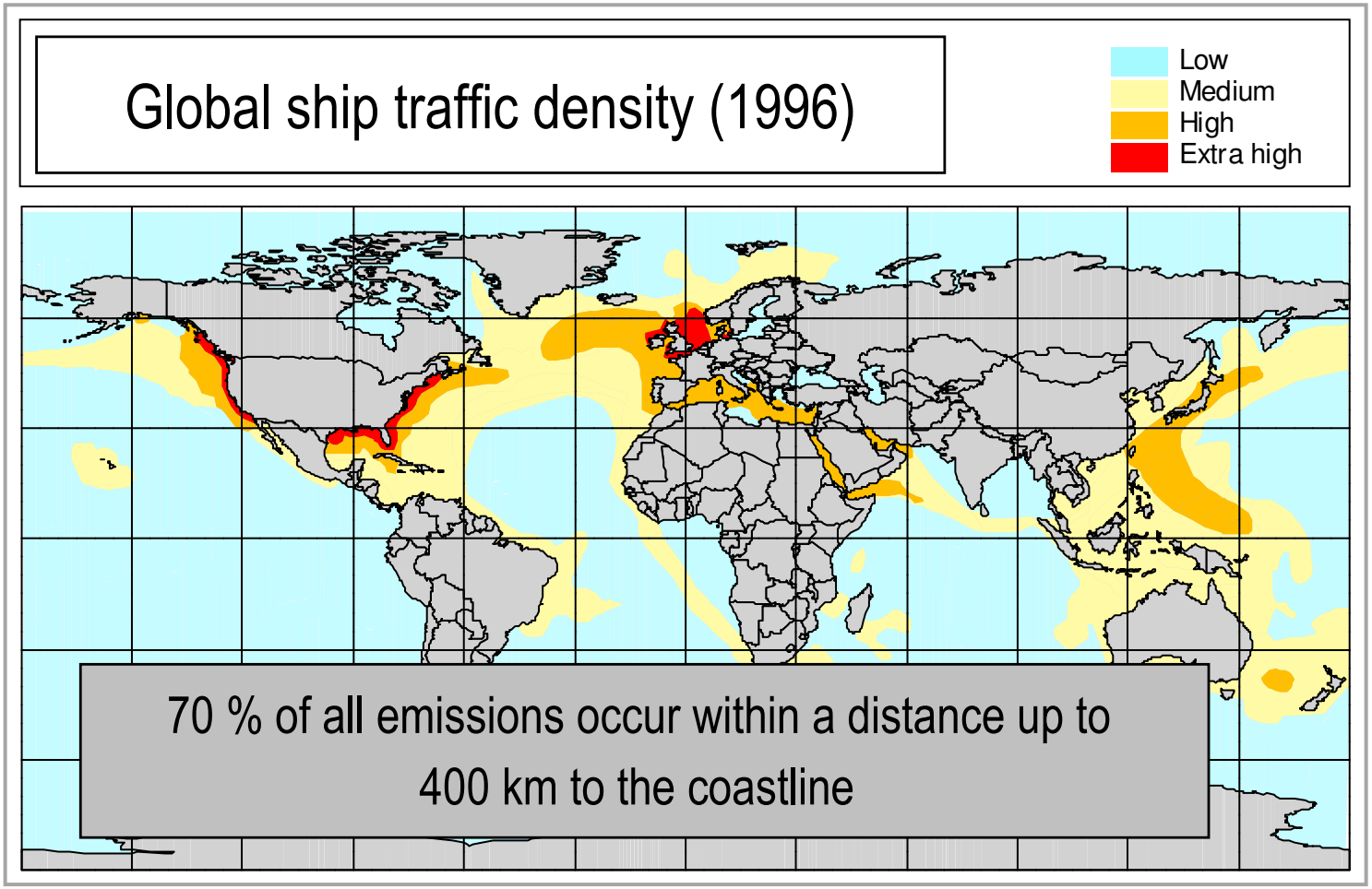
The Problem

- **Comparision of emissions from trucks with different EU standards and cargo vessels of various sizes [g/tons-km]**

	CO_2	PM	SO_2	NOx	VOCs
Heavy truck with trailer:					
Before 1990	50	0.058	0.0093	1.00	0.120
Euro 0 (1990)	50	0.019	0.0093	0.85	0.040
Euro 1 (1993)	50	0.010	0.0093	0.52	0.035
Euro 2 (1996)	50	0.007	0.0093	0.44	0.025
Euro 3 (2000)	50	0.005	0.0093	0.31	0.025
Cargo vessel:					
large (>8000 dwt)	15	0.02	0.26	0.43	0.017
medium size (2000-8000 dwt)	21	0.02	0.36	0.54	0.015
small (<2000 dwt)	30	0.02	0.51	0.72	0.016
RoRo (2-30 dwt)	24	0.03	0.42	0.66	0.029

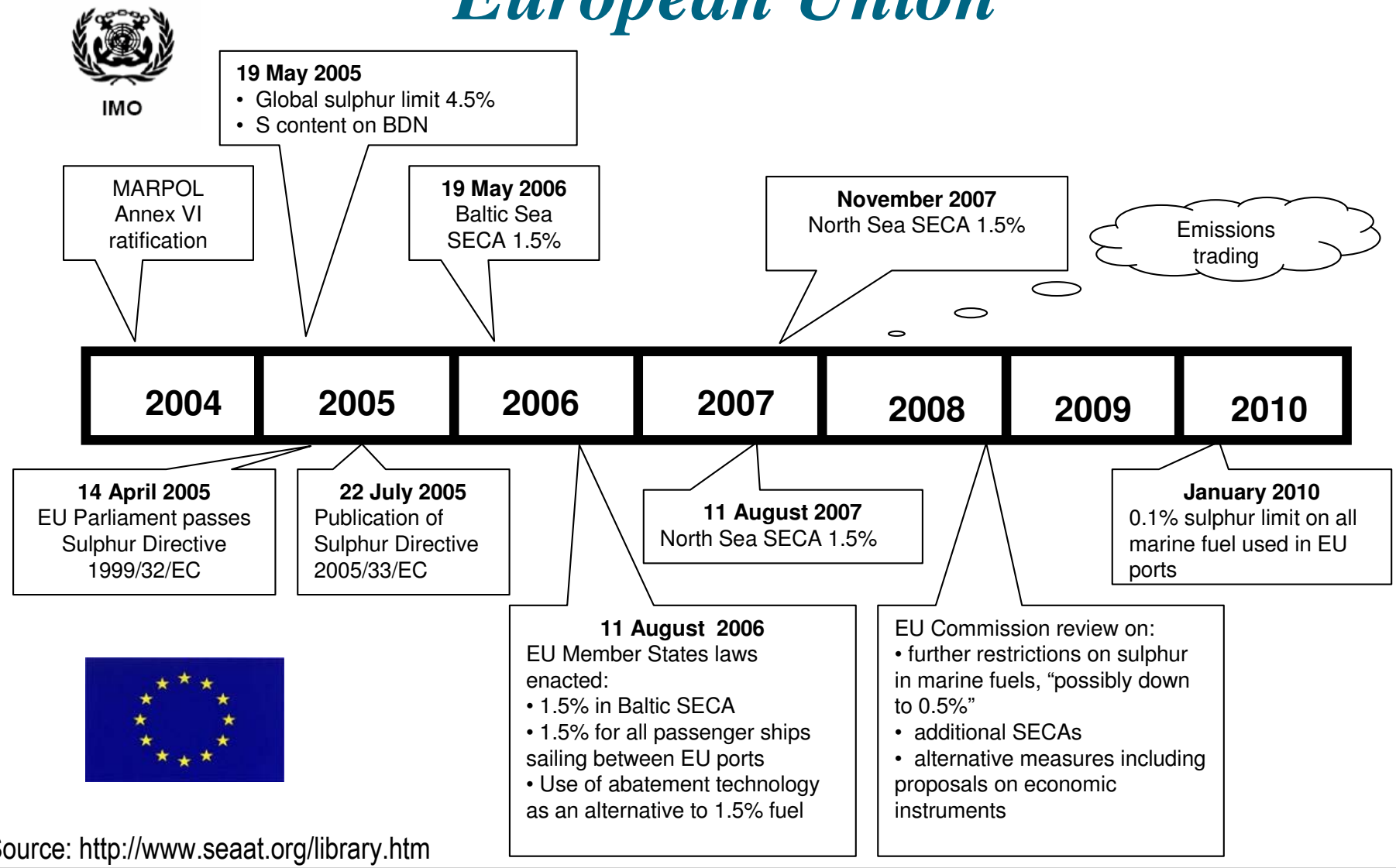
[a] Emissions are average in each case. Trucks: maximum overall weight 40 tons, loading 70 per cent, operating on diesel with a sulphur content of 300 ppm. Cargo vessel: bunker oil with and average sulphur content of 2.6 per cent, no cleaning of NOx. *Source:* www.ntm.a.se.

Emissions from Ships are a "Coastline Problem" to a Large Extend



Source: "Greenhouse Gas Emissions from Ships":
MEPC44; 2000-03-06; MARINTEK; CMU; DNV, ECON

Legislative overview – IMO and European Union

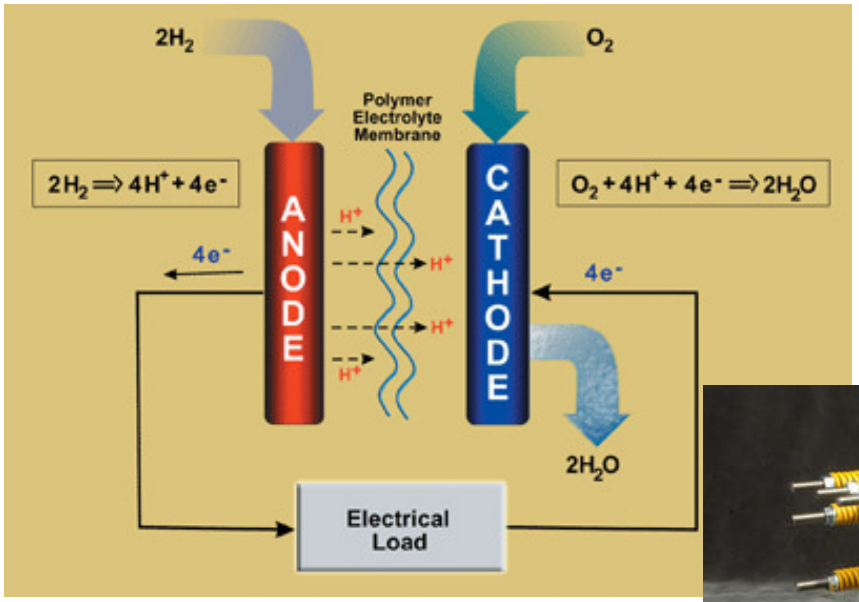


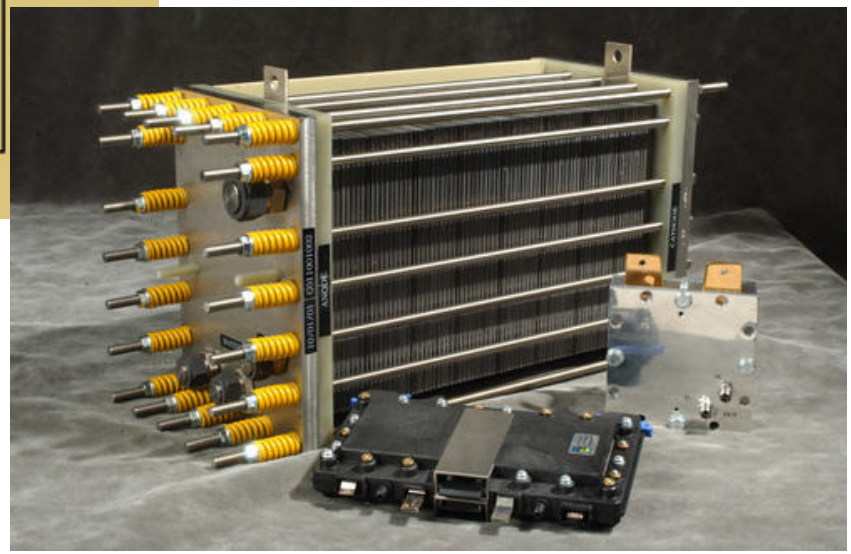
Source: http://www.seaat.org/library.htm

Possible Solutions

- Exhaust gas cleaning
- Dual fuel engine
- Gas fuelled Ships
- Land based power generation in the harbor
- **Fuel Cell Systems**

The Fuel Cell

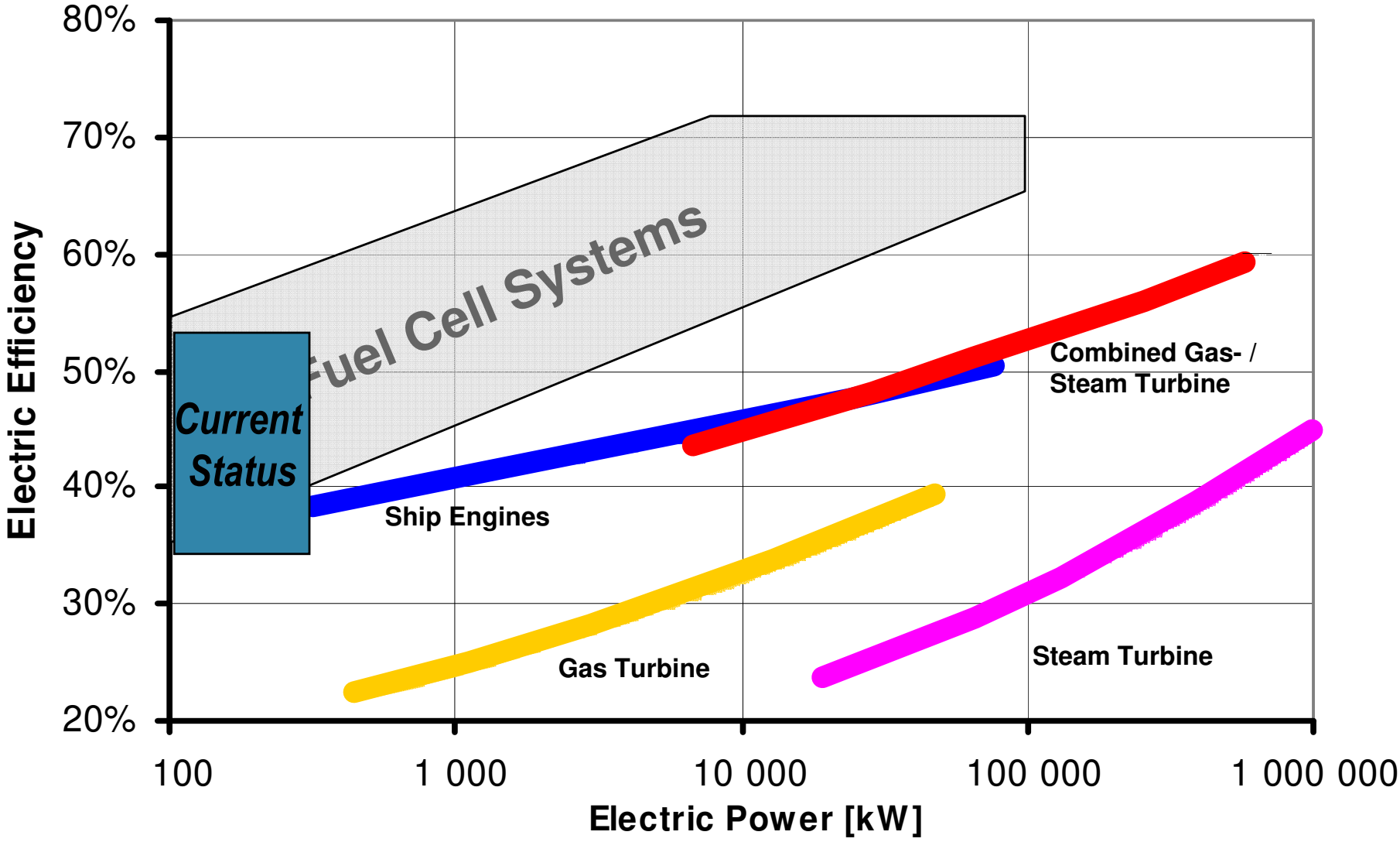




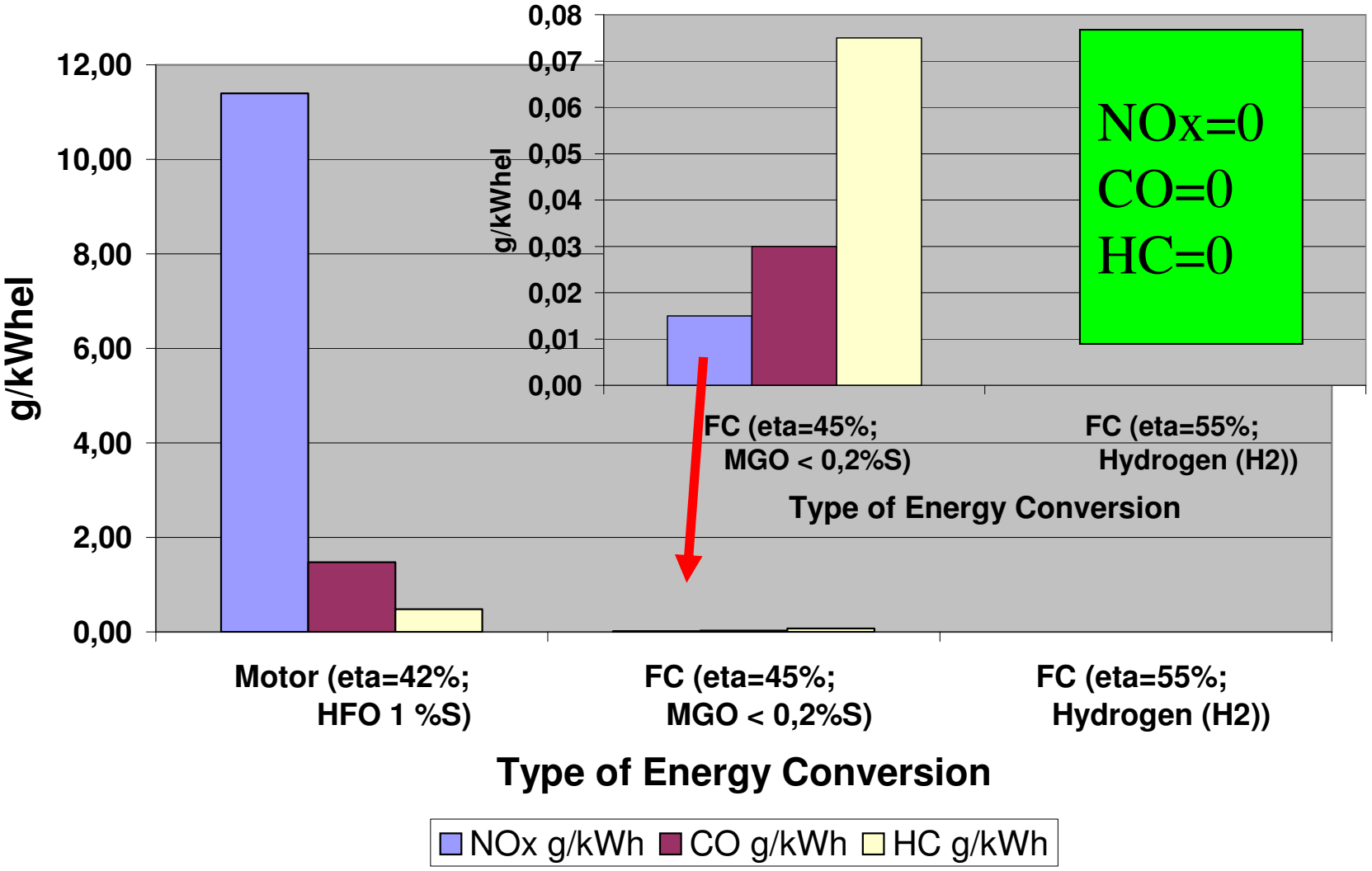
Benefits of the Fuel Cell

- **Low noise level**
- **No vibrations**
- **Modular design**
- **High reliability and availability**
- **High electric efficiency**

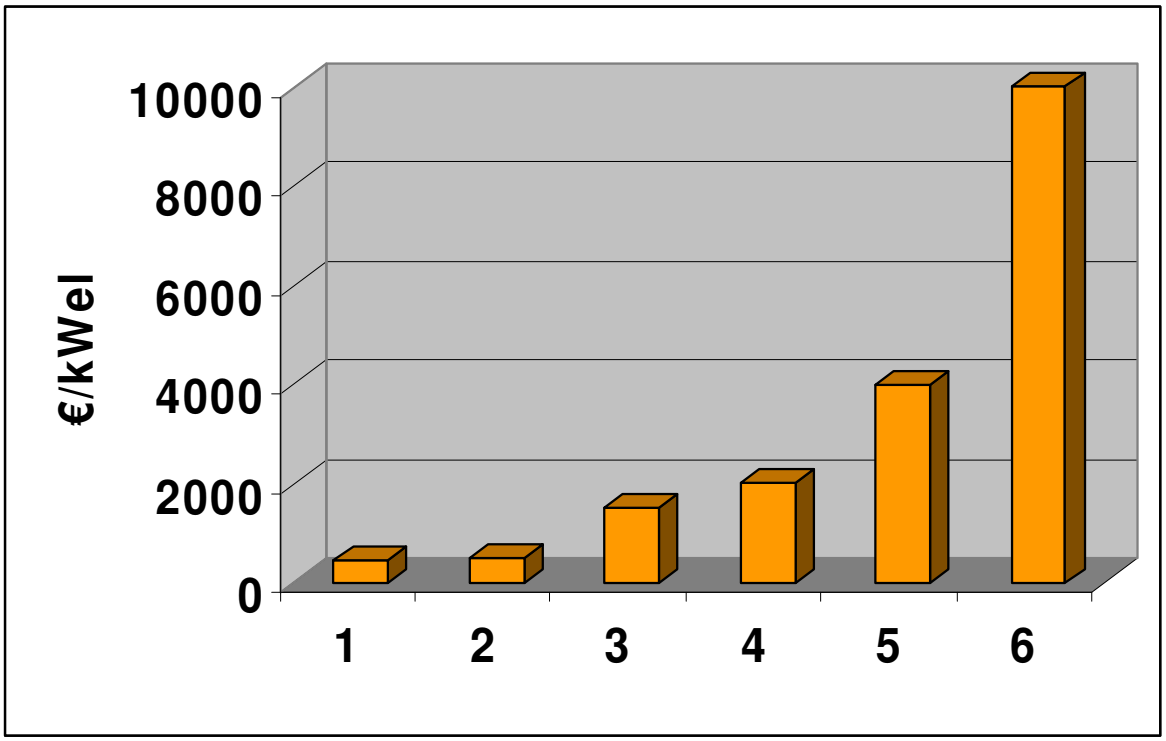
Potential for very high electric efficiency



Significant Reduction of Air Pollution from Ships Operation



What is the price of FC-systems?



1. ICE: fast- or medium speed engine: generating set for seagoing vessel, complete (according MARPOL Annex VI without catalyser)
2. Target price portable generators & Early Markets (HFP “Implementation plan – Status 2006”)
3. Target price stationary land based FC systems (HFP “Implementation plan – Status 2006”)
4. Target price FC system MTU „Hot Module“ from 2006: (start of serial production)
5. System price MTU „Hot Module“ (2004)
6. Today’s price for FC module for submarines

Market introduction – How?

- **Fuel Cells are/have**
  - expensive (no serial production, expensive materials)
  - low power output

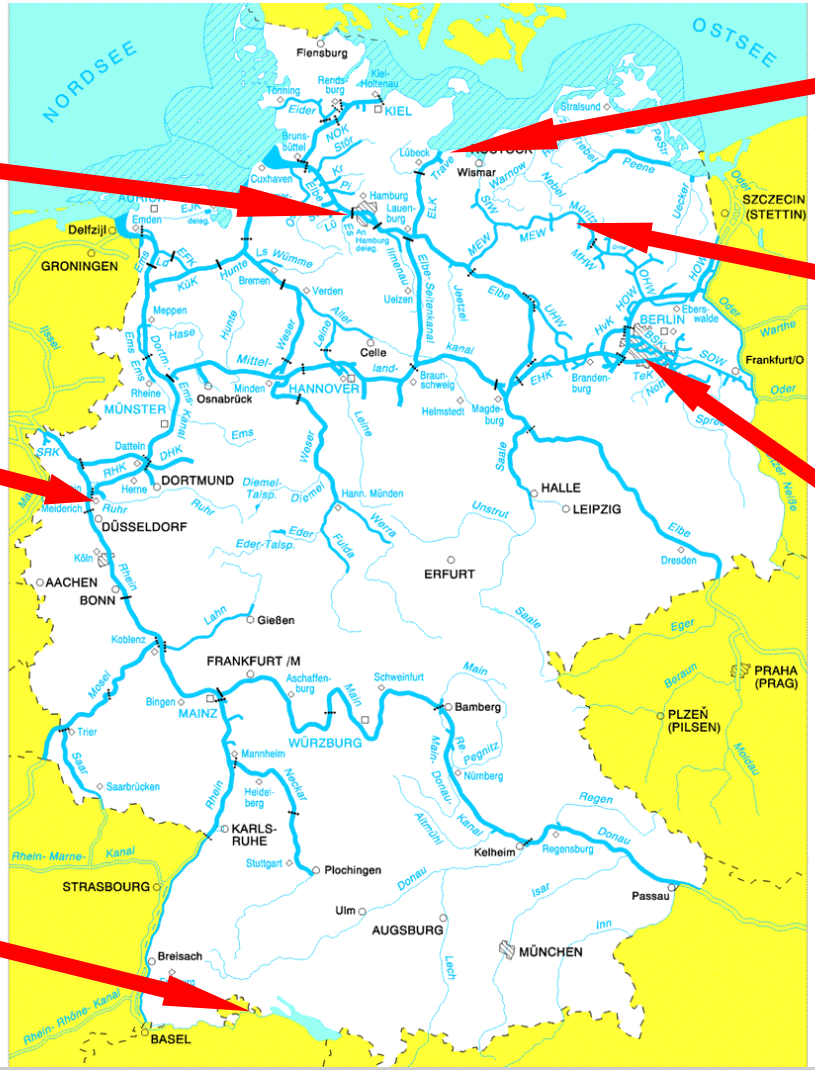
→ **Idea starting with smaller systems or find special market where the benefits of FC dominate the costs**

- **Getting experiences with small FC systems**
  - salted air / sea motions / humidity
  - different users / different estuaries
- **Getting higher lots with small FC systems**
- **Getting experiences in special markets (navy, mega yachts)**

Possible market for special markets

Possible market for small FC-systems

- Alster / Elbe
- Baldeneysee Essen
- Lake Constance



- Wakenitz
- Müritz
- The waters around Berlin
- . . .

Examples


KN 4 284 P5
ATG ALSTER-TOURISTIK GMBH
FRED VAN DEN BERG DESIGN 2005

„Hamburger Tuckerboot“

Thanks for your attention!