

The logo for 'synergetics' features the word in a blue sans-serif font, with the 'y' and 'e' in blue and the 'r' through 's' in green. To the right is a white circular arrow icon pointing clockwise.

Danube's Fuel Revolution Challenges for the Adoption of Alternative Fuels

Bernhard Bieringer – Kanzlei Anzböck – Consulting Engineers Naval Architecture

SYNERGETICS | Synergies for Green Transformation of Inland and Coastal Shipping

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DIPL.-ING. RICHARD ANZBÖCK
STAATLICH BEFUGTER UND BEIREDER
ZIVILINGENIEUR FÜR SCHAFFSTECHNIK

Guglgasse 8/29
A-1190 Wien

office@anzboeck.com
Tel.: +43 (0) 1 320 88 93

Major Challenges for the Use of Alternative Fuels on the Danube



1

Distances

2

Energy content of fuels

3

Infrastructure

4

Costs

1 - Distances



- Rhine: approx. 800 km (Rotterdam – Basel)
- Danube: approx. 2.400 km (Black Sea – Kelheim)

- Distances of voyages on the Danube are usually significantly longer than on the Rhine
- Practical applicability of alternative fuels highly dependent on possible storage volume on board and respective infrastructure (distance between bunkering stations)

2 – Energy content



▪ Benchmark: Diesel	42,9 MJ/kg	35,2 MJ/l	1
▪ Battery:	0,09-0,18 MJ/kg	0,18 – 0,32 MJ/l	110
▪ Methanol:	22,4 MJ/kg	17,85 MJ/l	1,97
▪ Hydrogen:	(120 MJ/kg)	(0,011 MJ/l)	(3200)
▪ Compressed (700 bar):	120 MJ/kg	5,04 MJ/l	6,98
▪ Cryogenic (-252,9° C):	120 MJ/kg	8,64 MJ/l	4,07
▪ LOHC:		6,48 MJ/l	5,43

(pure fuel without respective storage system)

Sources:

GRENDL Factsheets (<https://www.interreg-danube.eu/approved-projects/grendel/section/technological-factsheets>)

<https://neutrium.net/properties/specific-energy-and-energy-density-of-fuels/>

<https://demaco-cryogenics.com/blog/energy-density-of-hydrogen/>

<https://hydrogenious.net/how/#technology>

3 – Infrastructure



- Rhine: densely populated, highly industrialised along the entire river
 - Chemical industries along the Rhine make availability of alternative fuels quite probable (and also the reliability of availability), even as by-products
 - Short distances between bunkering stations possible
- Danube: lots of „space in between“
 - Hardly any chemical industry along the river, no synergies
 - Sufficiently narrow spacing of bunkering stations difficult to achieve
- General: transition from single-fuel environment (Diesel) to multi-fuel environment requires multiplication of bunkering/storage facilities

4 – Costs



- Anecdotal evidence only
- Batteries (evidently no use case, just for illustration):
 - In order to replace the average bunkering capacity of a typical Danube pusher (60 t) batteries with a total weight of ca. 1500 t / total volume 750 m³
 - Investment costs ca. 130 Million EUR
- Hydrogen:
 - Pressurised 20' gas container costs ca. EUR 300.000 – 500.000
 - Contains ca. 1 t of hydrogen – equal to approx. 3,4 t of Diesel
 - approx. 18 containers necessary to get equal bunkering capacity

What to do?



- Batteries: probably suitable for local passenger traffic (day cruises)
- Methanol / hydrogen: first of all hen-and-egg problem with regard to infrastructure
 - Ship-owners will not invest as long as there is no sufficient bunkering infrastructure
 - Bunkering companies will not invest as long as there are not enough vessels using alternative fuels
- Further challenges (examples)
 - Methanol: toxic, mixes with water → hazard to persons and environment
 - Hydrogen: in cryogenic form extremely cold → hazard to structural integrity of vessel in case of spillage (spontaneous embrittlement)?
 - Crew qualification

More Alternatives?



- HVO100
 - Up to 90% reduction in greenhouse gases immediately
 - Already approved by many major engine manufacturers
 - Diesel infrastructure can be used (on-board and shoreside)
 - Availability?
 - Diesel can always be used as fall-back (HVO100 and Diesel can be blended in any proportion)
 - Synergies with transport of agricultural products?
 - Can residuals and by-products be used as a basis for HVO100?

Sources:

GRENDL Factsheets (<https://www.interreg-danube.eu/approved-projects/grendel/section/technological-factsheets>)
<https://www.neste.be/en/neste-my-renewable-diesel-be>



DIPL.-ING. RICHARD ANZBÖCK
STAATLICH BEFUGTER UND BEEIDETER
ZIVILINGENIEUR FÜR SCHIFFSTECHNIK

Gugitzgasse 8/29
A-1190 Wien

E-mail

office@anzboeck.com

bernhard.bieringer@anzboeck.com

Dipl.-Ing. Bernhard Bieringer
Consulting engineer for Naval Architecture

+43 676 7232 600

Web

www.anzboeck.com



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