Need to go to 0-emission, faster

Need to eliminate oil & natural gas use

Embrace the hydrogen economy

Source:IDTechEx

essential for meeting societies' needs – increasing demand for offshore operations

wind-
instal

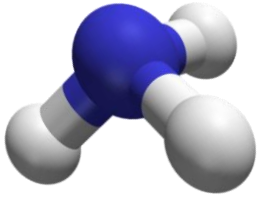
ocean going
sport

offshore
support

g,
g,
cable lay

Worst possible type of heavy oil fuel – extremely polluting

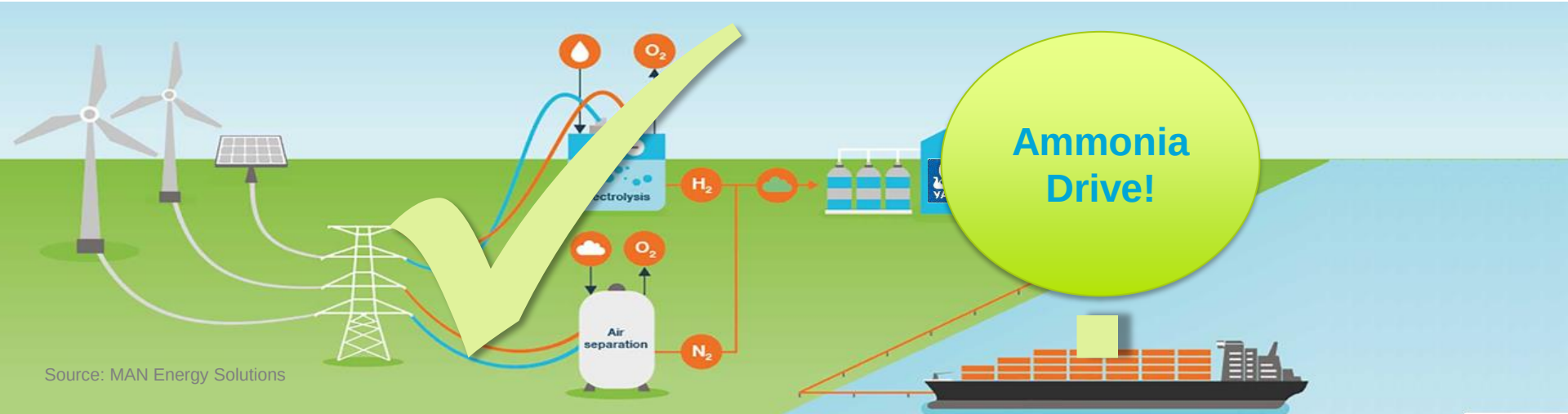
"If global shipping were a country, it would be the 6th largest producer of greenhouse gas emissions"



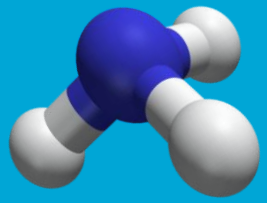
Wouldn’t it be great if we could make
all these operations completely carbon free?

Ammonia (NH_3) as fuel

carbon free, from renewable production – to consumption



Source: MAN Energy Solutions



Ammonia Drive

AmmoniaDrive

P20-18
NWO Perspectief

Toekenningen Perspectief | NWO

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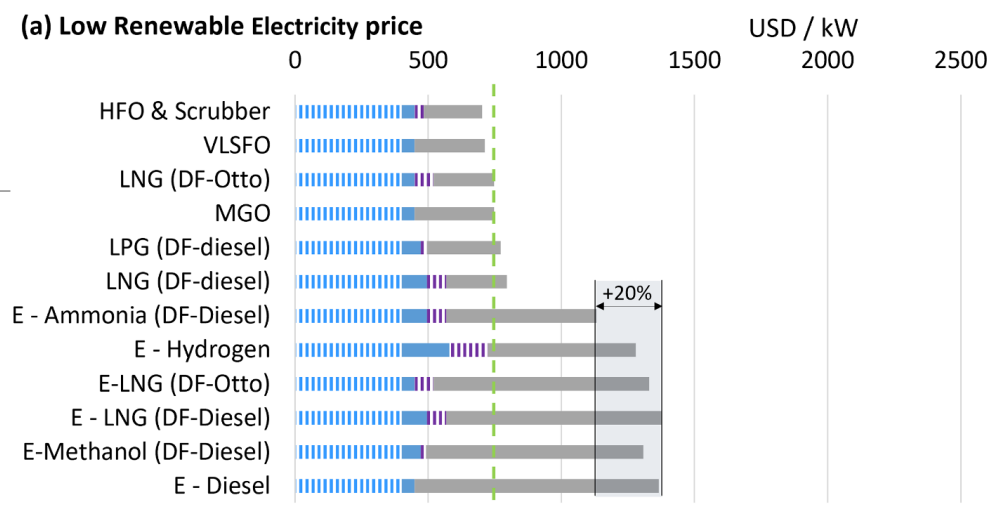
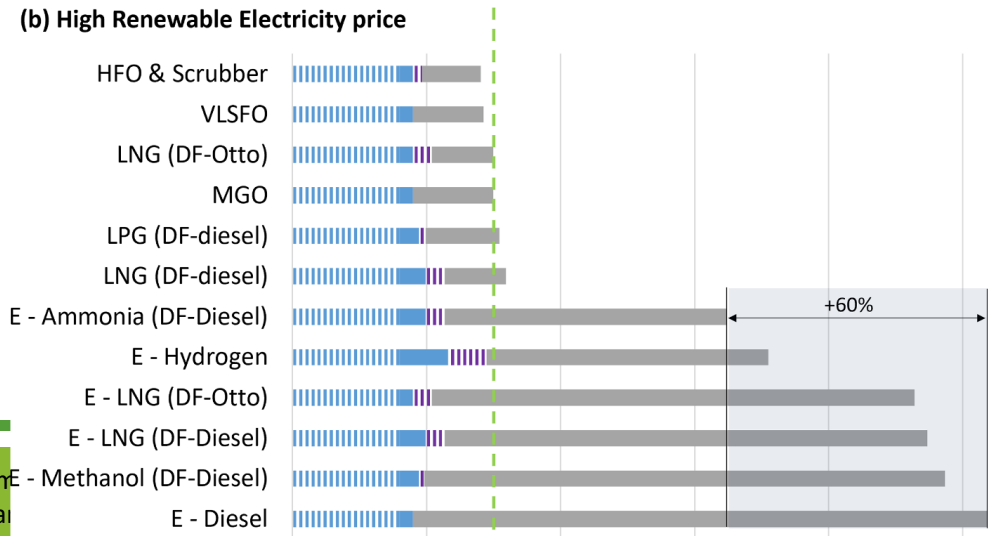
WAGENINGEN UNIVERSITY & RESEARCH
rijksuniversiteit groningen
UNIVERSITY OF AMSTERDAM
TNO MARIN
TUDelft

Why NH_3 then?

Source:

Reduction of maritime GHG emissions and the potential role of E-fuels, Lindstad et al., Transportation Research Part D, November 2021.

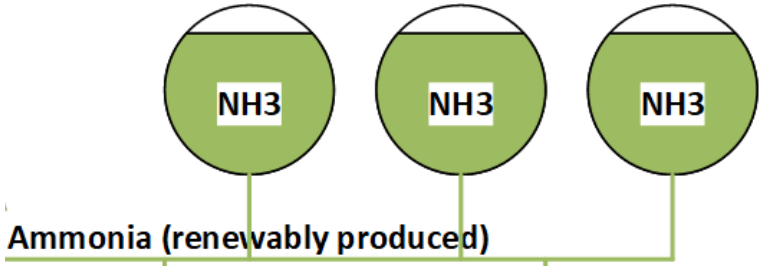


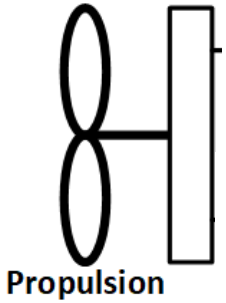


AMMONIA DRIVE

This publication is part of the project Am
programme NWO Perspectief which is finar

Innovative AmmoniaDrive Concept





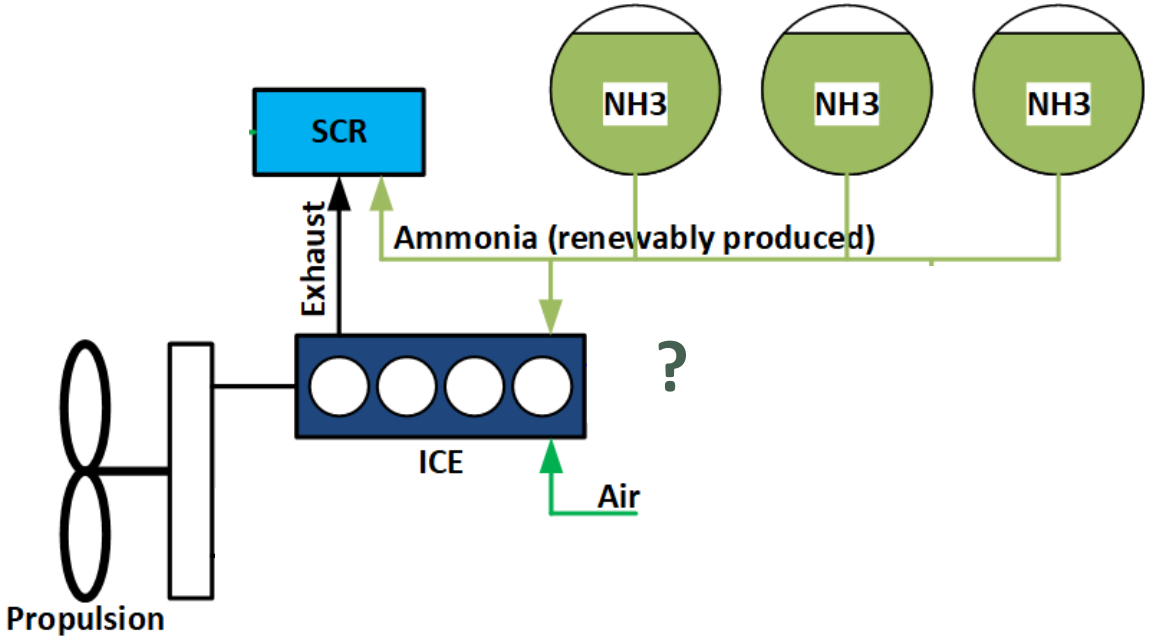
This publication is part of the project AmmoniaDrive with project number 14267 of the research programme NWO Perspectief which is financed by the Dutch Research Council (NWO)

Innovative AmmoniaDrive Concept

NH_3 incompatible with existing *engines*

'Slow' combustion

Need for promotor fuel



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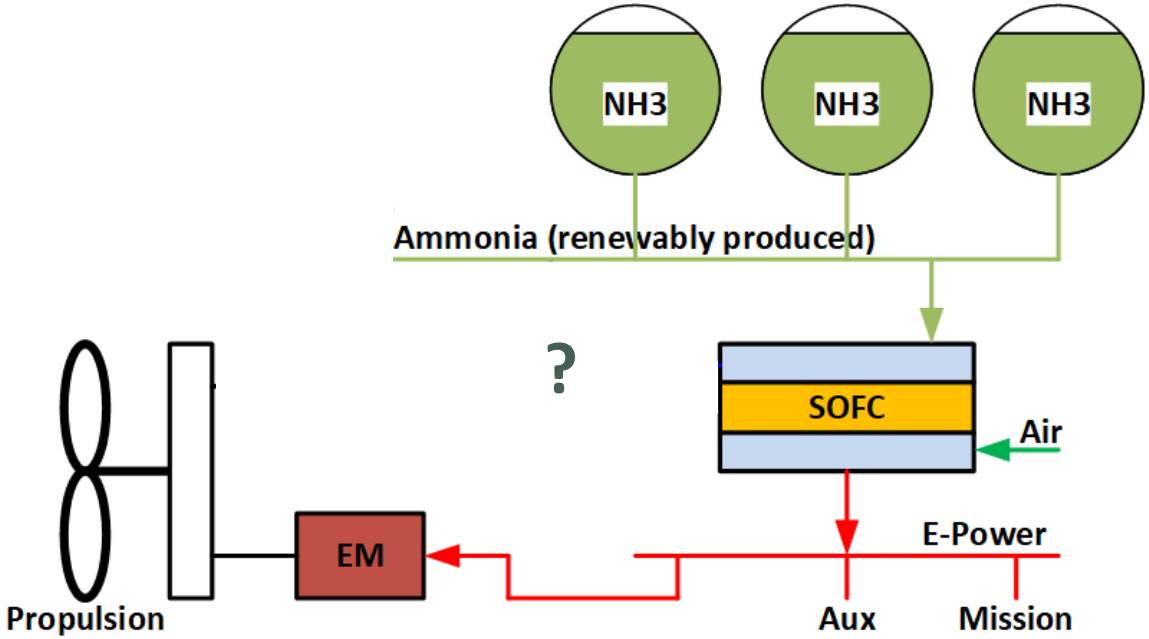
Innovative AmmoniaDrive Concept

Insufficient power for full electric

Insufficient transient loading capability

Large and expensive

Potential to obtain promotor?



AMMONIA DRIVE

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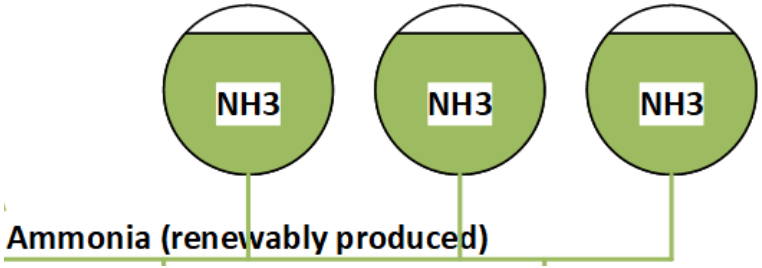
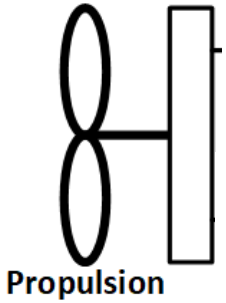
Innovative AmmoniaDrive Concept

Unique integrated SOFC-ICE concept





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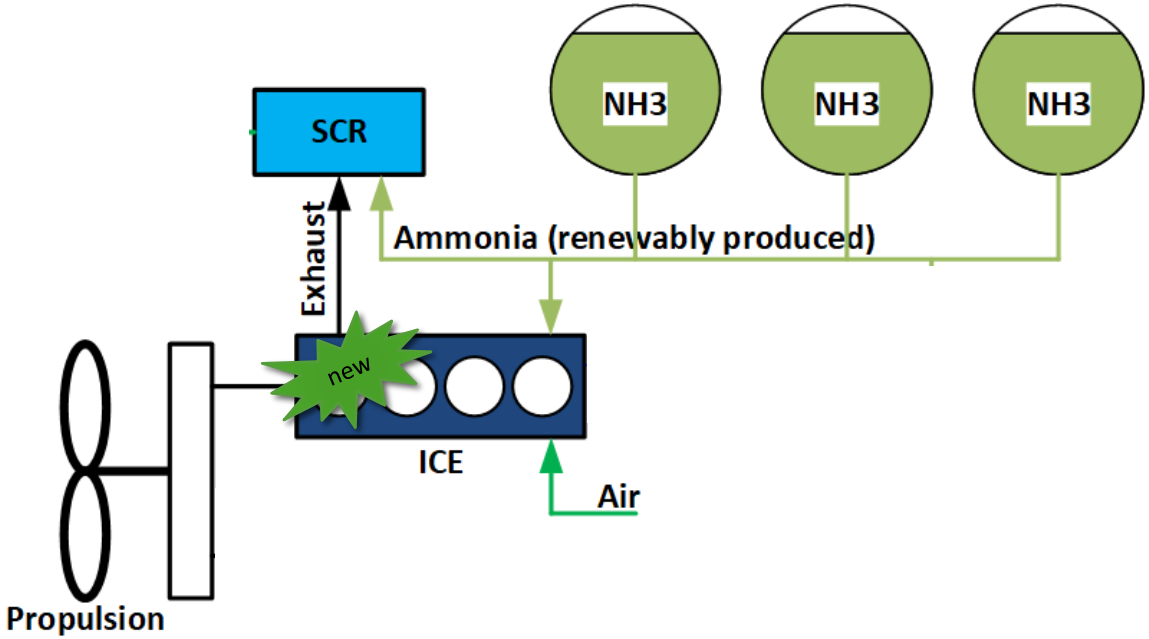
Innovative AmmoniaDrive Concept

Unique integrated SOFC-ICE concept



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Innovative AmmoniaDrive Concept

Unique integrated SOFC-ICE concept

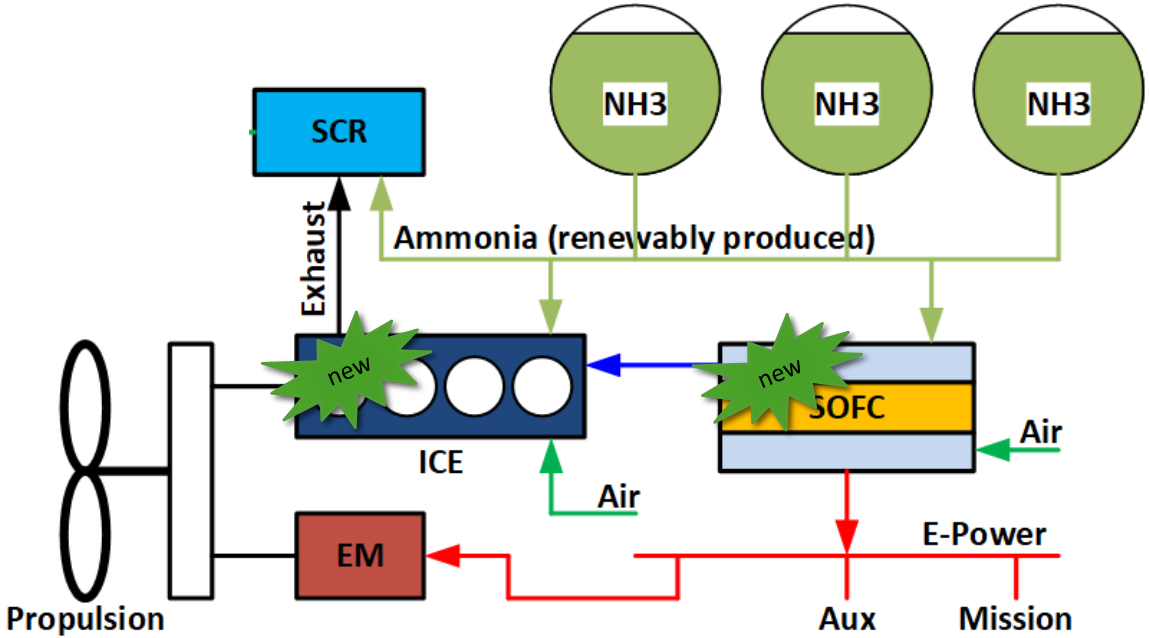
High energy & power density

Clean, low-cost fuel

High system efficiency

No harmful emissions during production & operation

Feedstock (air/water) available everywhere



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Characteristics AmmoniaDrive

The SOFC-ICE combined cycle fits very well with ammonia's characteristics as both hydrogen and energy carrier and enables trade-off possibilities and optimization opportunities for specific operational profiles. Different design objectives like efficiency, power plant size, transient loading capabilities and investment costs can be optimized using the power split between the SOFC and ICE!*

Despite the enormous challenges with regards to:

- Safety - ammonia is toxic (!)
- Availability of technology - e.g. ammonia's poor combustibility makes application in ICEs difficult
- Costs - all e-fuels are (currently) more expensive than fossil fuels
- Environmental impact - will we upset Earth's Nitrogen Cycle with large-scale ammonia application?
- Ship integration – will it fit? How to implement the AmmoniaDrive power plant safely and effectively? Crew training? Reliability, Availability, Maintainability?

* More insight into capabilities and limitations of involved technology is needed to better assess the validity of this statement.

AMMONIA DRIVE

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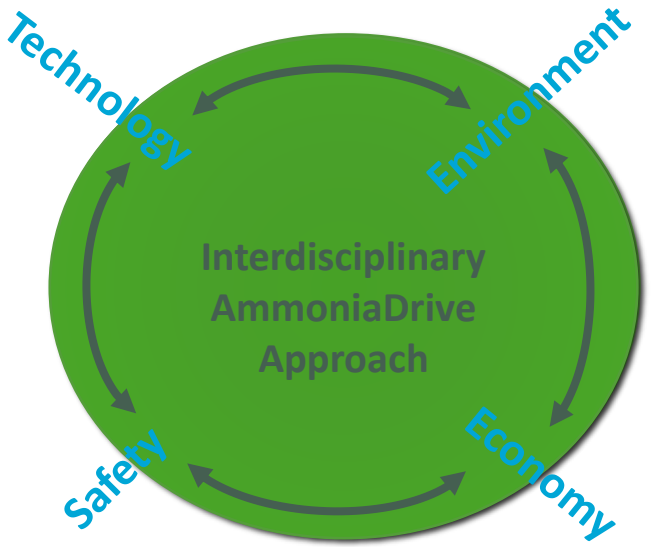
Interdisciplinary research project

Combustibility
SOFC interaction
Control & maintenance
Power plant integration

Ecological impact of moderate and high concentrations above and below the water surface unknown



Safe operations conditions during bunkering, storage, supply and use for humans

Cost-effectiveness of AmmoniaDrive power plant (incl. investment timing) unknown

AMMONIA DRIVE

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Results

Very, very,

early, preliminary,

results…

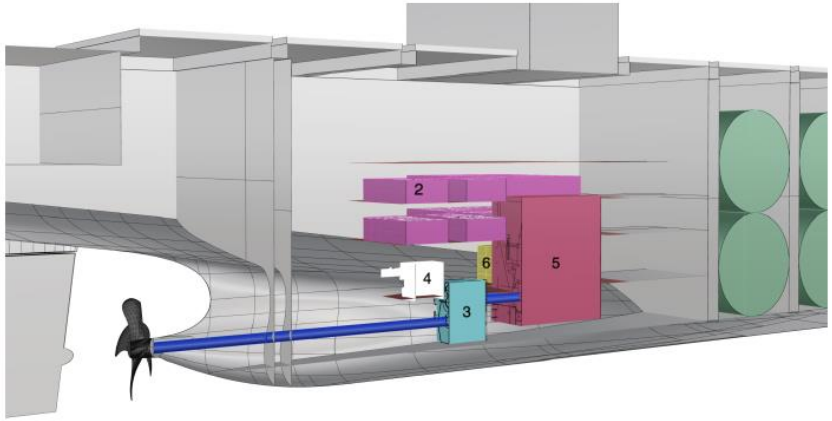
Thanks to:

Mees Feijen,

Joep van den Berg,

Britt van Lierop,

Jesse Zwart

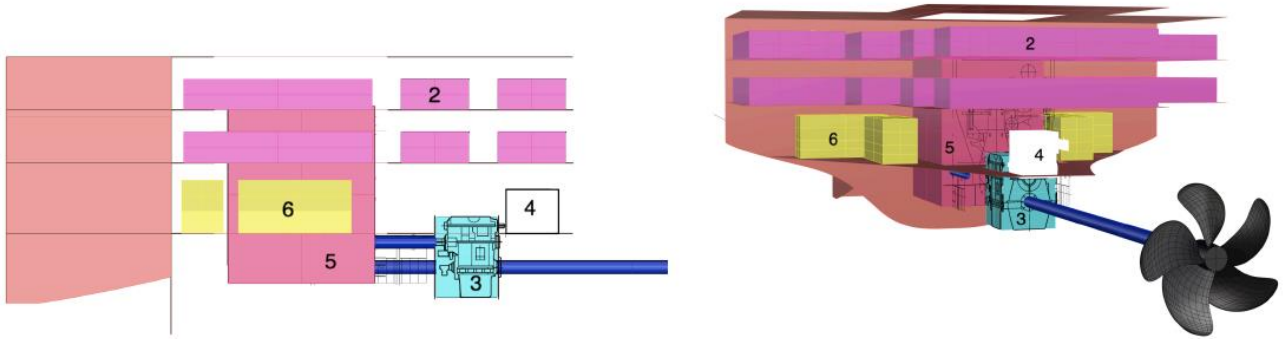


Figuur 32: Ammoniak motorkamer

Tabel 11: Componenten

Nummer	Component
2	SOFC stack
3	Tandwielkast
4	Asynchroon motor
5	Ammoniak motor
6	Hulpmotor ammoniak

Figuur 33 geeft een overzicht van de diesel motorkamer. De componenten zijn genummerd zoals in tabel 11 voor optimaal overzicht.



Figuur 33: Ammoniak motorkamer overzicht

This public
programme

AMMONIA & SHIP PRODUCTION, DESIGN, SYSTEM INTEGRATION, INFRASTRUCTURE & LOGISTICS

(LARGE & SMALL) INDUSTRIAL, CERTIFICATION & GOVERNMENTAL

Partners

AMMONIA DRIVE

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Hoe nu verder…?

AmmoniaDrive onderzoek doorzetten (looptijd tot 2028)

- Wil je op de hoogte gehouden worden? Meld je aan voor de Affiliate Partners door een mailtje te sturen naar p.devos@tudelft.nl

Nieuwe onderzoeksvoorstellen opstarten (Europa?)

Integratiestudies uitvoeren met AmmoniaDrive (Affiliate) partners…

Andere concepten blijven onderzoeken (zoals MeOH-DME en effecten van WASP on ICE)

Anders? …

Of… Demonstrator op ware schaal bouwen: Prototype!

AMMONIA DRIVE

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Unique Selling Points

1. Unique approach to power generation for different ship types and other remote applications:
   A. AmmoniaDrive has the potential to **fully decarbonize shipping**; i.e. GHG and other harmful emissions eliminated (very few solutions that are currently being investigated result in completely carbon-free shipping).
   B. The **SOFC-ICE integrated power plant** converts ammonia (NH_3) into useful energy with a higher efficiency than current marine power plants and is fuel-flexible.
2. Development of advanced combustion concept marine-sized engines (non-conventional dual-fuel approach for ammonia-hydrogen engines).
3. Environmental and economic gains of NH_3-shipping in general and AmmoniaDrive ships in particular are assessed holistically.
4. Safety-conscious design of ship technology (incl. smart maintenance) and risk management strategies.

AMMONIA DRIVE

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