

Eric Baudoin

MAN Energy Solutions

The CAHEMA project



Introduction to CAHEMA Project

Concepts of Ammonia/Hydrogen Engines for Marine Application - CAHEMA

Eric Baudoin, MAN Energy Solutions

Prof. Xue-Song Bai, Lund University

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About the consortium

❑ University partners

- ❑ Lund University
- ❑ Aalto University
- ❑ Norwegian University of Science and Technology
- ❑ Word Maritime University

❑ Industry partners

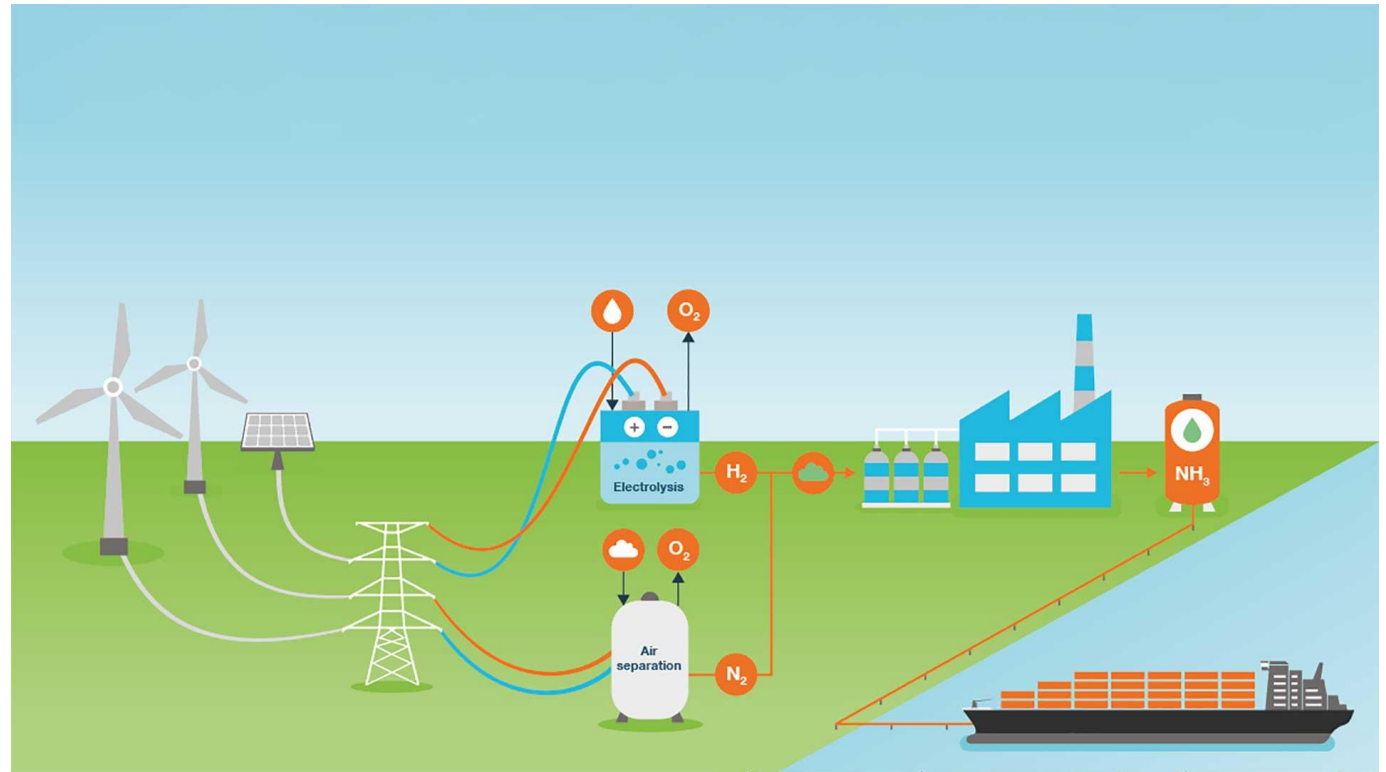
- ❑ ForSea
- ❑ Stolt Tankers
- ❑ Wärtsilä
- ❑ MAN Energy Solutions

Concepts of Ammonia/Hydrogen Engines for Marine Application



Marine transport contributes to

- ❑ 90% of goods traded around the world
- ❑ ~3% of worldwide GHG



<https://www.man-es.com/discover/two-stroke-ammonia-engine>

Concepts of Ammonia/Hydrogen Engines for Marine Application

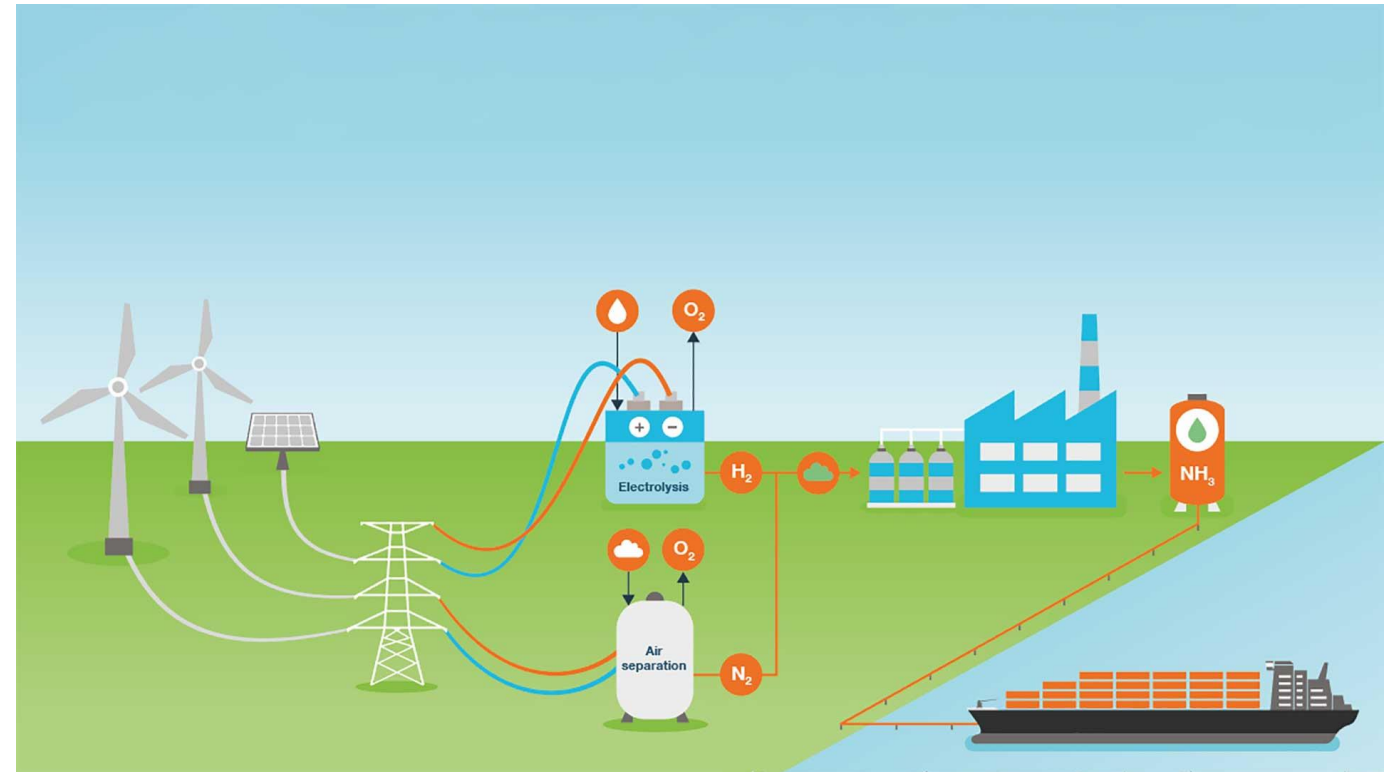


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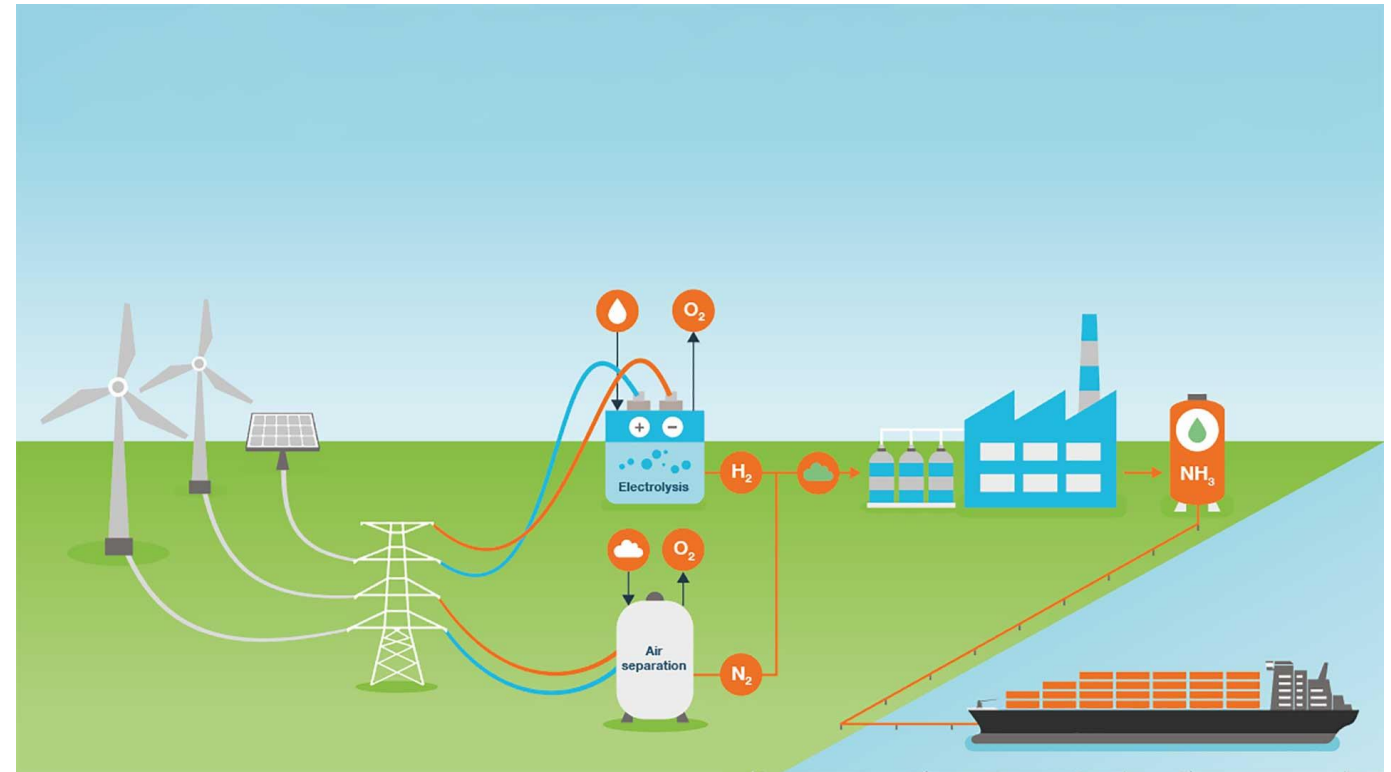
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- ❑ Easier to store & transport (than hydrogen)
- ❑ Ammonia combustion does not emit CO₂



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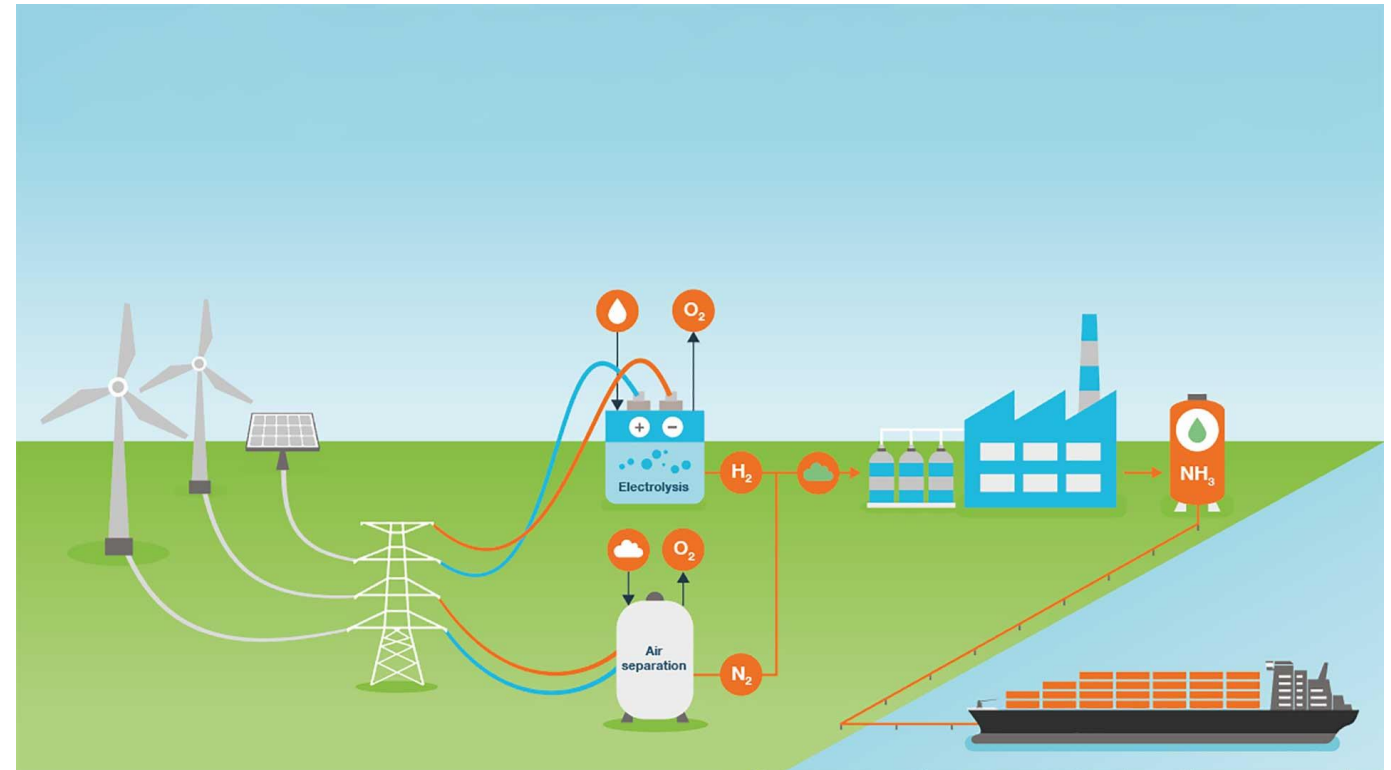
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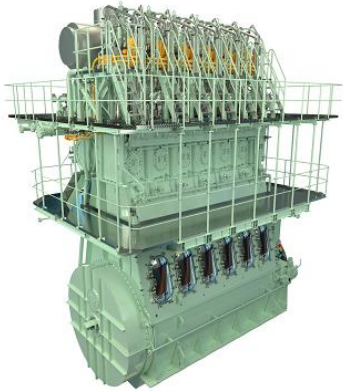
Ammonia engine faces certain challenges

- ❑ Low energy density, difficult to burn
- ❑ Ammonia/hydrogen/diesel dual fuel concept



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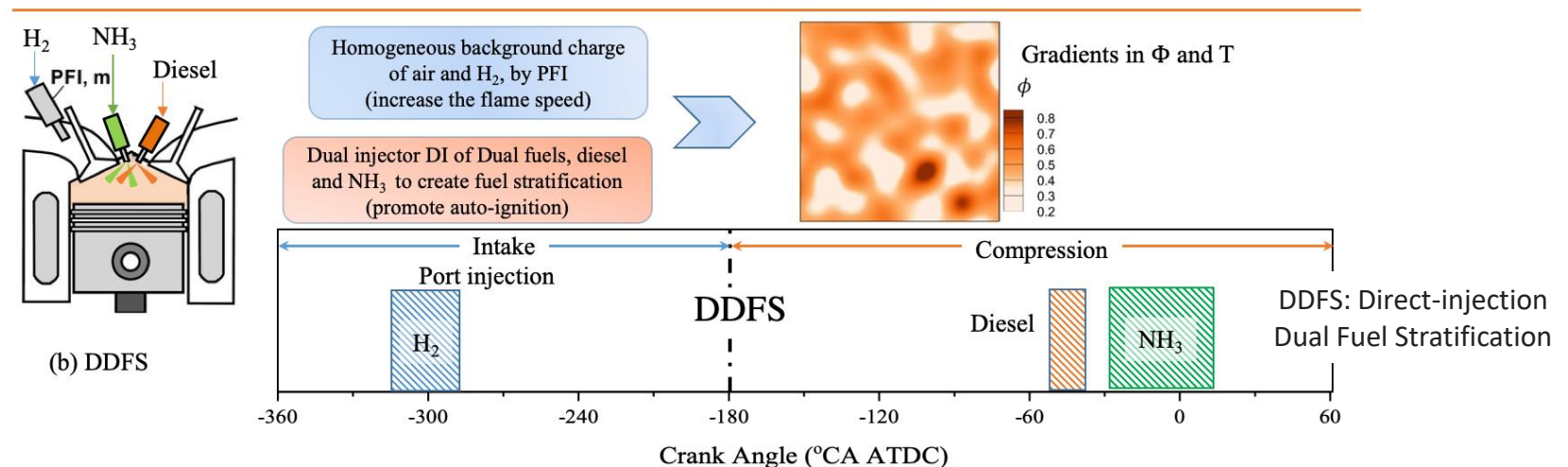
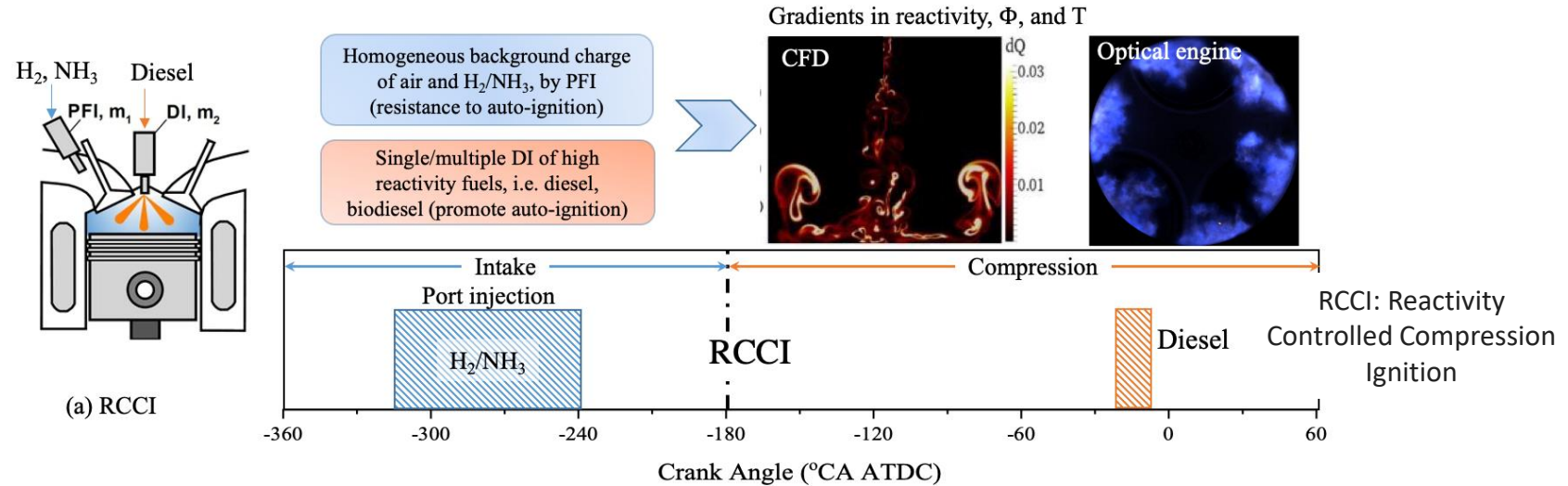
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MAN ES AMMONIA ENGINE PROJECT - AENGINE

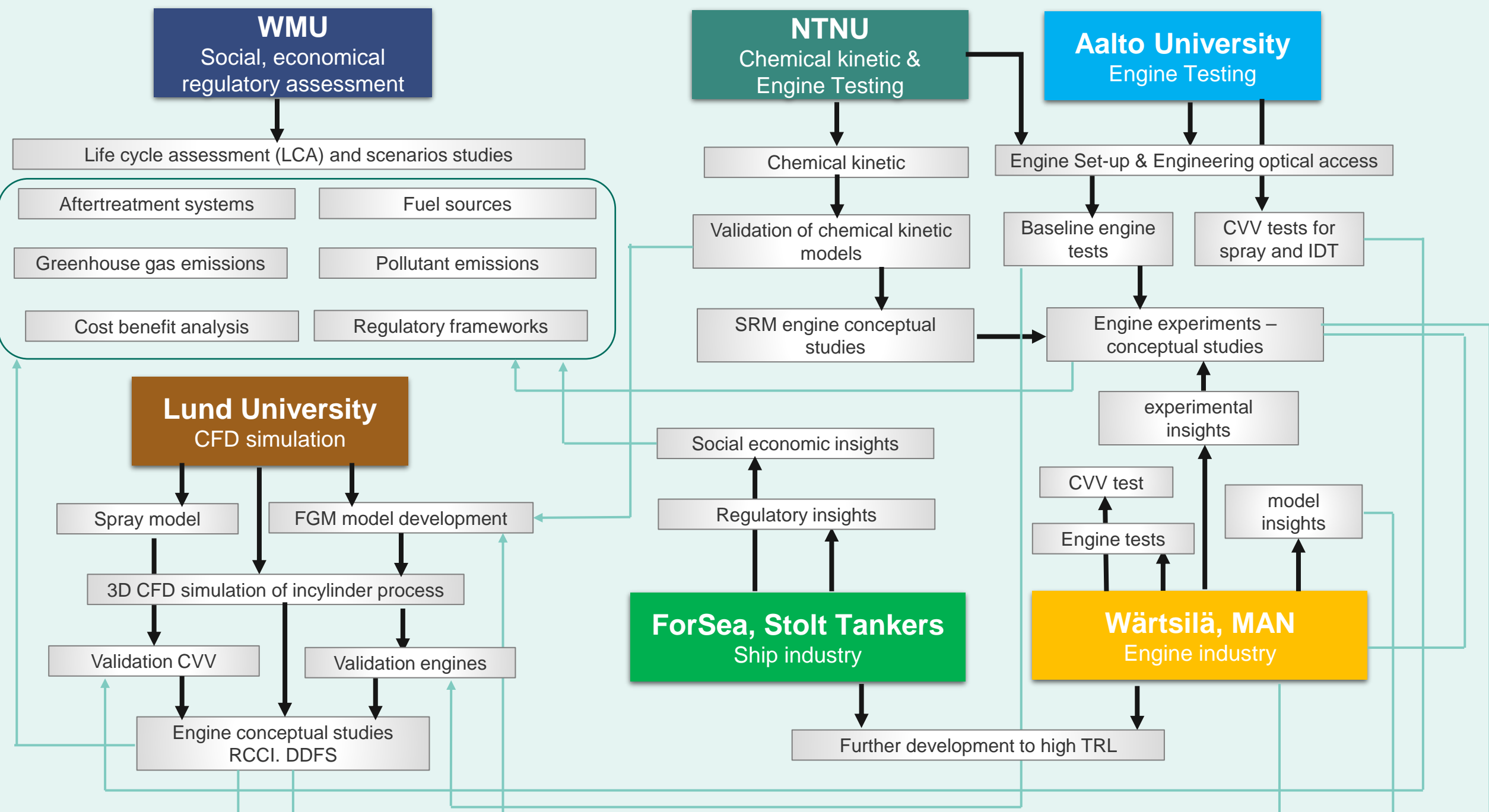


WÄRTSILÄ AMMONIA AND HYDROGEN RESEARCH



Goals

- ❑ To develop a chemical kinetic mechanism of ammonia co-firing with high reactivity fuels such as hydrogen and diesel surrogate (e.g. n-heptane)
- ❑ To develop and validate CFD modelling tools for analysis of ammonia/hydrogen combustion with diesel/surrogate ignition in marine engines
- ❑ To verify two different engine concepts firing with ammonia/hydrogen fuels with a n-heptane/diesel as ignition improver for marine application
- ❑ To assess environmental (climate change) and socio-economic (public health) impact of ammonia/hydrogen marine engines, using life-cycle assessment of ammonia and hydrogen as a marine fuel
- ❑ To give suitable recommendations for emissions regulations on the basis of a cost-benefit analysis comparing the economic cost of engine and emissions abatement technologies



Project contributions and industrial relevance



- ❑ Development of reduced chemical kinetic models for ammonia dual-fuel engines
 - ❑ Provide support to R&D in industry

- ❑ Ammonia spray experimental data
 - ❑ Provide insights to the fuel mixing

- ❑ Ammonia RCCI and DDFS engine simulations provide insights to
 - ❑ Ammonia slip in the engine
 - ❑ Source of NO and N₂O emissions
 - ❑ Impact of hydrogen enrichment on the emissions of ammonia, NO, and N₂O

- ❑ LCA of ammonia/hydrogen engines
 - ❑ Provide an holistic view of ammonia engine technologies

