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AMBHER and ARENHA Projects
invite you to the webinar
"Membranes and Reactors for Ammonia energy"

December 5th 2023 at 10:00

via Teams link

Introduction to AMBHER and ARENHA

www.ambherproject.eu

https://arenha.eu/

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The projects

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1. ARENHA: Advanced materials and Reactors for ENergy storage tHrough Ammonia

Topic: LC-NMBP-29-2019 - Materials for non-battery-based energy storage (RIA)

https://arenha.eu/

2. AMBHER: Ammonia and MOF Based Hydrogen storage for euRope

Topic: HORIZON-CL4-2021-RESILIENCE-01-17 - Advanced materials for hydrogen storage

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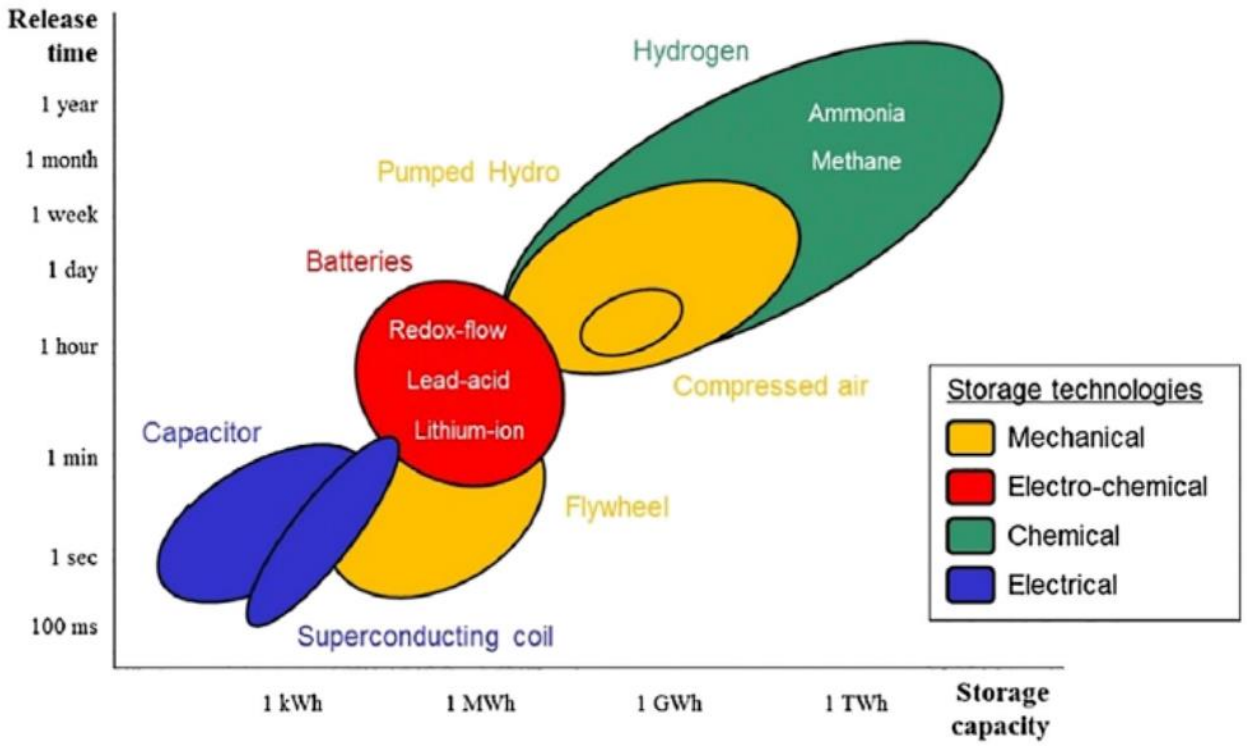
1. Introduction

Energy storage technologies



L.Ye et al. Reaction: "Green" Ammonia Production. Catalysis Vol. 3, Issue 5, p712-714, 2017
DOI: https://doi.org/10.1016/j.chempr.2017.10.016

- Batteries may not be the best solution to face all energy storage needs, due to cost, safety and environmental issues.
- Pumped hydro and methods such as compressed gas energy storage suffer from geological constraints to their deployment.
- Non-battery-based storage technology, such as Power-to-X technologies (Power-to-Gas, -Chemicals, -Liquids) that allows transforming renewable electricity into synthetic gases (hydrogen, methane or other gases) and chemicals/liquids, can be suitable solutions for different energy storage needs.
- The only sufficiently flexible mechanism allowing large quantities of energy to be stored over long time periods at any location is chemical energy storage: via hydrogen or carbon-neutral derivatives.
- H_2 has gained considerable attention as an ideal and clean energy carrier:
  - H_2 combustion produced only water as by-product
  - High efficiencies for energy conversion are achieved when it is employed as feedstock for power production.

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2. ARENHA: Advanced materials and Reactors for ENergy storage tHrough Ammonia

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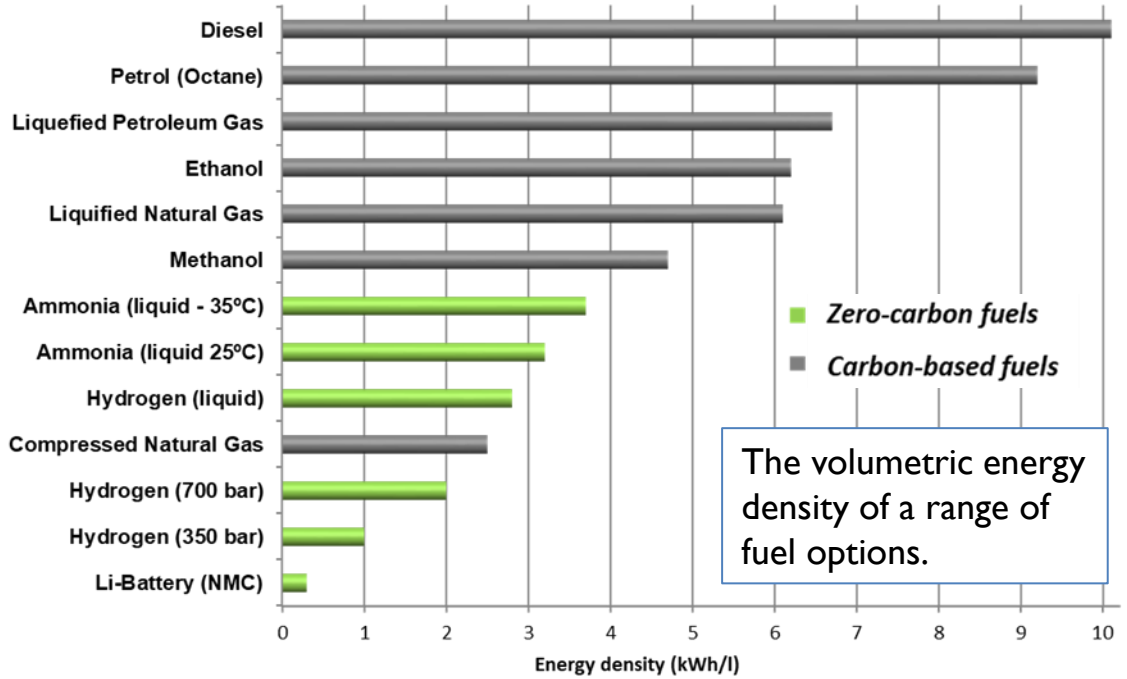
- The ARENHA project aims at using ammonia as a green hydrogen carrier and for that purpose it develops its main activities around the green hydrogen production, ammonia synthesis, ammonia storage, ammonia dehydrogenation and direct energy use of ammonia.
- ARENHA main goal is to develop, integrate and demonstrate key material solutions enabling the flexible, secure and profitable storage and utilization of energy under form of green ammonia.
- ARENHA will demonstrate the full power-to-ammonia-to-usage value chain at TRL 5 and the outstanding potential of green ammonia to address the issue of large-scale energy storage.

Ammonia as a potential H_2 carrier:

High volumetric energy density | Relatively low cost | Easy to liquefy | Easy to store and transport | Carbon free



The volumetric energy density of a range of fuel options.

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2.2. ARENHA: Overall approach

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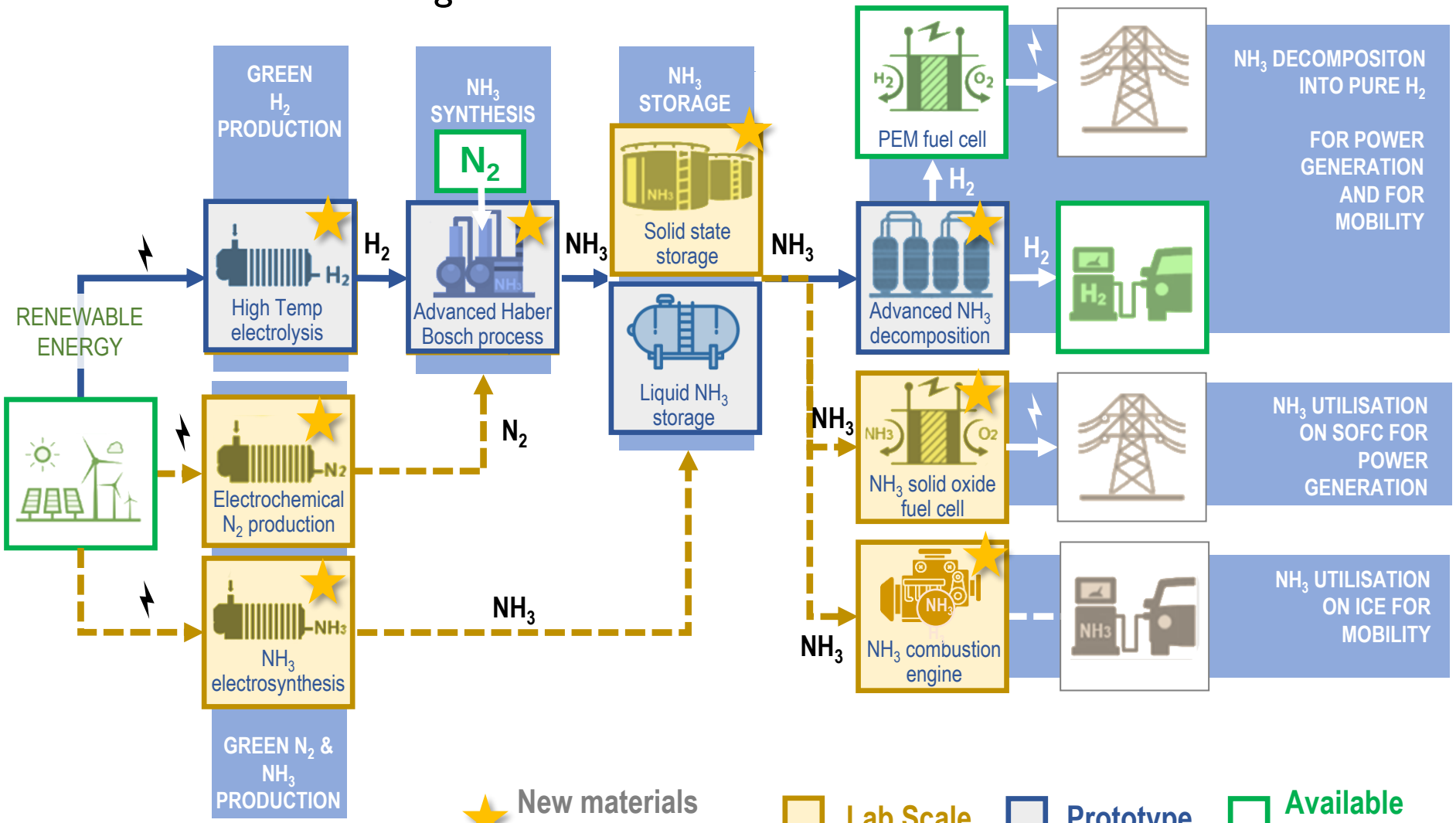
Power-to-ammonia-to-usage value chain in ARENHA



3. AMBHER: Ammonia and MOF Based Hydrogen storagE for euRope

The AMBHER project aims at providing a quantum leap in the development of hydrogen storage technologies, both for long-term in the form of ammonia, as for short-term in the form of ultra-porous materials, setting the basis for future commercialization of greener technological pathways all along the value chain.

- Designing and setting up a broad and complete network of value chains.
- Developing a set of flexible cost-effective and environmentally friendly technologies that can be easily tailored for the storage of H_2 in different forms and for different applications (Energy & Transport among others).
- Laying the foundations for new business opportunities, including:
  - the development of novel ultra-porous Metal Organic Frameworks (MOFs) for their integration in newly designed and cheaper storage vessels for transport applications.
  - the development of new catalysts and membranes integrated into membrane reactors to provide huge process intensification making possible the distributed generation of NH_3 as long-term storage media.

3.1. AMBHER: Main goal and S&T targets

- To develop a new pathway for short term hydrogen storage through advanced Nanoporous materials in the form of MOFs:
  - To develop scalable synthesis process for the manufacture of high surface are MOF (> 2.500 m^2/g) at competitive cost with a gravimetric storage capacity of 6 wt%.
  - To design and develop a MOF container for a storage hydrogen capacity of 40g/L at 100bar.

- To develop an innovative Catalytic Membrane Reactor (CMR) to produce green ammonia, with production rate 4 times higher than conventional reactors operated at the same conditions.
  - To develop innovative environmentally friendly catalyst materials that can be used at much lower pressures (<20 bar) and temperatures (<250 °C) compared to the Haber-Bosch (H-B) process. With NH_3 production rates superior to 8 mmol NH_3 $g^{-1}h^{-1}$ offered by state-of-the-art catalysts.
  - To design and manufacture highly conductive 3D printed Periodic Open Cellular Structures (POCS) with optimised heat and mass transfer.
  - To develop innovative membranes for selective separation of NH_3 during production process CMSMs with selectivities of NH_3/N_2 > 50 and NH_3/H_2 > 10 with an ammonia permeance > 5 x 10^{-7} mol·$Pa^{-1}m^{-2}s^{-1}$.

3.1. AMBHER: Main goal and S&T targets

- To develop a full LCA, LCC and Health and Safety Analysis (HSE) of AMBHER.

- To pave the way for future exploitation of AMBHER Key Exploitable results .
  - To elaborate the business case of KER1. Short-term hydrogen storage solutions: Novel ultra-porous Metal Organic Frameworks (MOFs) for newly designed and cheaper storage vessels
  - To elaborate the business case of KER2. Long-term H_2 storage solutions: Advanced catalysts and membranes integrated into a CMR for distributed generation of ammonia.

- To promote the dissemination and communication of AMBHER's results and expand its impact

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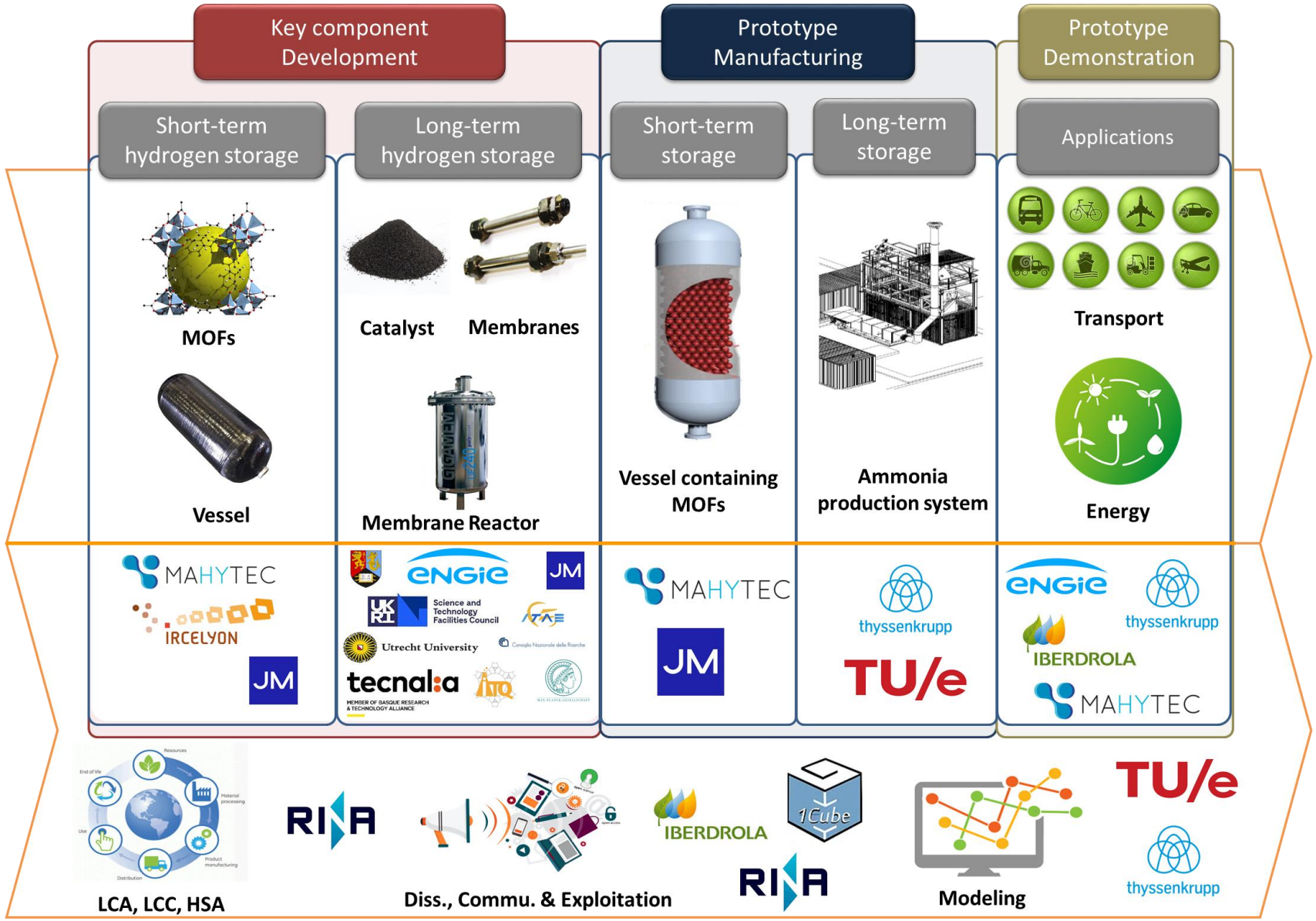
3.2. AMBHER: Overall approach and methodology



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4. Impact

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Decrease energy import dependency.

Promote the integration of offshore renewables for energy dependency.

Integration of renewable in power systems with large scale energy storage.

Strategic European leadership in energy storage.

Ammonia to diversify energy supply from third countries

Alternative energy import through renewable electricity storage and long-distance transportation.

- > $2.5 trillion per year
- > 5000 future jobs
- Reduction of NOx-emission = Increase quality of life
- Avoid 20 million barrels of oil per day

- Reduce annual CO_2 emissions by around 6 Gt

AMBHER

Hydrogen for mobility and industry decarbonisation

more efficiently and cheaper long-term energy storage in form of green ammonia

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Thank you for your attention