



COMBUSTION OF LIQUID AMMONIA, ASSISTED
BY PLASMA DISCHARGES, AS A NOVEL & CLEAN
ENERGY CONVERSION METHOD

1st Press Release

December 2024

Cheers to the CAIPIRINH₃A project's kick-off!

What is CAIPIRINH₃A?

CAIPIRINH₃A is an EU funded project aiming to develop a plasma-assisted self-learning combustor that uses **liquid ammonia (L-NH₃)** as a fuel to produce energy with high efficiency while minimising nitrogen oxide (NO_x) emissions. The CAIPIRINH₃A innovative technologies will overcome all the technical barriers that currently obstruct the clean combustion of L-NH₃ (**high-risk**) to unlock the full potential of NH₃ as an alternative, carbon-free fuel towards a green and sustainable EU economy (**high-gain**).



Why use ammonia?

Ammonia is one of the **top chemicals produced** globally and therefore benefits from an established storage and distribution infrastructure. It can be produced using renewable energy sources. L-NH₃ is a **zero-carbon fuel** that produces only water and nitrogen when efficiently combusted contributing to the reduction of greenhouse gas (GHG) emissions. Moreover, L-NH₃ has an **impressive energy content per volume**, making it a highly efficient option for energy storage and transportation. For example,



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L-NH₃ holds more energy per volume than liquefied or pressurised hydrogen. These facts showcase the **massive potential of L-NH₃ to complement, if not overtake, H₂ as the leading alternative fuel.**

The Challenge

Burning L-NH₃ without producing NO_x emissions is challenging. NO_x have a significant environmental impact because they contribute to the formation of acid rain, smog and ground-level ozone. Additionally, ammonia's unique physicochemical properties (low boiling point, high ignition energy, etc.), complicate the design of an efficient L-NH₃ combustor and often lead to combustion instabilities. Moreover, auxiliary systems are required to control emissions produced during the combustion process, adding extra weight. This is particularly crucial in marine and aviation applications where extra weight can increase fuel consumption, slow down transportation and increase operational costs.



The CAIPIRINH₃A Recipe

CAIPIRINH₃A will address the technical challenges of using ammonia as an alternative fuel by developing the Plasma Mist Ammonia (PlasMi-NH₃) burner. This innovative, plasma-enabled, self-learning combustor efficiently burns liquid ammonia with ultra-low NO_x emissions. The project will use detailed kinetic models, innovative injectors, non-equilibrium plasma systems, and tailored combustion control strategies to enhance combustion through multiple synergetic effects. The PlasMi-NH₃ burner will significantly relax the requirements of additional and costly systems and peripherals, facilitating the penetration of NH₃ as fuel in various sectors. Environmental, techno-economic, and social assessments will showcase the sustainability of the CAIPIRINH₃A solution within marine, automotive, aerospace industrial applications and power generation.

APPLICATIONS



Marine



Automotive



Aerospace



Power
Generation

First Day - Kick-off meeting



The project officially kicked-off with our meeting in Thessaloniki, Greece, hosted by the project Coordinator, Centre for Research and Technology Hellas (CERTH). CAIPIRINH₃A brings together a diverse mix of sciences, combining physics, chemical engineering, mechanical engineering, and AI, alongside a focus on sustainability and social sciences.



On the first day, the consortium meeting was held, where each partner presented their entity and their specific role in the project. Our project officer, attending online, provided valuable tips and guidelines about the project implementation.

The highlight of the meeting was a celebratory moment, where Dr. Konstantinos Kourtzanidis (our coordinator) prepared CAIPIRINH₃A drinks for the team, marking a symbolic moment of collaboration. The day concluded with a wonderful dinner in the center of Thessaloniki, where the team had the chance to engage in one-to-one discussions.



Second Day - Workshop Series

The second day featured a series of workshops covering the diverse scientific areas of our project:

- I. **Svetlana Starikovskaia (CNRS)**: “Plasma-assisted Ignition & Combustion: Nanosecond Discharges” – Offering valuable insights directly from plasma research.
- II. **George Skevis, Sotiris Mamalis (CLEOS)**: “Challenges for Ammonia Integration in the Ship Energy System” – Addressing the specific needs of the marine sector for ammonia integration.
- III. **Alexander Konnov (LUND)**: “What You Need & What We Can Do in NH₃ Kinetic Modeling” – Explaining the real requirements and potential approaches for NH₃ kinetic modeling.
- IV. **Ioanna Katsavou (EXELISIS)**: “Dissemination & Communication Activities” – Outlining the strategy behind the project’s D&C framework.



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