The rapid increase in energy cost and demand caused by the critical reduction of fossil fuel sources and environmental concerns relating to pollution, global warming, and the greenhouse effect have made H_2 gas a promising energy carrier in various applications in recent years. The reason is its cleanliness, renewability, and high specific energy density.

Unfortunately, during production, some additional gases are present in the stream. Thus, the introduction of “colors” for hydrogen was necessary to avoid some misunderstandings. The reason is that hydrogen, especially green one, is an essential element in a fuel cell. It plays a key role and can be differentiated from others: grey, blue, and green. Grey hydrogen is produced by hydrocarbon reforming and has a high CO_x emission. Blue also comes from fossil fuel processing, but the process is enhanced using emission-reducing CO_x capture methods. Zero emissions characterize green hydrogen, and the most popular source is water electrolysis. Also, NH_3 cracking fits this definition. Water electrolysis is not a favorable reaction in terms of thermodynamics, and thus its efficiency is still low in economic competitiveness. In addition, the main issues hindering the potential of H_2 fuel result from the challenges of handling and transportation in an energy-effective, cost-favorable, and safe method. Currently, storage and distribution of liquid H_2 is still an extremely costly procedure.

To address these problems, various reports have recommended using an H_2 carrier. Among various H-containing compounds, NH_3 seems the best solution. Interestingly, the NH_3 industry has been popularly applied worldwide. Thus, it has widespread facilities for storage, transport, and handling. In addition to the ease of handling, NH_3 under a liquefied condition also has much lower volatility than H_2, and offers an extraordinary volumetric density, i.e., 1.7 times compared with H_2 liquid.

Therefore, the design of a novel methodology for H_2 production and handling methodology based on NH_3 is a promising combination to achieve a safe and sustainable H_2 economy.

The idea of the project is to utilize a catalytically enhanced non-thermal plasma (NTP) environment for NH_3 rapid decomposition. We will test carbon-based materials due to their high surface areas, steerable acid-base properties, and easy-forming compounds with metal /metal-nitrides. Moreover, the natural resistance to reductive (H_2) atmosphere and some N-affinity at relatively low temperatures under NTP conditions cause carbonaceous materials to be ideal candidates for active, stable, and not expensive catalysts of the process. The possibility of switch on/off working causes that plasma environment is invaluable for fast- and high-energy density access.

Moreover, thanks to utilizing the unique experimental system and working with isotopically exchanged molecules, we can shed more light on the mechanism of green H_2 production.

In the opinion of PI the results of the studies of the application of new, based on graphene derivative matrices and SWCNH and HC as active phase composites can have a powerful impact on the development of both energy sources and modern carbon science. The use of carbons in the process opens up new possibilities as it is the only material for which porosity and acid/base properties can be easily controlled. Moreover, the ability to work in-situ inside the plasma stream will allow us to obtain unique results that will help us fully understand the NH_3 decomposition process under NTP conditions.