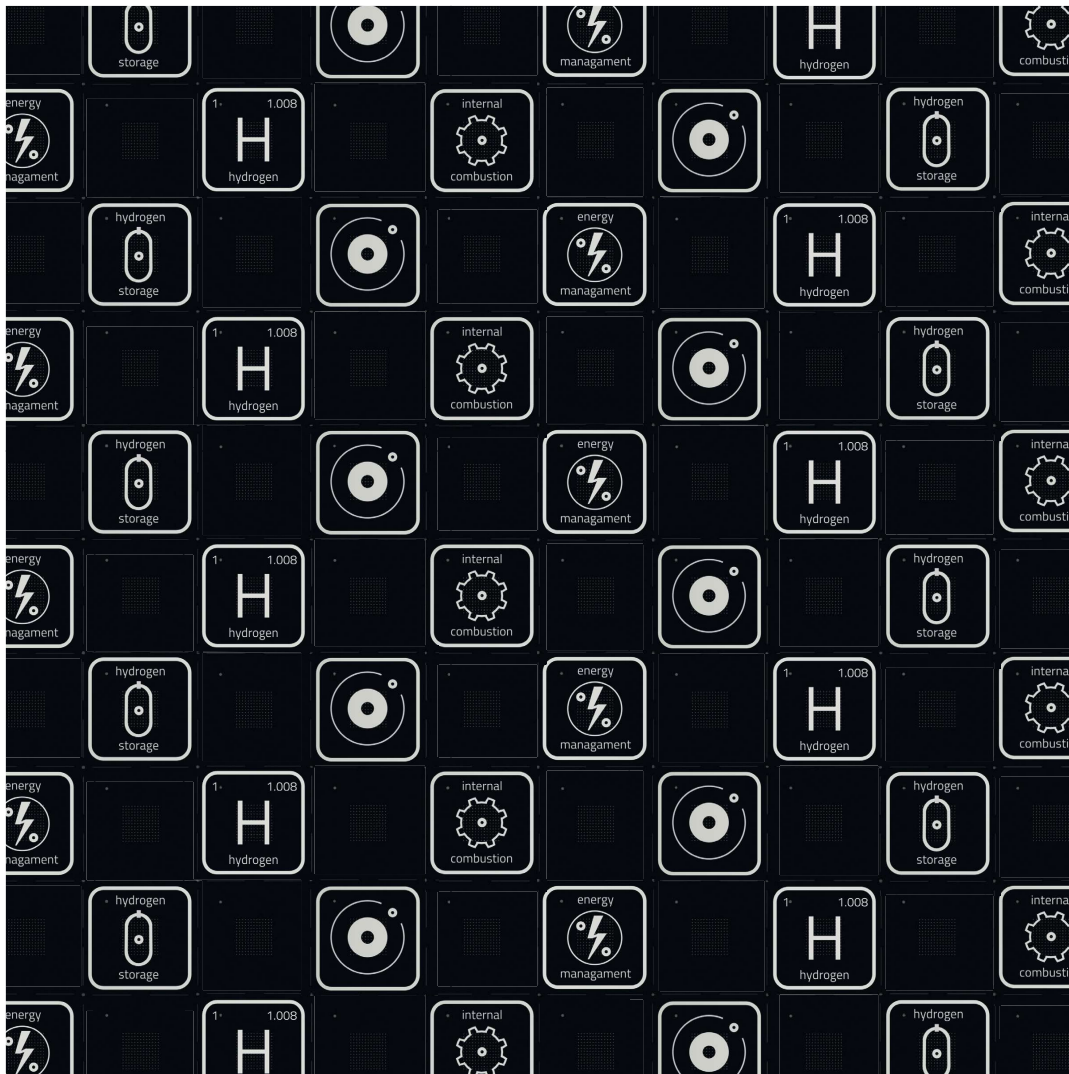




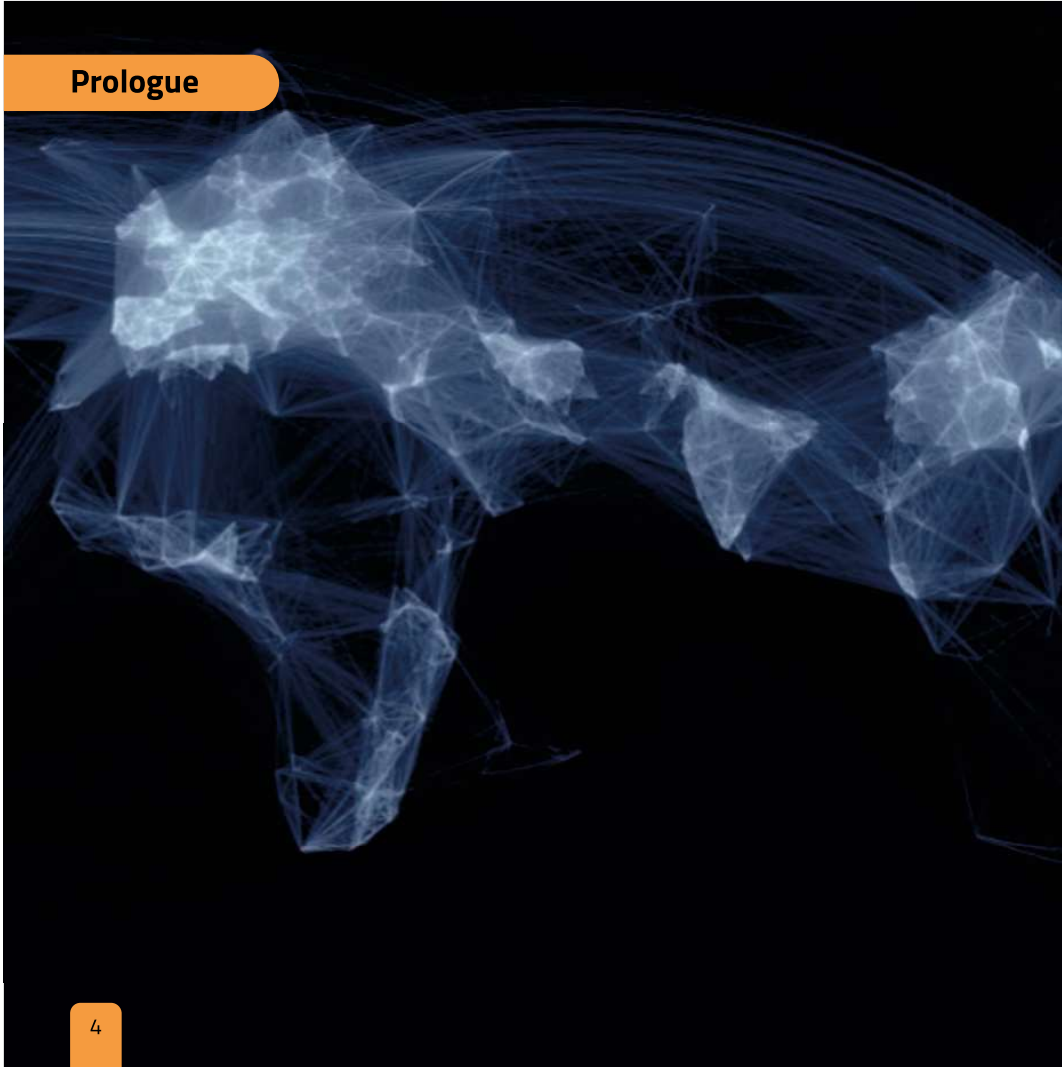
John von Neumann University
Hydrogen Technology
Research Center





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Prologue



Throughout its history, at the John von Neumann University a strong belief has been held in the pursuit of new opportunities and technologies with the promise of transforming our world. We stand at the precipice of a new era, marked by the convergence of science, technology, and sustainability, and we are ready to be at the forefront of pioneering advancements. John von Neumann, the namegiver of our university had always been committed to knowledge and progress, which drives us today to explore the boundless possibilities and challenges offered by hydrogen technology, which is one of the most promising paths to drive our society towards sustainability.

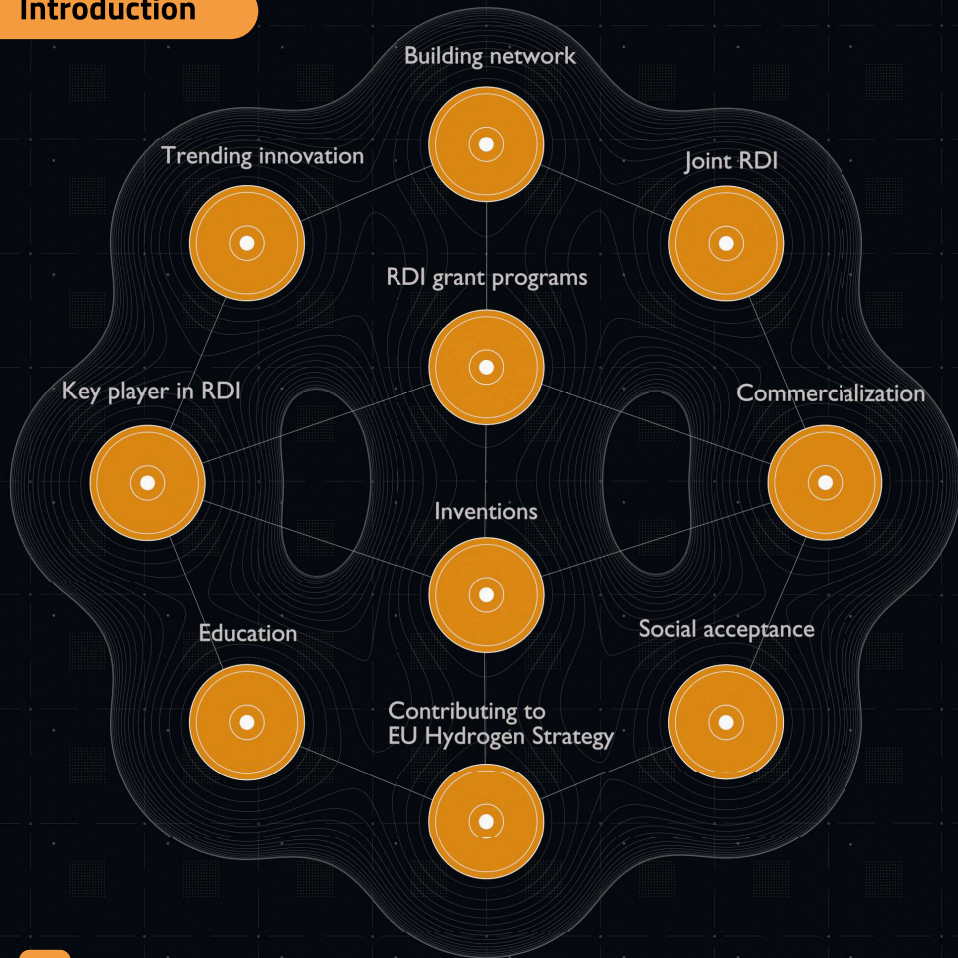
Potential in hydrogen as a clean energy source is an important pillar of our vision about a high-tech, eco-friendly world. The establishment of the Hydrogen Technology Research Center is a tangible manifestation of our dedication to becoming active participants in global networks that drive change. Our goal extends beyond the borders of our university, reaching towards a hydrogen-powered world that transcends geographical limitations.

Research, development, and innovation—these are the key factors upon which our journey towards a sustainable future rests. By engaging to them, we intend to contribute to the growth of the hydrogen global network, ensuring that this transformative technology reaches every corner of our planet. We lay the foundation for a future where sustainability and technology harmoniously coexist.

We firmly believe in innovative thinking, strategic action, and collaborative efforts. In this document our points of view are summarized for stakeholders, partners and other interesting parties in order to provide a starting point of new collaborations in an expressive way.

Norbert Csizmadia
Chairman of the board of trustees of
John von Neumann University Foundation

Introduction



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Efforts towards carbon neutrality as well as the struggle for fuels with high performance at reasonable price are international challenges that require very strong horizontal and vertical interactions among the scientific institutes and relevant industrial companies. Hydrogen has been in the middle of interest of scientists during the last few decades as a candidate to become a superior energy carrier with the help of which we can meet the requirements of the Paris agreement. However, its implementation has to be accelerated due to the difficult economic and political situation of the 2020s.

As a response to the aforementioned challenge, the Hydrogen Technology Research Center was established in 2022 at the John von Neumann University in order to increase the number of innovative organizations with key importance that are able to improve a global hydrogen society.

By using our high theoretical and practical competences, our vision is to demolish invisible borders. Borders among countries, among students and supervisors, among laymen and specialists, among scientists with different interests, so that the new generation of the energy economy can arrive as a result of a worldwide cooperation.

We are aware that even big goals can be achieved through well-defined, targeted steps. Our ones are demonstrated here divided into 10 points that cover the fields of RDI, international contacts, contribution to national strategy and education.

We hope that these thoughts will be inspiring and will help demonstrating our visions and creating new collaborations.

Dávid Kis
Director of
Hydrogen Technology Research Center

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Hydrogen Technology Research Center of John von Neumann University



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Building a network among the top global hydrogen players.



In the globalized world individual actions of the states relating to energy management and environmental protection seems to be a useless attempt. This is especially true for the hydrogen energy-based society, because despite of the advantages, we have to face many challenges that can be resolved with extensive horizontal and vertical cooperation.

We would like to support the plan of the European Commission according to which there is a need to unlock investment in key clean technologies and value chains. It stresses clean hydrogen as one of the essential areas to address in the context of the energy transition, and mentions a number of possible avenues to support it.

Europe is highly competitive in clean hydrogen technologies manufacturing and is well positioned to benefit from a global development of clean hydrogen as an energy carrier. We have a strong desire to be involved in this worldwide project.

Our main goal is to take part in complex projects of high-importance, with a strong support of top global hydrogen players.

We desire to build contacts with different stakeholders in the market and we are open for possible industrial implementation, too.

Learning about the most recent developments, trends, real needs of the industry.



Hydrogen networks will have to grow and diversify considerably over the 2020s to enable the world to meet its ambition regarding net zero carbon emission. We expect growth to be driven by production and demand. This decade will see key policy decisions taken that will influence how hydrogen networks develop and are operated.

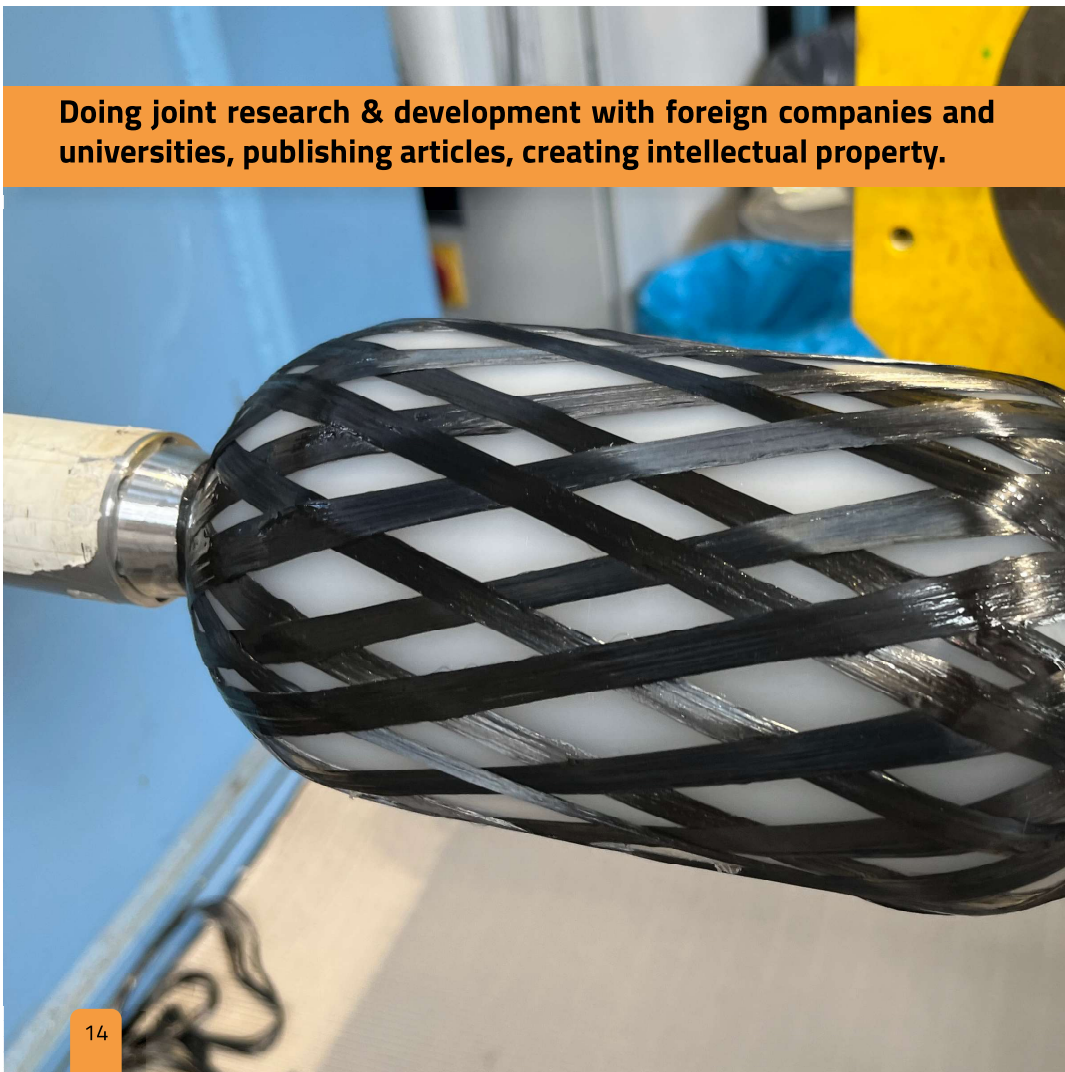
It is crucial to follow the needs and trends, because it is still not clear that early commercial arrangements for the production and use of hydrogen will be sufficient to enable scale up of the hydrogen economy in the later 2020s, or whether changes are needed to support this.

In line with our strategic principles, we will take part in research, innovation and commercialisation of hydrogen technologies alongside testing and at-scale deployment, to help overcome the barriers facing while allowing the global market to determine the optimal technology mix.

We regularly take part in specialized events, presentations, exhibitions to see new directions and results, as well as to demonstrate our ones.

Continuous, professional communication with external RDI institutes and industrial parties is especially important for us.

Doing joint research & development with foreign companies and universities, publishing articles, creating intellectual property.



Coordinated international action on the deployment of hydrogen technologies will make the transition to net zero faster, easier and cheaper for all. Academic institutes have a crucial role in supporting the coordination needed to develop and then move these technologies into the marketplace, ensure safe deployment and support early demand. By collaborating, we can accelerate progress towards these goals.

Research has been a good basis for creating active international contacts. In line with that, we look up universities and off-campus research centers that are open for cooperation with an innovative team with similar or even complementary fields of interest.

Using our skills in hydrogen storage, hydrogen energy management and hydrogen combustion development we wish to supplement the work of specialists having specializations in other fields.

We believe that sharing our competence and resources can result in practical equipment, precious publications and remarkable international presence. With such a kind of collaboration all participants can be more successful in different grant programs, too.

We are looking for partners, with whom our common activity becomes more valuable.



Becoming successful in Horizon Europe and further RDI focused grant programs.

We are aware that funding programmes for research and innovation, such as Horizon Europe can propel the spread of inventions that tackle climate change and boost the EU's competitiveness and growth. Its projects generally involve a research and innovation element and provide support to researchers and innovators to drive systemic changes to ensure a green and healthy EU. Pillar II and III of Horizon Europe are of specific interest for the deployment of

low carbon industry applications and breakthrough technologies, in which hydrogen plays a key role.

Hydrogen related projects of Horizon Europe include research and innovation projects, innovation actions, market deployment, as well as testing and demonstration of hydrogen technologies in industrial environments.

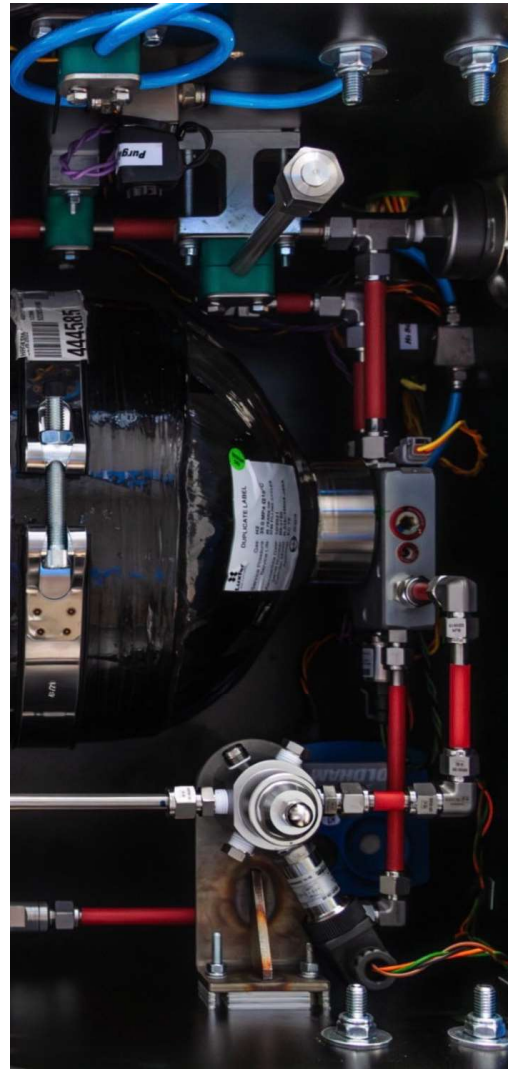
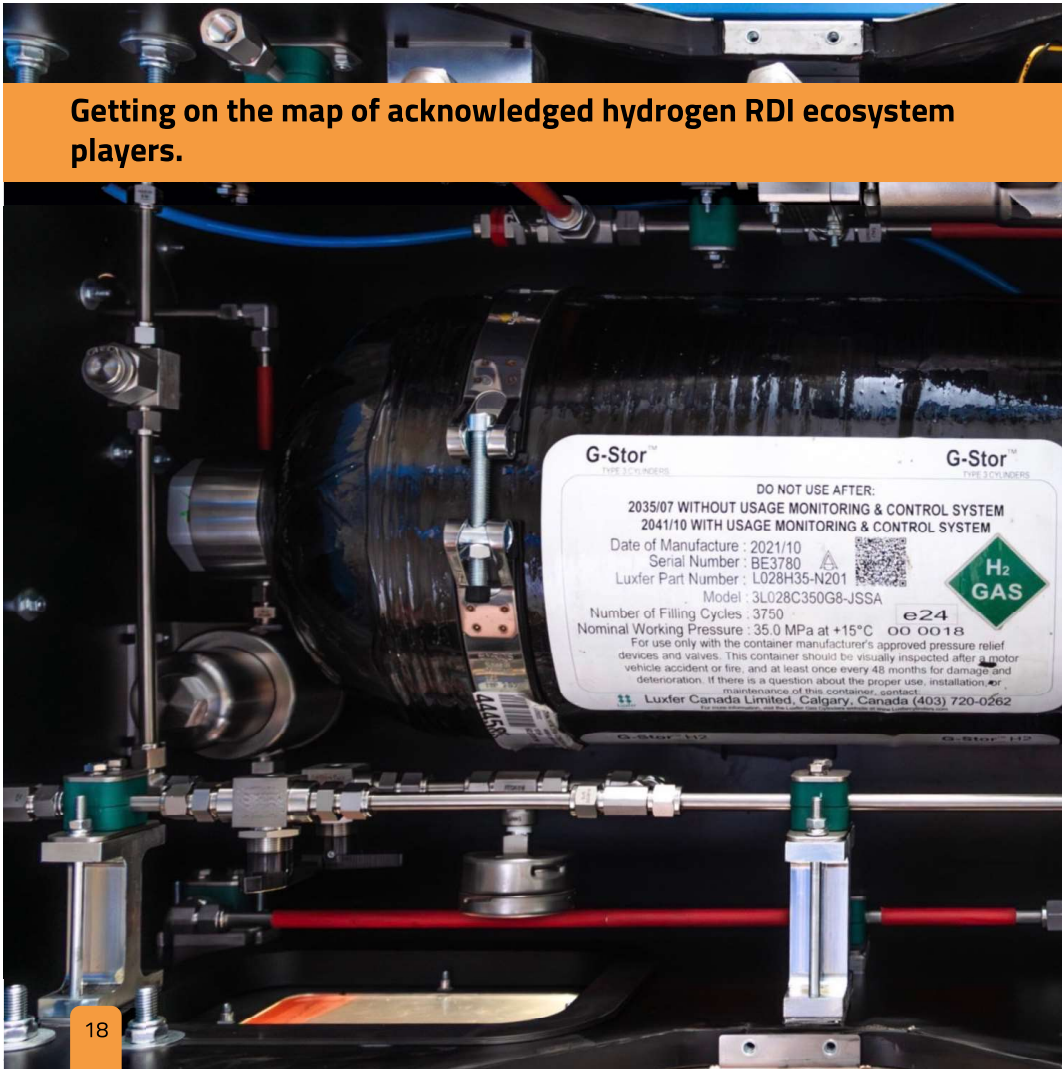


Sections of our development of hydrogen technology fit well with some calls of such prestigious grant programs, for instance optimizing effectiveness of multicomponent energy sources, zero-emission vehicle development, supplying manufacturing technology and service, sustainable water consumption in industry, using AI in applications fit for the Green Deal, creating expertise knowledge pools and industry-academia-public sector junctions.

Taking part in these opportunities can propel the work, as they supply not only financial support, but enhance collaboration at the same time. Our aim is to fulfill projects successfully in order to generate useful results and generate good reputation and new possibilities for our team.

We intend to prepare for new possible projects, looking for new partners and pay attention to new calls al.

Getting on the map of acknowledged hydrogen RDI ecosystem players.



In 2020, the European Union has adapted its strategy on hydrogen a vision for the creation of a European hydrogen ecosystem from research and innovation to scale up production and infrastructure to an international dimension.

An important step that needs to be taken to speed up the rollout of hydrogen technology is establishing a strong and open-minded knowledge pool regarding production and use of hydrogen. Published initiatives will send an important signal, encouraging new parties to take part in RDI actions and implement hydrogen technology as well.

Being an active member of the hydrogen-based society results in more and more new projects, as recognized knowledge, experience and willingness for collaboration provoke invitations into new scientific and industrial programs.

Our active presence in professional events, numerous publications and initiative to create collaborations will help us to become acknowledged by RDI worldwide.



Becoming successful in commercialization - licensing IP to companies, undertaking industrial assignments.

Hydrogen will have an important complementary and enabling role alongside clean electricity in decarbonising our energy system, with potential to help decarbonise heavy industry and provide greener, flexible energy across power, heat and transport.

We expect use of hydrogen across the economy to develop over the course of the 2020s and beyond, with early demonstration in industry, heat and power and use in transport applications in the earlier

part of the decade developing into a wide range of uses across multiple sectors by the late 2020s.

RDI is a strategic element underpinning energy and industrial policy. Only by developing long-term research and innovation programmes that cover the entire hydrogen value chain – from storage, transport and distribution all the way to its use – will it be possible to establish hydrogen as a key technology for the energy transition.



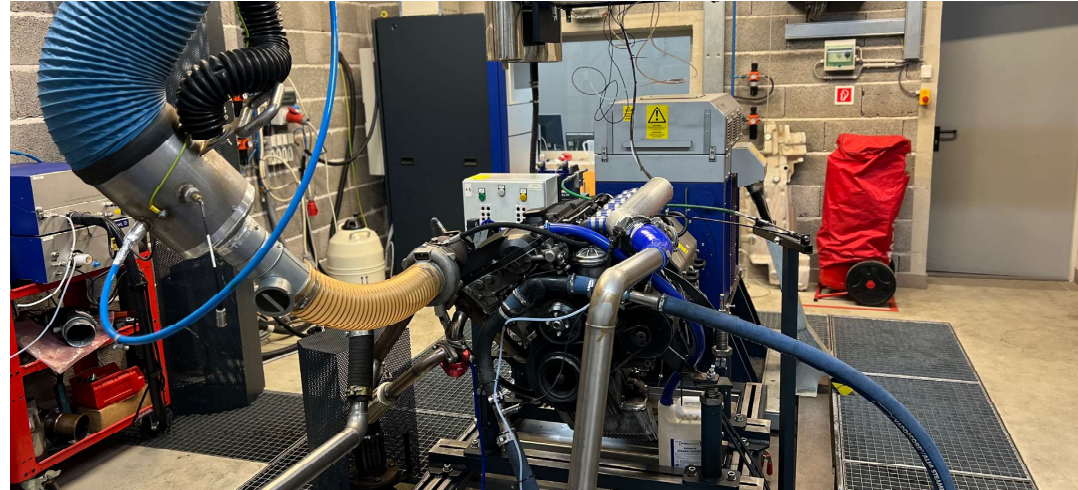
Hydrogen solutions need to be systematically developed to the stage of practical use at industrial scale by 2030.

At the John von Neumann University we carry out practical education and research. In our workshops real, usable prototypes are produced that can be implemented into industrial application. As an extra, their conformance can be proven in our labs.

As an objective for the long-term future, we would like to build up a framework, in which we are trustworthy RDI partners of industrial parties.

Achieving success involves not only the development of groundbreaking ideas but also the effective scaling-up of these innovations. By motivating collaboration and continuously pushing the boundaries of innovation, our research can yield applied results.

Doing excellence based independent research – generating inventions which are ahead of their time.



Owing to the high interest, the number of scientific initiatives in connection with hydrogen production and utilization are growing rapidly. We carry out extended research to analyze and supplement them using our high competence and awareness in order to create the top state-of-the-art ideas.

In order to achieve all our goals, it is essential that we pay special attention to self-improvement through participation in specialized events and reading relevant publications.

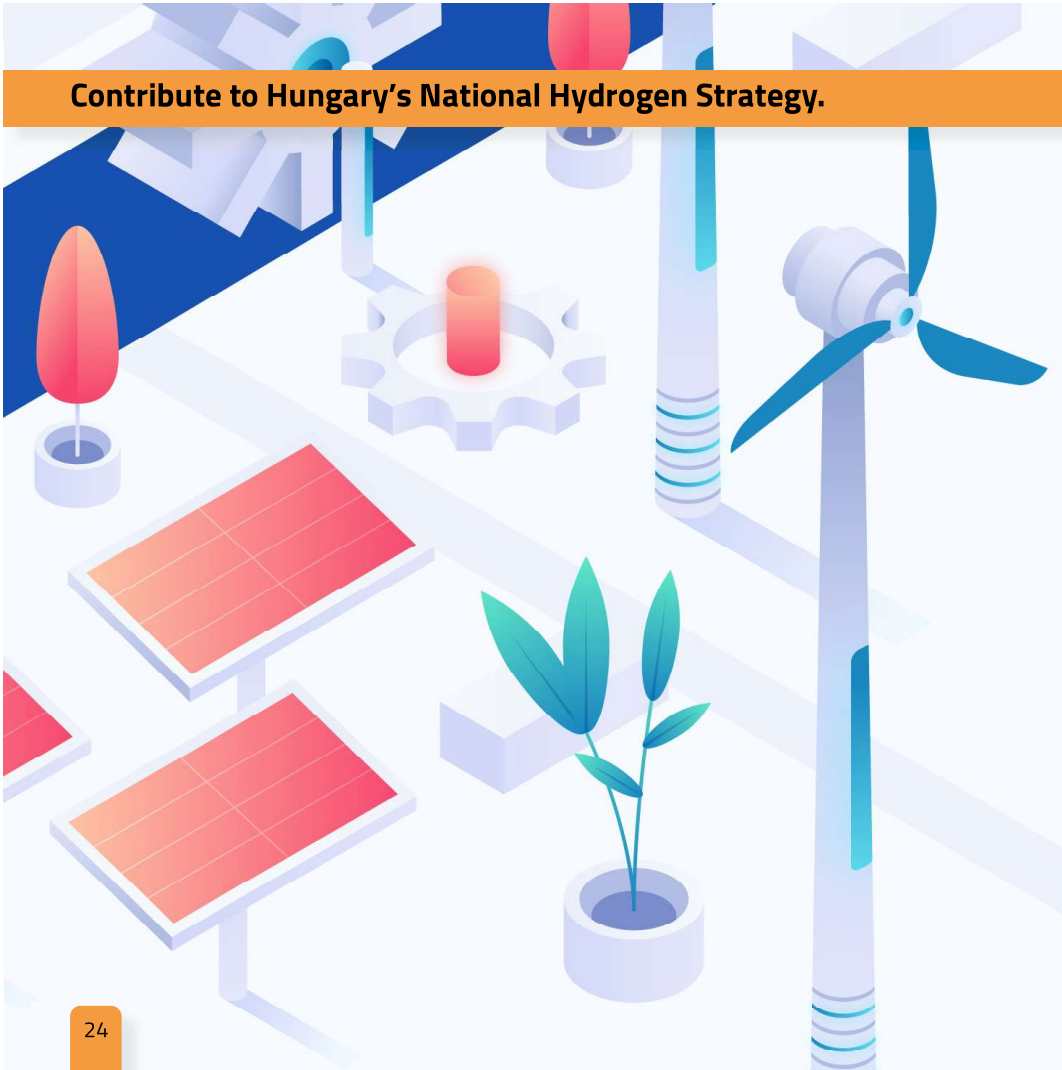
We form a knowledge center, members of which are well-skilled, active, know new trends and ready to react to them.

Although we are aware that implementation of a new invention can be hindered by several factors, believing in our work and having the right competences we are ready to form our inventions to what really useful can be.

Our innovations, particularly the hydrogen-based energy management is a revolutionary new approach that demands high-level expertise in energy resources and IT at the same time.

On the other hand, our studies in the field of adapting classic internal combustion engines for hydrogen use is expected to play a key role during the transition period towards the hydrogen-based society.

Contribute to Hungary's National Hydrogen Strategy.



To fulfill the requirements of NDCs and keep the competition, European states created their own hydrogen strategy documents. That of Hungary's appeared on May of 2021 demonstrating that Hungary desires to become an active member of the European hydrogen network.

Regarding the main points, we can contribute to green transportation with great competence. Transformation of traditional internal combustion engines to hydrogen combustion, one of our main interests, has a direct connection to environmentally friendly vehicle construction.

In order to comply with the social and specialized education goals, we integrate practical knowledge regarding hydrogen technology into the learning system of the John von Neumann University.

We aim to develop our own educational programs, teaching materials and adapt EU teaching materials. In the future, implementation of dual concept is desirable, similarly to other specializations at our university.

As a form of social education, we supply laymen with spectacular informative materials and presentations, too.



Organize the university's hydrogen technology education.

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In order to strengthen our position among academic institutes, we should recruit, train and foster outstanding scientists, new talent and skilled staff and engage in close dialogue with other leading research nations.


Professional training about renewable energy technologies has bilateral advantages: on one hand it helps the state-of-the-art inventions to become widespread in daily use, on the other hand it is inevitable for young specialists, who want to stay at the top.

Students have to be served with basic knowledge, such as the nomenclature and background of the need for implementing green fuels.

Interested students can apply for specialty course, during which concepts at constructing different parts of a working hydrogen system and relevant standards are demonstrated.

With the help of our group not only can the engineer candidates carry out laboratory measurements, but they can try the creations by themselves, even become a member of a team that builds a whole vehicle.

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Increase the awareness and acceptance of hydrogen technologies among society.

There is increasing realization amongst policy makers and industry that 'social acceptance' is a key issue in the deployment of low carbon energy technologies and infrastructures in Europe. There are models that unravel the direct and indirect effects among personal characteristics, knowledge about hydrogen, perceptions, attitudes, and willingness to use hydrogen applications. They suggest that more factual knowledge about hydrogen increases its acceptance.

Scientific results in general cannot be hidden from publicity. It is important that laymen know about hydrogen energy and notice the activity of the Research Centre as well. They have to know that they can take advantage of the hydrogen-based society, too.

It should be emphasized that developing a hydrogen economy is a good opportunity to transform industrial regions, attract investment, and create secure, good quality green life and jobs across the country.



Developing this nascent sector will require existing and important new skills awareness to be available in the right place at the right time.

Part of our mission is to take part in civil programs such as orientation days, workshops or scientific informative events, so that we boost social knowledge and acceptance.

During these events basic information can be spread by using spectacular tools of marketing, for instance

posters, oral presentations, exhibition items and handouts.

By fostering awareness, and actively participating in events that promote hydrogen as a sustainable energy solution we contribute to the widespread adoption of hydrogen, which is considered as a rather challenging endeavor. We are convinced that with help of such initiatives hydrogen energy can become a key player in the environmental future.

Main hydrogen research areas at JvNU

Hydrogen-based energy management

Our goal is to develop an autonomous energy control of a hybrid system using Artificial Intelligence. In this project we concentrate on an energy system that consists of a battery pack, solar cells and a hydrogen fuel cell stack. In order to demonstrate the capabilities, we redesign and build a prototype vehicle, that will be suitable for road use, as it will comply with all technical legislation in its category.

Hydrogen combustion

Through measuring and optimizing petrol engines with our engine brake dynamometer equipped uniquely in Hungary, hydrogen operation is compared to that of currently used internal combustion engines. Monitoring all EURO 6 standard values with high accuracy in real time is one of our main competences. We are highly interested in learning about the combustion characteristics of hydrogen, as well as in carrying out experiments to approach the EURO 7 norm.

Hydrogen storage

We focus on type IV cylinders which have composite overwrapped polymer liner. These pressure vessels are developed and tested in our specially equipped Plastic Processing and Material Testing Laboratory as well as through international cooperations. Test cylinders are created in order to validate our material and production technology developments.

Fuel cell development

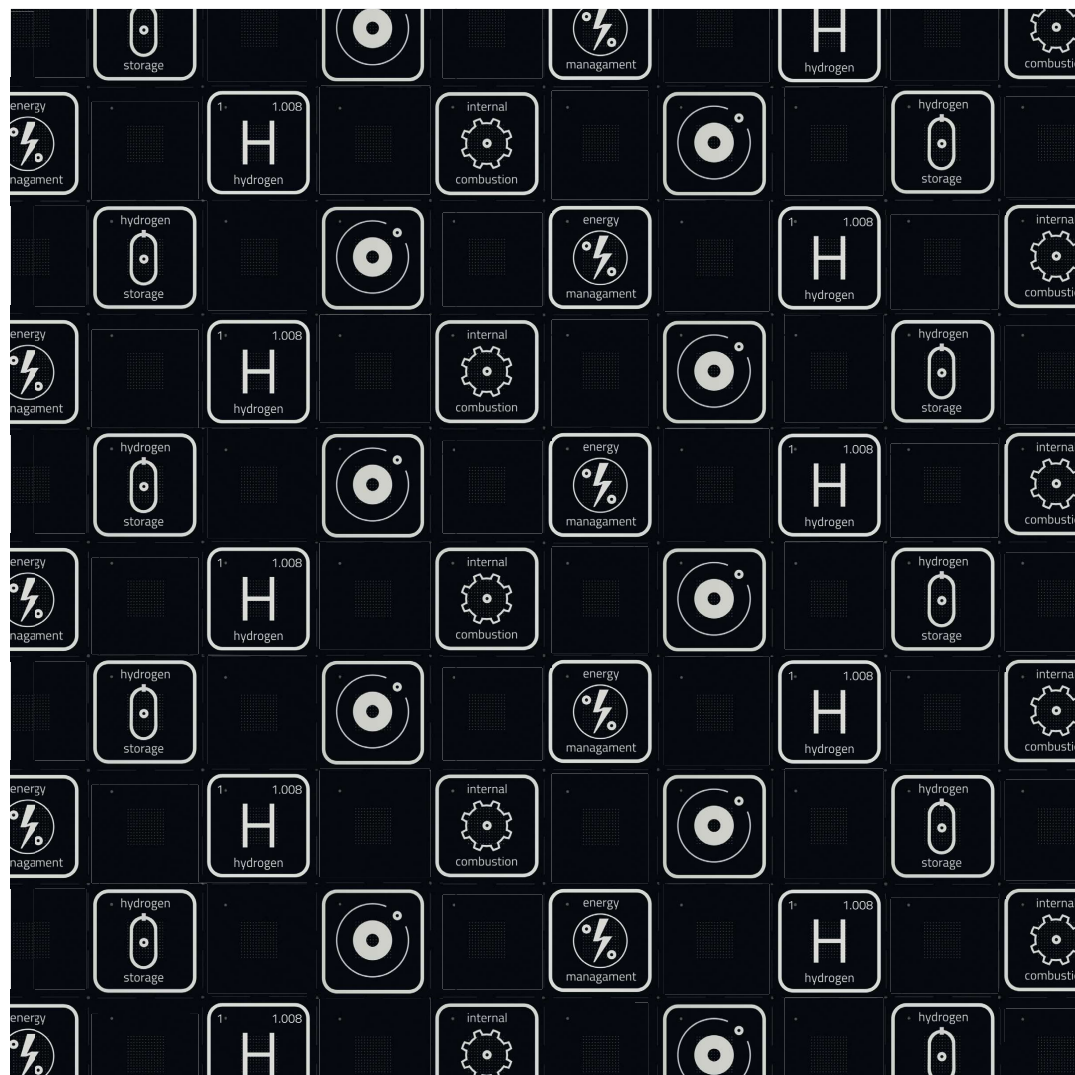
We take part in development of foam-structured flow paths of PEM-FC bipolar plates in the frame of the RRF-2.3.1-21-2022-00009 National Laboratory of Renewable Energies program. In our research simulation of flow models and electrochemical processes as well as manufacturing of prototypes are carried out. As a long-term plan, we desire to establish a laboratory of fuel cell tests and trainings.



In cooperation with Moholy-Nagy University of Art and Design Budapest



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