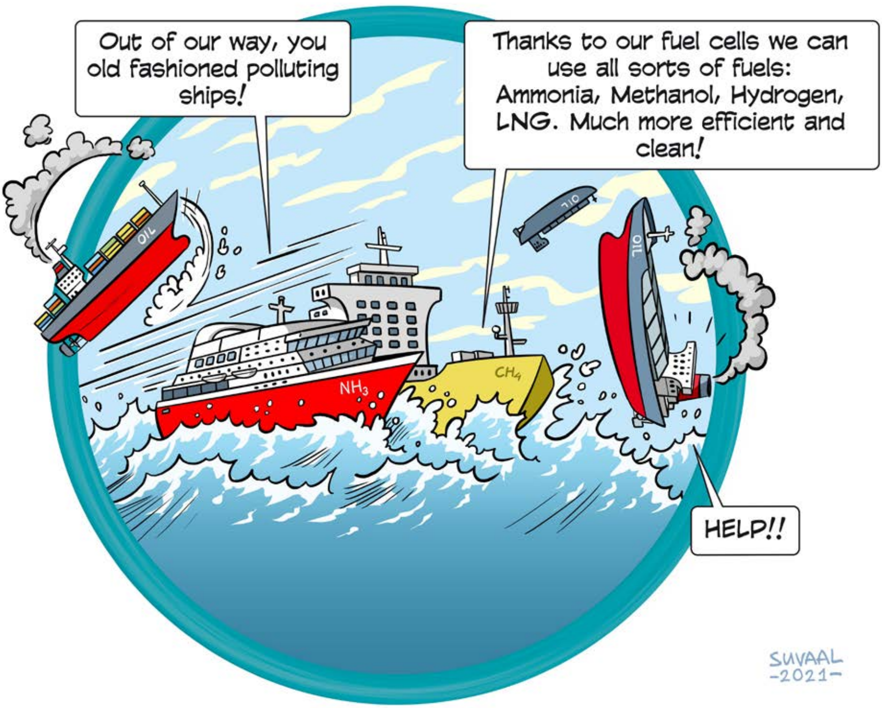
Home of Innovation

Hydrogen at TU Delft

A small taste of our cutting edge technology



TU Delft | Innovation & Impact Centre

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A small taste of our cutting edge technology

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Introduction

Our future energy supply needs both green electrons (electricity) and green molecules. Sustainable hydrogen can play an important role in covering additional energy and raw material demands, and will obtain an important role for large scale energy storage. European ambitions envisage a hydrogen supply of 10 million tons in 2030 (8% of the current natural gas demand), to be scaled up for complete coverage of the future pan European hydrogen demand.

The large-scale introduction of hydrogen in our energy system, however, poses many challenges. For instance, how to implement H_2 into the existing energy landscape, how to cost-effectively introduce H_2 for shipping, aviation, and urban applications, how to achieve cost reduction in electrolysis for scale up, how to cost efficiently get wind energy to shore and in what sectors to introduce H_2 first?

This special edition of the Home of Innovation therefore focusses on Hydrogen. The challenges we face and the technological solutions required are of such complexity that collaboration will be essential in ensuring success. The TU Delft Innovation & Impact Center is facilitating this in various ways, including setting up field labs in which companies can work together with scientist, researchers, start-up and the public in testing, validating and further developing new innovations. TU Delft's mission 'impact for a better society' is therefore more appropriate than ever when it comes to the energy transition.

The projects in this booklet have been captured in exciting visualizations and rated according to the their technology readiness level. Home of Innovation is a guide for companies and institutions keen to collaborate. Do you share our ambition for a better society? We are happy to join forces with you working towards a sustainable future.

Sincerely, Bendiks Jan Boersma and Peter Lucas, respectively scientific and managing director of the TU Delft H_2 Platform

Considering to Collaborate?

“Impact for a better society” is the central mission of Delft University of Technology. Building on an excellent scientific profile in science, engineering and design we offer knowledge-intensive, technology-driven solutions to societal challenges. These solutions are rooted in ground breaking research: research that makes us an attractive cooperation partner for other knowledge institutes, society and for businesses.

We deeply value our collaborations with industry, many of whom we have long-standing relations with deeply rooted in joint history. We are always open to welcome new partners, to explore new domains and establish new joint ventures, either through bilateral agreements or within the framework of, amongst others, Horizon Europe, national top sector funding, NWO and regional funding.

Our societal challenges need solutions now. The speed of innovation has become essential for all players in a worldwide market. We believe that multi party collaborations are key in accelerating innovation. We invite businesses to join our community and collaborate on research and innovation with the TU Delft and parties in our TU Delft Campus ecosystem. Together we identify your research and innovation challenges and connect these challenges to our ecosystem of academics, students, corporates and entrepreneurs.

The aim of TU Delft is to grow TU Delft Campus as a public private innovation campus of great international importance. This can only be achieved by creating strong interactions with knowledge institutions, government organizations, larger businesses, SME’s, start-ups, scale-ups and investors.

Our final call to you is: Let’s cooperate to create future society and future markets and work in a joint effort on impact for a better society!

Get in touch with the Innovation & Impact Centre

The Innovation & Impact Centre of the Delft University of Technology supports in establishing collaborations between businesses, government and knowledge institutes to initiate research and bring innovations to the market. Are you interested in collaborating with the Delft University of Technology, do get in touch.

The speed of innovation has become essential to compete in a worldwide market. We believe that multi-party collaborations are key in accelerating innovation. We invite businesses to join our community and collaborate on research and innovation topics with the TU Delft and parties in our TU Delft Campus ecosystem.

Together we identify your research and innovation challenges and connect these challenges to our ecosystem of academics, students, corporates and entrepreneurs. We offer strategic collaborations that accelerate innovation, inspire and spark entrepreneurship. This is your chance to innovate together.

The Corporate Innovation team members are well informed on the latest scientific research at TU Delft, and they know the needs from the private sector. This enables them to contribute to very effective market research, business development and matchmaking between small medium and large enterprises and researchers. To initiate and facilitate sustainable collaborations, the team continuously searches for key-partners in multidisciplinary settings, resulting in research and innovation collaboration. For Hydrogen, this team works closely together with the TU Delft Hydrogen platform which aims to bring together the researchers, research infrastructure and to link them to energy transition challenges. At TU Delft over 200 researchers are involved with Hydrogen and are co-working in over 50 projects.

Click here for more information.

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Valorisation indicators 2021

The Dutch universities formulated their valorisation objectives in their performance agreements with the Ministry of Education, Culture and Science in 2012. Following on from this, each university has developed its own valorisation indicators to measure performance. The following valorisation indicators were established in 2015, along with the other Dutch universities of technology, and they have been published in the annual report since 2016. This set of indicators provides a quantitative overview of the valorisation activities TU Delft.

Proportion of funding	
Government funding	618,6 M€
Indirect funding	58,5 M
Contract funding	147,6 M€
Internships and graduation projects for non- university institutions	
Master	650
PDEng	23
Co-publications with companies	
CWTS Leiden Ranking – University Industry Co-publications	#49
Proportion of publications with one or more companies as co-author	10,7%
Intellectual property	
Number of invention disclosures	98
Number of patent applications	69
Number of transfers	8
Number of licences	2
Business activities	
TU Delft spin-off with TU Delft IP	3
Startups – TU Delft founded, without TU Delft IP	0
Startups – by third parties, with TU Delft IP	0
Ancillary activities	
Number of professors with non-academic ancillary activities	128
Entrepreneurship education	
Entrepreneurship minors (30 EC)	262 students / 7860 EC
Aditional Entrepreneurship courses (5-8 EC per vak)	533 students / 2890 EC
Total EC Entrepreneurship education	795 students / 10750 EC
Alumni careers	
Percentage of alumni employed by non-academic organisations	85,1% (2019)

TRL & Icons explained

Research Themes

In total eleven research themes have been used for a thematic categorisation of the innovative projects. Each research theme has been assigned its own colour. You can find the themes on top of each project page. Please also see index page 36 to search by research theme.

Which faculty involved

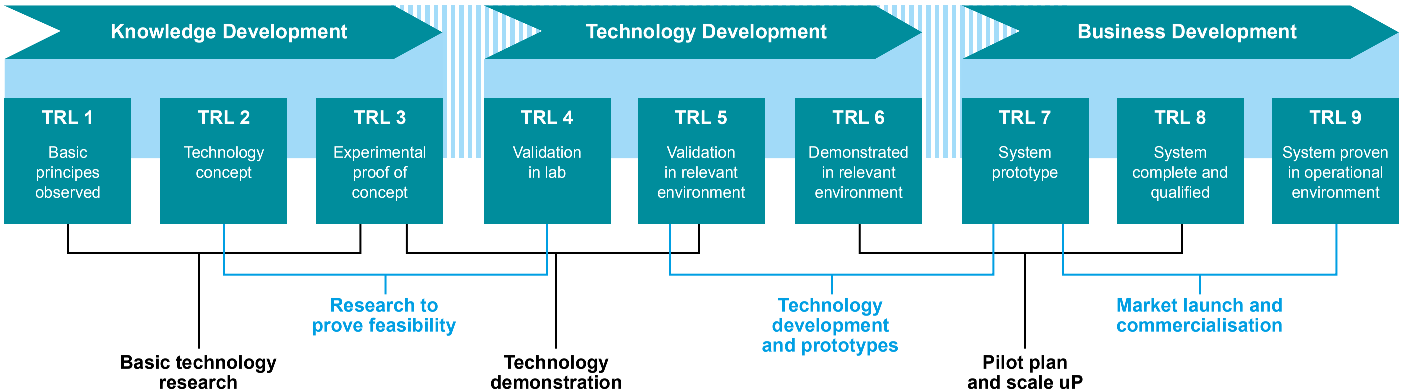
Delft University of Technology has eight faculties. For all projects we have indicated which faculties are involved using the following icons:

3mE	Mechanical, Maritime and Materials Engineering
ABE	Architecture and the Built Environment
AE	Aerospace Engineering
AS	Applied Sciences
CEG	Civil Engineering and Geosciences
EEMCS	Electrical Engineering, Mathematics & Computer Science
IDE	Industrustrial Design Engineering
TPM	Technology, Policy and Management

Technology Readiness Levels

The University is full of interesting, innovative research within its own specific theme and stage of development. Finding a project that matches your interest can be complex without some guidance. We have listed the projects according to their TRL level.

Technology Readiness Level (TRL)



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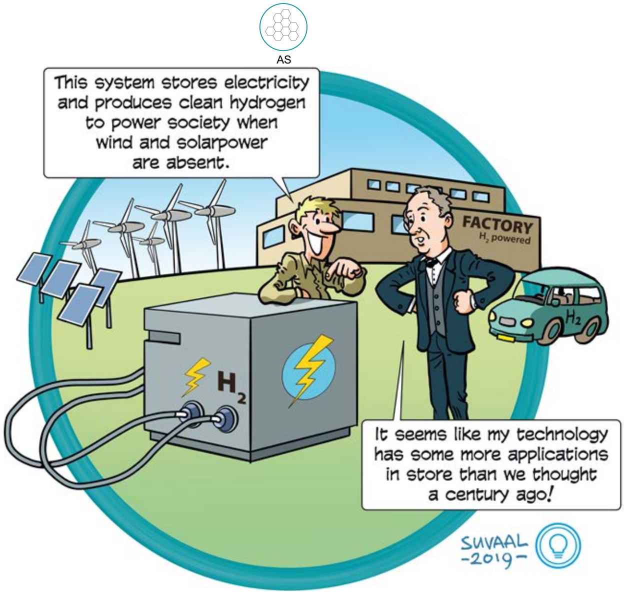
Prepared in accordance with Annex G of Horizon 2020

1.

H_2 Innovation Projects



TRL 4 3 2

Battolyser; combining electricity storage and conversion

prof. dr. Fokko Mulder

Summary

The challenge of renewable electricity generation is that it is not constantly available and that the electricity has to be used immediately. It is desirable to find means to store this electricity to match usage throughout the year. The research is developing a unique system in which sustainable electricity can be stored for both the short- and long-term usage. The novel system consists of a battery, integrated with an alkaline electrolyser. The unique feature of this system is that when the battery is fully charged the integrated system starts splitting water molecules into H_2 and O_2 via electrolysis.

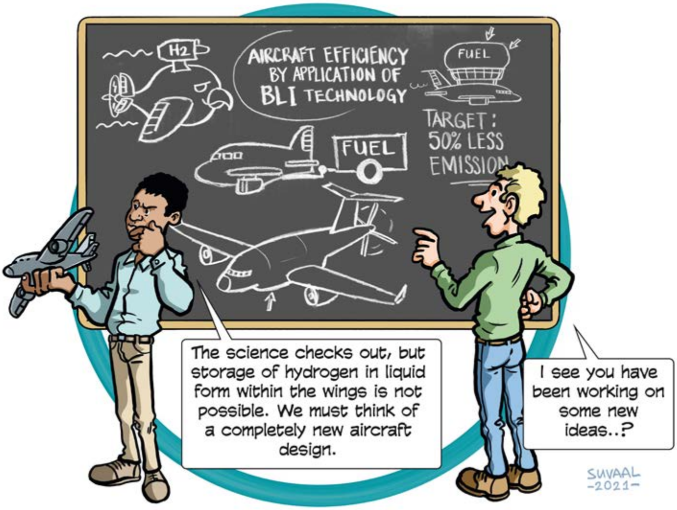
What's next?

This technology has formed the basis for the creation of a Spin-off company, Battolyser Systems bv. Their next step is the realisation of a scaled-up facility in the Eemshaven which should be operational by half 2019, and subsequent further scale-ups.

Contribution to the Energy Transition

Through this technology the electricity grid can be balanced by delivering energy at a high price to the grid when there is a shortage; and by cheaply buying energy from the grid for battery capacity charging and hydrogen production when there is a surplus.

AE



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TRL

Advanced Propulsion & Power Unit

prof. dr. A. Arvind Gangoli Rao

prof. dr. ir. Leo Veldhuis, dr. Ferry Schrijer, prof. dr. -ing. Georg Eitelberg, dr. Ivan Langella, dr. ir. Maurice Hoogreef, dr. ir. Roelof Vos, dr.ir. Tomas Sinnige, dr. Feijia Yin, dr. Anexander Heidebrech, ir. Kaushal Dave, Martijn van Sluijs MSc, ir. Sarah Link

Summary

Current aircraft use kerosene for propulsion, which is stored in the wings. When you would want to fly on hydrogen, storage in liquid form within the wings is impossible. In order to store hydrogen onboard, you would need to find space in the fuselage of the aircraft, thereby changing the shape, drag and other specifics of the aircraft. The researchers try to design an aircraft that can carry and fly on both, hydrogen and kerosene as not every airport would have hydrogen available at the same time. In the new design, the aircraft has a fuselage tail mounted propeller with a third engine that can burn the different types of fuels in its dual-fuel combustion chamber. This new type of engine and propeller configuration enhances the efficiency of the aircraft and also allows for steeper take offs and descends.

What's next?

The current configuration can store approximately 15 to 20% of the total energy in form of hydrogen, thereby reducing the aircraft emissions by around 25%. So for the next configuration, the researchers hope to bring increase the hydrogen percentage gradually to around 50 %, using the multi fuel combustor technology.

Contribution to the Energy Transition

Whereas small aircraft can be electrified, this solution is not scalable. So for bigger aircraftas used in civil aviation, an alternative has to be found. With the APPU project – introducing the possibility to fly on an energy mix - allows for a scalable, feasible, producible and economical aircraft that will use hydrogen in a synergistic way along with other innovative technologies and fuels. This will make the aircraft more efficient and will cut emissions significantly.

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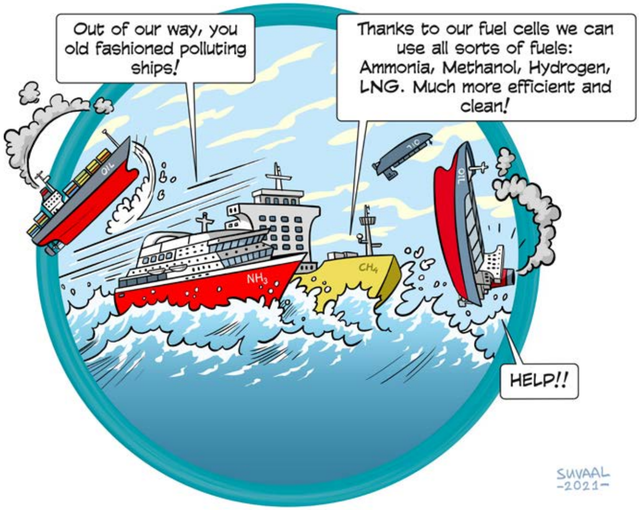


Use of Fuel Cells in the Maritime Sector

dr. ir. Lindert van Biert

dr. ir. Henk Polinder, ir. Klaas Visser, ir. Berend van Veldhuizen

Summary

Electrifying propulsion of huge ships can be done by using fuel cells on board. The researcher focusses on tailoring the system surrounding the fuel cell to the requirements of the maritime sector. The cell should be able to produce the needed power to move or maneuver a ship and be flexible enough to deal with variations in the power level. In this sector fuel cells are expected to run continuously, 24/7 for weeks on end. This raises questions on the wear or fatigue of such a cell. Fuel conversion to hydrogen and electrochemical oxidation of hydrogen take place simultaneously in the cell but how these process take place in in the cell, interact and affect the performance of fuel cells. The biggest challenge is to make these fuel cells smaller, cheaper, easier to operate and control, and more reliable and efficient.

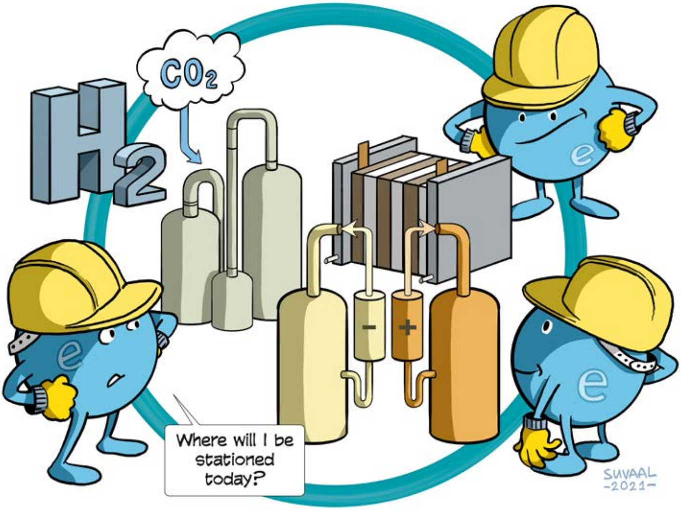
What's next?

The next step is to develop and validate models of individual components and integrate them to develop and test new system integration configurations and improved control algorithms.

Contribution to the Energy Transition

Fuel cells are the next step for sectors in which batteries are insufficient or the direct use of renewable energy is unavailable Shipping, especially the powering of large ships is such a sector. This research contributes to the transition that it makes fuel cells more equipped for the heavy duty that is needed to power a ship. And at the same time they become more flexible to operate increasing their efficiency.

3ME TPM



5 4 3 TRL

RELEASE- Reversible Large Scale Energy Storage

dr. Ruud Kortlever, prof. dr. ir. Andrea Ramirez Ramirez, prof. dr. ir. Wiebren de Jong

Summary

The energy transition is not only a technological challenge. It is also a societal challenges as the way we produce, transport, store and use energy has to transform. The researchers aim to take the whole value chain into account spurring innovation at different levels at the same time enhancing performance whilst reducing costs of large-scale energy storage systems, based on electrochemical conversion of electricity into molecules for short and long term energy storage. The project focusses on hydrogen production via water electrolysis, hydrocarbon production from CO_2 electrolysis and redox flow batteries. With these technologies the project emphasizes that the energy transition is interwoven with the resource transition. It focuses on development of electrodes and membranes, reactor designs, process control and intermittency to integration with industrial processes, and social innovations such as feasible business models and fair governance arrangements.

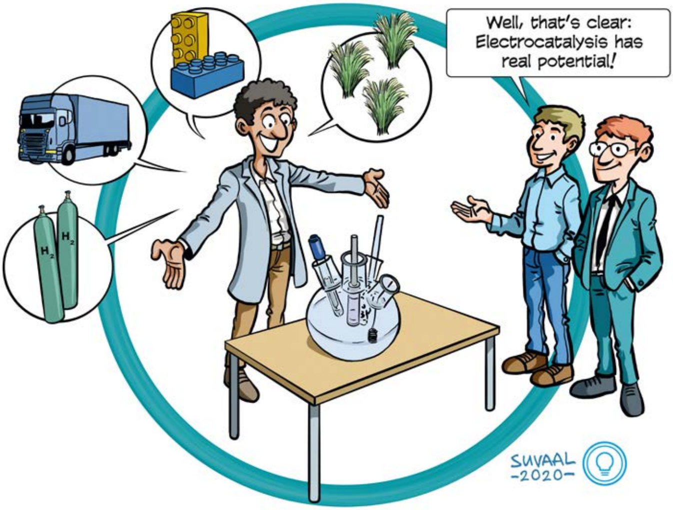
What’s next?

Everybody feels the urgency of the energy transition. However, since a shift of an entire system is required nobody knows exactly how to do this. RELEASE takes a complete value chain into account, developing technologies, business models and societal implementation is parallel. The goal is to accelerate innovation.

Contribution to the Energy Transition

This research contributes to the energy transition as it questions how we can make the transformation that is needed. By taking the whole value chain into account it tries to accelerate technical and social innovation at the same time.

3ME



TRL 5 4 3

Electrocatalysis for Energy Storage & Conversion

dr. Ruud Kortlever

Summary

The researcher focusses on electrocatalysts that are involved in electrochemical conversions that are relevant for renewable fuel production and the electrification of the chemical industry. Current catalysts exhibit high over potentials; meaning you have to invest more energy for the reaction to take place than theoretically needed. He tries to get a better understanding of how electrocatalyst work in order to develop novel catalysts He aims to develop novel stable, selective and cheap catalysts by manipulating the various atoms in catalytic particles. Besides designing catalysts he also aims to develop sequential catalytic processes to produce chemicals for which we currently don't have an electrochemical process. The major advantage of turning thermochemical conversions into electrochemical ones is that you would only need electricity to run the process at an ambient pressure and temperature, leading to possibly smaller, more energy efficient and safer factories.

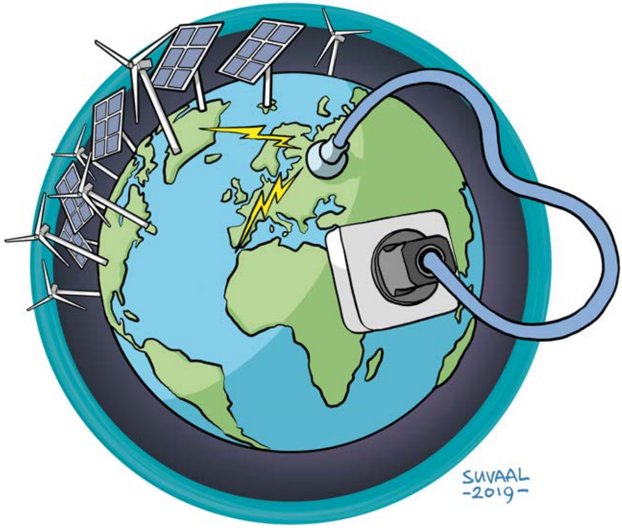
What's next?

The next step for this research is to find the optimal process conditions for the developed catalysts and to subsequently integrate them into an (industrial) reactor for it. For a further scale-up of these reactors the research would benefit from more contacts with industry so they can be applied in a relevant environment.

Contribution to the Energy Transition

With the help of mechanistical insights, modelling and theory predictions the researcher contributes to solving contemporary energy problems by developing new electrocatalytic systems and devices.

CEG



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TRL

Underground Hydrogen Storage

dr. Hadi Hajibeygi

Summary

Renewable energy can be converted and stored in the form of green hydrogen. One of its biggest benefits is that hydrogen can be stored in large scales (TWh), much beyond the scope of electricity-based batteries. This requires huge space, several billion cubic meters, as for its low volumetric energy content. The solution to this challenge is to utilize earth underground reservoirs. which offer giant capacities to store billions of cubic meters of hydrogen at high-pressures. Up till now little is known about how hydrogen behaves in the subsurface – the science is missing. In the newly established hydrogen research lab, the researcher is investigating not only how it behaves in the subsurface but also what type of subsurface would be the right reservoir to store it at a given quantity and scale. With a uniquely integrated multidisciplinary approach the researcher and his team are finding solutions to make this technology ready for field deployment within a few years.

What's next?

The next step for the underground hydrogen storage research is to investigate, at real-field conditions, how hydrogen will interact with the reservoir and cushion gas fluids. Specially mixing and reactivite physics under cyclic transport of hydrogen is to be investigated.

Contribution to the Energy Transition

Hydrogen is a very attractive renewable energy carrier. While we aim to scaleup renewable energy production, if we establish ways to store green hydrogen at large-scale (TWh) safe and pure in the giant underground reservoirs, we will certainly accelerate energy transition by several folds.

AE 3ME CEG

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Floating Wind Energy

dr. ir. Axelle Viré

prof. dr. Dominic von Terzi, prof. dr. ir. Jan-Willem van Wingerden, prof. dr. Andrei Metrikine, dr. ir. Delphine De Tavernier, dr. ir. Michiel Zaaijer

Siemens Gamesa Renewable Energy, Offshore Renewable Energy Catapult, EireComposites, GDG, Ideol, MARIN, NREL, Politecnico di Milano, University College Cork, DTU Wind Energy, INSA CORIA

Summary

The idea of floating wind is that you put a wind turbine on a floating support structure so it can capture wind energy. The advantage is that you can install wind turbines almost everywhere in the ocean which opens up new markets for harvesting this resource. However, as the turbine is no longer fixed to the sea floor its behaviour is quite different due to the influence of wind and waves. With high fidelity modelling the lead researcher and her team are looking at all the conditions that need to be taken into account for building these floating turbines – the type of turbine and floater, and the environmental conditions. Through this way of modelling she can test the assumptions of the engineering model before a physical model is built to be put to the test.

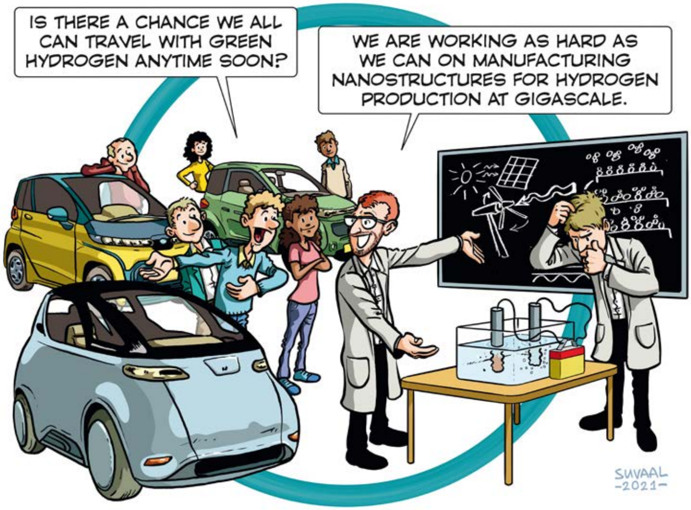
What's next?

Since the research is mostly model-based the next step is to build experimental facilities where the models can be physically tested. Parts of the facilities you would need to test floating wind are already on campus but there is need for smart way of connecting these. For instance, in the wind tunnel you would need a hexapod that moves mimicking the floating behaviour of the turbines.
Another next step is joining the floating wind research with research on producing hydrogen far offshore so you don't have to transport the electricity over huge distances.

Contribution to the Energy Transition

There is a huge need for suitable locations to install wind turbines. Wind at sea is one of the preferred options for capturing wind energy compared to wind at land. The current wind farms at sea are fixed to the sea floor and hence installed in shallow seas. More space is available in deeper waters which can be captured by using floating wind turbines instead.

AS



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Electrolysis of Green Hydrogen

prof. dr. ir. Ruud van Ommen

Summary

Hydrogen is created by putting electricity on a electrolysis cell filled with water. The water will be split into hydrogen and oxygen. Although this process is known for many years doing so on a large scale and in a sustainable way has many challenges. The first challenge is how to perform electrolysis with renewable energy. The supply of renewable energy fluctuates. For the longevity of the electrolyser you would want it to operate continuously. Research is being done on how this can be achieved. Seconly, for electrolysis you need critical materials for the electrodes which area scarce. Here the researcher is looking at how can we distribute this material as thinly as possible with nano layering technology so we can use it more efficiently and need less of the scares material per cell. The third challenge is to find smart ways to scale up the size of the electrolysers in 3 dimensions.

What's next?

For hydrogen the next step is to build installations on industrial scale. Another next step is to see if a renewable fuel can by produced directly from CO_2 using electrolyse technology or by combining hydrogen directly with CO_2 using catalysts.

Contribution to the Energy Transition

We need a conversion in order to store renewable energy. Batteries are very costly to store huge amounts of energy. So we are looking for methods to chemically store large amounts of energy of which Hydrogen is one of the possibilities.

3ME

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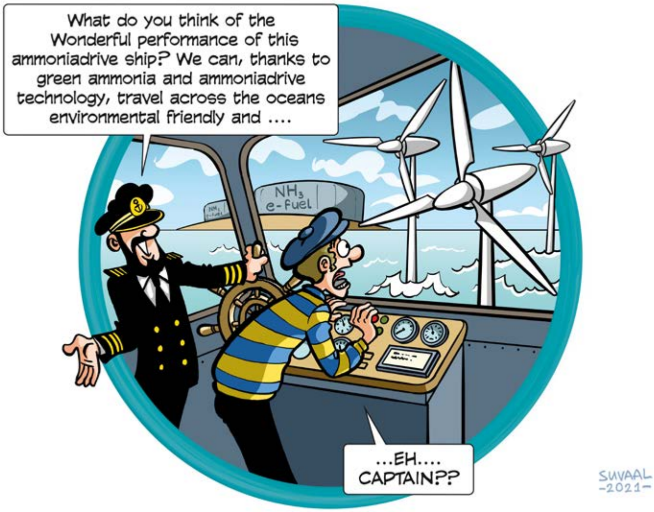


Ammonia Drive for Ships

dr.ir. Peter de Vos

ir. Klaas Visser, dr. ir. Lindert van Biert & prof. dr. ir. Rudy Negenborn

Summary

Sustainably produced ammonia is an interesting alternative to replace fossil fuel to power a ship. However, using ammonia raises a lot of questions related to the ship's design and operation. The researcher is looking at what the impact of using ammonia will be on the ship. Various aspects are considered.

For the burning of ammonia a second fuel is needed. The researcher is looking into how this second fuel can be freed by coupling the engine with an ammonia fuel cell. The beauty of this coupling is that hydrogen is released from the ammonia in the fuel cell. Moreover the coupling can also be used for dealing with quick variation in power that is needed for maneuvering; an option that is not allowed by fuel cell only power options.

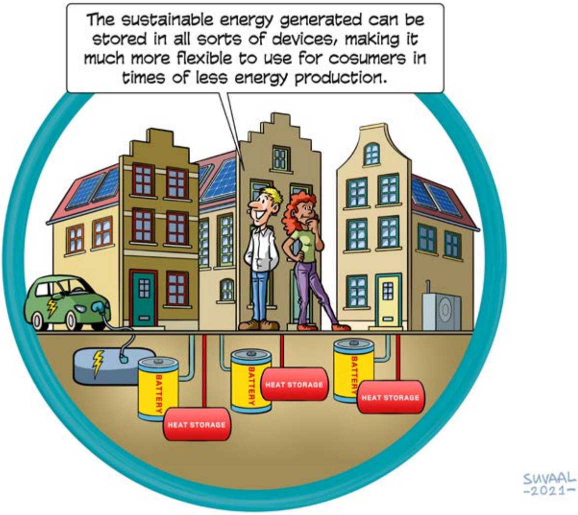
What's next?

Once we have demonstrated that using ammonia for fueling ships is feasible the next step is to implement this system. For that we need ship designers and engineers that will build these ships and ship owners who are willing to use these ships.

Contribution to the Energy Transition

Ships also need to find alternatives for their use of fossil fuels. The energy demand to move a ship is enormous when sailing intercontinentally. This constant high energy demand excludes batteries as an option, resulting in the exploration of energy storage in chemicals that can easily be transported. Hydrogen, Methanol and Ammonia are possible options with their specific pro's and con's; ammonia seems to be the best option for large ocean-going vessels. Using these alternative fuels will also require different engines and power plant designs; AmmoniaDrive is one of the most promising candidates.

EEMCS



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FLEXInet - Intelligent flexibility through integrated hybrid storage technologies

prof. dr. ir. Pavol Bauer, dr. Laura Ramirez Elizondo, dr. Gautham Ram Chandra Mouli

Dr Ten, TU/e. HET, LeydenJar Technologies, VITO, Summerheat, Recoy, DC Opportunities, The Green Village, Emmet Green

Summary

Most of the energy we consume at our homes, comes from elsewhere and is mostly used as electrical energy and for heating or cooling. Innovative in this project is cross energy coupling -electrical energy and heat - with innovative way of electrical energy and heat storage. The energy neutral house can generate its own solar energy which can be stored in a battery, connected electrical vehicle and heat. The researchers aim to develop an integral system for the intelligent and integrated control and implementation of hybrid energy storage technologies in the built environment. They are working on making the collective heat supply and the general energy consumption more sustainable. This system of generating and storing energy will be managed through an intelligent management system that can switch between the various energy resources available at the house.

What's next?

To further the innovation hydrogen storage will be added, more ancillary services for the grid have to be developed with corresponding regulations and business case.

Contribution to the Energy Transition

Flexinet contributes to the transition as it demonstrates how existing houses can become energy neutral by having the cross coupling of energy usage, storing the needed power electronics underground and having different energy storing option including heat.

2.

Future Energy Labs

3ME ABE AE AS CEG EEMCS IDE TPM

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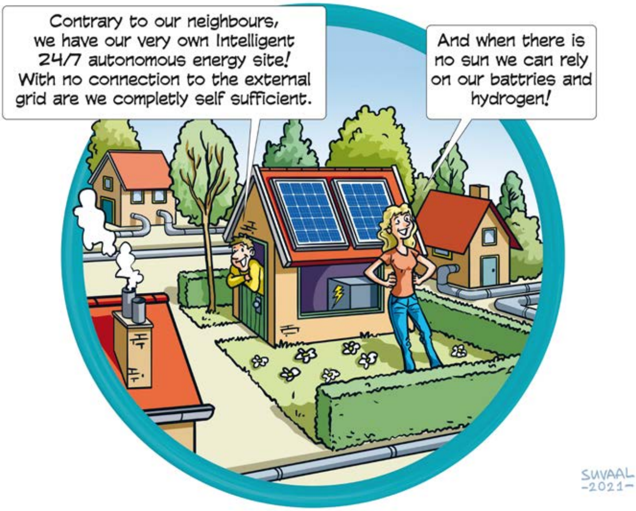


24/7 energy lab: A local, CO_2-neutral energy system for the built environment

prof. dr. Miro Zeman, prof. dr. ir. Zofia Lukszo,
dr. Phil Vardon, dr. ir. Martin ten Pierik

Summary

The 24/7 energy lab is located at The Green Village at TU Delft campus. At this site all components that are needed to solely use renewable energy for everything that you would do at home is integrated into one experimental energy system. This house has no cables or pipes that connects it to the external grid. It will demonstrate that with the developed technologies it can function totally autonomous. With PV panels renewable solar energy is converted into electricity which can be used either directly or can be stored in batteries and/or as hydrogen. Subsequently the hydrogen can be used in a fuel cell to generate electricity when there is not enough sun or wind available. This basic set up of the autonomous energy system can be extended with other technologies and devices over time.

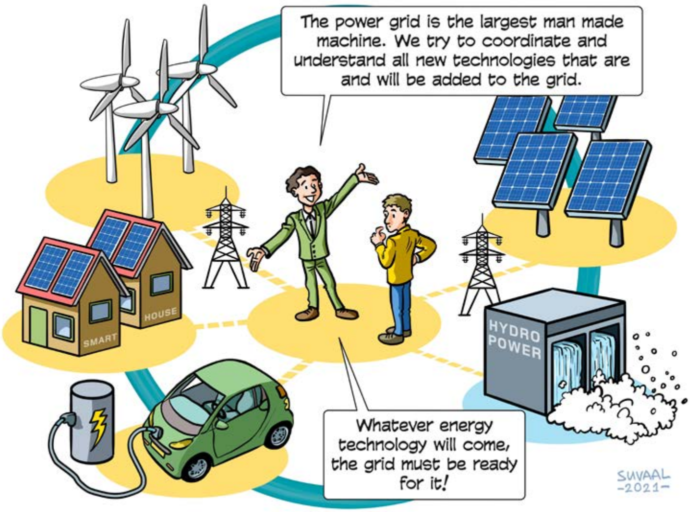
What's next?

With the realization of the 24/7 energy lab the next step is to learn from what happens when different types of technologies and devices are integrated or connected to the site. Users, construction companies, legislators, municipalities, grid companies and researchers will work together to learn and create new knowledge about how this sustainable energy system can be realized and will function. This learning process will raise new research questions about how to design and expand the system and how it works in a real-life working setting. This will also include legal, socio-economic and governance aspects.

Contribution to the Energy Transition

The realization of this site contributes to the energy transition by demonstrating the integration of the various renewable energy conversion and storage components on residential level. By making households and/or residential areas energy autonomous, fully relying on renewable energy sources, the pressure to expand or replace the underground local grid with thicker cables will be reduced.

EEMCS



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TRL

Electrical Sustainable Power Lab

prof. dr. ir. Peter Palensky, prof. dr. Miro Zeman,
prof. dr. ir. Pavol Bauer, dr. ir. Olindo Isabella

Summary

Developing a robust grid that is fed with fluctuating renewable resources is a major challenge. Additionally, making everything that can be attached to the grid smart enhances the complexity of the integration. It is hard to say what will happen when we electrify our entire society. The ESP lab is a unique facility at the TU Delft campus where all sorts of electrical energy technologies can be researched, developed and demonstrated. There is even a super computer and a control room that can be used for running grid simulations. At the lab different applications or real devices can be added to the (simulated) grid in order to investigate their impact or to train human operators on future scenarios. These simulations help to make the grid more resilient, efficient, flexible, safe, and reliable.

What's next?

With so many different electrical engineering disciplines gathered in one location the next step is to work on integrating these new technologies, principles, methods, and components to the electricity grid – to make it future proof.

Contribution to the Energy Transition

The Energy transition is full of uncertainty – nobody can foresee which technology or development will make the biggest impact. Planning, designing, and operating complex systems requires robust decision making. The ESP lab is a unique facility – a single location where different types and even combinations of innovations can be researched, experimented and tested. Innovations that need to hit the market quickly to accelerate the change of our grid and the way how we produce, distribute and use electrical energy.

TPM

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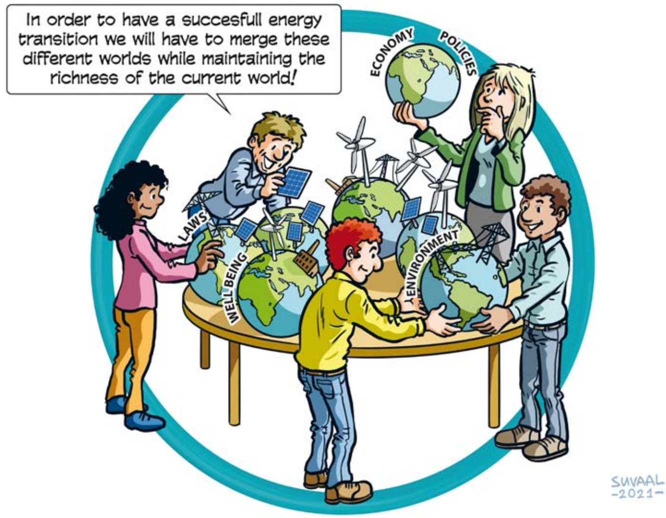


TPM Energy Transition Lab

dr. Gerdien de Vries & dr. Emile Chappin

Summary

The TPM Energy transition lab is more an institute which aims to capture and connect all the different types of social science expertise that is being furthered and developed within the TPM faculty focused on the energy transition. At this lab the researchers are trying to quantify and model different kinds of human aspects related to the energy transition. They are building models predicting how people are going to behave in order to create insight in what this means for society. Together they are developing new approaches, methods and tools for fostering an effective fair and legitimate energy transition. Their biggest challenge is to model human behaviour in such a way that it does not violate the richness of this behaviour and to be able to create insight into what is fair for the energy transition.

What’s next?

Besides creating more insights for the energy transition a next step for the Lab is to contribute to building a (systems)theory that will capture more of the psychological side of how a system works or can be changed. With the creation of the valuable insights for the transition the researchers also hope to stay at the forefront of their research field attracting more excellent researchers and stimulating or facilitating interdisciplinary research and education.

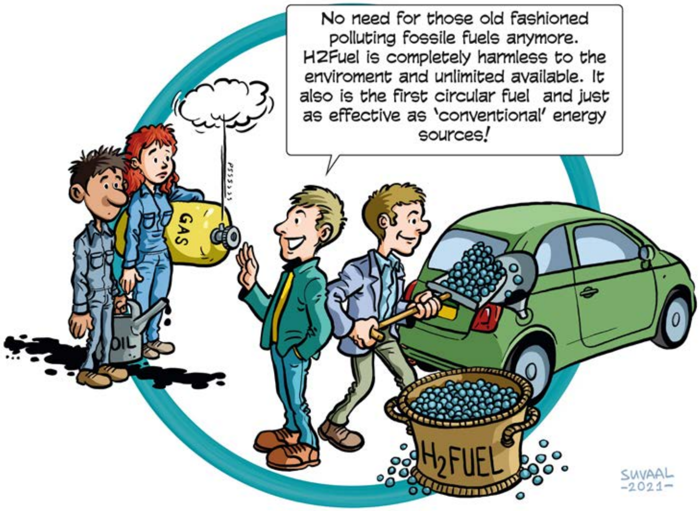
Contribution to the Energy Transition

Our energy system cannot be transformed by simply changing and replacing current ways of doing things for new technologies. Reality is much more complex as also policies, laws and regulations, people’s behaviour and opinions – depending on which stakeholder they represent - play a role. The TPM energy transition lab brings together various types of social science expertise to create insights into the complexity of the transitions and decisions that need to be made.

3.

Start-ups in the TU Delft Ecosystem

AS



5

TRL

H_2Fuel

Frank Dobbelaar

Gerard Lugtigheid

Summary

Hydrogen is widely accepted as a promising technology to replace fossil fuels. However, it is challenging to store hydrogen, requiring high pressure, cold temperatures or e.g. ammoniac.

H_2Fuel provides a way to produce, store and release hydrogen in powder form under atmospheric conditions. Hydrogen is produced in an exothermal reaction by adding ultra-pure water to sodium borohydride ($NaBH_4$), and does not require additional energy. Once the hydrogen has been issued, the residual substances can be returned to the powder state with hydrogen stored in them: this makes H_2Fuel the world's first circular fuel. By storing hydrogen in a powder, it does not need to be connected to the electricity grid. It can therefore replace generators in rural areas, or provide energy on location.

What's next?

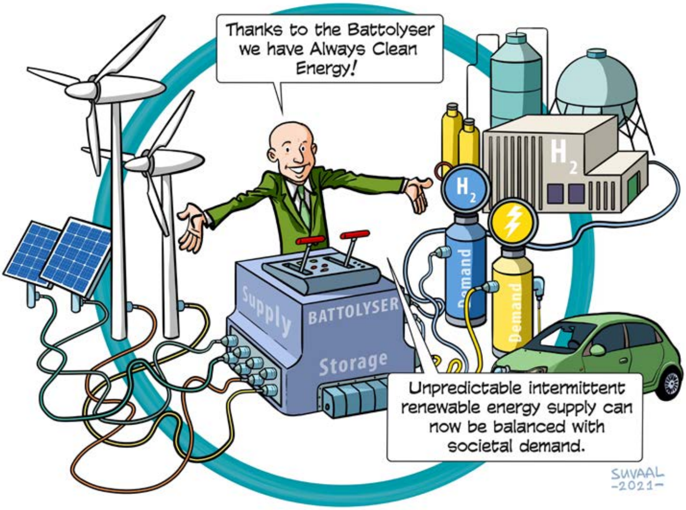
H_2Fuel is looking to license its patented technology, or sell it to the right third party.

Contribution to the Energy Transition

Enables the wider use of hydrogen by making it easy to produce, store and release hydrogen under atmospheric conditions and on off-grid locations.

AS

TRL 6–7



Battolyser Systems

Mattijs Slee
TU Delft, Proton Ventures, Koolen Industries

Summary

Currently, the intermittency of renewable energy generation makes it difficult to meet the society's energy consumption needs. Batteries and electrolysers only offer partial solutions. Integrating the two gives a special flexibility: it creates an electrolyser that can switch as fast as a battery, and a battery that cannot be full.

The integrated Battolyser System provides a balancing power in the electricity market as well as hydrogen for fuel and feedstock. It stores electricity from the grid at low prices when there is a surplus, turning it into hydrogen when the battery is already full, and sells electricity when there is a shortage, at a higher price. This creates a brilliant and unique business model for Battolyser System's clients.

What's next?

The Battolyser System is currently experimenting with demonstrators, and is working on increasing its scale to provide Megawatt capacities. To do so, they currently grow their team for which they see much interest even in the growingly competitive market.

Contribution to the Energy Transition

A Battolyser System balances the electricity grid by delivering energy at a high price to the grid when there is a shortage; and by cheaply buying energy from the grid for battery capacity charging and hydrogen production when there is a surplus.

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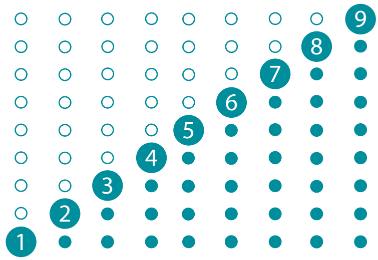
Index by TRL



Index by Theme

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Research at the Delft University of Technology is characterised by its inter- and multidisciplinary thinking spread across science, engineering and design disciplines. With ground breaking research we intent to make significant contributions to a sustainable society. Aiming to enhance collaboration with external partners this booklet presents a small selection of ideas that are being developed in Delft.

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