2024

Technological University of the Shannon: Midlands Midwest

Ollscoil Teicneolaíochta na Sionainne: Lár Tíre Iarthar Láir

Principles and Applications of Hydrogen Energy Technology

LEAVING CERTIFICATE ENGINEERING PRESCRIBED TOPIC 2025

CATHAL.O'DONNELL PHD, DAVID O'ROURKE MENG MSC MIEI, REUBEN NOYCE

Regional Skills MID WEST Partnerships for Skills

Contents

1 Introduction

Hydrogen energy is a promising and versatile alternative to fossil fuels, harnessing the potential of hydrogen (H_2), see Figure 1, as a clean, efficient source of power. Hydrogen is the most abundant element in the universe and can be used in various forms—whether in fuel cells for electricity generation, as a direct fuel for combustion, or in industrial processes. When hydrogen is utilized for energy, its primary by-product is water vapor, making it an environmentally friendly energy carrier that produces no harmful emissions. This is a crucial factor in the global push to reduce greenhouse gas emissions and combat climate change.

Figure 1: The Hydrogen Molecule

The principles of hydrogen energy are grounded in basic chemical and physical concepts, including electrolysis, fuel cell technology, and thermochemical processes.

- Electrolysis, for instance, involves using electricity to split water into hydrogen and oxygen, offering a clean method of hydrogen production, especially when powered by renewable energy sources like solar or wind.

- Fuel cells, which convert hydrogen into electricity through an electrochemical reaction with oxygen, are central to many emerging energy systems, from powering electric vehicles to providing stationary power for buildings and industries.
- Thermochemical reactions use high heat to split water or methane to make hydrogen.

Advancements in hydrogen storage and transport are key to making hydrogen a viable alternative energy source, as it needs to be compressed, liquefied, or chemically bound to be safely and efficiently stored and distributed.

Applications of hydrogen energy span multiple sectors, demonstrating its flexibility and potential for reducing carbon footprints across industries. In transportation, hydrogen fuel cells are seen as a promising solution for decarbonizing Heavy Goods Vehicles (HGVs), buses, and even ships, offering longer ranges and shorter refuelling times compared to Battery Electric Vehicles (BEVs). In the industrial sector, hydrogen plays a crucial role in producing ammonia for fertilizers which particularly important to our Irish agricultural sector. It is also used in refining metal, like steel, and other high-temperature applications that are difficult to electrify.

Hydrogen is also not just a simple fossil fuel replacement but is also being explored as a large-scale energy storage solution, helping balance intermittent renewable energy sources by storing excess electricity during periods of high generation and releasing it when demand is high. As hydrogen technologies continue to evolve, they have the potential to become a cornerstone of the global energy transition.

2 History of Hydrogen

The history of hydrogen stretches back centuries, with early discoveries and applications of this versatile element influencing a wide range of scientific, industrial, and technological advancements. Hydrogen was first identified in 1671 by the English chemist Robert Boyle, who noted the production of a flammable gas when metals reacted with acids. However, it was Henry Cavendish in 1766 who is credited with the discovery of hydrogen as a distinct element. Cavendish recognized hydrogen as a gas that, when ignited, produced water, leading him to name it “inflammable air” (Cavendish, 1766). His work laid the foundation for understanding hydrogen's chemical properties, including its highly combustible nature, and contributed to the early study of gases and the development of modern chemistry.

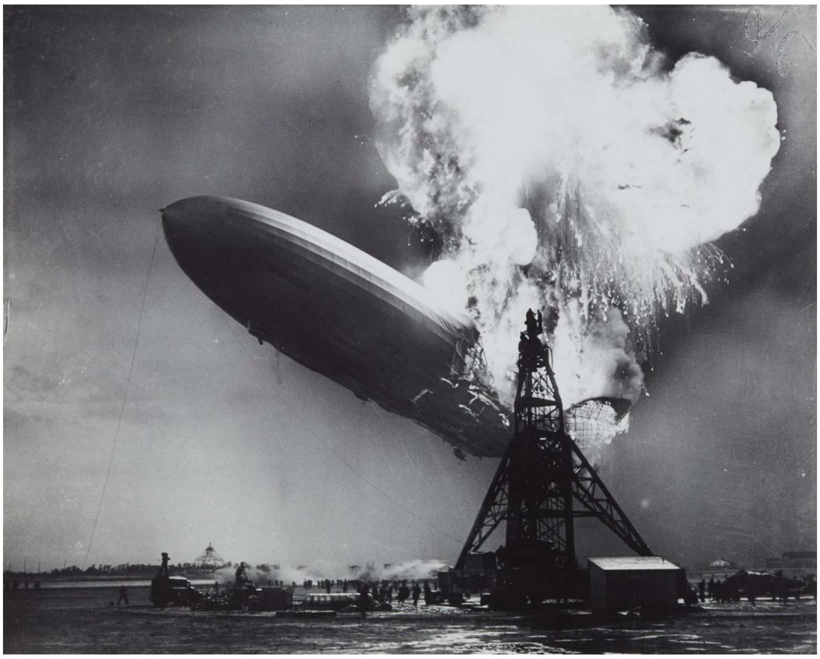


Figure 2: Hindenburg Disaster 1937

In the 19th and early 20th centuries, hydrogen's potential as a fuel began to be explored. The first significant practical application of hydrogen came in the form of the hydrogen-filled airships, such as the Zeppelin during the early 1900s. These airships, which used hydrogen as a lifting gas, demonstrated hydrogen's lightweight and flammable characteristics. However, the infamous Hindenburg disaster in 1937, in which a hydrogen-filled airship caught fire while attempting to land, led to growing concerns about hydrogen's safety in large-scale applications, see Figure 2. Despite this setback, hydrogen continued to be used in various industrial processes, especially in the production of ammonia for fertilizers and in the petroleum refining industry, where hydrogen is used for desulfurization and cracking processes.

The mid-20th century saw a surge in interest in hydrogen as a potential energy source, spurred by the development of hydrogen fuel cells and advances in the space program. The hydrogen fuel cell, which converts hydrogen into electricity through an electrochemical reaction, was first demonstrated in the 1830s by William Grove, but its modern application gained prominence in the 1960s. NASA's space missions, most notably the Apollo program, utilized hydrogen fuel cells to provide electrical power and water for astronauts during their missions. The success of these fuel cells in space highlighted hydrogen's potential as a clean energy source and sparked renewed interest in its broader applications on Earth, particularly in transportation and electricity generation.

The late 20th and early 21st centuries saw the rise of concerns about climate change and the need for cleaner energy sources, which accelerated research into hydrogen energy. The development of more efficient methods of hydrogen production, such as electrolysis powered by renewable energy sources, has made hydrogen a promising candidate for a sustainable future. Companies and governments around the world have invested heavily in hydrogen infrastructure, from fuel cell vehicles to large-scale hydrogen storage systems. International initiatives, such as the Hydrogen Council, have also been established to promote hydrogen's role in the global energy transition. Today, hydrogen is considered a key element in the decarbonization of sectors such as transportation, industry, and power generation, with ongoing advancements in hydrogen storage, production, and distribution technologies shaping its future role in the global energy mix.

3 Hydrogen Production

Hydrogen gas once produced can be used as clean fuel to be applied to many sectors and industries. However, if this Hydrogen is not produced in a sustainable manner, we cannot classify it as a “Green” Energy source. In an attempt to clarify the sourcing of this Hydrogen gas we use a colour coding system. This system allows us to identify how the fuel was produced and therefore assess its carbon and environmental impact. These methods of extraction and purification can have significant cost implications and some of them are summarised in Table 1 below.

Colour	Production Source	Process of production	Greenhouse Gas Emission impact
Green	Renewable Electricity sourced from Wind, Hydro, Geothermal Etc.	Electrolysis of water $2\ H_2O \rightarrow 2\ H_2 + O_2$	Very Low
Yellow	Solar	Electrolysis of water $2\ H_2O \rightarrow 2\ H_2 + O_2$	Very Low
White	Natural occurring Hydrogen	Drilling/Mining	Very Low
Blue	Natural Gas	Gas reforming with carbon capture and storage 1st stage: $CH_4 + H_2O \rightarrow CO + 3\ H_2$ 2nd stage: $CO + H_2O \rightarrow CO_2 + H_2$	Low
Grey	Natural Gas	Steam reforming of natural gas 1st stage: $CH_4 + H_2O \rightarrow CO + 3\ H_2$ 2nd stage: $CO + H_2O \rightarrow CO_2 + H_2$	Medium
Black	Coal	Coal carbonisation or gasification 1st stage: 3 C (i.e., coal) + O_2 + $H_2O \rightarrow H_2 + 3\ CO$ 2nd stage: $CO + H_2O \rightarrow CO_2 + H_2$	High

Table 1 Hydrogen Colour Codes

As can be observed in table 1 the primary sources for hydrogen currently take three major forms ;

- Extraction of naturally occurring H_2
- Extraction of H_2 gas from fossil fuel sources directly
- Electrolysis of water

While extraction of H_2 using electrolysis of water is currently very small, less than 0.1% of total hydrogen production in 2020, it is seen as the major future source of renewable hydrogen, capturing and storing large quantities of renewable energy, (IEA, 2019).

Electrolysis is a chemical technique that uses Direct Current (D.C.) to create a chemical reaction which wouldn't naturally occur. As shown in Figure 3 below, electrical power in the form of D.C. must be fed into an 'electrolyser' where it splits the water into H_2 and O_2. There are different types of designs to achieve this. A popular one is the Proton Exchange Membrane (PEM), as it does not need corrosive chemicals, and it is fast to ramp up and down production (Linde PLC, 2018).

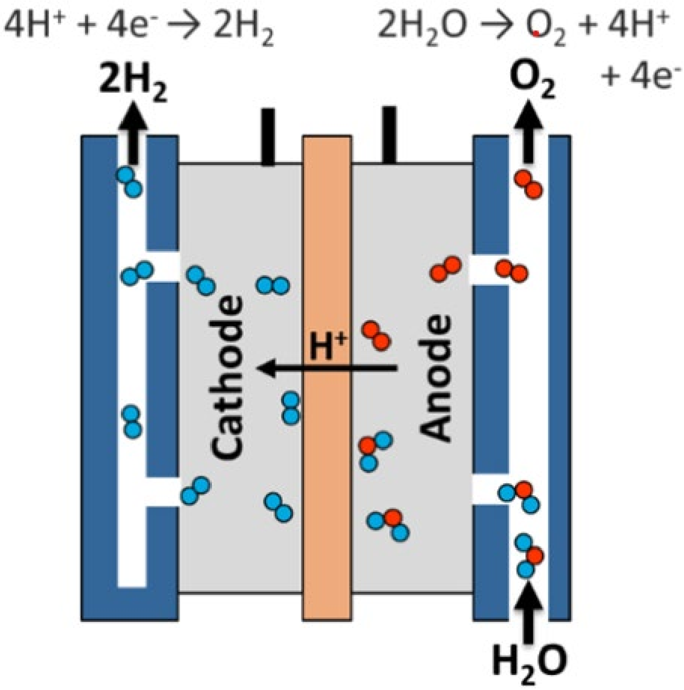


Figure 3 : PEM Electrolyser (Linde PLC, 2018)

The current needed to power the electrolyser, and make environmentally friendly hydrogen, can come from solar and or wind energy sources, in a set up like that shown in Figure 4. The site of the electrolyser would be located near to the wind/solar farm, to reduce transmission losses, and would be able to take power from both wind and solar either together or separately. The hydrogen could be produced and stored from surplus wind or solar energy and converted back into electrical power for the grid mains supply or simply to be burned in turbines or combustion engines. Various converters would be needed to transform from D.C. to alternating current (A.C.) and connect to the grid in a site like this.

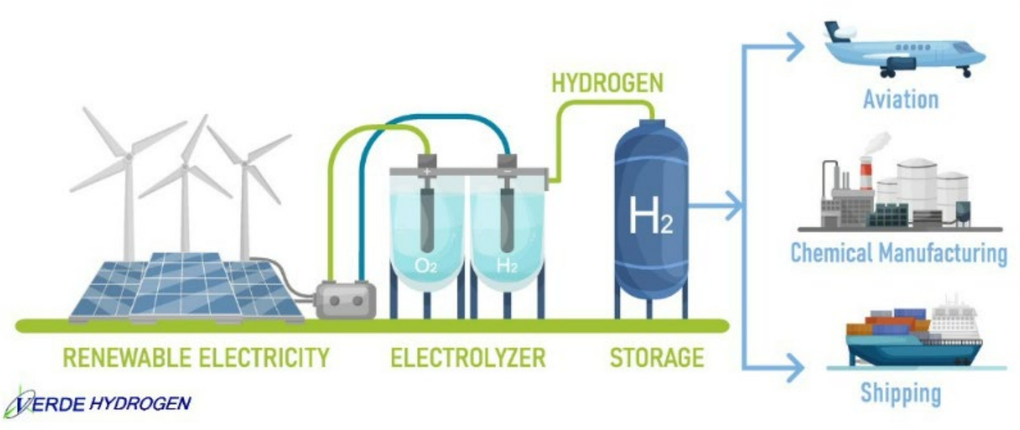


Figure 4: The path to green and yellow hydrogen, (Verde LLC Renewable Hydrogen Systems, 2024)

Surprisingly, H_2 exists in pockets underground, often associated with 'fairy circles', and may be 'mined' or collected like methane (natural gas). A small town in Mali is actually using ground source H_2 for power generation, (Hand, 2023), and it is believed that significant amounts of this natural source gas may be present all over the world. This carbon free hydrogen is much cheaper than the manufactured type and is deserving of further development and exploitation.

4 Harnessing the power of Hydrogen

As with any fuel, how we release and harness its stored energy is critical for its success. With hydrogen we actually have two major extraction methods we can use: Burning and Fuel Cells.

4.1 Burning Hydrogen

When we speak of traditional hydrocarbon-based fuels such as petrol, diesel or propane we burn each of these fuels in the presence of Oxygen (O_2) to release the stored energy in the form of heat. This heat is in turn used to drive our motors, heat our homes etc. As the name suggests these hydrocarbon-based fuels contain Carbon. During the process of burning this fuel the Carbon – Hydrogen bonds are broken and the Carbon bonds with Oxygen in the air to from Carbon Dioxide. This can be observed in the equation below.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

(Propane) + (Oxygen) → (Carbon Dioxide) + (Water)

However, if we burn hydrogen gas (H_2) this is not the case! Pure hydrogen gas does not contain any carbon atoms at all, in fact it contains nothing but pure Hydrogen molecules. Now when we burn this fuel in the presence of Oxygen, heat is released as with any other fuel, however no Carbon dioxide is formed, the only by product being water vapour.

$$2H_2 + O_2 \rightarrow 2H_2O$$

(Hydrogen) + (Oxygen) → (Water)

4.2 Hydrogen Fuel Cells

Hydrogen fuel cells, see Figure 5, are another method of releasing stored energy in Hydrogen Fuel. Instead of burning the fuel and using this heat to generate electricity by mechanical means, hydrogen fuel cells produce electrical energy directly from the fuel using chemical processes. The electrochemical cells contained within a fuel cell pack or “stack” allows donation and gaining of electrons which induces current flow which can be used to power electrical loads. This process still

TUS
Technological University of the Shannon: Midlands Midwest
Ollscoil Teicneolaíochta na Sionainne: Lár Tíre Iarthar Láir
Regional Skills MID WEST
Partnerships for Skills

produces water vapour as a waste product but is more efficient (approx. 60%) at converting the stored energy as much less energy is lost to heat compared to the burning of a fuel in an internal combustion engine (ICE) with a typical efficiency of approximately 30%.

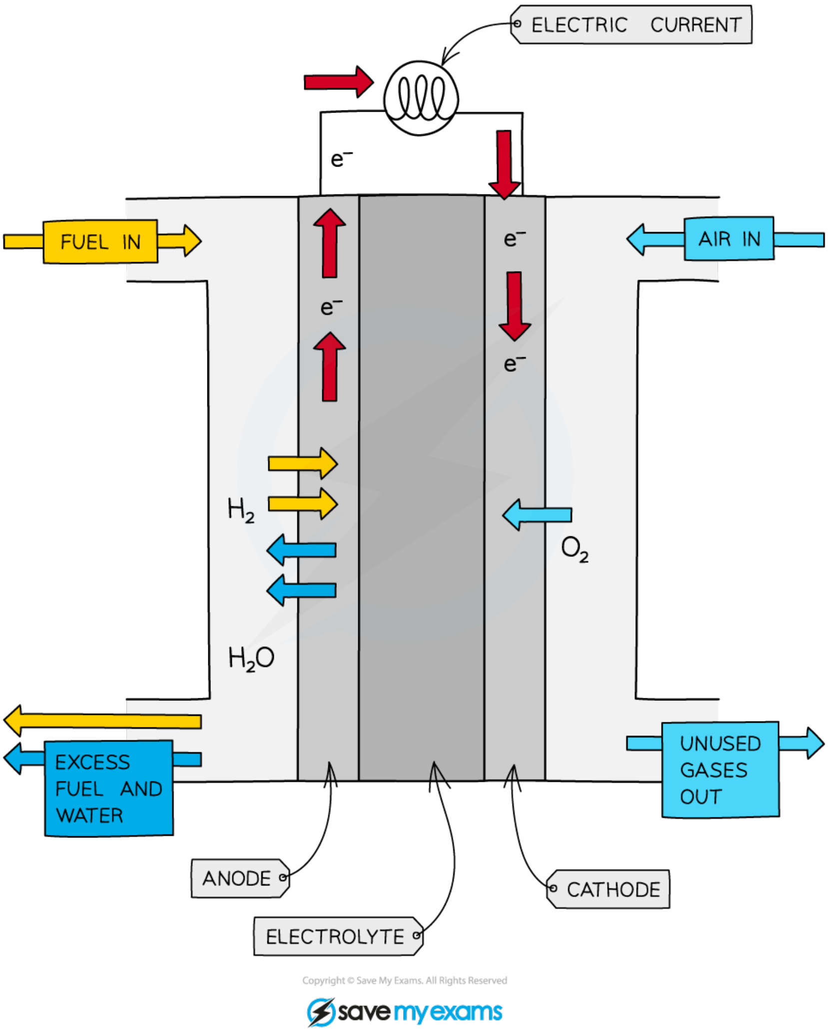


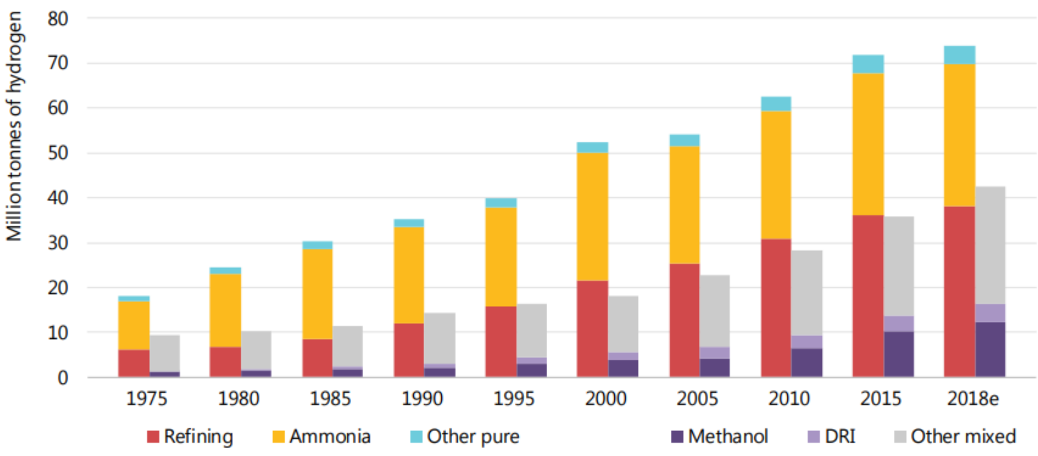
Figure 5: 'How does a fuel cell work?', (Brennan, 2024)

5 Applying Hydrogen to the Economy

Hydrogen can be used in two main ways to support and integrate into our economy; using it as a means of storing energy and as a fuel for our different types of vehicles. These include domestic cars, haulage trucks, heavy machinery for mining and industry and freight ships. Its main caveat is that it can be a dangerous gas to use, and the technology is on cusp of major integration, with pilot schemes around the world in progress or late planning stages.

5.1 Hydrogen for Electricity

Since helping develop the earliest combustion engines 200 years ago, hydrogen and energy have had a close relationship. Now, in our electrically powered world, hydrogen is fast becoming one of frontrunners in electricity production. One reason for this is the different technologies that are being developed to create green hydrogen, and also the fuel cell technology that expands its range of applications. Figure 6 shows the growth of demand for hydrogen, showing that demand has quadrupled in the last fifty years (IEA, 2019).



Notes: DRI = direct reduced iron steel production. Refining, ammonia and "other pure" represent demand for specific applications that require hydrogen with only small levels of additives or contaminants tolerated. Methanol, DRI and "other mixed" represent demand for applications that use hydrogen as part of a mixture of gases, such as synthesis gas, for fuel or feedstock.

Source: IEA 2019.

Around 70 MtH_2/yr is used today in pure form, mostly for oil refining and ammonia manufacture for fertilisers; a further 45 MtH_2 is used in industry without prior separation from other gases.

Figure 6: : Global demand for pure hydrogen, 1975-2018, (IEA, 2019).

5.2 Hydrogen for Transport

Hydrogen is still in its early days of development for use as a fuel source for transport as right now, 99% of the worlds hydrogen is produced using fossil fuels, therefore making it an extra step that only introduces wasted energy if used to power cars and public transport systems. That said there is a glimmering hope as a number of car manufacturers have released models that can run of hydrogen and, in Germany, there are already hydrogen powered trains in use. One restraint for wholescale implementation across a country is the upgrade of infrastructure as hydrogen fuelling needs extra safety features and the gas itself can be more corrosive than its oil counterparts.

Hydrogen can be used in two ways to propel an automobile, one as a fuel source for a hydrogen engine, and also as a fuel cell that then converts into electricity to propel an electric motor. Both of which are less efficient than wholly electric vehicles but development in the production of green hydrogen may change this in the future.

Another aspect of using hydrogen is that it must be compressed to store and use, which is an highly energy-intensive process. This then makes the tanks very heavy making it almost completely unfeasible for any small scale use (e.g. motorcycle/car propulsion) but still viable for heavy vehicle use, like heavy goods vehicles or buses. There is research being conducted in the development of hydrogen powered ships and aeroplanes but its low volumetric energy density means that hydrogen is best used close to where it was produced. For planes, since it can be heavy when compressed and stored in tanks, considerable redesign must be achieved to make this possible. For shipping, the distance and time away from a fuel source makes hydrogen impractical for long distance maritime transport but possible to adapt for river or ferry transport, as the distances are shorter and smaller volumes of fuel would be needed for this.

Biofuel mixes and electrofuels are another means of reducing oil dependence but again, extensive further research is needed to achieve any impactful reduction in fossil fuel dependence. From this,

"Hydrogen should not be seen as a miracle solution for reducing the carbon footprint of transport, because it is not." With that in mind and as green hydrogen is developed further, the possible uses in heavy industry widen for hydrogen but care must be taken to not allow it to be a smokescreen to allow us to forget the urgency of energy sobriety in transport. The following website contains some useful information ;

Hydrogen in transport: everything you need to know in 10 questions - Polytechnique Insights

5.3 Hydrogen for Commercial and Industrial Use

By being able to store surplus renewable energy, from wind or solar, hydrogen can be used to replace standard battery technology and generate electricity and heat through the mixing of H_2 with air to generate D.C., that in turn can be inverted to power the grid and used to supply the night-time (and low wind and sun time) loads, see Figure 7.

In order to make hydrogen safer for use in transport, careful site design, risk assessments and extra commissioning tests such as a tank leak test, car garage leak simulation and hydrogen tank drop test can all go towards proving that hydrogen is safe to use, store and distribute.

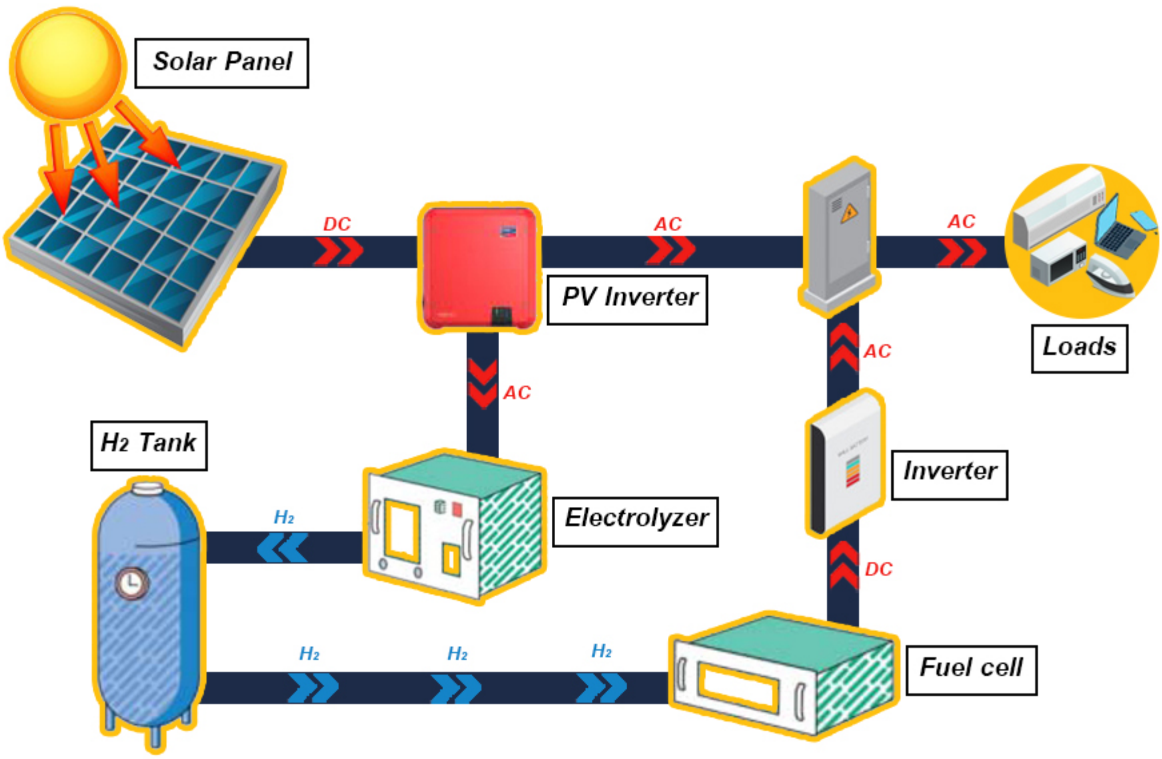


Figure 7: A grid set up that could be used to smooth supply and demand over a 24hr period, or even longer depending on the amount of H_2 stored. (Oelmaier Technology Co., Ltd., 2020)

5.4 Hydrogen as Storage

For a hydrogen fuel cell to function, essentially hydrogen and oxygen are mixed to create an electron flow and therefore supply current. See Figure 5 on page # above 'How does a fuel cell work?', for an illustration of how this works.

To improve the characteristics of the fuel cell, different mixtures and chemical reactions can be capitalised upon, leading to a growing range of technologies that are in operation and continuously being improved.

The following are some of the more prominent types in operation today:

Proton Exchange Membrane Fuel Cell (PEMFC)

- 40 – 60% efficient, suitable for use in cars and speciality vehicles, like forklifts.
- Also suitable for scaling up, like for backup in datacentres and telecommunications.

Solid Oxide Fuel Cell (SOFC)

- High operating temperatures so works well with Combined Heat Power (CHP) systems.
- Up to 70 – 80 % efficient, operating at just under 1000°C.

Phosphoric Acid Fuel Cell (PAFC)

- Higher operating temperature then PEMFC, means it can handle small impurities in the fuel.
- Can be used for cogeneration, assisting in heating and cooling of premises.
- Used for high energy demand applications, like hospitals, manufacturing, and schools.

Molten Carbonate Fuel Cell (MCFC)

- High-temperature fuel cells that operate at temperatures of 600 °C and above.

Alkaline Fuel Cell (AFC)

- Uses a solution of potassium hydroxide in water as the electrolyte and can use a variety of non-precious metals as a catalyst at the anode and cathode.
- Deployed in NASA Space missions with great success.

Direct Methanol Fuel Cell (DMFC)

- Draws hydrogen from liquid methanol, meaning they can operate at lower temperatures.
- Suitable for uses in electronics as battery's and can be scaled up for small backup systems.

To summarise , the benefits of using hydrogen fuel cells (FC's) over other technologies can be clearly shown here below:

- Low to zero emissions
- High efficiency
- Reliability
- Fuel Flexibility
- Energy security
- Durability
- Scalability
- Quiet operation

6 Advantages and Disadvantages of Hydrogen

As with all technologies, Hydrogen has its advantages and disadvantages. When discussing future energy options, it is always important to weigh up each of these before proceeding with any energy solution.

6.1 Advantages:

1. Hydrogen can be created using water and this water is reformed once the energy is extracted. This is therefore a renewable resource.
2. Hydrogen has a very high energy density per kilogram when compared to fossil fuel sources.# are there values of this figure#
3. Hydrogen when used does not create pollution with the only by-product being water.
4. Hydrogen energy can be directly harnessed with less mechanical/transmission losses (compared to hydrocarbon based power generation).

6.2 Disadvantages:

1. Currently Hydrogen is not produced in a renewable manner.
2. Hydrogen is very expensive and difficult to store in large quantities.
3. The process of creating hydrogen through electrolysis requires large amounts of energy.
4. Existing infrastructure does not support the use of hydrogen in the economy.
5. Hydrogen can be dangerous as it is highly volatile and very flammable.
6. Materials used in fuel cells are rare, expensive and have an associated carbon footprint.

7 Summary

Hydrogen energy is a promising alternative to fossil fuels because it's clean, efficient, and only produces water vapor as a by-product. It can be used in many areas, such as powering vehicles with hydrogen fuel cells or helping industries make things like fertilizers and steel. There are different ways to produce hydrogen, such as using renewable energy (like solar or wind) to split water into hydrogen and oxygen, or extracting it from natural gas with special technology to reduce emissions. While hydrogen has some great benefits— such as having a high energy density and producing zero pollution when used—there are still challenges. It's expensive to make, hard to store in large amounts, and there isn't enough infrastructure for it yet. Scientists are working on improving hydrogen technology, and it could play a big role in the future of clean energy. However, it's not a complete solution to climate change on its own and needs to be part of a bigger mix of sustainable energy sources.

TUS
Technological University of the Shannon: Midlands Midwest
Ollscoil Teicneolaíochta na Sionainne: Lár Tíre Iarthar Láir
Regional Skills
MID WEST
Partnerships for Skills

8 References

Brennan, 2024. How does the hydrogen fuel cell work? IGCSE Chemistry [WWW Document]. Save My Exams. URL https://www.savemyexams.com/igcse/chemistry/cie/23/revision-notes/4-electrochemistry/4-2-applications-of-electrolysis/4-2-2-hydrogen-fuel-cells/

Cavendish, 1766. XIX. Three papers, containing experiments on factitious air. Philos. Trans. R. Soc.

Lond. https://doi.org/10.1098/rstl.1766.0019

IEA, 2019. The Future of Hydrogen – Analysis [WWW Document]. IEA. URL

https://www.iea.org/reports/the-future-of-hydrogen

Linde PLC, 2018. Electrolysis for Green Hydrogen Production [WWW Document]. URL https://www.linde.com/clean-energy/our-h2-technology/electrolysis-for-green-hydrogen-production

Hand, 2023. Hidden hydrogen: Earth may hold vast stores of a renewable, carbon-free fuel [WWW Document]. URL https://www.science.org/content/article/hidden-hydrogen-earth-may-hold-vast-stores-renewable-carbon-free-fuel

Oelmaier Technology Co., Ltd., 2020. Hydrogen Storage Systems. URL https://www.chiangmaisolar.com/hydrogen-storage-systems/

Verde LLC Renewable Hydrogen Systems, 2024. Green Hydrogen Technology Eco-System [WWW Document]. URL https://verdehydrogen.com/eco-system-and-green-h2-applications.html

9 Why pick a course in Engineering ? : F.A.Q.

The following are questions we are often asked by students who are thinking of picking a course in engineering. We hope that some of these answers will help you make up your mind.

What makes for a good engineer ?

An engineer is someone who is inquisitive about how things work, why and how they are made, and wonders if they could be improved upon. They tend to be good at thinking logically and like problem solving.

What is an engineer (answer from ChatGPT) ?

"An engineer is a professional who applies scientific and mathematical principles to design and create solutions for technical problems. Engineers work in various fields, such as civil, mechanical, electrical, chemical, aerospace, and computer engineering, among others. They use their knowledge and skills to design, analyse, test, and improve systems, structures, devices, and processes."

Are there good job prospects for engineers ?

At the time of writing of this handout, yes there are. However by the time you might be graduating as an engineer, it could be June 2026, 26 or 27. Who can tell what the jobs market will be like then, which goes for any course you might pick. What we can say is engineering is broad disciplined qualification and graduate engineers are usually in good demand.

Is there work placement on the courses ?

All of our three year level 7 and four year level 8 courses come with a minimum of 5 months work placement, usually in 3rd year. The two year level 6 in Agricultural Mechanisation also features work placement.

Why should I not focus on the C.A.O. points ?

You should pick a course on the basis of what you are going to be studying in college for 2, 3 or 4 years, and the area/industry sector you see yourself working in, after you graduate. C.A.O. entry points constantly change and it's unfortunately a common mistake to select your course based on this year's points. Select your courses (10 Level 6/7 and 10 Level 8 courses) in the genuine order of the one you most want to do first. If you don't get the points, so be it. You go onto your second choice and so on. If you make a mistake in the order by which you select your courses, you may be stuck with a course you'd least prefer ahead of one you'd prefer. Unfortunately T.U.S., or any 3rd level educator cannot help you in this case.

If I pick a Level 6 or 7 course can I progress onto a higher level course ?

Yes, nearly all of our courses are designed with the ladder or opportunity in mind. This means that a student who passes a two year Level 6 course can go onto the 3rd year of Level 7 course (or into 3rd year of a Level 8) where a suitable one exists. Likewise a student who passes a three year level 7 course can go into the 4th year of a Level 8 course. Check the detail of each specific course on our website or prospectus to see the progression options.

What are the minimum entry requirements ?

For our Level 6 & 7 courses ;

A minimum of 5 O6/H7 grades in five Leaving Certificate subjects, including Mathematics and English or Irish.

For our Level 8 courses ;

A minimum of 2 H5 & 4 O6/H7 grades in six Leaving Certificate subjects, including English or Irish and a minimum of an O4 in Mathematics

What Leaving Cert subjects do I need to secure an engineering course ?

There are no mandatory subjects that you have to have for any of our engineering courses, apart from the generic minimum entry requirements as detailed above. You don't have to have engineering to study an engineering course here in T.U.S. However the majority of our students would have one or more of the following suitable subjects. It means there's a good chance that they can think and study like an engineer. Don't worry if you don't have some or any of these subjects. We won't assume you do in first year.

- Engineering
- Technology
- Design and Communication Graphics
- Physics
- Physics and Chemistry
- Construction Studies
- Agricultural Science
- Applied Mathematics

Do I need Higher level maths to enter an engineering course in TUS Midwest ?

No you don't. The majority of our first year students on any engineering course will have ordinary level maths. Most of our first years will start off feeling that they are not too confident in maths.

With so many courses (26) on offer how do I pick the right one ?

Keep on attending open days or marketing events in third level institutes and universities such as Engineering Week 2023. If you have a relation or friend who is or was on an engineering course, talk to them about their experience. Get into the detail of the list of modules or subjects to learn the difference between each type of engineering course. Don't be lead by just the nice photo or video. If you can, visit an engineer at their workplace to see what it is they do as a career. Ask your guidance counsellor or teachers at school for advice. Read, watch relevant videos and be inquisitive.

10 TUS Midwest Engineering Courses

We have 26 engineering courses across three departments, at 4 different levels.

10.1 Department of the Built Environment

Course :	Built Environment (Common Entry) (Hons)	
Level :	8	
Course Code :	US883	
CAO Points :	300	

Course :	Civil Engineering	
Level :	7	
Course Code :	US760	
CAO Points :	234	

Course :	Civil Engineering Management (Hons)	
Level :	8	
Course Code :	US886	
CAO Points :	358	

Course :	Construction Management (Hons)
Level :	8
Course Code :	US885
CAO Points :	280

10.2 Department of Electrical and Electronic Engineering

Course :	Electrician Apprenticeship	
Level :	6 (Cert)	
Course Code :	n/a	
CAO Points :	n/a	

Course :	Electrical Engineering	
Level :	7	
Course Code :	US750	
CAO Points :	289	

Course :	Electrical Engineering (Honours)	
Level :	8	
Course Code :	US900	
CAO Points :	347	

Course :	Electronic Engineering with Computer Systems
Level :	7
Course Code :	US751
CAO Points :	227

Course :	Electronic Engineering with Computer Systems (Honours)
Level :	8
Course Code :	US903
CAO Points :	278

Course :	Robotics and Automation Engineering
Level :	7
Course Code :	US753
CAO Points :	197

Course :	Robotics and Automation Engineering (Hons)
Level :	8
Course Code :	US902
CAO Points :	328

Course :	Renewable & Electrical Energy Engineering	
Level :	7	
Course Code :	US752	
CAO Points :	280	

Course :	Renewable & Electrical Energy Engineering (Hons)	
Level :	8	
Course Code :	US901	
CAO Points :	304	

10.3 Department of Mechanical and Automobile Engineering

Course :	MAMF (Fitter) Apprenticeship
Level :	6 (Cert)
Course Code :	n/a
CAO Points :	n/a

Course :	Motor Mechanic Apprenticeship
Level :	6 (Cert)
Course Code :	n/a
CAO Points :	n/a

Course :	Agricultural Mechanisation
Level :	6
Course Code :	US651
CAO Points :	254

Course :	Agricultural Engineering
Level :	7
Course Code :	US769
CAO Points :	303

TUS
Technological University of the Shannon: Midlands Midwest
Ollscoil Teicneolaíochta na Sionainne: Lár Tíre Iarthar Láir
Regional Skills MID WEST
Partnerships for Skills

Course :	Road Transport Technology and Management
Level :	7
Course Code :	US775
CAO Points :	311

Course :	Automotive Engineering & Transport Management
Level :	8
Course Code :	US915
CAO Points :	314

Course :	Engineering Technology Management
Level :	7
Course Code :	U779
CAO Points :	307

Course :	Engineering Technology Management
Level :	8
Course Code :	US909
CAO Points :	319

Course :	Mechanical Engineering
Level :	7
Course Code :	US771
CAO Points :	300

Course :	Mechanical Engineering
Level :	8
Course Code :	US911
CAO Points :	318

Course :	Precision Engineering
Level :	7
Course Code :	US774
CAO Points :	213

Course :	Precision Engineering
Level :	8
Course Code :	US914
CAO Points :	246

Course :	Process & Engineering Management (Hons)
Level :	8 (Add-on)
Course Code :	US914
CAO Points :	N/a

10.4 TUS Midlands Midwest Prospectus

A link to the full TUS Midlands and Midwest can be found at ;

https://tus.ie/undergrad/prospectus/

Scan here to view and download

the full TUS prospectus.

Thank you and the best of luck in your leaving cert exams in June and your continuing education in the third level sector.