



Application Focus: A Guide to Ex Lighting for the Hydrogen Industry



Renewable energy, including technologies such as wind and solar, is an obvious solution for a clean energy future. However, with the sun setting daily and days where there is little to no wind, we need clean fuel to fill in those energy gaps. As energy demand continues to rise, the increased need to store energy is a necessity to keep up with increasing demand.

Battery technology has seen huge advances in recent years, and there is also increasing demand for hydrogen fuel. The utilisation of hydrogen emits only water vapour and warm air and offers many other benefits over other clean fuels. However, the process of producing and storing hydrogen gas is high-risk and precautions must be taken to ensure that any environment where hydrogen is present is safe.

Hydrogen and Its Risks

Hydrogen is an odourless, colourless, and extremely reactive gas. Hydrogen has a very light molecular weight that is 14 times lighter than air. It's also prone to leakage. Even a small leak of hydrogen can cause it to collect in upper areas of confined spaces, creating a potentially explosive mixture. The gas cloud will continue to increase in size until it finds an ignition source.

Hydrogen also has a very low ignition energy threshold, which is evident when comparing the minimum ignition energy compared to other common fuels (see figure 1).

When ignited, it burns with a pale blue flame that is near invisible to the human eye and burns extremely hot and quickly creating an explosion. For this reason, hydrogen production is classed as an extremely hazardous process, and material precautions need to be taken at every point across the value chain.

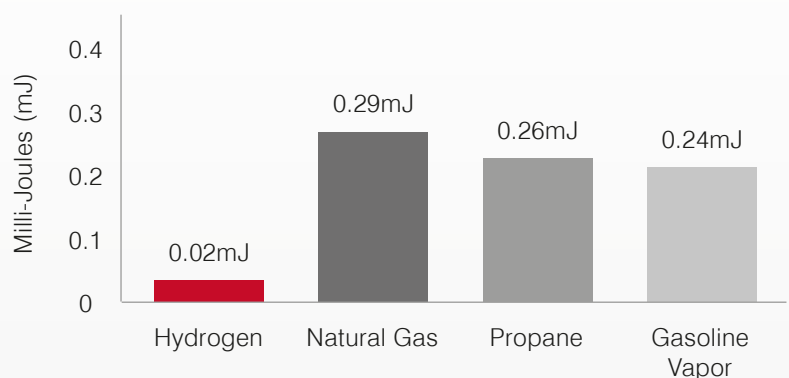


Figure 1 - Ignition energy of Hydrogen vs other fuels

The Importance of Ex Certification for Lighting

Throughout the value chain, specific Ex requirements are enforced where electrical equipment is being used in applications where hydrogen is (or could be) present. As part of the ATEX directive, all gases that present a risk of explosion are categorised into different 'gas groups', based on their level of risk. As one of the most volatile gases with the greatest risk of ignition, hydrogen is classified in the gas group which requires the highest level of protection;

- Group IIA: Atmospheres containing propane, or gases and vapours of equivalent hazard.
- Group IIB: Atmospheres containing ethylene, or gases and vapours of equivalent hazard.
- Group IIC: Atmospheres containing acetylene or hydrogen, or gases and vapours of equivalent hazard.



Gas group IIC represents the highest-risk gases, meaning that substances in this group can be ignited very easily. A luminaire must be certified to gas group IIC when being installed in areas where hydrogen is present.

Luminaires may also be certified to gas group IIB + Hydrogen (or IIB + H₂). This is more common on luminaires which are certified using the 'Ex d' protection method and use flame paths to prevent the spread of a flame. The IIB + Hydrogen gas group covers all gases within the IIB gas group, with the addition of Hydrogen.

At Raytec, all our SPARTAN hazardous area products are certified to be used in environments where hydrogen is present, with the majority classified to gas group IIC.

Zone Classification

Aside from gas groups, specifiers must also consider other elements of how a luminaire has been certified to ensure it's suitable for their application.

Every application is different. As with other gases and dusts, ventilation plays an important role in determining the zone classification required when hydrogen is present. Designing a site with sufficient air movement is important to dilute any hydrogen that may be released. A proper assessment must be carried out to determine the zone classification required for your application in order to ensure on-site safety.

Raytec offers a range of luminaires certified for Zone 1/21 and Zone 2/22 luminaires as part of the SPARTAN range of hazardous area LED lighting.

Supply Chain – Combating the Risk with Ex Certification

With an understanding of the risks, we'll now consider this in the context of the value chain and how it affects the stages in which hydrogen is produced, stored, transported and eventually utilised.

1. PRODUCTION

Hydrogen is the most abundant chemical substance in the world, but to produce it, it must be separated from the other elements in the molecules in which it exists.

While the utilisation of hydrogen may emit nothing but water vapour and air, today it is still produced in large quantities using fossil fuels and nuclear energy. However, in the drive for net zero, there is increasing demand for 'green hydrogen' produced from renewable energy such as biomass, solar, geothermal, and wind.

Electrolysis is one of the most common and environmentally friendly methods of hydrogen production and involves using electricity to create chemical reactions, most commonly with water. This is sustainable and is the most popular way to produce green hydrogen on the basis that renewable energy (such as wind and solar) is used as the input, meaning no greenhouse emissions throughout the supply chain.

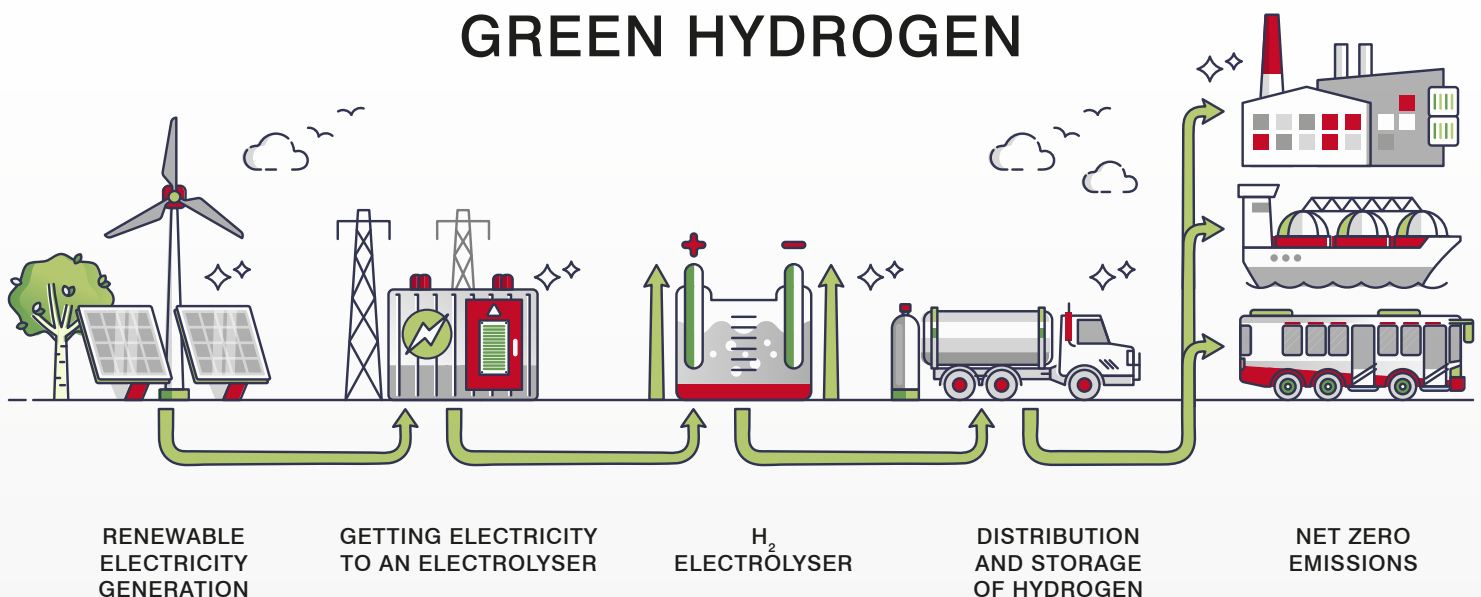
Why is Ex Lighting Needed During Production?

No matter the production method of hydrogen, the production facilities carry a risk of explosion if the site is not using correctly certified electrical equipment.

When producing hydrogen through electrolysis, the components used within the process operate at extremely high pressures and incorporate multiple connections that can be prone to leaks. If leakage does occur, the hydrogen will enter the atmosphere presenting an explosion risk.

These areas are likely to be designated as a Zone 1 or Zone 2 hazardous area and will require suitable Ex rated lighting to be installed in these areas. Any non-hazardous rated equipment must be isolated from hydrogen production areas to reduce the risk of an explosion.

GREEN HYDROGEN





2. DISTRIBUTION AND STORAGE

With some countries producing hydrogen in greater quantity than required for their own use, there is a need to import and export the gas, meaning that infrastructures safe for transporting hydrogen need to be in place.

One of the many advantages of hydrogen as an energy source is that it can also be physically stored as either a gas or a liquid. Storage of hydrogen generally requires the use of high-pressure tanks.

Much like other fuels, hydrogen can be transported in several different ways. For longer journeys, it can be transported by sea in gas tankers, by land in pressure cylinders in smaller amounts, or by pipelines.

Why is Ex Lighting Needed During Distribution?

Let's use an example of a vessel transporting compressed hydrogen. When transporting hydrogen by sea, thousands of tonnes of hydrogen are being conveyed, with the bulk of the hydrogen storage being at the bottom of the vessel in compressed tanks. These confined areas that store the hydrogen tanks are high-risk zones and a potentially explosive atmosphere that require hazardous area protection.

It is extremely important that any electrical equipment, such as lighting, is certified to the appropriate standards.

Hazardous area LED lighting also plays an important role in the on-site safety of the vessel. The appropriate lighting levels need to be achieved to maintain flexibility, functionality, and safety on-site.

3. UTILISATION

There are many ways in which hydrogen is utilised at the end of the value chain. Transportation and the development of hydrogen-powered vehicles (using a hydrogen fuel cell) is one of the most well-known uses. Because hydrogen can be physically stored, hydrogen-powered vehicles are becoming increasingly popular due to the fact they can be refilled in minutes, more akin to conventional petrol and diesel cars, helping to overcome some of the limitations of battery-powered electric vehicles.

Away from the automotive industry, hydrogen also has an important role in agriculture and the future of sustainable farming. Hydrogen fuel cells are deemed a far more viable alternative for powering heavy machinery than electrified alternatives due to the cost and range of batteries for this sector.

In addition to this, hydrogen can also be used as an alternative to natural gas for heating our homes or to be used in power stations to produce electricity.



Why is Ex Lighting Needed During Production?

Hazardous area equipment is required in many cases where hydrogen is utilised.

While consumers using hydrogen-powered vehicles, or those using hydrogen to heat their homes, are unlikely to have to concern themselves too deeply about the risks, manufacturers of these systems must give careful consideration to safety and ensure the correct components are used, including lighting.

Raytec products were recently deployed on the world's first hydrogen-powered passenger ferry, which required the use of ATEX-approved lighting. SPARTAN Bulkhead and SPARTAN Flood luminaires were installed in the vessel's hydrogen storage room and deck areas. Read the full case study to understand the technical requirements of the project.



SPARTAN Deployed on World's First Hydrogen Powered Passenger Ferry

Why Raytec?

Raytec has many years of experience in supplying products to areas where hydrogen is present. From hydrogen manufacturing plants to our hazardous area LED luminaires being deployed on the world's first commercial hydrogen-powered passenger ferry, we develop and implement innovative, intelligent lighting solutions for all your hydrogen applications.

Why Raytec products are suitable for applications where hydrogen is present;

- Raytec's SPARTAN range of hazardous area LED luminaires are rated to gas group IIC (or gas Group IIB + H2) – meaning they are suitable for installation in areas where hydrogen is present.
- SPARTAN luminaires are globally certified including Zone 1, Zone 2, and CID2.
- The SPARTAN range consists of a number of different luminaires, including Linear, Flood, Bay and Bulkhead options, all with a choice of emergency battery backup, different output, beam angles and other variants which can be tailored to your application.
- All SPARTAN luminaires are designed with maintenance in mind and offer Raytec's unique modular design where key components such as the PSU modules are easily accessible for straightforward maintenance and inspection.