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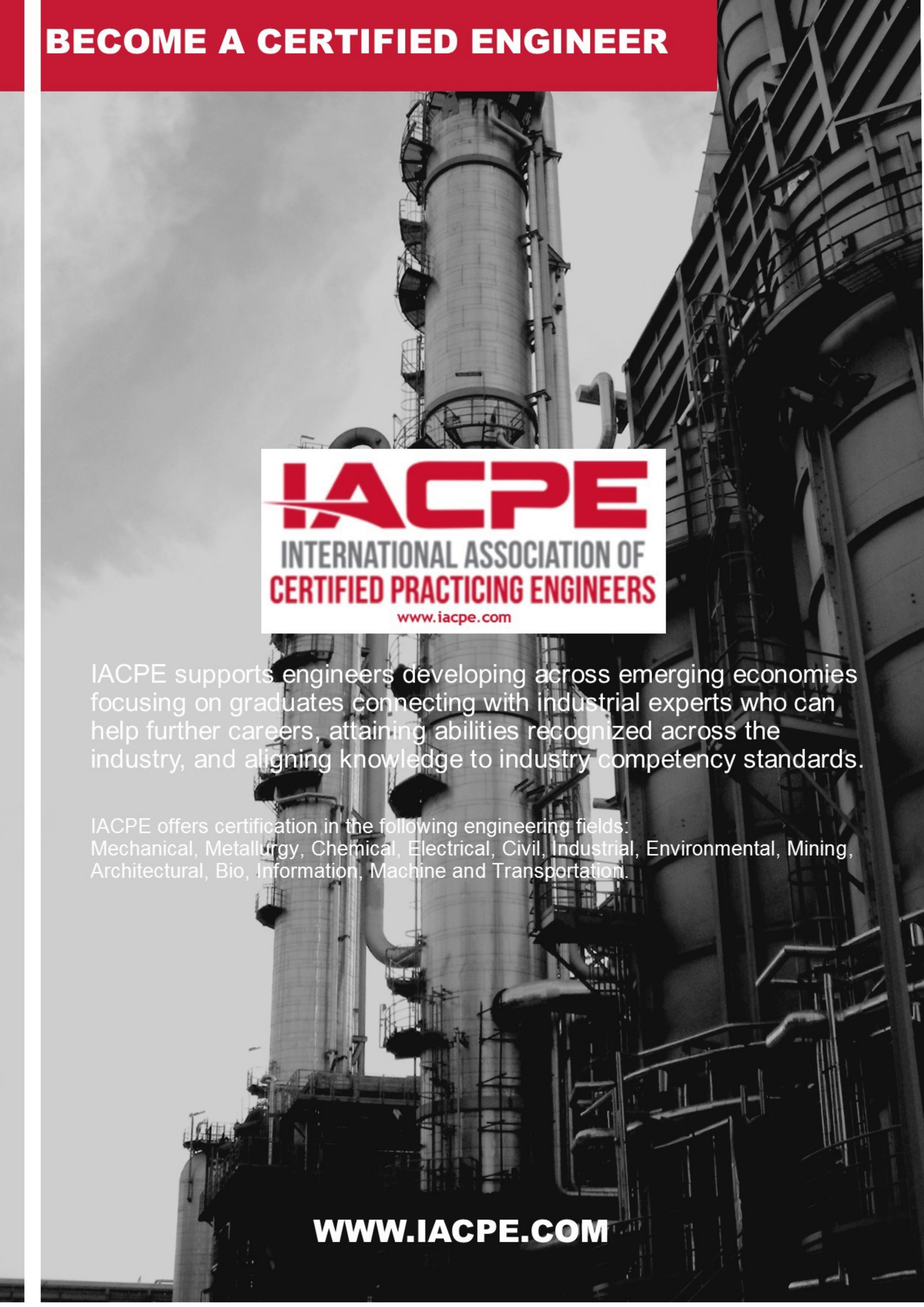
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Is It Possible to Inject Hydrogen to Natural Gas Pipeline?

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INTRODUCTION

Based on new search results, it is possible to inject hydrogen into natural gas pipelines, but there are some technical challenges and limitations. Hydrogen can be blended with natural gas up to a certain percentage (around 15%) without requiring major modifications to the pipeline infrastructure or the end-use applications. However, higher concentrations of hydrogen may cause issues such as hydrogen embrittlement of steel pipelines, permeation and leakage of hydrogen, and compatibility of compression and metering equipment. Therefore, converting existing natural gas pipelines to deliver pure hydrogen may require more substantial modifications.

BENEFITS

Also, injecting hydrogen into natural gas pipelines has some benefits such as energy storage, resiliency, and emissions reductions. Blending hydrogen with natural gas can help mitigate the negative effects of greenhouse gases and climate change by neutralizing carbon emissions. Blending hydrogen can also provide a steady demand for hydrogen production and utilization.

PET ANALYSIS

There are some of the challenges, costs, technologies, and policies related to hydrogen injection into natural gas pipelines as follows:

- Challenges: Hydrogen injection may cause embrittlement of steel pipelines, permeation and leakage of hydrogen, compatibility of compression and metering equipment, safety hazards due to flammability and explosion risks, and uncertainty of end-use applications.
- Costs: Hydrogen injection may reduce the upfront capital costs of hydrogen projects by using existing natural gas infrastructure. However, hydrogen production from renewable sources is still more expensive than natural gas or hydrogen from fossil fuels. Moreover, hydrogen injection may increase the operational costs of pipeline maintenance and monitoring.
- Technologies: Hydrogen injection requires technologies such as blending devices, separation units, leak detection systems, pipeline monitoring methods, and hydrogen-compatible appliances. Some of these technologies are still under development or need further improvement.
- Policies: Hydrogen injection requires policies such as standards and regulations for hydrogen quality, blend limits, safety measures, and emissions accounting. Some of these policies are still under development or need further harmonization at the EU and national levels.

INJECTING HYDROGEN IN NATURAL GAS GRIDS OPERATION

Governments and utilities worldwide are looking to low- and zero-carbon hydrogen injection into the natural gas grid to displace fossil fuel consumption and reduce emissions.

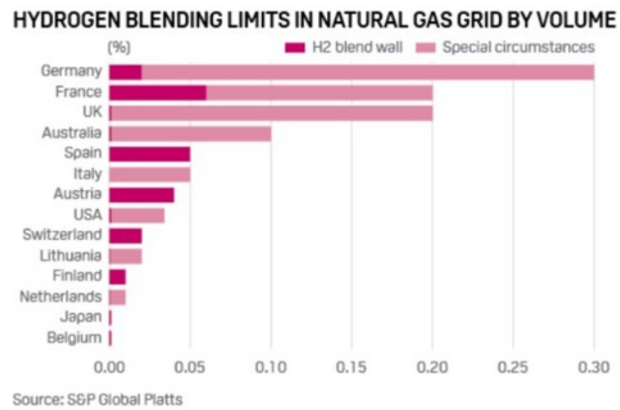
S&P Global Platts Analytics' Scenario Planning Service took an in-depth look into this topic in an special report, Hydrogen injection into California gas grid: a strategy to solidify demand to drive supply.

Hydrogen has a much lower energy density than natural gas on a volumetric basis. For this reason, end-users of a blended gas would require a higher volume of gas to achieve the same number of British Thermal Units versus end-users consuming pure natural gas. Hence, a 5% blending of hydrogen by volume does not directly translate into a 5% displacement of fossil fuel consumption.

As hydrogen blending increases, the average calorific content of the blended gas falls, and thus an increased volume of blended gas must be consumed to meet the same energy needs. For instance, a 5% blending by volume of hydrogen would only displace 1.6% of natural gas demand.

Pipeline injection has recently been featured in the national hydrogen strategies of the Netherlands and Australia, in addition to a host of small-scale pilot projects.

The graphic below shows the scale of various pilot projects exploring the impacts of hydrogen blending across countries. California has taken the lead on studying hydrogen injection in the US – with a Public Utilities Commission (CPUC) ruling from November 2019 giving utilities twelve months to propose a preliminary renewable hydrogen injection standard.



LOW EMISSIONS REDUCTION POTENTIAL

How the hydrogen is produced (as significant implications for the emissions reduction achieved from displacing natural gas)? Many policymakers, including California's CPUC, appear to be hesitant to subsidize fossil hydrogen even in cases where CCS technology is employed.

Steam methane reforming (SMR) is the source of over 70% of global hydrogen supply today. If the hydrogen were produced via this pathway without coupling with carbon capture and storage (CCS) technology, it would result in a significant increase in total emissions, a net increase in natural gas demand, and significant additional costs.

Assuming 100% of hydrogen were sourced from zero-carbon electricity, and energy delivered to end users was held constant, 5% hydrogen blending by volume in the California natural gas grid would reduce state-wide emissions by 2.0 million tons of CO2 in 2019, or less than 1% of state emissions. Hydrogen production of this magnitude would consume over 16% of the state's ample zero-carbon power generation.

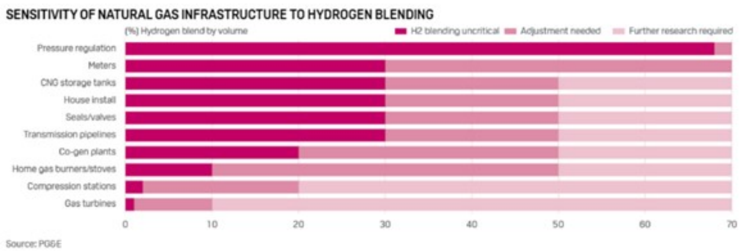
Platts Analytics has found also that, all things being equal, hydrogen blended into the natural gas grid has a low CO2 abatement potential versus other hydrogen-decarbonisation end use strategies. A kg of zero-carbon hydrogen used to displace grid methane has less than 20% of the impact of an equal amount employed in some of the most effective decarbonisation pathways such as low-carbon steel and materials production.

The benefits of hydrogen injection into the natural gas grid could extend past direct fossil fuel displacement and system decarbonisation. Early 2020, the Dutch central government released their national hydrogen strategy, which outlined potential regulatory support for hydrogen injection mandates as a form of stable near-term demand for the product. That has the potential to give a boost to hydrogen sector development.

As seen in the graphic below, taken from analysis done by US utility PG&E, at lower blend volumes the natural gas grid and its end users would require very little adjustment to accommodate hydrogen. This positions the natural gas grid, given the appropriate regulatory mandates, as a very low-cost source of hydrogen demand, providing greater certainty for investors in hydrogen supply.

A ramping up of supply would put downward pressure on levelized costs via economies of scale and learning-by-doing. This could further improve the economics of hydrogen in other applications with higher average per-kg decarbonisation potentials.

At higher blending ratios, some retrofits to the grid may be necessary. Some costly challenges of high volume blending include steel embrittlement of pipeline material and damage to burners caused by fuel combustion aberrations.



Because of low production efficiency of modern electrolysers and the relatively low carbon footprint of natural gas combustion versus other fossil fuels, hydrogen injection has a low average CO2 abatement potential per kg of hydrogen versus other zero-carbon hydrogen usages.

Grid injection is, however, an attractive source of near-term demand for hydrogen at low blend volumes due to low incremental costs. Increasingly, regions with aspirations to develop a low-carbon hydrogen economy are likely to turn to grid injection as a means of cultivating a market and stimulating investment into supply.

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COUNTRIES REFERENCES

Based on search results, some of the countries that inject hydrogen to natural gas pipeline are **Germany**, **Norway**, **the Netherlands** and **Australia**. These countries have either defined blending targets for 2030 or launched pilot projects to explore the impacts of hydrogen blending. Hydrogen blending is seen as a first step to decarbonising natural gas and reducing CO2 emissions.

COST

Green hydrogen production is more expensive than natural gas production in most regions. The levelised cost of hydrogen production from natural gas ranges from **USD 0.5 to USD 1.7 per kilogramme (kg)**, while the cost of green hydrogen production from renewable energy sources varies depending on the electricity price and the electrolyser capacity factor, but it is typically between **USD 3 and USD 6.5 per kg**. However, green hydrogen production costs are expected to decline in the future as renewable energy costs decrease and electrolyser efficiency improves.

WATER ELECTROLYSIS

Green hydrogen is hydrogen that is produced by using renewable energy sources, such as solar or wind power, to split water into hydrogen and oxygen through a process called electrolysis. Green hydrogen is also referred to as "clean hydrogen" because it does not produce any direct emissions of greenhouse gases or pollutants. Green hydrogen is different from other types of hydrogen, such as grey hydrogen (produced from fossil fuels such as coal), blue hydrogen (produced from natural gas with carbon capture and storage), or turquoise hydrogen (produced from methane pyrolysis).

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