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CROSS-CATTING ISSUES

# It would be a sensible government policy to produce hydrogen from natural gas

*Sería una política sensata del gobierno producir hidrógeno a partir de gas natural*

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**Environmental Safety in Transport Area (ASAT) of the JST.**

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## Abstract

The technical team of the Area of Environmental Safety in Transport (ASAT) talked with Dr. Laborde about the current situation of hydrogen in Argentina, to analyze what are the transport mechanisms for hydrogen, strategic countries and the need for human resources in studies, among other topics.

## Resumen

El equipo técnico del Área de Seguridad Ambiental en el Transporte (ASAT) conversó con el doctor Laborde acerca de la actualidad del hidrógeno en Argentina, para analizar cuáles son los mecanismos de transporte para el hidrógeno, los países estratégicos y la necesidad de los recursos humanos en los estudios, entre otros temas.

“Argentina has plenty of natural gas”, says Miguel Ángel Laborde; emeritus professor at the School of Engineering of Buenos Aires University (UBA), a Ph.D. in Chemical Sciences of La Plata National University, a member of the Board of Directors and former chair of the National Scientific and Technical Research Council (CONICET). This is the conversation that we had with one of the main leaders on hydrogen issues in Argentina, who was invited in 2013 to be one of the contributors and authors of the “National Hydrogen Plan”.

**What is green hydrogen?**

Before I respond, I should state that hydrogen is colorless.

Depending on how it is made, or what kind of energy source must be present for a reaction to happen, different colors are ascribed to it.

Hence, the idea of “green hydrogen” was widely accepted. It happens when water is the starting material, and the energy is generated through electrolysis using the wind, sun, or another renewable energy source, such as hydraulic or nuclear energy. That is, a significant amount of energy is provided to two electrodes in a water tank. The water molecule is broken by electric power, releasing oxygen and hydrogen without any carbon.

Green hydrogen is typically defined as hydrogen that was produced without the release of carbon dioxide, such as when using natural gas to produce hydrogen. The latter is referred to as “grey hydrogen,” and hydrogen turns blue when carbon dioxide is trapped to prevent emissions into the atmosphere.

It is also called green hydrogen when it is obtained from biomass. Although it releases carbon dioxide into the atmosphere, when it grows and absorbs carbon dioxide, the cradle-to-grave effect would be zero carbon dioxide emissions.

After reading this introduction, we realize that since hydrogen must always be produced using energy, green hydrogen is that which is produced by water electrolysis utilizing renewable energies. Therefore, production energy is always higher than energy obtained from hydrogen.

**How is it produced in Argentina?**

Anywhere in the world, if the necessary resources are available, hydrogen production is simple. Water, an electrolyzer, and a power supply are required. When you have natural gas, it can be created by a procedure known as “steam reforming,” which, together with electrolysis, is a fairly established technological method.

In Argentina, hydrogen is industrially used, and it is obtained through steam reforming using natural gas, with or without carbon dioxide capture.

**How can green hydrogen be implemented in transportation activities? Which are the implementation stages?**

Hydrogen, regardless of its color, requires an infrastructure to be implemented in transportation activities.

It may be used as a direct fuel —through combustion of hydrogen with air— instead of gasoline combustion.

There are two issues with this use. where energy is released and primarily lost through an exhaust pipe. The second issue is that at the temperature at which hydrogen and oxygen burn, nitrogen in the air reacts to produce nitrogen oxide, an orange-colored steam that eventually results in acid rain.

This type of use implies two problems. The “Carnot Cycle” is the first, where energy is released and largely lost through an exhaust pipe. The second issue is that at the temperature at which hydrogen and oxygen burn, nitrogen in the air reacts to produce nitrogen oxide, an orange-colored steam that eventually results in acid rain.

Hence, a fuel cell, a type of battery that is continuously fed with hydrogen and oxygen, may be utilized in conjunction with hydrogen to use it most effectively in transportation activities. Hydrogen reacts with oxygen forming water without combustion, and such chemical energy is converted to electrical power. The result is an electric vehicle that can be charged with hydrogen at a filling station rather than requiring it to be charged at 220V.

This is where the infrastructure problem arises. Hydrogen refueling stations will be needed, at a cost of approximately one or two million dollars each. In addition, Argentina is so vast that a major network of refueling stations will be required.

**In which transportation mode would the implementation be more feasible and why?**

Hydrogen would be used in heavy vehicles that need great driving range. This includes trains, trucks1 short-distance buses, long-distance buses, and so on. One hydrogen filling station at the terminals of the various modes of transportation would be advantageous. However, this basically applies to heavy vehicles.

The use of biomass or hydrogen-derived biofuels for ocean liners, airplanes, and ships in general is being studied. Jet fuels based on full oil and kerosene are not an option.

**What obstacles face the development and use of hydrogen?**

In addition to the infrastructure of filling stations, the key obstacles to a hydrogen-based economy are hydrogen storage and transportation. Since it is a very light and not so dense gas, it may be leaked from all sides. It has a huge gas diffusion and it may even weaken the steel in the pipes. Although storage in solid materials is intended and is being intensively researched for transportation storage, there is still a long way to go.

The only options left are to store hydrogen as liquid or at a high pressure of about 700 bars.

The issue with liquid hydrogen is that it must be kept at such pressure and temperature —which is highly expensive— in order to liquefy at 20 Kelvin. It looks like this are the only two alternatives for hydrogen transportation.

Using a carrier molecule is a third option. For instance, ammonia is composed of one nitrogen atom, three hydrogen atoms, and zero carbon atoms. Thus, the plan is to create ammonia from green hydrogen, which will then be further broken down in the place where it will be used.

**Which are the hydrogen transportation mechanisms now available? And the most feasible ones in Argentina**

Pipelines may be used for short or relatively short distances. Pipelines used to carry natural gas, or trucks, may be used to carry hydrogen. The question is to consider the condition of those pipelines.

Another option for transportation is to combine hydrogen and natural gas. Compressed natural gas (CNG) and hydrogen may be used to power CNG-powered vehicles. These would be combustion vehicles similar to current vehicles, not electric vehicles, with a little less pollution.

**What is the current regulatory framework in Argentina?**

A hydrogen legislation was released in 2006. The Energy Department, which had the power to enforce regulations, never did so. To facilitate the introduction of hydrogen into the market, a "National Hydrogen Plan" was devised in 2013 in conjunction with the establishment of the "National Hydrogen Fund." It was abandoned after Mauricio Macri was elected president of Argentina. But it is currently being recovered.

The 2006 law expired, and went unregulated for 15 years. Congress is currently looking at a new regulatory statute.

Moreover, the "Hydrogen Roadmap" is being created by the National Department of Strategic Affairs. To this purpose, a selection process was put in place involving various consulting firms to obtain the roadmap for production, demand and the regulatory framework.

The CONICET research teams and a consulting firm teamed up, and we were chosen to produce hydrogen. Along with the Department of Strategic Affairs, we are currently addressing this issue.

***Obtaining green hydrogen through electrolysis would prevent the emission of 830 million tons of CO2 yearly.***

When gas is created using fossil fuels, CO2 is produced. In addition, substituting grey hydrogen globally would produce an extra 3000 TWh of renewable energy each year (similar to the current electricity demand across Europe). Although there are some concerns regarding production feasibility, these concerns will be answered as global efforts to reduce carbon emissions advance and renewable energy generation becomes more affordable.

***Advantages of green hydrogen production***

Argentina has chances for investment and growth due to the production of hydrogen, mostly because of its potential applications. Hence, in addition to the strategic discussion held between associated industries and scientific/technological institutions, the National Low Emission Hydrogen Strategy 2030, a public-private effort, has already been presented.