Stantec Confirms That Environmental Services Have a Key Role to Play in Hydrogen Projects

Stantec executives discuss the environmental impacts and water requirements of hydrogen production.

Responding to CCBJ questions are:

- *Nathan Ashcroft, Strategic Business Developer, Energy*
- *Steve McManamon, Sector Leader, Environmental Services, Energy*
- *Eric Snelling, Principal, Environmental Planner*
- *Yasmeen Sultana, Senior Principal, Regional Business Leader, Environmental Services (US Mountain)*
- *Jillian Flanagan, Regional Practice Leader, Industrial Water*
- *Shil Basu, Principal, Water/Wastewater Treatment Team Lead*

CCBJ: How would you describe the complexities of hydrogen and hydrogen-hub projects in terms of permitting, air quality and health impacts?

Snelling & Sultana: Hydrogen can be used in a fuel cell or in a combustion device. When utilizing hydrogen in a fuel cell, the only direct releases are heat and water vapor. No air pollutants are expected.

When hydrogen is used as a fuel in combustion units, the main pollutant of concern is nitrogen oxides (NOx). Either on its own or blended with natural gas or other fossil fuel sources, there is the potential for the formation of NOx due to nitrogen present in ambient air. There is still great uncertainty around the formation of NOx emissions when combusting pure hydrogen. However, research indicates that combustion unit burner technologies can be designed to maintain, or potentially even reduce, NOx emissions as compared to combusting natural gas.

It is relevant to note that these technologies are not largely commercially available yet, and combusting hydrogen as a blend with natural gas, or on its own, in rich burn combustion units, does have the potential to increase NOx emissions as compared to combusting pure natural gas.

The use of hydrogen as a fuel combusted as pure hydrogen, or as a blend with natural gas, has the ability to reduce volatile organic compounds (VOC) and particulate matter (PM) emissions. When combusting pure hydrogen, VOC and PM emissions can potentially be reduced to near zero. The same is true for carbon dioxide (CO2) and methane (CH4) emissions. As there is no carbon in the fuel itself, no CO2 or CH4 is formed when combusting hydrogen. However, there is the potential for nitrous oxide (N2O) emissions when combusting hydrogen due to nitrogen in the air.

The use of hydrogen as a fuel in place of fossil fuels has the potential to significantly reduce VOC, PM, CO, CO2, and CH4 emissions. PM emissions from diesel fuel combustion has been shown to be a significant contributor to cancer risk in areas of California, as described in the MATES Program by the South Coast AQMD. PM from all fossil fuel combustion is known to cause respiratory tract irritation, asthma, and bronchitis. Volatile organic compounds (VOCs) and carbon monoxide (CO) are both precursors to Ozone, which has been linked to respiratory irritation and asthma. While VOCs are a large category of compounds, some VOCs can cause irritation to the body, and some are known carcinogens. Reducing these pollutants by replacing fossil fuels with hydrogen has the potential to reduce the health impact on communities.

CCBJ: What related projects are Stantec working on?

McManamon, Sultana & Snelling: Stantec is providing environmental services on projects for three of the seven DOE hydrogen hubs selected for grant negotiations. Our services include support of National Environmental Policy Act (NEPA) permitting and compliance, air quality and program management support. Due to current client confidentiality requirements, further detail cannot be provided at this time.

CCBJ: How is hydrogen production tied to water?

Ashcroft, Flanagan & Basu: Water is a molecule that contains two hydrogen atoms and one oxygen atom. A hydrocarbon is by definition a combination of hydrogen and carbon. Hydrogen is the simplest molecule and explains why it is the most abundant element in the universe.

Over 95% of the world's hydrogen produced today is from methane gas (hydrocarbon) reforming (termed grey/ blue hydrogen) or electrolyzing water to separate to produce hydrogen and oxygen. Hydrogen is produced through various methods, including electrolysis, steam methane reforming, and biomass gasification. In electrolysis, an electric current is passed through water to split it into hydrogen and oxygen gases. Steam methane reforming involves reacting steam with methane to produce hydrogen and carbon monoxide. Biomass gasification converts organic materials into hydrogen rich gas through high-temperature reactions.

CCBJ: How much water is required for hydrogen production?

Ashcroft & Basu: With current technology, the water demand is estimated to be 20 - 35 L/kg of hydrogen. The wide range is attributable to the following factors:

- Blue or green hydrogen (both from a stoichiometric water demand and from a cooling demand).
- Technology used to generate the hydrogen (e.g., PEM vs. alkaline electrolyzer technologies have varying water demand).

- Site specific properties that may further impact cooling water demand

By Stantec's calculations, that is equivalent to about 12 billion m3/year (3.2 trillion gal/year) by 2050 which is a small percentage of the global overall water demand. The bigger concern is that the hydrogen production ecosystem (including hydrogen production as well as localized supply chain development) could be concentrated in specific areas and the local supply of water could be disproportionately stressed if appropriate evaluation is not conducted.

We are supporting clients to secure the water from traditional sources as well as non-traditional sources depending on the site location. Non-traditional water resources (such as municipal or industrial wastewater) may require additional purifications steps for the water but could have greater water supply security. Water treatment for hydrogen production is well understood and can be done with existing treatment technologies.

CCBJ: What other environmental impacts could water sourcing create?

Snelling & Basu: If the water sourcing strategy is not done thoughtfully, it may lead to depletion of the water source, perhaps even irreversibly, and the associated long term affects. It could impact the operator's reputation as a good corporate citizen within the community in which it operates. More acutely, if water were to become so depleted, as we have seen in certain water bodies such as the Colorado River, more dire situations could arise such as mandatory water cuts.

CCBJ: How could water sourcing affect the hydrogen market in the long term?

Ashcroft & Basu: The goal for any energy source is to be abundant, affordable, and reliable. Hydrogen is promising and can achieve that goal. Water is critical for production but it is more critical for the communities and the environment that it serves. If water sourcing is not well thought out and reliable, production will not be either. ☼

WSP Discusses State of the Hydrogen Market and What it Will Take to Accelerate Infrastructure Development

WSP is helping to build the new hydrogen economy by supporting clients with production, storage, distribution and utilization of hydrogen as a clean fuel.

WSP (Montreal, Canada) is a global engineering, environmental and professional services firm that brings together engineers, planners, technical experts, strategic advisors and construction management professionals to design lasting solutions in the buildings, transportation, energy, water and environment markets. WSP has approximately 14,000 employees in 300 offices across the United States.

***Brian McCarthy, U.S. National Hydrogen Market Lead**, is responsible for strategy development and implementation. Prior to his role at WSP, he led a low carbon process-technology business with a portfolio that included hydrogen, synthetic natural gas and emerging plastics recycling technologies. He has been active in strategic partnering for delivery of renewable diesel and sustainable aviation fuel projects and is deeply passionate about advancing the energy transition and developing the new hydrogen economy.*

CCBJ: How would you describe the current state of the U.S. hydrogen market?

McCarthy: The hydrogen market can be viewed through frameworks that apply to any emerging market. From that perspective, the hydrogen market is in transition from being led by a handful of maverick innovators and approaching the stage where early adopters are gaining confidence to enter the market. The amount of resources needed to progress a low-carbon hydrogen market is substantial, and the timeframe for the majority of the economy to adopt hydrogen is likely to be measured in decades rather than months. I believe this is just the beginning for the U.S. market.

CCBJ: What key elements of the U.S. hydrogen economy need to be advanced to promote greater hydrogen use?

McCarthy: A viable infrastructure project, regardless of type, needs to be fully integrated into a market. For example, there would be limited interest to build a bridge if there were no connecting highways to facilitate transport. Hydrogen projects are no different. A viable hydrogen project requires the full value chain to be complete to achieve its decarbonization and economic objectives. While some industries — such as refining — have been using hydrogen for decades, most have not. So outside existing industrial clusters, there is no infrastructure available to complete the value chain for hydrogen.

Low-carbon hydrogen is expensive to produce today. While costs will come down over time from learning curve benefits, initial projects must be able to advance at the present-day capital and operating expenses. This is where government support becomes an important part of the project model.

Clean hydrogen commercial markets are not currently established, and while demand is strong it is fragmented. Hydrogen's promise to decarbonize industry and mobility is clear, but the willingness to pay for clean hydrogen varies significantly by geography and industry.

CCBJ: Please comment on the hydrogen value chain and how technology is providing the tools needed for it to become more efficient?

McCarthy: Improving the efficiencies of hydrogen production and storage is crucial for the development of a sustainable and cost-effective industry. Technology will play a critical role in enhancing production, storage and use. Advancements to develop efficiencies in electrolysis technology, storage and converting power to hydrogen and back are emerging across the industry. El-