



**SoCalGas Comments in response to July 8, 2019 Public Meeting: The Role of the Industrial Sector in Meeting California's Carbon Neutrality Goals**

## **Appendix A:**

# **Hydrogen Opportunities to Decarbonize California's Industrial Sector**

## Hydrogen Opportunities to Decarbonize California's Industrial Sector

California must address the decarbonization of the industrial sector in a “balanced way” by developing strategic and tactical innovative energy approaches that involve a portfolio mix of low- and zero-carbon energy resources.

The European Commission<sup>1</sup>'s study (2018)<sup>2</sup> in its “strategic long-term vision for a prosperous, modern and competitive climate neutral economy” evaluates the importance of hydrogen in the industrial sector. The study points out that steel, cement, and chemical processing dominate most of the industrial emissions in the European Union and states that “in the next 10 to 15 years, technologies that are already known will need to demonstrate that they can work at scale, and some of them are indeed already being tested at small scale, e.g. hydrogen-based primary steel production.”

Many industrial-related emissions (from processing) can be challenging to eliminate. Some choices to mitigate those emissions exists such as carbon capture and utilization (CCU).<sup>3</sup> Carbon dioxide (CO<sub>2</sub>) can be efficiently captured, stored, and used as end use materials for diverse applications. Instead of carbon intensive fuels used for industrial processing, both renewable hydrogen and sustainable biomass can be potential feedstocks for several industrial processes, including chemicals, food processing, and steel production.

### 1. Utilizing Low- and Zero-carbon Hydrogen Fuel

SoCalGas believes California should prioritize the development and use of hydrogen—produced from low- or zero-carbon feedstocks—which can play a significant role to facilitate decarbonizing the industrial sector in our state. Multiple cross-sectoral pathways, innovative technologies, and process innovations, which are discussed below and implemented elsewhere globally, can be adopted to help achieve California's carbon neutrality goal.

Hydrogen has been extensively employed as a process feedstock in the chemical industry and it can play a significant role elsewhere within the industrial sector. However, to decarbonize California's industrial sector, hydrogen will need to be produced from renewable sources, like water electrolysis using carbon-free electricity, renewable gas (RG) from landfills and dairy feedstocks, and/or from natural-gas steam reforming using carbon capture and storage. This low- or zero-carbon hydrogen can be used in several applications, including: energy storage in the power sector to accommodate the integration of intermittent and variable energy sources; as an energy carrier in transport heating; blending with natural gas for end-use applications in residential, commercial, and industrial sectors; and as a process feedstock for industries such as chemicals, refining, steel manufacturing, food processing, etc.

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<sup>1</sup> The European Commission is the executive of the European Union.

<sup>2</sup> European Commission. *Communication from the Commission to the European Parliament, the European Council, The Council, The European Economic and Social Committee, the Committee of the Regions and the European Investment Bank*. November 2018. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773&from=EN>, pg.13

<sup>3</sup> Carbon Capture and Utilization (CCU) is a process where CO<sub>2</sub> can be captured and then converted into a new product like carbon black, graphite, carbon nanotubes etc.

Zero- or low-carbon hydrogen can be used by the industrial sector by utilizing existing natural-gas energy infrastructure along with existing or “within reach” emerging technologies. Some potential hydrogen energy and technology integration options are listed below to illustrate its decarbonization potential.

#### *A. Hydrogen Blending with Natural Gas*

The usage of hydrogen-natural gas blends at “safe operating levels” in the industrial sector can quickly assist in meeting California’s decarbonization goals cost effectively. Blending hydrogen into the existing natural gas infrastructure can also help avoid the significant upfront capital costs involved in developing new transmission and distribution energy infrastructure.

According to the International Energy Agency’s *Future of Hydrogen Report*, “there are currently 37 demonstration projects examining hydrogen blending in the gas grid. The Ameland project in the Netherlands did not find that blending hydrogen up to 30% posed any difficulties for household devices, including boilers, gas hobs and cooking appliances.<sup>4</sup> Injection has also been tested at both the transmission and distribution level.”<sup>5</sup>

The Energy Futures Initiative, recently released report “Optionality, Flexibility and Innovation: Pathways for Deep Decarbonization in California,” states, “Assuming that natural gas infrastructure (power plants and pipelines) can safely integrate 10 to 15 percent hydrogen as an additive, and that this hydrogen is produced using a clean process, the carbon intensity of natural gas could decline by up to 10 percent.”<sup>6</sup>

Many European countries including Germany, France, and Spain have already adopted hydrogen blending protocols with blending percentages ranging from 2-10% based on end use application and other technical constraints (see Figure 1 below). The European Commission is examining developing detailed standards and the role of RG and hydrogen in the natural gas network.<sup>7</sup> There are also several European industry working groups (e.g. HyReady and HIPS-Net) examining standards for hydrogen blending into their natural gas grids. In the United Kingdom, Keele University is exploring hydrogen blending into its private gas network beginning in 2019 to reduce carbon emissions from heating buildings:<sup>8</sup> the HyDeploy Project plans to blend up to 20% hydrogen as part of their decarbonization efforts.<sup>9</sup>

The Australian Gas Infrastructure Group has announced plans to blend hydrogen into its natural gas supplies to take advantage of excess renewable generation. The utility announced plans for Australia’s first power-to-gas plant worth \$8.9 million to be built in Adelaide, South Australia.

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<sup>4</sup> International Energy Agency. *Future of Hydrogen Report, Seizing today’s opportunities*. June 2019. Page 73 Available at: <https://webstore.iea.org/the-future-of-hydrogen>

<sup>5</sup> *Ibid.*

<sup>6</sup> Energy Futures Initiative. *Optionality, Flexibility, & Innovation. Pathways for Deep Decarbonization in California*. 2019. Page 77. Available at: [https://energyfuturesinitiative.org/s/EFI\\_CA\\_Decarbonization\\_Full-b3at.pdf](https://energyfuturesinitiative.org/s/EFI_CA_Decarbonization_Full-b3at.pdf)

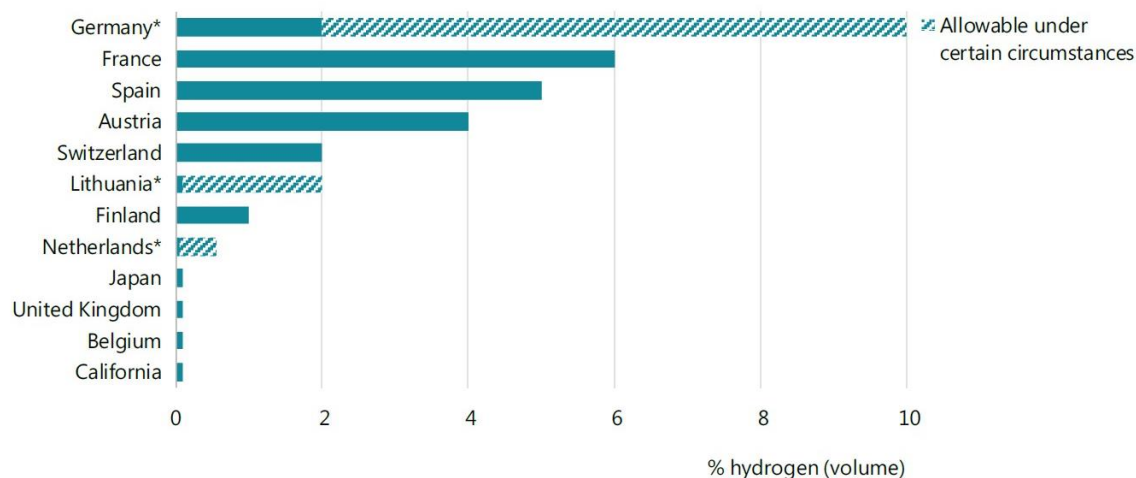
<sup>7</sup> International Energy Agency. *Future of Hydrogen Report, Seizing today’s opportunities*. Page 73.

<sup>8</sup> HyDeploy Website. Available at: <https://hydeploy.co.uk/>

<sup>9</sup> Gas Power Heat Systems Network. *Trial to explore blending hydrogen gas network*. February 2018. Available at: <https://networks.online/gphsn/news/1000904/trial-explore-blending-hydrogen-gas-network>

The hydrogen produced will be injected into the local gas distribution network to provide low-carbon gas to homes and businesses.<sup>10</sup>

**Figure 1: Current limits on hydrogen blending in natural gas networks (IEA, 2019)**



\* Higher limit for Germany applies if there are no CNG filling stations connected to the network; higher limit for the Netherlands applies to high-calorific gas; higher limit for Lithuania applies when pipeline pressure is greater than 16 bar pressure.

Sources: Dolci et al. (2019), "Incentives and legal barriers for Power-to-Hydrogen pathways: An international snapshot", *International Journal of Hydrogen*; HyLaw (n.d.), *Online Database*; Staffell et al. (2019) "The role of hydrogen and fuel cells in the global energy system", *Energy and Environmental Science*.

California has an opportunity to learn from the work being done in other countries and to lead the U.S. in achieving decarbonization through hydrogen blending. SoCalGas suggests that CARB or CEC administer a study by an independent third-party, such as the California Council on Science and Technology, to make recommendations on hydrogen blending/ combustion standards as part of hydrogen turbine retrofit for thermal generation applications. The goal of this independent analysis should be to confirm the benefits of development of hydrogen blending standards with natural gas for hydrogen-ready turbine retrofits that enable economical and technologically synergistic pathways for biomethane, hydrogen, and natural gas to support the State's GHG emissions reduction goals.

### B. Large Hydrogen Projects

Again, California can look to the international community on developing large-scale hydrogen projects. As part of the New Energy and Industrial Technology Development Organization<sup>11</sup> project in Japan, Obayashi Corporation and Kawasaki Heavy Industries, Ltd. delivered the world's first gas turbine fueled by 100% hydrogen for energy and heat generation.<sup>12</sup> Also in

<sup>10</sup> gtm. Australia Seeks Hydrogen to Soak Up Excess Renewable Energy Production. March 2018. Available at: <https://www.greentechmedia.com/articles/read/australia-looks-to-hydrogen-to-soak-up-excess-renewable-energy-production#gs.sb4MM1M>

<sup>11</sup> The New Energy and Industrial Technology Development Organization was established as a governmental organization in Japan to promote the development and introduction of new energy technologies.

<sup>12</sup> New Energy and Industrial Technology Development Organization. *World's First Heat and Electricity Supplied in an Urban Area Using 100% Hydrogen-Towards Establishing Optimal Energy Control Technology in Local*

Japan, Mitsubishi Hitachi Power Systems has successfully developed a “large-scale hydrogen gas turbine” combustor that uses a mix of liquified natural gas—the fuel used in gas-fired thermal power—and 30% hydrogen. It burns hydrogen while allowing suppression of NO<sub>x</sub> emissions to the level of gas-fired thermal power. The technology is compatible with an output equivalent to 700 MW (with temperatures at turbine inlet at 1600°C), and it offers a reduction of about 10% in CO<sub>2</sub> emissions compared with GTCC [Gas Turbine Combined Cycle].”<sup>13</sup>

Additionally, General Electric’s (GE) “hydrogen-ready” (6B.03) turbines at the Gibraltar-San Roque Oil Refinery in Spain, have logged thousands of hours combusting a blend of hydrogen and fuel gas. The same turbines are also in operation at a South Korean refinery, with more than 20 years combusting a fuel blend with more than 70% hydrogen and has even operated with a 90% hydrogen blend. In the U.S., a petrochemical plant in Louisiana has been combusting a blend of natural gas with hydrogen with GE 7F gas turbines.<sup>14</sup>

### C. Tri-generation Technologies

SoCalGas encourages CARB or CEC to consider the importance of incentivizing mature, established tri-generation technologies. For example, tri-generation solutions—developed by FuelCell Energy<sup>15</sup>—utilize fuel cell stacks configured to simultaneously generate power, hydrogen, and heat by reforming hydrogen-rich fuels including natural gas or renewable biogas. This technology is already installed in California and globally, and has helped with cross-sectoral decarbonization efforts.

One of the installations in California, funded by the U.S. Department Of Energy, is the Fountain Valley Trigeneneration Facility located at the Orange County Sanitation District. It is the world’s first tri-generation hydrogen energy and electrical power station to provide transportation fuel to the public and electric power to an industrial facility.<sup>16</sup> In April 2019, FuelCell Energy also announced a 1.4 MW project with the City of San Bernardino Municipal Water Department. The project will operate on anaerobic digester gas and as needed, natural gas, producing electricity and heat to support the operation of the Water Department’s water reclamation facility. FuelCell Energy is currently developing an application for their fuel cell, which may assist the industrial sector to become carbon neutral.

SoCalGas emphasizes the need to address the decarbonization of the industrial sector for California in a “balanced way” by developing strategic and tactical innovative energy approaches that involves a portfolio mix of low- and zero-carbon energy resources including electrification for fuel and as well(s) as processing feedstock resource in industrial applications.<sup>17</sup>

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*Communities*. April 2018. Available at: [https://www.nedo.go.jp/english/news/AA5en\\_100382.html](https://www.nedo.go.jp/english/news/AA5en_100382.html)

<sup>13</sup> Mitsubishi Hitachi Power Systems Website. Available at:

<https://www.mhps.com/special/hydrogen/article1/index.html>

<sup>14</sup> GE Reports. The Hydrogen Generation: These Gas Turbines Can Run On The Most Abundant Element In the Universe. January 2019. Available at: <https://www.ge.com/reports/hydrogen-generation-gas-turbines-can-run-abundant-element-universe/>

<sup>15</sup> Fuel Cell Energy Website. Available at: <https://investor.fce.com/Investors/default.aspx>

<sup>16</sup> U.S. Department of Energy. Energy Efficiency & Renewable Energy. Fuel Cell Technology. *Tri-Generation Success Story*. Available at: <https://www.energy.gov/sites/prod/files/2016/12/f34/fctofoountainvalleysuccessstory.pdf>

<sup>17</sup> European Commission. In-depth analysis in support on the COM(2018) 773: A Clean Planet for all - A European

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strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. November 2018.  
Available at: [https://ec.europa.eu/knowledge4policy/publication/depth-analysis-support-com2018-773-clean-planet-all-european-strategic-long-term-vision\\_en](https://ec.europa.eu/knowledge4policy/publication/depth-analysis-support-com2018-773-clean-planet-all-european-strategic-long-term-vision_en)