GREEN HYDROGEN COALITION

Date: April 24, 2023

Subject: GHC Opposition Letter - Resolution of the City Council of The City of Irvine, California, Opposing Hydrogen Blending at the University of California, Irvine

---

Dear City Council of Irvine,

On behalf of the Green Hydrogen Coalition (GHC),[1] we are writing to express our opposition to the resolution[2] proposed by the City Council of Irvine, California, which opposes hydrogen blending testing at the University of California, Irvine. The GHC is a 501(c)(3) educational nonprofit dedicated to ending our fossil fuel era and achieving a clean and just energy transition.

While the GHC understands that valid concerns may exist regarding the safety and health risks associated with hydrogen blending, we have evaluated ample evidence from industry and academia confirming that hydrogen blending testing at modest amounts can be conducted safely and is necessary for achieving California's ambitious goals to reduce greenhouse gas emissions.

1. ***Green hydrogen is key to ending our fossil fuel era.***

To protect the planet and our communities from the harmful effects of fossil fuels, we must find renewable alternatives. Many countries and jurisdictions around the world (e.g., Japan, Canada, Germany, Spain, etc.) have studied how to end dependence on fossil fuels and found that green hydrogen – a versatile renewable resource – is one of the key solutions that will enable humanity to achieve zero emissions economywide.

Green hydrogen is a nontoxic, greenhouse gas-free fuel that can displace fossil fuels in many hard-to-electrify sectors. Today, hydrogen is already a mature industrial commodity that is safely produced, stored, and transported. As of 2021, it had an annual global demand of 94 million tons.[3]

[1] https://www.ghcoalition.org/

[2] Resolution of the City Council of The City of Irvine, California, Opposing Hydrogen Blending at the University of California, Irvine. Available at: https://irvine.granicus.com/MetaViewer.php?view_id=68&event_id=2193&meta_id=139008

[3] International Energy Agency. Hydrogen. Available at: https://www.iea.org/reports/hydrogen

Historically, most hydrogen has been produced from fossil fuels.[4] Fortunately, renewable hydrogen can be commercially produced from water (H_2O) using renewable electricity (i.e., solar or wind), or other renewable feedstocks (e.g., agricultural waste, landfill gas). As a result, green hydrogen is an unlimited, carbon-free, scalable, and renewable fuel.

While green hydrogen is critically important in our fight against climate change, it is currently more expensive than fossil fuels, which makes widespread adoption infeasible. Finding ways to make green hydrogen cost competitive with fossil fuels is key to deploying this resource across needed sectors to save the planet. To solve this cost barrier, the GHC has dedicated multiple years to analyzing scenarios that achieve a low-cost, scaled green hydrogen ecosystem in Southern California. The findings are clear: at scale, green hydrogen can be cost competitive with fossil fuels.[5] Large-scale production of green hydrogen can take advantage of Southern California's abundant renewable resources, which exist outside of densely populated urban neighborhoods (e.g., where available land and solar capacity is abundant).

Our analysis demonstrated that a key enabler of a low-cost green hydrogen economy is the ability to use shared infrastructure to transport mass-scale green hydrogen from the point production to where it is needed, such as the Port of LA. There are already more than 1,600 miles of hydrogen pipeline in commercial operation in the US today, including 17 miles of hydrogen pipeline connecting oil refineries in Los Angeles. Today, where pipelines are not available, hydrogen is commonly transported by truck, resulting in very high costs to end users. A 2020 study from the U.S. Department of Energy found that delivery and dispensing costs of hydrogen at fueling stations ranges from $8-$11 per kilogram (in addition to the cost of the hydrogen itself). Based on industry feedback, approximately $4–5 per kilogram of this cost can be attributed to transport/trucking.[6] This is where making new use of our network of existing natural gas pipeline infrastructure can help. The GHC's analysis found that if green hydrogen can be delivered via

---

[4] U.S. Department of Energy. Hydrogen Resources. Available at: https://www.energy.gov/eere/fuelcells/hydrogen-resources#:~:text=Currently%2C%20most%20hydrogen%20is%20produced,more%20directly%20to%20generate%20hydrogen.

[5] GHC. HyBuild LA Phase 2. https://www.ghcoalition.org/ghc-news/hybuild-la-phase-2-report

[6] Industry feedback indicates that approximately 50% of the delivery and dispensing cost is related to transport/trucking.

pipeline, the transport cost is reduced from $4 or $5 per kilogram to $0.22-0.58[7] per kilogram of green hydrogen – a 10x reduction in transport cost! With scaled production and pipeline delivery, we can achieve a delivered cost of green hydrogen at $2.05 per kilogram – this is very good news because a kilogram of hydrogen provides about the same amount of energy as a gallon of diesel.[8,9]

Ultimately, we need to create a pipeline system to support the transport of 100% green hydrogen, similar to the approach being employed in Europe.[10] This is a daunting undertaking and cannot be achieved overnight. Therefore, we will need a phased approach to make measurable and impactful progress in the near term. Other California programs have followed a similar approach. For example, California's Renewable Portfolio Standard (RPS) did not start by requiring 100% of electricity to come from renewable standards; rather, it started at a much more modest 20% and thereby allowed the ecosystem to scale with our policy ambition.

The good news is that, as the European Hydrogen Backbone Initiative has shown, the most cost-effective pathway to building a green hydrogen pipeline system is to repurpose the existing natural gas pipeline. Many jurisdictions around the world have already begun testing the possibility of blending modest amounts of hydrogen into existing natural gas pipelines as a means to utilize existing infrastructure to provide near-immediate transport and storage of renewable hydrogen and jumpstart their green hydrogen economy. **While the GHC supports blending as a near-term solution to catalyze the GH_2 ecosystem, blending alone will not achieve the mass-scale green hydrogen system needed for economy-wide displacement of fossil fuels. Ultimately, 100% green hydrogen pipelines are needed.[11]** To ensure safety and determine an appropriate and safe blending percentage for California, additional testing is required. The GHC supports the CPUC's mandate to require the Joint Utilities to commence testing, which is why the GHC supports the proposed pilot at University of California Irvine. Fortunately, there is already a large and growing

[7] The lower cost ($0.22) includes the cost of the transport pipeline, whereas the higher cost ($0.58) also includes the cost of injection compression and compression stations.
[8] GHC. HyBuild LA Phase 2. https://www.ghcoalition.org/ghc-news/hybuild-la-phase-2-report. Note that this cost includes PV production, electrolysis, recycled water infrastructure, compression, geologic storage, and pipeline transport.
[9] Utilizing the incentives from the Inflation Reduction Act, this cost reduces to $0.69 per kilogram.
[10] European Hydrogen Backbone. Available at: https://ehb.eu/
[11] Not only will this starting step getting the molecule itself moving, but it will also help build the momentum and market forces needed to scale the hydrogen ecosystem.

body of work from elsewhere in the U.S. and around the world that indicates that the proposed test can be implemented safely and responsibly.

2. ***Demonstrated Safety of Hydrogen Blending***

Blending hydrogen into natural gas transmission and/or distribution lines is not a new concept; instead, it has been successfully demonstrated in multiple places.

Blending and Blending Testing Success in the United States

Blending hydrogen has been successfully demonstrated by Hawai'i Gas, New Jersey Natural Gas, Dominion Energy Utah, and SoCalGas. Notably, Hawai'i Gas has safely operated its existing gas pipeline network with blends of up to 15% hydrogen by volume for years in their existing natural gas pipeline network. The Hawai'i Gas' hydrogen blend is not a demonstration; this real-world application supports the decarbonization of the State's 1,100 miles of pipelines. The State's experience with safe operation over decades with a significant fraction of hydrogen has led to the research and development of hydrogen and supporting technologies for other end uses to decarbonize the State.[12]

In October 2021, New Jersey Natural Gas began injecting hydrogen into a distribution line. While this only represents less than 1% hydrogen by volume,[13] it nonetheless shows that this innovation is possible. In 2021, Dominion Energy Utah (DEU) launched hydrogen blending in Delta, Utah, to explore the opportunities of zero-carbon emissions fuel. A 5% by volume hydrogen blend was tested for almost a year and it was found that hydrogen is safe, compatible with current residential appliances, and helpful in reducing emissions from appliances using already clean-burning natural gas.[14] Also, at the University of California, Irvine (UCI), SoCalGas, and the National Renewable Energy Laboratory worked together in 2016 to develop a smaller-scale

[12] Hawai'i Gas. Decarbonization and Energy Innovation. Available at: https://www.hawaiigas.com/clean-energy/decarbonization

[13] National Renewable Energy Laboratory (NREL). Hydrogen Blending into Natural Gas Pipeline Infrastructure: Review of the State of Technology. https://www.nrel.gov/docs/fy23osti/81704.pdf

[14] Dominion Energy Utah. (2021, January 28). Dominion Energy Utah Starts Hydrogen Blending. PR Newswire. Retrieved from https://www.prnewswire.com/news-releases/dominion-energy-utah-starts-hydrogen-blending-301788625.html

blending demonstration in which they found that UCI's gas turbine can safely handle natural gas mixtures with up to 3.8% hydrogen by volume with no discernible impacts on operations or emissions.[15]

Hydrogen blending has also been studied empirically here in California. Recently, a study sponsored by the California Public Utilities Commission assessed the safety and operational concerns of injecting hydrogen into the existing natural gas pipeline system at various percentages, in compliance with Senate Bill 1369 and the California Public Utilities Commission (CPUC) Rulemaking 13-02-008. The analysis finds that hydrogen blends can be safely injected in the existing natural gas grid at blend fractions at or below 5% by volume and recommended that further assessments be undertaken the safety and feasibility of blends above 5%.[16]

International Blending Testing Success

Internationally, blending projects have also been successful. One of the most notable projects is the HyDeploy[17] project in the UK (conducted by Keele University), which successfully blended 20% by volume with natural gas in a pilot between 2019 and 2021.[18] After extensive laboratory testing and piloting on the effects of hydrogen blends in home appliances, businesses, and existing gas infrastructure, the results of the pilot concluded that a hydrogen blend of 20% by volume did not negatively impact the network pipes, boilers, hobs, cookers, or meters in this study.

Due to the success at Keele University, a more extensive project was deployed in Winlaton, Gateshead, in 2021 over the course of ten months.[19] This project powered over 668 homes, a school, businesses, and a church with a 20% hydrogen blend by volume, all while the Health and

[15] Topolski, K., Reznicek, E. P., Erdener, B. C., San Marchi, C. W., Ronevich, J. A., Fring, L., Simmons, K., Guerra Fernandez, O. J., Hodge, B.-M., & Chung, M. (2022, October). Hydrogen Blending into Natural Gas Pipeline Infrastructure: Review of the State of Technology.

[16] Miroslav Penchev, Taehoon Lim, Michael Todd, Oren Lever, Ernest Lever, Suveen Mathaudhu, Alfredo Martinez-Morales, and Arun S.K. Raju*. 2022. Hydrogen Blending Impacts Study Final Report. Agreement Number: 19NS1662.

[17] https://hydeploy.co.uk/about/news/first-uk-trial-of-hydrogen-blended-gas-hailed-a-success/

[18] Keele University. HyDeploy. Available at: https://www.keele.ac.uk/sustainablefutures/ourchallengethemes/providingcleanenergyreducingcarbonemissions/hydeploy/

[19] HyDeploy. Winlaton Trial. Available at: https://hydeploy.co.uk/project-phases/.

Green Hydrogen Coalition

Safety Executive ("UK") checked for health and safety issues. The results of this project were also successful, illustrating the safety of blending hydrogen at 20% by volume and its subsequent use by many downstream appliances and applications.

Additionally, Energinet,[20] the Danish national transmission operator for electricity and natural gas, completed a successful study in February 2022. This study demonstrated a long-term test of 12% hydrogen blends, and a short-term test of 14%. No leakage of hydrogen was detected throughout the testing period.[21] Energinet is now expanding its testing protocol to increase the hydrogen blend to 25% in a closed-loop system.

As noted in the above development, research, and deployments from around the world, hydrogen blending can be safely tested. Therefore, the concerns outlined in this Resolution regarding the safety and health risks associated with hydrogen blending testing are largely unfounded.

3. ***Green hydrogen is synergistic with electrification and supports healthy communities***

In California, we have set ambitious targets for economy-wide decarbonization while recognizing there are many 'hard to electrify sectors' (e.g., heavy-duty trucking, maritime shipping, and aviation). Today, many of these sectors rely on the dirtiest fossil fuels, such as diesel and bunker fuel, which leads to disastrous health consequences for nearby communities. Where electrification is difficult, green hydrogen offers the opportunity to capture renewable electricity to create a zero-carbon fuel, enabling economy-wide decarbonization and pollution reduction. Converting our abundant, low-cost renewable electricity into green hydrogen and using gas pipelines to store and transport this green hydrogen effectively enables us to electrify and decarbonize some portion of our gas system immediately. **Even a modest 5% green hydrogen**

[20] https://en.energinet.dk/
[21] https://www.gie.eu/m-r-helle-hydrogen-injection/

blend in California's natural gas system would be the equivalent of removing more than 384,000 cars off the road every year from carbon emissions standpoint.[22,23]

The ability to utilize our gas pipeline system to deliver green hydrogen very inexpensively will accelerate the adoption of green hydrogen as an alternative to diesel and bunker fuel, which will have profound air quality benefits, especially for communities of concern near ports, airports, and along major transit corridors.

4. ***Leveraging existing infrastructure is fiscally responsible and essential to an affordable energy transition***

For long-term decarbonization efforts to be both robust and sustainable in California, it is important to ensure that they can be implemented in the current economy. As California faces ongoing budget deficits,[24] hydrogen blending offers a potential pathway to begin reducing emissions while utilizing existing large-scale infrastructure. By incorporating modest amounts of green hydrogen into the existing natural gas infrastructure, minimal new capital investments are required (as opposed to building new renewable infrastructure from scratch). The GHC believes this can help reduce the capital expenditure required to begin our transition to a low-carbon economy, making it a more financially feasible near-term solution. Additionally, the use of blending in the near term establishes a clearer pathway to achieving 100% green hydrogen pipeline transport systems because it enables an immediate, much lower cost transport solution than

[22] California Energy Commission. Available at https://www.eia.gov/state/print.php?sid=CA ; U.S. Environmental Protection Agency. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

[23] Calculations:

- 2billion MMBTu X 0.53 kg CO2/MMBTU = 106 million kg of CO2 per year
- If we were to replace 5% of natural gas with hydrogen (by volume) then we can only achieve 1.67% CO2 savings because H2 is 1.67% of natural gas by energy. We still have to deliver same amount of energy in the pipeline. Although hydrogen is more energy dense than natural gas, it is less energy dense by volume. Hydrogen is 1/3 as energy dense by volume as natural gas.
- 106 million kg CO2 X 1.67% (H2 is 1/3 as energy dense as natural gas) = 1.77 million kg CO2 saved per year by a 5% hydrogen by volume injection standard.
- 1.77 million kg CO2/4.6 metric tons per car = 384,782 cars

[24] The 2023-24 Budget Multiyear Assessment. Available at: https://lao.ca.gov/Publications/Report/4687#top

trucking. As the state continues to tackle climate change, this approach could prove to be an essential piece of the puzzle in achieving a more sustainable and prosperous future.

5. <u>Conclusion</u>

The GHC appreciates this opportunity to respond and respectfully urges the City Council of Irvine to reconsider its opposition to hydrogen blending at the University of California, Irvine. Green hydrogen that is produced and transported at scale will prove to be a crucial component in California's effort to achieve its ambitious climate goals and end our dependence on fossil fuels economy wide.

Blocking important research projects that are needed to demonstrate safety and efficacy – like the one envisioned at the University of California, Irvine – will only serve to perpetuate our reliance on fossil fuels and hinder progress toward a sustainable future. By thinking strategically about climate change progress, which includes hydrogen blending as a critical step to get our green hydrogen economy started, the City of Irvine can join progressive clean energy thought leaders around the world to help lead our transition away from fossil fuels and to a cleaner healthier, more prosperous future for all.

Sincerely,

Janice Lin

Founder and President, Green Hydrogen Coalition

Nick Connell

Interim Executive Director, Green Hydrogen Coalition

Appendix: Additional blending projects across the globe

- The Wind to Gas Brunsbüttel project in Germany, which injects up to 2 volume percentage of hydrogen into a natural gas distribution grid and supplies a hydrogen fueling station.[25]

- The Wind2Gas Energy Inaugurates Electrolyzer in The Thüga plant project, which injects up to 2 vol% hydrogen into a natural gas distribution network.[26]

- In Australia, the Hydrogen Park SA project aims to inject up to 5 vol% hydrogen into a natural gas distribution network that will serve 710 properties, with the first hydrogen production and injection expected in mid-2020.[27]

- Snam's pilot in Italy injects 10 vol% hydrogen into a natural gas transmission system that supplies two industrial customers, a water bottling plant, and a pasta factory.[28]

- The Energiepark Mainz project in Germany injects up to 15 vol% hydrogen into a natural gas distribution network,[29]

- The ENGIE GRHYD project in France plans to inject up to 20 vol% hydrogen into a natural gas distribution network serving 100 households and a boiler for a health center.[30]

- The E.ON/Avacon Netz's pilot in Germany plans to inject up to 20 vol% into a natural gas distribution network.[31]

- In Canada, hydrogen was blended into Fort Saskatchewan's natural gas distribution system at 5% by ATCO.[32] Additionally, an Ontario pilot blending project was announced in 2022 by Enbridge Gas Inc., with Cummins Inc. (NYSE: CMI), Sustainable Development Technology Canada (SDTC), the Canadian Gas Association (CGA) and NGIF Capital

---

[25] FuelCellsWorks. Wind2Gas Energy Inaugurates Electrolyzer in Brunsbüttel: More Green Hydrogen for Customers of Greenpeace Energy. Available at: https://fuelcellsworks.com/news/wind2gas-energyinaugurates-electrolyzer-in-brunsbuttel-more-green-hydrogen-for-customers-of-greenpeace-energy

[26] Thüga. Thüga-Gruppe: Bundesweit erste Einspeisung von Wasserstoff in Gasverteilnetz. Available at: https://www.thuega.de/pressemitteilungen/thuega-gruppe-bundesweit-erste-einspeisung-von-wasserstoffin gasverteilnetz/

[27] Australian Gas Networks. About the project. Available at: http://blendedgas.agn.com.au/about-theproject

[28] Snam. Snam: Hydrogen blend doubled to 10% in Contursi trial. Available at: https://www.snam.it/en/Media/news_events/2020/Snam_hydrogen_blend_doubled_in_Contursi_trial.html

[29] Energiepark Mainz. Technical Data. Available at: https://www.energieparkmainz.de/en/technology/technical-data

[30] 13 ENGIE. Partners in the GRHYD project inaugurate France's first Power-to-Gas demonstrator. Available at: https://www.engie.com/en/journalists/press-releases/grhyd-inaugurate-frances-first-power-to-gasdemonstrato

[31] 5 E.ON. Hydrogen levels in German gas distribution system to be raised to 20 percent for the first time. Available at: https://www.eon.com/en/about-us/media/press-release/2019/hydrogen-levels-in-german-gasdistribution-system-to-be-raised-to-20-percent-for-the-first-time.html

[32] ATCO. Fort Saskatchewan's Hydrogen Blending Project. Available at: https://gas.atco.com/content/dam/web/projects/projects-overview/fort-sask-hydrogen-blending-info-sheet-june2022.pdf

Corporation.[33] This project served 3,600 customers in Ontario and is estimated to eliminate up to 117 tons of carbon dioxide (CO2) emissions annually.

[33] Enbridge Gas. Enbridge Gas announces the launch of the first-of-its-kind hydrogen-blending project in North America. Available at: https://www.enbridgegas.com/about-enbridge-gas/newsroom/newsdetail?releaseId=122757