This document has been prepared as part of the implementation project of Legal Pathways to Deep Decarbonization (Michael B. Gerrard and John C. Dernbach, eds. Environmental Law Institute [2019]) (LPDD). For background information on the project, see https://lpdd.org

Explanatory Memorandum: Federal Tax Credit for Hydrogen Fueling Equipment

There is a strong consensus in the scientific community that profound changes are occurring in the world's climate; that these changes are due in large measure to human activities; and that the consequences of unchecked climate change pose grave risks to the environment, human health and socioeconomic stability. *See, e.g., "Climate Science Special Report, Fourth National Climate Assessment," (the "National Climate Assessment")* which was released by the federal government on November 17, 2017 ("Earth's climate is now changing faster than at any time in the history of modern civilization, primarily as a result of human activities.")[1] The symptoms of climate change are now readily apparent: average global temperatures are increasing inexorably, sea levels are rising measurably, glaciers are retreating, arctic sea ice is disappearing, ocean waters are warming, permafrost is thawing, record droughts are occurring, wildfires are becoming more intense and storms are becoming more severe."[2]

The U.S. is not immune to such impacts. Recent years have seen record wildfires break out in the west, unprecedented flooding in the mid-west and devastating storms along our coasts. Over the longer term, reports published by NASA, Columbia University, and Cornell scientists in 2015[3] and 2016[4] predict that "megadroughts" (i.e., droughts of the depression-era "dust bowl" magnitude, but lasting for decades) "could become commonplace" in the southwest and U.S. plain states "if climate change goes unabated." *Id.* at 6. It is predictions such as these that have led the 2019 report of the World Economic Forum to identify the "failure of climate change mitigation and adaptation" to be one of the *top risks* facing society – ahead of weapons of mass destruction, cyber-attacks, terrorism and the increasing scarcity of potable water.[5]

The December 12, 2015 Paris Agreement aims to avoid the worst impacts of climate change by holding the increase in average global temperatures to "well below 2°C above pre-industrial levels" with efforts "to limit the temperature increase to 1.5°C above pre-industrial levels."[6] Achieving these goals will be a daunting task, requiring that greenhouse gas emissions from industrial countries like

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1 U.S Global Change Research Program, *Fourth National Climate Assessment*, p.34. https://www.globalchange.gov/browse/reports/climate-science-special-report-fourth-national-climate-assessment-nca4-volume-i

2 Id. at 37.

3 Benjamin I. Cook, Toby Ault, & Jason Smerdon, *"Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains States,"* SCIENCE ADVANCES (Feb. 12, 2015), http://advances.sciencemag.org/content/1/1/e1400082.

4 Toby Ault, Justin S. Mankin, Benjamin I. Cook & Jason E. Smerdon, *"Relative Impacts of Mitigation, Temperature, and Precipitation on 21st-Century Megadrought Risk in the American Southwest,"* SCIENCE ADVANCES (Oct. 5, 2016), http://advances.sciencemag.org/content/2/10/e1600873.

5 *The Global Risks Report 2019*, Part I, WORLD ECON. FORUM, https://www.weforum.org/reports/the-global-risks-report-2019

6 *Id.* The NASA Study indicates that the risks of a megadrought occurring in the Western U.S. drop sharply – to a range from 30-60 percent in a 2°C warming scenario. *See, e.g.,* https://www.ecowatch.com/megadroughts-2031955357.html.

the U.S. be reduced by about 80 percent by 2050. Reductions of this magnitude will take a colossal effort by virtually all levels of government in the U.S. and all sectors of the economy.

A book published by the Environmental Law Institute, entitled *Legal Pathways to Deep Decarbonization in the United States* (Michael Gerrard & John Dernbach, Eds., ELI 2019) ("LPDD"), has identified more than 1000 legal strategies that can be taken to achieve dramatic greenhouse gas emission reductions in the United States. Many of those pathways are focused on shifting transportation fuel sources in the U.S. away from fossil fuels, at a level that would result in the deployment of approximately 300 million alternative fuel vehicles – particularly electric vehicles ("EVs"), plug-in hybrid electric vehicles ("PHEVs") and hydrogen fuel cell vehicles ("HFCVs").

While it is true that production of hydrogen fuel is currently carbon intensive as it relies on fossil fuels, hydrogen will most likely be produced with increasing amounts of energy derived from renewable sources like wind power and solar energy and thereby become a clean fuel in a full-life cycle analysis. "Additionally although the EVs emit less air and GHG pollutants, a full life-cycle analysis indicates that they may emit more toxins over their lifetime [than internal combustion vehicles] because of pollutants associated with lithium mining and disposal." LPDD at 364, n. 149.

According to LPDD, "[o]ne of the most important steps to promote a low-carbon [light duty vehicle] fleet is to develop alternative vehicle infrastructure." LPDD at 367, n. 190-191. Providing such infrastructure has proven to be challenging, and particular challenges exist with respect to the development of the refueling stations that would be needed to service a large fleet of HFCVs. Currently, the only public hydrogen fueling stations in the U.S. are in California, and even there the stations tend to be confined to the Bay Area and the Los Angeles basin.

The "lack of infrastructure for out-of-state travel" is a major impediment to the adoption of HFCVs. *Id.* at 370, n. 238. According to the U.S. Department of Energy ("DOE"), "[t]he availability of stations providing reasonably priced hydrogen in places where vehicles will be deployed remains a key challenge to the adoption of this technology." (See afdc.gov/fuels/hydrogen_infrastructure.html). More generally, in a report for the G20 2019 Summit in Japan, The Future of Hydrogen, the International Energy Association ("IEA"), the world's leading energy authority covering all fuels and energy technologies, found that "[i]n the case of hydrogen use for road transport, where a network of refueling stations will be a precondition for widespread adoption of [fuel cell electric vehicles, the current pace of infrastructure development is a brake on adoption." IEA report at 28. Thus, "an important pathway for reducing carbon emissions from light duty vehicles aims to increase the number of hydrogen fueling stations." LPDD at 371.

A major obstacle to the development of such infrastructure is the enormous capital investment required to construct and equip a hydrogen refueling station. One state, California "has invested nearly $120 million since 2010 to fund hydrogen refueling stations to support the fuel cell electric vehicle market," and it will continue to allocate $20 million per year until there are at least 100 public stations,

per the requirements of Assembly Bill 8.[7] Jean Baronas, Gerhard Achtelik, et al. 2019. *Joint Agency Staff Report on Assembly Bill 8: 2019 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*, California Energy Commission and California Air Resources Board; Publication Number: CEC 600-2019-039 ("CEC 2019"), at 8. As of December 27, 2019, California had 43 open retail hydrogen refueling stations, with another 20 stations in development. CEC 2019 at iii. All but one of these stations received capital expense grants or contracts from either the California Energy Commission or the California Air Resources Board. CEC 2019 at 8.

The costs of building a station in California have been benchmarked at approximately $2.8 million for stations with an approximate 450 kg/day capacity. M. Melaina and M. Penev, *Hydrogen Station Cost Estimates*, *Comparing Hydrogen Station Cost Calculator Estimates with other Recent Estimates*, National Renewable Energy Laboratory Tech Report NREL/TP-5400-56412, Sept. 2013. *See also* Jean Baronas, Gerhard Achtelik, et al. 2018, *Joint Agency Staff Report on Assembly Bill 8: 2018 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*, California Energy Commission and California Air Resources Board Publication Number: CEC 600-2018-0008, at 74 (estimating the capital cost for a 400 kg station to be $3.0 million.) Due to such costs, recent studies suggest that launching hydrogen refueling infrastructure on a *national* scale sufficient to foster substantial increased manufacturing and sales of fuel cell electric vehicles will likely take at least ten years and cost "tens of billions of dollars." Joan M. Ogden, *Prospects for Hydrogen in the Future Energy System*, March 2018, UC Davis Institute of Transportation Studies, Research Report--UCD--ITS-RR-18-07 at 9.)

The proposed statute would provide financial assistance for the development of hydrogen refueling infrastructure in the U.S. by creating a tax credit equal to 30 percent of the capital costs of stationary hydrogen refueling infrastructure equipment, including the equipment itself and any shipping, installation, commissioning, or other standard service costs included by the equipment supplier in the purchase of the equipment. The credit would be available for tax years beginning after December 31, 2020, and remain available for a period of ten years, expiring on December 31, 2030.

[7] California's Fuel Cell Partnership has set a target for 1,000 hydrogen refueling stations by 2030, to support the use of 1,000,000 FCEVs (fuel cell electric vehicles). IEA report at 22.