SENATE COMMITTEE ON ENVIRONMENTAL QUALITY
Senator Allen, Chair
2021 - 2022 Regular

Bill No:	SB 18		
Author:	Skinner		
Version:	3/23/2021	**Hearing Date:**	4/29/21
Urgency:	No	**Fiscal:**	Yes
Consultant:	Eric Walters		

SUBJECT: Green hydrogen

DIGEST: Establishes a definition for green hydrogen, requires the California Air Resources Board (ARB) to include a strategic plan for green hydrogen in the next Scoping Plan update, requires the California Public Utilities Commission (CPUC) to consider green hydrogen in resource adequacy requirements, and requires the California Energy Commission (CEC) to submit a report to the Legislature on the uses of green hydrogen for transportation and energy decarbonization. Directs ARB, CPUC, and CEC to consider green hydrogen as a zero-carbon resource for electric utility procurement plans if its production meets specified criteria.

ANALYSIS:

Existing law:

1) Requires ARB to create a Climate Change Scoping Plan to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas (GHG) emissions from sources or categories of sources of GHG by 2020. The plan must identify and recommend direct GHG emissions reduction measures, alternative compliance mechanisms, market-based compliance mechanisms, and potential monetary and non-monetary incentives that the state board finds are necessary or desirable to meet the 2020 emissions reduction goals. ARB must update this scoping plan at least once every five years through a public workshop process. (Health and Safety Code (HSC) §38561)

2) Establishes the integrated resource plan (IRP) process for load-serving entities (LSEs) to file plans with the CPUC detailing the resources that the LSE will use to meet the state's climate goals while ensuring reliability at just and reasonable rates. Existing law specifies the requirements for the IRP process and specifies that for any additional procurements authorized through an IRP or procurement process, the CPUC must ensure that costs are allocated in a fair and equitable manner with no cost-shifting among LSE customers. (Public Utilities Code (PUC) §454.52)

3) Establishes a Renewables Portfolio Standard (RPS) requiring certain percentages of electricity retail sales be served by renewable resources, most recently increased by SB 100 (De Leon, 2018) to 60% by 2030 and a state goal of procuring 100 percent of electricity from eligible renewable energy resources and zero-carbon resources by December 31, 2045. Existing law requires state agencies, including the CPUC, CEC, and ARB, to take certain actions to support the state's clean energy goals. (PUC §454.53)

4) Requires the CPUC, CEC and CARB to consider green electrolytic hydrogen an eligible form of energy storage and consider its potential uses. (PUC §400.3)

5) Requires the CPUC to identify a diverse portfolio of resources needed to ensure reliability and integrate renewable energy resources in a cost-effective manner. The CPUC must direct each electrical corporation to develop a strategy for procuring best-fit and least-cost resources to satisfy the portfolio identified by the CPUC. (PUC §454.51)

6) Defines "green electrolytic hydrogen" as hydrogen gas produced through electrolysis and does not include hydrogen gas manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock. (PUC §400.2)

This bill:

1) Makes numerous findings and declarations, including but not limited to:
   a) The actions and intentions of the state on reducing pollutants released from the burning and decay of organic waste.
   b) The disproportionate impacts of diesel emissions on low income communities.
   c) The promise of renewable hydrogen, specifically that produced through electrolysis, for reducing both of the above, as well as advancing the state's climate and carbon neutrality goals.

2) Requires ARB to include the following in the 2022 Scoping Plan Update:
   a) A strategic plan for accelerating the production and use of hydrogen, including, but not limited to, a specific plan to accelerate green hydrogen, an assessment of difficult to decarbonize sectors, a review of similar efforts internationally, recommendations to the legislature, and a strategic plan for supporting hydrogen infrastructure.
   b) An analysis of how curtailed power could advance the above considerations by being used to produce hydrogen.

c) The input of the Labor and Workforce Development Board, and other labor organizations, on labor needs associated with hydrogen infrastructure.

3) Requires CEC to include an analysis of the potential growth and role of various types of hydrogen in its next update of the Integrated Energy Policy Report.

4) Requires CPUC to modify the resource adequacy requirements to provide equal consideration of green hydrogen resources, unless insufficient information to make such a consideration possible.

5) Requires CPUC to consider electrolytic hydrogen, as part of a rulemaking proceeding on energy storage and to encourage portfolio diversity.

6) Defines "green hydrogen" as "hydrogen gas that is not produced from fossil fuel feedstock sources and does not produce incremental carbon emissions during its primary production process."

7) Requires ARB, CEC, and CPUC to, in addition to considering green electrolytic hydrogen as an eligible form of energy storage, must also :

a) Consider green hydrogen and green electrolytic hydrogen as zero carbon-emitting resources pursuant to PUC §454.51 and §454.53,
b) Work to include green hydrogen in the IRP, and
c) Consider other potential uses of green hydrogen in all their decarbonization strategies.

Background

1) *How we make hydrogen*. Hydrogen can be produced using a number of different processes. Thermochemical processes use heat and chemical reactions to release hydrogen from organic materials such as fossil fuels and biomass. Water (H2O) can be split into hydrogen (H2) and oxygen (O2) using electrolysis or solar energy. Microorganisms such as bacteria and algae can produce hydrogen through biological processes.

Some notable methods to produce hydrogen include:
a) Natural Gas Reforming/Gasification: Synthesis gas, a mixture of hydrogen, carbon monoxide, and a small amount of carbon dioxide, is created by reacting natural gas with high-temperature steam. The carbon monoxide is reacted with water to produce additional hydrogen. This method is the cheapest, most efficient, and most common. Natural gas reforming using steam accounts for the majority of hydrogen produced in the United States

annually.

A synthesis gas can also be created by reacting coal or biomass with high-temperature steam and oxygen in a pressurized gasifier, which is converted into gaseous components—a process called gasification. The resulting synthesis gas contains hydrogen and carbon monoxide, which is reacted with steam to separate the hydrogen.

b) Electrolysis: An electric current splits water into hydrogen and oxygen. If the electricity is produced by renewable sources, such as solar or wind, the resulting hydrogen will be considered renewable as well, and has numerous emissions benefits. Power-to-hydrogen projects are taking off, where excess renewable electricity, when available, is used to make hydrogen through electrolysis.

c) Renewable Liquid Reforming: Liquids derived from biomass resources—including ethanol and bio-oils—can be reformed to produce hydrogen in a process similar to natural gas reforming. Biomass-derived liquids can be transported more easily than their biomass feedstocks.

2) *How we (can) use hydrogen*. Hydrogen can be used in fuel cells to generate power using a chemical reaction rather than combustion, producing only water and heat as byproducts. It can be used in cars, in houses, for portable power, and in many more applications. In practice today, almost all of the hydrogen produced in the United States is used for refining petroleum, treating metals, producing fertilizer, and processing foods.

There has been particular focus on hydrogen in the context of deep decarbonization scenarios. Hydrogen has significant, sector-spanning potential as a carbon-free fuel that can be used in many otherwise-hard-to-decarbonize applications where fossil fuels have long been considered required. It is particularly appealing in high-heat industrial settings, for long-range transportation where batteries may be prohibitively expensive or bulky, and for materials production such as cement and steel.

One promising application of hydrogen is as a way to firm our renewable-rich energy grid. By using low-cost, abundant, electricity from intermittent renewables during the day to produce hydrogen, and then using that hydrogen in fuel cells to provide power at other times, hydrogen can act as a chemical form of storage for low- or zero-carbon electricity. However, in practice, electrolyzer technology is still prohibitively expensive and unable to economically cycle on and off in line with the availability of intermittent renewables. While technology continues to improve and bring this role closer to a cost-effective reality, experts state it is still likely several years away at least—as are many of hydrogen's most promising applications.

3) *What's the holdup?* The primary challenge for hydrogen production is reducing the cost of production technologies to make the resulting hydrogen cost competitive with conventional fuels.

   In the transportation space, the state has spent more than $300 million dollars in the past 10 years funding rebates for those who buy or lease hydrogen cars, construction of refueling stations and the purchase of transit buses, as well as subsidizing development of hydrogen-driven freight trucks. Almost all of the country's nearly-8,000 hydrogen fuel cell electric vehicles are in California.

   For energy storage applications, where abundant electricity from renewables is stored in the form of fuel cells, electrolyzer technology still needs to advance to make the process economical. Both in terms of upfront and operating costs, it is simply not profitable to install an electrolyzer to only run when abundant electricity from renewables is available.

4) *The many colors of hydrogen*. Perhaps due to the multiplicity of hydrogen production technologies, a simplified parlance arose describing hydrogen with colors. These are neither universally agreed-upon nor rigorous definitions, so interpretations of each can vary depending on the source.

   Gray, blue, and green are the most commonly used colors. Broadly speaking, gray hydrogen is made from fossil fuels through steam methane reforming, blue hydrogen is gray hydrogen with added carbon capture and storage, and green hydrogen is made from electrolysis of water using low-carbon (or zero-carbon) electricity sources.

   However, the spectrum of hydrogen technologies does not stop there. Turquoise hydrogen can refer to a byproduct of methane pyrolysis resulting in solid (instead of gaseous) carbon. Pink hydrogen can refer to electrolytic hydrogen using electricity from nuclear energy. Yellow hydrogen can refer to electrolytic hydrogen using only solar energy, or it can refer to electrolytic hydrogen made using the mixed-resource power of the grid.

   In hydrogen technology, or in any complicated topic, simplified jargon is only as useful as it is accurately understood. For instance, if two parties discussing green hydrogen each had a different definition of "green hydrogen" in mind, and each believed they were in agreement, the use of the term "green hydrogen" would become more of an obstacle than an asset to clear communication.

In the California context, the Legislature has provided some input on defining green hydrogen in the past. Specifically, "Green electrolytic hydrogen" was defined by SB 1369 (Skinner, Chapter 567, Statutes of 2018) as "hydrogen gas produced through electrolysis and does not include hydrogen gas manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock." However, not all electrolytic hydrogen is "green," when you consider the source of the electricity going into it. Moreover, since there is no definition of "green hydrogen" in statute, some sources of hydrogen that use renewable resources and have low associated emissions—but that do not use electrolysis—are summarily excluded under the current definition.

5) *Cleaning up the state's electricity generation.* California's ambitious renewable portfolio standard (RPS) program is jointly implemented and administered by the CPUC and the CEC. The RPS program requires the state's load-serving entities (LSEs) to procure 60 percent of their total electricity retail sales from eligible renewable energy resources by 2030, and a mix of RPS-eligible and zero-carbon resources by December 31, 2045, for a total of 100 percent clean energy.

   The RPS program established very clear definitions of eligible renewable energy resources under the program. The ninth edition of the RPS eligibility guidebook was released by CEC in 2017 and covers specific standards for twelve different electricity sources, including biomass, biomethane, fuel cells using renewable fuel, municipal solid waste, solar, and wind, among others.

Comments

1) *Purpose of Bill.* According to the author, "The most basic element in the universe – hydrogen – may be poised to help California and the world move to a cleaner economy while protecting well-paying jobs for our workers. Green Hydrogen – which can be created using excess renewable electricity from solar and wind, through steam reformation of biogas, and other clean pathways – can be used to decarbonize some of California's most difficult to decarbonize sectors: transportation, long haul trucking, ocean shipping, even air travel. It can also store renewable energy for later use, and power industry or the electrical grid. All while preserving well-paying jobs in traditional industries.

   "SB 18 advances green hydrogen by requiring the CA Air Resources Board (CARB) and other state agencies to start planning so our state can take full advantage of green hydrogen."

2) *Defining "green" hydrogen.* As stated in the background, the existing definition of "green electrolytic hydrogen" in PUC §400.2 is not sufficiently precise or descriptive. While a robust, precise, and universally accepted definition of "green hydrogen" does not exist, it tends to serve as a stand-in more broadly for more renewable, sustainable technologies that advance the state's climate goals.

   Although SB 18 attempts to define "green hydrogen" in statute, it may still be premature to do so without more information about the true environmental impacts and emissions profiles of hydrogen production processes. Many of the technologies that promise "green" hydrogen are not yet commercially viable at scale, making it impossible to accurately assess their claims.

   The committee may wish to remove the proposed definition of "green hydrogen" from SB 18 until more broadly agreed upon criteria can be reached.

   Going forward, the author may further wish to consider if a different approach altogether for defining green hydrogen might be more prudent. For instance, a public process under the auspices of ARB should be considered. Alternatively (or additionally), given the diversity of hydrogen production technologies available and under development, a more technology-neutral approach guided by a quantitative metric (such as carbon intensity) might be more suitable. Although carbon intensity does not necessarily capture the full range of environmental impacts associated with a fuel's production, it does get closer to the full life-cycle understanding needed to comprehensively compare processes.

3) *Air pollution considerations.* Several "support if amended" position letters were submitted to the committee, which shared a concern about some of the technologies included under the definition of "green hydrogen." Specifically, concerned parties referenced the GHG and air pollutant emissions, additionality and deliverability of feedstocks, and other impacts of biomethane and biomass feedstocks.

   The decision of whether or not to call hydrogen produced through these processes "green" does not (and cannot) address these stakeholders' fundamental underlying concern. Is there any level of air pollution that is acceptable for hydrogen production when zero-emission technology does exist? Some of these feedstocks would themselves release methane or other GHGs absent any industrial intervention. And as stated in the background, much of the truly zero-emission hydrogen production technology remains too expensive at many scales. Moreover, any hydrogen production facilities, regardless of technology, would be subject to local air district stationary source regulations. While these facts do support hydrogen production from biomass and biogas sources, the decision to include these technologies in a future definition of "green hydrogen" should be done thoughtfully, and with due consideration of any associated air pollution.

4) *Better understanding green hydrogen*. Green hydrogen has the potential to aid in achieving many of the state's efforts to protect the environment and support economic growth. However, the state cannot commit to large-scale and far-reaching integration of green hydrogen into its emission reduction goals without a thorough understanding of what exactly green hydrogen is and how it can be produced.

   Given the fact that many green hydrogen production technologies are in their infancy and cannot yet be adequately assessed at scale, the committee may wish to remove the provisions of this bill that would automatically include green hydrogen in the RPS, IRP, and Integrated Energy Policy Report.

   There are numerous end uses for hydrogen across the transportation, electricity, and industrial sectors. Hydrogen is limited by competing demands for the clean sources of energy needed to produce it, and the production of hydrogen comes with significant resource trade-offs and efficiency costs. Thus, investments in hydrogen should prioritize applications and use cases without decarbonization alternatives, and this technical process of prioritization may be best left to the experts in the relevant agencies working with comprehensive data on performance and emission profiles.

   Ultimately, before committing to including green hydrogen in the state's decarbonization strategies, we need a robust understanding of what it is and where it can best be used. At this stage, SB 18 should perhaps focus on accomplishing the latter. ARB's scoping plan update can assess which hydrogen technologies may reasonably be expected to deliver tangible emission reduction opportunities in the near future. The CPUC can still consider electrolytic hydrogen as part of future energy storage and resource adequacy procurements, but in so doing must be able to make apples-to-apples comparisons against other energy resources. As the state's understanding and supply of green hydrogen increases, those decisions can be made using the best available science and in line with best industry practices.

Related/Prior Legislation

SB 662 (Archuleta, 2021) requires the CPUC, in collaboration with ARB and CEC, to initiate a proceeding to authorize gas corporations to file applications for investments in programs to accelerate zero-emission vehicle transportation. SB 662 is currently before the Senate Appropriations Committee.

SB 697 (Hueso, 2021) tasks ARB with establishing a Green Hydrogen Credit Program, which would allocate 10 cap-and-trade allowances to an industrial facility for every 1 ton of green hydrogen, as defined, that it produces. SB 697 is currently before the Senate Environmental Quality Committee.

SB 1369 (Skinner, Chapter 567, Statutes of 2018) required the CPUC, CARB, and CEC to consider green electrolytic hydrogen, as defined, an eligible form of energy storage, and consider other potential uses of green electrolytic hydrogen.

SOURCE: author

SUPPORT:

8minute Solar Energy
Advanced Power and Energy Program
Aquahydrex
Brightnight LLC
California Hydrogen Business Council
Center for Transportation and The Environment
City of Pinole
Elders Climate Action Nor Cal and Socal Chapters
Energy Independence Now
Friends Committee on Legislation of California
Green Hydrogen Coalition
Intersect Power
Magnum Development
Marin Clean Energy (MCE)
Mitsubishi Powers Americas
Natural Resources Defense Council
Nikola
Northern California Power Agency
San Diego Gas & Electric
Sempra Energy Utilities
Southern California Gas Company
State Building and Construction Trades Council of CA

OPPOSITION:

350 Humboldt: Grass Roots Climate Action
350 Silicon Valley
California Environmental Justice Alliance (CEJA) Action
Center for Biological Diversity
Leadership Counsel for Justice & Accountability
Sierra Club California

ARGUMENTS IN SUPPORT: According to the Green Hydrogen Coalition, SB 18, "will create pathways for California to meet its critical decarbonization goals by facilitating the production and use of green hydrogen. Advancing planning and deployment of green hydrogen allows California to accelerate its decarbonization targets across the power sector and many hard-to-abate sectors, including industrial end uses, maritime transport, aviation and heavy-duty transportation. Green hydrogen production and use also enables California to take advantage of its abundant wind and solar resources, reduce curtailment, and dispatch renewable energy when it is most needed to support reliability and resiliency. Green hydrogen is a viable and scalable solution to reduce reliance on fossil fuels in the gas sector and transportation sectors and represents a tremendous economic development and export opportunity for California as global demand grows.

ARGUMENTS IN OPPOSITION: According to 350 Humboldt, "the definition of green hydrogen seems to permit burning biomass to create green hydrogen. The last thing we need in the next thirty years is huge amounts of dirty carbon emissions directly into the atmosphere (which is an inevitable consequence of burning biomass for power). It would also be a tragedy if in pursuing green hydrogen we decimated forests, increased harmful salvage logging or in other ways reversed the sequestration of carbon that biomass can provide."

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