The Role Hydrogen Should – and Shouldn't – Play in The Clean Energy Transition

Hydrogen's potential in the clean energy transition is a very popular topic these days, with hydrogen related policy proposals popping up all over the country. Hydrogen has significant, sector-spanning potential – in theory a carbon-free fuel that can be used in otherwise hard-to-decarbonize applications where fossil fuels have long been considered required. But, as always, there's a catch. **This issue brief seeks to help lawmakers better understand the role hydrogen should – and shouldn't – play in the clean energy transition,** building a framework for evaluating hydrogen legislative proposals.

Hydrogen Rainbow

Hydrogen (H) is the most abundant element on earth. In its gas-phase (H_2), it is an energy-dense gas that can be combusted to produce energy. Unlike methane, which produces greenhouse gas (GHG) emissions when burned, burning pure hydrogen has no associated GHG emissions. Unfortunately, hydrogen rarely occurs naturally in its gaseous phase. In order to harvest H_2 for fuel, it is extracted from other resources, such as methane and water. This process is extremely energy intensive. Based upon the raw material processed & source of energy utilized to create hydrogen gas, there is a rainbow of options.

- **Green**
  - Hydrogen sourced from electrolysis of water using renewable energy.
- **Gray**
  - Hydrogen sourced from processing natural gas with water in steam form, resulting in CO_2 emissions. This type makes up the vast majority of currently produced hydrogen.
- **Blue**
  - The same as Gray hydrogen, but with carbon capture and storage. Studies show that CO_2 emissions from Blue hydrogen are only 9-12% less than Gray. [1]

[1] *https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956*

- **Brown/Black**
  - Processed from fossil fuels like coal. Not as relevant moving forward into energy transition but is currently commonly used.
- **Pink**
  - Electrolysis of water using nuclear energy
- **Turquoise**
  - An unproven method of processing methane in a way that the carbon released is in solid form
- **White**
  - Hydrogen that occurs naturally underground and is released with fracking but we have no way to harvest at present
- **Yellow**
  - Electrolysis of water using solar power, simply a subsect of Green.

Today, about 95% of hydrogen comes from steam reforming of natural gas, which contributes to greenhouse gas emissions. Any role hydrogen technology plays in the clean energy transition must instead use green hydrogen. Some "colors" of hydrogen, such as green, pink, and yellow are clean options because they do not emit greenhouse gasses during the extraction process, while others such as gray, blue, and black/brown are greenhouse gas emitting and therefore not viable options. **While green hydrogen may play a role in difficult-to-decarbonize sectors, it is important to understand where it should and should not be implemented.**

CLIMATE CABINET EDUCATION

Electricity Generation

Because creating the gas form of hydrogen is so energy intensive, **hydrogen – including green hydrogen – should not be used for electricity generation**.

- Electrolysis, powered by renewable sources like solar and wind, is extremely energy intensive, rendering it largely inefficient today.
- Throughout the processes, around 60-70% of the original energy is lost.
- Because of this, green hydrogen is not an optimal electricity source. Using green hydrogen for electricity generation is duplicative and wasteful, as the sources of its production (solar, wind, etc.) and battery storage are far more energy efficient and cost effective.

Homes and Buildings

Hydrogen should not be used in homes or buildings because it is a major safety risk. **Electrification is the only viable option for home and building decarbonization.**

- Hydrogen molecules are much smaller than methane gas molecules, meaning the existing pipeline infrastructure is unsafe.
- Hydrogen is highly combustible and has no compatible odorants, rendering any leaks undetectable by humans.
- While hydrogen can be blended with methane gas, the emissions reductions are minor, while drastically increasing air pollution. Using hydrogen is significantly more expensive than using methane gas in buildings, which is already more expensive than electric heating.

Manufacturing Feedstock

While hydrogen is not a solution for electricity generation, or for energy in homes and buildings, **green hydrogen has the potential to be used as an industrial feedstock** because of its effectiveness at producing heat. However, using green hydrogen in this manner would redirect existing clean energy resources currently supporting the electrical grid.

- Because there is not yet a surplus of clean energy powering the grid, prematurely using green hydrogen for feedstock may be an inefficient use of resources.
- Lawmakers should proceed with extreme caution when considering policy proposals of this nature.

Energy Storage

Another possible use of green hydrogen is in energy storage. Hydrogen energy storage is another form of chemical energy storage in which electrical power is converted into hydrogen.

- Similar in concept to battery energy storage, helping offset peak electricity demand charges by storing and supplying unused energy as necessary. However, significant challenges exist.
- High density hydrogen storage remains a significant challenge. Presently available storage options typically require large-volume systems that store hydrogen in gaseous form.
- Currently unproven on an industrial scale.