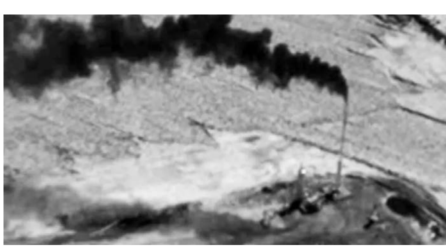
Climate impacts of hydrogen systems

Although hydrogen is widely considered a climate “solution,” it creates several climate challenges depending on how it is produced, managed, and used. Fortunately, there are actions we can take to maximize the climate benefits of hydrogen by ensuring it is deployed strategically and effectively.

	Challenges	Recommendations
Production	99% of current hydrogen production produces **high carbon** emissions. The climate benefits of “blue” hydrogen can be undermined by **upstream methane leaks** and **insufficient carbon capture and storage**. “Green” hydrogen may **displace renewable capacity** that could be more efficiently used for direct electrification.	Prioritize **decarbonizing existing** production. Require upstream gas to be produced with **methane emissions below 0.2**%. Require **carbon** capture technologydesigned to achieve at least **95% efficiency** and credibly demonstrated long-term storage Renewable electricity used to produce green hydrogen should be **additional**, not pulling renewables away from the grid.
Management	Hydrogen is a **small, leak-prone molecule** that when purged/vented/leaked can cause potent near-term warming by increasing amounts of short-lived GHGs in the atmosphere through chemical reactions. Total hydrogen emissions from current systems are **unknown** – the technology capable of measuring small leaks isn’t yet commercially available (monitoring for safety isn’t sufficient). Depending on how much hydrogen is emitted, anticipated climate benefits can be **severely undercut** in the near-term.	R&D for **sensor equipment** capable of detecting leaks at low levels (e.g. 10 ppb) & fast response times (e.g. every sec). **Testing** new technology and **participating** in measurement campaigns. Conduct research to identify leakage mitigation measures and **best practices.** Require companies to incorporate plans for **Monitoring, Reporting and Verification and Leak Detection and Repair** programs early in their project design. Incorporate hydrogen emissions into **Life Cycle Assessments** and consider GHG impacts over all timescales, not just 100y.
Usage	Many uses of hydrogen have more energy efficient and cleaner **alternatives**. Using electricity directly vs. using it to produce hydrogen can provide heat for up to **16x** more homes and power up to **9x** more vehicles. Deployment of hydrogen can significantly delay when we can meet economy-wide clean energy and climate goals.	Incorporate **risks** of hydrogen leakage and energy intensity considerations indecisions and guidance about where/how to deploy hydrogen and associated incentives. Improve **Life Cycle Assessment** comparisons to direct electrification alterna-tives by including climate impacts of hydrogen and methane emissions over multiple timescales.

Drivers of blue hydrogen intensity



Oil and gas methane emissions (CH_4)

Leakage varies 1-5% across supply chain and over different regions.

Carbon capture and storage (CO_2)

Capture technologies for permanently storing carbon dioxide vary between 60-95%.

Hydrogen leakage (H_2)

No one knows how much hydrogen escapes but estimates range between 1-10%.