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Maximizing the Climate Benefits of Hydrogen

Thursday, June 01, 2023

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Non-partisan Educational Resources for Policymakers

A bipartisan Congressional caucus founded EESI in 1984 to provide non-partisan information on environmental, energy, and climate policies

Direct Assistance for Equitable and Inclusive Financing Program

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop "on-bill financing" programs

Commitment to Diversity, Equity, Inclusion, and Justice

We recognize that systemic barriers impede fair environmental, energy, and climate policies and limit the full participation of Black, Indigenous, people of color, and legacy and frontline communities in decision-making

Sustainable Solutions

Our mission is to advance science-based solutions for climate change, energy, and environmental challenges in order to achieve *our vision of a sustainable, resilient, and equitable world*.

Policymaker Education

Briefings and Webcasts

Live, in-person and online public briefings, archived webcasts, and written summaries

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Bi-weekly newsletter with everything policymakers and concerned citizens need to know, including a legislation and hearings tracker

Fact Sheets and Issue Briefs

Timely, objective coverage of environmental, clean energy, and climate change topics

Social Media (@EESIOnline)

Active engagement on Twitter, Facebook, LinkedIn, and YouTube

Implementing the 45V Clean Hydrogen Tax Credits

Stakes, Risks and Solutions

Rachel Fakhry

Policy Director for Emerging Technologies, NRDC

Key Points

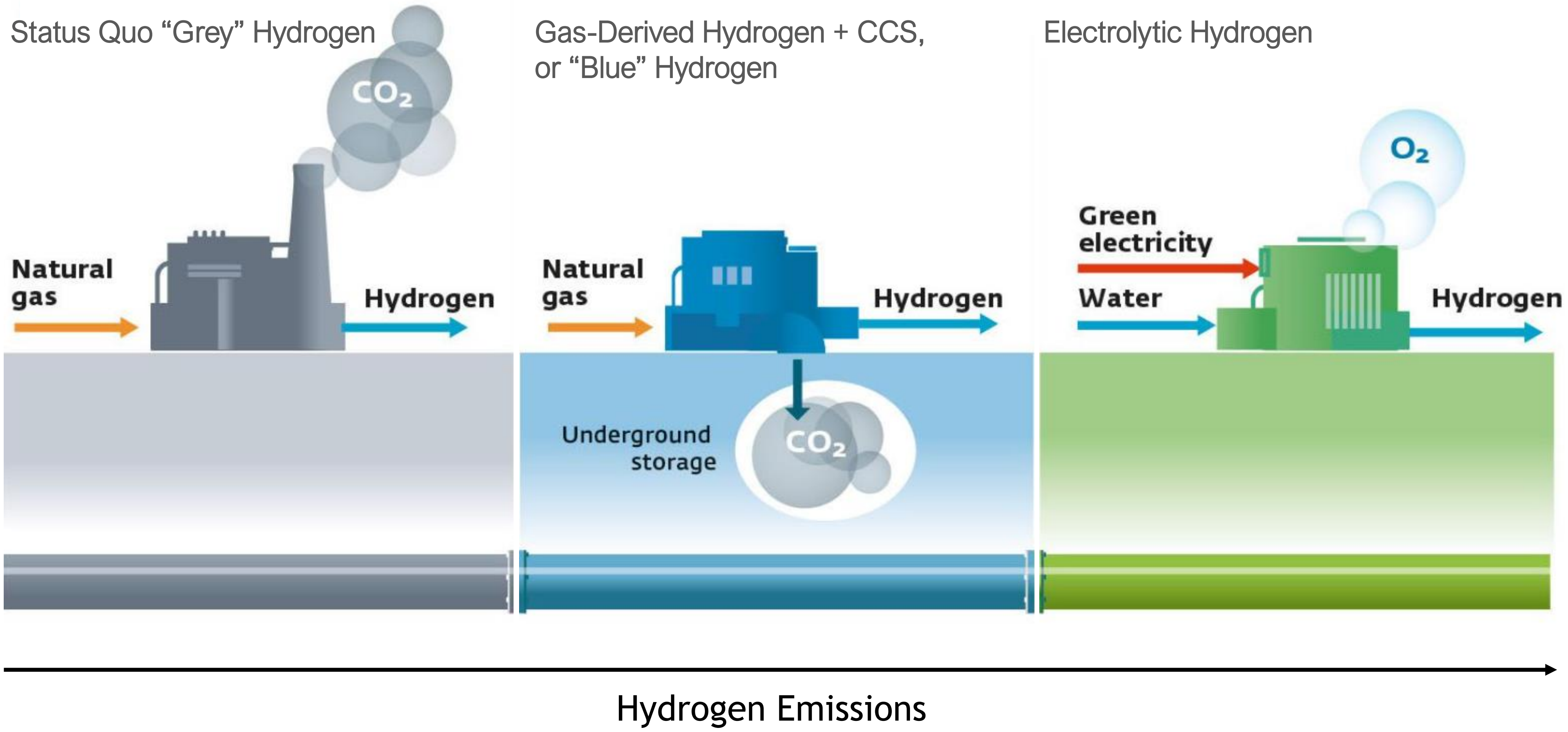
- High stakes: billions of $$ and potential hundreds of tons of carbon emissions
- It all hinges on the Biden administration
- Rigorous guardrails are necessary in the form of the three pillars – new clean supply, hourly matching, deliverability

The three pillars:

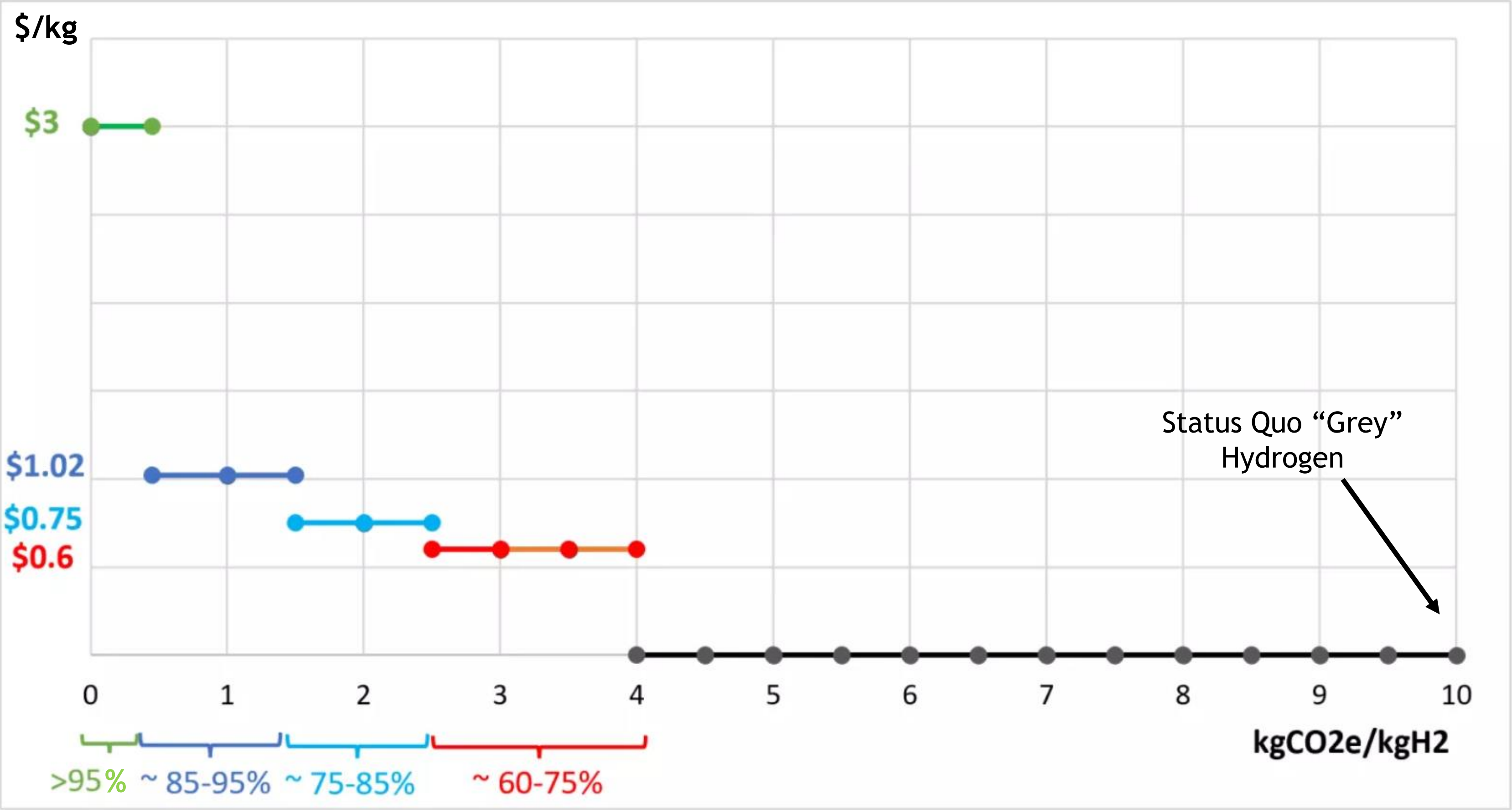
- Are necessary to prevent significant emissions increases and meet the IRA's requirements
- Will support robust industry growth
- Require simple reporting

CONTEXT SETTING

Hydrogen production sources



What is the 45V clean hydrogen tax credit?



Production tax credit in $ per kilogram of hydrogen produced ($/kg) relative to the carbon intensity of the produced hydrogen in kilograms of carbon dioxide equivalent per kilogram of hydrogen (kgCO2e/kgH2).

45V is a substantial and long-lived subsidy

- More than $100B over its lifetime
- AES/Air Products project in Texas: $3 Billions in subsidies *(Energy Innovation estimate)*
- Very long lived (~2045)

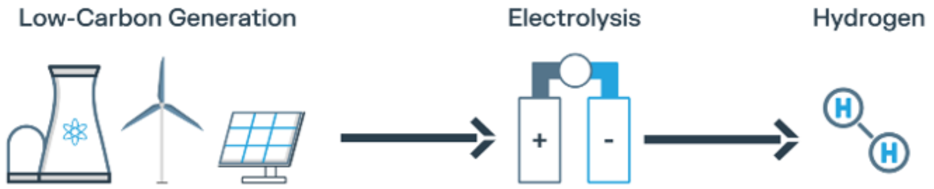
The implications of 45V hinge on Treasury, DOE, EPA and the White House

- Subsidy tied to the lifecycle GHGs of hydrogen production
- Treasury directed to issue guidance for calculating the lifecycle GHGs of hydrogen projects, within one year of the IRA's enactment
- DOE, EPA, and the White House are closely engaged
- Treasury guidance expected by August 2023

COMPLEXITY AND RISKS

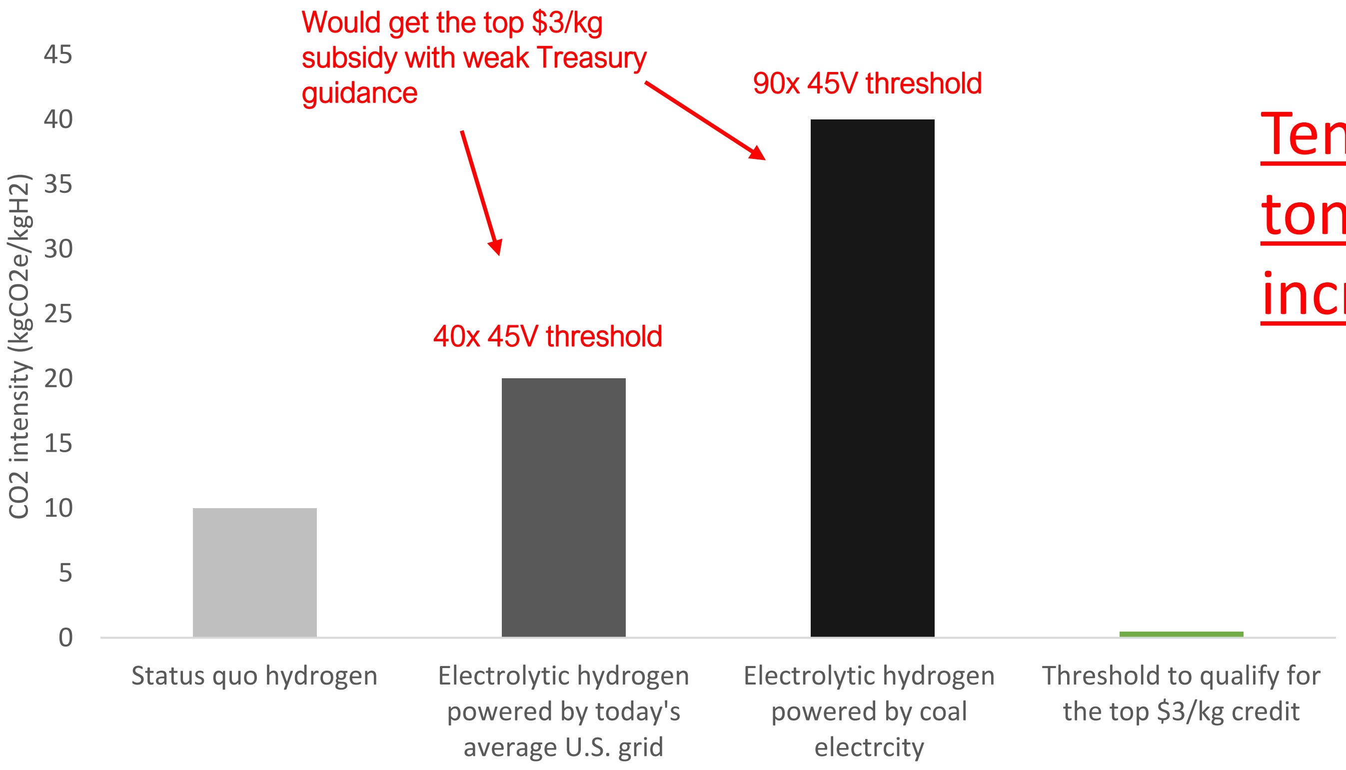
Hydrogen projects range in complexity; projects need rigorous rules

- Calculating lifecycle GHG emissions can be quite tricky
- The complexity varies from project configuration to another
  - EASY: “Behind the meter”, not drawing power from the grid
  - MORE COMPLICATED: Grid-connected, drawing grid power, buying credits
- Need rigorous rules around those credits



High risks of 45V *increasing* emissions if Treasury guidelines are weak

- Electrolysis is an electricity hungry process (more than 25% of electricity is lost in the process)
- Even small shares of fossil fueled electricity powering electrolysis would result in significant emissions



Tens to hundreds of millions of tons of potential emissions increases in this decade.

IRA STATUTORY REQUIREMENTS

The IRA text is clear: lifecycle emissions include *systemwide* emissions

- NRDC-Clean Air Task Force legal analysis
- IRA defines a hydrogen project's lifecycle emissions by referencing section 211(o)(H)(1) of the Clean Air Act (implements the federal Renewable Fuel Standard)
- Section 211 requires EPA to account for direct emissions and ***significant indirect emissions***
- EPA has interpreted significant indirect emissions to include **system impacts**
- The analogy to 45V is clear:
  - Effectively requires Treasury to **account for the *systemwide* emissions of hydrogen production, i.e., induced grid emissions**
  - For example, if a hydrogen project drives increased fossil fuels on the grid, ***Treasury must account for those emissions***.

THE THREE PILLARS

The three pillars: why do we need them?

- Three pillars = parameters/guardrails around the credits

- **Necessary to ensure prevention of grid emissions increases and meet IRA statutory requirements**
  - Substantial evidence base:
    - Princeton University's ZERO Lab; Energy Innovation, Rhodium Group, MIT Energy Initiative
    - Upcoming study by Evolved Energy Research

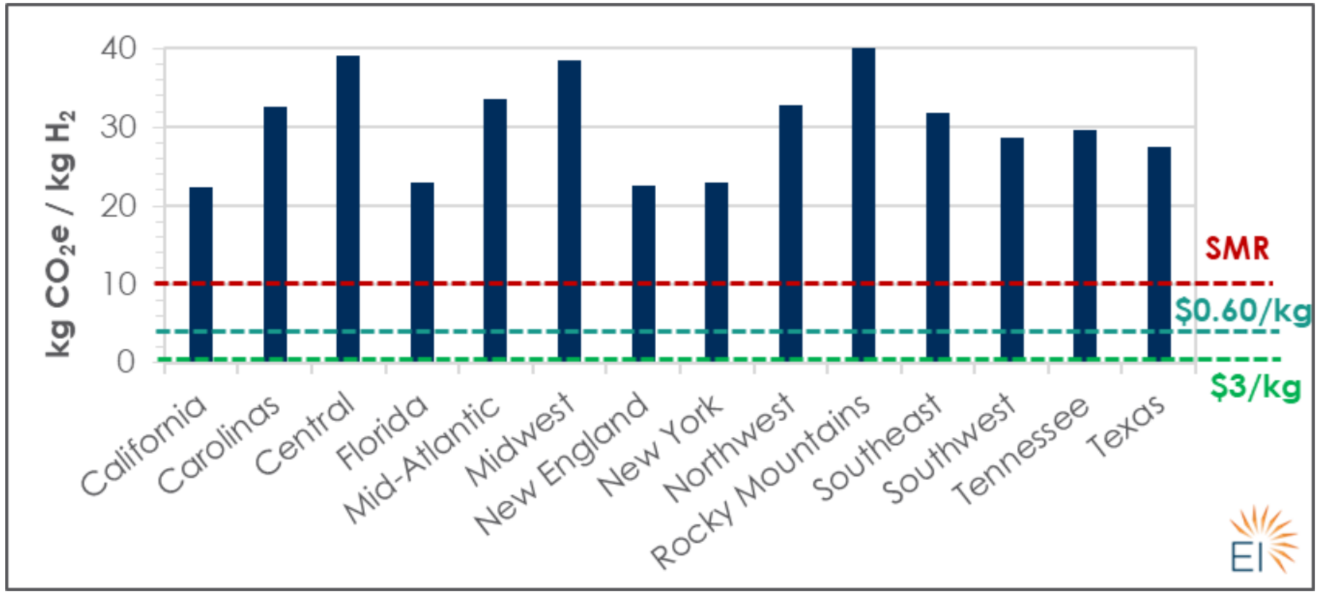
New clean supply

- New clean supply (aka, additionality): a hydrogen project must be powered by a clean energy project not currently on the grid
- **Alternative:** hydrogen projects can locate on the grid, add significant demand without adding new clean supply to meet that demand
- **Straightforward implementation:**

Multiple options, including (*not limited to*):

  - A hydrogen developer enters into a power purchase agreement with one or more new clean energy projects (e.g., new wind and/or solar project)
  - A hydrogen project purchases credits from a clean energy project built within 36 months of hydrogen project (EU approach)

Figure 6. Electrolysis emissions impact of forgoing additionality

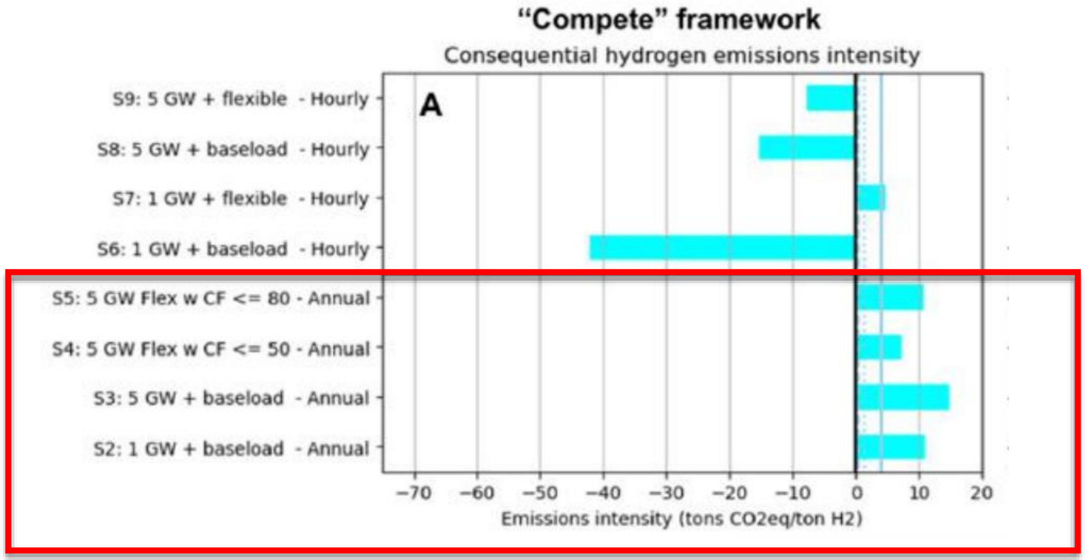


Hourly matching

- Hourly matching: a hydrogen project can only operate ***during the same hours*** where the procured new clean energy project operates
- Alternative: Annual matching, a hydrogen's project's *annual* operations must match a clean energy projects *annual* generation, on a volumetric basis

→ will spur increased fossil fuel generation

- **Straightforward implementation:**
  - A hydrogen producer demonstrates that its hourly operations match the hourly operations of a new clean energy project (either via books and records, or via credits)



MIT Energy Initiative

Not new: The clean energy market is moving away from annual matching

SUSTAINABLE BUSINESS

Carbon Accounting Changes Could Lift Corporate Greenhouse-Gas Emissions

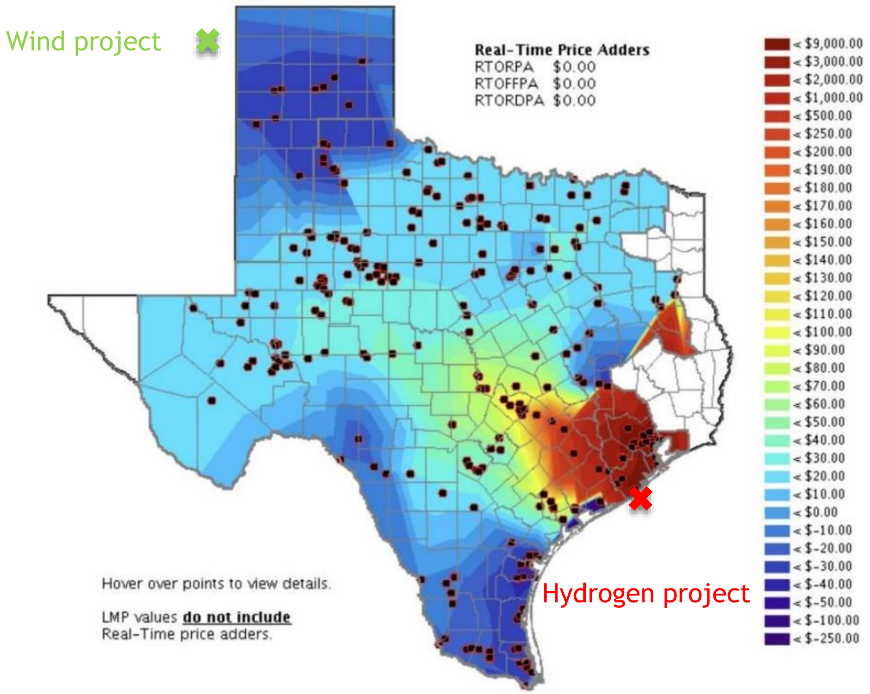
Some multinationals might be underestimating their emissions by close to 50% under current rules

- Voluntary movement away from annual matching to more accurate practices that truly confirm that operations support new clean energy deployment, e.g., hourly matching operations (Volts podcast, Dave Roberts)

Deliverability

- Deliverability: the new clean energy project(s) must be physically deliverable to the location where the hydrogen project is located
- Alternative: no geographic/spatial requirements
- **Straightforward implementation:**
  - A hydrogen project and clean energy project must be located within specific boundaries (e.g., DOE congestion zones)

Figure 8. Example of transmission congestion in the Texas power market



Dark red reflects high power prices while dark blue reflects low-to-negative power prices. The differential represents transmission congestion between these locations on the power grid.

Simple reporting for a vast majority of hydrogen projects

Hourly operations

+

PPA/contractual agreement and/or hourly credit (which already shows the date and location of the clean energy project, as well as the hour of generation)

FINANCIAL VIABILITY

Announced projects show that the three pillars are economically viable

- AES and Air Products will build a behind-the-meter facility in Texas, ramping up and down their electrolyzers based on availability of wind and solar power

- Hystor is planning a similar project with underground hydrogen storage in Mississippi

- Growing global pipeline

News | December 9, 2022

Air Products and AES to build $4bn hydrogen facility in Texas

The project includes around 1.4GW of wind and solar power capacity.

Strong analytical evidence that the three pillars will support robust industry growth

- 6 studies concluding that 3 pillar-compliant projects can be very cost-competitive from the outset, including by:
  - Academics (Princeton and MIT Energy Initiative);
  - Electrolyzer OEMs (Electric Hydrogen);
  - Two renewable energy developers;
  - Research groups (Energy Innovation)

Summarized in this Princeton white paper.

- Upcoming Evolved Energy Research study confirms that electrolyzer deployment through 2030 is nearly identical under loose rules vs. three pillars

THANK YOU!

Upstream Methane Accounting for 45V

David McCabe

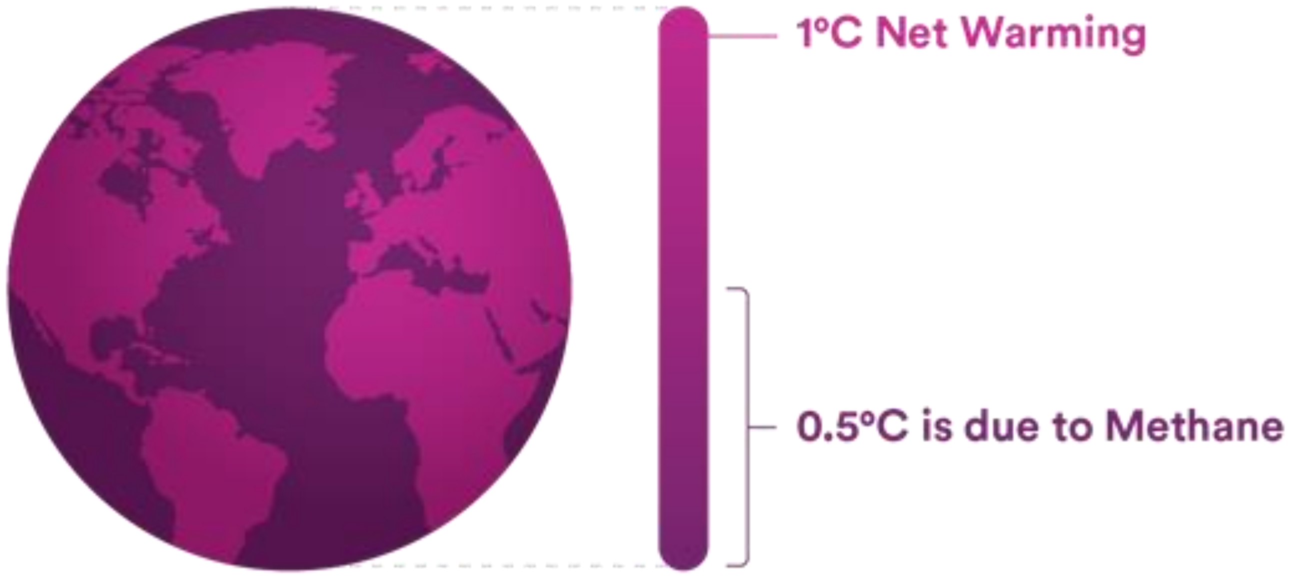
1 June 2023

CLEAN AIR TASK FORCE

The upstream methane problem

Methane is ~**80x more damaging to climate** than carbon dioxide, ton for ton, in the short term, and concentrations in the atmosphere are surging. It is responsible for at least 0.5°C of the warming have already experienced. Climate goals cannot be met without steep methane cuts.

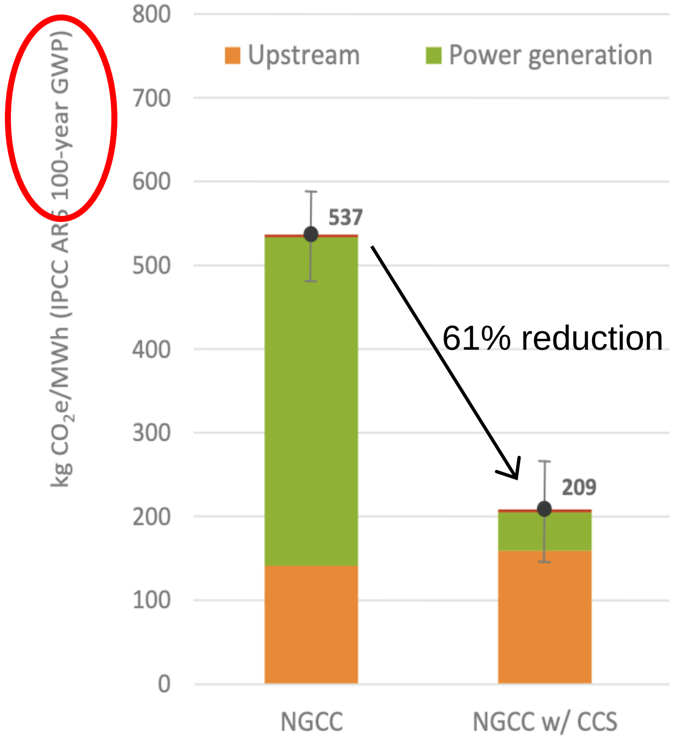
Methane associated with oil and gas production, processing, and transport is one of the largest anthropogenic sources, both in the US and globally, and clearly one of the most feasible and cost-effective to mitigate.



The upstream methane problem for natural gas

Because of methane's potency and natural gas systems' leakiness, upstream methane emissions are a large portion of the climate impact of gas consumption – and if they aren't addressed, they limit the effectiveness of mitigation via CCS for systems such as blue hydrogen.

Power plant life-cycle emissions



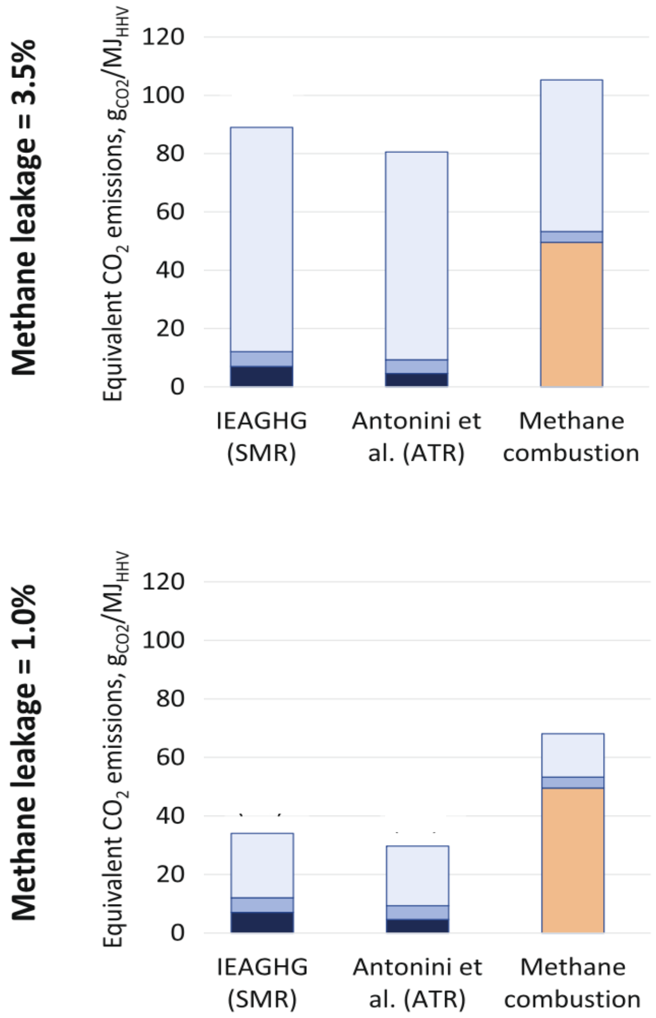
NETL 2022

According to NETL, CCS on NGCC power plants only reduces total emissions 61% (left). *NETL's analysis substantially **underestimates** methane's impact for power generation.*

Because of the energy losses involved in converting methane to hydrogen, blue hydrogen production requires more gas than would be needed to generate the same heating directly with natural gas. **This further magnifies upstream emissions.**

Upstream abatement is necessary for energy systems utilizing CCS, such as blue hydrogen, to achieve their decarbonization potential.

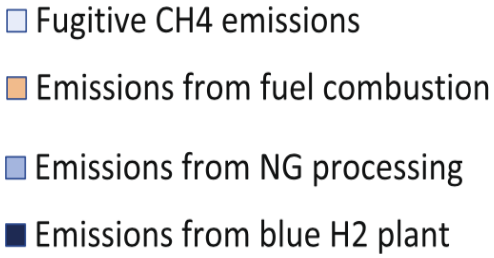
The upstream methane problem for blue hydrogen



Adapted from Romano et al 2022

These figures for blue hydrogen are calculated using a 20-year GWP for methane. In that case, when methane emissions are high (top panel) there is little advantage for burning blue H_2 over burning natural gas (without CCS).

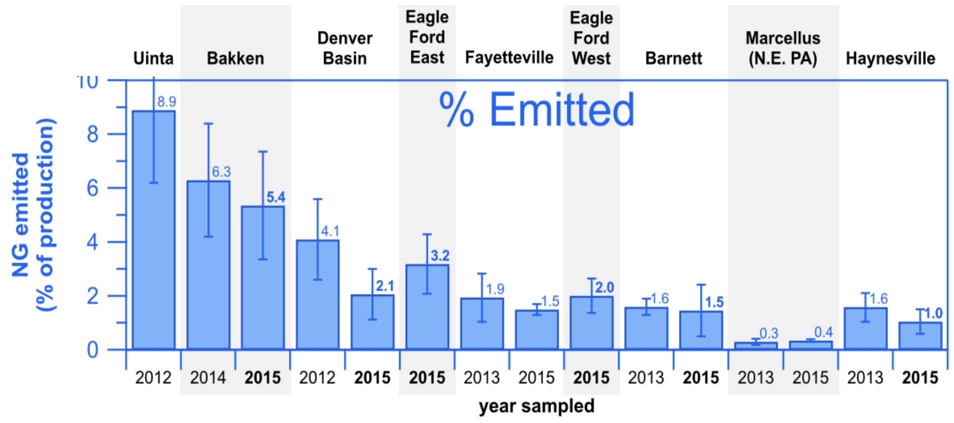
Even with optimistic assumptions about leak rate (bottom panel), blue H_2 emissions remain significant compared to uncontrolled natural gas.



Upstream Accounting for 45V

Upstream methane will be the largest source of lifecycle GHG emissions for blue hydrogen, so accurate accounting is essential.

- EPA Inventories (US GHG Inventory, GHGRP) *substantially* underestimate oil and gas methane emissions
  - A large body of "top-down" measurement studies have demonstrated equipment-based inventories (like EPA's) significantly underestimate real emissions
  - "Top-down" & Equipment-based emissions estimates both show that emissions variation between regions and is very large



- Models such as GREET take into account national top-down estimates, but still appear to underestimate average upstream emissions.
  - GREET estimates 1.0% leakage, substantially lower than estimates based on top-down analysis
  - GREET also provides just a single national estimate. Top-down and bottom-up analyses both indicate large variability between producing regions and operators

Upstream Accounting for 45V – Best Practices

- EPA and GREET currently underestimate upstream emissions
  - Upstream emissions are most accurate when based on “top-down” assessments
  - Emissions estimates should be transparent for inputs and calculations / methodology
- Upstream assessments of emissions **based on specific operators, and for specific producing regions,** will improve accuracy and increase incentives to reduce emissions
  - Due to the large variability in emissions between operators and producing regions, upstream emissions cannot be estimated accurately simply by using national figures.
    - Example: Alvarez et al estimated 2015 national leak rate (oil + gas) = ~2.3%, but recent estimates from the Permian have ranged as high as 9%
  - If any default upstream emissions estimate for 45V is set conservatively high, hydrogen producers will be incentivized to require gas suppliers to provide information on gas origin and emissions associated with that gas. In turn this provides a market incentive for producers to reduce emissions and document those reductions
  - Leading jurisdictions and programs are **developing rigorous methodologies** for quantifying emissions that operators can apply to their assets, which can be applied for programs such as 45V

Thank you

Maximizing the climate benefits of hydrogen:

Hydrogen emissions

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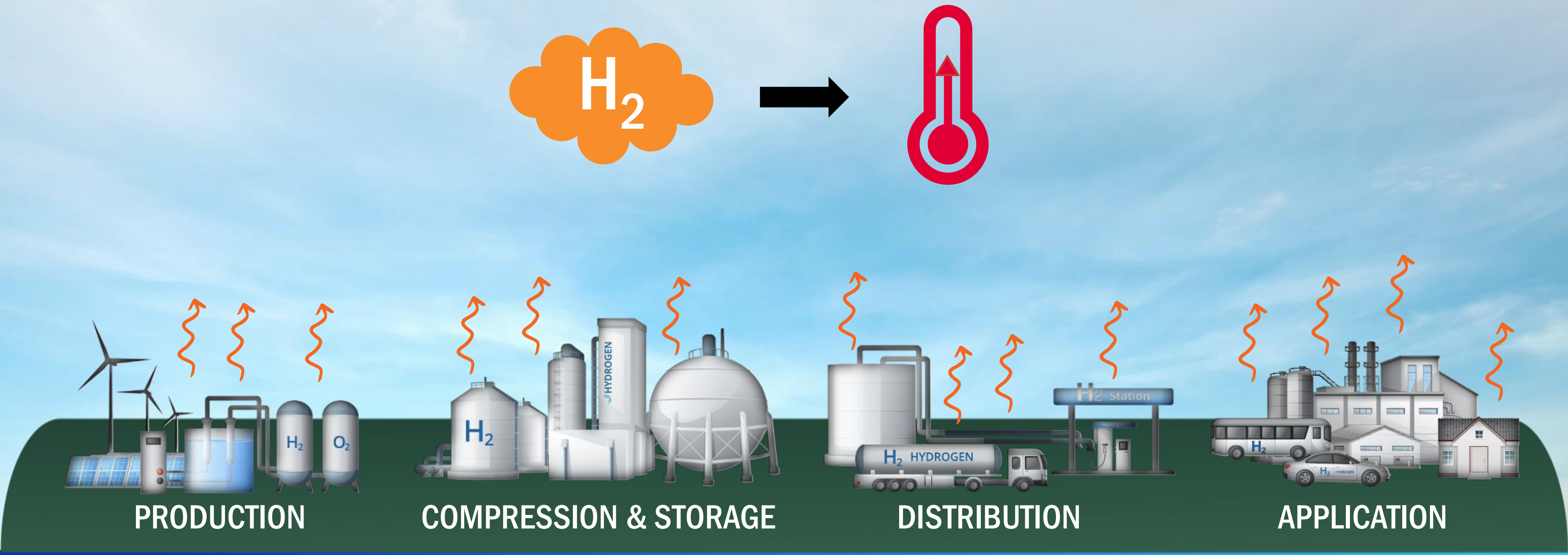
June 1, 2023

Environmental Defense Fund

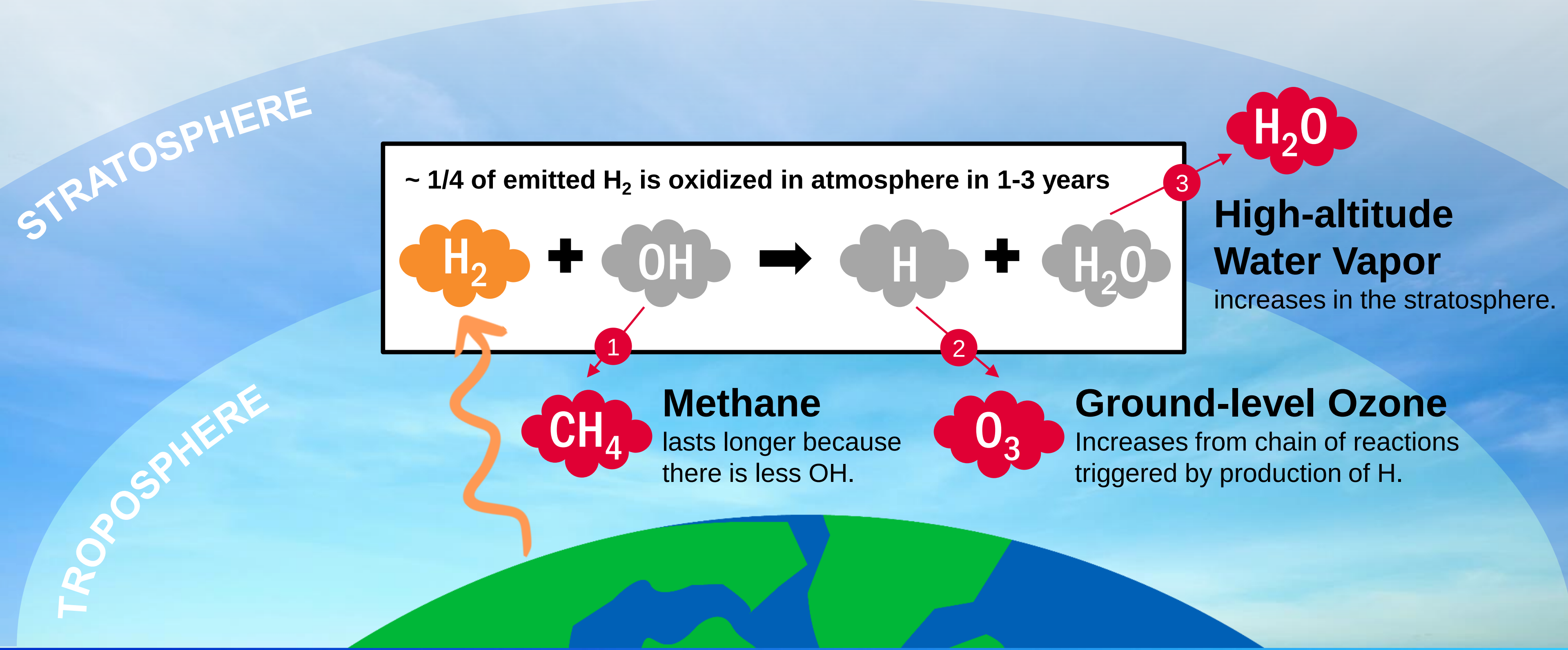
Hydrogen's climate risk

Hydrogen is a leak-prone gas that leads to potent climate warming in the near-term.



Hydrogen's warming effects

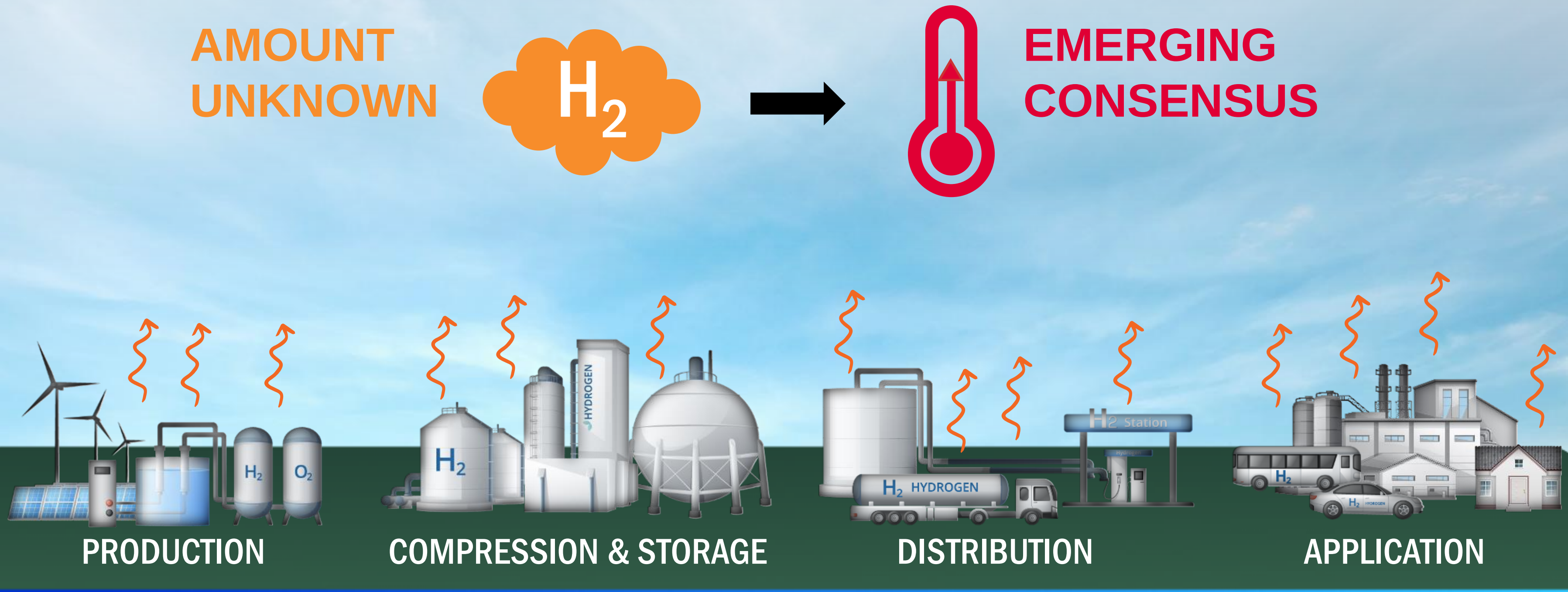
Hydrogen emissions warm the climate indirectly by increasing amounts of short-lived greenhouse gases.



Source: Paulot et al. 2021

State of the science

There is emerging consensus on hydrogen's warming effects but emissions rates are unknown.

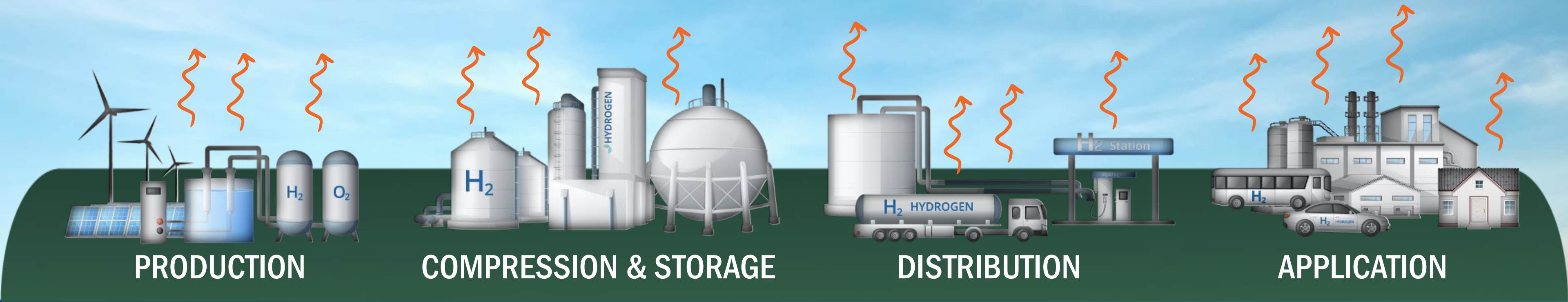


State of the science

There is emerging consensus on hydrogen's warming effects but emissions rates are unknown.

EMERGING CONSENSUS

- H_2 chemistry known since the 1970s
- H_2 warming effects studied since the early 2000s
- Latest science suggests H_2 is **40x** more powerful at trapping heat than CO_2 **over 20-year period** and 12x over 100 years (Global Warming Potential)



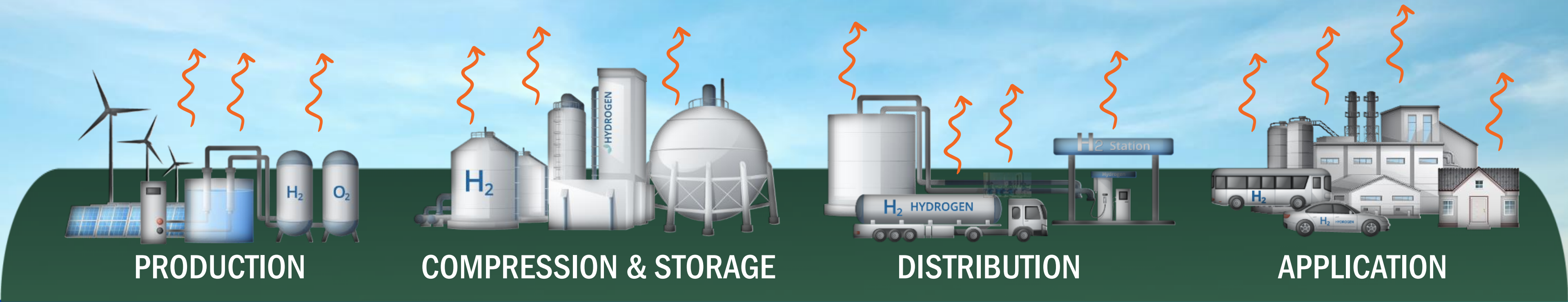
Sources: Levy 1972; Derwent et al. 2001;Hauglustaine et al. 2022

State of the science

There is emerging consensus on hydrogen's warming effects but emissions rates are unknown.

AMOUNT
UNKNOWN

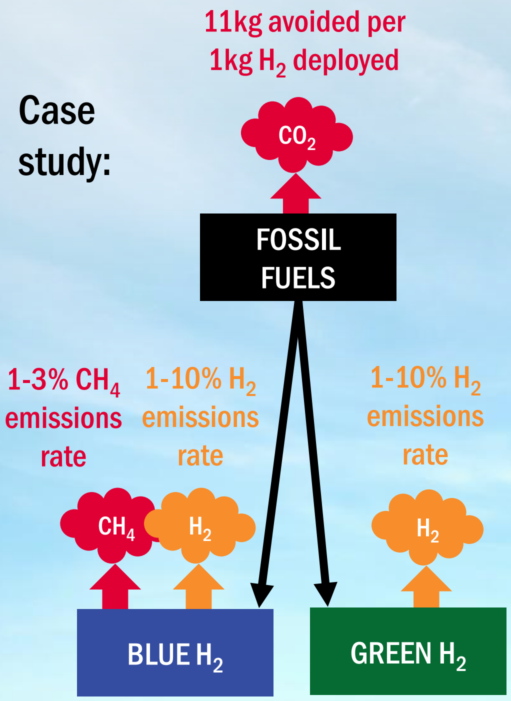
- Tiniest molecule in existence
- Intentionally & unintentionally emitted
- No empirical data from facilities
- Emissions estimates range from **<1%** to **20%**
- Measurements require new sensor technologies

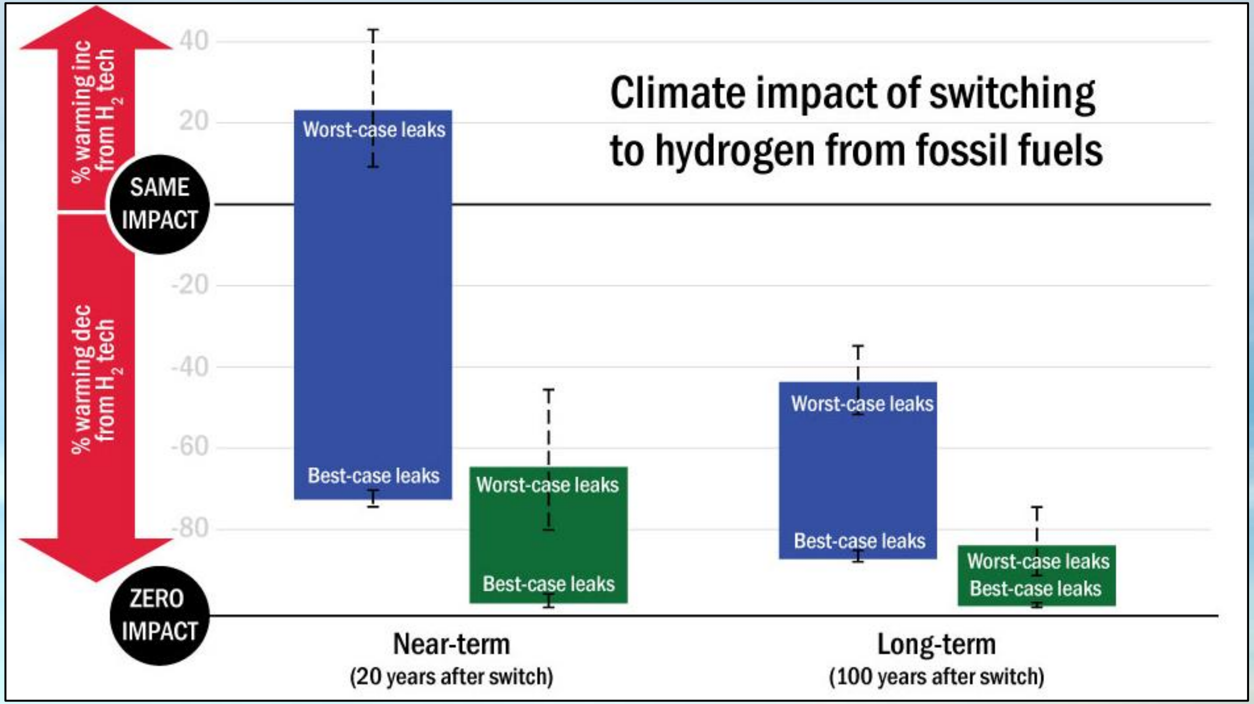


Sources: Arrigoni et al. 2022; Esquivel-Elizondo et al. in review

Seriousness of issue

Climate benefit of switching to hydrogen from fossil fuels depends on emissions and time.





Source: Ocko and Hamburg 2022

Actions to minimize hydrogen emissions

Several actions can be taken immediately to minimize hydrogen emissions and maximize climate benefits.

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Sensors Development

R&D for sensor equipment capable of detecting small leaks

Measure Emissions

Test sensor tech and support measurement campaigns

Minimize Emissions

Identify leakage mitigation measures, venting/purging alternatives, and best practices

Emissions Programs

Incorporate plans for Monitoring, Reporting, Verification and Leak Detection and Repair programs

Incorporate in LCAs

Incorporate H2 emissions and warming effects in Life Cycle Assessment calculations

Maximizing the climate benefits of hydrogen:

Hydrogen emissions

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Environmental Defense Fund

Maximizing the Climate Benefits of Hydrogen

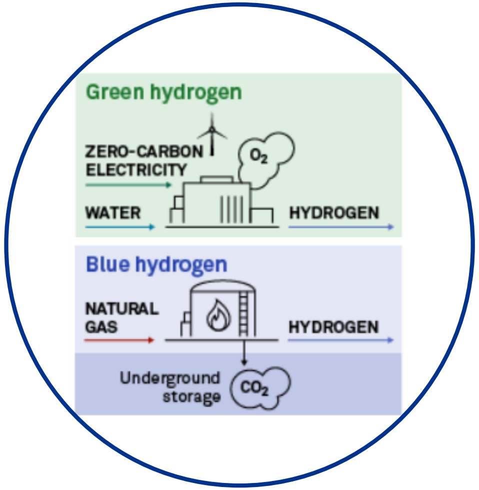
Policy Implications

Morgan Rote

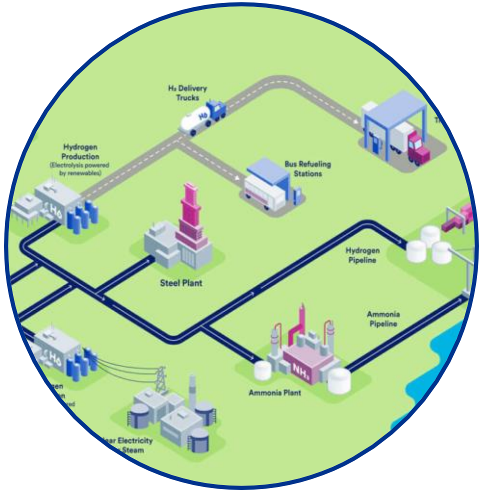
Environmental Defense Fund

Hydrogen Policy Landscape

45V PTC



H2 Hubs



RD&D

ENERGY earthshots
U.S. DEPARTMENT OF ENERGY
Hydrogen

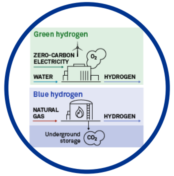
Production visuals from S&P; Hubs visual from CATF

Renewable Electricity Accounting

Electrolytic hydrogen projects must meet 3 criteria to prevent increasing overall grid emissions:

- New clean supply (additionality)
- Deliverability
- Hourly matching

45V PTC

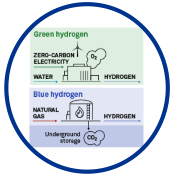


Methane Emissions

Fossil gas-derived hydrogen projects must meet rigorous criteria:

- More accurate nationwide estimates of methane leakage in 45V
- Move toward operator & basin-specific estimates
- Rigorous reporting and verification practices

45V PTC



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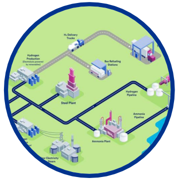
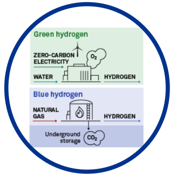


Hydrogen Emissions

Hydrogen projects must minimize the risk of subsidizing fugitive or intended hydrogen emissions:

- Hydrogen that is purged, vented, or flared should not be eligible to receive 45V
- Companies should develop plans for hydrogen emissions mitigation (e.g., best practices, best available sensors)
- More investment in high-precision sensors and research into leakage rates

45V PTC



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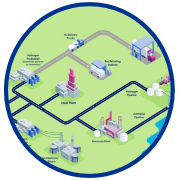

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Hydrogen

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Thank you!

Environmental Defense Fund

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