DOCKETED

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Maximizing the climate benefits of hydrogen systems

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IEPR Commissioner Workshop on the Potential Growth of Hydrogen
September 8, 2023

Environmental Defense Fund

Hydrogen's climate risks

Dedicated efforts are needed to ensure climate integrity of new hydrogen systems.

PRODUCTION

☒ No H_2 production method is universally beneficial to the climate.

☑ **Need careful accounting of all climate-influencing emissions and assessment of system-wide implications.**

MANAGEMENT

☒ H_2 is a leak-prone gas that warms the climate in the atmosphere.

☑ **Need to develop new sensors, measure/mitigate emissions, design systems that minimize emissions, include impacts in LCAs.**

USE

☒ Can be inefficient use of clean energy and better options may be available.

☑ **Do not pursue H_2 for applications that can be easily electrified; LCAs must include all climate impacts.**

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Hydrogen production

No H_2 production method is universally beneficial to the climate.

WIND & SOLAR

☒ Can delay decarbonization of power grid if capacity not additional.

☑ **Need to ensure new capacity or capacity that otherwise would be curtailed or retired.**

BIOGAS

☒ Can increase GHG emissions through changes in land use and/or diverting resources, or encouraging new biomass production.

☑ **Only use waste biomass that has no use or recyclability** *(such as ag/forestry residues, non-recyclable or compostable municipal solid waste (MSW), sewage sludge, waste cooking oils).*

FOSSIL GAS & CCUS

☒ Range in CC efficiencies and CCUS does not address methane emissions.

☑ **Require capture tech designed to achieve ≥ 95% efficiency and require upstream methane emissions below 0.2%.**

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Hydrogen management

H_2 is a leak-prone gas that warms the climate in the atmosphere.

H_2 EMISSIONS

- **Tiny:** smallest molecule in existence; 8x lighter than methane
- **No data:** We have not been measuring intentional and unintentional emissions; sensor tech capable of site-wide emissions not yet available
- **Concerning:** Similar infrastructure to natural gas which leaks more than originally thought; properties of H_2 make it harder to contain

WARMING

- **Indirect greenhouse gas:** Chemically breaks down in the atmosphere and result is increase in potent, short-lived greenhouse gases
- **Studied for decades:** Chemistry known since 1970s; warming effects studied since early 2000s
- **Science robust:** Recent study showed high confidence in warming effects from multiple models

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→ **Amount unknown**

Esquivel-Elizondo et al. 2023

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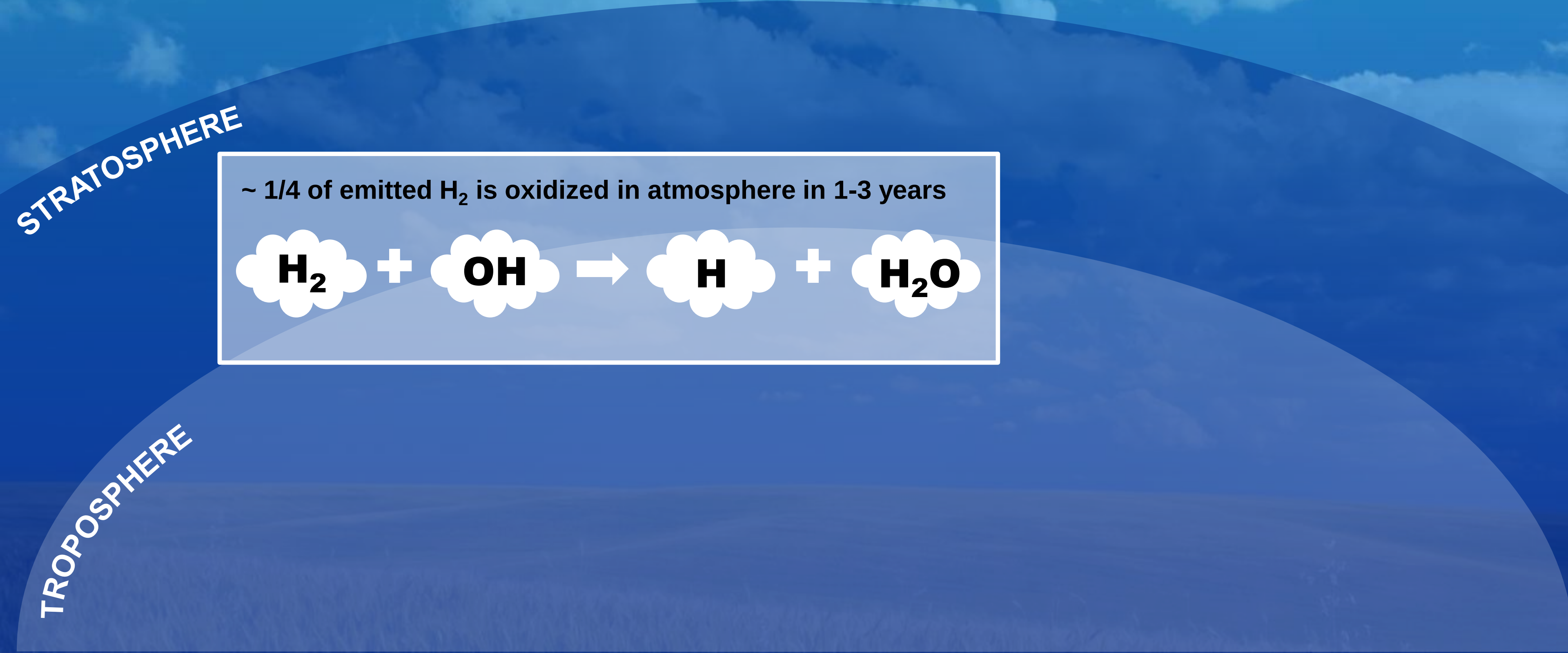
→ **Scientific consensus**

Sand et al. 2023

Hydrogen's warming effects

Scientific consensus that H_2 is indirect greenhouse gas that increases short-lived GHGs.



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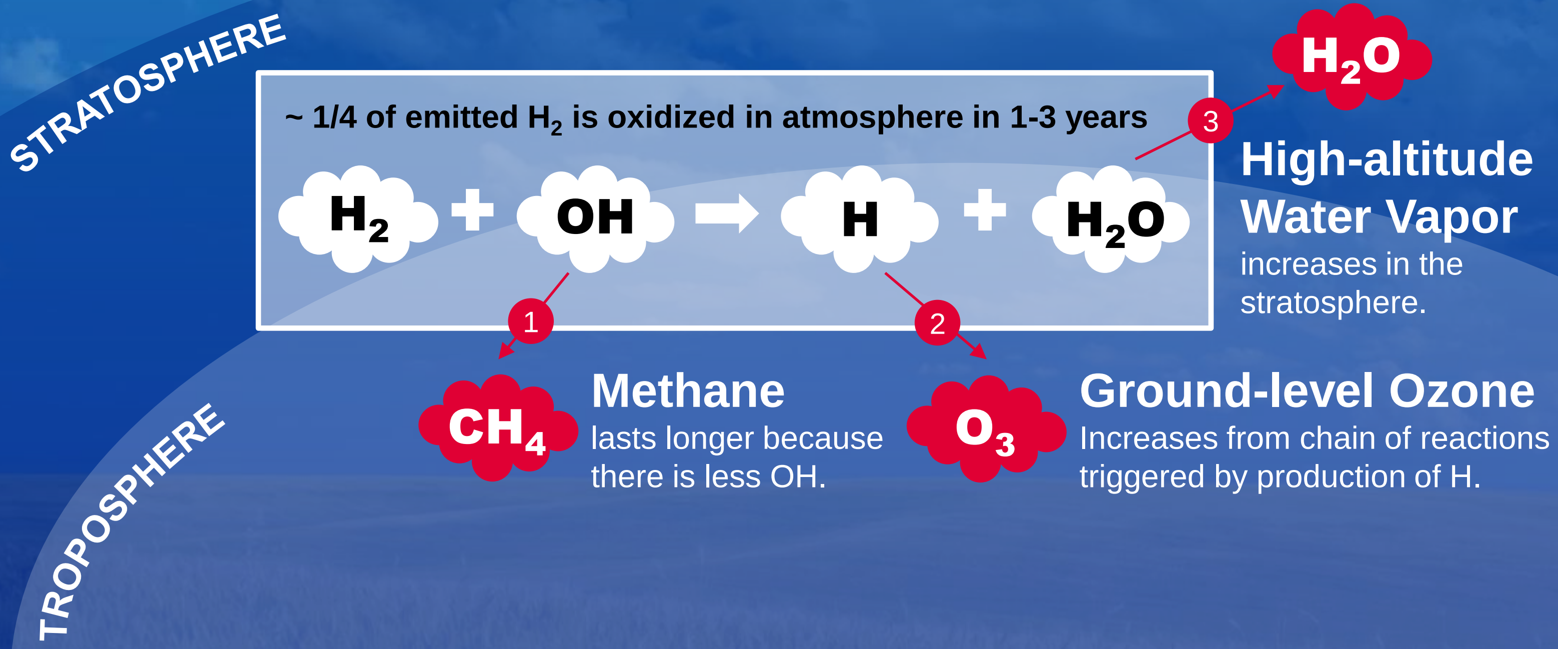

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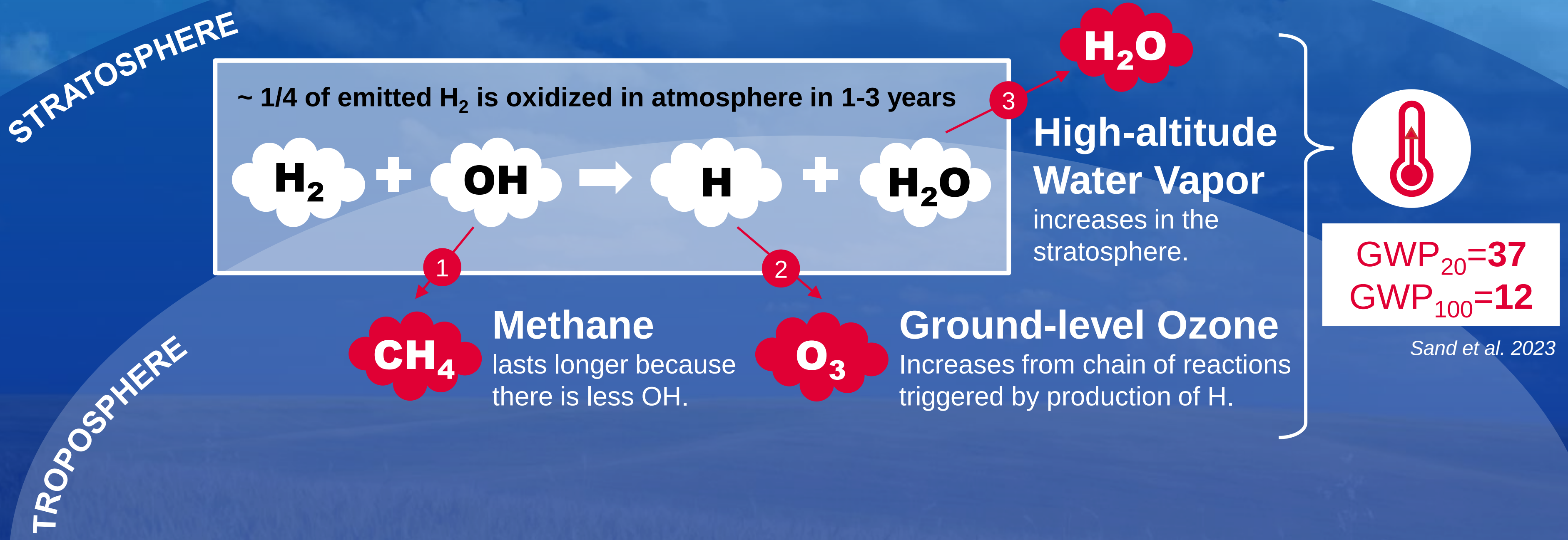

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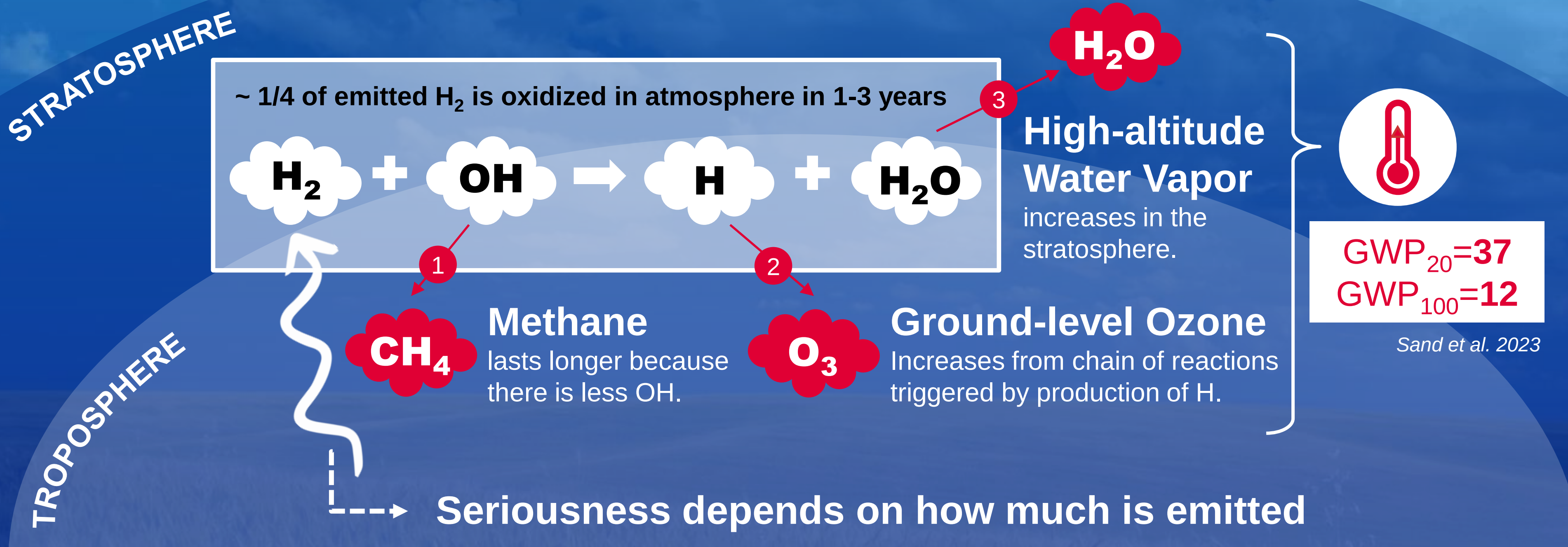
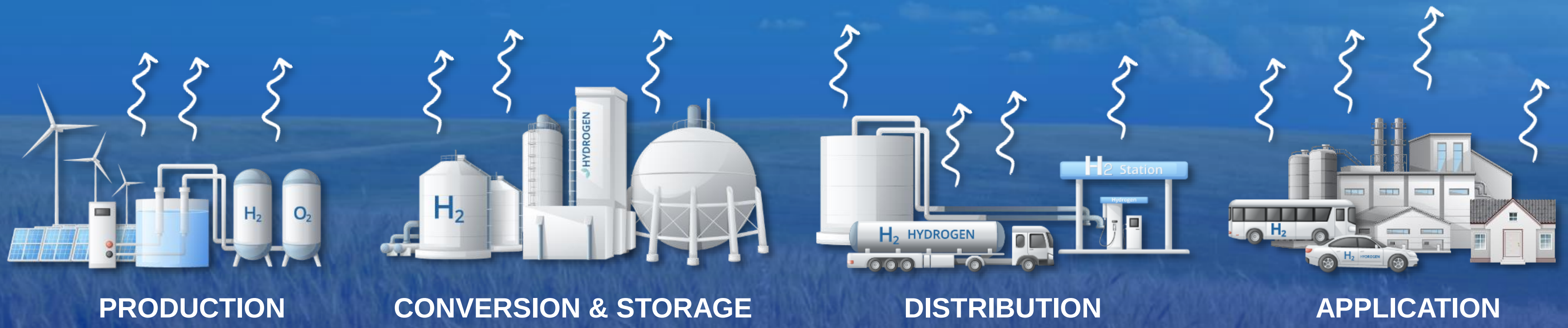


Hydrogen emissions

There are intentional and unintentional emissions of hydrogen throughout the value chain.



Hydrogen emissions

There are intentional and unintentional emissions of hydrogen throughout the value chain.

Leakage • Permeation • Diffusion • Residual • Venting • Purging • Boil-off

PRODUCTION

Electrolysis **(L,R,Pu)**
SMR **(L,R,V,Pu)**

CONVERSION & STORAGE

Compression **(L,V,Pe)**
Liquefaction **(L)**
Above ground gas **(L,Pe)**
Above ground liquid **(L,Pe,V,B)**
Underground **(L,Pe,V,Pu)**

DISTRIBUTION

Pipelines **(L,D,V)**
Tube trailer gas **(L,P)**
Truck liquid **(B)**
Shipping **(L,B)**
Liquid handling **(L,V,B)**
Refueling gas **(L,Pe,V,Pu)**
Refueling liquid **(L,B,Pu)**

APPLICATION

Industry **(L,R)**
Buildings **(L,P)**
Power gen FC **(L,V,Pu)**
Power gen ICE, gas turbine **(L,V,Pu)**

Esquivel-Elizondo et al. 2023

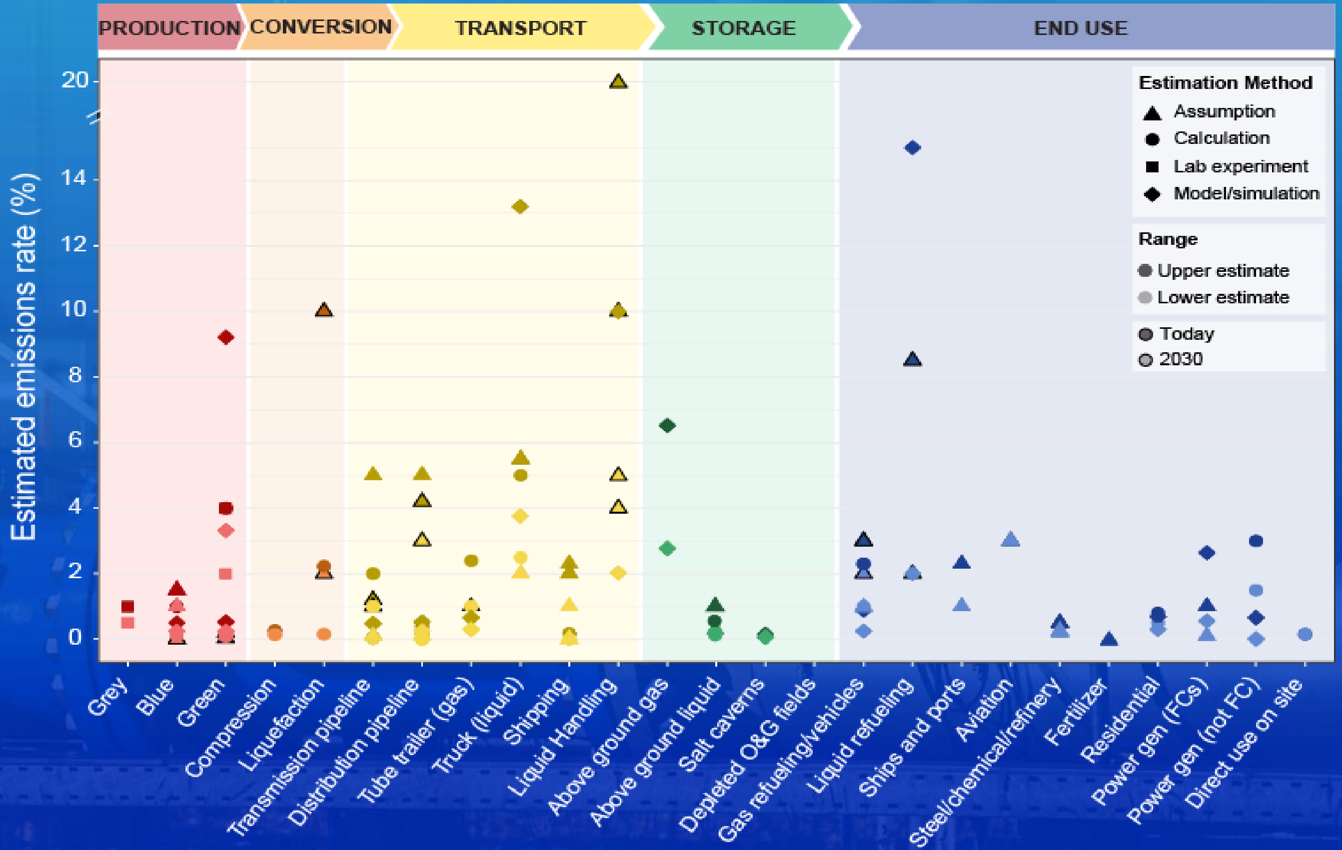
Hydrogen emissions

Esquivel-Elizondo et al. 2023

Total amount of H_2 currently emitted into atmosphere unknown, only have best guesses.

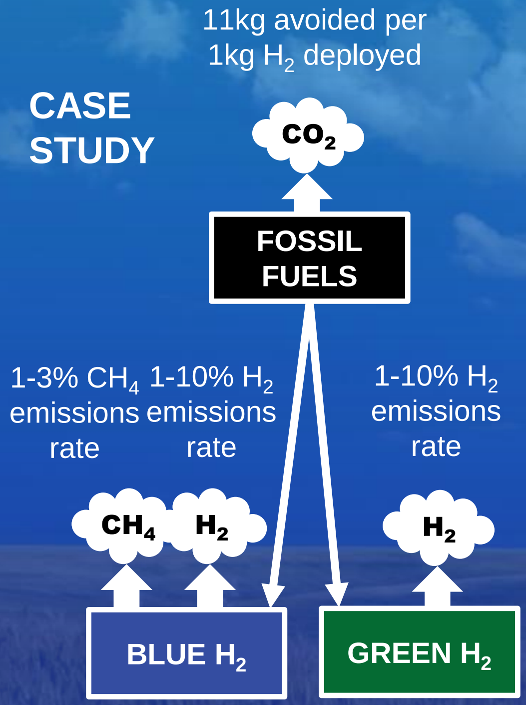
Total value chain emissions estimates:

<1% to **20%**



Climate implications

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



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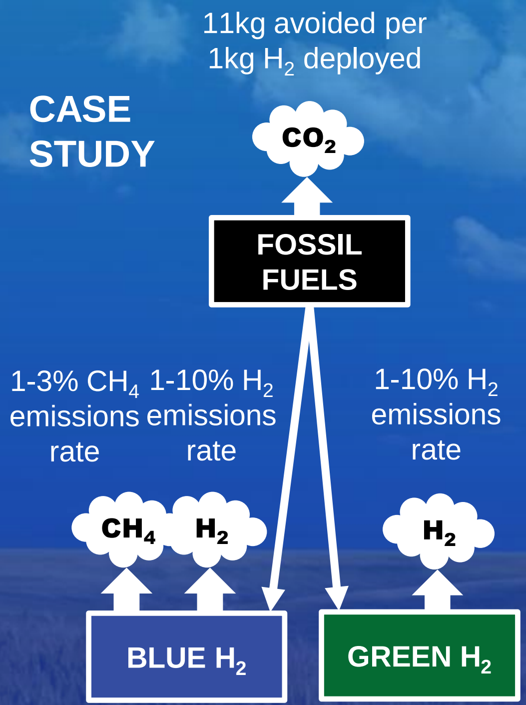

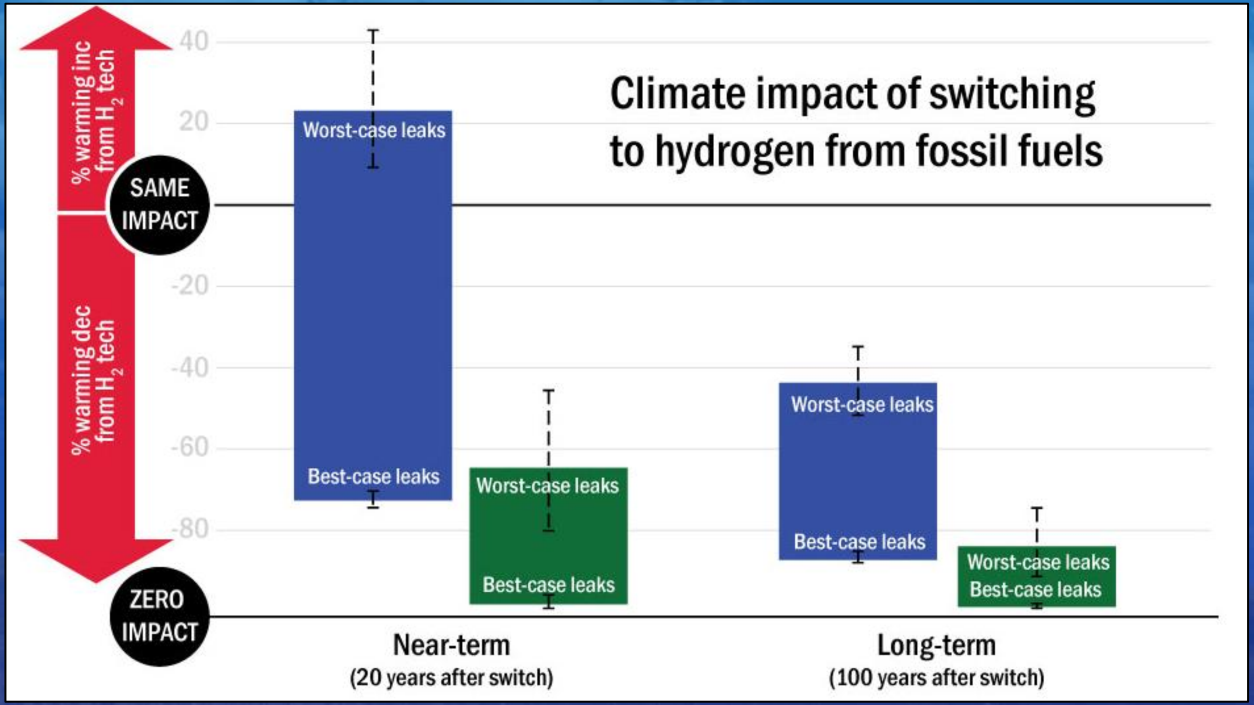

Ocko and Hamburg 2022

Minimizing hydrogen emissions

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

Develop sensors

R&D for sensor equipment capable of detecting small leaks

Measure Emissions

Test sensor tech and support measurement campaigns

Mitigate 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

Include in decisions

Incorporate emissions risks into decisions on where and how to best deploy H_2

Minimizing hydrogen emissions

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

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EDF launching field campaign

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Hydrogen use

Can be inefficient use of clean energy and better options may be available.

Decision-making tools e.g. LCAs

- ☒ Do not yet include warming effects from hydrogen emissions and exclusively consider long-term climate impacts *(via Global Warming Potential (GWP) with 100-year time horizon which masks near-term warming impacts of hydrogen and methane).*
- ☑ **Need to incorporate hydrogen emissions risks and multiple timescales in order to accurately assess climate impacts of a specific technology.**

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References and resources

Esquivel-Elizondo, S, AH Mejia, T Sun, E Shrestha, SP Hamburg, IB Ocko, **Wide range in estimates of hydrogen emissions from infrastructure**, *Frontiers in Energy Research*, 11 (2023) – ***EDF complementary blog post***

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