

Hydrogen & the Climate

Beth Trask, Environmental Defense Fund

Hydrogen considered the 'fuel of future'

Environment Climate Change Hydrogen

Is hydrogen the Holy Grail in the quest for net zero?

BusinessLine NEWS 9

Green hydrogen is the 'fuel of the future', says Gadkari

Policy paper

Hydrogen investor roadmap: leading the way to net zero

WTO

Goldman predicts clean hydrogen will be a \$1 trillion market. Here's how to play it.

BUSINESSFOCUS

Hydrogen seen as green way forward



40+ countries have released national plans



1000+ new projects underway worth **>\$500B**

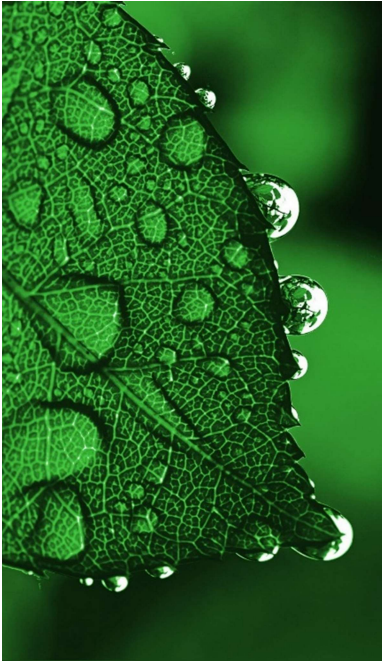


Estimated **3-10x** increase in demand by 2050

Why is there so much excitement?

Hydrogen is an abundant, carbon-free, and versatile form of energy.

1 ABUNDANT



2 CARBON-FREE



3 VERSATILE



CAN REPLACE
FOSSIL FUELS IN:

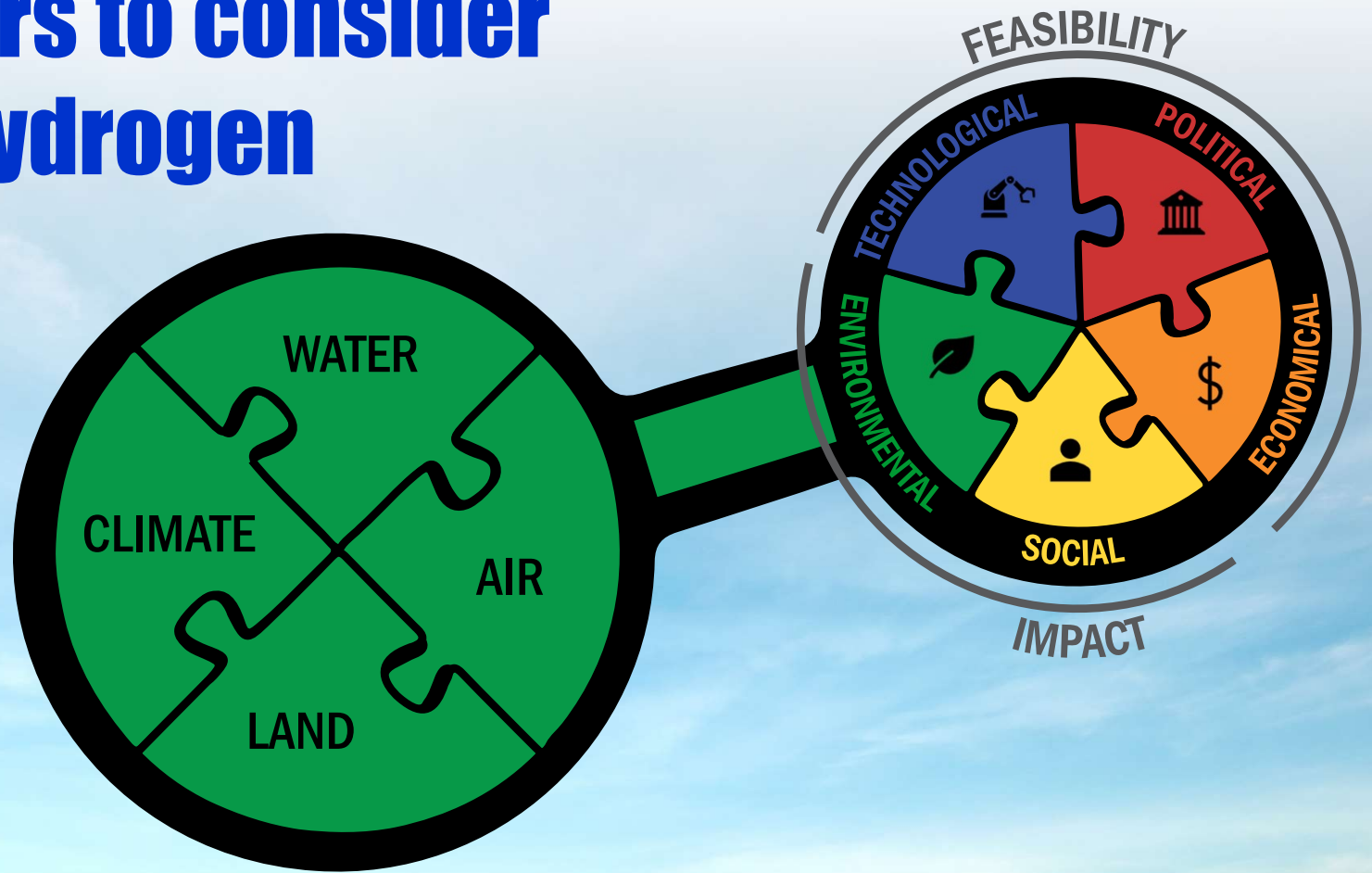
 Industry

 Transport

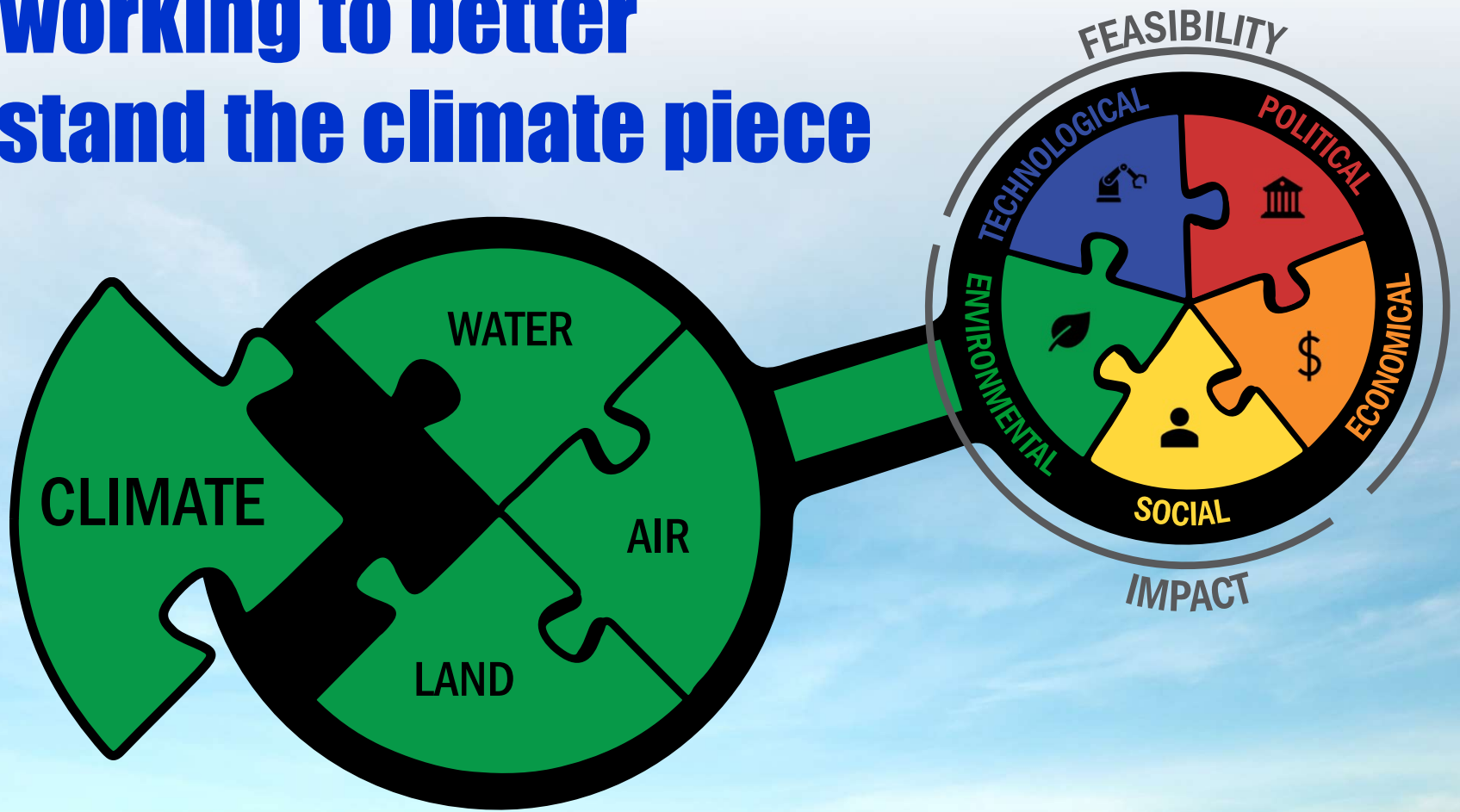
 Power

 Buildings

Many factors to consider for using hydrogen



EDF is working to better understand the climate piece



Hydrogen's climate risks

While considered a “climate solution,” hydrogen systems can also contribute to climate change.



1. HOW H₂ IS MADE



2. HOW H₂ IS MANAGED



3. HOW H₂ IS USED

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1. HOW H₂ IS MADE



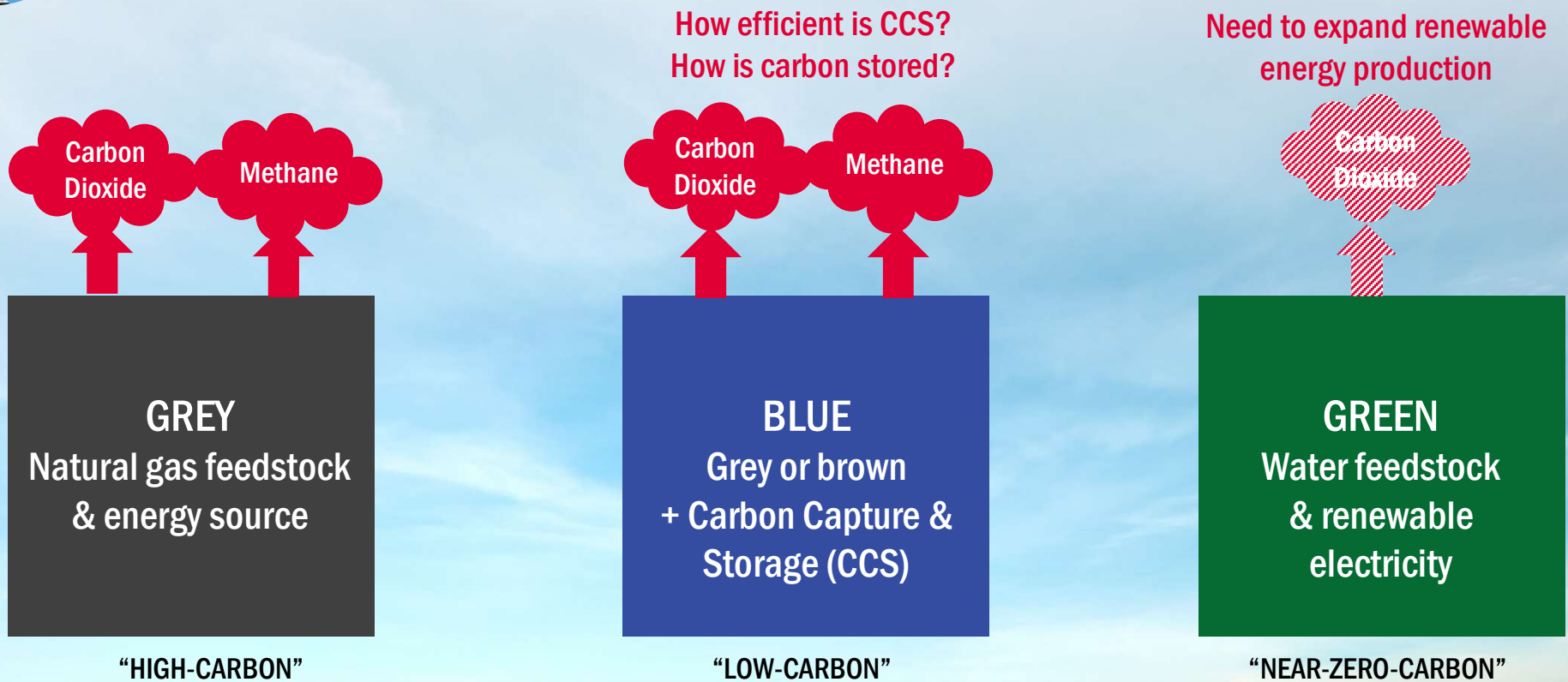
2. HOW H₂ IS MANAGED



3. HOW H₂ IS USED

How hydrogen is made

Hydrogen can be produced from high- and low-greenhouse gas emitting sources.



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1. HOW H₂ IS MADE



2. HOW H₂ IS MANAGED

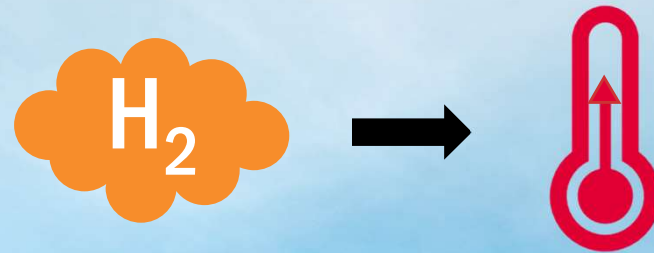


3. HOW H₂ IS USED



How hydrogen is managed

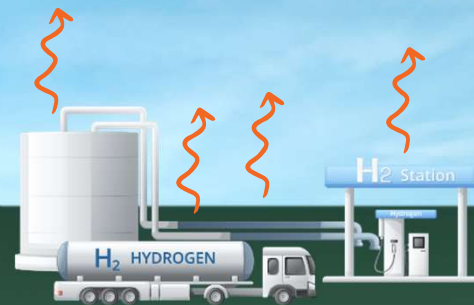
Hydrogen emissions warm the climate by increasing amounts of short-lived greenhouse gases.



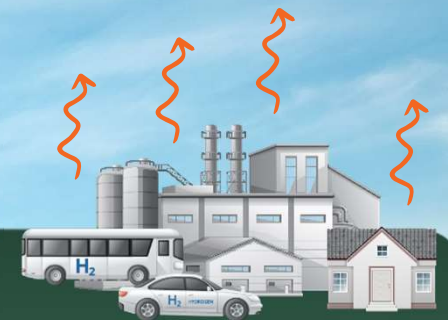
PRODUCTION



COMPRESSION & STORAGE



DISTRIBUTION



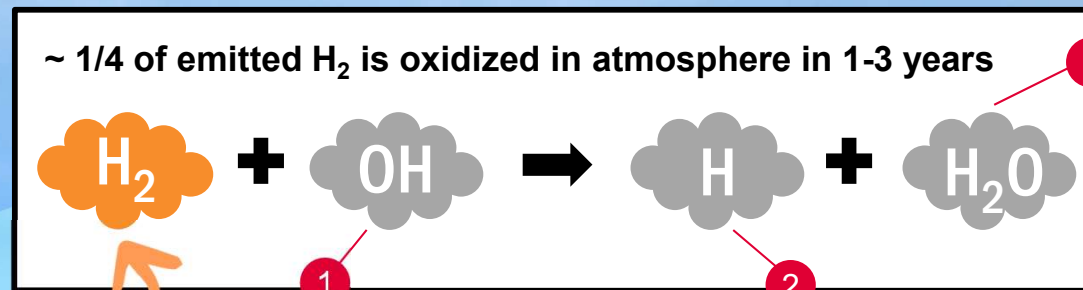
APPLICATION

How hydrogen is managed

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



STRATOSPHERE



H₂O
High-altitude Water Vapor
increases in the stratosphere.

TROPOSPHERE

CH₄
Methane
lasts longer because there is less OH.

O₃
Ground-level Ozone
Increases from chain of reactions triggered by production of H.



How hydrogen is managed

There is consensus on hydrogen's warming effects.



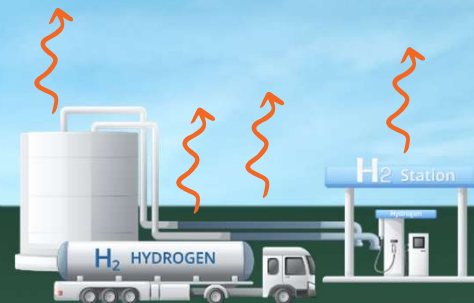
Latest science suggests H₂ is **>35x** more powerful at trapping heat than carbon dioxide over **20-year period**.



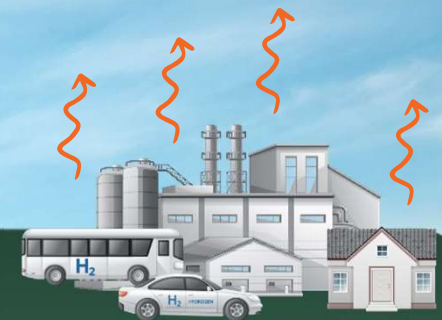
PRODUCTION



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DISTRIBUTION

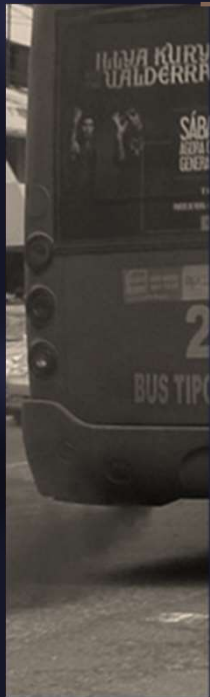


APPLICATION

Sources: Levy 1972; Derwent et al. 2001; Sand et al. 2023



Comparison of 20-Year Warming impact



Fossil Fuel Systems



-98%

1% H₂ emitted



-65%

10% H₂ emitted



-75%

1% H₂ emitted
1% CH₄ emitted



+25%

10% H₂ emitted
3% CH₄ emitted



“Green” Hydrogen Alternatives

OR

“Blue” Hydrogen Alternatives



How hydrogen is managed

Emissions rates are unknown.

AMOUNT
UNKNOWN



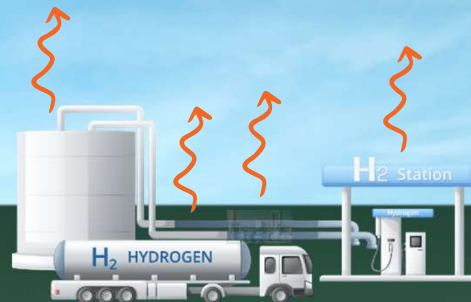
- Tiniest molecule in existence / Highly leak-prone
- We don't know how much is being emitted currently. Emissions estimates range from **<1%** to **20%**
- Measurements require new sensor technologies



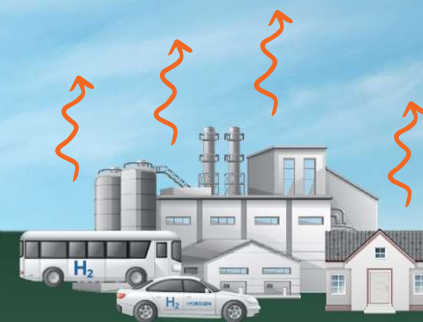
PRODUCTION



COMPRESSION & STORAGE



DISTRIBUTION



APPLICATION

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

Hydrogen's climate risks

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3. HOW H₂ IS USED


Hydrogen end use


When is Hydrogen the most climate-beneficial option?

Industry

 Low-temp heat


 Medium-temp heat

 New plastics production


 e-Methanol production

 Steel production*

 Refining

 High-temp heat*


 Fertilizer production

 Chemical feedstock


Transport

 Cars


 Buses


 Heavy-duty long-haul trucks


 Ships

 Small trucks


 Regional Rail


 Long-distance rail

 Aircrafts

 E-fuels, SAFs, ammonia production


Power

 Mechanism to transport electricity


 Co-firing in coal/gas power plants

 Back-up power


 Energy storage

 Base power (where RE not available)

Buildings

 Gas grid blending

 Domestic heating

 Commercial heating

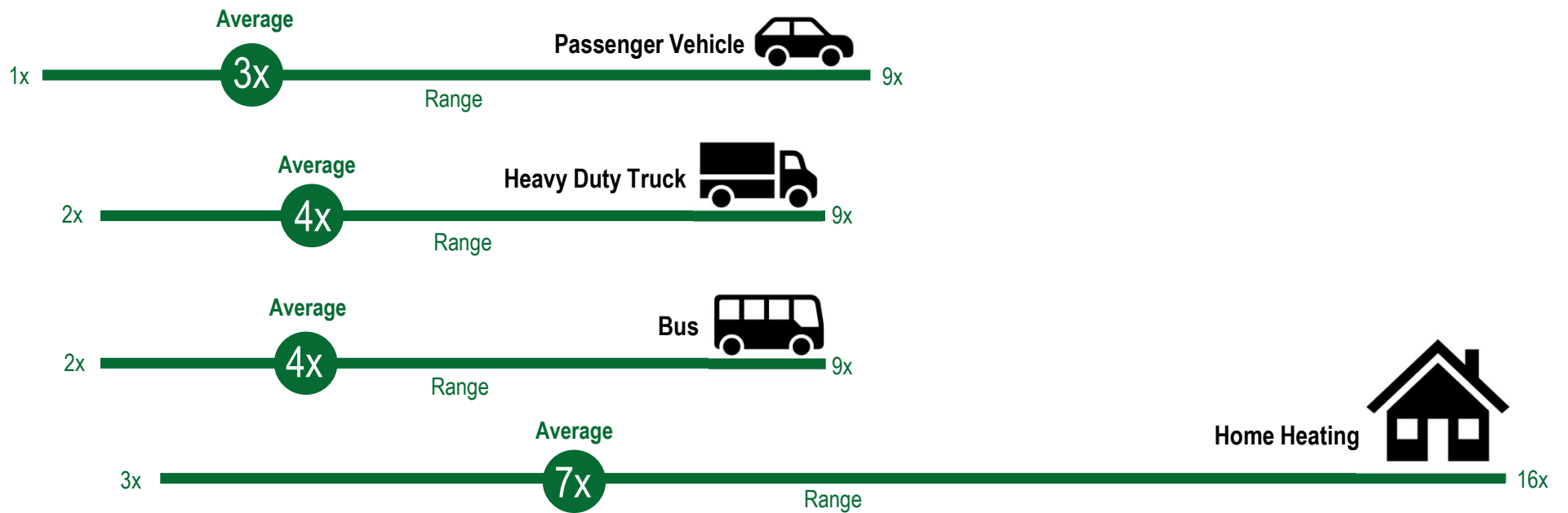
 Domestic cooking

*Electrification may eventually be possible



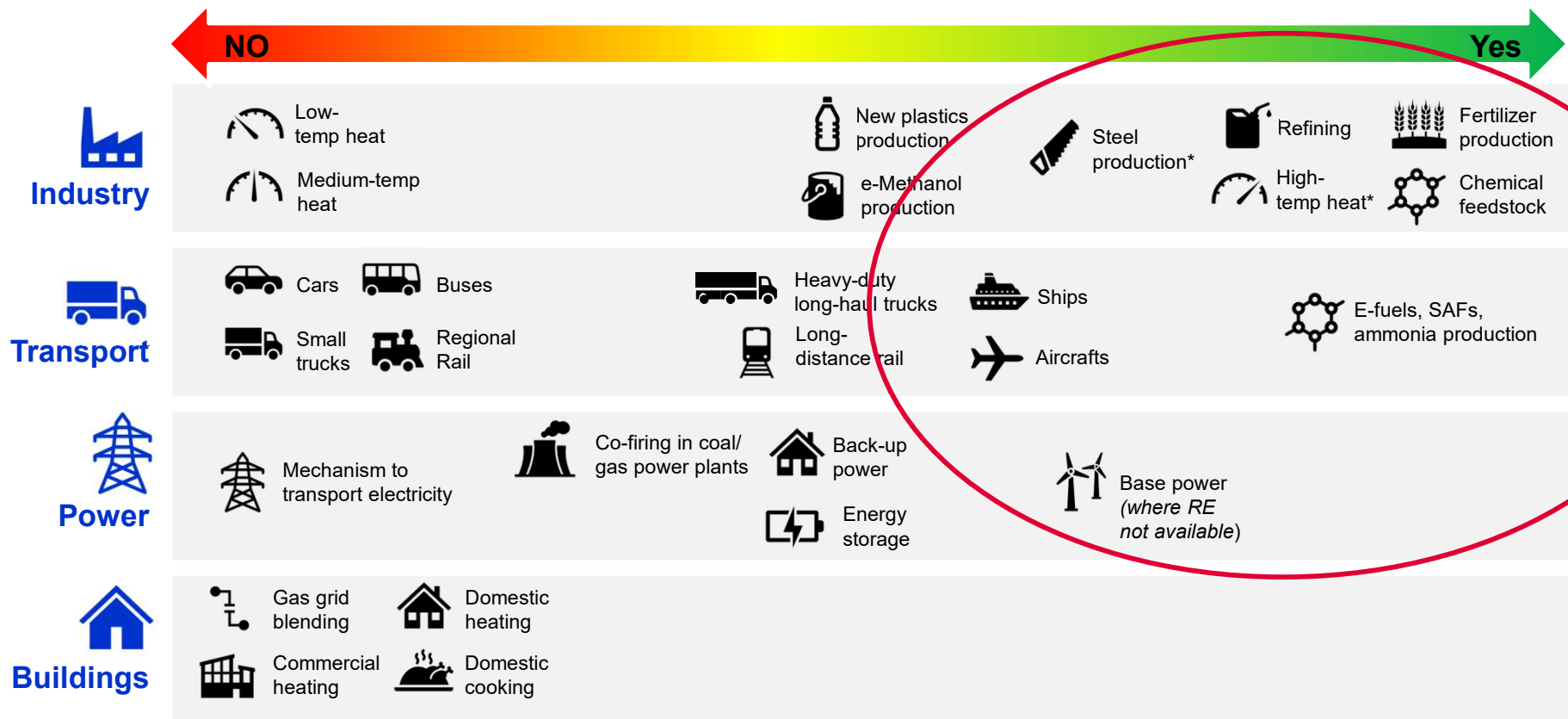
H₂ use

Important to consider energy required to use green hydrogen vs. direct electrification



Hydrogen end use

Is Hydrogen the most efficient option?



*Electrification may eventually be possible

Thank you!