



CLIMATE IMPACTS OF  
A HYDROGEN ECONOMY:  
The pathway to knowledge

**°CICERO**  
Center for International  
Climate Research

# The role of hydrogen for climate and environment

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Credit: Frederick Doerschem, iStock

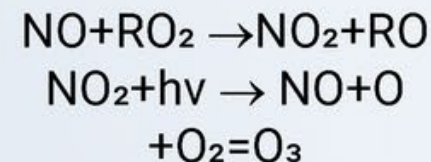
# ADDING H<sub>2</sub> CHANGES THE ATMOSPHERIC COMPOSITION, INFLUENCING CLIMATE AND ENVIRONMENT

Increased production of water vapor in the stratosphere

Changes in the ozone layer

Stratosphere  
Troposphere

Increased methane levels and lifetime



Changes in air pollution

Increased ozone in the troposphere

Changed aerosol production

H<sub>2</sub>

# HYDROGEN set-up: - 5 global atmospheric chemistry models



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University of California Irvine

**UCI CTM**

Los Angeles



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Director of the Climate and Global Dynamics Laboratory,  
NCAR, Colorado

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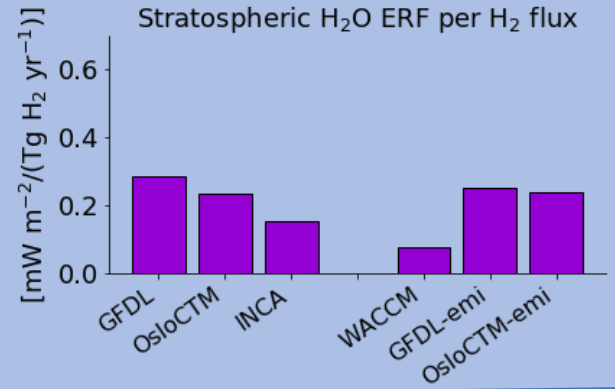
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STRATOSPHERE

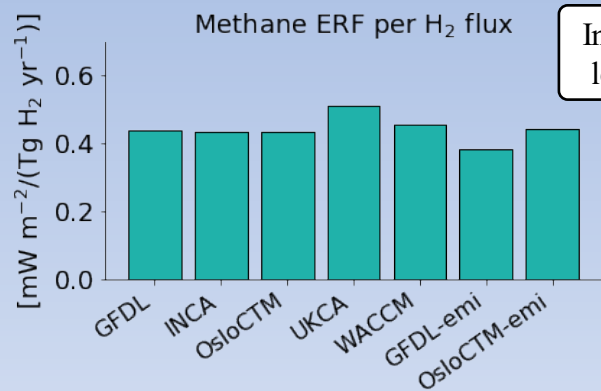
TROPOSPHERE

Water vapor

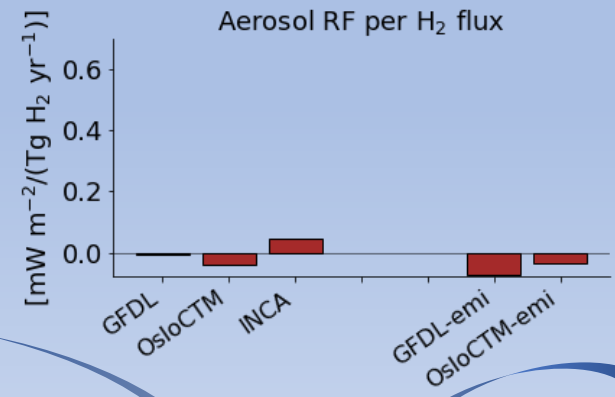
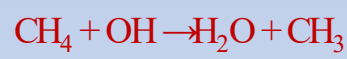
Increased production of water vapor in the stratosphere



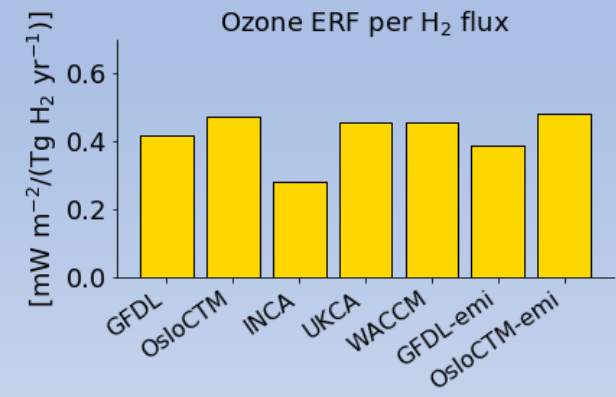
Increase and decrease in ozone in the stratosphere



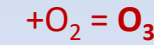
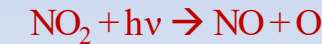
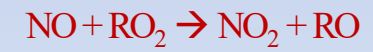
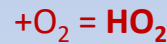
Increased methane levels and lifetime



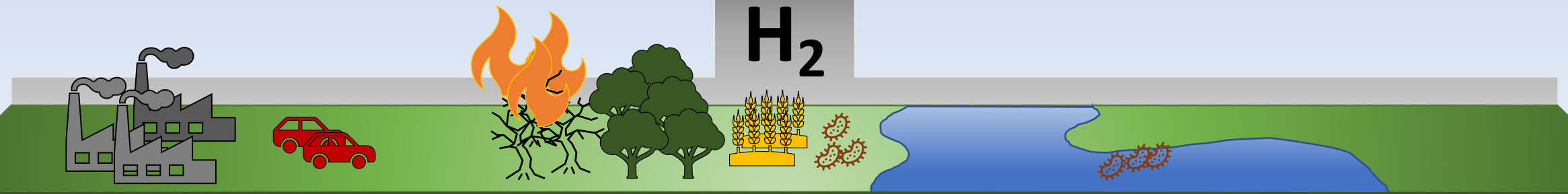
Changes in the aerosol production



Increased ozone in the troposphere

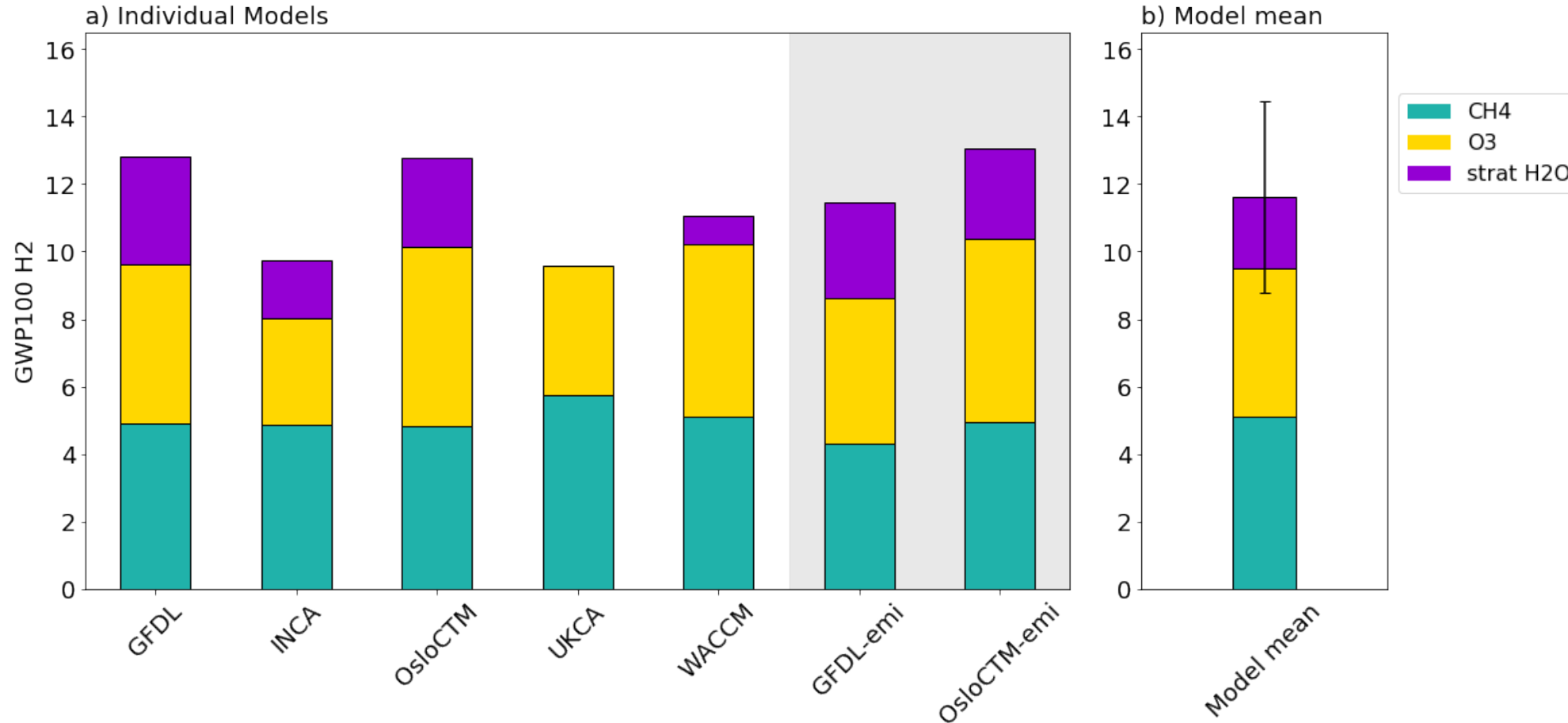


H<sub>2</sub>





# Models reveal a GWP100 of hydrogen of $11.6 \pm 2.8$



Other estimates: Warwick et al (2023):  $12 \pm 6$ , Hauglustaine et al. (2022):  $12.8 \pm 5.2$ , Derwent et al., 2020:  $5 \pm 1$

**communications** earth & environment

**A multi-model assessment of the Global Warming Potential of hydrogen**

[Maria Sand](#), [Ragnhild Bieltvedt Skeie](#), [Marit Sandstad](#), [Srinath Krishnan](#), [Gunnar Myhre](#), [Hannah Bryant](#), [Richard Derwent](#), [Didier Hauglustaine](#), [Fabien Paulot](#), [Michael Prather](#) & [David Stevenson](#)

# THE ATMOSPHERIC HYDROGEN BUDGET

H<sub>2</sub> conc. 530-540 ppb

## H<sub>2</sub> SOURCES

Photooxidation  
24-41 Tg/yr

Geological  
sources  
0-20 Tg/yr



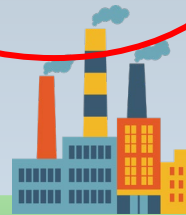
Biomass  
burning  
12-20 Tg/yr



Nitrogen fixation  
6-12 Tg/yr



Fossil fuels  
11-20 Tg/yr



## H<sub>2</sub> SINKS

OH sink  
15-19 Tg/yr

Soil uptake  
54-88 Tg/yr



The future atmospheric hydrogen budget, will depend on emissions of other components (available from the SSP scenarios) as well as hydrogen emissions from combustion of fossil fuel and possible hydrogen leakages.

# What data are available?



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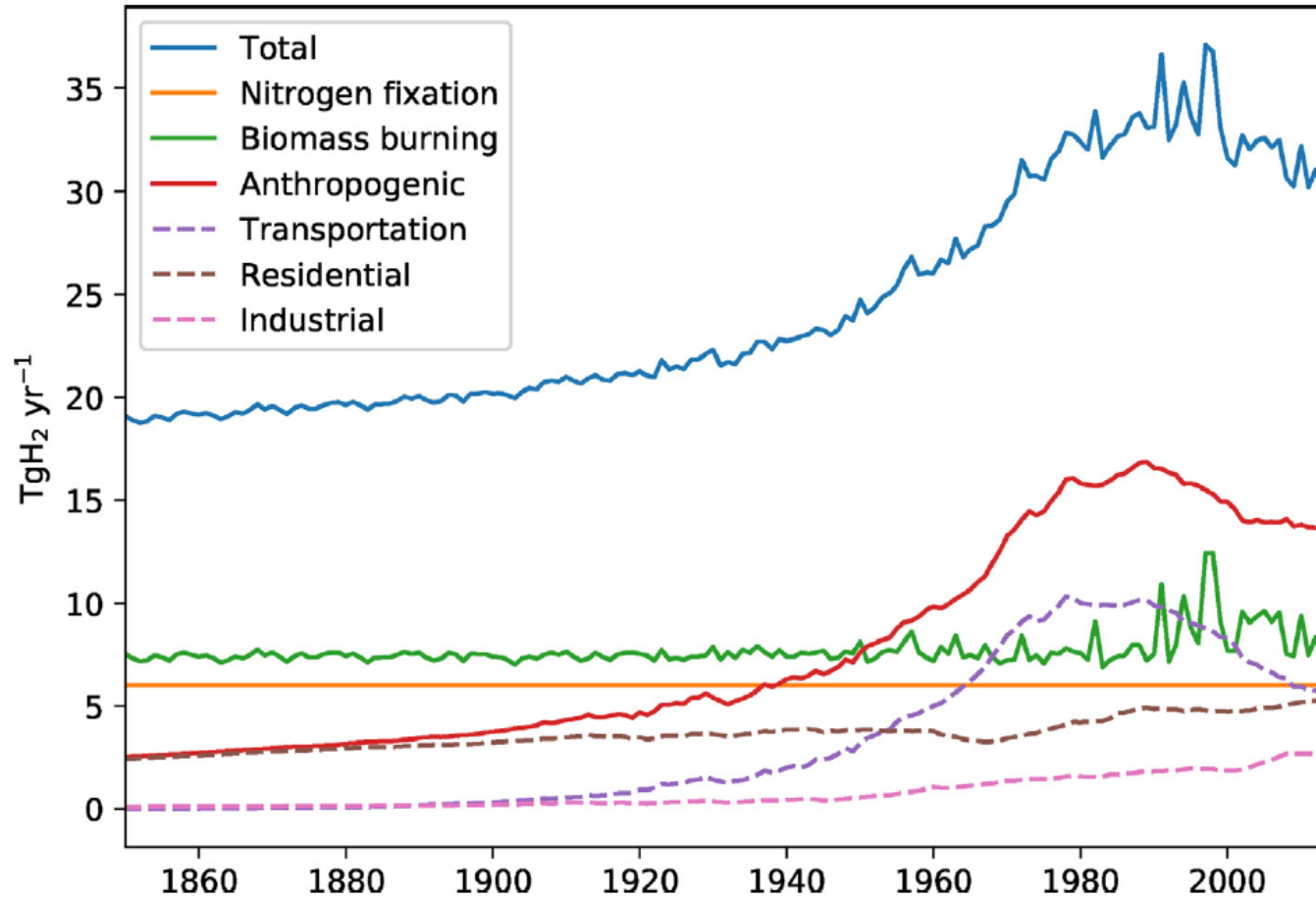


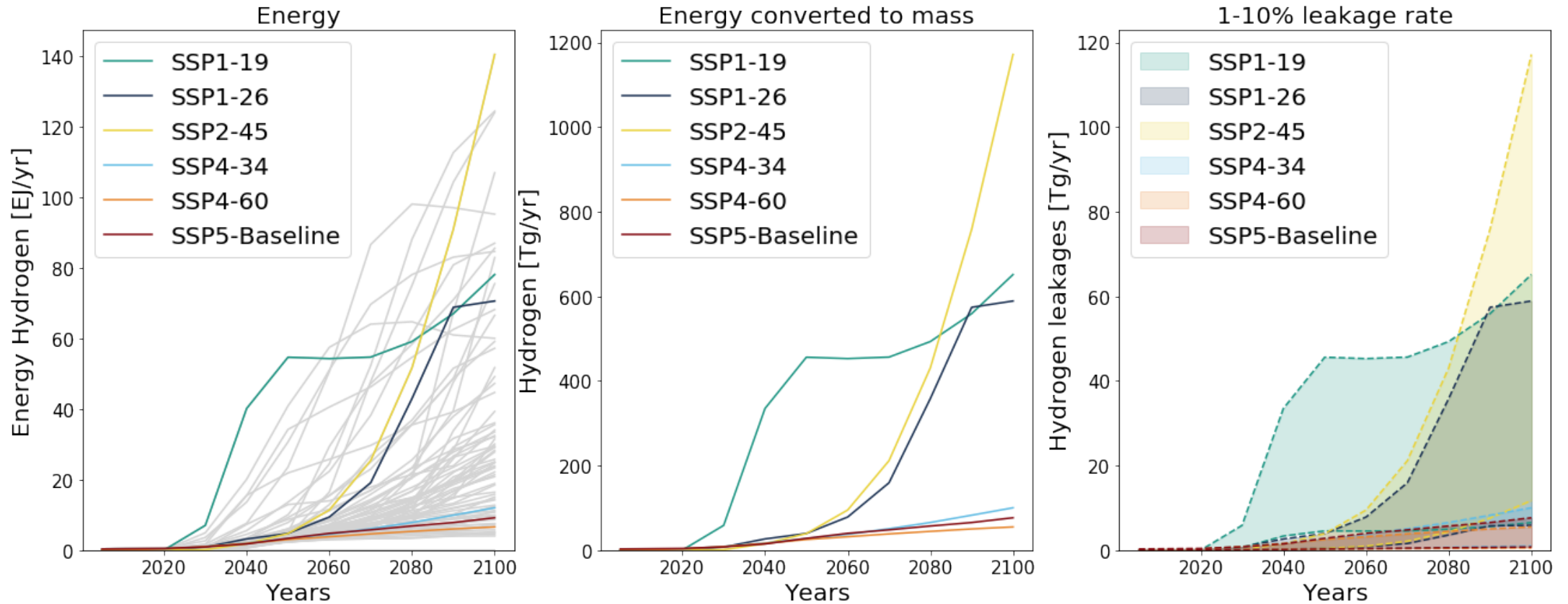
Fig. 1 – Historical H<sub>2</sub> emission.

# No estimates of hydrogen leakages in the SSPs,

- but some have hydrogen energy as an output (on regional level)

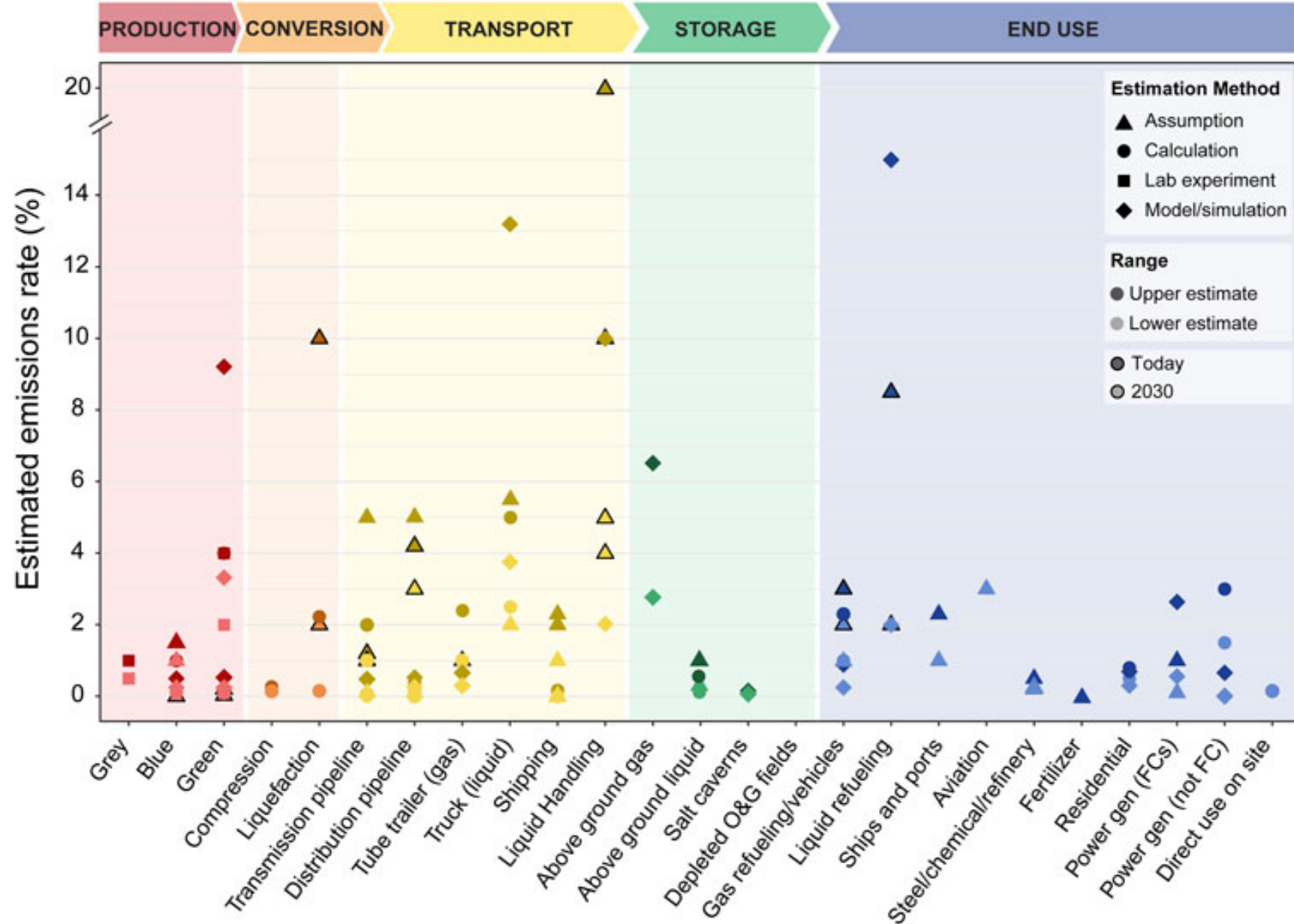


Hydrogen Energy in SSP database





# How large are the leakages?



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Thank you!

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