



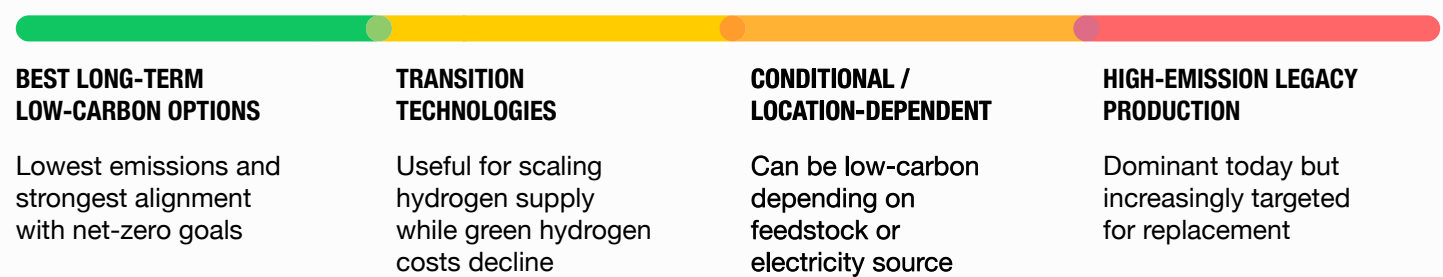
# THE CLEANLINESS SCALE OF HYDROGEN: A COLOUR-CODED GUIDE

## MAPPING THE HYDROGEN SPECTRUM

Hydrogen is classified by colour based on how it is produced, with each pathway varying in carbon emissions, environmental impact, and cost. This infographic compares the main hydrogen types, highlighting their relative cleanliness and key applications across industry and the countries leading in production.\*



### CLEANLINESS SCALE



**THE GCC POTENTIAL**

For energy-exporting countries in the GCC, particularly the United Arab Emirates and Saudi Arabia, the most economically attractive pathways are generally considered **green hydrogen** (leveraging low-cost solar power) and **blue hydrogen** (leveraging existing natural gas resources and carbon-capture infrastructure).

### UNDERSTANDING THE UPSIDES AND TRADE-OFFS OF EACH HYDROGEN TYPE

	ADVANTAGES	DISADVANTAGES
White	May require little energy input for production	Exploration and commercial extraction are still immature
Green	Lowest established carbon footprint; renewable	High electricity demand and cost
Pink (Purple/Red)	Reliable 24/7 low-carbon power source	Nuclear cost, waste, public acceptance
Turquoise	Produces solid carbon instead of CO <sub>2</sub>	Not yet widely commercialized
Biohydrogen	Uses waste biomass	Feedstock supply and efficiency constraints
Blue	Uses existing gas infrastructure	Capture rates and methane leakage vary
Yellow	Flexible deployment	Carbon intensity depends on grid mix
Gray	Lowest cost and most mature process	Significant CO <sub>2</sub> emissions
Brown	Uses domestic coal resources	Extremely carbon intensive
Black	Established process	Worst climate impact among major pathways

\*This ranking is based on the carbon intensity of each production pathway as described by the following sources:  
 The International Energy Agency, which notes that hydrogen from unabated natural gas emits roughly 10–12 kg CO<sub>2</sub>e/kg H<sub>2</sub> and hydrogen from unabated coal emits roughly 22–26 kg CO<sub>2</sub>e/kg H<sub>2</sub>, while emissions can be substantially reduced through carbon capture.  
 The World Economic Forum, which describes green hydrogen as the only widely recognized climate-neutral production pathway and identifies black/brown hydrogen as the most environmentally damaging.  
 Harvard Kennedy School Belfer Center, which provides emissions ranges and production-method definitions for gray, blue, and green hydrogen.  
 CSIRO, which classifies green, blue, turquoise, and pink hydrogen as lower-emission pathways than gray, brown, and black hydrogen.

**Important note:** There is no universally accepted international standard for hydrogen colors, and actual emissions depend on electricity source, methane leakage rates, carbon-capture performance, and supply-chain assumptions. The International Energy Agency has recommended focusing on measured emissions intensity rather than color labels alone.