



PART 1

Read the text below and answer questions 1–13.

THE HYDROGEN ECONOMY: PROMISE AND PITFALLS

A

Hydrogen is often described as an elegant answer to decarbonisation because, when used in a fuel cell or burned, its direct by-product is water vapour rather than carbon dioxide. This makes it attractive for activities that are hard to electrify with batteries or direct grid power, including high-temperature industrial heat, steelmaking, long-haul trucking, shipping, and possibly parts of aviation. Yet the slogan “clean fuel” conceals a basic constraint: hydrogen is not an energy source extracted like coal, nor a primary flow like sunlight. It is an energy carrier—an energy vector—whose usefulness depends on how it is produced, stored, and delivered. The hydrogen economy therefore promises flexibility, but it also inherits every limitation of the systems that manufacture and move hydrogen at scale.

B

At present, the dominant route is fossil-based. Most commercial hydrogen is produced via steam methane reforming (SMR), in which natural gas reacts with steam to generate hydrogen and carbon monoxide, followed by a “shift” reaction that converts carbon monoxide into carbon dioxide. The result—often called grey hydrogen—has a large carbon footprint because the CO_2 is released to the atmosphere. Blue hydrogen keeps the same chemistry but adds carbon capture and storage (CCS), aiming to trap a portion of the CO_2 and store it underground. Supporters portray this as a bridge: a near-term method that could supply volume while renewable capacity grows. Critics respond that capture rates vary by plant design and operating practice, that CO_2 compression and transport require additional energy, and that upstream methane leakage can erode or even negate the claimed climate gains. In short, blue hydrogen can reduce emissions relative to grey, but it does not automatically create a low-emissions fuel in all real-world conditions.

C

Green hydrogen is produced by electrolysis: splitting water into hydrogen and oxygen using electricity. In principle, the process can be close to zero-carbon at the point of production, but the climate value hinges on the electricity supply. If electrolyzers draw power from a grid still dominated by coal or gas, the indirect emissions embedded in that electricity can remain high, even though the chemistry is “clean.” A further practical complication is intermittency. Renewable generation varies by weather and time of day, and electrolyzers operate most economically when utilised at high capacity. Matching variable renewable



output to continuous industrial demand therefore requires careful system design—either flexible demand, cheap storage, or abundant renewable overbuild—otherwise the headline promise of green hydrogen can be undermined by real operating patterns.

D

Even when hydrogen is produced with low-carbon power, thermodynamic losses accumulate across the conversion chain. Turning electricity into hydrogen, compressing or liquefying it, transporting it, and then converting it back into electricity or mechanical motion sacrifices energy at each step. This is why many analysts argue that direct electrification should be prioritised wherever feasible: a battery electric drivetrain, or direct electric heating, usually delivers far more end-use energy per unit of renewable generation than a hydrogen pathway does. Hydrogen's comparative advantage is therefore selective. It becomes most defensible where direct electrification is technically impractical, where energy must be stored over long periods, or where industrial processes require molecules rather than electrons. Treating hydrogen as a universal replacement for all fossil fuels would ignore these efficiency realities and would place excessive strain on renewable electricity supply.

E

Distribution is difficult because hydrogen has low volumetric energy density: a large volume contains relatively little energy compared with liquid fuels. To move meaningful quantities, hydrogen can be compressed to high pressures, liquefied at extremely low temperatures (around -253°C), or converted into other chemicals—such as ammonia—that are easier to ship and can later be reconverted. Each option introduces cost and energy penalties. Compression requires strong tanks and energy input; liquefaction demands intense cooling and careful boil-off management; chemical conversion adds extra processing steps and efficiency losses. Planners therefore face trade-offs between practicality and thermodynamic efficiency, often deciding that hydrogen is most viable when production and demand are geographically linked, reducing the need for long-distance transport.

F

Infrastructure adds another layer of constraint. Much of the existing gas network was designed for methane, not pure hydrogen. Hydrogen molecules are small and can leak more readily, and some metals can suffer embrittlement when exposed to hydrogen over time, weakening pipes, valves, and compressors. Retrofitting is possible but not trivial: components may need replacement, monitoring systems must be upgraded, and safety protocols must address hydrogen's wide flammability range. These engineering realities mean that scaling hydrogen is not simply a matter of making the fuel; it requires building



and regulating an entire supply chain capable of handling it reliably. This is why early deployment often focuses on industrial clusters where infrastructure can be shared and learning-by-doing can lower costs.

G

Policy interest has grown quickly, partly because governments see hydrogen as a strategic complement to electrification, and partly because it offers an industrial pathway for decarbonising sectors that have few alternatives. National strategies increasingly emphasise cost reduction through scale: improving electrolyser efficiency, standardising equipment, and creating workforce skills. A common development model is the “hydrogen valley”—a geographic cluster that links producers, storage sites, and end users so that transport distances are short and infrastructure costs are shared. Even in optimistic scenarios, however, most expert assessments describe hydrogen’s future role as selective rather than universal. Its contribution to net-zero goals is likely to depend on abundant low-cost renewables, robust regulation of methane leakage and CO₂ storage where blue hydrogen is used, and infrastructure investment that addresses leakage and embrittlement without compromising safety.

Questions 1–5

Choose the correct heading for each paragraph.

List of Headings

- i** The conditions required for green hydrogen to deliver climate benefits
- ii** Technical challenges regarding storage and transportation efficiency
- iii** The claim that hydrogen should replace fossil fuels in every sector
- iv** The dominance of fossil-fuel based production and the carbon capture debate
- v** Physical constraints of existing infrastructure and safety concerns
- vi** Hydrogen’s potential as a versatile solution for hard-to-electrify sectors
- vii** Carbon capture as a complete solution to the environmental impacts of blue hydrogen
- viii** The thermodynamic reality: energy losses in the conversion chain
- ix** Global strategies and the emergence of industrial clusters

1 Paragraph B

2 Paragraph C



3 Paragraph D

4 Paragraph E

5 Paragraph F

Questions 6–9

Choose **TRUE** if the statement agrees with the information given in the text, choose **FALSE** if the statement contradicts the information, or choose **NOT GIVEN** if there is no information on this.

6 Experts recommend prioritizing direct electrification over hydrogen whenever technically feasible.

7 The passage states that liquefied hydrogen is cheaper to transport than hydrogen converted into ammonia.

8 Existing methane gas networks can transport pure hydrogen safely without any modification.

9 Experts expect hydrogen to play a universal rather than selective role in a net-zero future.

Questions 10–13

Complete the notes below. Choose **NO MORE THAN TWO WORDS** from the text for each answer.

Hydrogen: Handling and Deployment Challenges

- Due to hydrogen's low volumetric energy density, its distribution requires complex processing.
- Transporting substantial amounts may involve compressing hydrogen to **10** or turning it into a liquid through extreme cooling.
- Alternatively, it can be converted into other **11** such as ammonia, which are easier to ship.
- One development model is known as a **12**, linking producers, storage sites, and end users within a geographic cluster.
- Despite these advances, hydrogen's role in a net-zero future is expected to remain **13**, mainly where other options are impractical.

Answer Key



1. iv
2. i
3. viii
4. ii
5. v
6. TRUE
7. NOT GIVEN
8. FALSE
9. FALSE
10. high pressures
11. chemicals
12. hydrogen valley
13. selective