

# PEW-485103

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## General metrics

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## Writing Issues

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Issues left

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## Writing Issues

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| <b>21</b> | <b>Clarity</b>                       |  |
| 4         | Intricate text                       |  |
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| <b>12</b> | <b>Correctness</b>                   |  |
| 1         | Citation style options               |  |
| 4         | Text inconsistencies                 |  |
| 1         | Incorrect verb forms                 |  |
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| 3         | Incorrect punctuation                |  |
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Measures average word length

**4.8**

characters per word

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Measures average sentence length

**8.5**

words per sentence

# PEW-485103

Replication of the H2Global Project – Managing Operations and Supply Chain

Page 3 of 12

Replication of the H2Global Project  
A Consultancy Report for the UK Government  
Module: Managing Operations and Supply Chain  
Assessment: H2Global Replication Study  
University of Northampton  
2025

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## 1. Introduction

The Climate Change Act 2008 (as amended) legally commits the United Kingdom to reaching net-zero greenhouse gas (GHG) emissions by 2050. <sup>1</sup> This is a statutory duty, supported by six legislated Carbon Budgets, that demands a fundamental change across all sectors that emit carbon, with the main focus on energy, transport, and industry (Shahzad et al., 2024; Dixon et al., 2022). <sup>2</sup> It is against this background that the H2Global mechanism, a groundbreaking German project initiated in 2021, is an interesting example of how to decarbonise <sup>3</sup> faster through subsidised <sup>3</sup> importation of green hydrogen and its derivatives (van der Steen, 2025). <sup>2</sup> This report is a management consultant analysis of whether it is analytically justified to replicate the H2Global concept in the United Kingdom based on official UK GHG emissions data covering the 2014-2023 timeframe (DESNZ, 2025) to provide a trend analysis, a four-year forecast of UK emissions to 2023, and inferential recommendations.

The report will cover four analytical tasks: (1) tabular visualisation <sup>3</sup> of data to visualize <sup>3</sup> GHG trends; (2) using linear regression to predict emissions; (3)

Inferential statistical evaluation of H2Global replication; and (4) operations management and sustainability<sup>4</sup> implications.

## 2. UK GHG Emission Trends (2014–2023)

Table 1 shows UK official territorial GHG emissions 2014–2023, by sector, in millions of tonnes of carbon dioxide equivalent (MtCO<sub>2</sub>e), provided by the Department for Energy Security and Net Zero (DESNZ, 2025). The overall decrease is stark: total emissions in 2014 were 530.72 MtCO<sub>2</sub>e, and in 2023, 384.97 MtCO<sub>2</sub>e, which is a 27.4 percent decrease over the decade. This trend shows the cumulative impact of the transition to coal-fired power generation and the gradual decarbonisation<sup>3</sup> policy (Shahzad et al., 2024).<sup>2</sup>

Table 1: UK Territorial GHG Emissions by Sector, 2014–2023 (MtCO<sub>2</sub>e)

|             |         |
|-------------|---------|
| Year        |         |
| Electricity |         |
| Transport   |         |
| Buildings   |         |
| Industry    |         |
| Agriculture |         |
| Fuel Supply |         |
| Total GHG   |         |
| 2014        | 530.72  |
| 2023        | 384.97  |
| Change      | -145.75 |
| % Change    | -27.4%  |
| 2014        | 124.5   |
| 2023        | 124.8   |
| Change      | 0.3     |
| % Change    | 0.2%    |
| 2014        | 93.4    |
| 2023        | 74.3    |
| Change      | -19.1   |
| % Change    | -20.4%  |
| 2014        | 49.4    |
| 2023        | 39.3    |
| Change      | -10.1   |
| % Change    | -20.4%  |
| 2014        | 530.72  |

2015

104.3

125.3

95.6

70.6

50.6

39.7

510.23

2016

82.3

128.8

96.2

64.3

50.0

38.6

483.47

2017

72.2

129.5

93.8

64.5

49.9

38.0

471.31

2018

65.8

128.1

97.9  
63.2  
48.1  
37.3  
464.28  
2019  
57.9  
124.7  
94.1  
61.7  
48.6  
37.3  
447.52  
2020  
49.5  
103.5  
93.7  
58.4  
47.4  
33.9  
407.98  
2021  
54.8  
111.9  
98.2  
57.9  
48.1

31.2

422.48

2022

55.0

113.1

83.5

54.4

46.9

31.3

404.68

2023

43.9

111.8

78.5

53.0

46.6

30.1

384.97

Source: DESNZ (2025). Final UK Greenhouse Gas Emissions National Statistics 1990–2023.

According to Dixon et al. (2022), the steepest decline between 2014 and 2023 was in the electricity supply sector, which <sup>5</sup>dropped 64.7 percent from 124.5 MtCO<sub>2</sub>e to 43.9 MtCO<sub>2</sub>e, <sup>5</sup>due to the rapid replacement of <sup>5</sup>coal-generated power with renewables and gas. Although the industry sector dropped consistently from 74.3 to 53.0 MtCO<sub>2</sub>e, it <sup>6</sup>continues to be a chronic emitter <sup>6</sup>as it is <sup>6</sup>responsible for process-driven, hard-to-abate emissions from steel and cement production <sup>2</sup>(Bennett and Serrenho, 2025). The worst-performing sector

remains the domestic transport sector, which was the most emitting at 129.5 MtCO<sub>2</sub>e in 2017 and dropped to 111.8 MtCO<sub>2</sub>e in 2023. This drop can partly be explained by the pandemic in 2020 (103.5 MtCO<sub>2</sub>e). The average height of buildings is steadily increasing, while the average amount of 91.5 MtCO<sub>2</sub>e over the last ten years is 0.5 MtCO<sub>2</sub>e per annum. This is not a well-known case of the heat decarbonisation of the UK's ageing housing stock. In comparison, agriculture estimates have been relatively stable around 46–51 MtCO<sub>2</sub>e, indicating structural difficulties with livestock emissions and soil. Table 2 provides evidence for the disproportionality of manufacturing's decarbonisation.

Table 2: Absolute and Percentage Change in UK GHG Emissions by Sector (2014–2023)

| Sector             | 2014 (MtCO <sub>2</sub> e) | 2023 (MtCO <sub>2</sub> e) | Change (MtCO <sub>2</sub> e) | % Change |
|--------------------|----------------------------|----------------------------|------------------------------|----------|
| Electricity Supply | 124.5                      | 43.9                       | -80.6                        | -64.7%   |
| Domestic Transport | 124.8                      | 111.8                      | -13.0                        | -10.4%   |

**Buildings & Products**

93.4

78.5

-14.9

-16.0%

**Industry**

74.3

53.0

-21.3

-28.7%

**Agriculture**

49.4

46.6

-2.8

-5.7%

**Fuel Supply**

39.3

30.1

-9.2

-23.4%

**Total GHG**

530.7

385.0

-145.7

-27.4%

Source: Computed by author from DESNZ (2025).

**3. UK GHG Emissions (20242027) Projection**

A simple linear regression model is <sup>13</sup>used on the 2014-2023 total GHG time series to estimate <sup>13</sup>what is expected to occur in 2024-2027 in terms of <sup>13</sup>emissions. It is a transparent, auditable method, <sup>14</sup>and is in line <sup>14</sup>with the assignment guidance that favours simplicity over complexity (Makridakis et al., 2022).<sup>2</sup> The linear regression model is:

$$\hat{Y} = -15.53(t) + 31,798.2$$

where  $\hat{Y}$  is projected total GHG emissions (MtCO<sub>2</sub>e), and t is the calendar year. The mean rate of decrease of the decade 2014-2023 has the slope of -15.53 MtCO<sub>2</sub>e/year (R<sup>2</sup> -0.94, a good linear fit). Table 3 shows the obtained forecast.

Table 3: Forecasted UK Total GHG Emissions, 2024–2027 (Linear Regression)

| Forecast Year    | Predicted GHG (MtCO <sub>2</sub> e) | Year-on-Year Change (MtCO <sub>2</sub> e) | Cumulative Reduction from 2014 (%) |
|------------------|-------------------------------------|---|------------------------------------|
| 2024 (Projected) | 367.4                               | -17.6                                     | -30.8%                             |
| 2025 (Projected) | 351.8                               | -15.6                                     | -33.7%                             |
| 2026 (Projected) | 336.3                               | -15.5                                     | -36.6%                             |
| 2027 (Projected) |                                     |   |                                    |

320.8

-15.5

-39.6%

Source: <sup>11</sup> Author's calculation using linear regression on DESNZ (2025) data (slope =  $-15.53 \text{ MtCO}_2\text{e/year}$ ).

It is projected that with the current trend, the entire UK GHG emissions will be near 320.8 MtCO<sub>2</sub>e <sup>15</sup> in 2027. Although this is a positive step, it is still significantly below the 2035 Carbon Budget, 6 of a 78% reduction at 1990 levels - meaning that yearly emissions lie within a range of 170-180 MtCO<sub>2</sub>e <sup>16</sup> (Committee on Climate Change, 2021). Linear <sup>17</sup> model neglects accelerating policy actions or technological discoveries, so it can be underestimated in terms of <sup>18</sup> decline rate in case of an ambitious policy, but it is a solid base of inferential <sup>19 17</sup> comparison (Makridakis et al., 2022). <sup>17 2</sup>

Most critically, the forecast states that the categories of sectors that cause undying emissions, especially industry, transport, and agriculture, will not decrease enough on a business-as-usual pathway. This <sup>20</sup> is precisely the place where clean hydrogen importation, as envisioned by H2Global-style mechanisms, will be able to provide targeted and scalable <sup>21</sup> decarbonisation <sup>3</sup> (Stöckl et al., 2021; Bennett and Serrenho, 2025). <sup>2</sup>

#### 4. Inferential Analysis and the Case for H2Global Replication

##### 4.1 What is H2Global?

H2Global is a German-supported mechanism, introduced in 2021 and realized <sup>3</sup> by the HINT.CO foundation, which will cover the difference between international production costs for green hydrogen and the price the European market is willing to pay. It is based on a double-auction system: HINT.CO buys green hydrogen and its derivatives, such as ammonia, methanol and synthetic aviation fuels, on contracts with producers in low-cost regions of renewable

energy and sells them to European industrial customers on smaller contracts at market-competitive prices, with the German state subsidizing the spread (van der Steen, 2025; Kundu et al., 2026).

In December 2021, the German Federal Ministry of Economic Affairs and Climate Action provided H2Global with an initial amount of 900 million, and deliveries are scheduled to start in 2024 (Thies et al., 2026). By acquiring large-scale green hydrogen shipping infrastructure, thereby de-risking investment in it, H2Global stimulates supply chain growth in exporting countries and, at the same time, lowers the import costs of energy-intensive industries in importing countries.

#### 4.2 Inferential Approach: Correlation and Trend Analysis

This <sup>22</sup> employs an inferential method using the Pearson correlation coefficient and a descriptive sector-based comparison to determine where a hydrogen substitution mechanism would be most effectively applied in the UK to address emissions. The value of Pearson  $r$  indicates the magnitude and the direction of the linear relationship between sectoral emission trends and the overall GHG trajectory (Field, 2024).

Table 4: Pearson Correlation of Sector Emissions with Total UK GHG (2014–2023)

Sector

Pearson  $r$

Interpretation

H2 Substitution Relevance

Electricity Supply

0.97

Very strong positive

Low — already decarbonised rapidly

Domestic Transport

0.93

Very strong positive

High — heavy goods & shipping sectors

Industry

0.98

Very strong positive

Very High — steel, cement, ammonia

Buildings

0.78

Strong positive

Moderate — heating applications

Agriculture

0.73

Strong positive

Low-Moderate — limited pathway

Fuel Supply

0.96

Very strong positive

Moderate — green hydrogen terminals

Source: <sup>11</sup> Author's calculation from DESNZ (2025) data. All correlations significant <sup>23</sup> at  $p < 0.05$  ( $n = 10$ ).

The correlation analysis in Table 4 indicates that industry ( $r = 0.98$ ) and electricity supply ( $r = 0.97$ ) are most closely matched with the total GHG decrease. Nevertheless, <sup>24</sup> the provision of electricity <sup>24</sup> is already on the verge of deep decarbonisation <sup>3</sup>; the remaining challenge is the industrial processes that cannot be easily electrified. These hard-to-abate industries, steel, cement,

<sup>3</sup>fertilizer manufacturing, and long-distance shipping, are the very ones that are mentioned by the IEA (2023) and by Bennett and Serrenho (2025) as the most appropriate ones to be replaced with green hydrogen in the UK scenario. Domestic transport ( $r = 0.93$ ) shows a strong correlation with the overall trajectory. Still, its decline has been relatively small ( $-10.4\%$  during 2014-2023), which can be attributed to structural inertia stemming from reliance on private cars and the gradual adoption of electric vehicles in heavy goods transport. A competitive H2Global-style mechanism to enable competitive hydrogen pricing can have an important positive impact on decarbonizing<sup>3</sup> heavy road freight, maritime shipping, and aviation, as identified in the sixth Carbon Budget (CCC, 2021; Zhai et al., 2023).<sup>2</sup>

The fact that agriculture ( $r = 0.73$ ) and buildings ( $r = 0.78$ ) are rather weakly correlated implies that the former and the latter tend to vary less along the overall GHG curve. In buildings, green hydrogen can play a role through<sup>25</sup> domestic hydrogen boilers. Still, given the UK's<sup>11</sup> existing infrastructure and safety limitations, it cannot be used in the near term (Herdem and Adams, 2026).<sup>2</sup>

#### 4.3 Analytical Recommendation

The inferential analysis is a solid argument in favor of a UK adaptation of H2Global, with priority given to industrial and heavy transport sectors where (i) emissions are still high, (ii) electrification is technically limited, and (iii) a hydrogen replacement would be the most effective decarbonisation<sup>3</sup> benefit per unit of imported volume (Bennett and Serrenho, 2025; Stöckl et al., 2021). The recommendation has been summarized<sup>3</sup> in the sector-by-sector evidence base as presented in Table 5.

Table 5: Evidence Matrix – Sectoral Priority for UK H2Global-Style Mechanism  
Sector

2023 Emissions (MtCO<sub>2</sub>e)

Forecast 2027 (MtCO<sub>2</sub>e)

Hard-to-Abate?

H2 Priority

Industry

53.0

~44.0

Yes — process emissions

★★★★★

Domestic Transport (HGV/Maritime)

111.8 (partial)

~98.0

Yes — weight/range constraints

★★★★★

Fuel Supply

30.1

~23.5

Moderate

★★★☆☆

Buildings (Heating)

78.5

~65.0

Partial

★★★☆☆

Agriculture

46.6

~44.0

Mostly biological

★★☆☆☆

Electricity Supply

43.9

~28.0

No

★☆☆☆☆

Source: Author's<sup>11</sup> analysis based on DESNZ (2025), Bennett and Serrenho (2025), CCC (2021).

## 5. Operations and Sustainability Implications

### 5.1 Operations Management Perspective

Competitive green hydrogen tenders should be conducted by a publicly funded UK body, leveraging centralized<sup>3</sup> purchasing power to achieve cost advantages and long-run supply security for producers in the Middle East, North Africa and Chile (IEA, 2023; Chen et al., 2025; Chopra and Meindl, 2022).<sup>2</sup> Although ammonia and LOHCs are more realistic carriers than liquid hydrogen, losses in reconversion efficiency remain a problem, and their viability across international borders has been proven with the Kawasaki (Shi et al., 2023)<sup>2</sup> Brunei-Japan route. Infrastructure at Milford Haven, Isle of Grain, and South Hook has potential starting points but would require significant capital retrofitting before accepting hydrogen or ammonia at scale (He et al., 2021; Ma et al., 2022).<sup>2</sup> The most resilient approach to addressing geopolitical, technological, and regulatory risks under the UK Low Carbon Hydrogen Standard is a dual-sourcing production model with imports (Bag et al., 2025; Stöckl et al., 2021).<sup>2</sup>

### 5.2 Sustainability Perspective

Green hydrogen can provide significant GHG benefits only when electrification is prioritized<sup>3</sup>, and hydrogen is implemented in hard-to-electrify industries, with potential savings of 280 MtCO<sub>2</sub>e per year across all industries (Bennett and Serrenho, 2025)<sup>2</sup>. Socially, the port, terminal, and industrial industries are expected to benefit from the creation of skilled jobs. Still, the rapid depletion of the North Sea's<sup>11</sup> fossil fuel industry requires well-regulated just transition support in line with the overall European Green Deal guidelines (Shahzad et al., 2024; Herdem and Adams, 2026; Dixon et al., 2022)<sup>2</sup>. Green hydrogen is 2-7 times more expensive than grey hydrogen today, but steep electrolyser<sup>3</sup> learning curves are expected to push the costs down to USD 2/kg in renewable-abundant areas (IEA, 2023; Kim et al., 2024)<sup>2</sup>. Subsequently, H2Global-style subsidies should be seen as temporary market-making tools, not as enduring support policies, and should fade away naturally as costs equal those of fossil substitutes (Kim et al., 2024)<sup>2</sup>.

## 6. Recommendations and Conclusion

Implement UKHIA as a publicly-funded agency that is independent and<sup>27</sup> acquires certified green hydrogen through<sup>26</sup> competitive<sup>27</sup>, three-corridor, double-auction.

Prioritize<sup>3</sup> the target steel, cement, and long-distance freight as priority offtake markets, offering the greatest GHG reduction per pound of subsidy (Bennett and Serrenho, 2025; CCC, 2021)<sup>2</sup>.

Adapt Milford Haven, Isle of Grain, and Humberside ports to receive ammonia and LOHC, lowering logistics expenses and supply-side risk (He et al., 2021)<sup>2</sup>.

Blend national 10 GW production goals with the imports of the UKHIA to balance price spikes and electrolyser<sup>3</sup> hold-ups (Stoeckl et al., 2021; Bag et al., 2025)<sup>2</sup>.

Introduce UK Low Carbon Hydrogen Standard certification <sup>30</sup> on all imports to ensure <sup>28</sup> integrity of the <sup>30</sup> lifecycle <sup>29</sup> emissions and avoid greenwashing (Herdem and Adams, 2026; Bennett and Serrenho, 2025).<sup>2</sup>

In conclusion, the quantitative analysis of UK GHG emissions confirms a robust but insufficient downward trend. The linear forecast projects emissions reaching 320.8 MtCO<sub>2</sub>e by 2027 — still far short of the 2035 Carbon Budget target. The H2Global replication is not merely an energy procurement exercise; it is a systemic intervention to restructure the <sup>11</sup> UK's industrial and transport supply chains around low-carbon hydrogen, delivering environmental, economic, and energy security co-benefits simultaneously. The analytical evidence, supported by emerging academic literature and the operational lessons of the H2Global pilot, makes a compelling case for prompt government action.

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|    |   |                           |             |
|----|---|---------------------------|-------------|
| 1. | <i>This</i>   | Intricate text            | Clarity     |
| 2. | <i>(Shahzad et al., 2024; Dixon et al., 2022); (van der Steen, 2025); (Shahzad et al., 2024); (Bennett and Serrenho, 2025); (Makridakis et al., 2022); (Stöckl et al., 2021; Bennett and Serrenho, 2025); (van der Steen, 2025; Kundu et al., 2026); (Thies et al., 2026); (Field, 2024); (CCC, 2021; Zhai et ...</i> | Citation style options    | Correctness |
| 3. | <i>decarbonise; subsidised; visualisation; visualize; decarbonisation; realized; subsidizing; decarbonised; fertilizer; decarbonizing; summarized; centralized; prioritized; electrolyser; Prioritize; decarbonization; optimization-based; optimization; utilization</i>   | Text inconsistencies      | Correctness |
| 4. | <i>sustainability; Sustainability</i>   | Text inconsistencies      | Correctness |
| 5. | <i>According to Dixon et al. (2022), the steepest decline between 2014 and 2023 was in the electricity supply sector, which dropped 64.7 percent from 124.5 MtCO<sub>2e</sub> to 43.9 MtCO<sub>2e</sub>, due to the rapid replacement of coal-generated power with renewables and gas.</i>                            | Paragraph can be improved | Clarity     |
| 6. | <i>Although the industry sector dropped consistently from 74.3 to 53.0 MtCO<sub>2e</sub>, it continues to be a chronic emitter as it is responsible for process-driven, hard-to-abate emissions from steel and cement production (Bennett and Serrenho, 2025).</i>  | Paragraph can be improved | Clarity     |
| 7. | <i>The worst-performing sector remains the domestic transport sector, which was the most emitting at 129.5 MtCO<sub>2e</sub> in 2017 and dropped to 111.8 MtCO<sub>2e</sub> in 2023.</i>  | Paragraph can be improved | Clarity     |
| 8. | <del>pandemic in 2020</del> → 2020 pandemic   | Paragraph can be improved | Clarity     |

|     |   |                           |             |
|-----|---|---------------------------|-------------|
| 9.  | <i>The average height of buildings is steadily increasing, while the average amount of 91.5 MtCO<sub>2</sub>e over the last ten years is 0.5 MtCO<sub>2</sub>e per annum.</i>   | Paragraph can be improved | Clarity     |
| 10. | <i>This</i>   | Intricate text            | Clarity     |
| 11. | <i>UK's; manufacturing's; Author's; Sea's; ';; challenges'</i>  | Text inconsistencies      | Correctness |
| 12. | <i>In comparison, agriculture estimates have been relatively stable around 46–51 MtCO<sub>2</sub>e, indicating structural difficulties with livestock emissions and soil.</i>   | Paragraph can be improved | Clarity     |
| 13. | <i>A simple linear regression model is used on the 2014-2023 total GHG time series to estimate what is expected to occur in 2024-2027 in terms of emissions.</i>  | Paragraph can be improved | Clarity     |
| 14. | <i>It is a transparent, auditable method, and is in line with the assignment guidance that favours simplicity over complexity (Makridakis et al., 2022).</i>  | Paragraph can be improved | Clarity     |
| 15. | <i>It is projected that with the current trend, the entire UK GHG emissions will be near 320.8 MtCO<sub>2</sub>e in 2027.</i>   | Paragraph can be improved | Clarity     |
| 16. | <i>Although this is a positive step, it is still significantly below the 2035 Carbon Budget, 6 of a 78% reduction at 1990 levels - meaning that yearly emissions lie within a range of 170-180 MtCO<sub>2</sub>e (Committee on Climate Change, 2021).</i> | Paragraph can be improved | Clarity     |
| 17. | <i>Linear model neglects accelerating policy actions or technological discoveries, so it can be underestimated in terms of decline rate in case of an ambitious policy, but it is a solid base of inferential comparison (Makridakis et al., 2022).</i>   | Paragraph can be improved | Clarity     |

|     |   |                                      |             |
|-----|---|--------------------------------------|-------------|
| 18. | <del>, so</del> → so that   | Inappropriate colloquialisms         | Delivery    |
| 19. | <del>, but it</del> → . Still, it   | Hard-to-read text                    | Clarity     |
| 20. | <i>This</i>   | Intricate text                       | Clarity     |
| 21. | <del>will be able to</del> → can  | Paragraph can be improved            | Clarity     |
| 22. | <i>This</i>   | Intricate text                       | Clarity     |
| 23. | were significant  | Incorrect verb forms                 | Correctness |
| 24. | <i>Nevertheless, the provision of electricity is already on the verge of deep decarbonisation; the remaining challenge is the industrial processes that cannot be easily electrified.</i>                 | Paragraph can be improved            | Clarity     |
| 25. | <del>play a role through</del> → be used in   | Paragraph can be improved            | Clarity     |
| 26. | a competitive   | Determiner use (a/an/the/this, etc.) | Correctness |
| 27. | <i>Implement UKHIA as a publicly-funded agency that is independent and acquires certified green hydrogen through competitive, three-corridor, double-auction.</i>   | Paragraph can be improved            | Clarity     |
| 28. | the integrity   | Determiner use (a/an/the/this, etc.) | Correctness |
| 29. | <i>lifecycle; life-cycle</i>  | Text inconsistencies                 | Correctness |
| 30. | <i>Introduce UK Low Carbon Hydrogen Standard certification on all imports to ensure integrity of the lifecycle emissions and avoid greenwashing (Herdem and Adams, 2026; Bennett and Serrenho, 2025).</i> | Paragraph can be improved            | Clarity     |
| 31. | . Supply  | Incorrect punctuation                | Correctness |

|     |   |                        |             |
|-----|---|------------------------|-------------|
| 32. | <b>pathways '</b>   | Incorrect punctuation  | Correctness |
| 33. | <b>.Discovering</b>   | Incorrect punctuation  | Correctness |
| 34. | <i>van der Steen, M. (2025) H2Global: Can Private Investment Help in Scaling the European Green Hydrogen Economy.</i> | Ungrammatical sentence | Correctness |