| | |
|---|---|
| **Title:** Low carbon hydrogen certification scheme impact assessment<br><br>**IA No:** DESNZ030(F)-23-HICCD<br><br>**RPC Reference No:** N/A<br><br>**Lead department or agency:** Energy Security & Net Zero<br><br>**Other departments or agencies:** None | **Impact Assessment (IA)**<br><br>**Date:** 21/08/2023<br><br>**Stage:** Consultation response<br><br>**Source of intervention:** Domestic<br><br>**Type of measure:** Non-legislative<br><br>**RPC Opinion:** N/A |

## Summary: Intervention and Options

| **Cost of Preferred (or more likely) Option** (in 2019 prices) | | | |
|---|---|---|---|
| **Total Net Present Social Value** | **Business Net Present Value** | **Net cost to business per year** | **Business Impact Target Status** |
| -£7.1m | -£4.1m | £0.58m | Not a regulatory provision |

**What is the problem under consideration? Why is government action or intervention necessary?**

Low carbon hydrogen will play a critical role in decarbonising the UK and reaching net zero emissions for 2050. The Low Carbon Hydrogen Standard (LCHS) sets out a definition for "low carbon hydrogen" in the UK and is used as an eligibility criterion for government subsidy schemes. At present, there is no means for buyers and users of hydrogen to trace and verify the emissions intensity of hydrogen through proving compliance with the LCHS. This limits the ability for the LCHS to drive decarbonisation in the hydrogen economy and act as a standardisation tool. By introducing a certification scheme for low-carbon hydrogen, the Government would provide a means for end users to trace and verify the emissions intensity, and confirm the LCHS compliance, of their purchased hydrogen, and allow the LCHS to set a clear definition for "low carbon" across the market.

**What are the policy objectives of the action or intervention and the intended effects?**

The intended low-carbon hydrogen certification scheme will be voluntary and non-legislative. Its primary design feature is to provide end users with a robust and independent means to verify the emissions intensity of their hydrogen. In turn, this should facilitate the growth of the hydrogen economy by encouraging use of hydrogen, which support the UK's decarbonisation pathway towards net zero carbon emissions. The indicators of success will be uptake of the scheme – the proportion of the UK hydrogen market that is enrolled in the scheme and being certified.

**What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)**

**Counterfactual (do nothing)**: no certification scheme introduced by government. All other hydrogen policies e.g. funding programmes (such as the HPBM and NZHF) remain in place.

**Option 1 (preferred)**: a certification scheme with a mass balance chain of custody.

**Option 2**: a certification scheme with a book-and-claim chain of custody.

Both Options 1 and 2 are voluntary and non-regulatory.

| | | | | |
|---|---|---|---|---|
| **Will the policy be reviewed?** It will be reviewed. **If applicable, set review date:** 2028. | | | | |
| Is this measure likely to impact on international trade and investment? | | Yes | | |
| Are any of these organisations in scope? | **Micro**<br>Yes | **Small**<br>Yes | **Medium**<br>Yes | **Large**<br>Yes |
| What is the $CO_2$ equivalent change in greenhouse gas emissions? (Million tonnes $CO_2$ equivalent) | | **Traded:**<br>**N/A** | **Non-traded:**<br>**N/A** | |

***I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.***

Signed by the responsible Minister: Martin Cole Date: 26/09/2023

# Summary: Analysis & Evidence

Policy Option 1

**Description:** a hydrogen certification scheme with a mass balance chain of custody.

**FULL ECONOMIC ASSESSMENT**

| Price Base Year 2019 | PV Base Year 2020 | Time Period Years 8 | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| | | | **Low:** N/A | **High:** N/A | **Best Estimate:** -£7.4m |

| COSTS (£m) | Total Transition (Constant Price) Years | Average Annual (excl. Transition) (Constant Price) | Total Cost (Present Value) |
|---|---|---|---|
| **Low** | N/A | N/A | **N/A** |
| **High** | N/A | N/A | **N/A** |
| **Best Estimate** | £2.4m | £0.8m | **£7.1m** |

**Description and scale of key monetised costs by 'main affected groups'**

Monetised costs to business consist of familiarisation (£40,000 in 2030), annual audits of production plants (£120,000 in 2030) and registering of certificate transactions (£2.1m in 2030). Monetised costs to government consist of the set-up costs of the scheme, including IT infrastructure (£2.75m in total), and ongoing costs of processing enrolments into the scheme (£40,000 in 2030), issuing certificates (£240,000 in 2030) and management & overheads, including enforcement activity (£50,000 in 2030). All costs are nominal at current prices and apply to all business collectively.

**Other key non-monetised costs by 'main affected groups'**

No non-monetised costs.

| BENEFITS (£m) | Total Transition (Constant Price) Years | Average Annual (excl. Transition) (Constant Price) | Total Benefit (Present Value) |
|---|---|---|---|
| **Low** | N/A | N/A | **N/A** |
| **High** | N/A | N/A | **N/A** |
| **Best Estimate** | N/A | N/A | **N/A** |

**Description and scale of key monetised benefits by 'main affected groups'**

No monetised benefits.

**Other key non-monetised benefits by 'main affected groups'**

We expect the hydrogen certification scheme will facilitate and encourage the growth of the UK hydrogen economy, increasing investment and generating additional jobs. In turn, this will aid the UK's decarbonisation, reducing emissions by supporting fuel switching to hydrogen and increasing end use of hydrogen.

| **Key assumptions/sensitivities/risks** | **Discount rate (%)** | 3.5 |
|---|---|---|

Given lack of data due to the nascency of the low-carbon hydrogen market at present, we have relied on proportionate use of assumptions for this analysis. Our key assumptions relate to the time taken for the various activities required under the scheme and the nature of hydrogen production such as load factor. These assumptions are simplifying, and the hydrogen market may ultimately look different. On hydrogen production in particular, our simplifying assumptions likely bias our estimates for costs upwards. Separately, we have assumed the scheme is UK-wide, as per the intention of the Government Response, but this is not confirmed.

**BUSINESS ASSESSMENT (Option 1)**

| Direct impact on business (Equivalent Annual) £m: | | | Score for Business Impact Target (qualifying provisions only) £m: |
|---|---|---|---|
| **Costs:** 0.58 | **Benefits:** N/A | **Net:** -0.58 | 2.9 |

# Contents

# Evidence Base

## Problem under consideration and rationale for intervention

1. In 2019 the UK legislated for a binding target of net zero carbon emissions for the country by 2050 and in 2021 published its Net Zero Strategy[1], which set out the UK's plans for meeting its future carbon budgets and its vision for a decarbonised economy in 2050.

2. In the Net Zero Strategy, low carbon hydrogen is expected to play a significant role in the UK's transition to being a net zero economy by replacing use of fossil fuels, particularly natural gas, in industry, and potentially providing an alternative power source for industries which cannot easily be electrified, such as heavy transport. The Net Zero Strategy set a target of 5GW of hydrogen production capacity for 2030, which was then increased by the British Energy Security Strategy in 2022 to 10GW, of which at least half would be electrolytic production[2].

3. Separately, the Government also published the Low Carbon Hydrogen Standard (LCHS) in April 2022, updated in April 2023[3], which defined low carbon hydrogen as having an emissions intensity under $20gCO_{2e}/MJ\ H_2$ (LHV) and set out an emissions accounting methodology. The LCHS is for use in government support schemes for hydrogen production, such as the Hydrogen Production Business Model (HPBM)[4].

4. Currently, there is no reliable, robust means for an end user of hydrogen to know definitively the emissions intensity of the hydrogen they are using, or whether their purchased volumes are compliant with the LCHS. Given that low and high carbon hydrogen are physically indistinguishable, this risks information failure on the part of consumers. Certification based on other standards could be used by industry but there will be a lack of clarity on if the hydrogen is meeting UK Government standards. In turn, this could impede the growth and operation of the low carbon hydrogen market where the LCHS is limited in its ability to create standardisation across the UK market and therefore lessen government's ability to drive the hydrogen economy towards net zero through the standard.

5. In addition, without a way to demonstrate the emissions intensity of their hydrogen against the LCHS, end users will find it more difficult to assess (and demonstrate) the emissions intensity of their own products in line with UK standards. This could lead to a reduction in consumer confidence when purchasing low carbon hydrogen and reduce the ability for low carbon hydrogen to drive decarbonisation in offtaker sectors. Slower adoption of low carbon hydrogen to replace fossil fuels and high carbon hydrogen currently in use will impede industrial decarbonisation, which forms a critical part of the UK's path towards achieving net zero emissions by 2050.

6. There is therefore a need for intervention to provide consumers with the information on the origin and emissions intensity of the hydrogen they are using in line with the LCHS, facilitating the future growth and operation of the hydrogen market, both domestically and internationally. Industry schemes may come forward and certify for the LCHS but this is unlikely to be delivered in time for when volumes of low carbon hydrogen start to come online, estimated for 2025.

7. Alternatively, an abundance of industry schemes could overcomplicate the market and reduce the effectiveness of standardisation, leaving industry with a lack of clarity over what certification schemes will meet their needs. A certification scheme led by government for low-carbon hydrogen can therefore provide a consistent, robust and independent means of verifying the emissions intensity of hydrogen for industry. This can then be used to increase the confidence of end users in the low-carbon credentials of the hydrogen they buy.

8. Separately, international trade is likewise affected by the lack of clarity over UK certification and standards. Different countries have different definitions of 'low-carbon' and, therefore, when hydrogen is traded internationally there will be a method of providing evidence on emissions to

[1] *Net Zero Strategy*, BEIS, 2021.
[2] British Energy Security Strategy, BEIS, 2022, p. 22.
[3] Low Carbon Hydrogen Standard, DESNZ, 2023.
[4] Via allocation exercises like the Hydrogen Allocation Rounds.

give confidence for end users. Certification is one way of solving this by providing the means to demonstrate compliance with the UK's LCHS.

9. Different certification schemes will exist for different low-carbon standards. In the future, therefore, we will need a way of 'mutually recognising' different schemes so that they are interoperable and do not hinder international trade. Lack of interoperability will require businesses trading across different standard areas to use multiple schemes to access different markets, increasing costs for business.

10. Overall, the government is best placed to resolve this market failure as it can a) provide a consistent and fair methodology for the entire market and (via the scheme administrator) apply it in an independent and transparent manner, and b) seek 'mutual recognition' with other standards and schemes to facilitate international hydrogen trade.

11. The proposed certification scheme would be voluntary and non-legislative, at least initially. It is intended to be introduced in 2025 and may need to evolve over time as the hydrogen market develops. In the longer-run, as the hydrogen market and economy mature, the certification scheme may be legislated for, subject to future policy decisions.

## Rationale and evidence to justify the level of analysis used in the IA (proportionality approach)

12. The market for low-carbon hydrogen is immature both domestically and internationally. Future supply and demand are highly uncertain, as are the long-term business models and producer-consumer relationships in the market. Also, many of the technologies under consideration are experimental or unproven at scale, and there will likely be significant technological advancement in hydrogen production techniques over the coming decades.

13. Moreover, future, and currently undetermined, policy decisions, both by the UK Government and other countries, will shape and affect the market in deep and fundamental ways. For example, decisions over the use of hydrogen (such as for heating or transport) have the potential to radically shape domestic and international demand.

14. Consequently, robust data on the future hydrogen market does not exist. Evidence on the potential impacts of the certification scheme is therefore severely limited. Accordingly, given the scheme is voluntary and non-regulatory, we have employed a proportionality approach, making reasoned assumptions to estimate costs where appropriate when there is a lack of specific evidence. See the 'Risks and Assumptions' section for more detail. Annexes A and B provide the methodological details and specific underlying assumptions.

15. These assumptions are similar to those used in the de minimis assessment[5] and were tested in our consultation, receiving largely supportive responses. In response to comments around uncertainty for some estimates, we have conducted sensitivity analysis.

16. Nonetheless, some potential impacts were not possible to monetise. These are covered in more detail in the Costs and Benefits section below, but in summary were the benefits of a) facilitating the growth of the hydrogen economy and b) encouraging decarbonisation by substituting fossil fuels for hydrogen alternatives, and c) the potential transfer from end users to government via producers through the interaction of a 'green' premium of certification with the HPBM.

17. The appraisal period for this assessment is 2023-2030. The immaturity of the hydrogen market at present, and the resultant uncertainty, means projecting our assumptions forward further than 2030 is likely to not be robust, so we have restricted the appraisal period accordingly.

[5] UK Low Carbon Hydrogen Certification Scheme: de minimis assessment, BEIS, 2023.

## Description of options considered

18. The Government committed to setting up a certification scheme for low-carbon hydrogen in the British Energy Security Strategy (BESS) from 2025[6]. This commitment did not pre-judge the form of the certification scheme.

19. There are several low-carbon hydrogen certification schemes (or more general schemes which can certify hydrogen) in development internationally. CertifHy[7], TÜV SÜD[8], and the International Sustainability and Carbon Certification (ISCC)[9] are the main European examples, either as a Guarantee of Origin which looks to demonstrate the share or quantity of energy from renewable sources in an energy supplier's energy mix, or as a certification scheme to prove compliance with mandatory requirements for the supply of Renewable Fuels of Non-Biological Origin (RFNBOs). These certify to the requirements set out in the Renewable Energy Directive (REDII), accompanying delegated acts and standards (CEN-EN 16325). The EU operates under an 'recognition' model, where private schemes apply to the European Commission for recognition.

20. Under these schemes, hydrogen certified under a Guarantee of Origin, which operates with a book and claim chain of custody while certification for RFNBOs operate under a mass balance system. These schemes distinguish between renewable hydrogen (generated by renewable electricity) and from fossil input with low associated emissions. Other countries are also developing their certification schemes (China, Australia and others). Although Government will not prevent producers from accessing other schemes, some of these schemes are only available to EU markets, and they do not currently certify to the UK's LCHS meaning they are not well suited to the future UK hydrogen economy.

21. For the purposes of this impact assessment, the cost-benefit analysis focuses on the prospective chain of custody the certification scheme could employ, continuing the approach used in the de minimis assessment. Chain of custody refers to how hydrogen will be traced throughout the value chain. In any certification scheme, certified products must be tracked throughout the supply chain so that valid claims can be made about their sustainability properties when they are consumed. This tracking can be more or less strict depending on the selected chain of custody. It will hence determine which producers and end users have the right to make sustainability claims. It is, therefore, the most important decision for defining the shape of the certification scheme.

22. The consultation on the introduction of a Low Carbon Hydrogen Certification Scheme asked respondents whether they preferred a mass balance or book-and-claim chain of custody, with the Government's minded-to position being for mass balance. These two alternatives therefore form the options considered in this impact assessment, as follows:
    - **Option 0 (counter-factual)**: do nothing (i.e. do not introduce a certification scheme);
    - **Option 1 (preferred)**: a mass balance chain of custody-based certification scheme; and
    - **Option 2 (alternative)**: a book-and-claim chain of custody-based certification scheme.

23. Excluding the counter-factual, the two options have several elements in common:
    - To make use of certificates, producers and end users are required to enrol in the scheme;
    - Metering of hydrogen production and storage until it leaves the production site;
    - Production plants are to be annually audited to ensure they align with their reporting; and
    - Production and emissions data is to be submitted and verified every month.

### Option 0 (counter-factual): do nothing

24. In this impact assessment, the monetised costs and benefits of introducing a certification scheme are measured against a counterfactual where there is no UK scheme, or equivalent, introduced.

25. The current support schemes – the Net Zero Hydrogen Fund and the Hydrogen Production Business Model – would continue to operate as planned.

[6] British Energy Security Strategy, BEIS, 2022, p. 23.
[7] https://www.certifhy.eu/
[8] https://www.tuvsud.com/en-gb
[9] https://www.iscc-system.org/

## Option 1 (preferred): a mass balance chain of custody-based certification scheme

26. Under this Option, the certification scheme would use a mass balance chain of custody. This is the Government's preferred approach. Under this chain of custody, the certificate that verifies the low carbon status of a batch of hydrogen entering the system is passed along the supply chain until the point that a consumer requiring certified hydrogen takes it out of the system. The certificate is 'bundled' with the sale of hydrogen at each link in the supply chain.

27. By way of example:
    - An electrolyser produces 10MWh of hydrogen that it bundles as a single volume. The electrolyser operator submits its emissions calculations for that volume to the scheme administrator, which are verified to be $10gCO_{2e}$/MJ $H_2$ (HHV).
    - Accordingly, the electrolyser operator is issued 10 certificates for 10MWh, which record that the hydrogen was produced at an emissions intensity of $10gCO_{2e}$/MJ $H_2$ (HHV).
    - That volume is then sold to a supplier, who on taking possession of the hydrogen also receives the certificates, as these are tied to the hydrogen.
    - That hydrogen is then sold on to an industrial end user, who also receives the certificates.
    - The end user then combusts the hydrogen and the certificates are no longer traded.

28. As certificates are tied to the hydrogen, they are not tradeable independently (cf. to Option 2 below). Certificates could be used by end users (or anyone in the supply chain buying the hydrogen) to verify the emissions intensity of the hydrogen they have bought, as each certificate would have the emissions intensity of the corresponding hydrogen included.

29. Each time the ownership of the physical hydrogen, and hence the attached certificate, changes, this change of ownership would have to be registered by the relevant businesses in a certificate registry operated by the scheme administrator.

30. This is our preferred option as it best meets the Government's primary design feature for the certification scheme, namely providing end users of hydrogen with the robust and verified information about the emissions content of their purchased hydrogen.

## Option 2 (alternative): a book-and-claim chain of custody-based certification scheme

31. Under this form of chain of custody, certificates would be issued at the point of production on a per MWh basis and then be separate commodities to the hydrogen itself. Certificates would be bought and sold on a trading platform created and administered by the scheme administrator. An end user wishing to badge their hydrogen as 'low carbon' could buy the appropriate number of certificates to do so. The certificates would be retired when the hydrogen was consumed.

32. By way of example:
    - An electrolyser produces 10MWh of low carbon hydrogen that it bundles as a single volume. The producer submits its emissions calculations for that volume to the scheme administrator, which are $10gCO_{2e}$/MJ $H_2$ (HHV), and so comply with the LCHS.
    - The producer receives 10 certificates, which record the emissions intensity and LCHS compliance (as well as other mandatory data fields). The producer then puts those certificates up for sale on the trading platform.
    - Separately, an industrial end user buys 10MWh of natural gas. It then buys the above 10 certificates via the trading platform and assigns these, with their recorded emissions intensity, to the 10MWh of natural gas used.
    - The end user then combusts the natural gas and the 10 certificates are registered as "retired" in the trading platform. The certificates are used by the end user to "offset" the emissions from natural gas, so they can claim they have reduced their emissions.

33. Under this option, it would not be possible to trace the emissions of hydrogen, as the certificates are not tied to a physical volume of hydrogen. Also, this would create the risk of 'greenwashing', whereby high-carbon activities can be masked as low-carbon through certificates. It would likely, however, be less burdensome on intermediaries (e.g. transporters), who would not need to participate in the scheme and report certificate transactions.

## Policy objective

34. The overall objective of the certification scheme is to support the decarbonisation of the hydrogen economy. To this end, it should align with the UK's net zero objectives. It should also minimise any risk of greenwashing and encourage decarbonisation through compatibility with other domestic decarbonisation schemes to generate synergies. This is best achieved by making sure that there is a clear link between producers and end users of low carbon hydrogen.

35. Accordingly, the primary design feature of the scheme is to connect producers and end users by providing a method of verifying and tracing the emissions of low carbon hydrogen use, so that end users can have confidence in the low carbon credentials of their hydrogen.

36. It should also support other, secondary, design features, namely:
    - The scheme should stimulate market growth and incentivise the production of low carbon hydrogen. To this end, it should allow for wide participation across the hydrogen industry. It should also reflect market preferences for low carbon hydrogen as a distinct product through certificate transactions and pricing that allows producers and consumers in the market to capture the low carbon (or 'green') premia of low carbon hydrogen. Supporting market growth also requires a user-friendly scheme with limited administrative burdens and participation costs for scheme participants.
    - The scheme should facilitate cross-border trade in low carbon hydrogen. Its design should consider compatibility with international schemes of an appropriate standard, including those of likely hydrogen trade partners. It should also be predictable and provide a stable, long-term investment perspective to international markets so international players can easily forecast certification compliance.

37. The principal indicator of success of the scheme will be the proportion of hydrogen that is enrolled and certified by the scheme. Industry feedback will also be critical to assess its success.

## Summary and implementation of preferred option

38. The certification scheme will, on launch from 2025, be a voluntary and non-legislative scheme with mass balance as its chain of custody (Option 1), fulfilling our priority design feature of providing end users with a means to track and verify the emissions intensity of their hydrogen. The secondary priority design feature aims to stimulate market growth and incentivise the production of low carbon hydrogen by allowing wide participation across hydrogen industry and facilitating cross border trade in low carbon hydrogen.

39. The scheme will be led by government. Government will act as scheme administrator and 'competent authority'. The Low Carbon Contracts Company (LCCC), as the intended delivery partner for the scheme, would take on the roles of the certification and issuing body.

40. The scheme may need to evolve as the hydrogen market and government policy develops. To ensure that the scheme retains its value in the context of emerging needs and priorities, we will continue to work closely with Devolved Administrations on the development of the scheme and to consider and accommodate different regional contexts within it where possible, while aiming to retain the benefits of offering a single, UK-wide scheme. Moreover, the scheme being tied to the LCHS, which will itself evolve with the hydrogen market, will provide further flexibility for the certification scheme to ensure it meets the needs of the hydrogen economy.

## Monetised and non-monetised costs and benefits of each option

### Risks and assumptions

41. Full methodological details for our cost-benefit analysis are found in Annexes A (production and volume of certificates) and B (monetised costs). As noted above, the immaturity of the low-carbon hydrogen market means there is limited evidence available for us to use in analysis. Consequently, given the scheme is voluntary and non-regulatory, we have used a proportional approach where we made reasonable assumptions based on our understanding of hydrogen production and the planned structure of the scheme.

42. These assumptions are largely the same as those we used for the de minimis assessment which accompanied the consultation (with some small adjustments as noted in the Annexes). In the consultation, we sought feedback and comments on those assumptions, in particular:
    - Whether there were any significant costs of participating in the scheme not captured; and
    - Whether our assumptions around the labour time taken for each activity (e.g. familiarisation, registering certificate transactions and so on) seemed reasonable.

43. On the former, we received mostly positive responses that we had captured all the relevant costs. Some responses suggested we had omitted the cost for producers of setting up IT systems to collect and report the necessary data for certification. We considered this and concluded that, since HPBM funding is also contingent on demonstrating compliance with the LCHS, and the certification scheme's reporting requirements are aligned with the approach taken by the HPBM, the reporting requirements for producers accessing HPBM funding will be minimal. As we expect most, if not all, hydrogen producers in the appraisal period to be receiving HPBM funding, we therefore made the simplifying assumption that there will be no additional costs to producers.

44. On the latter, most responses again agreed with our approach, though many noted the considerable uncertainty inherent in these assumptions. Accordingly, we have conducted sensitivity analysis on the labour assumptions, varying the time taken for each activity by $\pm$50% and assessing the resulting effect on cost estimates.

45. Separately, we also asked in the consultation about whether there would be a 'green premium' for certificated versus non-certificated hydrogen. The potential existence of this was raised in the de minimis assessment but left non-monetised due to then undetermined interactions with the HPBM. Responses mostly agreed that there would be a green premium but noted the uncertainty. We have noted this as a potential transfer, per the below.

**Monetised costs**

*To business*

46. Costs to business from participating in the scheme come from three sources:
    - **Registering certificate transactions**: dependent on the chain of custody, businesses participating in the scheme will have to register the changes in ownership of certificates.
    - **Audit**: the costs associated with having production plants audited every year.
    - **Familiarisation**: the costs associated with reading and understanding the scheme guidance for a business to properly use the scheme.

47. We estimated the nominal annual costs to business as a whole for each option to be as follows:

**Table 1: nominal annual costs to business by activity (nearest £000s), Option 1 (mass balance)**

| Activity | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Registering certificate transactions | - | - | 55 | 227 | 514 | 915 | 1,431 | 2,061 |
| Audit | - | - | 3 | 14 | 31 | 55 | 85 | 123 |
| Familiarisation | - | - | 19 | 21 | 27 | 32 | 38 | 43 |
| ***Total*** | ***-*** | ***-*** | ***77*** | ***262*** | ***572*** | ***1,002*** | ***1,554*** | ***2,227*** |

**Table 2: nominal annual costs to business by activity (nearest £000s), Option 2 (book-and-claim)**

| Activity | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Registering certificate transactions | - | - | 37 | 152 | 343 | 610 | 954 | 1,374 |
| Audit | - | - | 3 | 14 | 31 | 55 | 85 | 123 |
| Familiarisation | - | - | 19 | 21 | 26 | 31 | 36 | 41 |
| ***Total*** | ***-*** | ***-*** | ***59*** | ***186*** | ***399*** | ***696*** | ***1,075*** | ***1,538*** |

*Note: may not sum due to rounding.*

48. For both options, registering certificate transactions is the main component (c.90%) of costs to business from participating in the scheme. This is driven by the volume of batches of certificates we have estimated per Annexes A and B. As noted there, our simplifying assumption around the load factor of hydrogen production (assumed as 100%) is likely to lead to an overestimate for the volume of certificates and in turn the costs of registering certificate transactions. This cost is lower for option 2 because of the nature of book-and-claim versus mass balance, reflected in our assumption of 2 and 3 certificate transactions respectively needing to be registered on average per Annex B, as in mass balance every change of ownership (e.g. from producer to transporter to end user) of the hydrogen has to be registered.

49. Familiarisation costs are similar for both options, with option 2 marginally lower as transporters are not included in the number of businesses needing to familiarise themselves with the scheme as, under book-and-claim, they will not need to participate in the certification scheme as they do not need to register certificates. Audit costs are the same for both options as we assumed the same number of enrolled production plants and auditing approach for both options, per Annex B.

50. These costs give an equivalent annualised net direct costs to business (EANDCB) of:
    - **Option 1 (mass balance)**: £581,000
    - **Option 2 (book-and-claim)**: £403,000

51. Overall, our preferred option (Option 1) has higher costs to business than Option 2, because under mass balance hydrogen intermediaries and the midstream (e.g. transporters) have to interact with the system in addition to end users and producers, unlike under book-and-claim. Nonetheless, it is out preferred option because, as detailed above, it best meets our strategic objectives for the certification scheme. Mass balance, in contrast to book-and-claim allows tracing and verifying of the emissions intensity of hydrogen through the supply chain, which is the primary priority design feature of the certification scheme.

*To government*

52. Costs to government come from two sources (see Annex B for methodology details):
    - **Set-up**: the costs of designing the certification scheme and creating the requisite IT infrastructure (such as the certificate registry).
    - **Ongoing**: the costs of processing enrolments into the scheme, issuing certificates, and management and overheads (includes enforcement and non-compliance where relevant).

53. We estimated the nominal annual costs to government for each option as follows:

**Table 3: nominal annual costs to government by activity (nearest £000s), Option 1 (mass balance)**

| Activity | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Set-up costs | - | 2,432 | - | - | - | - | - | - |
| Processing enrolments | - | - | 17 | 19 | 23 | 28 | 33 | 38 |
| Issuing certificates | - | - | 6 | 27 | 60 | 108 | 168 | 242 |
| Management and overheads | - | 304 | 3 | 6 | 10 | 23 | 38 | 38 |
| ***Total*** | ***-*** | ***2,736*** | ***26*** | ***51*** | ***94*** | ***153*** | ***226*** | ***315*** |

**Table 4: nominal annual costs to government by activity (nearest £000s), Option 2 (book-and-claim)**

| Activity | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Set-up costs | - | 2,432 | - | - | - | - | - | - |
| Processing enrolments | - | - | 17 | 18 | 23 | 27 | 32 | 36 |
| Issuing certificates | - | - | 6 | 27 | 60 | 108 | 168 | 242 |
| Management and overheads | - | 304 | 3 | 6 | 10 | 17 | 25 | 35 |
| ***Total*** | ***-*** | ***2,736*** | ***26*** | ***51*** | ***94*** | ***152*** | ***225*** | ***313*** |

*Note: may not sum due to rounding.*

54. Costs to government of both options are almost identical, with option 2 being marginally lower because of lower processing enrolments costs (and in turn management and overheads, which are taken as 12.5% of all other costs to government in a given year). This derives from transporters not having to be enrolled in the scheme under book-and-claim, so there are slightly fewer applications to process.

*Total costs*

55. The total costs for both business and government under each option are taken by summing the above costs to business and government for each option in a given year:

**Table 5: total nominal costs to government and business for each option (£mns).**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Option 1 (mass balance)** | 0 | 2.7 | 0.1 | 0.3 | 0.7 | 1.2 | 1.8 | 2.5 |
| **Option 2 (book-and-claim)** | 0 | 2.7 | 0.1 | 0.2 | 0.5 | 0.8 | 1.3 | 1.9 |

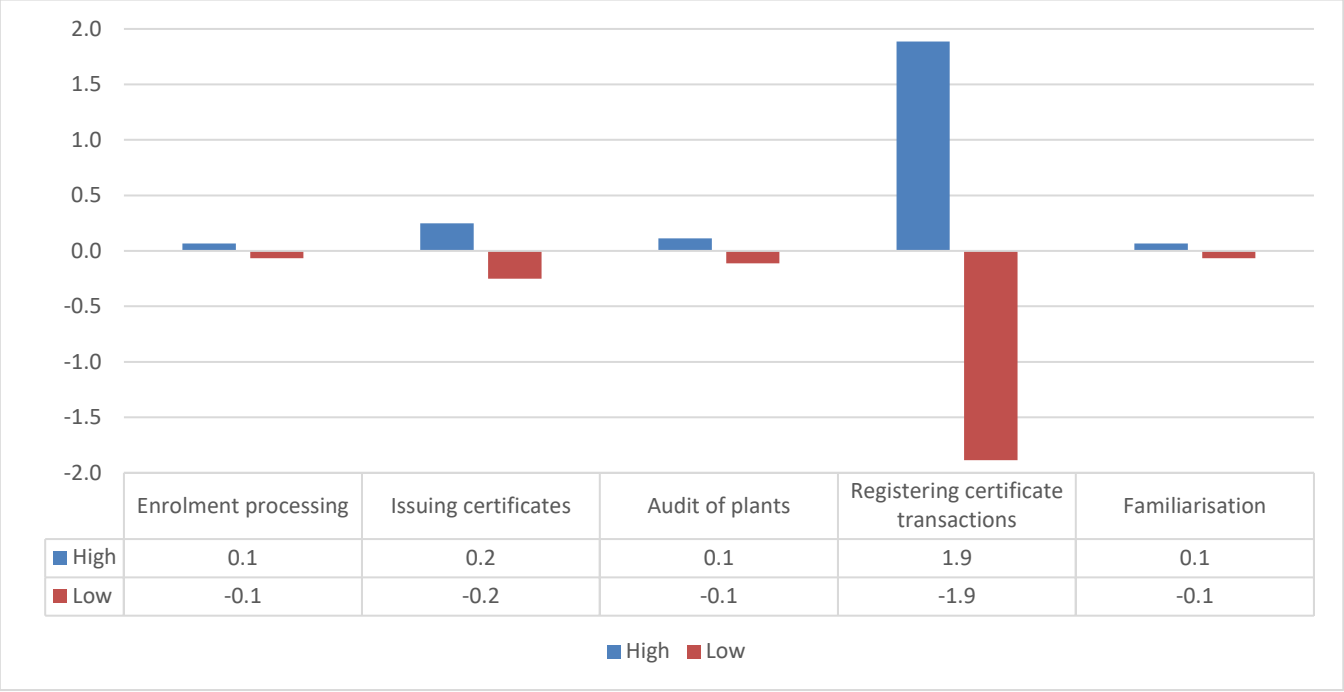
*Note: rounded to nearest 100,000.*

56. These were then discounted to give the NPV costs in the economic assessment above.

**Sensitivity analysis of monetised costs**

57. As noted above, in the consultation responses to our question about the labour assumptions, many responses noted the uncertainty in estimating these. Accordingly, we have conducted sensitivity analysis by varying the time taken for each ongoing activity by ±50%, reflecting the range of responses to the consultation, and assessing the resulting effect on the social net present value (SNPV). We have only done this for our preferred option, Option 1.

**Figure 1: change in SNPV compared to central estimate, by labour activity (£mns).**




58. SNPV is most sensitive to the input assumptions (the time taken per registration, the wage rate and the number of batches of certificates) of registering certificate transactions, following directly on from it being, by a considerable margin, the largest component of the SNPV.

**Non-monetised transfers**

59. In addition to the monetised costs above, there may also be, to some degree, a transfer from end users to producers deriving from the expected low carbon (or 'green') premium of certification. Transfers are not included in the headline SNPV estimates. As certificated hydrogen is expected

to have a higher sales price if end users are willing to pay a higher price for certified hydrogen, this may reduce the amount of revenue support a producer will receive under the HPBM, subject to the treatment of low carbon hydrogen certificates under the LCHA. This would be a transfer from end users, who are paying a higher price, to government, which is paying less subsidy. We have not monetised this as the design of the certification scheme is still under development, and further work is required to consider the appropriate interactions between certification and the LCHA as well as the treatment of any green premium under the LCHA.

**Non-monetised benefits**

60. We expect there to be considerable benefits from the certification scheme stemming from its potential to encourage the growth of the hydrogen economy. With the information failure corrected, end users will have more confidence in using hydrogen and thus will adopt it more quickly and to a greater extent. This would help stimulate investment and create jobs, while also accelerating decarbonisation and supporting the UK's path towards net zero carbon emissions.

61. As noted above, the nascency of the hydrogen market means there is a lack of robust data available for analysis. This is especially significant for these potential benefits which will be strongly shaped by how the hydrogen market and economy develop. We have therefore not monetised these benefits.

## Impact on small and micro businesses

62. Overall, it is unclear whether small and micro businesses (SMBs) will be impacted more or less than larger businesses. We expect that many production plants themselves, particularly electrolysers, as well as hydrogen intermediaries (e.g. transporters) and specific end users, will fall under the 49-employee threshold to be classed as an SMB, though the plant may be operated by a larger business.

63. On the one hand, under both options, the main driver of costs is registering certificate transactions (especially in Option 1). The size of these costs for a given business are a product of the volume of batches of certificates it will handle, which is ultimately a product of the volume of hydrogen being produced, transported or consumed; larger hydrogen businesses will inevitably have to handle more batches and so will incur higher costs than smaller ones in absolute terms.

64. On the other hand, smaller businesses may have higher per incidence costs (see Annex B) than larger ones e.g. taking longer to familiarise themselves with the details of the scheme. The Government will aim to ensure the details of the scheme are available and published sufficiently long before the launch of the scheme itself to alleviate this risk. Also, where possible, we will align reporting and verification requirements with hydrogen support schemes such as the HPBM to reduce the burden on business from these requirements.

## Wider impacts

65. As this measure only affects businesses and not individuals, we do not anticipate any impacts on individuals with protected characteristics. Individuals will not participate in the scheme as producers, transporters or end users and so will neither incur any of its costs nor enjoy its benefits. It is possible that individuals, including those with protected characteristics, may be indirectly affected by end users passing on the costs/benefits, though we cannot determine this at present given the nascency of the market.

66. As considered above, we expect that the certification scheme will encourage the growth of the hydrogen economy by making hydrogen more attractive to end users as they are now able to have confidence in its reported emissions intensity. This may increase investment and generate jobs, while also supporting decarbonisation and reducing UK carbon emissions.

## Potential trade implications of the certification scheme

67. In the longer-run, the certification scheme could provide the means to facilitate trade in low-carbon hydrogen by allowing verification of emissions intensity across national borders. This will

require international cooperation and developments in international standards. Various international forums are assessing solutions for mutual recognition and how certificates will follow hydrogen when it is traded across borders.

68. For example, UK-produced hydrogen could be exported to another country, have its UK-certificate recognised by the relevant foreign regulator (or exchanged for an equivalent national certificate), and therefore have its emissions intensity verifiable by the foreign importer and ultimate end users. A similar situation could arise for imports, allowing UK importers of foreign hydrogen to verify its emissions intensity.

69. Domestic and foreign businesses producing, transporting or using low-carbon hydrogen in the UK will not face different obligations, as certificates are issued based on UK production regardless of the ultimate ownership of the business. The scheme's focus will be UK initially and policy for international alignment is not yet developed. Therefore, this IA does not prejudge how the scheme will apply to imports and exports.

70. That, combined with the nascency of the low-carbon hydrogen market at present, led us to make the simplifying assumption that there is no international trade of hydrogen for the duration of the appraisal period in this assessment. Therefore, there are no international trade impacts captured in this assessment.

## Monitoring and Evaluation

71. The certification scheme as launched in 2025 will continue to evolve as the hydrogen market develops. Through the early years of its operation, we will continually monitor and evaluate the performance of, compliance with, and risks of, the scheme against its aims as set out above. This evidence will inform the refinement and evolution of the scheme in parallel with the development of the hydrogen market, enabling the scheme to settle into its permanent form.

72. In particular, we will monitor enrolment in the scheme, as well as spend and benefits, and work closely with the scheme administrator to ensure sufficient information is collected to permit effective monitoring and evaluation of the scheme against its key objectives. We will also monitor compliance to ensure that the scheme structure and guidelines are effective in ensuring that only eligible low-carbon hydrogen is certified and that certificates are being used appropriately.

73. Post-implementation evaluation projects will provide further analysis of information not collected by the administrator. A thorough evaluation plan will be developed in advance of the commencement of the scheme and will be integrated into its delivery.

## Annex A: volume of certificates methodology

1. To estimate the potential costs and benefits of the certification scheme, we first had to estimate the volume of certificates that would be in circulation over the appraisal period.

2. We estimate this through the following equation:

$$N = H \times L \times U \times I$$

3. Where *N* is the total number of certificates in circulation in a given year; *H* is the total low-carbon hydrogen production capacity that year; *L* is the weighted average load factor of hydrogen production; *U* is the uptake rate of the certification scheme by producers for that year i.e. the proportion of production being certified; and *I* is the number of certificates issued per MWh.

*Production capacity (H)*

4. We benchmarked low-carbon production capacity according to announced aims: 2GW of annual capacity in 2025, per the Investment Roadmap[10], and 10GW total annual capacity 2030, per the British Energy Security Strategy ambition.

5. For simplicity, we assumed production capacity increases at a constant rate of 1.6GW per year between 2025 and 2030 to get from 2GW to 10GW, as the precise pathway to 10GW depends on future policy decisions around allocation rounds for hydrogen production. There are no assumptions made about the technologies underlying production (e.g. electrolytic or CCUS-enabled hydrogen). These assumptions are purely illustrative for the purposes of this analysis and do not pre-judge future policy decisions.

**Table A.1: hydrogen production capacity online (GW) to 2030.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Production | 0.0 | 0.0 | 2.0 | 3.6 | 5.2 | 6.8 | 8.4 | 10.0 |

*Average load factor (L)*

6. Load factor measures the proportion of time which a hydrogen production plant is operating for. It turns production capacity (*H* above) into actual production e.g. 1GW of production capacity at 50% load factor produced 0.5GW of hydrogen (per day).

7. Given we make no assumptions about the relative amounts of electrolytic and CCUS-enabled hydrogen in the production mix, and a lack of data about real-world load factors, for simplicity we assume an overall weighted average load factor of 100%, so *L* will equal 1 for all years. This means that our estimate for the number of certificates created each year will be an overestimate, as in practice the average load factor will likely be less than 100% e.g. due to maintenance.

8. We can therefore calculate actual hydrogen production in GWh by year by multiplying *H* by *L* and then converting into GWh:

**Table A.2: hydrogen production (GWh) to 2030.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Production | 0.0 | 0.0 | 17.5 | 31.5 | 45.6 | 59.6 | 73.6 | 87.6 |

*Uptake rate (U)*

9. The uptake of the scheme is the proportion of total hydrogen production in a given year that gets certified. We expect it to initially be low but rise steadily over time as the market becomes familiar with certification and the hydrogen market develops. As there is no data on this, we have assumed that the uptake rate starts at 10% in 2025 (being N/A before as there is no production), then increases at a linear rate to reach 75% in 2030, reflecting the increasing familiarity with certification and the developing market. This is for both options.

[10] Hydrogen net zero investment roadmap, DESNZ, 2023, pg. 16.

10. This assumption is different from that used in the de minimis assessment, where we assumed an initial 2025 uptake rate of 10% for mass balance and 5% for book-and-claim and then linear increase to 75% for both in 2030. We have reviewed this assumption and, on further consideration, concluded that there was insufficient evidence to justify it. We have, therefore, imposed the same uptake rate assumptions on both Options as above.

11. This assumption accounts for some producers choosing not to, or being unable to, certify their hydrogen (for example, because it does not meet the LCHS). It is, ultimately, an assumption however, and in practice uptake could be higher (or lower, though we think that it is unlikely). Beyond 2030, we would expect the uptake rate to increase further as the market matures and certification becomes the norm.

12. This gives annual uptake rates for *U* as below:

**Table A.3: uptake rate of the certification scheme (% of production).**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Rate | N/A | N/A | 10% | 23% | 36% | 49% | 62% | 75% |

*Issuance (I)*

13. We set the issuance rate at 1 i.e. 1 certificate issued for every MWh. This is for simplicity as the precise relationship between hydrogen volumes and number of certificates issued will depend on the operational details of the mass balance system and the certificate registry.

*Number of certificates*

14. We can therefore calculate the number of certificates per the above equation. As the various elements are the same for both Options (chains of custody), the number of certificates issued each year will be the same for both as well.

15. These figures are likely to be an overestimate given our simplifying load factor assumption above, and in turn this will bias our Cost and Transfer estimates upwards.

**Table A.4: number of certificates (millions) per year.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Certificates | 0 | 0 | 1.8 | 7.3 | 16.4 | 29.2 | 45.6 | 65.7 |

## Annex B: monetised costs methodology

16. We separate costs into two categories: to business (hydrogen producers, transporters and end users) and to government (including the scheme administrator). The method used follows that from the de minimis assessment, with the changes to volume methodology noted above.

17. Costs to business come from three sources:
    i. **Registering certificate transactions**: dependent on the chain of custody, businesses participating in the scheme will have to register the changes in ownership of certificates.
    ii. **Audit**: the costs associated with having production plants audited every year.
    iii. **Familiarisation**: the costs associated with reading and understanding the scheme guidance for a business to properly use the scheme.

18. These costs would fall on businesses differently, depending on whether they are producers (plants), transports or end users:

**Table B.1: costs faced by different types of business.**

| Type of business | Registering certificate transactions | Audit | Familiarisation |
|---|---|---|---|
| **Producers** | ✓ | ✓ | ✓ |
| **Transporters** | ✓ *Under Option 1* | ✗ | ✓ *Under Option 1* |
| **End users** | ✓ | ✗ | ✓ |

19. Costs to government come from two broad sources, with various sub-components:
    i. **Set-up**: costs of designing and implementing the scheme and associated systems. This is made up of:
        a. **Design**: costs of designing the certification scheme (labour costs).
        b. **Digital infrastructure**: costs of setting up the digital infrastructure for the scheme, such as a trading platform for book-and-claim or a registry for mass balance.

    ii. **Ongoing**: maintaining and administering the scheme and systems. This is made up of:
        a. **Enrolment**: costs of enrolling new users onto the scheme (processing and verifying applications etc.).
        b. **Certification**: costs around confirming the validity of data for reported volumes and issuing the certificates.
        c. **Management/overheads**: costs to run the certification scheme, including legal costs, handling enquiries, stakeholder management, registry operators, and so on.

*Overarching assumptions*

20. We made, for simplicity, three overarching assumptions common to both options throughout this cost analysis:
    i. **Enrolled production plants**. We assumed that the average plant size is 50MW (accounting for a mix of hydrogen production technologies such as electrolytic and CCUS-enabled plants) and then divided total production (as in Annex A Table A.2) by that to give the number of enrolled plants each year. This is the same across both Options. It is not indicative of our expectations of the potential split between different hydrogen production technologies, merely a simplifying assumption reflecting the twin-track approach.
    ii. **Total businesses enrolled**. Alongside plants, we expect two other types of business to be interested in the certification scheme: hydrogen transporters and end users. For transporters, we assumed 1 for every 10 production plants, and only counted them for mass balance (as for book-and-claim midstream transactions are not relevant). For end users, we assumed 1.5 for every production plant for both Options, adjusted by the uptake rate from Annex A Table A.3 to reflect use of certified hydrogen. These are both simplifying assumptions to reflect a) the tendency for production to be in clusters, allowing a single transporter to serve multiple producers, and b) the requirement for producers receiving HPBM funding to have offtakers.

iii. **Batched certificates**. In practice, we expect certificates to be treated as batches rather than individually, reflecting likely business practices of selling and using hydrogen as volumes larger than 1MWh. Per the DESNZ position, certificates will be issued monthly, giving 12 certification periods a year. We then assumed, based on likely volume sizes and potential production patterns, that CCUS-enabled plants will produce a certified volume once per day and electrolysers once every 30 minutes and other technologies will align with one of these. With a further simplifying assumption of a constant and even split of total hydrogen production between CCUS-enabled and electrolytic, we arrive at a constant 745 total volumes per month on average. Multiplying this by 12 gives the number of volumes per year; dividing the total number of certificates in a year by that gives the number of batches of certificates per year.

21. Note that the assumption relating to number of end users per producer in ii. above has changed from the de minimis assessment. Previously, we assumed that mass balance had 1.5 end users per producer and book-and-claim 2.5. As with uptake rate above, we harmonised these assumptions this time, bringing book-and-claim into line with mass balance so both options have 1.5 end users per producer.

**Table B.2: number of enrolled businesses and batches of certificates, mass balance.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Number of enrolled plants** | 0 | 0 | 40 | 72 | 104 | 136 | 168 | 200 |
| **Number of enrolled businesses** | 0 | 0 | 46 | 98 | 164 | 243 | 335 | 440 |
| **Batches of certificates*** | 0 | 0 | 40,000 | 150,000 | 330,000 | 600,000 | 930,000 | 1,340,000 |

**Table B.3: number of enrolled businesses and batches of certificates, book-and-claim.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Number of enrolled plants** | 0 | 0 | 40 | 72 | 104 | 136 | 168 | 200 |
| **Number of enrolled businesses** | 0 | 0 | 46 | 97 | 160 | 236 | 324 | 425 |
| **Batches of certificates*** | 0 | 0 | 40,000 | 150,000 | 330,000 | 600,000 | 930,000 | 1,340,000 |

**Rounded to nearest 10,000.*

22. These assumptions, while we believe are reasonable, are ultimately made based on expert judgement in the absence of robust evidence.

*Labour costs*

23. As the costs to business (registering certificate transactions, audit and familiarisation) and government are labour costs, we first calculated the cost per incidence for familiarisation, audit and registering certificate transactions e.g. the cost of one audit.

24. We assumed these each required a certain number of FTE equivalent hours on all occasions, and then an average labour cost of £25.60 per hour for business, per the ONS ASHE tables[11], and £22.40 for government[12].

[11] Mean Hourly pay for 'Professional, Scientific and Technical Activities, Business, Media and Public Service Professionals', ASHE Table 25a, ONS, 2021.
[12] Mean Hourly pay for 'Public administration professional occupations' ASHE Table 25a, ONS, 2021.

25. Labour costs per incidence for each activity ($c_i$) are estimated according to the following equation, giving the costs in Tables B.4 and B.5 below:

$$c_i = FTE \times 25.60 \text{ (or } 22.40 \text{ for government)}$$

**Table B.4: nominal cost per incidence by activity for business.**

| Activity | FTE equivalent hours | Explanation | Cost per incidence |
|---|---|---|---|
| Registering certificate transactions | 0.02 per batch | 1 FTE spending 0.02hrs per batch of certificates. | £0.51 |
| Audit | 32 | 2 FTEs for two days (8hrs per day). | £819.20 |
| Familiarisation | 16 | 1 FTE for two days (8hrs per day). | £409.60 |

**Table B.5: nominal cost per incidence by activity for government.**

| Activity | FTE equivalent hours | Explanation | Cost per incidence |
|---|---|---|---|
| Processing enrolments | 16 | 1 FTE for two days (8hrs per day). | £358.88 |
| Issuing certificates | 6 | 1 FTE for six hours. | £134.58 |

*Costs to business*

26. We monetised the following costs to businesses participating in the scheme:
    i. Registering transactions of certificates;
    ii. Auditing of plants; and
    iii. Familiarisation.

*Registering certificate transactions*

27. The total cost across all businesses of registering certificate transactions $C_T$ for a given Option (chain of custody) in a given year is given by the equation:

$$C_T = c_t \times N_t \times T$$

28. Where $c_t$ is the cost per registration, per Table B.4 above; $N_t$ is the number of batches of certificates issued in a given year per Tables B.2 and B.3 above; and $T$ is the number of transactions required under a given chain of custody.

29. The number of transactions $T$ was set at 3 under Option 1 (mass balance), accounting for the certificate and physical hydrogen being traded together, meaning that midstream transporters would likely have to register certificate transactions in addition to producers and end users. It was set at 2 under Option 2 (book-and-claim) given only the production and then 'consumption' of the certificate by end users are relevant under that chain of custody as certificates and physical hydrogen are traded separately, so transportation would not need to be registered.

30. This gives estimates for each Option as follows:

**Table B.6: nominal total cost for registering certificate transactions (nearest £000s) across all businesses.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Option 1 (mass balance)** | 0 | 0 | 55 | 228 | 514 | 915 | 1,431 | 2,061 |
| **Option 2 (book-and-claim)** | 0 | 0 | 37 | 152 | 343 | 610 | 954 | 1,374 |

31. Recalling that we assumed a 100% load factor for hydrogen production when calculating volume of certificates (Annex A), these figures are likely to be overestimates because the number of batches of certificates being handled each year (Tables B.2 and B.3) are also overestimates.

*Auditing plants*

32. Audit costs $C_A$ only apply to enrolled production plants and are estimated according to the following equation:

$$C_A = c_a \times N_P$$

Where $c_a$ is the per incidence cost of an audit and $N_P$ is the number of enrolled production plants in a given year, per Tables B.2 and B.3 above. These values do not change by Option, so audit costs are estimated to be the same across both Options.

**Table B.7: nominal total audit costs (nearest £000s) across all businesses for both Options.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Audit | 0 | 0 | 3 | 14 | 31 | 55 | 85 | 123 |

*Familiarisation*

33. Familiarisation costs $C_F$ apply to all businesses and were estimated according to the following:

$$C_F = c_f \times N_B$$

Where $c_f$ is the per incidence cost of familiarisation from Table B.4 and $N_B$ is the total number of relevant new businesses enrolled in the scheme, as only relevant businesses newly joining the scheme will need to familiarise themselves with it). This is from Tables B.2 and B.3 above, calculated by taking the number of enrolled businesses in one year and subtracting the number in the previous year.

**Table B.8: nominal total familiarisation cost across all businesses for each Option (nearest £000s).**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Option 1 (mass balance)** | 0 | 0 | 19 | 21 | 27 | 32 | 38 | 43 |
| **Option 2 (book-and-claim)** | 0 | 0 | 18 | 21 | 26 | 31 | 36 | 41 |

*Costs to government*

34. We monetised the following costs to government:
    i. Design of the certification scheme;
    ii. Setting up digital infrastructure;
    iii. Processing enrolment applications;
    iv. Issuing certificates; and
    v. Management and overheads.

Where i. and ii. are set-up costs and iii.-v. are ongoing costs.

*Set-up costs*

35. We estimated the costs of designing the certification scheme itself by assuming that 14 FTEs across DESNZ and the appointed delivery partner spend one year designing the scheme, working 7.5 hours a day at a wage rate of £22.40 as above. This gives a total design cost of £612,00 for both options. For simplicity, we assumed there would be no further design work by government to 2030, as this is contingent on future policy decisions over whether, and how, to refine the scheme as the hydrogen market develops.

36. For the costs of setting up the necessary digital infrastructure under Options 1 and 2, we took the total budget of CertifHy, an analogous scheme, setting up its digital trading platform, which is estimated at £1.82m[13]. For simplicity, we assumed this cost to be identical across both options. As this is CertifHy's entire budget, it may be an overestimate for IT set-up costs alone. Also, a certificate trading system is different from a certificate registry, so in practice the costs of setting up these respective systems may be different.

[13] Benchmark of International low-carbon and green H2 certification mechanisms, World Bank, 2021, pg. 34. CertifHy has a total budget through its implementation of €2.11m, which gives £1.82m using HMRC's average 2021 exchange rate of €0.8626: £1.

37. For simplicity, we also assumed that these set-up costs fall entirely in 2024. In practice they are likely to be spread over the 2023-25 period, but the allocation depends on future policy decisions that we have not pre-judged, for example when relevant contracts are signed and when in 2025 the scheme launches.

*Ongoing costs*

38. For enrolment processing, for each option we took the cost per incidence from Table B.5 above and multiplied that by the number of new businesses in the given year from Table B.2 and B.3 for options 1 and 2 respectively, to reflect new businesses enrolling in the scheme.

**Table B.9: nominal total cost to government for processing enrolments (nearest £000s) for both options.**

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Option 1 (mass balance)** | - | - | 17 | 19 | 23 | 28 | 33 | 38 |
| **Option 2 (book-and-claim)** | - | - | 17 | 18 | 23 | 27 | 32 | 36 |

39. For issuing certificates, for each option we took the cost per incidence from Table B.5 above and multiplied that by the number of certification periods, the uptake rate and the number of enrolled plants in a given year.

40. Management and overheads are taken as a constant 12.5% of all other costs to government in a given year.