

Consultation impact assessment

Title: Phased ban on carbon dioxide stunning of pigs

Type of measure: Secondary Legislation

Department or agency: Department for Food, Environment and Rural Affairs

IA number: AW/036

RPC reference number: ...

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1. Summary of proposal

1. This consultation Impact Assessment considers the options available to end the use of carbon dioxide stunning of pigs. High concentration carbon dioxide stunning of pigs is known to cause significant pain, fear, and respiratory distress, usually lasting for 30 seconds until unconsciousness starts. The UK's independent Animal Welfare Committee recently provided an animal welfare assessment¹ of the relevant and most recent scientific evidence, including the PigStun project². The preferred policy option is to amend the welfare at the time of killing legislation³ to ban the use of carbon dioxide when stunning pigs with a three-year transition period. The consultation seeks views on a transition period of 3 years as well as whether a shorter transition period of 2 years is feasible. This Options Assessment also monetises the impact of a longer transition period of 4 and 5 years. The identified transition period will allow industry to plan for and implement the adoption of alternatives for commercial application, including planning requirements, investment decisions, design, approval and build stages that will need to be coordinated across the UK to maintain pig processing capacity. Non-regulatory options were considered in a full Options Assessment, rated green by the Regulatory Policy Committee, but were not considered likely to bring about the policy aim.
2. The aim is to improve the welfare of pigs at slaughter, and the policy proposal seeks to achieve this by:
 - Improving animal welfare at slaughter by ending the domestic pig industry's use of CO₂ gas stunning, in favour of a more humane slaughter alternative. This includes minimizing the number of pigs killed using CO₂ stunning in any transition period. The transition away from existing CO₂ methods will be measured using slaughter data from the Food Standards Agency (FSA), Food Standards Scotland (FSS) and Department of Agriculture, Environment and Rural Affairs in NI.
 - Maintaining the capacity of domestic pig slaughter industry in the long run. Ensuring that the viability of the domestic sector is maintained, with processors given adequate time to transition to alternative methods, without significant harm to the supply chain.
 - Ensuring there are no significant long-run increases in the volume of imports of pork slaughtered by lower welfare methods as a direct result of the policy.
3. Following HMT Greenbook guidance, the Options Framework- Filter was used to develop a long list of options that were scored using SMART objectives and critical success factors to arrive at a short list of options. The short list of options considered are:
 - **Option 0** – Do nothing.
 - **Option 1a** – A ban on CO₂ stunning of pigs, at the end of a 2-year transition period.
 - **Option 1b** – A ban on CO₂ stunning of pigs, at the end of a 3-year transition period.
 - **Option 1c** – A ban on CO₂ stunning of pigs, at the end of a 4-year transition period.
 - **Option 1d** – A ban on CO₂ stunning of pigs, at the end of a 5-year transition period.

As noted above, the consultation seeks views on a transition period of 3 years and whether a shorter transition period of 2 years is feasible. This Options Assessment also monetises the impact of a longer transition period of 4 and 5 years.

¹ <https://www.gov.uk/government/publications/opinion-on-carbon-dioxide-gas-stunning-of-pigs-and-alternative-methods>

² <https://eurcaw-pigs.eu/dossier/pigstun>

³ <https://www.legislation.gov.uk/uksi/2015/1782/contents>

4. At this stage, consultation, all the above options are considered viable. Each of the options' Net Present Values (NPVs) are similar. The consultation process will seek to validate or refine existing cost estimates, such as familiarisation costs, and identify additional costs that are currently non-monetised. Research was commissioned by Defra to estimate the benefits of improved animal welfare outcomes from the identified options, through a willingness to pay framework. These monetised benefits are included alongside small environmental benefits from the policy.
5. Table 1 shows the Benefits, NPV, Benefit Cost Ratio (BCR) which compares the present value of benefits to the present value of costs, and Equivalent Annual Net Direct Cost Business, which assesses the average annual net direct costs to businesses, for each option to the nearest £1m in 2026 prices. The lead figures are Defra's central cost estimates. The ranges provided in parenthesis are the low and high sensitivity estimates for the central scenario. The consultation on this proposal will set out the options considered allowing for comments which will be reviewed in the final impact assessment.

Table 1:

Options	Sum of benefits (20-year appraisal)	EANDCB (20-year appraisal)	NPV (20-year appraisal)	BCR
Option 1a (2yr)	£2,106m	£9m (6m to £17m)	-£128m (£-95m to £-253m)	16.5
Option 1b (3yr) (Preferred option)	£1,957m	£8m (£6m to £16m)	£-120m (£-90m to £-237m)	16.3
Option 1c (4yr)	£1,814m	£8m (£6m to £15m)	£-113m (£-85m to £-222m)	16.0
Option 1d (5yr)	£1,676m	£7m (£5m to £14m)	£-106m (£-80m to £-207m)	15.8

6. The consultation on this proposal will set out the options considered allowing for comments which will be reviewed in the final impact assessment.

2. Strategic case for proposed regulation

What is the problem under consideration:

7. The Government made a Manifesto commitment to improve animal welfare. However, across the UK, high concentration carbon dioxide stunning is the primary method used in the slaughter of pigs. In England and Wales, this method was used in 90% of pig slaughtered in 2024⁴, rising from 50% in 2011⁵ due to the lower costs and production efficiencies of the method. Pigs are exposed to high concentrations of CO₂ using a pit with a series of gondolas rotating in a carousel system. Unconsciousness is caused through induced hypercapnic hypoxia and inhibition of neurons through acidosis. High concentration CO₂ stunning method for pigs is known to cause significant pain, fear, and respiratory distress, usually lasting for 30 seconds until unconsciousness starts. Pigs experience air hunger and a feeling of

⁴ <https://www.gov.uk/government/publications/farm-animals-slaughter-sector-survey-2024>

⁵ <https://webarchive.nationalarchives.gov.uk/ukgwa/20171207164502/https://www.food.gov.uk/enforcement/sectorrules/animal-welfare/animal-welfare-survey>

breathlessness. CO2 creates painful acidic conditions in contact with moist body membranes (mouth, nostrils, respiratory surfaces, ^{6 7}).

8. Recent scientific progress, such as the EU's PigStun project, has explored commercially feasible systems to replace high concentration CO2 stunning of pigs with more humane alternatives⁸. This consultation Impact Assessment outlines the cost implications associated with changes intended to transition the industry away from its current reliance on high concentration CO2 stunning.
9. Using HMRC and Defra slaughter statistics, in 2025, Denmark, Belgium and Spain were the top three exporters of pigmeat⁹ to the UK. By weight, Denmark accounted for about 21% of total imports, while Belgium and Spain represented roughly 15%. Imports made up roughly 45% of the UK's supply of pigmeat in 2024. Evidence suggest that CO2 stunning of pigs in Denmark and Spain ranges between 85% and 95%. Whilst CO2 stunning is used in many countries, certain countries such as New Zealand rely only on electrical stunning of pigs. Examples of European countries where some high throughput plants use non-CO2 gas systems are Germany and Netherlands¹⁰. There is a risk to the UK's reputation as a world leader in animal welfare should high concentration CO2 stunning continue and similarly to the social licence to operate for the pork industry.

What evidence is there to support the problem?

10. The Farm Animal Welfare Council (FAWC, 2003¹¹), the European Food Standards Authority (EFSA, 2004¹², 2020¹³), animal welfare and veterinary bodies have recommended that stunning live conscious pigs with direct exposure to high concentration CO2 gas mixtures should be phased out. FAWC in 2003 stated: "We conclude that the use of high concentrations of CO2 (80% and above) to stun and kill pigs is not acceptable"; and recommended "Government and the industry should fund research and development into the use of non-aversive gas mixtures. The use of aversive gas mixtures should be phased out within five years."
11. An EFSA report published in 2004 stated that CO2 gas was aversive over concentrations of 30% as it caused '*hyperventilation and irritation of the mucous membranes*' as well as gasping behaviour before loss of consciousness. In contrast use of argon, nitrogen or mixtures of these gases.... '*have animal welfare advantages because hypoxia induced with these gas mixtures is not aversive to pigs.*' As a result of these findings, it was recommended that '*the gas used to induce unconsciousness should be non-aversive*'.
12. A further EFSA Scientific opinion on the welfare of pigs at slaughter published in 2020 said: "*Exposure to CO2 at high concentrations (defined in this opinion as higher than 80% by volume) is considered a serious welfare concern.*" "*The exposure to inert gases and CO2 with*

⁶ <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2004.45>

⁷ <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2020.6148>

⁸ <https://eurcaw-pigs.eu/dossier/pigstun>

⁹ Using the Harmonised System Codes of HS4 0203 (Pork carcass meat), HS6 021011, 021012, 021013 (Bacon & Ham)

¹⁰ <https://eurcaw-pigs.eu/dossier/pigstun> (Compaxo - Netherlands)

¹¹ <https://www.gov.uk/government/publications/fawc-report-on-the-welfare-of-farmed-animals-at-slaughter-or-killing>

¹² <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2004.45>

¹³ <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2020.6148>

inert gases is less aversive as it causes less pain, fear and respiratory distress compared with exposure to CO2 at high concentrations”; and one of EFSA’s recommendations was that: *“Exposure to CO2 at high concentration (defined in this opinion as higher than 80% by volume) should be replaced by exposure to other gas mixtures that are less aversive.”*

13. The EU has invested two million Euros in research work looking at non-aversive alternatives to CO2 stunning of pigs, such as argon, helium and automated electrical stunning. Results of the PigStun¹⁴ project detailed the significant improvements in welfare to pigs at slaughter when alternate slaughter methods were used. PigStun concluded that *“inert gases (argon and Helium) consistently demonstrated lower agitation levels and respiratory distress compared to CO2. These findings underscore the potential of gas alternatives to improve welfare parameters during induction.”* and *“For electrical stunning, careful handling and proper equipment design (e.g., minimizing the use of electric prods and improving raceway layouts) potentially mitigates pre-stunning stress. Stunning reliability is a paramount concern, as failures can lead to significant animal suffering. Electrical stunning systems show high effectiveness in inducing immediate unconsciousness but require sufficient training and rigorous adherence to operational protocols to ensure proper electrode placement.”*
14. The independent advisory committee, the Animal Welfare Committee (AWC), was commissioned in 2024 to consolidate the evidence on the animal welfare impacts of CO2 stunning of pigs and potential alternatives (e.g. inert gases, manual electrical, automated electrical). AWC concluded that exposure to high concentrations of CO2 in commercial stunning systems causes pigs to suffer pain, respiratory distress and fear as demonstrated through escape behaviour, gasping and vocalisation and recommended that, as a result, high concentration CO2, along with CO2 in gas mixtures, should be removed from the list of approved methods of stunning for pigs. AWC has also concluded that adding CO2 to inert gas mixtures provides no welfare benefit at low levels and would cause harm at nociceptive levels and recommends its use is prohibited.¹⁵
15. They found that inert gases are significantly less aversive to pigs than CO2 and of these, argon is the most suitable alternative for commercial use. They also found that electrical stunning, as used in automated electrical stunning, results in near instant unconsciousness without pain or suffering when the electrodes are placed correctly. Handling for electrical systems has been improved and could be further refined to protect pig welfare.¹¹ These are both already permitted stunning methods in the law. In its cover letter submitting its Opinion to Senior Responsible Officers, AWC stated that *‘From a scientific point of view, there is no doubt that the evidence base has now grown to the extent that further research is unnecessary and action for change is required.’*
16. There is also evidence of significant public concern regarding the use of carbon dioxide stunning of pigs and support for intervention in the sector. Defra-funded research¹⁶ has outlined consumers’ willingness to pay for improved welfare outcomes for animals. Building on this, more recent Defra-funded research has been completed which provides a method for the economic valuation of benefits associated with improvements to the welfare of farm

¹⁴ <https://eurcaw-pigs.eu/dossier/pigstun>

¹⁵ <https://www.gov.uk/government/publications/opinion-on-carbon-dioxide-gas-stunning-of-pigs-and-alternative-methods>

¹⁶ R.M. Bennett, A. Butterworth, P.J. Jones, A. Kehlbacher, R.B. Tranter. Valuation of Animal Welfare Benefits. A Report to Defra, University of Reading (2012)

animals brought about by certain policy changes¹⁷. This involves scoring the welfare consequences for a series of policy scenarios. This methodology has been applied to the policy scenario of transitioning away from high concentration CO2 stunning to higher welfare alternative stunning methods. This provides a monetised valuation of the animal welfare related benefits of the policy. These results are provided in detail in section 7 of this document.

Why is government action or intervention necessary?

Information failure:

17. There are multiple information failures that exist in the pigmeat sector. Firstly, consumers of pork are typically unaware of the use of high concentration carbon dioxide¹⁸. A YouGov poll in 2020² identified that the British public is largely unaware of high concentration CO2 stunning of pigs. 78% did not know if it happens often in the UK, whilst 8% believed it happened rarely or not at all.
18. Therefore, consumers are unable to exert preferences over the product they buy, as the meat returned from different slaughter methods is not distinguished by retailers. High welfare accreditation schemes (e.g. RSPCA Assured) allow their labels on meat slaughtered using this method. Consumers therefore experience an information failure as they do not have sufficient information to choose the product based on their welfare preferences. A negative externality arises because the social cost of this stunning method is not considered in the price of meat from high concentration CO2 stunned pigs. Therefore, demand for this type of meat is higher than it would be if the social cost was reflected in the price. This cannot be resolved by the market alone; Government intervention is needed to bring welfare standards in line with wider public value.
19. Defra engaged with industry during 2024 and 2025 to discuss the impacts of the use of high concentration CO2 and potential alternative higher welfare stunning/killing methods for pigs. The information received then and from additional past engagement suggests that encouragement is unlikely to lead to significant progress from industry voluntarily. The industry benefits from the lower on-going costs of the current method per pig and also higher throughput. The industry also has financial incentives to maintain existing methods to avoid the capital and downtime costs of transitioning to a new stunning method. The industry does not have sufficient incentive from consumers, retailers, food services or processed industries to voluntarily move away from high concentration CO2 stunning. Industry will sell CO2 stunned pork products if consumers still buy them.
20. As shown in paragraph 10, evidence surrounding the welfare concerns from the practice of high concentration CO2 stunning of pigs has been available for over 20 years. Industry has been aware of the negative welfare outcomes associated with this practice for many years, during that time its use has significantly increased, and there is limited evidence to suggest that a change in practice is closer to occurring.

What gaps or harms would occur if government doesn't intervene?

¹⁷ <https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21860>

¹⁸ <https://yougov.co.uk/consumer/articles/32222-what-do-brits-think-uk-farming-practices>

21. Pig welfare would continue to be compromised through continued use of CO2 gas stunning. . An estimated 9.7 million pigs are stunned and killed by high concentration CO2 in the UK every year, 90% of the domestic industry, according to the Slaughter Sector Survey of England and Wales in 2024¹⁹.

Current regulatory landscape & Post Implementation Review:

22. The assimilated version of Council Regulation (EC) No 1099/2009 on the protection of animals at the time of killing legislation (“Regulation 1099/2009”) applies in England, Wales and Scotland²⁰, whilst the EU version of that Regulation²¹ applies directly in NI by virtue of the Windsor Framework²². This legislation is supplemented by stricter rules, set out in separate legislation in England, Wales, Scotland and NI, which provides greater protection for animals at the time of killing in respective nations.
23. Article 4(1) of the assimilated and EU versions of Regulation 1099/2009 provides that animals shall only be killed after stunning in accordance with the methods and specific requirements related to the application of those methods set out in Annex I. For pigs the permitted stunning methods in Annex I include penetrative captive bolt device, firearm with free projectile, head only electrical stunning, head to body electrical stunning, carbon dioxide at high concentration, carbon dioxide associated with inert gases, inert gasses, lethal injection, and in England non-penetrative captive bolt device for piglets under 10kg. Stricter national rules in the relevant domestic implementing legislation also cover the use of gas as a stunning method for pigs.
24. Whilst the use of carbon dioxide is permitted in Annex 1, Recital 6 of Regulation 1099/2009 acknowledged the findings of the aforementioned 2004 EFSA report which covered carbon dioxide stunning of pigs. It goes on to state that: ‘Community law in this area should be updated to take into account those scientific opinions. Recommendations to phase out the use of carbon dioxide for pigs and the use of waterbath stunners for poultry are not included in this Regulation because the impact assessment revealed that such recommendations were not economically viable at present in the EU. However, it is important to continue this discussion in the future.’ Therefore, the use of carbon dioxide remained a permitted stunning method in Regulation 1099/2009.
25. The first Post Implementation Review of the Welfare of Animals at the Time of Killing (England) Regulations 2015 was published in February 2021²³. A second review was published in²⁴. Both reviews noted the longstanding animal welfare concerns with this method expressed by scientific bodies like FAWC and EFSA and by animal welfare organisations such as Compassion in World Farming, the British Veterinary Association, Red Tractor and the RSPCA. The review recognised the research supported by government to date and identified that this was “an area we need to consider further in terms of research into alternative systems for stunning pigs.”

¹⁹ <https://www.gov.uk/government/publications/farm-animals-slaughter-sector-survey-2024>

²⁰ <https://www.legislation.gov.uk/eur/2009/1099/contents>

²¹ <https://eur-lex.europa.eu/eli/reg/2009/1099/oj/eng>

²² <https://www.gov.uk/government/publications/the-windsor-framework>

²³ https://www.legislation.gov.uk/ukia/2025/19/pdfs/ukia_20250019_en.pdf

²⁴ https://www.legislation.gov.uk/ukia/2026/11/pdfs/ukia_20260011_en.pdf

3. SMART Objectives for intervention:

26. The following objectives were designed under the SMART objectives' framework and link to Defra and His Majesty's Government (HMG) objectives, such as the growth mission.

No.	Policy Objective
1	Improving animal welfare at slaughter by causing a guaranteed end to the domestic pig industry's use of CO₂ stunning, in favour of a more humane slaughter alternative. This includes minimizing the number of pigs killed using CO₂ stunning in any transition period. Given the small number of sites using CO₂ gas stunning and that the cost of the slaughter process as a proportion of the total production costs of pork is minor (e.g. the costs associated make up less than 1% of the price a slaughterhouse receives for the value of a butchered pig carcass (£234)), a transition away from CO₂ stunning is achievable and realistic. This would lead to an improvement in the animal welfare of over 9 million pigs per year due to the ending of CO₂ stunning for pig slaughter once the transition away from existing CO₂ methods is completed. This would be measurable by using slaughter data from the Food Standards Agency (FSA), Food Standards Scotland (FSS) and Department of Agriculture, Environment and Rural Affairs in NI.
2	Maintaining the capacity of domestic pig slaughter industry in the long run. Ensuring that the viability of the domestic sector is maintained, with processors given adequate time to transition to the alternative methods, without significant harm to the supply chain. This would be achievable and realistic, as slaughterhouses would want to maintain throughput and would invest to increase capacity through capital investments to ensure that throughput and business income is maintained. All analysis has been informed by discussions with the industry, who will have an opportunity to provide further feedback at consultation. We would expect to see any impacts on the capacity and throughput once the transition from CO₂ stunning is completed. This would be measurable by using slaughter data from the Food Standards Agency (FSA), Food Standards Scotland (FSS) and Department of Agriculture, Environment and Rural Affairs in NI.
3	Ensuring there are no significant long-run increases in the volume of imports of pork slaughtered by lower welfare methods as a direct result of the policy. This is both achievable and realistic because switching from CO₂ stunning to alternative methods would have a negligible impact on consumer pork prices. As a result, the policy is unlikely to affect the UK domestic industry's competitiveness against imports. HMRC trade data will be used to monitor and track imports of different pork products entering the UK, as well as from which countries to understand what stunning method was used. Any impact on imports caused by government policy would be expected to be seen after the transition from CO₂ stunning is completed.

Intended outcomes:

27. The policy intends to improve animal welfare outcomes by eliminating the use of CO₂ stunning of pigs in the domestic supply chain. The policy intention is to leave enough flexibility in the regulatory proposal to ensure pig welfare can be maximised across the industry, without posing a risk to the viability of the domestic sector.

Indicators of Success:

28. The success of the policy can be easily identified by government. Slaughterhouse throughput data is made available to government and FSA/FSS/DAERA staff have direct supervision of the stunning method being used at the 12 slaughterhouses using CO₂ gas stunning in the UK. Trade data is also available to monitor changes in pork imports. As a result, the proportion of pigs stunned using CO₂ gas or alternative methods (Objective 1), trends in domestic production levels (Objective 2) and any increases in lower welfare pork imports (Objective 3), is easy for Government to monitor allowing an assessment of whether the objectives are met. Success will also be evaluated as part of the existing five yearly post-implementation review cycle as stipulated in The Welfare of Animals at the Time of Killing (England) Regulations 2015, the next being due in Jan 2031.

Alignment with HMG objectives:

29. The policy objectives ensure that improvements in animal welfare in the pig slaughter sector takes into consideration impact on the slaughter industry. This policy may have some short-term growth impacts, for example increases in demand in construction, but the primary objective is to improve animal welfare. There is an opportunity for renewed investment, following legislative changes to ban the use of carbon dioxide stunning of pigs, that could expand the capacity of the domestic slaughter sector. Whilst this alone may not increase the size of the domestic industry (the current size of the pig farming sector and other production bottlenecks must also be considered), it is possible that the policy could contribute to the longer-term sustainability and potential future expansion of the domestic pig industry and contribute to the government's growth program. If the objective around ensuring the long run viability of the domestic pig sector was not met, it would affect other government objectives, such as food security.
30. HMG is committed to improving the long-term resilience of CO₂ supplies for industrial use. The UK CO₂ usage market has been disrupted several times over the past decade, partly because the nature of CO₂ as a low value byproduct of other processes. Import dependencies are currently expected to rise further due to pressures on domestic industries that produce CO₂ as a byproduct. In the event of widespread shortages, Defra would seek the voluntary prioritisation of CO₂ for animal slaughter, given the animal welfare risk posed by animals ready for slaughter backing up on farms. In extreme scenarios welfare culls would become necessary as the capacity of alternative slaughter methods would not be sufficient. This would come at significant cost to affected farmers, potentially making some farm businesses unviable. A transition away from CO₂ stunning of pigs would improve resilience across Defra sectors, as it would remove a risk posed by CO₂ shortages in the slaughter industry and remove the need for voluntary prioritisation to porcine slaughterhouses.

4. Description of proposed intervention options and explanation of the logical change process whereby this achieves SMART objectives

Set out a brief description of the preferred option and explain how it achieves the objectives:

31. The preferred option is to ban carbon dioxide stunning of pigs with a three-year transition period. The length of transition period that should be given is still being considered. The key trade-off is the increased numbers of pigs remaining being CO₂ gassed vs time provided for industry to adjust to maintain throughput. Based on our discussions with industry and analysis, we think that giving a three-year transition is appropriate and would allow an adequate amount of time for the pig processors to gain any necessary planning permissions and to carry out the works.
32. On this basis, Objective 1 would be met. Passing legislation that prohibits CO₂ stunning of pigs with a three-year transition period would improve welfare at slaughter for most pigs across the industry, approximately 9.5 million annually. The UK's welfare reputation would be enhanced by leading the way in banning the widely used low welfare practice.
33. Objective 2 would also be met. Argon gas stunning or automated electrical stunning can reproduce the throughput of CO₂ stunning systems. As mentioned, our assessment is that with the three-year transition period, pig throughput could be maintained without an impact on the domestic supply chain with the appropriate capital investment or in some cases changing operating hours. There are only 8 CO₂ slaughterhouses in England, none in Wales, 1 in Scotland and 3 in NI. These are typically run by large businesses.
34. Objective 3 will be met. The cost of the slaughter process as a proportion of the total production costs of pork is minor. The modelled cost rises detailed in section 65 inform Defra's assumption that there will be no significant shift in demand away from domestically produced pork to imports slaughtered using CO₂ methods from the EU or elsewhere supposing that domestic slaughter capacity is maintained by the end of the transition.
35. Therefore, having carefully considered a range of options, as outlined in section 5, the preferred option is a proposal to ban CO₂ stunning of pigs with a three-year transition period.

5. Description of shortlisted policy options

36. Policy options :

- 0) Do nothing
- 1) Phased ban of CO₂ stunning of pigs
 - a) Transition in 2 years
 - b) Transition in 3 years
 - c) Transition in 4 years
 - d) Transition in 5 years

37. In this section, we provide the summary of our shortlist appraisal. The baseline and policy options are monetised to observe the total cost impacts of the policy. The feasibility, cost implications and consumer impact will continue to be considered, as the department gathers more evidence from the response to the consultation process. The benefits of the policy have been identified using Defra commissioned research to monetise consumers' willingness to pay for improvements in animal welfare from the movement away from CO₂ stunning.

38. The Agriculture and Horticulture Development Board (AHDB) has published an economic analysis examining the costs of converting from carbon dioxide (CO₂) stunning to an argon-based system for pig slaughter in a commercial UK setting.²⁵ Baseline CO₂ stunning costs differ notably between the AHDB analysis and Defra's options assessment. AHDB estimates substantially lower CO₂ costs (£0.42 per pig) than those used in Defra's analysis (£1.48 per pig), reflecting different assumptions on CO₂ pricing and plant throughput. AHDB's estimates are based on industry-provided data, including long-term gas supply contracts and a high-throughput plant assumption (around 450 pigs per hour). In contrast, Defra's estimates use national slaughter statistics, evenly distributed throughput across operating plants, and CO₂ pricing provided by industry suppliers. In addition, AHDB's costs are expressed in 2024 prices, whereas Defra's costs have been inflated to 2026 in line with HM Treasury Green Book guidance; this difference contributes modestly to, but does not fully explain, the divergence.

39. These differing baselines lead to contrasting estimates of the cost impact of switching to argon. Defra estimates an increase of £0.87 per pig, equivalent to a 59% increase relative to its CO₂ baseline, while AHDB estimates an increase of £1.07 per pig, representing a substantially larger proportional increase due to its lower assumed baseline CO₂ and utility costs rather than higher absolute argon costs. Both analyses draw on utility cost estimates from the PigStun report, which includes low, medium and high scenarios, although it is unclear which elements benefited from stakeholder input, potentially contributing to variation. Defra does not currently have sufficient evidence to reconcile the differences between costs reported by slaughterhouses and those provided by industry suppliers, particularly for CO₂ pricing. As a result, no changes have been made to Defra's estimates at this stage; however, additional evidence will be sought from industry through the consultation to improve confidence in key cost assumptions.

40. The table below outlines the total cost to business over a 20-year appraisal period following the laying of the SI. A longer appraisal period than the standard 10 years has been chosen to reflect the lifetime of the infrastructure changes required and the range of transition periods being considered. To

²⁵ [New evidence-led analysis on CO₂ stunning in the UK pig processing sector | AHDB](#)

accurately assess the monetary value of benefits, especially given that these benefits begin to accrue at different times depending on the transition pathway (from 2 to 5 years), a 20-year appraisal period was considered most appropriate. However, a ten-year appraisal period is considered in the sensitivity analysis in Annex 1. Costs are estimated, based on a move to argon gas stunning (based on engagement with pig processors and the comparative costs of argon gas and automated electrical stunning), as rises from the baseline costs for options 1a, 1b, 1c and 1d. These scenarios are outlined in detail later in this section. All costs are discounted following Greenbook guidance.

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Option 1d (5yr)	£1,676m	£7m (£5m to £14m)	£-106m (£-80m to £-207m)	15.8

41. Variation in the observed NPV's and EANDCB's above results from time within the appraisal where cost increases are delayed because of longer transition and the associated impacts of discounting. Similar methodology of calculating the cost impacts is used in each iteration of Option 1, therefore a full methodology of ongoing and transition costs is provided below for the baseline and option 1a only. Option 1b is currently considered as the placeholder preferred policy option due to its close alignment with the Critical Success Factors. This is subject to change.

Option 0: Do nothing.

Transition Cost	N/A
Ongoing Annual Cost	£14.4 m

42. The do-nothing approach will lead to no change in business behaviour. High concentration CO2 stunning of pigs will continue to be the primary slaughter method used for pigs in the UK. The ongoing running costs, of the slaughter-end of existing slaughterhouses using CO2 gas stunning of pigs, have been modelled to create a baseline cost to industry. This baseline cost is then used to test the impact to business, consumers and others, of the counterfactual scenarios in option 1.

Assumptions:

43. A key simplifying assumption within the modelling of the baseline costs to industry is that each of the 11 large commercial high concentration CO2 stunning slaughterhouses operates at the same capacity, an even share of the industry throughput.
44. On the ongoing variable costs such as yield and utilities that are calculated on a per pig basis. Labour and facilities costs are calculated on an average cost per gas stunner per year, based on evidence gathered from industry stakeholders.

Cost Breakdown:

Ongoing:

Cost	Description	Calculation	Central Scenario	High Scenario	Low Scenario
Utilities	Utility costs cover the cost of existing gas, water and electricity used at the point of stunning and sticking within the slaughterhouse. These costs are calculated separately and combined to create a total utilities cost. Gas: Cost is calculated using costs of CO2 gas per kg, average volume of gas used per pig kg, and annual throughput levels.²⁶ Water: Cost is calculated using average water cost per pig in gas stunner system and annual throughput levels.²⁷ Electricity: Cost is calculated using average water cost per pig in gas stunner system and annual throughput levels.²⁸	Gas: (CO2 £/kg (£0.69) * CO2 kg/head (0.4)) * TPUT per hour (3,872) * Operating hours (10) * Operating days (250) Water: Water £/head (£0.018) * TPUT annual (879,970) * no. gas stunner plants (11) Electricity: Electricity £/head (£0.0083) * TPUT annual (879,970) * no. gas stunner plants (11)	£2.9 m	£3.8 m	£2.0 m
Labour	Labour costs are calculated using: Hourly wages, wage uplift (to account for non-wage labour costs), operating hours per year, staff required per gas stunner and the number of high concentration CO2 gas stunners in use.²⁹	Labour: (Wage £/h (£22.07) * wage uplift (22%)) * operating hours (10) * staff requirement (4) * no. gas stunning plants (11) * Operating days (250)	£3.0 m	£3.1 m	£2.4 m
Facilities	Facilities cost in the do-nothing scenario cover the maintenance costs of the existing CO2 stunning equipment. This comes in the forms of annual maintenance contracts with the seller of the equipment.³⁰ No transition or downtime costs exist in the baseline	Maintenance: Average annual maintenance contract £ (£69,000) * no. gas stunning plants (11)	£0.8 m	£0.9 m	£0.6 m
Yield	Yield costs in the do-nothing scenario cover the percentage of production of pigmeat that is rejected from the food chain due to a range of meat quality issues. CO2 stunning is associated with limited meat quality issues. Cost is calculated using value of processed pig, throughput and yield loss rate.³¹	Yield: Processed pig £/head (£320) * TPUT (879,970) * yield loss % (0.25%) no. gas stunning plants (11)	£7.7 m	£10.2 m	£5.6m

²⁶ Based on stakeholder engagement with industrial gas industry, CO2 slaughterhouses, & FSA data.

²⁷ Pigstun data.

²⁸ Pigstun data.

²⁹ Based on stakeholder engagement with CO2 slaughterhouses.

³⁰ Based on stakeholder engagement with CO2 slaughterhouses.

³¹ Based on stakeholder engagement with CO2 slaughterhouses, FSA data, Pigstun results, and assumptions.

Option 1 (a, b, c, d): Ban CO2 stunning of pigs (Preferred Option)

Transition Cost	£43.4 m
Ongoing Annual Cost	£20.6 m

45. Option 1b outlines the impact of a ban on the use of the CO2 gas in the stunning of pigs in domestic slaughterhouses with a 3-year transition period. Policy options where the transition period is too short to allow for a viable transition of the domestic sector to an alternate slaughter method have been removed at the longlist appraisal stage. Additionally, longer transition periods would be expected to see businesses delay transitions away from CO2 stunning. This means the estimated policy costs only vary from different transition periods based on discounting and number of years with increased costs within the appraisal period. As a placeholder, Option 1b, a ban to CO2 stunning of pigs with a 3-year transition period will be used to identify the costs below, and in the regulatory scorecard in section 7. Additional costs based on options 1a, 1c & 1d are available in the Annex.

Assumptions:

46. *Industry structure:* Defra assumes that all existing sites will continue to operate post legislation. This assumption is based on the concentration of the industry and stakeholder communications. Additionally, if some sites close, it would be expected that the domestic supply would be maintained by the expansion of capacity in other sites. Therefore, any cost to business associated with this risk could be mitigated.
47. *The small CO2 slaughterhouse:* We exclude one of the twelve UK domestic slaughterhouses that use CO2 stunning from the costs analysis. One CO2 slaughterhouse in operation is significantly smaller with different cost implications. Based on evidence available to Defra at this time, it is assumed that this site will be able to maintain its existing capacity with minimal capital investment. The cost modelling will focus on the 11 large CO2 slaughterhouses in the UK. This will not affect variable cost estimates to industry such as utilities and yield as these are calculated based on the existing throughput of the CO2 slaughter industry.
48. *Substitution:* We assume the capital investment choices are taken by the industry. The central scenario estimates an outcome where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. From stakeholder engagement, this appears the most likely outcome because of the meat quality concerns with electrical stunning.
49. *Capacity:* It is assumed that slaughter capacity is maintained by the construction and installation of a second argon gas stunner at six of the eleven existing sites³² to compensate for the increased stunning times required when using argon stunning of pigs. Of the six additional gas stunnings, we assume three low-cost and three high-cost transitions. This distinction highlights the difficulty of adapting some existing sites for a second gas stunner. We believe this assumption is cautious as it is likely that the cheapest-to-adapt sites would be most likely to install an additional stunner. Other sites may also consider increasing the length of their weekly killing operations or adjusting the existing gas stunnings (some sites may be able to install extra gondolas to increase throughput), to maintain throughput. Industry insights, policy expertise, and likely behaviour based on cost modelling, has informed the response outlined in the central scenario. However, there are still many possible choices available to businesses on how to respond to the preferred option. Therefore, this assumption is tested in the

³² With no construction, 2.8 million annual throughput of pigs would be lost compared the baseline of 9.7 million annual throughput (11 slaughterhouses with 1 argon stunner has a 6.9 million annual throughput). The construction of six second gas stunner would maintain capacity, adding an additional 1 million annual throughput of pigs (with 5 slaughterhouses with 1 argon stunner has a 3.1 million annual throughput, 6 slaughterhouses with 2 argon stunnings has a 7.5 million annual throughput, totalling 10.6 million annual throughput)

sensitivity analysis in Annex 1. Some additional scenarios are modelled on possible expected behaviour, whilst others were designed to stretch the limits of business behaviour, allowing to test the highest and lowest possible cost scenarios. Therefore, the sensitivity analysis in Annex 1 mitigates the risk of our central scenario inaccurately forecasting business behaviour. The consultation process will test this assumption further and there is scope for this assumption being updated in the final impact assessment.

50. A clear risk and limitation from the above assumption is that throughput is forecasted to rise at six of the 11 existing sites in the central scenario following the construction of a second gas stunner. This covers the reduction in capacity of all existing gas stunners when transitioning to argon. There is a potential additional cost to increase capacity at these six sites as other bottlenecks may exist outside of the slaughter process. These potential costs are unclear due to a lack of evidence. These are included as a non-monetised cost at the consultation impact assessment stage and outlined in more detail in section 7. To account for this risk, in a situation where it is not possible to sufficiently increase throughput at 6 existing sites, scenarios where every site is able to increase capacity and maintain throughput are monetised in Annex 1.
51. *Throughput*: It is assumed that there is no rise in the throughput of the domestic sector despite an expansion in capacity. As a result, increases in variable costs are limited, since the higher slaughter capacity is not being utilised. Additionally, there are no monetised benefits from the potential expansion in slaughter capacity. This reflects the likely existence of other bottlenecks within the supply chain that are not impacted directly by the legislative change.
52. Some of the transition and construction costs may be mitigated as some existing sites told us that they are not currently functioning at maximum capacity. Some sites are operating shorter hours than others or operating below the maximum number of gondolas per gas stunner. There is, therefore, scope for increased capacity at some sites which may reduce the requirement for additional slaughter facilities in the industry. Though there are complexities with operating longer killing hours e.g. recruiting and maintaining a second shift. These potential cost reducing options are not considered in cost modelling to ensure the cost to business estimates a worst-case scenario.
53. *Variable slaughter costs*: It is assumed that the higher variable argon slaughter costs occurs in the final year of the transition, allowing for a worst-case scenario of high variable slaughter cost in the final year of the transition by assuming all slaughter is at the new higher variable cost of argon Slaughter for the final year. In practice, it is anticipated that the transition from CO₂ to argon will be staggered over the final year of the transition period and therefore many pigs will still be slaughtered using the lower cost CO₂ gas stunning in the final year.
54. *Administrative burdens*: These figures involve three administrative burdens identified using the standard cost model³³. The initial estimate for administrative burdens to all businesses ranges from £80,000 to £124,000, depending on the uplifted wage rate applied and rounded to the nearest thousand. These are a one-off cost to businesses. Further evidence will be gathered during consultation to refine this estimate. For these figures, we assume 24 staff at each slaughterhouse would need to be informed and require training to use inert gases for stunning. Only 12 slaughterhouses are expected to face these administrative burdens.
 - 1) *Familiarisation cost for reading the new legislation*: We assume five people per slaughterhouse will need to read the new legislation, estimated at £400–£700 for all businesses. Engagement with stakeholders, such as management at slaughterhouses, means businesses are already familiar with

³³ [Microsoft Word - Standard Cost Model manual UK.20050929.doc](#)

this policy. We will strengthen the assumption on the number of staff at each slaughterhouse required to read the legislation at consultation.

2) *Internal meeting costs*: Time spent (assumption of 5 hours for each worker) cascading information and updating affected staff, estimated at £24,000–£38,000 for all businesses. We will strengthen this assumption at consultation on the number of staff required for internal meetings. Internal meetings may also require the time of managers and other staff members. During the consultation, we will ask how many of these individuals would be involved.

3) *Training and certification costs*: Staff on stunning lines will need to attend the FDQ's Protect pig welfare in stunning with inert gases (Y/615/3013)³⁴ module from an FDQ-approved provider in order to obtain the certificate of competency so the staff can continue to work. It is estimated at £48,000–£77,000 for all businesses in staff time (10 hours³² for each worker) and £5,000 for all businesses in terms of the cost of the course module (£17.50³⁵ for each worker). We assume all staff already hold a certificate of competence, as this is a requirement for their role. Therefore, they would only need to pay for the additional unit rather than the full certificate. However, there may be additional costs such as site visits and training days if required. In addition, an £8 fee³⁶ would be needed to amend the certificate and add the activity code D34 (Pigs/Inert Gases) to their certificate of competency (around £2,000 total for all businesses). We will strengthen the assumptions concerning the number of staff needing training, as well as the time and cost involved in completing an FDQ-approved course. The costs for external meetings were not included because it is uncertain what meetings might occur, such as possible roundtables with ministers or meetings with consultants. Similarly, retraining costs would vary depending on the specific operations of each slaughterhouse and the extent of any required redesign. In addition, some businesses may provide their own in-house training for staff, which would cost less.

Most sensitive assumptions:

55. This table sets out the key cost assumptions used in our modelling of impacts. We focus on assumptions that have significant effect on the overall cost. RAG ratings are used to highlight the level of confidence within the assumption and the risk the assumption has on skewing the estimated NPV. These assumptions are critical to the overall cost estimates provided within this consultation impact assessment. Defra seeks to gather more data, to validate or improve these assumptions, at the consultation phase.

Data	Value: (range)	Evidence	Confidence	Risk	Sensitivity scope
Infrastructure costs (excl. machinery cost of new gas stunner and pit)	Site with Space: £2m (£1.5m to £2.5m) Site with space constraints: £4m (£3m to £5m)	Anecdotal from stakeholder engagement based on expectations of planning & adapting existing sites to use two gas stunners simultaneously. (excl. new gas stunner & pit construction)	Low	Medium	Large
Yield loss	CO2 yield loss: 0.25% (0.2% to 0.3%) Argon yield loss: 0.25% (0.2% to 0.5%) Automated electrical yield loss: 1.75% (1.5% to 2.0%)	Combined evidence based on stakeholder engagement and PigStun results.	High	High	Medium

³⁴ [FDQ - Qualification Specification](#)

³⁵ The figure is based on engaging an FDQ-approved provider, as course costs are not publicly available online.

³⁶ [Certificate of Competence or licence to slaughter or kill animals - GOV.UK](#)

Downtime cost when installing an additional gas stunner	Site with space: 3 weeks (2 weeks to 4 weeks) Site with space constraints: 6 weeks (4 weeks to 8 weeks) Automated electrical transition: 9 weeks (6 weeks to 12 weeks) Weekly downtime cost: £255,000 (£200,000 to £300,000)	Anecdotal from stakeholder engagement based on shutdown costs and potential construction times.	Low	Medium	Large
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Cost Breakdown:

Transition:

Cost	Description	Calculation	Central Scenario	High Scenario	Low Scenario
Facilities	Facilities transition costs in option 1b cover the equipment alternations, new equipment & pit construction, additional construction & redesign costs and transition downtime costs. Equipment alteration cost covers the cost to adapt existing stunners from CO2 to function using argon gas e.g. changing the sensors from CO2 to O2 sensors. New equipment & pit construction costs cover the cost to dig a new pit, purchase an additional gas stunner and install. Additional construction and redesign cover the costs of any additional required changes made to ensure the smooth transition from CO2 to argon gas stunning. These costs cover planning, new buildings, lairage redesigns, adapting entry point to processing plant, other site redesign. Downtime costs estimate the cost to business arising from periods of closure to enable the required changes to existing site.	Facility costs for two stunners – space to expand: Equipment Alteration: CO2 gas stunner alteration (£13,328) * no. existing of CO2 stunners (11) = £146,608 New equipment and pit construction: (New Equipment £ + Pit construction £ + Installation £) (£3m) * no new gas stunners (11) = £33m Additional construction and redesign: Extra costs with space £ (£2.05m) * no. new stunners at sites with space (11) = £22.5m Downtime: Downtime cost per week (£255k) * no. weeks downtime (3) * No of existing stunners (11) = £8.42m Total: £146,608 +£33m+£22.5m+£8.42m= £64,066,608 * Percentage of plants with two stunner – space to expand (27.27%) = £17.5m Facility costs for two stunners – no space to expand: Equipment Alteration: CO2 gas stunner alteration (£13,328) * no. existing of CO2 stunners (11) = £146,608 New equipment and pit construction: (New Equipment £ + Pit construction £ + Installation £) (£3m) * no new gas stunners (11) = £33m Additional construction and redesign: Extra costs with limited space £ (£4.1m) * no. new stunners at sites with limited space (11) = £45.1m Downtime: Downtime cost per week (£255k) * no. weeks downtime (6) * No of existing stunners (11) = £16.8m Total: £146,608+£33m+£45.1m+£16.8m= £95,046,608 * Percentage of plants with two stunner – no space to expand (27.27%) = £26m	£43.4m	£54.4m	£35.2m

		Facility costs for one stunner – no space to expand: Equipment Alteration: CO2 gas stunner alteration (£13,328) * no. existing of CO2 stunners (11) = £146,608 Total: £146,608 * Percentage of plants with one stunner – no space to expand (45.45%) = £66,633 Grand Total: £17.5m + £26m + £66,633 = £43.4m			
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Ongoing (all annual):

Cost	Description	Calculation	Central Scenario	High Scenario	Low Scenario
Utilities	Utility costs cover the cost of gas, water and electricity used at the point of stunning and sticking within the slaughterhouses once the preferred option is implemented. These costs are calculated separately and combined to create a total utilities cost. Gas: Cost is calculated using costs of argon gas per kg, average volume of gas used per pig kg, and annual throughput levels.³⁷ Water: Cost is calculated using average water cost per pig in a gas stunner and annual throughput levels.³⁸ Electricity: Cost is calculated using average water cost per pig in gas stunner system and annual throughput levels.³⁹	Utilities costs for one stunner – no space to expand: Gas: (Argon £/kg (£1.27) * argon kg/head (0.56)) * TPUT per hour (2,766) * Operating hours (10) * Operating days (250) = £4,917,948 Water: Water £/head (£0.018) * TPUT annual (628,550) * no. gas stunner plants (11) = £124,453 Electricity: Electricity £/head (£0.0083) * TPUT annual (628,550) * no. gas stunner plants (11) = £57,387 Total: £4,917,948 + £124,453 + £57,387 = £5.1m* Percentage of plants with one stunner – no space to expand (45.45%) * TPUT as % of capacity (90.59%) = £2.1m Utilities costs for two stunners – no space AND space to expand: Gas: (Argon £/kg (£1.27) * argon kg/head (0.56)) * TPUT per hour (5,531) * Operating hours (10) * Operating days (250) = £9,834,118 Water: Water £/head (£0.018) * TPUT annual (1,257,101) * no. gas stunner plants (11) = £248,906 Electricity: Electricity £/head (£0.0083) * TPUT annual (1,257,101) * no. gas stunner plants (11) = £114,773 Total: £9,834,118 + £248,906 + £114,773 = £10.2m* Percentage of plants with two stunners (54.55%) * TPUT as % of capacity (90.59%) = £5.04m Grand Total: £2.1m + £5.04m = £7.15m	£7.15m	£9.4m	£4.9m
Labour	Labour costs are calculated using: Hourly wages, wage uplift (to account for non-wage labour costs), operating hours per year, staff required per gas stunner and the number of high concentration argon gas stunners in use.⁴⁰	Labour costs for one stunner – no space to expand: (Wage £/h (£22.07) * wage uplift (22%)) * operating hours (10) * staff requirement (4) * no. gas stunning plants (11) * Operating days (250) = £2,962,300 Total: £2,962,300 * Percentage of plants with one stunner – no space to expand (45.45%) = £1.35m	£4.6m	£4.9m	£3.8m

³⁷ Based on stakeholder engagement with industrial gas industry, CO2 slaughterhouses, & FSA data.

³⁸ Pigstun data.

³⁹ Pigstun data.

⁴⁰ Based on stakeholder engagement with CO2 slaughterhouses.

		<u>Labour costs for two stunners – no space AND space to expand:</u> (Wage £/h (£22.07) * wage uplift (22%)) * operating hours (10) * staff requirement (8) * no. gas stunning plants (11) * Operating days (250) = £5,924,600 Total: £5,924,600 * Percentage of plants with two stunners (54.55%) = £3.23m <u>Grand Total:</u> £1.35m + £3.23m = £4.6m			
Facilities	Ongoing facilities cost in option 1b covers the maintenance of converted gas stunners. ⁴¹	<u>Maintenance costs for one stunner – no space to expand:</u> Average annual maintenance contract (£68,972) * no. gas stunners (11) * Percentage of plants with one stunner – no space to expand (45.45%) = £344,826 <u>Maintenance costs for two stunners – no space AND space to expand:</u> Average annual maintenance contract (£137,943) * no. gas stunners (11) * Percentage of plants with two stunners (54.55%) = £827,727 Total: £827,727 + £344,826 = £1.2m	£1.2m	£1.4m	£0.9m
Yield	Yield costs in the do-nothing scenario cover the percentage of production of pigmeat that is rejected from the food chain due to a range of meat quality issues. Argon stunning on retrofit systems was found in PigStun research to have no statistical difference in meat quality to CO2. Cost is calculated using value of processed pig, Throughput and yield loss rate. ⁴²	<u>Yield costs for one stunner – no space to expand:</u> Processed pig £/head (£320) * TPUT annual (628,550) * yield loss % (0.25%) * no. gas stunners (11) * Percentage of plants with one stunner – no space to expand (45.5%) * TPUT as % of capacity (90.6%) = £2,736,173 <u>Yield costs for two stunners – no space AND space to expand:</u> Processed pig £/head (£320) * TPUT annual (1,257,101) * yield loss % (0.25%) * no. gas stunners (11) * Percentage of plants with two stunners (54.6%) * TPUT as % of capacity (90.6%) = £5,466,346 Total: £2,736,173 + £5,466,346 = £7.7m	£7.7m	£16.9m	£5.6m

Monetised benefits

Improved animal welfare

56. Research commissioned by Defra estimated the willingness-to-pay (WTP) of households/society for welfare improvements for 6 species of farm animals including pigs and established a measurement method to compare welfare scenario⁴³. The expert panel, consisting of 13 animal welfare experts, scored pig welfare out of 100 with 100 being highest welfare possible. The estimated lifetime welfare scores were for pigs bred and reared indoors herds and then slaughtered using CO2 stunning of pigs, 26.8; 28.2 for argon stunning of pigs; and 27.1 for Automated electrical stunning of pigs. Factors such as feeding, housing conditions, health and natural behaviours were considered in developing the welfare scores. A nationally representative survey of approx. 3,000 participants was conducted that asked a person per household how much they would be willing to increase their annual spend on food

⁴¹ Based on stakeholder engagement with CO2 slaughterhouses.

⁴² Based on stakeholder engagement with CO2 slaughterhouses, FSA data, Pigstun results, and assumptions.

⁴³ [Provision of a method for the economic valuation of animal welfare benefits suitable for use in policy appraisal - Main Report January 2025.pdf](#)

for improvements in welfare scores of pigs. Households were on average willing to increase their spending on pork products by £4.27 per year per 1-point improvement in welfare for all domestic pigs up to score of 41 where diminishing contributions occur. Given willingness to pay studies can be considered subjective, that consumers preferences can change over time and contexts, sensitivity tests are done on how much lower the WTP values could be before there is no net benefit to society from the policy. i.e. the costs are equal to the benefits. The results of the sensitivity analysis are in Annex 2.

57. The table below shows the welfare score provided by the expert panel for the different stunning methods. To monetise the improvements in pigs' welfare, we first take the difference in welfare scores between CO2 stunning and the two alternative methods. A household's willingness to pay to see a switch from CO2 gassing to argon gassing production is $£4.27 \times 1.4 = £5.98$. The same method is used to calculate a household's willingness to pay to see a switch from CO2 stunning to Automated electrical stunning. These figures represent one household's WTP and assume all pigs move from CO2 stunning to an alternative which is not the case. This value is scaled down to account for the proportion of pigs that are slaughtered using CO2 stunning (90%). A household's willingness to pay would therefore be $£5.98 \times 0.9 = £5.38$. Therefore, we multiplied the household's WTP by the total number of UK households (28,400,000⁴⁴) to presents the whole society's willingness to pay for this policy shown in the final column.

Monetised benefits calculation

Production system	Animal welfare score	Difference in welfare score to CO2 stunning	One household's willingness to pay	Annual WTP to move from CO2 stunning (UK)
Pigs bred and reared indoors herds and then slaughtered using CO2 Stunning	26.8	-	-	-
Pigs bred and reared indoors herds and then slaughtered using argon Stunning	28.2	1.4	£5.38	£152.8m
Pigs bred and reared indoors herds and then slaughtered using Automated Electrical Stunning	27.1	0.3	£1.15	£32.7m

SAMBA Assessment

58. For context, all of the 11 large commercial CO2 slaughterhouses in the UK have total employee numbers that exceed 50 employees. Additionally, most are owned by large food processing companies with pork processing making up part of the total business. Many of these businesses operate multiple CO2 pig slaughterhouses. Pilgrims operates two CO2 pig slaughterhouses in England (Westerleigh & Spalding), Karro/Sofina operate one in England (Malton) and one in NI (Cookstown), Cranswick operate two in England (Preston & Watton) and one in NI (Ballymena) and Woodheads/Myton Food Group operate two in England (Colne & Spalding). Three additional companies run one slaughterhouse each (one in Scotland, one in NI and one in England).

⁴⁴<https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2023#:~:text=There%20were%20an%20estimated%2028.4,for%20which%20data%20are%20available>

59. The one additional high concentration CO₂ pig slaughterhouse in operation in the UK (in NI) operates at very low domestic capacities. The current assumption is that with low daily throughputs, output could be easily maintained with the existing blueprint. We have not estimated a significant cost impact to this business. We intend to gather more information during the consultation period.
60. Overall, small slaughterhouses are not expected to face significant costs when transitioning away from CO₂ stunning. These businesses typically operate at low throughput and capacity, so they are unlikely to need additional stunners to maintain production levels. In addition to switching to argon, small slaughterhouses have the option to use the higher welfare method of manual electrical stunning to slaughter pigs, which we expect to be their preferred choice. Electrical stunning is more financially viable for their low production volumes compared to CO₂ or argon stunning. In fact, 70 small and medium sized Slaughterhouses in England and Wales used the manual electrical stunning method in 2024.⁴⁵
61. Small local slaughterhouses have lost significant market share over previous decades with just 10% of the domestic market in 2024, fallen from 48% in 2013 and 50% in 2011⁴⁶. The impact on these businesses is uncertain and non-monetised. If CO₂ gas stunning is banned as in shortlisted options 1 (a,b,c,d), average costs for the large commercial slaughterhouses are likely to rise. This may erode some of the competitive price advantage achieved using commercial CO₂ slaughter of pigs, compared to the more expensive and labour intensive manual electrical slaughter method. This could slow the industry shift away from manual electrical stunning slaughter of pigs. Also, remaining SMB's in the industry are commonly local and often specialist companies that may prioritise specific breeds or production types.
62. High uncertainty on business behaviours and investment decisions makes it difficult to anticipate the impact on existing small and micro pig slaughterhouses. The central scenario assumes a small increase in slaughter capacity for gas slaughterhouses. If throughput rises to meet this capacity, the market share of small and micro pig slaughterhouses may be eroded. However, it is assumed that there is no expansion of throughput in gas slaughterhouses because of bottlenecks in processing.
63. A continued reduction in market share of small and micro pig slaughterhouses is expected, regardless of any legislative changes. Evidence suggests that some existing CO₂ slaughterhouses are already intending to expand existing capacity and throughput which will exacerbate the current trend away from small local abattoirs.
64. The shortlisted legislative proposal and transition periods are expected to have a limited impact on small and micro businesses. We do not propose an exemption for these businesses for two key reasons:
65. *Proven viability* – As mentioned before, currently one small slaughterhouse successfully operates using CO₂ stunning, demonstrating that the practice can be financially feasible for small slaughterhouses. This means any small slaughterhouses could adopt CO₂ stunning in the future if they wish to do so, given that it is currently financially viable to do so. This creates a possible incentive for these businesses to consider CO₂ stunning going forwards. This means uncertainty about how many small slaughterhouses might adopt CO₂ stunning in the future, and therefore what the potential impact of a phased ban would be. It is also important to note that small slaughterhouses have the alternative option of using electrical stunning, which is more cost effective for their lower production volumes compared with CO₂ or argon stunning.
66. *SMART Objective not met* - Exemptions would undermine the core objective of the policy, 'improving animal welfare at slaughter by ending the use of CO₂ stunning in the domestic pig industry in favour of more humane alternatives'. Allowing exemptions could enable the existing small slaughterhouse to continue using CO₂ stunning or encourage others to adopt it, negatively impacting pig welfare over time. Animal welfare is experienced at the level of the individual pig, and pigs have no agency over the slaughterhouse to which they are sent. Consequently, any exemption would result in inconsistent animal welfare standards, as a proportion of pigs would continue to be slaughtered using CO₂ stunning.

⁴⁵ [25-02-14 Slaughter Sector Survey 2024 \(REVISED\)](#)

⁴⁶ <https://webarchive.nationalarchives.gov.uk/ukgwa/20171207164502/https://www.food.gov.uk/enforcement/sectorrules/animal-welfare/animal-welfare-survey>

67. Based on the above evidence, no exemption or mitigation is necessary for small and micro businesses (SMBs). The proposed legislation and transition periods are expected to have minimal impact on small and micro businesses, which have affordable options such as electrical stunning that suit their low production levels. Exemptions are not recommended, as they would undermine the policy's goal of ending CO₂ stunning and would mean inconsistent animal welfare standards.

6. Regulatory scorecard for preferred option

Part A: Overall and stakeholder impacts

(1) Overall impacts on total welfare		Directional rating
Description of overall expected impact	The overall impact of this regulation is positive. This regulation is expected to result in a significant social welfare gain, outweighing the business cost of moving away from CO₂ stunning of pigs, as on average consumers are willing to pay for improvements in animal welfare. All consumers gain from the improvement in animal welfare, even those who do not consume pork products. Recent research (commissioned by DEFRA) has monetised the household's WTP for improvements to the welfare of pigs. The findings of this research are used to calculate the benefits to society of the policy, which outweigh the costs. Full monetised cost to business impacts are included in the table below. We expect no significant impact on public finances. This option would not require additional government funding or generate additional revenues through taxation.	Positive Based on all impacts (incl. non-monetised)
Monetised impacts	Total NPSV – £1,837m Option 1b – Ban on CO₂ stunning of pigs with 3-year transition. We use a 20-year appraisal period because the depreciation period of the stunning equipment is at least 20 years. Costs are presented in real terms and are discounted. • Benefits – £1,957m ○ Wider Society WTP Benefit: £1,947m ○ Environment – GHG costs: £10.1m • Costs – £120.4m ○ Business – Production costs: £76.8m ○ Business – Capital Costs: £43.6m • BCR – 16.3	Positive
Non-monetised impacts	Labour conditions: The conditions for the labour force are potentially improved as an indirect effect of the policy. PigStun found that the risk of inhalation by humans of toxic levels of argon is estimated to be lower than for CO₂. Therefore, the transition observed in the central scenario will reduce health risk to staff members. The impact of this is non-monetised as risk change has not been quantified. Additionally, as there has not been any substantiated evidence of poor labour conditions caused by the use of CO₂, a counterfactual is difficult to measure and monetise. Separately, it is expected that moving to higher welfare stunning methods will increase the satisfaction that slaughterhouse employees find in their work because of the improved experience of the pigs. There is evidence, both anecdotal and academic,	Positive

	into the connection between slaughterhouse work and mental health outcomes. ⁴⁷	
Any significant or adverse distributional impacts?	We do not expect the policy to lead to significant adverse or distributional impacts relative to the baseline. Whilst the number of CO2 gas stunning slaughterhouses is small, these are not geographically clustered in a single area. We do not anticipate that existing slaughterhouses will close business. The central scenario along with most sensitivities observe an increase in labour requirements, meaning impacts on communities surrounding the existing businesses are expected to be positive.	Neutral

(2) Expected impacts on businesses		
Description of overall business impact	There will be costs from this regulation that directly impact businesses. There will be a significant transition cost to business from the implementation of the preferred option. A small number of large CO2 pig stunning slaughterhouses will be subjected to capital costs as existing slaughterhouses adapt their facilities to be conducive to an alternate stunning method. The level of capital investment will vary significantly based on business decisions and the resulting throughput they maintain. Argon stunning requires pigs to be present in the pits for longer periods meaning throughput speed within existing gas stunners would reduce and additional gas stunning facilities will need installation to maintain total throughput. Additionally, significant construction work to adapt existing facilities are likely to create costs to business from downtime. CO2 stunning has low marginal costs, (such as labour and utilities), and the implementation of the preferred option is anticipated to increase running costs for existing facilities over the long term. CO2 stunning results in limited meat quality issues and a transition to alternative methods may reduce business revenue due to a fall in yields. However, preliminary PigStun results suggest this issue isn't significant in a transition to argon. The mandated investment in a new slaughter method for existing CO2 pig slaughterhouses may have an impact on the size of the domestic sector. Dependent on business choices, there is a scope for the capacity of the sector to expand. However, this may be dependent on additional non-monetised costs to remove other existing bottlenecks such as the capacity within the farming sector, or additional processing capacity at the existing sites after the point of slaughter.	Negative
Monetised impacts	Business NPV: -£120.4m (-£89.9m to -£237.1m) over 20-year appraisal The long-term variable slaughter cost per pig is estimated to rise by significantly less than 0.5% of the price per pig received by commercial CO2 slaughterhouses. In addition, there is limited evidence of the likelihood of cost rises passing through to consumers. For these reasons, at this stage we assume additional costs to business are internalised. The cost increase will make a negligible difference to final prices for consumers when considering other trend production cost rises and food inflation. The central cost estimates to business were outlined in section 6. The sensitivity scenarios are outlined in Annex 1.	Negative Business NPV: -£120.4m (-£89.9m to -£237.1m) EANDCB: £8.2m (£6.1m to £16.1m) 20-year appraisal
Non-monetised impacts	Capacity: The central scenario assumes that six of the eleven large sites will build a second gas stunner. This increases UK slaughter capacity sufficiently to	Negative

⁴⁷ <https://pmc.ncbi.nlm.nih.gov/articles/PMC10009492/>

	maintain existing industry wide throughput levels, despite the slower slaughter process with argon gas. There may be additional costs required to remove other bottlenecks of slaughter capacity at these sites. These costs have not been monetised because of a lack of evidence on the bottlenecks and their likelihood of being removed. Stakeholder engagement has suggested that removal of these bottlenecks is possible. To mitigate the cost risk of these changes proving too expensive, or not possible, there are monetised cost scenarios where every site builds a second stunner and maintain throughput in Annex 1. There may be benefits to business for the increase in killing capacity to the slaughter systems. The central scenario estimates that killing capacity in the UK will rise from 9.7m pigs per year to 10.7m per year. Sensitivity analysis explored in Annex 1 observes scenarios where this capacity could increase further. Additional capacity provides the opportunity for existing slaughterhouses to increase output and revenue. However, to monetise these potential increases in revenue may be misleading for an array of reasons. Firstly, slaughter capacity at existing CO2 slaughterhouses may not be the only, or most significant bottleneck in production. Evidence from stakeholder engagement highlighted that some sites are currently operating below potential slaughter capacity because of other bottlenecks. Further investment costs increasing capacity elsewhere in the slaughterhouse, such as expanding the size of chillers, may be required if slaughterhouses are to expand output. In addition, stakeholders have identified that some excess capacity may already exist within the slaughter processing chain. This means that the supply of pigs may be a crucial factor in restricting the revenue growth. This highlights the final caveat, that any significant growth in the throughput of commercial CO2 pig slaughterhouses would also require a significant expansion of the pig farming sector. The short-term likelihood of this is uncertain but doubtful. Given the overall uncertainty of outcomes, the potential for large revenue changes, additional significant investment costs and a vast expansion of domestic pig farming, the impact of any potential capacity changes are non-monetised at this point. Recruitment and Training costs: Staff recruitment and retention is difficult in the slaughter industry. Outside of the additional labour costs included in the monetisation, there will be additional administrative costs in recruitment of staff that have not been monetised. These costs are difficult to estimate, due to lack of evidence, but are unlikely to have a significant impact on the overall NPV. Job Creation: In the central scenario additional jobs are created at slaughterhouses. Benefits to society are not monetised as they are an indirect benefit resulting from resources used in complying with regulation. Therefore, benefits from the creation of new jobs are not included in NPSV calculations. Whilst the preferred legislative option will create approximately 24 new jobs across the 11 large CO2 slaughterhouses in the UK, these are not considered a societal benefit. Whilst the governments reform package will lead to an increase in demand for labour, it is assumed that those employed will be switching from work of an equivalent social value. Small Abattoirs: Small abattoirs may benefit from an increase in demand for their services over the transition period if existing capacity is temporarily reduced. It has not been considered proportional to monetise this benefit.	
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Any significant or adverse distributional impacts?	We do not expect the policy to lead to significant adverse or distributional impacts relative to the baseline. Whilst the number of CO2 gas stunning slaughterhouses is small, these are not geographically clustered in a specific area, with slaughterhouses across the UK. We do not anticipate that existing slaughterhouses will close business. The central scenario along with most sensitivities observe an increase in labour requirements, meaning impacts on communities surrounding the existing businesses are expected to be positive.	Neutral
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(3) Expected impacts on households		
Description of overall household impact	The ban on CO2 stunning of pigs is expected to have a neutral indirect monetary impact on households. Over the past decade, Standard Pig Prices (SPP) have risen 59%. Global pork markets have faced major shifts in response to major disease outbreaks. Rising feed, energy and labour costs have had a significant impact on the sector. Other inflationary measures and currency movements have significant impacts on the price of pork purchased by consumers. Defra modelling indicates that ongoing costs rises due to the preferred option will result in a rise in costs equivalent to less than 0.5% of the GB SPP (The price of pigs purchased by slaughterhouses) or 0.2% if assessed against the full retail value of a carcass after butchering. We therefore consider the likelihood of price increases passing through to consumers as negligible. If the costs are passed through to consumers the impact would be extremely limited. The continued price consumers to pay for pork is significantly more likely to be affected by global factors mentioned above.	Neutral
Monetised impacts	Approx net financial cost to household EANDCH: £0 of which admin costs £0 – no direct costs to households' budgets. This policy does not dictate that costs must be passed on to households. Please indicate if pass through to businesses has been deducted from these figures - No Please indicate any pass-through costs from business to households (if available) £0 – none Defra modelling shows that the impact on consumers buying pork and pork products would be negligible. From our modelling, the additional cost of the preferred policy if allocated evenly across all pork products, equates to approximately 0.1p per sausage, or up to 0.2p if the additional cost of the preferred policy is applied only to sausages (and no other pork products). For other pork products, additional cost of preferred policy if evenly spread across all pork products equates to 0.2p per pork belly slice, or 0.9p if cost is applied only to belly slices; 0.2p per pork chop if spread across all pork products, or 1.3p if applied only to pork chops; and 0.2p per loin steak if spread evenly, or 0.9p if applied only to loin steaks. In the extreme, the modelling assumes that 100% of the additional cost is passed through to consumers. Given current evidence of price sensitivity, this full pass-through is unlikely. Retailers also face menu costs, meaning it is not economically rational to adjust prices by only a few pence. As a result, there is very limited scope for prices to increase under the preferred policy, and we therefore judge a price effect to be unlikely and have not monetised it. In practice, broader cost drivers, such as feed prices and electricity, are likely to have a far greater influence on the price of pork and pork products.	Neutral Based on analysis

	Any ban on the use of carbon dioxide to stun pigs would only take effect at the end of a transition period, the length of which is subject to consultation and would be at least two years from the date that the legislation to introduce the ban is made. These proposals are therefore not expected to have any impact on consumer prices in the immediate or short term.	
Non-monetised impacts	The costs incurred by businesses are not expected to pass through to consumers. This assumption will be tested at consultation. A recent investigation by the Competition & Markets Authority found that grocery retailers had not passed through costs to consumers in 2022-23 with consumers typically switching grocers to get the best deals⁴⁸. With regards to food services, 51% of consumers surveyed in the latest Barclays Consumer Confidence Survey said that they are planning to cut down on discretionary spending, with the most cited ways of cutting back being a reduction in dining out at restaurants (54%) and ordering fast food and takeaways (53%).⁴⁹ With consumers being price sensitive and able to shop around, food services will need to be cautious on if or how much of the cost is passed through to consumers.	Neutral
Any significant or adverse distributional impacts?	No	Neutral

Part B: Impacts on wider government priorities

Category	Description of impact	Directional rating
Business environment: Does the measure impact on the ease of doing business in the UK?	Business environment: The overall domestic business environment will face mixed outcomes. A higher level of regulatory burden for business, as scope for acceptable slaughter methods reduces, may create a negative impact on the overall competitiveness of the domestic market. There is not expected to be a significant impact on the competitiveness of the UK market, however, data limitations and uncertainty exist in current estimates. However, the existing business environment will benefit from the clarification of stance that will come with new legislation. Existing businesses are delaying expansion and investment decisions until the government stance on current methods is made clear. Additionally, the industry's domestic and global reputation will likely improve if leading the way in the transition away from CO2 stunned pigs. Issues of CO2 supply have previously created major issues in the slaughter sector, largely as CO2 production is a by-product of fertiliser, bioethanol and ammonia plants which have had to periodically shutdown and continue to face pressures. Argon is produced in the UK through cryogenic air-separation units (ASUs), which extract argon as a by-product of large-scale oxygen and nitrogen production. Because these ASUs operate continuously to meet stable national demand for oxygen and nitrogen across healthcare, manufacturing, and energy sectors, argon output is correspondingly steady and resilient. The	Uncertain

⁴⁸ [Competition and profitability in the groceries sector](#)

⁴⁹ [UK Consumer Spend Report | Barclays Corporate](#)

	transition to argon would likely reduce risks associated with CO2 shortages for other domestic industries too.	
International Considerations: Does the measure support international trade and investment?	Trade: It is assumed that pork imports into GB from the EU from pigs that had been subject to CO2 stunning will continue. However, following the EU sponsored PigStun project the EU may also look at phasing out the method in the future too. The main pig processors use imports to secure carcase balance and so would prefer the measure to not apply to imports. Further evidence on this could be collected in the consultation. Additionally, the estimated cost impact of the policy on the cost of pork for consumers is expected to be negligible. Defra assumes that there will not be significant changes in the trade balance for pork with key EU producers, or others.	Uncertain
Natural capital and Decarbonisation: Does the measure support commitments to improve the environment and decarbonise?	Environmental impact: The central scenario observes a transition from the use of CO2 gas towards the use of argon gas. Argon gas is not a greenhouse gas as it does not trap heat. Therefore, emissions coming out of the pig slaughter sector are estimated to fall. However, argon is more energy intensive during extraction and capture than CO2. Argon is however most often produced as a byproduct of oxygen production at air separation plants. Factoring these contributors, and using green book guidance, in the central scenario over a 20-year appraisal period, there is an equivalent reduction in greenhouse gas pollution to the value of £9.4m. There may be additional emissions involved in the transition process caused by construction works. These estimates have not been monetised at the consultation impact assessment stage because of a lack of evidence.	Supports

7. Monitoring and evaluation of preferred option

68. A robust evaluation plan will articulate the intended outcomes of the legislation, and propose how these can be evaluated, including key success measures and data requirements, timeline, available resources, the key challenges of evaluating the legislation and how the findings will be used. The evaluation will follow the Green book (HM Treasury, 2022)⁵⁰, Magenta book (HM treasury and Evaluation Task Force, 2020)⁵¹ and Theory of Change Toolkit (Defra, 2022)⁵², and will encompass a range of approaches including process evaluation (*what can be learned from how the intervention was delivered?*), impact evaluation (*what difference did the intervention make?*), and value-for-money (*was this good use of resources?*).
69. To evaluate success, the evaluation will measure the impacts of banning CO2 stunning on pig welfare and supply chains. Furthermore, there are a range of risk factors that will likely have an impact on the success of the intervention:
70. **Reduced profits:** Progress requires industry bear a significant portion of the load, including the cost of building redesigns, the higher costs of alternative slaughter methods and (for automated electrical) any yield loss due to increased incidence of pale, soft, and exudative (PSE) meat. Reduced resilience in the pork sector is possible during the transition.

⁵⁰ [The Green Book: appraisal and evaluation in central government - GOV.UK](#)

⁵¹ [The Magenta Book - GOV.UK](#)

⁵² [15392 4.DefraToCTool Report.pdf](#)

71. **Supply chain disruption:** CO2 supply chains have been subject to various shocks in the last 10 years; therefore, it is likely that supply chains will experience improved resilience as a result of this legislation. However, it is worth noting that risks do exist. If abattoirs are unable to maintain production at the same level, disruption to supply chains is possible. Any disruption of the just-in-time supply chain could have major consequences for pigs/industry.
72. **Stakeholder buy-in:** Stakeholder buy-in is important in determining the rate of change. There are risks surrounding industry/retailer resistance to change, damage to levels of trust in Defra, and consumers' lack of knowledge on the reality of pig slaughter.
73. Key success measures and risk factors will be monitored and evaluated through available data sources, and could be supplemented with social research with key stakeholders.

Monitoring of available data sources

74. There are existing sources of data that will be used to inform the review. These data sources are collected and owned by the Food Standard Agency (FSA), Food Standards Scotland and DAERA and are all readily available on request:
 - Day to day monitoring of slaughterhouse operations by Official Veterinarians
 - Approval system for new slaughterhouses or substantial alterations to stunning operations
 - Establishment throughput data. This includes how many animals of each species are slaughtered at each slaughterhouse. Data exists in different time aggregations.
75. These data sources will provide robust measures to track the adoption of alternate stunning systems across time.

Evaluation questions as part of the next PIR of the welfare legislation.

76. Some of the key evaluation questions are described in Table 1. This list is not exhaustive.

Table 1. Evaluation questions, evaluation type and the methodology that could be used to address them.

Question	Type	Method
To what extent did the actual costs differ from those estimated in the original impact assessment, and what factors contributed to any variance?	Process	Social research
How did industry adapt to the regulation (for example, time taken to transition, conversion vs new built, capacity)?	Process	Social research
How effective was the communication of regulatory requirements to different stakeholder groups, and to what extent did they understand and act on the information provided?	Process	Social research
What unintended consequences, if any, emerged following the legislation, and how did these impact outcomes?	Impact	Social research
Were there any impacts on price received from slaughterhouses as a direct result of the regulation?	Impact	Social research

Timing

77. Evaluation activities will make use of the existing five yearly post-implementation review cycle as stipulated in The Welfare of Animals at the Time of Killing (England) Regulations 2015. The first PIR was published in January 2021, the second PIR was published in January 2026, and the subsequent PIR will be published in January 2031.
78. Evaluation activities will also take place at timely intervals during the transition period to understand effectiveness and whether improvements can be made to the way the intervention is being delivered.

Use of evaluation learnings

79. Learning from the monitoring and evaluation activities will feed into the development of the intervention by several routes, including presentations and development of future training material, discussions, debate and challenge at senior level.

8. Minimising administrative and compliance costs for preferred option

80. Slaughterhouses already have rigorous health and safety and monitoring systems in place to ensure the existing machinery is operating effectively and safely. The systems and processes will still be functional and adequate following a transition from CO2 to argon gas stunning. Therefore, there should only be minimal increases to existing compliance costs and administrative burden. The FSA already charge industry for their involvement on site at slaughterhouses.
81. The issues with CO2 stunning have been known about by industry since 2003. Given the proposed transition period, slaughterhouses will have significant time preparation for any legislative changes, meaning familiarisation costs will be limited. Additionally, the high concentration of the industry means that the administrative burdens are confined to this small group of firms and therefore overall time and cost requirements are expected to be low.

Declaration

Department:

...

Contact details for enquiries:

...

Director responsible:

...

I have read the Options 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:

Sign here

Date:

Date

Annex 1: Sensitivity Analysis on Cost to Business

Our Central Scenario in the modelling assumes the outcome of business choices in response to the preferred option of banning the CO2 stunning of pigs in legislation. Industry insights, policy expertise and likely behaviour based on cost modelling has informed the response outlined in the central scenario. However, there are still many possible choices available to businesses on how to respond to the preferred option. The scenarios described below offer a range of possible outcomes. Some outcomes are modelled on expected behaviour, others are less likely but are designed to stretch the limits of business behaviour, allowing to test the highest and lowest possible cost scenarios. In addition, we test these scenarios with a 10-year appraisal period as well as a 20-year appraisal period.

Sensitivity Scenarios and Definitions

Sensitivity Scenario	Central Scenario (NPV, Total)
Central scenario - All argon - maintain capacity mixed cost	The Central scenario highlights an outcome where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. In addition, capacity is maintained by the construction and installation of a second argon gas stunner at six of the eleven existing sites. Of the six new sites we assume a mix of three low and three high-cost transitions. This distinction highlights the varied difficulty of adapting existing sites for a second gas stunner.
All argon - no construction	This Scenario highlights an approach where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. No additional construction takes place. Additional costs arise due to a reduction in industry throughput.
All argon - 2 gas stunners low cost	This Scenario highlights an outcome where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. In addition, the construction and installation of a second argon gas stunner goes ahead at all 11 large existing sites. Of the 11 sites we assume all sites undergo low-cost transitions. This assumes there were limited difficulties in transitioning existing sites.
All argon - 2 gas stunners high cost	This Scenario highlights an outcome where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. In addition, the construction and installation of a second argon gas stunner goes ahead at all 11 large existing sites. Of the 11 sites we assume all sites undergo high-cost transitions. This assumes there were significant difficulties in transitioning existing sites.
All argon 2 gas stunners mixed cost	This Scenario highlights an outcome where all eleven existing large CO2 stunning slaughterhouses are retrofitted to transition from CO2 to argon gas. In addition, the construction and installation of a second argon gas stunner goes ahead at all 11 large existing sites. Of the 11 sites we assume 5 sites undergo high-cost transitions. Of the 11 new sites we assume 6 sites undergo low-cost transitions.
All automated electrical - 2 stunners	This scenario highlights an outcome where all existing large CO2 stunning slaughterhouses move away from high concentration gas systems and transition to automated electrical stunning. This site assumes that each existing slaughterhouse purchases 2 automated electrical stunning systems. Additional costs arise due to a reduction in industry output.
All automated electrical - 4 stunners	This scenario highlights an outcome where all existing large CO2 stunning slaughterhouses move away from high concentration gas systems and transition to automated electrical stunning. This site assumes that each existing slaughterhouse purchases 4 automated electrical stunning systems.
All automated electrical maintain capacity	This scenario highlights an outcome where all existing large CO2 stunning slaughterhouses move away from high concentration gas systems and transition to automated electrical stunning. This site assumes that the industry maintains its existing capacity with the new stunning system. Two existing slaughterhouse purchases 4 automated electrical stunning systems whilst the remaining nine slaughterhouses purchase 2 automated electrical stunners.

Option 1a: Ban on CO2 stunning with 2-year Transition period (20-year and 10-year appraisal).

Sensitivity Scenario	Central Scenario (NPV, Total) (low to high)	EANCB £ Central scenario (low to high)	NPSV £	BCR	Annual Throughput capacity of Pigs ⁵³ (Change from baseline)
(Central Scenario) All argon maintain capacity mixed cost (20-year appraisal period)	-£127.8m (-£95.4m to -£253.0m)	£8.7m (£6.5m to £17.2m)	£1,977.7m	16.5	10.7m (+1.0m)
(Central Scenario) All argon maintain capacity mixed cost (10-year appraisal period)	-£89.7m (-£68.1m to -£163.8m)	£10.4m (£7.9m to £19.0m)	£1,083.5m	13.1	10.7m (+1.0m)
All argon no construction (20-year appraisal period)	-£509.5m (-£380.1m to -£704.1m)	£34.6m (£25.8m to £47.9m)	£1,000.3m	3.0	6.9m (-2.8m)
All argon no construction (10-year appraisal period)	-£282.8m (-£211.0m to -£390.8m)	£32.9m (£24.5m to £45.4m)	£561.0m	3.0	6.9m (-2.8m)
All argon 2 gas stunners low cost (20-year appraisal period)	-£170.8m (-£127.0m to -£302.0m)	£11.6m (£8.6m to £20.5m)	£1,932.4m	12.3	13.8m (+4.1m)
All argon 2 gas stunners low cost (10-year appraisal period)	-£122.3m (-£91.3m to -£201.7m)	£14.2m (£10.6m to £23.4m)	£1,048.5m	9.6	13.8m (+4.1m)
All argon 2 gas stunners high cost (20-year appraisal period)	-£200.7m (-£157.8m to -£341.3m)	£13.6m (£10.7m to £23.2m)	£1,902.6m	10.5	13.8m (+4.1m)
All argon 2 gas stunners high cost (10-year appraisal period)	-£152.2m (-£122.2m to -£241.0m)	£17.7m (£14.2m to £28.0m)	£1,018.7m	7.7	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (20-year appraisal period)	-£184.4m (-£141.0m to -£319.9m)	£12.5m (£9.6m to £21.7m)	£1,918.9m	11.4	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (10-year appraisal period)	-£135.9m (-£105.3m to -£219.6m)	£15.8m (£12.2m to £25.5m)	£1,034.0m	8.6	13.8m (+4.1m)
All automated electrical 2 stunners (20-year appraisal period)	-£773.1m (-£616.8m to -£949.5m)	£52.6m (£41.9m to £64.5m)	-£358.6m	0.54	8.9m (-0.7m)
All automated electrical 2 stunners (10-year appraisal period)	-£458.7m (-£365.7m to -£562.3m)	£53.2m (£42.5m to £65.3m)	-£228.7m	0.50	8.9m (-0.7m)
All automated electrical 4 stunners (20-year appraisal period)	-£800.9m (-£660.0m to -£964.3m)	£54.4m (£44.9m to £65.6m)	-£352.0m	0.56	17.9m (+8.1m)
All automated electrical 4 stunners (10-year appraisal period)	-£488.2m (-£403.5m to -£584.3m)	£56.7m (£46.9m to £67.9m)	-£239.1m	0.51	17.9m (+8.1m)
All automated electrical maintain capacity (20-year appraisal period)	-£713.2m (-£577.3m to -£870.9m)	£48.5m (£39.2m to £59.2m)	-£264.3m	0.63	10.6m (+0.9m)

⁵³ This reflects the change in capacity for throughput. In all modelled scenarios, actual throughput remains at the baseline level, even though additional capacity is available.

All automated electrical maintain capacity (10-year appraisal period)	-£428.0m (-£346.3m to -£521.2m)	£49.7m (£40.2m to £60.6m)	-£178.9m	0.58	10.6m (+0.9m)
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Option 1b: Ban on CO2 stunning with 3-year Transition period (20-year and 10-year appraisal).

Sensitivity Scenario	Central Scenario (NPV, Total) (low to high)	EANCB £ Central scenario (low to high)	NPSV £	BCR	Annual Throughput capacity of Pigs (Change from baseline)
(Central Scenario) All argon maintain capacity mixed cost (20-year appraisal period)	- £120.4m (-£89.9m to -£237.1m)	£8.2m (£6.1m to £16.1m)	£1,836.9m	16.3	10.7m (+1.0m)
(Central Scenario) All argon maintain capacity mixed cost (10-year appraisal period)	- £82.2m (-£62.6m to -£147.9m)	£9.6m (£7.3m to £17.2m)	£942.7m	12.5	10.7m (+1.0m)
All argon no construction (20-year appraisal period)	-£473.6m (-£353.3m to -£654.5m)	£32.2m (£24.0m to £44.5m)	£929.9m	3.0	6.9m (-2.8m)
All argon no construction (10-year appraisal period)	-£246.9m (-£184.2m to -£341.2m)	£28.7m (£21.4m to £39.6m)	£490.7m	3.0	6.9m (-2.8m)
All argon 2 gas stunners low cost (20-year appraisal period)	-£161.1m (-£119.8m to -£283.5m)	£10.9m (£8.1m to £19.3m)	£1,794.1m	12.1	13.8m (+4.1m)
All argon 2 gas stunners low cost (10-year appraisal period)	-£112.6m (-£84.1m to -183.2m)	£13.1m (£9.8m to £21.3m)	£910.2m	9.1	13.8m (+4.1m)
All argon 2 gas stunners high cost (20-year appraisal period)	-£189.9m (-£149.5m to -£321.5m)	£12.9m (£10.2m to £21.9m)	£1,765.2m	10.3	13.8m (+4.1m)
All argon 2 gas stunners high cost (10-year appraisal period)	-£141.4m (-£113.9m to -£221.2m)	£16.4m (£13.2m to £25.7m)	£881.3m	7.2	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (20-year appraisal period)	-£174.2m (-£133.3m to -£300.8m)	£11.8m (£9.1m to £20.4m)	£1,780.9m	11.2	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (10-year appraisal period)	-£125.7m (-£97.6m to -£200.5m)	£14.6m (£11.3m to £23.3m)	£897.0m	8.1	13.8m (+4.1m)
All automated electrical 2 stunners (20-year appraisal period)	-£721.1m (-£575.3m to -£885.5m)	£49.0m (£39.1m to £60.2m)	-£335.8m	0.53	8.9m (-0.7m)
All automated electrical 2 stunners (10-year appraisal period)	-£406.7m (-£324.2m to -£498.3m)	£47.2m (£37.7m to £57.9m)	-£205.9m	0.49	8.9m (-0.7m)
All automated electrical 4 stunners (20-year appraisal period)	-£748.0m (-£616.5m to -£900.4m)	£50.9m (£41.9m to £61.2m)	-£330.8m	0.56	17.9m (+8.1m)
All automated electrical 4 stunners (10-year appraisal period)	-£435.3m (-£360.0m to -£520.4m)	£50.6m (£41.8m to £60.5m)	-£217.9m	0.50	17.9m (+8.1m)
All automated electrical maintain capacity (20-year appraisal period)	-£665.6m (-£538.7m to -£812.7m)	£45.2m (£36.6m to £55.2m)	-£248.3m	0.63	10.6m (+0.9m)

All automated electrical maintain capacity (10-year appraisal period)	-£380.4m (-£307.7m to -£463.0m)	£44.2m (£35.8m to £53.8m)	-£163.0m	0.57	10.6m (+0.9m)
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Option 1c: Ban on CO2 stunning with 4-year Transition period (20-year and 10-year appraisal).

Sensitivity Scenario	NPV £ Central scenario (NPV, Total) (low to high)	EANCB £ Central scenario (low to high)	NPSV £	BCR	Annual Throughput capacity of Pigs (Change from baseline)
(Central Scenario) All argon maintain capacity mixed cost (20-year appraisal period)	-£113.2m (-£84.6m to -£221.7m)	£7.7m (£5.8m to £15.1m)	£1,700.8m	16.0	10.7m (+1.0m)
(Central Scenario) All argon maintain capacity mixed cost (10-year appraisal period)	-£75.0m (-£57.4m to -£132.6m)	£8.7m (£6.7m to £15.4m)	£806.6m	11.8	10.7m (+1.0m)
All argon no construction (20-year appraisal period)	-£438.9m (-£327.4m to -£606.6m)	£29.8m (£22.3m to £41.2m)	£861.9m	3.0	6.9m (-2.8m)
All argon no construction (10-year appraisal period)	-£212.2m (-£158.3m to -£293.2m)	£24.7m (£18.4m to £34.0m)	£422.6m	3.0	6.9m (-2.8m)
All argon 2 gas stunners low cost (20-year appraisal period)	-£151.6m (-£112.7m to -£265.7m)	£10.3m (£7.7m to £18.1m)	£1,660.3m	12.0	13.8m (+4.1m)
All argon 2 gas stunners low cost (10-year appraisal period)	-£103.1m (-£77.1m to -£165.4m)	£12.0m (£9.0m to £19.2m)	£776.4m	8.5	13.8m (+4.1m)
All argon 2 gas stunners high cost (20-year appraisal period)	-£179.5m (-£141.5m to -£302.4m)	£12.2m (£9.6m to £20.6m)	£1,632.5m	10.1	13.8m (+4.1m)
All argon 2 gas stunners high cost (10-year appraisal period)	-£131.0m (-£105.9m to -£202.1m)	£15.2m (£12.3m to £23.5m)	£748.6m	6.7	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (20-year appraisal period)	-£164.3m (-£125.8m to -£282.4m)	£11.2m (£8.6m to £19.2m)	£1,647.7m	11.0	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (10-year appraisal period)	-£115.8m (-£90.2m to -£182.1m)	£13.5m (£10.5m to £21.2m)	£763.8m	7.6	13.8m (+4.1m)
All automated electrical 2 stunners (20-year appraisal period)	-£670.8m (-£535.2m to -£823.7m)	£45.6m (£36.4m to £56.0m)	-£313.7m	0.53	8.9m (-0.7m)
All automated electrical 2 stunners (10-year appraisal period)	-£356.4m (-£284.0m to -£436.5m)	£41.4m (£33.0m to £50.7m)	-£183.9m	0.48	8.9m (-0.7m)
All automated electrical 4 stunners (20-year appraisal period)	-£697.0m (-£574.6m to -£838.7m)	£47.4m (£39.1m to £57.0m)	-£310.3m	0.55	17.9m (+8.1m)
All automated electrical 4 stunners (10-year appraisal period)	-£384.3m (-£318.1m to -£458.7m)	£44.6m (£37.0m to £53.3m)	-£197.4m	0.49	17.9m (+8.1m)
All automated electrical maintain capacity (20-year appraisal period)	-£619.6m (-£501.5m to -£756.4m)	£42.1m (£34.1m to £51.4m)	-£232.9m	0.62	10.6m (+0.9m)

All automated electrical maintain capacity (10-year appraisal period)	-£334.4m (-£270.5m to -£406.7m)	£38.9m (£31.4m to £47.2m)	-£147.5m	0.56	10.6m (+0.9m)
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Option 1d: Ban on CO2 stunning with 5-year Transition period (20-year and 10-year appraisal).

Sensitivity Scenario	Central Scenario (NPV, Total) (low to high)	EANCB £ Central scenario (low to high)	NPSV £	BCR	Annual Throughput capacity of Pigs (Change from baseline)
(Central Scenario) All argon maintain capacity mixed cost (20-year appraisal period)	-£106.2m (-£79.5m to -£206.9m)	£7.2m (£5.4m to £14.1m)	£1,569.3m	15.8	10.7m (+1.0m)
(Central Scenario) All argon maintain capacity mixed cost (10-year appraisal period)	-£68.0m (-£52.2m to -£117.7m)	£7.9m (£6.1m to £13.7m)	£675.1m	10.9	10.7m (+1.0m)
All argon no construction (20-year appraisal period)	-£405.4m (-£302.4m to -£560.3m)	£27.6m (£20.6m to £38.1m)	£796.2m	3.0	6.9m (-2.8m)
All argon no construction (10-year appraisal period)	-£178.7m (-£130.1m to -£241.4m)	£20.8m (£15.1m to £28.0m)	£356.9m	3.0	6.9m (-2.8m)
All argon 2 gas stunners low cost (20-year appraisal period)	-£142.5m (-£106.0m to -£248.4m)	£9.7m (£7.2m to £16.9m)	£1,531.1m	11.7	13.8m (+4.1m)
All argon 2 gas stunners low cost (10-year appraisal period)	-£94.0m (-£70.4m to -£148.1m)	£10.9m (£8.2m to £17.2m)	£647.2m	7.9	13.8m (+4.1m)
All argon 2 gas stunners high cost (20-year appraisal period)	-£169.4m (-£133.8m to -£283.9m)	£11.5m (£9.1m to £19.3m)	£1,504.2m	9.9	13.8m (+4.1m)
All argon 2 gas stunners high cost (10-year appraisal period)	-£120.9m (-£98.2m to -£183.6m)	£14.1m (£11.4m to £21.3m)	£620.3m	6.1	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (20-year appraisal period)	-£154.7m (-£118.7m to -£264.5m)	£10.5m (£8.1m to £18.0m)	£1,518.9m	10.8	13.8m (+4.1m)
All argon 2 gas stunners mixed cost (10-year appraisal period)	-£106.3m (-£83.0m to -£164.3m)	£12.3m (£9.6m to £19.1m)	£635.0m	7.0	13.8m (+4.1m)
All automated electrical 2 stunners (20-year appraisal period)	-£622.2m (-£496.4m to -£763.9m)	£42.3m (£33.7m to £51.9m)	-£292.4m	0.53	8.9m (-0.7m)
All automated electrical 2 stunners (10-year appraisal period)	-£307.8m (-£245.3m to -£376.7m)	£35.8m (£28.5m to £43.8m)	-£162.6m	0.47	8.9m (-0.7m)
All automated electrical 4 stunners (20-year appraisal period)	-£647.7m (-£534.0m to -£779.0m)	£44.0m (£36.3m to £53.0m)	-£290.5m	0.55	17.9m (+8.1m)
All automated electrical 4 stunners (10-year appraisal period)	-£336.0m (-£277.5m to -£399.0m)	£38.9m (£32.2m to £46.4m)	-£177.6m	0.47	17.9m (+8.1m)
All automated electrical maintain capacity (20-year appraisal period)	-£575.1m (-£465.5m to -£702.0m)	£39.1m (£31.6m to £47.7m)	-£218.0m	0.62	10.6m (+0.9m)

All automated electrical maintain capacity (10-year appraisal period)	-£290.0m (-£234.5m to -£352.3m)	£33.7m (£27.2m to £40.9m)	-£132.7m	0.54	10.6m (+0.9m)
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Annex 2: Society WTP Switching Values:

This sensitivity tests how much lower the WTP values from the research commissioned by Defra⁵⁴ could be before there is no net benefit to society from the policy. i.e. the costs are equal to the benefits. In the central analysis, the WTP for 1 point of welfare improvement for pigs at current welfare levels is £4.27 per household per year. Under the preferred option, the WTP value could be 94% lower at £0.26 for the BCR to be 1. Our assessment is that it is very unlikely for the WTP value is 94% lower than in the research.

Society WTP Switching Values	Option 1a	Option 1b	Option 1c	Option 1d
	Ban CO2 stunning of pigs with 2-year transition	Ban CO2 stunning of pigs with 3-year transition	Ban CO2 stunning of pigs with 4-year transition	Ban CO2 stunning of pigs with 5-year transition
For BCR = 1, and NPV = 0	WTP= £0.25 94% decrease	WTP = £0.25 94% decrease	WTP = £0.25 94% decrease	WTP = £0.26 94% decrease

Annex 3: Data & Assumptions

Description	Assumption	Source
Appraisal Period.	The standard appraisal period of 10 years would not effectively capture the impacts of the policy given that the relevant stunning equipment has a depreciation period of 20+ years therefore a 20-year appraisal period is used. Despite this 20-year transition, impacts are expected to continue after this period.	N/A
Transition Costs.	Machinery conversion cost, Downtime costs, Equipment & Construction costs (Argon & Automated electrical) Additional planning and construction costs, Downtime length	Industry provided Assumption based on industry feedback and policy expertise.
Ongoing costs.	Standard Pig Price (SPP) – 2022 to 2024 average (p/kg), Average pig weight - 2022 to 2024 average (kg),	AHDB GOV.UK

⁵⁴ [Provision of a method for the economic valuation of animal welfare benefits suitable for use in policy appraisal - Main Report January 2025.pdf](#)

	Production costs - 2022 to 2024 average (p/kg) UK pig slaughter total - 2022 to 2024 average (head) % of slaughter using CO2 UK (2024) Water & Electrical average cost (head) – all methods, Time for argon Stun, Meat quality impacts on Yield CO2 & argon Costs Annual Salary – Slaughter, Labour requirements (staff numbers), Operating time (hours, days, weeks) per annum, CO2 Usage, Maintenance costs, Time for CO2 stun,	DEFRA/FSA PigStun Domestic industrial gas supplier Industry provided
Carbon Savings	Carbon Values (2023) CO2 gas use per pig (kg) Argon/Nitrogen gas use per pig (kg) Cost of extraction (CO2e/kg) for CO2 and argon	Green Book Industry Provided