AVEC

The Association of Poultry Processors and Poultry Trade in the EU Countries

Costs and implications of the European Chicken Commitment in the EU

A report prepared by RSK ADAS Ltd

March 2024

ADAS GENERAL NOTES

Project No.: 1011059

Title: The cost and implications of adopting European Chicken Commitment Standards in the European Union

Client : AVEC, Rue du Luxembourg 47-51, B-1050 Brussels, Belgium

Date: March 2024

Office: Cefn Llan Science Park, Aberystwyth, UK

Status: Final

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Date:	March 2024	Date:	March 2024

EXECUTIVE SUMMARY

The European Chicken Commitment (ECC) includes standards for chicken production that exceed current EU legislation. On-farm requirements of ECC include a maximum stocking density of 30kg liveweight per square metre and the use of breeds (strains) that are slower-growing than conventional chickens. A guide threshold growth rate of 60g per day is included in the Commitment. Natural light, perch space and other enrichment are also required.

The aim of this report is to identify the additional costs and likely implications of the adoption of ECC requirements on EU chicken production. **Emphasis has been placed on calculating costs 'per kg of meat'. This is considered a key metric and one that has generally not been included in previous studies.** Costs 'per bird' and 'per kg of liveweight' are also provided for comparison. Typical commercial performance data and recent costs have been used. Impacts on greenhouse gas emissions of chicken production, land use changes and water use have been assessed. The scope of the study did not extend to assessing the welfare benefits of ECC production.

Standard and ECC production costs were based on current liveweight targets. It was assumed that thinning is permitted (although it is 'discouraged' in ECC) and that birds are thinned at 1.8kg liveweight, with the remaining birds reaching 2.7kg at final depopulation. Based on commercial experience and breed performance data, it was assumed that these liveweights would be reached at 31 and 40 days in standard production and at 37 days and 51 days in ECC. A 10-day turnaround time (clean-out) was assumed throughout, feed conversion ratio (FCR) was estimated to increase from 1.55 for standard to 1.85 for ECC.

Production costs per bird liveweight (in eurocents) are shown in Figure 1. The cost increase between standard production at 39 kg per square metre (273.7 eurocents per bird) and ECC production (333.7 eurocents per bird) is calculated as +21.9%.

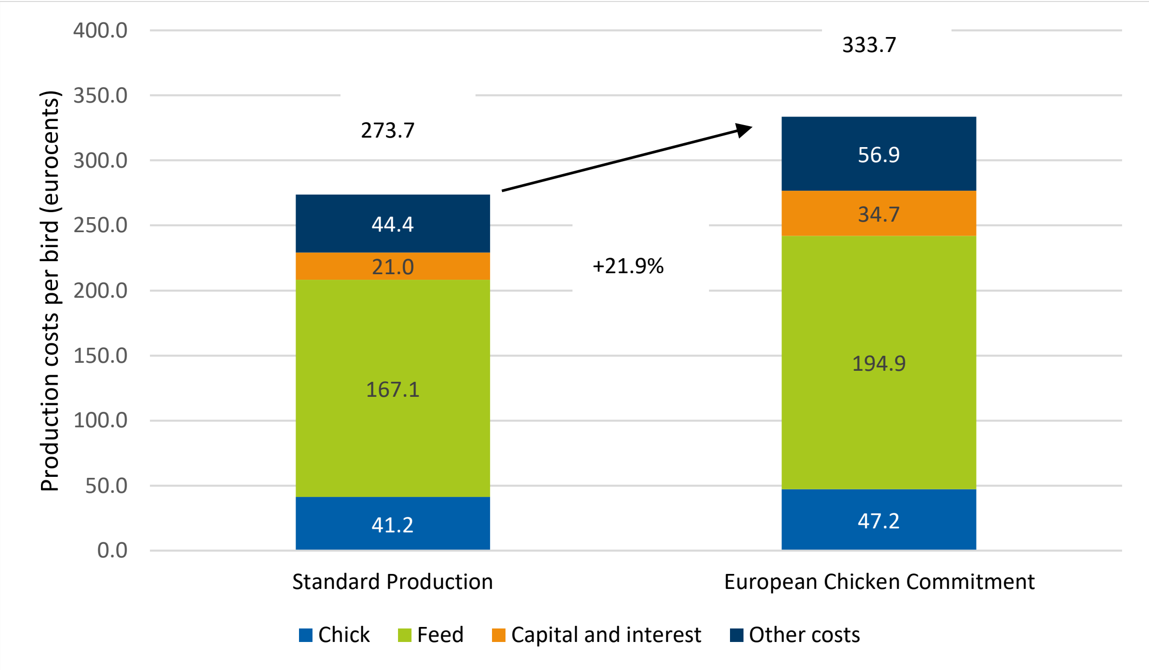

Figure 1 Cost of production (eurocents) for standard and ECC production per bird

From this, the cost of production 'per kg of meat' was calculated. The findings are shown in Figure 2 and the production cost increase from 201.8 eurocents (for standard) to 277.4 eurocents (ECC) is +37.5%.

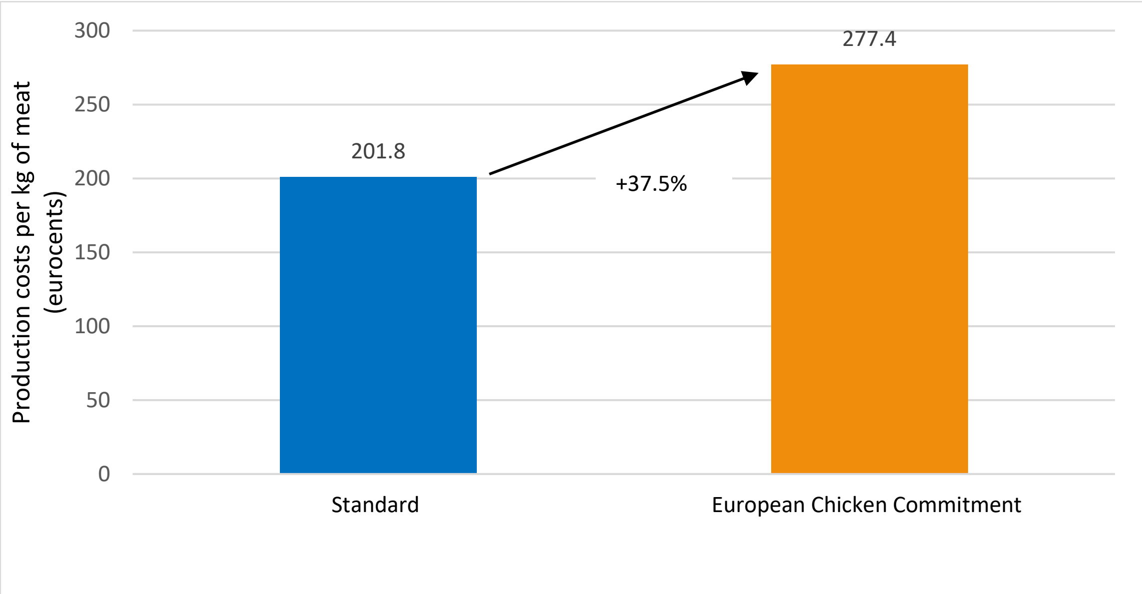

Figure 2 Cost of production (eurocents) for standard and ECC production per kg of meat

A key finding is that on a 'per kg of meat' basis, the percentage cost increase for ECC is much higher than it is 'per bird'. This is because the meat yield of the slower-growing bird is expected to be 11.3% lower (49.94% of liveweight) than it is for standard birds (56.29% of liveweight). The amount of meat produced annually per square metre of growing space is reduced by 44% in ECC production as shown in Figure 3. This is due to differences in stocking rates, cycle length and carcass yield.

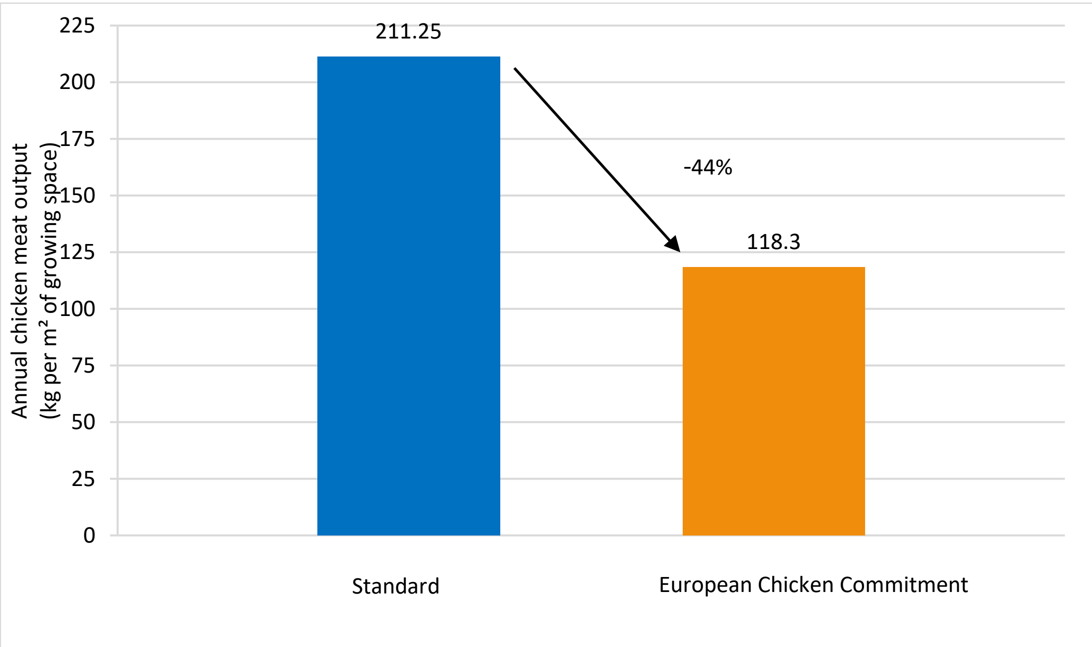

Figure 3 Comparison of annual meat output per square metre for standard and ECC production (kg)

For ECC production, feed use would increase by 720 grams per bird and water consumption by 1.23 litres per bird (this excludes water for clean-out). Both represent an increase of around 19% on a liveweight basis. Per kg of meat produced, compound feed use would increase from 2.75kg to 3.70kg and water use for drinking from 4.68 litres to 6.29 litres as shown in Figure 4, both representing increases of around 34.5%.

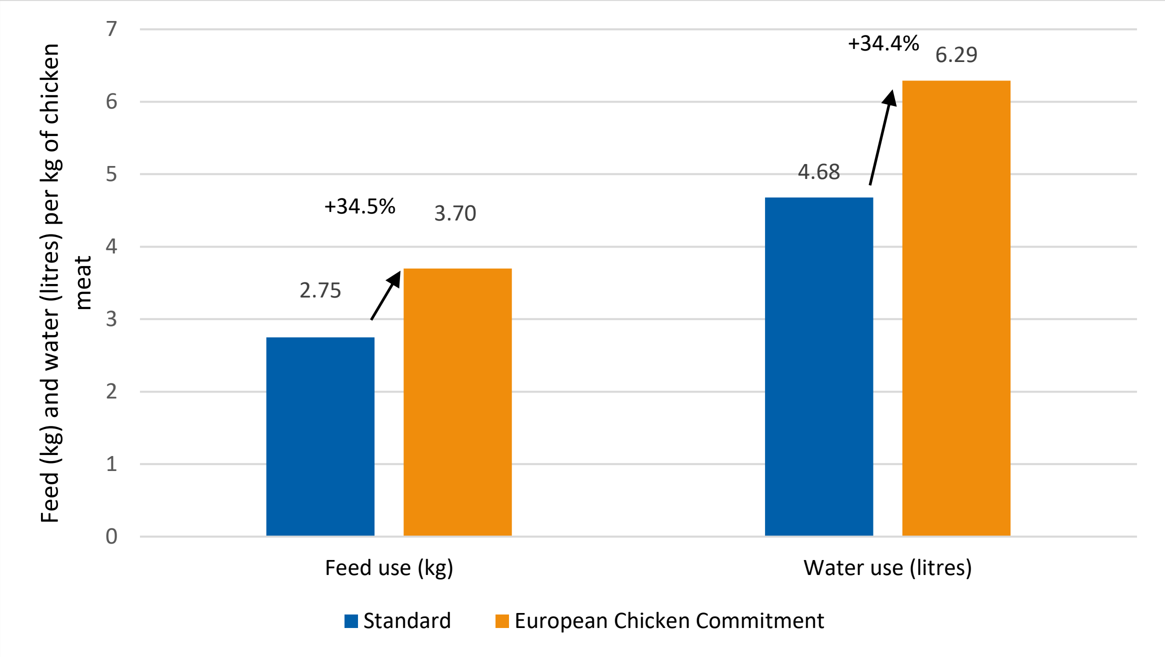

Figure 4 Comparison of feed use and water use per kg of meat

Based on 5,674 million birds per year moving from standard to ECC production in the EU, increases in feed and water intake to maintain the current output of chicken meat are shown in Figures 5 and 6 below. Feed use would increase by some 7.30 million tonnes (+34.5%) and water use by 12.44 million cubic metres (+34.6%) if the current output of chicken meat is to be maintained.

Assuming crop yields remain constant, an additional 1.57 million hectares of land would be needed for crop production to meet the increased requirement for poultry feed if the current output of chicken meat is maintained in ECC production.

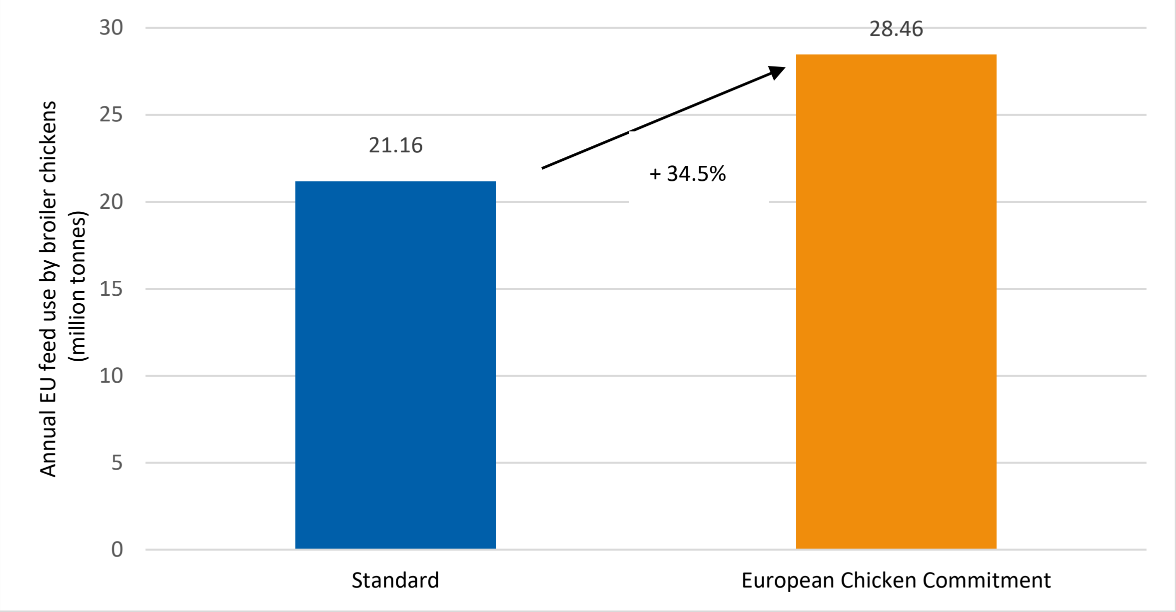

Figure 5 Annual EU feed use (million tonnes) for current standard production and full conversion to ECC to maintain meat output

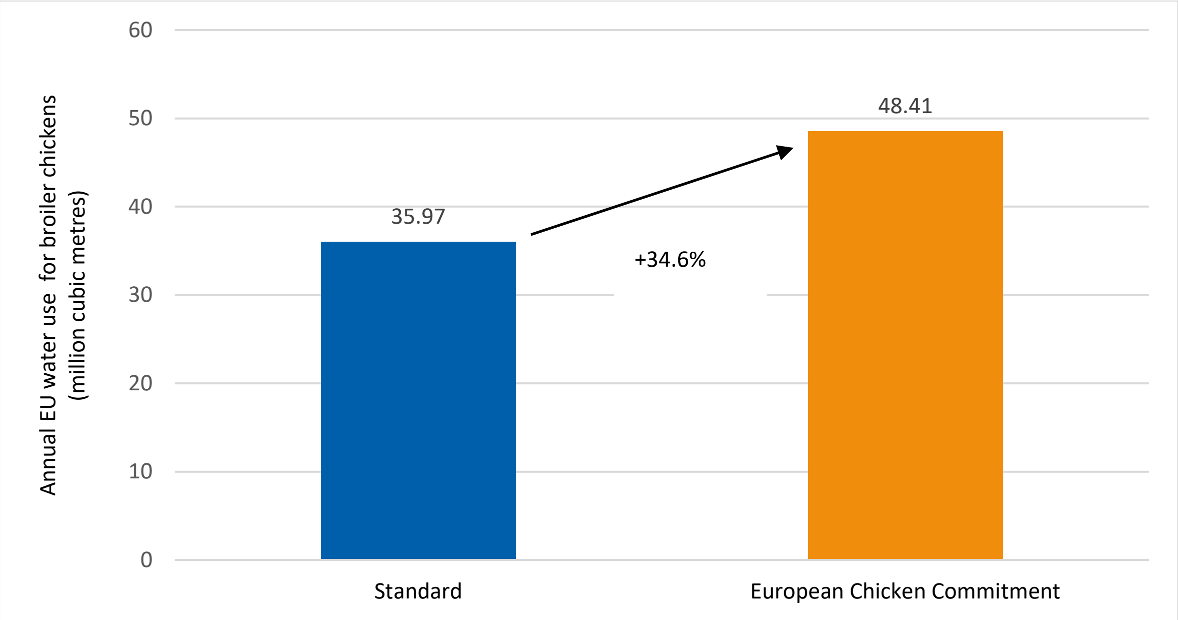

Figure 6 Annual EU water use (million cubic metres) for current standard production and full conversion to ECC to maintain meat output

In terms of climate impact, the longer cycle length and greater overall feed requirement, as well as the lower percentage of meat for ECC production, results in a 24.4% increase in greenhouse gas emissions per kg of meat produced (6.68 kg CO_2e in standard production compared to 8.31 kg CO_2e in ECC; Figure 7). Overall, this would mean an increase in greenhouse gas emissions of 11.05 million tonnes of CO_2e per year at EU level if the same meat output was produced in ECC production.

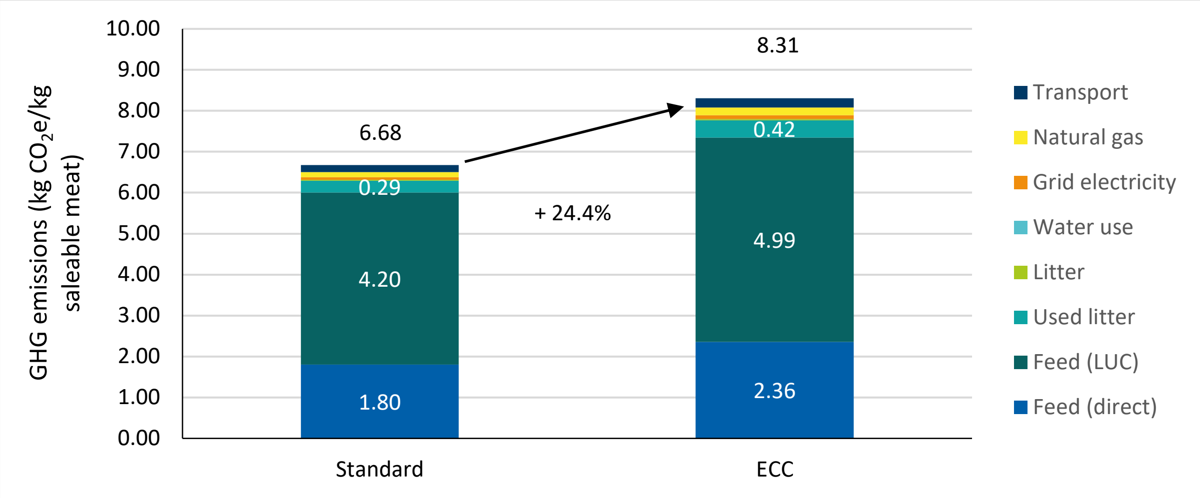

Figure 7 Greenhouse gas emissions per kg of meat produced for standard and ECC

Stocking rate at day-old was calculated to be reduced from 21.98 in standard production to 16.87 birds per square metre in ECC, assuming that thinning is allowed. Because of this and the longer cycle length, annual chicken output is expected to decrease from 155.79 (standard) to 98.37 (ECC) birds per square metre of growing space, a reduction of 36.9%. The impact of this on annual liveweight and annual meat output is shown in Figure 8. The percentage reduction is larger for meat output (44%) because of the yield difference between standard and slow growing birds.

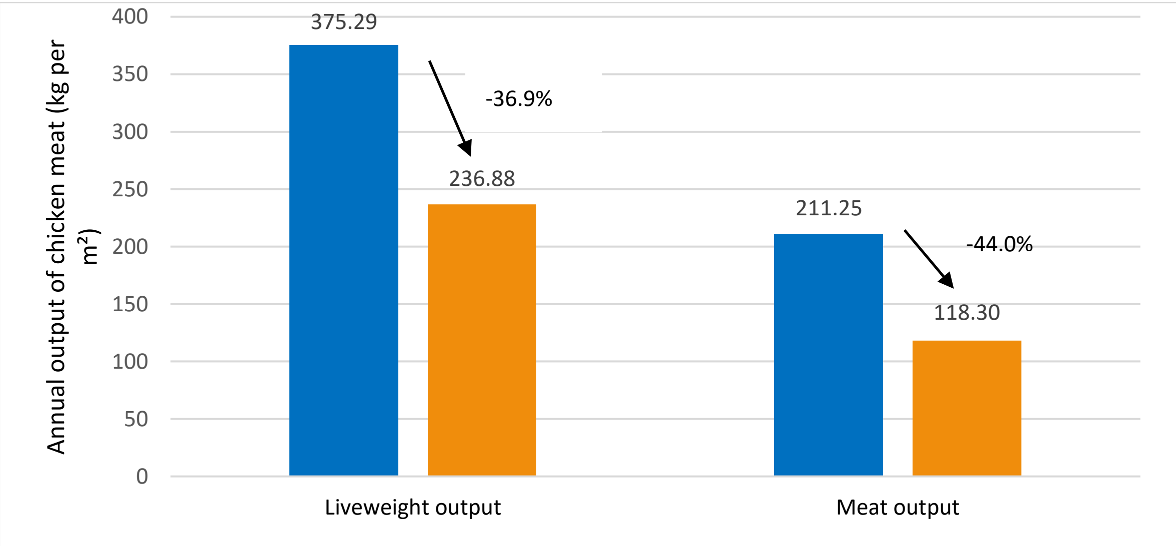

Figure 8 Annual output of liveweight and chicken meat (kg) for standard (blue) and ECC production (orange)

The overall result is that additional growing space will be required if the current numbers of chickens and output of chicken meat are to be maintained within the EU. This is summarised in Figure 9. Approximately 18.40 million square metres of growing space would be required for new buildings to retain the same annual number of birds. However this would still mean a reduction in annual meat output because of the difference in meat yield between standard and ECC birds. A further 7.15 million square metres of growing space would be required to maintain the same annual output of chicken meat. In total, the amount of growing space would need to increase from 38.56 million to 64.11 million square metres (an additional 25.55 million m²) to maintain the current annual meat output. This represents an increase of 66.3%.

A total of 9,692 new poultry houses would be needed to maintain annual chicken meat output, assuming an average of 2,025m² of growing space per house. The estimated cost of this is €8.24 billion based on a capital cost for new buildings of €420 per square metre of growing space.

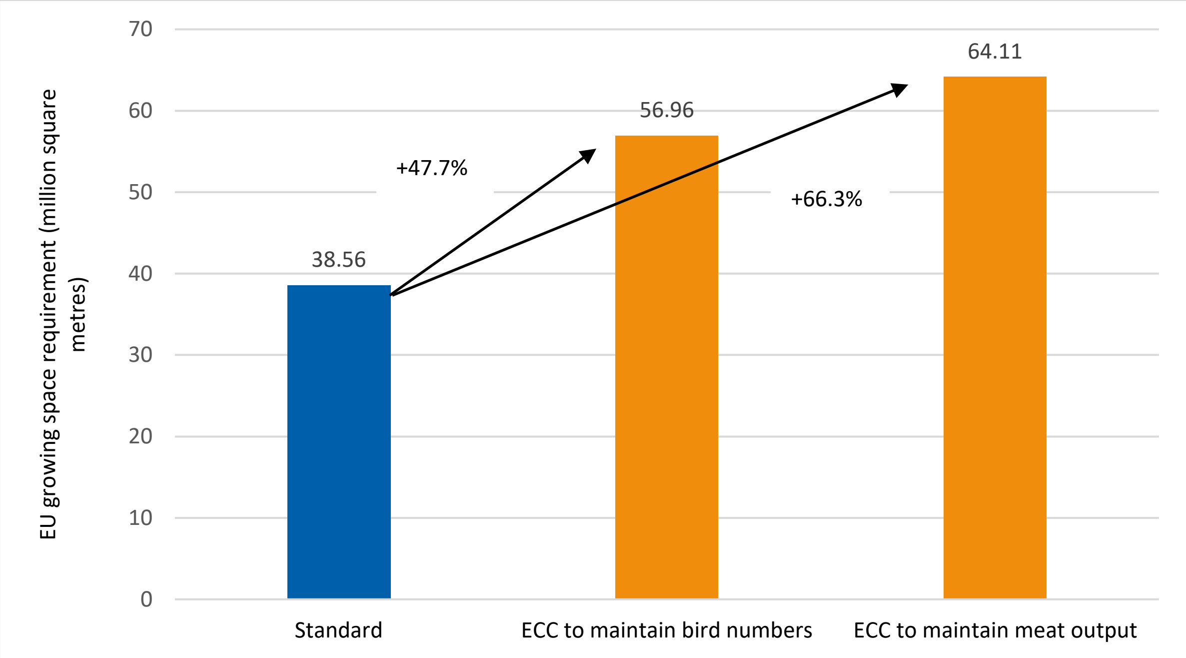

Figure 9 EU growing space requirements (million square metres) for current standard production (over 30kg/m²) and for ECC to maintain bird numbers and to maintain meat output

If thinning was prohibited in ECC production, production costs would increase and more houses would be required to maintain the current output of meat. If the number of birds marketed reduced from 16.45 to 11.11 per square metre, this could require an additional 30.8 million square metres of growing space at a cost of around €12.9 billion.

An increase in production facilities (growing space) is dependent on the sector having the confidence, the financial means and the consent to invest e.g. in terms of planning permission and obtaining an environmental permit. If no new housing is built, annual EU chicken output from systems currently stocked at over 30kg liveweight per square metre is estimated to drop from 5,674 million birds to 3,794 million birds. Figure 10 shows that in terms of meat output, the change would be from 7.694 million tonnes to 4.564 million tonnes, a reduction of 41%.

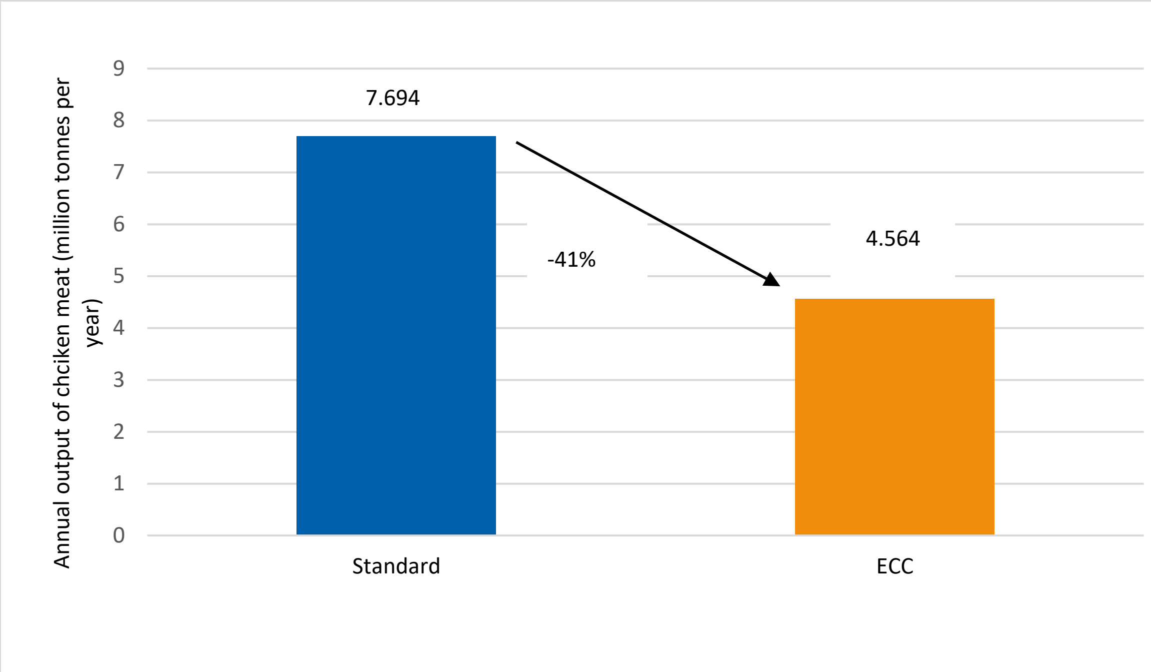

Figure 10 Annual output of meat (million tonnes) at present in existing EU growing space (>30kg/m²) and if converted to ECC production

Such a reduction in output would have wider implications for allied trades, including farmers growing crops which are used in poultry feeds. Within poultry supply chains, there would be implications for slaughterhouses and processing costs and for employment throughout the sector. This may be assessed in a separate study.

If the EU becomes less self-sufficient in chicken, there will be an increase in imported supplies which are likely to have a greater emissions intensity than current production.

CONTENTS

1 INTRODUCTION

This report has been prepared by RSK ADAS Ltd ('ADAS'), a consultancy business with expertise in agriculture and in understanding its impacts on sustainability and the environment.

The main author is Jason Gittins who has over 30 years consultancy experience in the poultry sector, working for government departments and agencies, representative bodies, corporate companies and farmers. This has included projects for the European Commission and EFSA, working in the UK, the EU and elsewhere.

The sections on sustainability have been prepared by Ryan Douglas and Toby Townsend from the ADAS Climate and Sustainability group.

1.1 Objectives

The aim of this report is to identify the costs and the likely implications of all EU chicken production fully adopting requirements that are at least equivalent to those in the European Chicken Commitment (ECC), as set out below. At present, 'standard' production is generally regulated by EU Council Directive 2007/43/EC[1] which sets out minimum rules for the protection of chickens kept for meat production. This includes maximum stocking densities, expressed as 'liveweight (kg) per square metre'. A maximum of 42kg per m^2 may be used under the terms of the Directive if stated criteria are met, but the legislation in some Member States imposes a lower limit.

Costs for standard and ECC production in this report are provided on a 'per kg of meat' basis since this is considered a key metric for comparison and one that has generally not been included in previous studies. Comparisons 'per bird' and 'per kg of liveweight' are also provided.

Wider implications considered include the effects on flock size and on the annual output of birds. The need for (and the cost of) new housing to offset the expected shortfall in growing space and to maintain current EU chicken output is also calculated. The scope of the study does not include an assessment of the welfare of chickens in different systems.

The report recognises that there are differences at present between chicken production systems in different EU Member States. Where higher stocking rates are currently used, the impacts of ECC would be greater and account is taken of this in the calculations.

The report also considers the impacts of adopting ECC standards on key sustainability metrics, such as the carbon footprint of chicken production, land use changes and implications for water use and supply. As above, these are presented 'per kg of meat' with 'per bird' and 'per kg of liveweight' comparisons also made.

Information for this report has been gathered from published sources, technical data and from sector representatives in major chicken-producing countries in the EU. Funding for the project has been provided by AVEC (The Association of Poultry Processors and Poultry Trade in the EU Countries) but this report has been prepared on an independent basis by ADAS.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007L0043

1.2 The European Chicken Commitment

The European Chicken Commitment[2] (ECC) is reported to have been instigated by the Albert Schweitzer Foundation[3] in Germany, in conjunction with other animal welfare groups.

ECC includes standards for chicken production that exceed legislative requirements and those of many existing voluntary standards. Retailers, food service companies and others are encouraged to adopt ECC standards by 2026 at the latest for all fresh, frozen, and processed chicken supply chains. Lists of food service and other companies that have committed to adopting ECC requirements have been published by Compassion in World Farming[4] and other bodies.

The main requirements of the European Chicken Commitment[5] are set out in Table 1 below.

Table 1 European Chicken Commitment Requirements

Subject	Requirement
Animal welfare legislation	Full compliance with all EU animal welfare laws and regulation, regardless of the country of production.
Stocking density	A maximum of 30kg of liveweight per m².
Flock thinning (partial depopulation)	This is discouraged and if practiced it must be limited to one thin per flock.
Choice of breeds	Only breeds that demonstrate higher welfare outcomes are permitted. A list of suitable breeds is provided and the RSPCA Broiler Breed Welfare Assessment Protocol[6] is used as a reference. This includes a guide threshold value of 60g daily growth rate, based on bird age at a liveweight of 2.2kg.
Environmental standards	The following are specified: • At least 50 lux of light, including natural light; • At least two metres of usable perch space, and two pecking substrates, per 1,000 birds; • For air quality, the maximum requirements of Annex II paragraph 3 of the EU Broiler Directive[7] apply, regardless of stocking density; • No cages or multi-tier systems.

[2] This is also referred to the 'Better Chicken Commitment' and 'Broiler Asks'.

[3] https://albertschweitzerfoundation.org/campaigns/european-chicken-commitment

[4] https://www.compassioninfoodbusiness.com/our-work/key-tools-for-success/better-chicken/

[5] Based on https://welfarecommitments.com/europeletter/

[6] https://science.rspca.org.uk/sciencegroup/farmanimals/standards/chickens

[7] This includes requirements that ammonia must not exceed 20ppm, carbon dioxide must be less than 3,000 ppm. See Council Directive 2007/43/EC

Subject	Requirement
Stunning at the time of slaughter	Controlled atmospheric stunning must be adopted using inert gas or multi-phase systems, or effective electrical stunning without live inversion.
Compliance	This must be demonstrated via third-party auditing and annual public reporting on progress towards this commitment.

In Table 1, the 'choice of breeds' states a guide threshold value of 60g daily growth rate. This is less than the norm in standard broiler production and for that reason, the term 'slower-growing' is often used to describe a key characteristic of the birds used in ECC production.

European Chicken Commitment standards do not include a commitment to 'free range' systems. This is said to be because of the high conversion costs and the need to establish systems that provide enhanced minimum standards.

This report assumes that current free range chicken production would be unchanged (i.e. not affected) by the adoption of ECC elsewhere.

1.3 Recent studies

ADAS prepared a report on the impacts of the Better Chicken Commitment (BCC)[8] in the UK in 2019[9]. Cost comparisons were made between BCC and 'standard' UK chicken production with a stocking rate of 38 kg per m^2 and an average liveweight of 2.26kg. This included as-hatched growing, 30% thinning at 1.85kg liveweight and a final depopulation weight of 2.45kg, all of which were considered typical for UK production at the time. The same turnaround time between flocks was assumed for both systems, but the growing cycle length was increased by 10 days (from 39-49 days) to account for the use of slower-growing birds in BCC production. This difference was based on average performance reported in the UK at the time. Assumed feed conversion ratios (FCR) of 1.59 (standard production) and 1.92 (BCC) equated to the use of an extra 770 grams of feed per bird for BCC. However, a 1% reduction in mortality was assumed in the slower-growing birds.

Based on UK costs for feed and other inputs in 2019, total farm costs of production were found to be 18% higher for BCC. At recent currency exchange rates[10], production costs per bird would have been equivalent to €2.12 and €2.50, respectively.

Differences in feed intake were mainly responsible for BCC production having a higher carbon footprint in this study. The difference was calculated as an increase of 23%. Other key impacts included a need for additional housing to maintain existing annual chicken throughput levels and a possible carcass yield reduction of around 1%. This was estimated to be equivalent to a difference of around 22 grams for a 2.26kg liveweight chicken.

[8] As noted, 'Better Chicken Commitment' and 'European Chicken Commitment' standards are the same.

[9] https://www.nfuonline.com/archive?treeid=139718

[10] £1 (UK) equivalent to €1.17 (February 2024)

Also in 2019, the paper, 'Global Prospects of the Cost-Efficiency of Broiler Welfare in Middle Segment Production Systems'[11] compared technical inputs, prices, and production costs for a range of different broiler production systems and three different country scenarios. The most relevant comparisons for the current study were the 'conventional' system in the Netherlands which follows EU legislation with stocking at a maximum of 42kg per square metre and the Global Welfare Standard. This states a maximum stocking density of 30kg per square metre and the use of a slower-growing strain. A cost difference of approximately 23% was noted, with the higher stocking density system being the lower-cost production method.

In 2020, the paper 'Economics of broiler production systems in the Netherlands'[12] included a comparison of production costs in three different production systems. These were:

- A conventional system with 39-42kg of liveweight per m²;
- Dutch retail standard production with up to 38kg per m², slower-growing strains and a maximum growth rate of 50 g per day;
- The 'Better Life one Star' system[13] with 25kg per m², slaughter age at least 56 days and a covered run or veranda provided.

Total production costs for these systems at farm level (per kg liveweight) were calculated at 82.6, 99.5 and 119.2 eurocents respectively. These represented cost increases of 20% and 44% respectively compared to the use of standard broilers at 42kg. Slower-growing broilers were reported to have a lower yield in the processing plant and reduced breast meat yield.

In 2022, the paper 'Environmental impacts of broiler production systems in the Netherlands'[14] included a life cycle analysis for the same three production systems. The focus in the study was on greenhouse gas emissions, land use and phosphorus excretion. The study concluded that feed production and feed conversion ratio are the most important parameters for environmental impact. Key results are summarised in Table 2 below.

Climate change impacts (greenhouse gas emissions) were lowest with standard birds and in higher stocking density systems when land use change (e.g., deforestation) was excluded. This was attributed mainly to differences in feed conversion ratio. When land use change was included though, the lowest stocking density system had the lowest impact because the other two included more soya from Brazil in the diets. The system using the standard strain was the most efficient in terms of land use and for phosphorus excretion.

[11] Luuk SM, de Jong IC, van Horne P and Saatkamp HW, Global Prospects of the Cost-Efficiency of Broiler Welfare in Middle-Segment Production Systems. Animals 2019; 9

[12] https://www.wur.nl/en/newsarticle/economics-of-broiler-production-systems-in-the-netherlands.htm

[13] https://beterleven.dierenbescherming.nl/english/

[14] https://edepot.wur.nl/580961

Table 2 Comparison of sustainability indicators in different chicken production systems in the Netherlands (per kg of liveweight slaughtered)

	Standard strain 42 kg/m² maximum	Slow-growing strain 38 kg/m² maximum	Slow-growing strain 25 kg/m² maximum
Climate change (kg CO2e) excluding land use change	1.38	1.58	1.75
Climate change (kg CO2e) including land use change	3.75	4.07	3.64
Land use (m² per crop)	3.59	4.00	4.32
Phosphorus excretion (grams)	3.02	3.80	5.01

Also in 2022, a report prepared for World Animal Protection by Blonk Consultants from the Netherlands (un-published) used a life cycle analysis approach to compare climate change impacts in a range of systems and countries. These included standard production (42kg per m²) and a lower stocking density system (30kg per m², slow-growing birds) in the Netherlands. They concluded that:

- Climate change impacts were 2.02 and 2.24 kg CO_2e for conventional and low stocking density systems respectively (2.00 and 2.19 kg CO_2e with land use change).
- Water scarcity impact was 1.34 and 1.46m³e for conventional and low stocking density systems.

The impacts on both climate change and water were therefore found to be lower in the conventional system. The slower growing bird required slightly more feed, but it was suggested that a lower protein feed for slow-growing birds and reduced feed requirements for the parent generation could help to offset these differences.

In 2023, Eurogroup for Animals published a report on Economics of slow growing broilers[15] which included calculations of production costs for standard and ECC broilers in the Netherlands and five other European countries. The ECC costs were based on the slower-growing Hubbard Redbro bird. The increase in costs in the Netherlands was calculated as 17% per kg of liveweight, assuming thinning was permitted for ECC. For the other countries, the increase was generally reported to be between 16.9% and 18.5%. In France, it was lower at 14.8%, and this was attributed to a shorter growing period and lower final liveweight.

The current study reported here differs from others, including the recent Eurogroup for Animals report above in that comparisons of costs, sustainability and output are calculated primarily on a 'per kilogram of meat' basis rather than just 'per bird' or 'per kilogram of liveweight'.

[15] https://www.eurogroupforanimals.org/files/eurogroupforanimals/2023-03/Wageningen%20UR%20-%20Factsheet%20Economic%20analysis%20of%20ECC-21dec2022_FINAL%20%281%29.pdf

2 METHODS

The impacts of European Chicken Commitment (ECC) standards reviewed in this report can be divided into three main areas:

- A comparison of production costs;
- Output impacts, including annual throughput per square metre of growing space and the need for additional space if current EU output levels are to be maintained;
- Climate change impacts and changes in land, feed and water use.

The approach taken for each is set out below.

2.1 Production cost impacts

The overall objective was to calculate the typical on-farm cost of 'standard' EU and ECC chicken production and the percentage cost difference between them. Costs per kg of meat take account of likely differences in carcass yield between strains used for standard and ECC production.

The comparisons are not straight-forward, because no single 'standard' production system exists for all Member States. There are two main reasons for this:

- Implementation of EU Directive 2007/43 can legitimately vary between countries e.g., some allow a maximum stocking density of 42 kg per m² if certain conditions are met, whilst others do not.
- Quality assurance and retailer standards that exceed legislative requirements are widely adopted in some countries. This typically brings the stocking density closer to (but generally still above) the 30 kg per m² requirement in ECC.

2.1.1 Comparison of physical performance in standard and ECC systems

To provide a clear comparison, it was assumed that liveweight requirements on the farm would be the same for standard and ECC production. Whilst some slow-growing birds are currently grown to lower final weights, this may change if there was widespread ECC adoption.

Typical current liveweight requirements for standard chicken production in the EU were provided by industry sources. It was assumed that flocks would be thinned in both systems, although it is noted that the practice is 'discouraged' in ECC (see Table 1). It was also assumed that birds would be grown 'as hatched', and that the turnaround (clean-out) period would be the same.

Technical data from breed companies and expert views from industry contributors were used to estimate the following for standard and ECC production:

- Age at the time of thinning and at final depopulation (days);
- Feed conversion ratio (FCR), to calculate the average feed use (kg per bird);
- Water use (litres per bird);
- Mortality (%);
- Carcass yield (%) i.e. the oven ready carcass weight in relation to the liveweight;
- Meat yield (%) i.e. the total breast, leg and wing meat in relation to the liveweight.

2.1.2 Comparison of costs in standard and ECC systems

Comparative costs were obtained from industry contributors and from published data for the following inputs (currency: euros or eurocents):

- Day-old chick;
- Average broiler feed price (per tonne) for the whole production cycle;
- The cost of water, electricity and energy for heating (assumed to be natural gas);
- Medication and vaccines;
- Labour (either ‘per bird’ or as an hourly labour cost);
- Disposal costs for mortality during the growing cycle;
- Capital costs for new housing, including related infrastructure.

The data gathered were used for cost comparisons between standard and ECC production. The differences were also presented on a ‘percentage change’ basis from standard production to ECC.

2.1.3 Differences in stocking density within the European Union

Since no current data are known to exist on broiler stocking densities and the uptake of quality assurance and retailer requirements in each Member State, estimates were provided for this study by industry contributors and from published information from 2017.

Industry contributors represented the following 13 countries. These included many with large annual outputs of chicken, namely:

- Austria, Belgium, Finland, France, Germany, Hungary, Italy, Latvia, the Netherlands, Poland, Slovenia, Spain and Sweden.

The following key questions were asked of contributors for each of these countries:

- What is the maximum stocking density for broilers based on Council Directive 2007/43?
- What percentage of the national broiler flock is estimated to be stocked at this rate?
- What percentage of the national broiler flock is currently grown to European Chicken Commitment standards?

Data were also requested on the percentage of the national flock stocked at intermediate rates (i.e., between the maximum stocking density allowed and the ECC stocking limit of 30 kg/m²) and in other systems. Information was requested as follows:

  - The intermediate stocking densities used;
  - Whether the birds are standard or slow-growing breeds;
  - Whether outdoor access is provided (free range or organic).

For the other 14 countries in the EU (which generally included those with lower annual outputs of chickens), data on stocking densities were gathered from a European Commission study on the application of the Broiler Directive (February 2017)[16]. This provided information on stocking densities in all EU Member States, with categories divided as follows[17]:

- Between 39 and 42kg per m²;
- Between 33 and 39kg per m²;
- Less than or equal to 33kg per m².

The data were provided graphically and in the absence of figures, the percentages for each had to be estimated.

2.1.4 Chicken sector size in different Member States

To accurately calculate impacts at EU level, an estimate of the current annual output of chickens in each Member State was required. For this, official statistical data on the European Commission website[18] were used.

Based on chicken output reported for each Member State, annual numbers were calculated for (i) standard systems at the maximum permitted stocking density, (ii) intermediate systems (as above) (iii) ECC production and (iv) free range and organic. This was estimated from the percentages identified in section 2.1.3 above.

2.2 Output impacts

The number of birds that could be stocked (per square metre) was calculated for standard production (up to 42kg per m²), for ECC production (30kg per m²) and for the main intermediate stocking densities.

Information on the expected length of the growing cycle and the house turnaround period was used to calculate the number of flock cycles each year and then the annual throughput of birds per square metre of growing space. This was repeated for each stocking density, based on:

- The number of day-olds placed for each flock (per m²) multiplied by the number of flock cycles per year.

The annual output of birds per square metre at each stocking rate was then used to calculate the total amount of growing space in use in each country and then for the EU. The number of birds marketed per square metre of growing space was calculated after adjusting for mortality.

Separately, the total amount of growing space required for conversion to ECC production (at 30kg per m²) was calculated, first for each country and then for the EU. This allowed the following to be determined:

- The additional growing space needed to maintain the current annual output of chickens and chicken meat in the EU and what this is likely to mean in terms of the number of extra poultry houses needed;
- The percentage increase in growing space required to maintain chicken and chicken meat output;
- The estimated cost, based on typical new-build prices for poultry units;

[16] https://op.europa.eu/en/publication-detail/-/publication/f4ccd35e-d004-11e7-a7df-01aa75ed71a1

[17] See Figure A3.1 on page 100 of the report.

[18] https://agridata.ec.europa.eu/extensions/DashboardPoultry/PoultryProduction.html

- The effect of ECC on annual EU chicken and meat output if no more growing space is added.

It was assumed that all growing space is fully utilised in the EU at present and that there is no spare (un-used) growing capacity available.

To assess carcass differences, standard data from breeding companies were used to determine carcass yield (%) and the main meat components (breast, leg, wing).

2.3 Climate change and water use impacts

Greenhouse gas (GHG) emissions and direct water use (excluding embedded water in feed) were calculated using a bespoke greenhouse gas emission calculator developed based on IPCC methodologies.

2.3.1 GHG emissions assessment boundary

This assessment included all inputs involved in the growing process up to the farm-gate (i.e., excluding onward transport to processor). Transport of day-old chicks onto the growing farm is included but the emissions associated with breeding and hatching of the day-old chicks is excluded since this adds complexity to the analysis and accounts for a small proportion of the total emissions. The system boundary of the assessment is visualised in Figure 11 below. It is assumed that emissions arising from new houses needed to maintain output in ECC production are the same as those from existing houses.

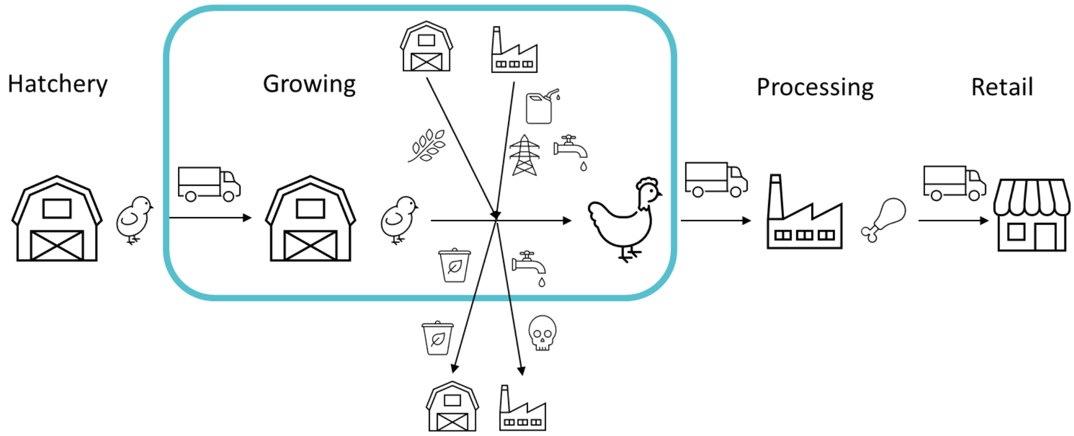

Figure 11 Summary of the GHG emissions assessment boundary

Included within the system boundary was:

- Transport of day-old chicks from hatchery to growing facility.
- Direct feed emissions and indirect land-use change emissions provided by Mostert et al., 2022, calculated using Feedprint[19].
- Direct and embedded emissions from fuel for heating (assumed to be natural gas).
- Direct and embedded emissions from electricity used for ventilation, feeders, lighting etc.

[19] Mostert, P. F., Bos, A. P., van Harn, J., & de Jong, I. C. (2022). The impact of changing toward higher welfare broiler production systems on greenhouse gas emissions: a Dutch case study using life cycle assessment. *Poultry Science*, *101*(12), 102151.

- Emissions from used litter during the production period but not the subsequent land application, combustion or digestion.
- Water supply and any off-site treatment of wash water, but not the processing of deadstock.

2.3.2 Data and emission factors

Data came from various sources referenced throughout this document. The main parameters used in the model were:

- Number of birds placed per square metre;
- Liveweights at thinning and slaughter;
- Mortality and thinning rates;
- Length of cycle;
- Feed, drinking water, electricity and natural gas use per bird per cycle;
- Washdown water and litter use per square metre;
- Carcass and meat yield.

Emission factors used in the calculations were taken from various sources and are summarised in Table 3.

Table 3 Summary of emission factors sources used in the GHG calculations.

Emission category	Emission factor source	Date
Grid electricity	AIB European Residual Energy Mix	2021
Fuel (direct)	BEIS UK GHG Conversion Factors	2022
Fuel and electricity (indirect)	BEIS UK GHG Conversion Factors	2022
Used litter	ADAS calculations based on IPCC 2019 refinement	2019
Feed	Mostert et al., 2022 using Feedprint[20]	2022
Litter	Feedprint	2020
Water supply and treatment	BEIS UK GHG Conversion Factors	2022
Transport	BEIS UK GHG Conversion Factors	2022

2.3.3 Assumed rations

Feed (both direct emissions and from land-use change) is a large contributor to GHG emissions in poultry systems, therefore minor changes in the assumptions or emission factors used can have a large impact on the results.

Rations for standard and ECC production are based on those in the 2022 paper 'Environmental impacts of broiler production systems in the Netherlands'[21], with conventional birds assumed to be fed the 'Conventional (Ross 308)' ration and ECC birds assumed to be fed the 'Ranger classic' ration. A weighted average was calculated for each ration to accurately account for changes in emissions intensity of the ration over the lifecycle of the birds. The main differences between the rations are summarised in Table 4.

[20] Mostert, P. F., Bos, A. P., van Harn, J., & de Jong, I. C. (2022). The impact of changing toward higher welfare broiler production systems on greenhouse gas emissions: a Dutch case study using life cycle assessment. *Poultry Science*, *101*(12), 102151.

[21] https://edepot.wur.nl/580961

Table 4 Average percentage of key ingredients in conventional and ECC rations in the GHG emission model (%).

Ingredient	Conventional	ECC
Wheat	31.8	33.5
Corn	25.5	26.7
Soybean meal	25.5	23.2
Beans	3.9	4.4

2.3.4 Land-use change

Soybean has a high embedded emission due to its association with land-use change in source countries, so the reduction of soya use in the ECC ration in the Table (23.2%) compared to the conventional ration (25.5%) has a substantial impact on the overall difference in emissions between the two systems. There is growing pressure on the poultry sector to transition towards sourcing 100% certified sustainable soya, and when this is robustly implemented there will be a large reduction in the emissions associated with soya in both systems.

Since the conventional ration has higher levels of soya, it will experience a greater reduction which will reduce the emissions gap between the two rations.

2.3.5 Model development

Using the parameters described in section 2.3.2, a model was constructed that simulated one typical production cycle for both standard and ECC production, including:

- Number of birds and average weight over time accounting for assumed mortality and thinning rates.
- Quantity of meat and liveweight produced at thinning and at slaughter.
- Total quantity of inputs (feed, litter, water, electricity, natural gas) per cycle.
- Quantity of manure and nitrogen produced from the birds based on numbers and average weights, which was then used to calculate emissions from used litter as per the IPCC 2019 Refinement methodology.[22]
- Transport emissions based on the quantities of inputs and assumptions on the average transport distance.

These values were then multiplied by the emission factors described in section 2.3.2 to determine total GHG emissions per cycle. These were then divided by the total liveweight, and meat produced in each production system to determine the GHG emissions per kg for both standard and ECC chicken.

[22] IPCC 2019, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

The calculated figures for water use per cycle were also divided by the total liveweight and meat produced to determine the drinking and washdown water use per kg.

3 RESULTS

3.1 Flock performance in standard and ECC production

A stocking density of 39kg per m² has been taken to be typical of standard chicken production in the EU at present[23]. In general, stocking densities above 39kg per m² may be associated with slightly lower production costs per bird for capital and interest, heating and labour but slightly higher electricity costs, mainly for ventilation. Below 39kg per m², the converse is expected. There may also be small differences in flock performance at different stocking rates.

3.1.1 Liveweight and thinning schedule

Target liveweights for thinning and final depopulation on the farm vary within the EU. The figures used for comparative purposes here (considered to be averages) are set out in Table 5. The same targets are used for both standard and ECC production.

Table 5 Assumed final liveweight targets and thinning schedule

	Standard and ECC production
Average liveweight at thin (kg)	1.800
Average liveweight at final depopulation (kg)	2.700

3.1.2 Cycle length

Standard broilers have been bred to achieve faster growth rates, but slower-growing strains are required for ECC production (see section 1.2). These birds need more time to reach the liveweight targets set out in Table 5 above.

Growth rate assumptions used in this study are set out in Table 6. These are based on industry estimates of typical performance, with account also being taken of breed performance objectives e.g., from Aviagen[24] for standard production and from Hubbard for the Redbro[25].

Current turnaround times in the industry (i.e., the clean out period) are reported to range from 5 to 14 days. For a particular farm, the turnaround time between flocks is likely to be the same for both standard and ECC production. A typical figure of 10 days has been assumed for both.

The number of cycles per year (365 days) has been calculated from the length of each cycle, including a 10-day turnaround period between flocks.

[23] This is based on data that is provided later in the report, see Table 20.

[24] https://en.aviagen.com/assets/Tech_Center/Ross_Broiler/RossxRoss308-BroilerPerformanceObjectives2022-EN.pdf

[25] Hubbard Redbro data were not published on www.hubbardbreeders.com at the time of writing but have been made available for this report by Hubbard

Table 6 Comparison of cycle length and number of cycles per year

	Standard production (39kg/m²)	ECC production (30kg/m²)
Days to reach thinning liveweight of 1.800 kg (days)	31	37
Days to reach final liveweight of 2.700 kg (days)	40	51
Turnaround time (days)	10	10
Total cycle length for growing and turnaround (days)	50	61
Cycles per 365 days	7.30	5.98

Based on Table 6, the average growth rate is calculated as 66.4g per day for standard production and 52.1g per day for ECC, the latter being well within the guide threshold value (see Table 1). Both figures are based on a final liveweight of 2.7kg with the weight of the day-old chick (assumed to be 44g) being subtracted[26].

With an extra 11 days required for each cycle in ECC production, the number of annual cycles decreases by around 18%.

3.1.3 Mortality

Industry views suggest that mortality would generally be lower with slower-growing strains in lower stocking density systems than in standard production. A difference of 0.5% has been used in these calculations based on the percentages set out in Table 7 below.

Table 7 Comparison of mortality

	Standard production (39kg/m²)	ECC production (30kg/m²)
Total mortality per flock (%)	3.0	2.5

3.1.4 Stocking rates and average liveweight

It is assumed that the commercial objective for both standard and ECC production is generally to be as close as possible to (but always still within) the maximum stocking density permitted at the time of thinning and at final depopulation. Stocking densities are therefore calculated on this basis, although in practice a range of other factors, including environmental conditions and customer requirements may mean that changes are required.

[26] For ECC production, subtraction of the day-old weight (44g) from the final liveweight (2700g) gives a difference of 2656g. For a growing period of 51 days, the average daily growth rate has been calculated as 2656/51 = 52.1g per day.

Based on the liveweight assumptions in Table 5, the number of birds that can be stocked per square metre has been calculated.

Maximum numbers at **final depopulation** (2.700kg liveweight) are calculated as follows:

- For standard production at 39kg per m², 14.44 birds can be stocked per square metre (i.e., 39/2.7);
- For ECC production at 30kg per m², 11.11 birds can be stocked per square metre (i.e., 30/2.7).

Maximum numbers at **thinning** (1.800kg liveweight) are calculated as follows:

- Standard production: 21.66 birds can be stocked per square metre (i.e. 39/1.8);
- ECC production: 16.66 birds can be stocked per square metre (i.e. 30/1.8).

Note that these numbers have been rounded down (rather than rounded up) to ensure compliance with stocking density maximums. For instance, the calculation for standard production (39/1.8) could be rounded up to 21.67, but using this as an actual figure would represent a stocking density exceedance i.e. 21.67 x 1.8 = 39.006. The same is true for the calculation (30/1.8) for ECC.

It is assumed that 50% of the total mortality occurs up to the point of thinning and that extra birds are placed at day-old to offset expected losses to this point. This would mean:

- Standard production 21.98 birds can be stocked at day-old (i.e. 21.66 + 1.5%);
- ECC production 16.87 birds can be stocked at day-old (i.e. 16.66 + 1.25%).

Mortality up to the time of thinning is therefore calculated as follows;

- Standard production 0.32 birds per m² (21.98-21.66);
- ECC production 0.21 birds per m²(16.87-16.66).

Assuming the same number of birds per m² are lost (mortality) after thinning, the total number of birds leaving the farm is calculated as follows:

- Standard production 21.98 (day-old) – (2 x 0.32) = 21.34;
- ECC production 16.87 (day-old) – (2 x 0.21) = 16.45.

The number of birds removed at thinning is calculated as follows:

- Standard production 21.66 - (14.44 + 0.32) = 6.90 birds per m²;
- ECC production 16.66 – (11.11 + 0.21) = 5.34 birds per m².

The total liveweight output (kg per m²) for each cycle in standard and ECC production is calculated in Table 8. It includes an allowance for mortality of 3% for standard production and 2.5% for ECC to the time of final depopulation.

Table 8 Comparison of bird and liveweight output per cycle

	Standard production (39kg/m²)	ECC production (30kg/m²)
Day-old birds per m²	21.98	16.87
Birds at thinning per m² (A)	21.66	16.66
Birds at final depopulation per m² after mortality (B)	14.44	11.11
Birds removed at thinning per m² (C)	6.90	5.34
Birds marketed from farm per m² (B+C)	21.34 (approx. 97% of day-olds placed)	16.45 (approx. 97.5% of day-olds placed)
Thinned birds as a percentage of birds marketed	32.3 (6.90 / 21.34)	32.5 5.34 / 16.45)
Average liveweight (kg) for thinning and final depopulation combined	2.409 (32.3% @ 1.8) (67.7% @ 2.7)	2.408 (32.5% @ 1.8) (67.5% @ 2.7)
Total liveweight output per m² per cycle (kg)	51.410 (6.90 @ 1.8) (14.44 @ 2.7)	39.612 (5.34 @ 1.8) (11.11 @ 2.7)

Annual output per square metre of growing space for standard and ECC production is shown in Table 9, expressed both 'per kg of liveweight' and 'per bird'. Note that annual output per kg of chicken meat is presented later (see Table 12).

Table 9 Comparison of liveweight and livestock output per year

	Standard production (39kg/m²)	ECC production (30kg/m²)
Liveweight output (kg per m² per cycle)	51.410	39.612
Number of cycles per year	7.30	5.98
Liveweight output (kg per m² per year)	375.29	236.88
Average liveweight (kg)	2.409	2.408
Number of birds per m² per year	155.79	98.37

3.1.5 Feed use

Standard broilers are more efficient at converting feed to liveweight (and chicken meat) than slower-growing birds and this results in lower feed use. The assumptions in Table 10 below are based on breed performance objectives for Aviagen and Hubbard Redbro and on industry opinion on what is typical in commercial practice.

Table 10 Comparison of feed use

	Standard production (39kg/m²)	ECC production (30kg/m²)
Feed conversion ratio (FCR)	1.55	1.85
Average liveweight (kg)	2.409	2.408
Feed consumption per bird (kg)	3.73	4.45

3.1.6 Carcass and meat yield

Carcass yield and component data shown in Table 11 have been taken from performance objectives for Aviagen 308 and Hubbard Redbro[27]. The figures provided for a final liveweight of 2.4kg have been used in each case since this is the closest to the assumed average final liveweights set out in Table 10.

The various terms and components are defined as follows:

- **Carcass yield %** is the eviscerated carcass without the neck, internal organs or abdominal fat;
- **Breast %** is breast meat without skin and bone, as a percentage of the liveweight;
- **Leg %** is thigh and drumstick including bone and skin, as a percentage of liveweight;
- **Wing %** is the whole wing including wing tips, as a percentage of the liveweight.

Table 11 Carcass yield and components for standard and ECC production (2.4kg liveweight, as hatched)

	Standard Production Aviagen 308	ECC Production Hubbard Redbro
Carcass yield (%)	72.65	71.05
Breast (%)	25.62	20.70
Leg (%)	23.13	21.64
Wing (%)	7.54	7.60
Total breast + leg + wing (%)	**56.29**	**49.94**

[27] Data for Aviagen 308 are available at https://aviagen.com/assets/Tech_Center/Ross_Broiler/RossxRoss308-BroilerPerformanceObjectives2022-EN.pdf. Redbro data were not published on www.hubbardbreeders.com at the time of writing but have been made available for this report by Hubbard.

The sum of the three component parts (breast, leg, and wing) is taken to be the meat component of the carcass, which includes the leg and the wing bone. Based on chicken output data in Table 9 and the carcass components (meat yield) figures in Table 11, Table 12 compares meat output per square metre of growing space.

Table 12 Comparison of meat output for standard and ECC production (per square metre per year)

	Standard Production Aviagen 308	ECC Production Hubbard Redbro
Liveweight output (kg per m² per year) from Table 9	375.29	236.88
Meat (breast, leg, wing) as a % of liveweight from Table 11	56.29	49.94
Meat (kg per m² per year)	211.25	118.30

The amount of meat produced annually per square metre of growing space is calculated to reduce by some 44% in ECC production, due to differences in stocking rates, cycle length and carcass yield.

3.2 Cost of production (liveweight) for standard and ECC production

A comparison of production costs is first provided on a 'per bird' basis, since this is a frequently-used industry parameter. From this, costs per kg of meat are then calculated in section 3.3. Detailed cost of production data for standard and ECC are provided in Table 13 below. The basis for each pair of figures is provided in Appendix 1.

Costs per bird can be rounded to €2.74 per bird for standard production and €3.34 for ECC, a difference of €0.60. This represents an increase of 21.9% for ECC. Based on average final liveweight figures (see Table 9), costs per kg of liveweight are calculated as follows:

- **Standard** €1.14 per kg of liveweight (based on 2.409kg liveweight);
- **ECC** €1.39 per kg of liveweight (based on 2.408kg liveweight).

Table 13 Comparison of production costs per bird for standard and ECC production

	Cost per bird (eurocents)	
Cost item	Standard (39kg per m²)	European Chicken Commitment (30 kg per m²)
Day-old chick (inc. mortality)	41.2	47.2
Feed	167.1	194.9
Heat	12.0	15.6

	Cost per bird (eurocents)	
Cost item	**Standard (39kg per m²)**	**European Chicken Commitment (30 kg per m²)**
Electricity	4.0	5.5
Water	2.9	3.4
Litter (+ enrichments)	1.0	1.8
Vaccines	4.0	4.0
Medication	3.0	2.0
Site clean out	5.0	6.5
Repairs and maintenance	3.0	4.0
Labour	5.5	9.1
Capital repayment and interest[28]	21.0	34.7
Overheads and miscellaneous items	4.0	5.0
Total	**273.7**	**333.7**

3.3 Cost of production per kg of meat

This has been calculated from liveweight data in Table 9, carcass yield data in Table 11 and the cost of production comparison in Table 13. The findings are set out in Table 14 below, showing production costs per kg of chicken meat of 201.8 eurocents for standard production and 277.4 eurocents for ECC. This represents an increase of 37.5%.

Table 14 Comparison of production costs per kg of meat

	Standard production	ECC production
Cost of production per bird in eurocents (Table 13) (A)	273.7	333.7
Average liveweight (kg) (Table 10)	2.409	2.408
Sum of % breast, leg, and wing (Table 11)	56.29	49.94
Weight of breast, leg, and wing (kg) (C)	1.356	1.203
Cost of production per kg of meat i.e. breast, leg and wing (eurocents) (A/C)	201.8	277.4

[28] This includes fitting of windows for ECC to provide natural daylight.

3.4 Sensitivity analysis

Compound feed is by far the largest single cost item in Table 13, representing around 60% of the total on a liveweight basis. It was assumed that the feed price for standard production is €448 per tonne, with a €10 per tonne reduction for ECC[29]. This difference is based on lower-protein feeds being used for slower-growing birds.

FCR assumptions are shown in Table 10. The quantity and cost of feed per kg of chicken meat produced for standard and ECC production is calculated as follows:

- For **standard**, 3.73kg of feed per bird at €448 per tonne produces 1.356kg of meat. Per kg of meat produced, 2.75kg of feed are required at a cost of €1.23.
- For **ECC**, 4.45kg of feed per bird at €438 per tonne produces 1.203kg of meat. Per kg of meat produced, 3.70kg of feed are required at a cost of €1.62.

Changes in the price difference between standard and ECC feeds and in assumed FCRs would impact the relative production costs per kg of meat, and these are considered in Table 15. The effects on cost of production (% increase per kg of meat) of an FCR for ECC of 1.80, 1.85 and 1.90, together with feed price differences of zero, €5, €10 and €20 per tonne are explored. For this exercise, assumptions for standard production are unchanged (FCR of 1.55, feed at €448 per tonne).

The assumptions for ECC made in Table 13 are highlighted in blue in Table 15 (an increase of 37.5%). The sensitivity assessment shows that this could be reduced to +33.3% (assuming lower FCR and lower feed price) or increased to +42.4% (higher FCR, no difference in feed price).

Table 15 Effect of changes in FCR and feed price differential on cost of production increases for ECC (% per kg of meat)

FCR for ECC production	Feed price differential (€ per tonne)			
	No difference (€448 per tonne)	€5 (€443 per tonne)	€10 (€438 per tonne)	€20 (€428 per tonne)
1.80	+37.1	+36.0	+34.9	+33.3
1.85	+39.8	+38.7	+37.5	+35.3
1.90	+42.4	+40.8	+40.1	+37.9

3.5 Chicken sector size by Member State

Data for 2022 compiled from the European Commission website[30] provided individual Member State data on annual chicken output for all countries except Estonia, with a zero-return provided for Luxembourg. The details are shown in Table 16, together with percentages of EU production and total EU output. This amounts to an annual total of some 6,288 million broiler chickens.

[29] See Appendix section A1.2

[30] https://agridata.ec.europa.eu/extensions/DashboardPoultry/PoultryProduction.html

Based on these figures, the responses gathered from 13 Member States for this project (see section 2.1.3) represent around 82% of total EU production. Data from the 2017 European Commission report on stocking densities account for the remaining 18%.

Table 16 Annual broiler output by country and percentage of the EU total (2022)

Rank	Country	Annual broiler chicken production (Million birds)	% of EU total
1	Poland	1,200	19.1
2	France	734	11.7
3	Spain	701	11.1
4	Germany	631	10.0
5	Italy	534	8.5
6	Netherlands	518	8.2
7	Belgium	298	4.7
8	Romania	285	4.5
9	Portugal	217	3.5
10	Hungary	178	2.8
11	Greece	147	2.3
12	Czech Republic	118	1.9
13	Sweden	110	1.7
14	Austria	100[31]	1.6
15	Denmark	98	1.6
16	Ireland	98	1.6
17	Finland	81	1.3
18	Lithuania	46	0.7
19	Bulgaria	46	0.7
20	Slovenia	41	0.7
21	Croatia	39	0.6
22	Slovakia	30	0.5
23	Latvia	22	0.3
24	Cyprus	13	0.2
25	Malta	3	0
26	Luxembourg	0	0
	EU TOTAL (exc. Estonia)	**6,288**	**100**

[31] Latest available information is for 2021

3.6 Current broiler stocking densities in each Member State

Stocking densities in each country and the estimated percentage share for each are reported here. This provides a basis for estimating the current growing space available, the additional space needed for ECC production and the approximate cost of this.

The results are presented in two sections (see section 2.1.3). The first is based on evidence from 13 Member States, gathered for this report, the second is from published data for 12 Member States, excluding Estonia and Luxembourg.

3.6.1 Member State stocking densities based on data for this study

Stocking density data gathered for this report are shown in Table 17 below.

Table 17 Percentage of broilers kept at various stocking densities in 13 Member States

Country	% Stocked at 42kg	% Stocked at 38-39kg	% Stocked at 35-36kg	% Stocked at 33kg	% Stocked at 30kg or less	% Free range and organic
Poland	4	27	0	68	1	0
France	23	55	0	5	0	17
Spain	0	79	0	10	10	1
Germany	0	10	80	0	8	2
Italy	0	59	0	34	4	3
Netherlands	30	35	0	0	30	5
Belgium	90	7	0	0	0	3
Hungary	40	40	15	0	4	1
Sweden	0	0	99	0	0	1
Austria	0	0	0	0	86	14
Finland	55	45	0	0	0	0
Slovenia	0	80	0	20	0	0
Latvia	0	100	0	0	0	0

Table 18 converts these percentages to annual throughput figures, based on the data in Table 16.

Table 18 Estimated number of birds (millions per year) at various stocking densities in 13 Member States

Country	No. stocked at 42kg	No. stocked at 38-39kg	No. stocked at 35-36kg	No. stocked at 33kg	No. stocked at 30kg or less or in free range or organic systems
Poland	48	324	0	816	12
France	169	404	0	37	125
Spain	0	554	0	70	77
Germany	0	63	505	0	63
Italy	0	315	0	182	37
Netherlands	155	181	0	0	181
Belgium	268	21	0	0	9
Hungary	71	71	27	0	9
Sweden	0	0	109	0	1
Austria	0	0	0	0	100
Finland	45	36	0	0	0
Slovenia	0	33	0	8	0
Latvia	0	22	0	0	0

3.6.2 Member State stocking densities based on published data

Table 19 below shows stocking density estimates for 12 countries based on a European Commission study (see section 2.1) and annual throughputs at each stocking density.

Table 19 Percentage of broilers kept at various stocking densities in 12 Member States

Country	Annual broiler chicken production (millions)	Estimated stocking density (Kg per m²)	Assumed number at each stocking density (millions per year)
Romania	285	Over 40% at 39kg and at 42kg max, remainder at 33kg max	57m at 33kg 114m at 39kg 114m at 42kg
Portugal	217	All at 33kg max.	217m at 33kg
Greece	147	All at 33kg max.	147m at 33kg
Czech Republic	118	75% at 39kg max, just over 20% at 33kg max and the remainder at 42kg max	24m at 33kg 89m at 39kg 5m at 42kg
Denmark	98	All at 42kg max	98m at 42kg
Ireland	98	Generally at 39kg max.	98m at 39kg
Bulgaria	46	All at 33kg max.	46m at 33kg
Lithuania	46	Approx two-thirds up to 39kg max, most of the remainder up to 33kg max, but a few up to 42kg	14m at 33kg 30m at 39kg 2m at 42kg

Country	Annual broiler chicken production (millions)	Estimated stocking density (Kg per m²)	Assumed number at each stocking density (millions per year)
Croatia	39	All at 33kg max.	39m at 33kg
Slovakia	30	Approx equal numbers at 33kg and 39kg max	15m at 33kg 15m at 39kg
Cyprus	13	All at 33kg max.	13m at 33kg
Malta	3	All at 33kg max.	3m at 33kg

Based on the numbers set out in Tables 18 and 19, Table 20 below shows the estimated number of birds stocked at each rate for all EU Member States.

Table 20 Number of broilers at various stocking densities in the EU

Stocking density (kg/m²)	Total number (million)	% of total
42	976	16
38-39	2,370	38
35-36	640	10
33	1,687	27
30 or less (including free range and organic)	614	9
Total	**6,288**	**100**

Table 20 shows that some 54% of all broilers in the EU are stocked at between 38 and 42kg per square metre. The most common stocking density is around 38-39kg per square metre.

Approximately 9% of all broilers are grown in systems with stocking densities of 30kg per m² or lower. This percentage includes birds grown in free range systems and in accordance with organic standards.

Changes would be required for approximately 91% (5,674 million broilers per year) to meet ECC requirements. The need for additional growing space in the EU to maintain output is considered later in this report.

3.7 Sustainability

3.7.1 Greenhouse gas emissions

A breakdown of greenhouse gas (GHG) emissions for standard and ECC production is shown in Table 21 and Figure 12. All emissions are presented as carbon dioxide equivalents (CO_2e) with emissions of nitrous oxide and methane converted into CO_2e using the IPCC 2019 global warming potentials over 100 years (GWP_{100}). These results are presented and discussed on a ‘per kilogram of meat’ basis to give like-for-like comparisons. Emissions per square metre might be very different in the comparisons, due to differences in stocking densities.

Emissions per kg of meat were calculated as follows:

- Standard production 6.68 kg CO_2e/kg of meat;
- ECC production 8.31 kg CO_2e/kg of meat.

The increase in greenhouse gas emissions per kg of meat is calculated to be 24.4% for ECC on this basis.

For comparison, emissions per kg of liveweight were calculated as follows:

- Standard production 3.76 kg CO_2e/kg liveweight;
- ECC production 4.15 kg CO_2e/kg liveweight.

The increase in greenhouse gas emissions per kg of liveweight is much lower at 10.4% on this basis.

Table 21 Breakdown of GHG emissions per kg of chicken meat for standard and ECC production systems

Emission category	GHG emissions (kg CO_2e/kg chicken meat)		% change
	Standard	ECC	
Feed (direct)	1.80	2.36	+30.8%
Feed (LUC)[32]	4.20	4.99	+18.7%
Used litter in house	0.29	0.42	+47.2%
Purchased litter	0.02	0.03	+45.9%
Water (drinking and washdown)	0.00	0.00	+35.9%
Grid electricity	0.07	0.10	+45.9%
Natural gas	0.13	0.18	+45.9%
Transport	0.17	0.23	+34.0%
Total	6.68	8.31	+24.4%

[32] Land Use Change (LUC)

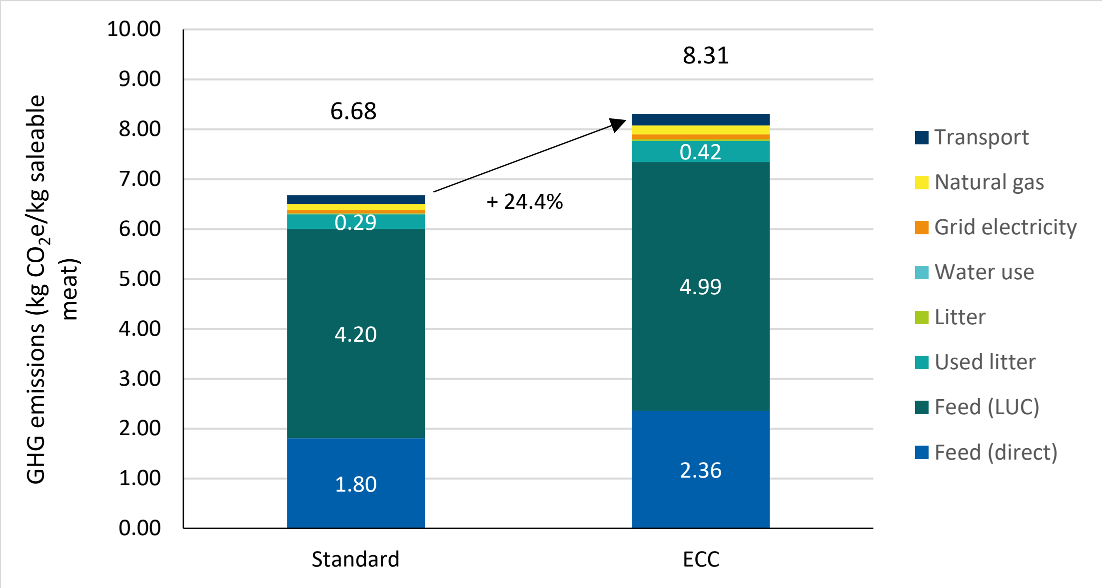

Figure 12 Breakdown of GHG emissions per kg of chicken meat for standard and ECC production by emissions source.

Feed makes up approximately 90% of total GHG emissions in both systems, and so emissions were found to be strongly influenced by the FCR of the production systems. Different rations were assumed for each system (see section 2.3.3 for details). These figures assume substantial emissions due to land-use change associated with Brazilian soybean meal and oil production. The use of soybean products which are robustly verified as not being associated with deforestation would substantially lower the emissions per kg of chicken meat in both systems, and since the conventional ration has a higher proportion of soya, would have a relatively larger reduction than the ECC system.

Drinking water was calculated based on feed intake, so this mirrors differences in FCR and cycle length. Washdown water requirement per kg of chicken meat was higher in the ECC system due to an increase in the floor area required for comparable production. Emissions associated with water use were very low, accounting for less than 0.01 kg CO_2e/kg of meat. More information on water use is provided in section 3.7.2.

Used litter was the second greatest source of emissions and is calculated based on the excreta produced by the birds and the resulting methane and nitrous oxide emissions. A larger number of birds, average weight or length of time will increase the quantity of excrement and therefore the emissions. Since average weight at thinning and at slaughter is assumed to be the same and the number of birds is very similar (only minor differences in mortality rates), the main factors were the increased cycle length of ECC production and the lower proportion of meat in the EEC birds.

Fresh litter use was calculated for each production system on an area basis, then multiplied by the same emission factor for each system. The lower stocking density of ECC production means that a larger housing area is required per bird per cycle and so there are greater emissions associated with purchased litter, although this is a small part of total emissions.

Energy (grid electricity and natural gas) was estimated for standard and ECC production. Electricity use per bird is affected by cycle length and stocking density. At lower stocking densities, use per bird increases for feeders and lighting but overall, it is expected to be similar for ventilation on a 'per cycle' basis. Natural gas for heating was assumed to be consistent per square metre but is higher per bird in ECC production. Most transport emissions were due to transporting feed onto the site, and so the difference in overall feed requirements is reflected in the difference in transport emissions between the two systems.

3.7.2 Water use

Drinking water use was assumed to be directly proportional to feed intake, so the increased feed requirements per cycle of ECC birds led to higher drinking water consumption. Water used per bird for washing down was greater in the ECC system on a per cycle basis, since a larger floor area is required to keep a given number of birds. However, washdown water was assumed to be only 4% of the total water used (Figure 13).

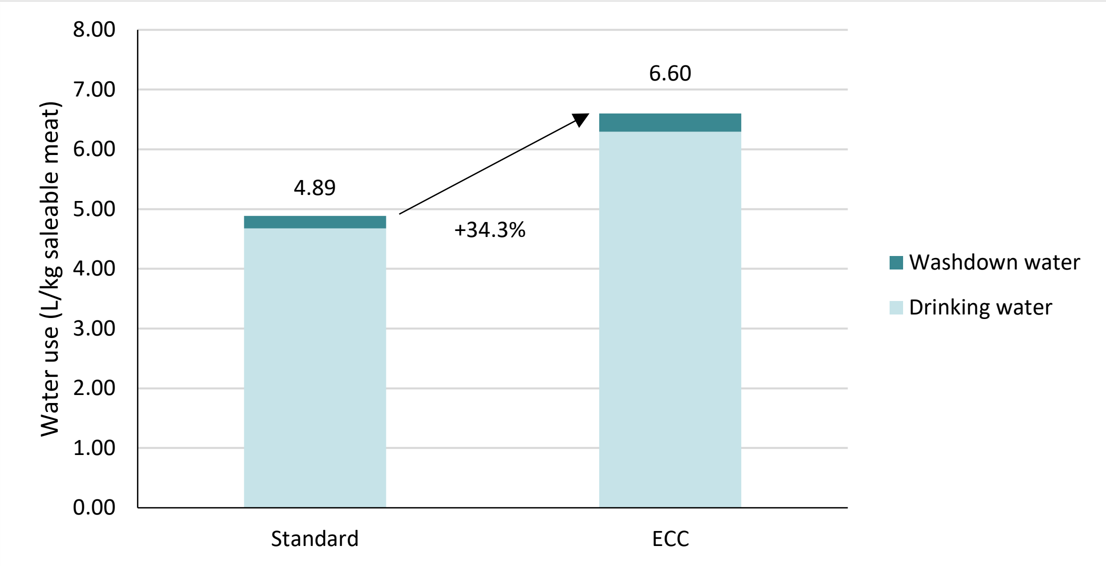

Figure 13 Summary of water use per kg of chicken meat between standard and ECC production.

The overall water use per kg of meat produced in each system is as follows:

- **Standard production**
  - Drinking water: 4.68 litres per kg of meat;
  - Washdown water: 0.21 litres per kg of meat;
  - Total water: 4.89 litres per kg of meat.
- **ECC production**
  - Drinking water 6.29 litres per kg of meat;
  - Washdown water 0.31 litres per kg of meat;
  - Total water 6.60 litres per kg of meat.

The increase in water use for ECC production is calculated to be 35.1% per kg of chicken meat produced. Per kg of liveweight, the increase in water use is calculated as 20%[33].

[33] This is based on 2.75 and 3.30 litres of water per kg of liveweight respectively.

4 IMPLICATIONS

4.1 Additional growing space requirements

To retain the current EU annual output of chickens and chicken meat using ECC production methods, additional growing space would be needed. This is because of the lower stocking density and extended growing cycles and (for meat) due to differences in carcass yield. The amount of additional space needed is estimated in this section.

4.1.1 To maintain the number of birds marketed

For this, the following data have been used:

- Annual chicken output (2022) for 25 Member States (see Table 16).
- The number of birds currently produced annually at various stocking densities in each country (see Tables 18 and 19).

From these, total growing capacity in each country was calculated, assuming that all current capacity is fully utilised. For each country, the total growing space was determined from the assumed annual output of birds per square metre. This in turn varies according to stocking density (kg per square metre).

To account for the range of stocking densities in use, annual outputs were calculated as shown in Table 22, based on the approach in section 3.1.4. The number of birds marketed includes an allowance for mortality of 3% for all stocking densities except for 30kg (slow-growing) where 2.5% is used. Annual throughput at 39kg per square metre is also shown (highlighted) to compare and check with Table 9 but this is not used in the subsequent calculations in Table 22.

Table 22 Annual throughput of birds at various stocking densities (kg/m²) in standard production

Stocking density (kg/m²)	No. of birds marketed (birds per m²) after mortality	Number of cycles per year	Annual output (birds marketed per m² per year)
42	23.0	7.30	168.0
39	21.3	7.30	155.8
38-39 (38.5)	21.1	7.30	153.7
35-36 (35.5)	19.4	7.30	141.6
33	18.0	7.30	131.5
30 (slow growing)	16.5	5.98	98.4

Table 23 shows the calculated current growing space for each country, the amount required for full conversion to ECC and the extra growing space needed to maintain the same output of birds. These estimates exclude the growing space currently used for existing ECC, free range and organic production, which is assumed to be un-changed. For example, for Poland, the estimated current growing space is 8.6 million square metres. Full conversion to ECC for all houses stocked at over 30kg per square metre would require an extra 3.33 million square metres to maintain the same output of birds.

At EU level, it is calculated that an extra 18.40 million square metres of growing space would be needed if the current annual chicken output is to be maintained in ECC production. This is equivalent to a total land area of 1,840 hectares[34].

Table 23 Estimated additional growing space required to maintain the same bird output in ECC production[35]

Country	Annual broiler chicken production in all systems (million birds)	Calculated current growing space for birds stocked over 30kg/m² (million square metres)	Calculated growing space needed for conversion to ECC (million square metres)	Additional growing space needed for ECC (million square metres)
Poland	1200	8.60	11.93	3.33
France	734	3.91	6.12	2.21
Spain	701	4.13	6.26	2.14
Germany	631	3.97	5.70	1.73
Italy	534	3.43	4.99	1.56
Netherlands	518	2.10	3.38	1.28
Belgium	298	1.73	2.90	1.17
Romania	285	1.85	2.86	1.01
Portugal	217	1.65	2.18	0.53
Hungary	178	1.07	1.70	0.62
Greece	147	1.12	1.48	0.36
Czech Republic	118	0.79	1.18	0.40
Sweden	110	0.77	1.09	0.32
Austria	100[36]	0	0	0
Denmark	98	0.58	0.98	0.40
Ireland	98	0.64	0.98	0.35

[34] One hectare is 10,000 square metres

[35] Excludes Estonia and Luxembourg

[36] Latest available information is for 2021

Country	Annual broiler chicken production in all systems (million birds)	Calculated current growing space for birds stocked over 30kg/m² (million square metres)	Calculated growing space needed for conversion to ECC (million square metres)	Additional growing space needed for ECC (million square metres)
Finland	81	0.50	0.81	0.31
Lithuania	46	0.31	0.46	0.15
Bulgaria	46	0.35	0.46	0.11
Slovenia	41	0.28	0.41	0.14
Croatia	39	0.30	0.39	0.09
Slovakia	30	0.21	0.30	0.09
Latvia	22	0.14	0.22	0.08
Cyprus	13	0.10	0.13	0.03
Malta	3	0.02	0.03	0.01
Total	**6288**	**38.56**	**56.96**	**18.40**

From Table 23, the growing space required at present for birds stocked at over 30kg/m² is 38.56 million square metres.

These calculations make no allowance for future changes in demand due to human population change in the EU or in *per capita* chicken consumption levels.

Whilst human population is expected to be broadly static[37], EU forecasts suggest that poultry meat consumption could increase from 23.5kg per capita in 2021 to 24.8kg in 2031 (+5.5%). In addition, EU chicken production was expected to increase by 0.4% per year[38]. Over a 10-year period from 2021 to 2031, this would mean a 4% increase in production. This in turn would require an extra 2.55 million square metres of growing space[39] for housing poultry at the ECC stocking rate.

4.1.2 To maintain chicken meat output

Section 3.6.2 concludes that 5,674 million birds per year would be moved from standard to slow growing breeds for ECC production. However, this would still result in a reduction in total chicken meat in ECC because of the 'per bird' differences set out in Table 14.

[37] A small population increase of 0.6% is forecast between 2019 and 2026, followed by a gradual decree. See https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115#Population_projections

[38] https://agriculture.ec.europa.eu/news/eu-agricultural-outlook-2021-31-consumer-behaviour-influence-meat-and-dairy-markets-2021-12-09_en

[39] Calculated as an extra 251 million birds per year over the current 6,288 million. At an annual throughput of 98.4 birds / m² for ECC production, an extra 2.55 million square metres would be needed.

Table 14 shows that meat yield is 1.356 kg per bird for standard production and 1.203 kg per bird for ECC, a difference of 0.153 kg (153 grams). Meat output per bird would therefore be reduced by 11.3%.

The number of extra birds needed to maintain the same annual output of meat from ECC production is shown below:

- In standard production, 5,674 million birds would produce 7,693,944 tonnes of meat per year, assuming 1.356kg of meat per bird;
- In ECC production, 5,674 million birds would produce 6,825,822 tonnes of meat per year, assuming 1.203kg of meat per bird;
- The difference between these two is 868,122 tonnes per year (-11.3%);
- Assuming 1.203kg of meat per bird for ECC production, the number of extra birds needed (per year) to maintain meat output would be 721.63 million;
- Assuming 5.98 cycles per year for ECC, the number of extra birds per cycle would be 120.67 million;
- Assuming 16.87 birds per square metre at day-old, 7.15 million square metres of growing space would be needed.

In summary, the amount of growing space for ECC would need to increase from 38.56 million square metres (the current space for birds currently stocked at over 30kg/m²) to 56.96 million square metres (+18.40 million; +47.7%) to maintain bird numbers and from 38.56 million to 64.11 million square metres (+7.15 million; +66.3%) to maintain meat output.

4.2 Additional feed and water requirements

Table 10 shows that a move from standard to ECC production increases average feed intake from 3.73kg per bird to 4.45kg per bird, because of the difference in FCR. For water intake, it is assumed that 1.7 litres of water are used per 1kg of feed[40] and therefore water use increases from 6.34 litres to 7.57 litres per bird.

The impacts of this at EU level are shown in Table 24. This is based on maintaining bird numbers i.e. 5,674 million birds per year being changed from standard to ECC production (based on data derived from Table 20). Small differences in the amount of water used annually for clean-out (due to differences in cycle length and stocking) are not considered in these calculations.

[40] This estimate is explained and referenced in Appendix 1; section A1.5

Table 24 Additional annual EU requirements for feed and water in ECC production

	Standard	ECC
Feed consumption per bird (kg)	3.73	4.45
Annual feed use (million tonnes for 5,674 million birds)	21.16	25.25
Additional feed to maintain bird numbers for ECC (million tonnes)	4.09 (+19.3%)	
Water consumption per bird (litres)	6.34	7.57
Annual water consumption (million cubic metres[41], 5,674 million birds)	35.97	42.95
Additional water to maintain bird numbers for ECC (million cubic metres)	6.98 (+19.4%)	

To maintain the same output of meat in ECC production, an extra 721.6 million birds would be needed annually (based on section 4.1.2). These additional birds would require the following:

- An extra 3.21 million tonnes of feed. This is based on 721.6 million birds eating 4.45 kg per bird;
- An extra 5.46 million cubic metres of water. This is based on 721.6 million birds using 7.57 litres of water per bird.

Therefore, **to maintain chicken meat output in ECC production**:

- The amount of additional feed needed per year would be around 7.30 million tonnes (4.09 + 3.21), bringing the total to 28.46. This represents an increase of around 34.5%.
- The amount of additional water needed would be around 12.44 million cubic metres (6.98 + 5.46), bringing the total to 48.41, this representing a similar increase (calculated as +34.6%).

4.3 Costs and consent for new buildings

In the Appendix (section A1.12), the average cost of existing buildings and associated equipment and infrastructure in the EU is estimated at €350 per square metre of growing space and this figure has been used to calculate current production costs in Table 13. The capital cost for new growing space needed to maintain existing output would be higher than this, particularly since costs are known to have increased significantly in recent years. Average costs differ from country to country and after a review undertaken for this study, an average price of €420 per square metre of growing space has been used for the following calculations for new buildings. This includes the building, equipment and associated infrastructure[42].

The overall cost of constructing and fitting new buildings for an additional 18.40 million square metres of growing space to maintain current chicken output (see Table 23) is calculated as follows:

- Cost of construction per square metre €420;
- Cost of construction for one million square metres €420 million;

[41] One cubic metre (m^3) is 1,000 litres

[42] See also Appendix A1.12

- Cost of constructing 18.4 million square metres €7,728 million (€7.728 billion)

This is an estimated overall figure which will vary according to location and housing design specification.

The development of new poultry production facilities will require planning consent, although specific requirements vary according to location. The application process and fee, together with associated other costs are also likely to differ. The process can be difficult, prolonged and expensive, with no guarantee of success.

Meeting requirements for additional space in the form of new housing is also dependent on producers having the confidence and the necessary financial resources to invest. The scale of the investment needed for chicken production is substantial. One full time equivalent worker is estimated to be needed for 4,050m² of growing space (see Appendix A1.11) and this may be considered a minimum scale of investment. Based on €420 per square metre, the cost of this farm development would be around €1.7 million.

To meet the requirement for an additional 18.40 million square metres of growing space, some 4,543 developments of this size would be needed across the EU. If 4,050m² of growing space equated to two separate houses, some 9,086 new houses would be required in total. This calculation excludes any allowance for increased chicken consumption in future (see section 4.1.1).

As noted in section 4.1.2, total chicken meat output would still be reduced by some 11.3% even if bird output was unchanged following a move to ECC. The reduction amounts to some 868,122 tonnes of meat per year and would require an additional 7.15 million square metres of growing space (see section 4.1.2). Assuming 2,025 square metres of growing space per house, this equates to 3,531 new houses and a cost of some €3,003 million (€3.003 billion) based on €420 per square metre.

The total capital cost to maintain current EU chicken meat output from ECC production is therefore estimated as follows:

- Capital cost to maintain the current number of chickens in the EU in ECC production (9,086 new houses) is €7.728 billion;
- Additional cost to offset the reduction in meat yield per bird in ECC production (3,531 new houses) is €3.003 billion;
- Total capital cost to maintain meat output (12,617 new houses) is around €10.731 billion.

4.4 Annual EU chicken output with no new buildings

If all the growing space that currently produces chickens in systems that exceed 30kg per square metre was converted to ECC requirements, there would be a substantial reduction in output, as set out here.

Growing space in the EU at present for birds stocked at over 30kg per square metre is estimated to be 38.56 million square metres at present. Based on an annual throughput of 98.4 birds per square metre for ECC in future (based on Table 9), the total output would be some 3,794 million chickens per year.

Current output is estimated at 5,674 million chickens per year (see section 3.6.2) and so this change would mean an annual reduction of 1,880 million birds (i.e., the difference between 5,674 and 3,794 million) or the loss of around 33% of current production.

In terms of meat output, the percentage reduction would be greater, and the following impacts are calculated:

- 5,674 million birds per year currently produce 7.694 million tonnes of meat from standard birds[43].
- 3,794 million birds per year would produce 4.564 million tonnes of meat from slow-growing birds[44].
- This would represent an overall reduction in meat output of around 41%.

Such a reduction in chicken throughput would also have wider implications for allied trades and for the poultry supply chain. For example, compounders would be adversely affected by lower throughput at feed mills as would EU farmers producing crops used in feeds for poultry. Within the supply chain, slaughterhouses would be affected by reduced throughput because existing facilities would not be fully utilised. This is likely to result in an increase in fixed costs on a 'per bird' basis. This may be assessed in a separate study.

Finally, there would be implications for employment, with fewer people required on farms, at slaughterhouses and in allied trades.

4.5 Removal of thinning

The calculations in this report assume that one single thinning is carried out, although ECC requirements state that the practice is 'discouraged' (see Table 3). If thinning were to be prohibited in ECC production, the result would be a reduction in the number of birds that could be stocked at day-old. This in turn would further reduce the annual output of meat. The cost of production per kg of chicken meat would also increase.

It is likely that the loss of thinning would mean changes to stocking policies on farms and growing cycle lengths. Different approaches may be needed on different sites to meet requirements for a range of liveweights and so the following figures are provided for guidance only.

Based on the assumed liveweight at final depopulation of 2.7kg used in this report (Table 5), the following can be calculated:

- ECC with thinning 16.45 birds marketed per square metre (see Table 8);
- ECC without thinning 11.11 birds marketed per square metre (i.e. 30/2.7).

Based on 64.11 million square metres of growing space being required to maintain the current meat output in ECC production (see section 4.1.2), the following calculations are made:

- With thinning, 16.45 birds are marketed per square metre, hence the total capacity is 1,054 million birds;
- Without thinning, 11.11 birds are marketed per square metre, hence the total capacity is 712 million birds;
- Without thinning, extra growing space would be needed for 342 million birds per cycle. At 11.11 birds per square metre, 30.8 million square metres of growing space would be required.
- At £420 per square metre, the total cost is calculated as €12.9 billion.

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[43] This is based on 1.356kg of meat per bird.

[44] This is based on 1.203kg of meat per bird.

4.6 Sustainability

4.6.1 Greenhouse gas emissions

From a climate perspective, production efficiency is the key to reducing the emissions intensity (GHG emissions per kg production) of a product. Therefore, the longer an animal takes to get to slaughter weight, the more days of feed it consumes and the more excrement it produces. Both of these are key parts of the overall emissions contribution from chicken meat production.

Introduction of ECC production systems across the EU could increase emissions from chicken meat production by an average of 1.63 kg CO_2e per kg of meat produced (or 24.3%). Scaled up to EU level, this emissions increase would apply to some 6.78 million tonnes of meat produced each year. On this basis, GHG emissions would increase by 11.05 million tonnes of CO_2e per year.

4.6.2 Land use

Producing the additional feed required for ECC production will also require a greater area of agricultural land for crop production, both within the EU and elsewhere. Mostert et al., 2022, estimate that the equivalent land area for crops required to produce 1kg of chicken feed (averaged across four rations in a standard production cycle) is approximately 2.15m^2.

Switching to ECC across the EU would require an additional 4.09 million tonnes of feed (Table 24) if current chicken numbers are maintained. Assuming yields remain constant, this would therefore require an additional 879,000 hectares of land for crop production.

To maintain the current output of chicken meat, an additional 7.30 million tonnes of feed would be needed (see section 4.2). This would require an additional 1.57 million hectares of land for crop production.

4.6.3 Water use

Since water requirement in broiler chicken production is related to feed intake, the greater feed requirement of ECC chicken will also require additional water. On average this would amount to an extra 1.71 litres of water per kg of meat for drinking and cleanout water (see Figure 13). To maintain chicken meat output in ECC production, the amount of extra water needed would be around 12.44 million cubic metres (see section 4.2), an increase of around 35%.

The European Commission estimated (2019) that 38% of the EU population and 29% of EU territory was affected by water scarcity[45]. Water scarcity is a seasonal, annual or multi-annual state of water stress that occurs when water demand regularly exceeds the supply capacity of the river system. Water scarcity is measured as the ratio of renewable freshwater resources to water abstraction. Droughts are temporary reductions in water availability e.g. due to insufficient rainfall and can exacerbate water scarcity. Table 25 shows the range of water scarcity within selected countries as determined by the Aqueduct platform[46].

[45] https://environment.ec.europa.eu/topics/water/water-scarcity-and-droughts_en

[46] https://www.wri.org/applications/aqueduct/country-rankings/

Table 25 Summary of agricultural water scarcity in selected European countries[47].

Country	Lowest region	National average	Highest region
Poland	0.07	1.41	3.18
France	0.48	2.29	3.52
Spain	1.92	3.96	4.91
Germany	0.26	1.93	3.51
Italy	1.11	2.80	4.71
Netherlands	0.52	1.55	3.67

These figures show that there are regions within several key chicken-producing countries that already have high water scarcity, with Italy and Spain showing potential issues even in the least water-scarce regions. Further work is needed to determine what the potential impacts on water scarcity might be from switching to ECC production across the EU.

4.6.4 Carbon leakage

Consumer demand for poultry in the EU is forecast to increase in the future (see section 4.1.1). Assuming this is the case, any reduction in production within the EU could lead to more imports which may have greater emissions intensity than EU production systems. This is termed carbon leakage and is an important consideration for any policies that may impact domestic production. A more detailed analysis, involving identifying key importing countries and their respective GHG emissions, would be required to understand the potential impact of this more fully.

[47] Note: 0-1 = Low, 1-2 = Low-medium, 2-3 = Medium-high, 3-4 = High, 4-5 = Extremely high

5 CONCLUSIONS

The adoption of European Chicken Commitment requirements would have a substantial impact on the cost of chicken production in the European Union. Annual output in the EU would be substantially reduced unless new poultry housing was built; chicken produced outside the EU may be available at lower cost. The carbon footprint of production would be increased, and more feed and water would be required per bird.

The main impacts identified in this report are as follows:

5.1 Production cost impacts

- Cost of production per bird is calculated to be 21.9% higher for ECC compared to standard production at 39 kg per square metre. This is based on costs per bird of €2.74 for standard and €3.34 for ECC.
- Per kg of meat produced, the cost of production is €2.02 for standard and €2.77 for ECC, an increase of 37.5%. This is based on breed performance data showing that the meat yield from slower-growing birds used in ECC production is 11.3% lower than for birds used in standard production.

5.2 Feed and water impacts

- Feed is a major reason for the cost difference between standard and ECC production. Changing the assumptions made in this study show that the cost of production increase for ECC per kg of meat could range from 33.3% (lower FCR, reduced feed price) to 42.4% (higher FCR, no difference in feed price).
- For ECC production, feed use would be increased by 720 grams per bird and water consumption by 1.23 litres per bird. Per kg of meat produced, this would represent an increase of around 34.5% for both feed and water.
- To maintain the current EU output of chicken meat, an extra 7.30 million tonnes of feed would be needed and an extra 12.44 million cubic metres of water.

5.3 Output impacts

- Based on standard data from breeding companies at 2.4kg liveweight, the bird used in standard production is assumed to produce 1.356kg of meat and the slower-growing bird used in ECC production to produce 1.203kg, a reduction of 11.3% as noted in section 5.1.
- To maintain the current number of chickens produced in the EU, extra growing space covering some 18.40 million square metres would be required. Based on an average new house with 2,025m² of growing space, this equates to 9,086 new buildings. To maintain the current EU output of chicken meat, an extra 1.28 million square metres of growing space would be needed, equivalent to 606 buildings with 2,025m² of growing space.
- The cost of this is estimated based on a current cost of €420 per square metre of growing space for new buildings. The cost to maintain EU chicken numbers would be €7.728 billion. The cost to maintain chicken meat output would be €8.243 billion.
- If no new housing is built, annual chicken output from systems currently stocked at over 30kg per square metre is estimated to drop from 7.694 million tonnes to 4.564 million tonnes, a

reduction of 41%. This would have important implications for the poultry supply chain, for allied trades, for employment and for farmers producing crops used in poultry feeds.

- These estimates exclude any requirement to increase production to meet the forecast higher demand for chicken in the EU which is estimated at +0.4% per year.
- Higher production costs in the EU are likely to make chicken produced in non-EU countries more price competitive. This could lead to higher levels of imports at the expense of home production, with resulting impacts on the local economy.

5.4 Sustainability impacts

- Switching from standard to ECC production would increase GHG emissions by 1.63 kg CO_2e per kg of meat produced, or 24.4%.
- This is driven primarily by the lower meat yield percentage of ECC birds and the longer cycle length of ECC production, requiring more feed per kg of liveweight, although it is partially offset by an assumed reduction in soybean meal in the ECC ration compared to the conventional ration.
- Scaled up to EU level and assuming the same numbers, GHG emissions would increase by 11.05 million tonnes of CO_2e per year to produce the same meat output in ECC.
- To maintain the same output of chicken meat, an additional 7.30 million tonnes of feed would be needed, because of the higher feed intake of birds in ECC production. This would require an additional 1.57 million hectares of land for crop production, based on 2.15m^2 of land being required to produce 1kg of feed for chickens.
- The increase in water usage (an extra 1.63 litres per kg of meat) would increase annual water consumption by chickens across the EU by 12.44 million cubic metres if current chicken meat output is maintained. This could have important implications, particularly for water-scarce regions.
- If the EU becomes less self-sufficient in chicken (e.g., due to lack of growing space or competition from non-EU countries with lower production costs), there will be an increase in imported supplies which are likely to have a greater emissions intensity than current production.

ECC aims to improve the welfare of chicken production through slowing the growth of birds and increasing time to slaughter. However, this extension of the growing period contrasts with the goals of reducing the climate intensity of meat production. Key focuses for reducing emissions from meat production would start with increases in productivity to reduce used litter volume produced (fewer days on farm) and improve the feed conversion ratio to reduce the embedded emissions from feeding poultry.

In a system where there is an increase in time on farm, it would be necessary to focus emissions reductions on decarbonisation of the feed supply chain e.g., changes in raw materials used, a focus on low emissions fertiliser use and nitrification / denitrification inhibitors to reduce emissions from feed production. In addition, it becomes increasingly important to find ways of reducing the emissions from the litter whilst it is in the house and also to consider the wider emissions from the eventual storage and application of poultry litter to land, or other utilisation methods.

5.5 Other considerations

Production cost impacts in section 5.1 assume that thinning is allowed in ECC, although it is said to be discouraged. If it were prohibited in future for ECC, production costs would increase per kg of chicken meat and additional houses would be required to maintain meat output.

Current ECC requirements are considered a 'compromise'[48] based on what is currently achievable and so future changes seem possible. The welfare benefits need to be considered alongside the impacts set out above, but this was outside the scope of this study.

Reducing the growth rate of slow-growing birds from the guide figure of 60 grams per day in ECC would result in longer growing cycles and increased feed (and water) use per bird. Production costs would be expected to increase as a result. The feed price differential (per tonne) between standard and slower-growing production may however increase in favour of the latter due to specification changes, such as the use of lower crude protein levels.

This report has not considered all aspects of the feasibility of converting EU production to ECC. A key issue would be the time required for breeding companies to develop and produce enough of the slow-growing stock required, and the associated costs.

From a farm perspective, additional costs incurred would need to be recompensed and this would require new supply chain agreements. Finally, the sector would need to have the confidence, the financial means, and the opportunity (consent) to increase the growing space. Key issues include the ability to gain planning consent for new developments and to obtain an environmental permit under Industrial Emissions legislation. If these criteria are not met, there would be a substantial reduction in annual chicken output within the EU.

[48] https://albertschweitzerfoundation.org/campaigns/european-chicken-commitment

APPENDIX 1

A1 Cost assumptions

A1.1 Day-old chick

A range of different day-old chick prices have been reported for standard production and an average of 40 eurocents per bird is considered typical. For slow-growing birds, contributors stated that the cost could be up to 7 eurocents higher. Overall, an average difference of 6 eurocents was assumed to be typical. Taking account of mortality, costs per bird marketed are calculated as follows:

Standard	40 cents per bird with 3% mortality = 41.2
ECC	46 cents per bird with 2.5% mortality = 47.2

The current higher price for slow-growing birds is understood to be due in part to development costs. Certain performance improvements are claimed for the parent stock of slower-growing strains, including higher egg numbers and lower feed consumption. This may lead to a reduction in day-old costs for slower-growing birds in future.

A1.2 Feed

Feed costs for chicken production vary considerably around the EU and responses from 11 different Member States showed a range from €460 to €620 per tonne in late 2022. From these responses, a weighted average price of €527 per tonne was calculated for standard production, based on the sector size in each country.

Since then, feed prices have generally decreased, and industry representatives estimate that prices in 2023 were around 15% lower. On that basis, an average price of €448 per tonne has been used.

Feed with a slightly lower protein content may be used for slow-growing chickens and so the price per tonne can be lower. A study in the Netherlands (2020)[49] indicated that the crude protein content of a grower feed for standard production would be nearly 1% higher than that for production using a slower-growing strain.

The price difference will vary according to raw material costs. In these calculations, a difference of €10 per tonne has been assumed and so a feed cost of €438 per tonne has been used for ECC production. If the price differential was increased (i.e., a lower specification feed was used), it is possible that the cycle length would be increased, and this would affect other costs and also the annual throughput of birds.

Based on the feed intakes set out in Table 12, costs per bird are calculated as follows:

Standard	3.73kg per bird @ €448 per tonne = 167.1 eurocents (€1.67);
ECC	4.45kg per bird @ €438 per tonne = 194.9 eurocents (€1.95).

A1.3 Heat

It is assumed that the heating cost is the same per square metre of growing space for standard and ECC production, but the cost per bird increases as the stocking density decreases. Since heat is provided for young birds only, the extended growing cycle for ECC is assumed to have no impact.

[49] Economics of broiler production systems in the Netherlands by van Horne

Based on information provided by contributors for this report, an average heating cost of €0.12 per bird is assumed for standard production. The cost per bird for ECC production is calculated as follows:

- Stocking density (kg/m^2) difference at day old (21.66 / 16.66) x €0.12 = €0.156 per bird.

This approach is consistent with the previous study in the Netherlands (see above). The use of natural gas is assumed, although other heat sources may also be used.

A1.4 Electricity

Electricity use in chicken production is mainly to provide ventilation, to operate feeders and for lighting. The cost per bird is affected by cycle length and stocking density. At lower stocking densities, the cost per bird increases for feeders and lighting but overall, it is expected to be similar for ventilation.

The method used here is based on the previous study in the Netherlands (see above) in which it was estimated that electricity use is 0.17kWh per bird. Some 75% of this is for ventilation and 25% for feeders and lighting. Information received for this project indicates that the typical electricity cost for standard production is currently €0.04 per bird. The cost for ECC has therefore been calculated as follows:

- **For ventilation** 0.04 x 0.75 x (51/40 days) = €0.0383
- **For feeders and lighting** 0.04 x 0.25 x (51/40 days) x (21.66/16.66) = €0.0166
- **Total electricity for ECC** 0.0383 + 0.0166 =€0.0549 (i.e. 5.5 eurocents per bird)

A1.5 Water

The extended growing cycle and increased feed intake for ECC production leads to higher water use. Typically, water use (litres) is proportional to feed use (kg) and estimates suggest an average ratio of 1.7 litres of water to 1 kg of feed[50]. This is likely to vary between farms.

On this basis, the following calculations are made:

- **Standard production** 3.73 (feed intake, kg) x 1.7 = 6.34 litres
- **ECC production** 4.45 (feed intake, kg) x 1.7 = 7.57 litres

Water prices are understood to vary considerably within the EU and based on available data, a typical average water price of €4.50 per cubic metre was assumed (0.45 eurocents per litre). The calculated costs are:

- **Standard production** 2.85 eurocents per bird
- **ECC production** 3.41 eurocents per bird

A small amount of water is also required for clean-out and a standard rate of 6 litres per m^2 of growing space has been assumed for both standard and ECC production. Based on the price above, this would cost 2.7 eurocents per m^2. On a 'per bird' basis, this would be less than 1 eurocent and therefore this has been excluded from these costs.

[50] https://en.aviagen.com/assets/Tech_Center/Broiler_Breeder_Tech_Articles/English/AviagenBrief-WaterUtilizationInBroilers2018-EN.pdf

A1.6 Litter and enrichments

Cost differences between standard and ECC production on a 'per bird' basis are likely to be due to stocking density and the need for enrichments for ECC. An estimate of one eurocent per bird marketed is used for litter in standard production.

For ECC, 0.5 eurocents per bird is added for enrichments and so the total costs are calculated as follows, based on numbers in section 3.1.4:

- For litter 1 x (21.34 / 16.45) = 1.30 eurocents per bird
- For enrichments = 0.50 eurocents per bird
- **Total for ECC = 1.80 eurocents per bird**

A1.7 Vaccines

No differences are expected between standard and ECC production. Based on information from industry, an average cost of €0.04 per bird is estimated for both.

A1.8 Medication

Reduced stocking and growth rates are expected to lead to lower medication costs for ECC production and this may partly reflect ease of stockmanship. Based on information from industry, typical 'per bird' costs of €0.03 (for standard) and €0.02 (for ECC) have been used.

A1.9 Site clean-out

The cost per bird for standard and ECC production is likely to differ due to stocking rates. The length of the growing period and the need for 'top-up' litter during the growing cycle may also have an impact. If a fee is received for used litter, then the value per bird would be higher for ECC production.

For this study, it is assumed that the cost difference is due to stocking density only and that the average is €0.05 per bird marketed in standard production. The cost for ECC has therefore been calculated as follows:

- 0.05 x (21.34 / 16.45) = 0.065 (€ per bird)

A1.10 Repairs and maintenance

As above, stocking density differences are likely to be the biggest cause of cost differences on a 'per bird' basis. An average of €0.03 per bird marketed is assumed for standard production. The cost for ECC has therefore been calculated as follows:

- 0.03 x (21.34 / 16.45) = 0.04 (€ per bird)

A1.11 Labour

Labour requirements are determined by the amount of growing space and the number of birds. At lower stocking densities, there may be some labour savings e.g., due to lower mortality and the need for fewer litter top-ups. Equal amounts of time will be needed for house set-up and for feed and ventilation adjustments, but at lower stocking rates, the cost of this time will be divided by fewer birds. When comparing standard and ECC production, account must also be taken of differences in growing cycle length.

In line with our previous report for the UK and studies reported in the Netherlands, we have assumed that the labour requirement will be the same for standard and ECC production on a 'per square metre' basis and that one full time worker is required for housing with 4,050m² of floor space. At the time of thinning, this would stock approximately 87,500 standard broilers at 21.66 birds per square metre. For ECC production at 16.66 birds per square metre, the capacity would be some 67,500 birds.

The cost of labour varies within the EU and a 2018 report[51] stated that the EU average for paid labour in agriculture was just €8.70 per hour. Poultry production requires a comparatively high level of expertise and industry views for this report suggest a current average of €20 per hour in some countries. To reflect the whole of the EU, an average of €15 per hour (€120 per day) has been assumed, which excludes any other employment costs. This figure has been used in the following calculations:

- **Standard production** 40 days @ €120 per day = €4,800 or 5.49 eurocents per bird;
- **ECC production** 51 days @ €120 per day = €6,120 or 9.07 eurocents per bird.

A1.12 Capital and interest

The cost of broiler growing facilities is normally expressed on a 'per square metre of growing space' basis. This includes buildings, associated infrastructure and equipment but excludes the cost of the land. Reported costs vary between countries and an average cost of €350 per m² was used here for existing buildings (but note that a separate estimate of €420 per m² has been used for the cost of new buildings in section 4.3).

To arrive at a capital cost figure per bird, the following assumptions were made:

- 70% of the total cost relates to the building and infrastructure and this is depreciated over 20 years;
- The remaining 30% relates to equipment and this is depreciated over 10 years.

Annual repayment costs for buildings and equipment were determined and a loan calculator was used to calculate interest costs. These items were then added together to arrive at a total capital and interest cost as shown in the table below.

	Standard and ECC production
Cost of existing building and equipment (€ per m²)	350
Building cost at 70% of total (€ per m²)	245
Annual cost repayment for 20 years (€ per m² per year)	12.25
Annual interest charge for buildings at 5% rate (€ per m²)	7.15
Building repayment + interest (€ per m² per year)	19.40
Equipment cost at 30% of total (€ per m²)	105
Annual repayment, 10 years (€ per m²)	10.50
Annual interest charge for equipment at 5% rate (€ per m²)	2.86
Equipment repayment + interest (€ per m² per year)	13.36
Annual total repayments + interest for buildings and equipment (€ per m²)	**32.76**

[51] https://agriculture.ec.europa.eu/system/files/2021-11/eu-farm-econ-overview-2018_en_0.pdf

Based on an annual total of €32.76 (3276 eurocents) per square metre, the cost for standard and ECC production per bird marketed was calculated as follows:

- **Standard production**
    - 155.79 birds per square metre per year (see Table 9);
    - A cost of 21.03 eurocents per bird (3276/155.79).
- **ECC production**
    - 98.37 birds per square metre per year (see Table 9).
    - A cost of 33.30 eurocents per bird (3276/98.37).

For ECC, there is also a requirement to provide natural daylight (see Table 3) and it is assumed that existing houses would need to be fitted with windows to achieve compliance. For this, a sum of €11 per m^2 of growing space has been assumed, paid over 10 years at 5% interest. The total repayment is calculated at €1.40 per year, or 1.42 eurocents per bird based on an annual throughput of 98.37 birds per square metre per year. This figure has been added to the capital and interest cost above (33.30 eurocents) to arrive at a total of 34.7 eurocents per bird in ECC.

A1.13 Overheads and miscellaneous items

A small additional sum has been added to cover insurance costs, vehicles and fuel and other business-associated items which are either fixed or related to the amount of growing space. The cost of these items per bird is expected to be higher in lower stocking density systems. Costs of four and five eurocents per bird have been assumed for standard and ECC production.