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**Final report**

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# Resource Maps for Fresh Meat across Retail and Wholesale Supply Chains



Mapping out resource use in the retail and wholesale supply chain of fresh meat

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Legacy research commissioned by the previous government.

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**Front cover photography:** Cattle in a field

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# Executive summary

## Introduction

Consumers spend more money on meat than any other food item. WRAP has already shown that households are wasting around 570,000 tonnes of fresh meat each year, of which 260,000 (46%) is avoidable with a value of about £1,300M. These wasted products also include embedded water and embedded carbon. This research has focused on the supply of meat from the farm gate onwards, including livestock slaughtering, meat preparation, processing and packaging, distribution and retail. It focuses on fresh meat from the four animal species which comprise some 96% by weight of all animals slaughtered for human consumption, namely chickens, cattle, pigs and sheep as well as burgers, bacon, sausages and cooked hams, which are then sold through the retail supply chain.

The project's aim was to develop detailed 'resource maps' that show how each animal is utilised, in order to generate data on product waste, packaging waste, water usage and greenhouse gas emissions. The specific objectives were:

- to develop a method to quantify the amount of fresh meat waste in the retail and wholesale supply chain;
- to quantify the waste arisings in terms of tonnage, economic value and carbon equivalents (and for product to identify avoidable and unavoidable waste);
- to quantify the amount of water used by the meat industry;
- to identify the waste (product, packaging and water) profiles of chicken, beef, lamb and pork production;
- to identify waste profiles in terms of primary, secondary and tertiary packaging, and by material;
- to identify how product loss and waste is managed along the supply chain, and where it ends up;
- to consider potential impacts on reducing household food and packaging waste;
- to provide an indication of waste levels by country using actual data sets as well as market share and/or population data;
- to develop anonymised benchmarking reports for participating companies, so they can see how their business performs in relation to others; and
- to identify good practice that will lead to improved resource efficiency in the meat industry.

## Methodology

The data on which the research is based is derived from more than 50 interviews with 45 separate organisations in the fresh meat retail supply chain, including all the major multiple retailers and more than 150 manufacturing plants in the UK. The survey has been supplemented with a wide range of secondary sources derived from the industry and from Government statistics.

## Key Findings

### *Context*

The slaughter of animals produces meat and what we have termed residual material (that is the remainder of the animal). Before the outbreak of Bovine Spongiform Encephalopathy (BSE) in 1996, the industry harvested a considerable amount of residual material for the human and pet food markets (although the markets for these products were at that time volatile).

In March 1996 the EU, followed by most international governments, banned the importation of UK beef and the derived products. The loss of the export trade along with normal market volatility ensured a near collapse of the market for beef. Furthermore, in 2001 the introduction of the Animal By-Products Regulations (ABPR) ensured that these products now had to be processed by rendering (before disposal) or incinerated.

For the abattoirs it proved to be more economic not to separate products, but to send most of their residual material for rendering. As a result, in the last fifteen years many of the skills involved in harvesting residual material have been lost, and larger volumes than necessary have been sent for rendering. Since 2006 the Levy boards have been working with industry to reverse this practice.

The results from this research show that about 1.4M tonnes of residual material derived from the slaughter of animals is still being disposed of by rendering. Abattoirs either pay for the disposal of this material, if it is Specified Risk Material (SRM) for example, or receive a fee for best fats. The rendered material is used to produce a range of products including biodiesel and to a limited extent, dry pet food.

#### *Product waste*

A great deal of the residual material that is currently being disposed of by rendering could be diverted into products that could either be consumed by humans or pets (and livestock if and when regulatory changes allow). Within the current regulatory framework, the meat industry could obtain benefits estimated at around £110M from reduced disposal costs and increased revenue. This could be achieved through better separation of source material, coupled with collaborative programmes between abattoirs. Initial work in Scotland has shown results of this magnitude to be achievable. The benefits may be expected to vary between rural and urban-based operations, which often face contrasting challenges.

A benchmark that shows an optimal target for using residual material has been developed, by which individual companies can judge their performance in this regard. There is also further potential to recover energy from this material through Anaerobic Digestion (AD), although the economics of this are not clear when compared with rendering.

The European Commission have presented a draft proposal to allow the feeding of all processed animal protein derived from non-ruminants, to non-ruminants of a different species subject to tight channelling and testing controls. Discussion with Member States is on-going, however, on the face of it industry data suggest that at EU level any impact from lifting the ban will be quite modest. If the regulations do change to encourage both the greater use of residual material and the feeding of rendered protein to livestock (avoiding intra-species recycling), then there may be some potential benefits to industry.

About 72,000 tonnes of fresh meat are disposed of by retailers and treated as an animal by-product (in the same way that certain residual materials from slaughter and processing are treated). The majority of this material goes for either rendering or AD. This is approximately 4% by weight of the total volume sold.

In addition to being charged a collection fee for this waste, retailers will also incur an economic loss because the majority will mark down meat that is close to its 'sell by date', and they class this as 'waste'. This research has been unable to obtain information on how much meat is affected in this way, and the potential economic loss.

#### *Packaging*

Meat processing uses significant quantities of packaging for a variety of reasons, including inter-country and inter-plant transfers and maturation. Around 110,000 tonnes of packaging waste is produced, of which 81,000 tonnes (73%) are landfilled. The majority of this material is cardboard and plastic that is mildly contaminated with blood following contact with meat. The need to improve the disposal of this material is a widely recognised issue. The material that is not landfilled is recycled, and comprises wood, cardboard and plastic. Other causes of packaging waste include:

- Leaking vacuum packs, which in some cases affects up to 2% of all vacuum packs, requiring re-work and the defective pack to be discarded. In most cases the packs just burst. Re-packing also has to be carried out when incorrect pack sizes have been used, which is also a frequent cause of packaging waste.
- Machine breakdowns, which occur occasionally in all production processes. While preventative maintenance can help reduce these occurrences, they cannot stop them happening altogether. Changeovers associated with short production runs can also result in wasted packaging.
- Labelling changes resulting from regulations (just impacting on beef), voluntary agreements (for example in relation to country of origin), product differentiation, promotion and design. This leads to the use of incorrect labels which, when corrected, results in the packaging being discarded.
- Poor storage of packing materials.

There is considerable opportunity to reduce the weight of retail packs, both by using less material in existing packaging formats, and by switching to lighter vacuum skin packs. Because these skin packs change the colour of meat from reddish to brown, there has been consumer reluctance to accept such packs, and at least one trial with a major multiple retailer has failed. However the opportunity remains and needs to be backed up with consumer education, because these packs appear to have positive impacts on the eating quality of meat.

### *Water*

This research has shown that the industry uses about 12 million cubic metres (m<sup>3</sup>) of water per year. This estimate puts water usage higher than previous research from the Food Industry Sustainability Strategy (FISS). However, with the increase in the number of small cutting plants, the belief is that this still could be an underestimate. Water usage is high because of EU hygiene regulations, though opportunities exist to reduce water use through sub-metering and other activities, which are proven to be cost-effective. Perhaps the greater opportunity lies in reducing effluent charges (which are more significant) through better on-site treatment. Waste prevention reviews undertaken as part of this research project alone identified potential reductions in water use in excess of 80,000 m<sup>3</sup> per annum, delivering savings of £250,000.

### *Greenhouse gases*

Finally, the project has provided estimates of greenhouse gas emissions associated with slaughtering and processing, and the rendering of by-products. Some 454 kt CO<sub>2</sub>e per year are generated, of which 65% is from poultry processing, which is much more mechanised and automated than slaughtering and processing livestock. This is in contrast to the animal production stage, in which poultry emits less CO<sub>2</sub>e per unit weight than livestock. Rendering generates net emissions of 1310 kt CO<sub>2</sub>e per year, but also produces useful products. The uncertainties relating to the whole chain life cycle analysis and CO<sub>2</sub>e emissions from rendering are high (on-going research should soon reduce these), but the balance of actual emissions and the embedded emissions in useful products are roughly the same.

### **Causes of product waste**

Most abattoirs and cutting plants regard ABPR as the main cause of waste. However, any relaxation of these regulations in favour of feeding residual material to other livestock (avoiding intra-species recycling) or fish will not necessarily reduce the quantity of animal by-product generated, though it could extend the range of products produced by rendering, and thereby improve the economic value of this material. Abattoirs and cutting plants can only reduce the amount of animal by-products by harvesting more of the carcass for human or pet food consumption.

Although the quantities involved are significantly less than those sent for rendering, product waste also arises in abattoirs and cutting plants for a variety of operational reasons. These include poor process controls, for example line stops due to machine breakdown, floor waste, over-trimming and customer returns. Another specific issue that affects all species is animal contamination. Sometimes animals are presented to abattoirs in an unfit or diseased condition. The whole animal or parts of the animal will then have to be disposed of, in effect, as a Category 1 by-product. Operational issues also arise on packing lines, which, in general, are being run at less than optimal efficiency.

At the retail stage, waste arises for a variety of reasons including demand management, basic shop-keeping and supply chain operations. Most respondents saw the inter-play of promotions, forecasting and weather as the main cause of waste. More fresh meat has been sold on promotion over the last two years, and while promotions were seen to have positive benefits in terms of removing stock, they could also increase waste if the promotion was timed to coincide with an event that was weather dependent for its success, for example a bank holiday.

Store managers are measured on their sales performance, and will trade-off product availability against waste targets. In general, merchandising standards are high, and together with stock rotation, this is only a minor cause of waste. More significant are the refrigeration systems, some of which were old, and some (for example, because of their location) are put under pressure during hot spells. The consensus is that fresh meat waste increases during the summer.

The table below, provided by one of the major retailers, shows the wide range of potential quality issues that can arise in the fresh meat market, indicating that attention to detail has to be applied throughout the supply chain. No single item in the table on its own was identified as a major cause of waste.

Leaking packs Incorrect gas levels in packs Product not lasting its shelf-life Product stored in incorrect back up Product stored in incorrect display cabinet Refrigeration breakdown Cold doors left open	Refrigeration problems/missed defrosts/ inefficiencies Exposure to ultra violet light Temperature abuse prior to receipt into store High microbiological count Production issues
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## Recommendations

It is clear that the management of product and packaging waste and usage of water are significant economic and environmental issues for the fresh meat industry. Although there are some initiatives in place that will lead to better resource use, including, for example, the recently published road maps for beef, sheep (EBLEX) and pigs (BPEX), a great deal of scope remains to increase revenue. The following recommendations are not in order of significance. Taken together, they offer the fresh meat industry an opportunity to minimise all types of waste, reduce costs and benefit the environment.

### *Measurement*

It did not prove possible to obtain all the quantitative data to complete all of the objectives of this research. There are several reasons for this, of which commercial confidentiality is one. Measurement of waste is the first step towards more effective management. The meat supply chain should improve data on product and packaging waste throughout the supply chain, to provide key performance indicators against which to track progress and drive improvement.

Many of the larger multi-plant companies have started to centralise their waste data collection, but none provided evidence of using it actively to drive improvement. All meat processing companies should analyse in more detail their residual material from slaughter and cutting operations, and make use of the benchmark that has been developed in this report. Meat processors should introduce detailed data collection arrangements to measure their residual material, and use this data to make better use of all parts of the animal in line with the waste hierarchy.

Retailers do measure wastage, but it was not possible to get a breakdown of this waste by species or product. The data on waste required to meet Integrated Pollution Prevention and Control (IPPC) Regulations and the Courtauld Commitment have been aligned. However, more effort is required to make this information readily obtainable from retailer and supplier order management systems, and to ensure that it is more widely understood within the industry, using tonnes as a common metric.

### *Processes*

Although there are significant regulatory constraints, there are many ways in which improvements can be made to move residual material up the waste hierarchy. Each abattoir and cutting plant will need to decide how best this can be achieved depending on their location, throughput and business goals. Waste prevention can be achieved by preventing as much residual material being disposed of through the lowest value or negative value disposal routes. This could be realised if abattoirs recovered more edible product from the carcase.

Process improvements that reduce waste, for example, by using lean manufacturing principles, should be more widely applied. Their application across businesses we analysed was rare, yet they have proven commercial benefit. Although most suppliers and retailers have long established relationships, few are truly collaborative in the sense that they have developed dedicated supply chains. Retailers and suppliers should improve their communications along the supply chain through structured pilot programmes.

Individual meat processors could also work more closely with their suppliers to improve and incentivise input quality. Smaller companies in particular could collaborate more often, for example, to bulk up volumes of product suitable for the export trade or pet food supplies.

### *Responsibility deals*

Only one major meat processor has signed the Courtauld Commitment, and this falls short of WRAP's ambition to include the main category leaders. There needs to be a greater awareness of this agreement within the industry and the benefits that it can bring. The Federation House Commitment provides the basis for the development of a plan for water management within the fresh meat industry. Four major processors have signed this agreement; however, there is still scope to promote it more widely and to encourage companies to take up the support that is available to develop water reduction plans.

### *Packaging*

Landfill is still being used as the main route to dispose of packaging waste, primarily because of the prevalence of large quantities of plastic vacuum packs contaminated with blood. Currently a lot of packaging is used as an intermediate process to age the primals. Carcasses are deboned into primals, which are vacuum packed for several days, and then stored in cardboard boxes. These primals are then opened, the packaging discarded and the meat then cut, sliced or diced, and then retail packed. A solution needs to be found to address the problems of disposing of this packaging.

At the retail stage, there is further opportunity to 'light-weight' trays, film and labels, although a more significant opportunity exists in the use of vacuum skin packs, which offer both economic and environmental benefits. However, before these can be more widely adopted, consumer resistance needs to be overcome because their use changes the colour of meat to its more natural state. The evidence from discussions with Courtauld signatories who are using these packs suggests that they can also bring eating quality benefits for consumers. In addition, more general waste could be recycled if there was better separation at source.

#### *Water*

The Environment Agency indicates that water consumption and emissions to water are the most significant environmental impacts of meat processing. Managing water did not appear to be a high priority, and the research only identified five examples of plants where water sub-metering was being conducted. The evidence indicates that sub-metering is cost effective and it should be more widely adopted. More plants are dealing pro-actively with their effluent discharges, though a majority of plants have no on-site treatment.

Meat plants must comply with meat hygiene standards that necessitate the use of large quantities of potable water. Water is used for watering and washing livestock and the carcasses, and cleaning the lairage, process equipment, personnel and work areas. Containment of infectious diseases is also of paramount importance to the industry, and transport vehicles are washed upon site entry and exit. These standards mean that there is a limit on water reduction possibilities.

The Environment Agency is tightening up the specifications on effluent concentrations and what can be sent out as effluent. More abattoirs are being targeted and are being made to improve the "quality" of their effluent. These new controls can include both a volume and contaminant concentration target. However, savings can be generated if the wastewater is pre-treated. Many of the larger companies now fall within the IPPC regime, and are actively working to improve their status. However, when compared to other industries, there is a great deal more that could be done.

#### *Greenhouse gas emissions*

Most previous research has focussed on greenhouse gas emissions arising from livestock production, which tends to dominate the supply chain. Meat processing emissions quantified in this study came from energy and water use, as well as waste management. Chicken processing accounted for about 65% of all these emissions, because it is much more mechanised than for mammalian species. Processing emissions are all substantially lower than from primary production, but variation was large indicating that there is considerable scope for improvement. The contribution from retail waste is relatively small, although it should be noted that research by Brunel University (2008) has highlighted the large contribution of refrigerant leakage from retail displays and mobile refrigeration units, which have not been quantified in this study.

Our work suggests that the rendering industry is plausibly broadly greenhouse gas neutral, but further work is required to fully understand the carbon footprint of the industry. This depends considerably on the value of its useful outputs. Furthermore, rendering cannot be treated completely in isolation: the industry clearly interacts with the processing and retail sectors so that waste reduction there would affect rendering efficiency.

A number of suppliers indicated that they are taking steps to reduce their emissions because of pressure from their retail customers. Emission reduction strategies should be developed further to build on this progress. Given that much of this is linked to energy saving, it should be of double benefit.

#### **Concluding remarks**

This research has highlighted the extent to which meat products are wasted or lost in the UK's food supply chain. By identifying how, where and why the products are wasted, these resource maps have enabled the identification of where better management practices, in particular, can be used to develop more resource efficient strategies within the fresh meat sector. Based on the recommendations outlined in this report, the project team estimates that substantial financial savings can be realised throughout the meat supply chain, particularly through improved harvesting of residual material and increased participation in the renewables energy market.

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# Acronyms and Glossary

ABPR	Animal By-Products Regulations
AD	Anaerobic Digestion
AHDB	Agricultural and Horticulture Development Board
AIMS	Association of Independent Meat Suppliers
BAT	Best Available Techniques
BMPA	British Meat Processors Association
BPC	British Poultry Council
BPEX	British Pig Executive (part of the AHDB)
BSE	Bovine Spongiform Encephalopathy
CAP	Common Agricultural Policy
CCL	Climate Change Levy
EA	Environment Agency
EBLEX	English Beef and Lamb Executive (part of the AHDB)
ECR	Efficient Consumer Response
EU	European Union
FABRA	Food and Biomass Renewables Association
FSA	Food Standards Agency
GHG	Greenhouse Gas Emissions
HDPE	High Density Polyethylene
IGD	Institute of Grocery Distribution
IPPC	Integrated Pollution Prevention and Control
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MAP	Modified Atmosphere Packaging
MBM	Meat and Bone Meal
ONS	Office of National Statistics
PAP	Processed Animal Protein
PET	Polyethylene Terephthalate
PP	Polypropylene
PRN	Packaging Waste Recovery Note
QMS	Quality Meat Scotland
RPA	Rural Payments Agency
SRM	Specified Risk Material
TSE	Transmissible Spongiform Encephalopathy, also known as prion diseases, are a group of progressive conditions that affect the brain and nervous systems. BSE is an example of these diseases, as is Scrapie.
WID	Waste Incineration Directive
WRAP	Waste & Resources Action Programme

Animal by-products	Material from the animal not intended for human consumption and categorised into three groups, Categories 1, 2 and 3.
Edible co-products	Major organs from the animal not suitable for human consumption in their unprocessed state, e.g. stomach, bladder, intestine.
Evisceration	Organ removal after slaughter.
Fifth quarter	Parts of the carcass that are not lean meat, e.g. offal, hide.
Lairage	A place where livestock are kept temporarily
Meat	Meat as defined by the Meat Product Regulations, 2003.
Offal	Parts of the carcass including hooves, lungs, liver, kidneys, cheek meat, tendons, blood, soft bones.
Primal	A piece of meat initially separated from the carcass during butchering, often of the highest value, from which other cuts are made.
Residual material	Can include offal, edible co-products, animal by-products.

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## 1.0 Introduction

### 1.1 Background

Meat is a core product in our diet and lives, providing protein and nutrients for health. The supply of fresh meat in the UK has had to deal with many challenges over the recent past that continue, albeit in different forms, today. The 1980s and early 1990s were, in hindsight, characterised by relatively good economic times – increasing domestic and international demand and a production base that was highly subsidised.

In 1996 the outbreak of Bovine Spongiform Encephalopathy (BSE) resulted in an export ban, lost markets, changes in the roles of organisations within the meat supply chain, and the introduction of a raft of new regulation that still affects the industry today. Further disease outbreaks, including Foot and Mouth Disease, Pig Wasting Disease, TB, Avian Flu and the Blue Tongue Virus, have also impacted the industry adversely over the past decade.

From 2006, changes to the Common Agriculture Policy (CAP) resulted in cattle and sheep farmers losing headage subsidies. These were replaced by a Single Farm Payment that reduces over time, and shifts progressively from an amount based on the number of animals to one based on the number of hectares farmed. Many livestock and poultry farmers struggle for profitability. More recently all livestock and poultry farmers have been faced with increasing costs, particularly for feed and other inputs. The structure of the meat supply chain has rationalised, with fewer larger producers at all stages, a process that is on-going.

Today the meat and livestock industry is also caught in the climate change debate and has to deal with calls to improve its sustainability. This is not just a matter of greenhouse gas emissions, but also waste, water, energy, pollution and bio-diversity. There is also debate over the role of meat in our diets, and considerable research underway to identify the contribution of meat to a 'sustainable diet', with many calling for reductions in meat consumption.

At the same time many commentators expect the global population to reach 9bn by 2050, and with this some countries like China, for example, are experiencing a dietary transition towards increased meat consumption as people adopt a western diet. The availability of land for farming, water scarcity and the impact of greenhouse gas emissions all conspire to make food security and the supply of meat of increasing concern to policy makers.

Against this background, research has been conducted to establish the amount of fresh meat and packaging waste arising in the UK retail supply chain. Water usage has also been measured, as have the associated greenhouse gas emissions arising from waste. Research by WRAP has shown that households waste around 570,000 tonnes of meat every year, of which 260,000 tonnes (46%) is avoidable, raising concerns about the economic and environmental impacts.

The report is structured as follows. This chapter examines consumption trends and how the industry is currently structured to deliver value to consumers. Chapter 2 outlines the methodology that underpins this research, which then paves the way for subsequent chapters to present a series of 'resource maps' that are the main focus of this research. These maps show the amount of waste product arising from the consumption of fresh meat, and how fresh meat is utilised, including the associated packaging, water use and greenhouse gas emissions. Finally, in Chapter 6 a series of recommendations are made to improve resource efficiency.

### 1.2 Aims and objectives

The project's overall aim was to provide both a quantitative and qualitative analysis of fresh meat waste and associated packaging waste in the UK retail and wholesale supply chain. The specific objectives were:

- to develop a methodology to quantify the amount of fresh meat waste in the retail and wholesale supply chain;
- to quantify the waste arisings in terms of tonnage, economic value and carbon equivalents (and for product to identify avoidable and unavoidable waste);
- to quantify the amount of water used by the meat industry;
- to identify the waste (product, packaging and water) profiles of chicken, beef, lamb and pork production;

- to identify waste profiles in terms of primary, secondary and tertiary packaging, and by material;
- to identify how product loss and waste is managed along the supply chain, and where it ends up;
- to consider potential impacts on reducing household food and packaging waste;
- to provide an indication of waste levels by country, using actual data sets as well as market share and/or population data;
- to develop anonymised benchmarking reports for participating companies, so they can see how their business performs in relation to others; and
- to identify good practice that will lead to improved resource efficiency in the meat industry.

### 1.3 Consumption trends

According to the Office of National Statistics (ONS), meat represents the largest single category of food expenditure for consumers in the UK, with over £16bn spent in 2008.

In the UK in 2008, poultry represented about 36% of the total volume of meat consumed, pig meat 30%, beef 25% and lamb 9%. Consumers have shown a preference for poultry (white meat), which has captured an increasing proportion of the market at the expense of beef and lamb (red meat). According to Kantar in 2008 as a proportion of all protein sold, chicken accounted for 21% by value, pork 29%, beef 20% and lamb 5% (with fish, vegetarian protein and other items accounting for the remainder).

Considering each animal individually, less than 18% of meat (volume) derived from pigs was purchased as fresh (or frozen) cuts, with the rest being in the form of bacon, hams and sausages as well as ready meals, pies, and canned products, for example. For beef the equivalent proportion is 45% as fresh meat, for chicken 59% as fresh meat and lamb 69% as fresh meat, with the remainder, as with pig meat, being eaten in various other forms. These 'other' forms of meat, for example ready meals and tinned products, are not covered by this project, which has a focus on fresh meat products only. WRAP has commissioned research into pre-prepared foods, to be published separately.

The proportion of fresh meat sold through the multiple retailers has increased over the years, such that now about 95% of chicken is sold through the multiples, 90% of pig meat and beef, falling to about 87% for lamb. Traditional butchers have declined in importance from around 20%-25% of the market 20 years ago, to, in 2010, around 3% for chicken rising to around 9% for beef, lamb and pork respectively. Other retail outlets, for example farm shops and market stalls, have less than 1% of the market and are not included in this report.

The table below breaks down further the types of fresh meat, and shows in rank order of importance the main products by volume sold through the multiple retailers.

**Table 1:** Meat products in 2009 (Market importance, ranked by tonnes sold)

<b>Chicken</b>		<b>Beef</b>		<b>Pork</b>		<b>Lamb</b>	
Whole birds	1	Mince	1	Sausages	1	Legs	1
Breasts	2	Burgers	2	Cooked	2	Shoulders	2
Legs	3	Roasting	3	Bacon	3	Chops	3
		Frying	4	Steaks	4	Steaks	4
		Stewing	5	Chops	5	Mince	5

Source: Kantar Worldpanel

Three chicken products account for 89% of the market, five beef products account for 85% of the market, five pork products account for 75% of the market, and five lamb products account for 87% of the market. These 18 products comprise the main fresh meat items across four animal species, and also four (namely burgers, sausages, ham and bacon), which require some additional processing. Our research has focused on these products.

Over the long term the consumption of beef has been in decline, though since 2000 there has been a slight increase (as the beef market recovered from the fall in consumer confidence caused by the BSE crisis in the 1990s). Lamb consumption has declined over the long term, while the consumption of poultry has increased and only very recently has poultry consumption started to decline. Pork consumption has remained broadly constant though bacon consumption has been falling. A snapshot of the current position on household consumption of fresh chilled meat is shown in Table 2 below from the Family Food Survey.

**Table 2:** Household consumption trends

<b>Meat</b>	<b>2007 (grams per person per week)</b>	<b>2008 (grams per person per week)</b>	<b>%</b>
Poultry (cooked and uncooked)	251	250	-0.3
Carcase beef and veal	235	211	-10.3
Bacon and Ham	109	108	-0.7
Carcase mutton and lamb	55	45	-11.9
Carcase pork	54	55	+2.1

Source: Defra – Family Food Survey (2008)

Poultry, followed by beef and bacon (ham), are the most significant fresh meat products in household diets, although, as explained earlier, a great deal of pig meat is eaten in a processed form.

Recent research by the AHDB for 2009, covering home and out-of-home consumption and all types of meat, confirms these trends. Beef and lamb have recorded the greatest declines (7% and 11% respectively from 2007 compared with 2009) while pig-meat and poultry fell by 2% over the same period.

These recent declines in consumption are probably caused by increasing meat prices, the economic recession, as well as changing preferences for other proteins, for example fish. It is likely the recession has caused consumers to switch between different types of meat in favour of poultry, to switch within a given type of meat to cheaper cuts and from fresh to frozen, and to reduce consumption overall. However, certain cuts of meat may have benefited from more 'cooking from scratch'. The recession could leave a lasting legacy on meat consumption if households continue to cook from scratch, though switching to lower quality tiers may be temporary. Welfare and provenance are likely to continue to influence purchasing habits.

During the course of any year there will be fluctuations in retail sales driven by the seasons. For example, over the summer sales of steaks, burgers and sausages will increase, particularly if the weather is good, while in the winter there will be increased sales of whole birds and roasting joints.

There is growing pressure on consumers to reduce their meat consumption for a variety of reasons, for example, from dietary advice to calls to reduce greenhouse gas emissions. There has also been a significant amount of media pressure encouraging "meat free Mondays" and vegetarianism, which has been steadily increasing. Ideas for change range from reformulating composite meals to changing portion sizes. It appears that there may be a proportion (12%) of consumers who would be willing to reduce their meat consumption, in response to concerns over the impact of meat animals on the earth's climate. Research carried out by AHDB on behalf of EBLEX and BPEX (most recently in January 2011) showed that:

- climate change has not influenced the majority in the way they buy their food;
- only 12 % of consumers would reduce red meat consumption if it meant cutting GHG emissions (however 'undecided' represented approximately a quarter of all those questioned);
- more than 30% of consumers are not concerned about GHG emissions from animals;
- more than 50% do not want to see more imports of red meat, even if that meant cutting carbon emissions; and
- fewer than half those questioned believed agriculture should invest in cutting its emissions.

While there are many uncertainties, it is possible that fresh meat consumption in the UK will continue to gradually decline to lower levels, with knock-on consequences for other parts of the supply chain.

### 1.3.1 Packaging

Although a number of the multiple retailers have meat counters, the majority of fresh meat (in excess of 95%) is sold pre-packed. Even counter meat is packed, often in heat sealed foil, for transporting to the home. Marks and Spencer led the way in the early 1990s by introducing pre-packed fresh meat in non-leaking sealed trays. It was not until the mid-1990s that Tesco adopted centralised packaging for all its stores. This is now normal for all the major retailers other than Morrisons, who, for their own label meat products act in the same way as a traditional butcher, with cutting and packaging in store.

Pre-packed meat is found in a variety of packaging depending on product and individual retailer. The main packaging is typically a tray, which is overwrapped with film that allows oxygen to pass through, though these have largely been replaced with modified atmosphere packs that contain a variety of gases designed to enhance shelf life. According to one estimate from a major packaging supplier, about 70% of the market is supplied in modified atmosphere packs.

The main types of packaging are as follows:

- Polypropylene (PP) trays are widely used for poultry products like breasts and legs, which are currently not recycled, although some are now available with recycled HDPE content.
- Expanded foam polystyrene (EPS), which are lighter than PP trays, but also cannot easily be recycled.
- PET trays are used widely for pork and poultry products, and can include a significant proportion of post-consumer recycled content (rPET).
- Vacuum packs which seal joints or cuts of meat into plastic bags, from which air has been excluded.
- Skin packs which are secure packs that follow the natural shape of the product.
- Treated card typically used for a range of processed products.

Examples of packaged meat are provided in Figure 1.

**Figure 1:** Examples of packaged meat



## 1.4 Meat production

After recovering from the problems caused by BSE and Foot and Mouth disease, the numbers of cattle slaughtered has recently started to fall. Sheep slaughtering has fallen since CAP reform in 2005. Poultry slaughtering has fallen since its high point of 2005. Only the number of pigs slaughtered has increased in recent years (and by less than 1%) after falling by over 40% from its peak of 16m in 1998.

There is a small trade in live animals, but in practice the majority of animals slaughtered will have been born and reared here. However, the UK is a net importer of meat of all types, with product coming from all corners of the world. The most significant trade is with other EU countries. Today multiple retailers have a preference for sourcing their fresh meat from the UK, but there is still a large and increasing volume of imports.

Table 3 below shows that chicken represents the highest number of animals slaughtered in the UK, followed by sheep, pigs and cattle. The table also shows an average live-weight for each of the four species.

**Table 3:** Animals slaughtered in UK 2008

Animal	Number slaughtered (millions)	Live weight per animal (kg)	Total weight (million tonnes)	% Total weight
Chicken	831	2.19	1.75	33
Cattle	2.67	616	1.64	31
Pigs	8.99	103	0.93	18
Sheep	16.99	42	0.71	14
Other: (Duck, Turkey, etc.)	30		0.2	4
<b>TOTAL</b>			<b>5.23</b>	<b>100</b>

Source: Defra/AHDB

About 5.2M tonnes are slaughtered every year, from which meat and what we have termed other residual products are obtained. In this study we are only concerned with the first four species, which in total account for 5.0M tonnes.

In terms of the total weight, slaughtered chicken comprises about 33%, and together with cattle, pigs and sheep, the four species account for 96% of the total kill. In recent years the total weight slaughtered has been relatively unchanged, as live-weights have tended to increase, offsetting the decline in the number of animals being slaughtered. Because of the small volumes involved, duck, turkey and other species (for example, deer and boar) are not considered in this report.

Around 59% of cattle are slaughtered in England, 20% in Scotland and 16% in NI. For sheep, around 60% are slaughtered in England, 28% in Wales and 8% in Scotland. For pigs, 79% are slaughtered in England and 14% in NI. Because the statistics on poultry slaughtering are not broken down by country we cannot be precise, but a large majority of chicken are slaughtered in England. Table 4 below shows the detailed breakdown.

**Table 4:** Animals slaughtered in UK 2008

Animal	Total UK	England	Wales	Scotland	NI
	millions	% rounded			
Cattle	2.67	59	5	20	16
Sheep	16.99	60	28	8	4
Pigs	8.99	79	<1	7	14
Chickens	831				

Source: UK Agriculture Departments

### 1.4.1 Production tracking

In theory, and in line with 'mass balance' principles, it should be possible to 'track' how the 5.0M tonnes of slaughtered animals of the four species are utilised each year, and what happens to each part of the animal. In practice, it has been very challenging to achieve this accurately. These animals will be used for all types of meat product, bought by all types of customers through different market channels, of which only fresh meat through

the retail channel is considered here. Furthermore, many abattoirs do not assign any meat derived from these animals to particular markets or customers. This is not done until meat is cut to customer requirements.

Some domestic production is exported, and the UK also imports a large amount of meat. Some meat will come into the country as carcasses, some in the form of primal cuts, some will be de-boned and some will be finished product. Likewise meat exports will take a variety of forms. This trade in meat will add to the weight of meat handled in the country (because we are a net importer) and it will add to the packaging that has to be disposed of.

Defra statistics can be used to estimate our self-sufficiency in meat. Home-fed production as a percentage of total supply for use in the UK accounted for 82% of beef and veal, 52% of pig meat, 92% of poultry and 88% of sheep meat.

Table 5 below shows imports to and exports from the UK. For the four species together, the UK imports a net one million tonnes.

**Table 5:** Meat Trade data (product weight in 000 tonnes) 2008

	Imports (000 tonnes product weight)			Exports (000 tonnes product weight)		
	Bone in	Boneless	Total	Bone in	Boneless	Total
Beef and veal	45.0	202.6	247.6	45.3	36.0	81.3
Mutton and lamb	Carcases 7.4	Boneless cuts 30.4	111.7	Carcases 74.2	Boneless cuts 12.6	86.8
	Bone-in cuts 73.9					
Fresh/frozen pork	Carcases 29.3	Boneless cuts 158.4	393.0	Carcases 38.6	Boneless cuts 82.7	121.3
	Bone-in cuts 205.3					
Chicken	Whole birds 52.8	Boneless cuts 164.5	293.7	Whole birds 6.5	Boneless cuts 41.3	230.9
	Bone-in cuts 76.4			Bone-in cuts 183.1		

Source: UK Trade Statistics

Apart from sheep, where significant quantities are imported from New Zealand, EU countries are the main destination and origin for the UK meat products.

#### 1.4.2 A breakdown of the animal

The meat products that we consume are 'disassembled' from whole animals or from parts of animals, leaving a considerable quantity of residual material. Figure 2 shows the types of product that are derived from slaughtered animals.

**Figure 2:** Animal products from slaughtered livestock

Animal products from livestock slaughtered for food production				
Edible Products ("meat")	Edible Co-Products	Animal By-Products		
Examples	Examples	Examples		
<ul style="list-style-type: none"> <li>wholesale and retail meat</li> <li>carcase material used for meat recovery (e.g. MSM)</li> <li>blood, livers and kidneys used to make edible products</li> </ul>	<ul style="list-style-type: none"> <li>raw fatty tissues used for edible fat and greaves ("rendered animal fats and greaves")</li> <li>raw fit bones and hide splits for edible gelatine and collagen</li> <li>intestines used for edible casings</li> </ul>	<p>Category 3</p> <ul style="list-style-type: none"> <li>parts of animals slaughtered and found fit, but not intended, for human consumption</li> </ul>	<p>Category 2</p> <ul style="list-style-type: none"> <li>dead on arrivals</li> <li>post mortem failures</li> <li>soiled or contain medicine residues</li> </ul>	<p>Category 1</p> <ul style="list-style-type: none"> <li>TSE positives</li> <li>SRM</li> </ul>

Source: Food Standards Agency

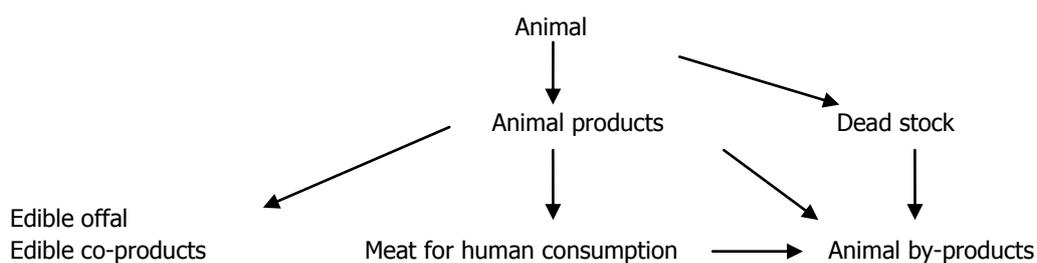
Regulation in this area is extremely complicated, and is largely covered by the EU Animal By-Product Regulation (ABPR), which should be read in conjunction with the Transmissible Spongiform Encephalopathy (TSE) Regulations.

The ABPR defines by-products not intended for human consumption, and specifies how they may be disposed of. Animal by-products cannot be sent directly to landfill (though some derogations exist for plants in remote locations). In practice the majority is rendered, with certain types of material able to go direct for pet food or energy recovery (and composting).

A new ABPR has been agreed by the EU and came into force on March 4<sup>th</sup>, 2011, introducing a more risk-proportionate approach to controls on animal by-products and clarifying the regulations, including their interaction with other EU legislation.

The following approach has been used in this report in order to accommodate the various EU regulations which impact this area. In simple terms, an animal is butchered to produce meat and other products, some of which can be consumed, but in the main have to be disposed of in line with legal requirements. We have made a simple distinction between meat and the rest of the animal, which has been termed residual material.

**Figure 3: Animal Products**



**Table 6: Definitions**

Term	Definition
Animal	Live animal – all species
Dead Stock	A dead animal either on farm or in transit to a slaughterhouse
Meat	All edible parts of the animal
Offal	Meat other than that of the carcass including viscera and blood
Residual material	Offal, Edible co-products, Animal by-products
Edible co-products	Major organs not suitable for human consumption in their unprocessed state
Animal by-products	Material from the animal not intended for human consumption and categorised into 3 groups, Categories 1, 2 and 3.

Following slaughter, skeletal meat is cut into primals and subsequently into the fresh meat products that appear on retail shelves. Both slaughter and cutting produce residual material that is either sold or disposed of as an animal by-product. There are three types of animal by-product:

- Category 1 (very high risk) includes specified risk material like brain and spinal cord;
- Category 2 (high risk) includes diseased animals, manure and digestive tract content and material from wastewater treatment; and
- Category 3 (low risk) is material that is fit, but not intended, for human consumption.

Some parts of the animal other than carcass meat can also be used for human consumption. These products, for example edible offal (e.g. liver and kidneys) and edible co-products (e.g. tripe, sweetbreads), may be harvested, sold for pet food or rendered as animal by-product.

Table 7 below shows permitted disposal routes for animal by-products.

**Table 7:** Acceptable routes for the disposal of Animal By-Products

		Rendering	Incineration or Co-incineration	Pet food	Compost or biogas	Landfill
ABP Category	1	Yes	Yes	No	No	No/yes (a)
	2	Yes *	Yes	No/yes (c)	No/yes (b)	No/yes (b)
	3	Yes **	Yes	Yes	Yes	No/yes (b)

Note: All processing options refer to the processing of raw material

(a)- *Pre-processing is required: Pressure rendering process 133<sup>o</sup> C, 3 bar pressure, 20 mins, then the material can be disposed of to landfill.*

(b)- *Pre-processing is required: Pressure rendering process 133<sup>o</sup> C, 3 bar pressure, 20 mins, then the material can be disposed of to landfill or treated in a biogas or composting plant.*

(c)- *that derived from fallen stock can be fed to animals not destined for human consumption. e.g. zoo animals, hounds, fur farms, maggot farms, etc.*

\* Rendered fats, use in oleochemical plant to produce tallow derivatives for technical use only.

\*\* Rendered fats, use in oleochemical plant to produce tallow derivatives.

A major part of the residual material is rendered (see below for a more detailed explanation). The rendering industry regards these residual materials, which include fish as well as all types of meat, as raw material for the production of a range of marketable products. The rendering industry also supports livestock farmers in the disposal of 'fallen stock' (animals that die from injury or disease) and, increasingly, are working with the multiple retailers and households in the management of their food waste that is being diverted from landfill.

Other parts of the animals that are not commonly rendered, such as hide and skin, are processed into products that also find markets either in the UK or abroad.

Starting with the whole carcase and adopting a typical specification, approximately 75% of a pig (not carcasses processed for bacon where the proportion is lower), 69% of a cow and 80% of a sheep ends up as meat products that can be consumed. For chicken the equivalent proportion is 62%, though about half of all birds are sold as whole carcasses. These parts of the animals also contain bones, fat, and trim for example, and the on-going disassembly and cutting into recognisable cuts of meat results in further residual material that comes within the scope of EU Regulations.

### 1.4.3 Pollution inventory

In 1996 the EU adopted a set of common rules for permitting and controlling industrial installations in the Integrated Pollution Prevention and Control (IPPC) Directive. IPPC is a regulatory system that employs an integrated approach to controlling the environmental impact to air, land and water arising from industrial activities. In order to gain an IPPC permit, operators of industrial sites must show they have systematically developed proposals to apply the Best Available Techniques (BAT) to pollution prevention and control.

IPPC applies to specified installations, including both existing and new builds, requiring each operator to obtain a permit from the appropriate regulator, which are the Environment Agency (EA) in England and Wales and the Scottish Environmental Protection Agency (SEPA) in Scotland. The Food and Drink industry is regulated under IPPC and all companies operating in this sector (above the specified thresholds) were required to have obtained their permit by 31 September 2005.

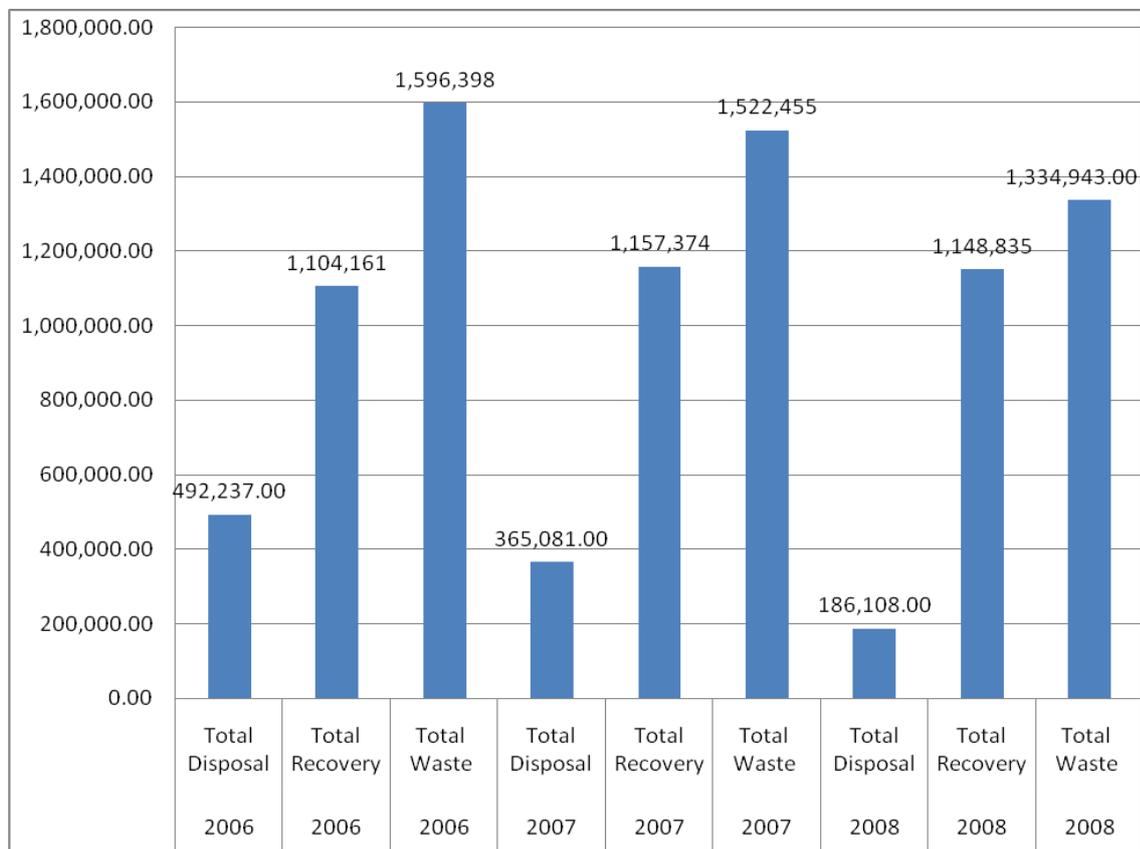
### 1.4.4 IPPC returns

The meat processing industry covering red (cattle, sheep and pigs) and white (chicken) meat has been subject to the provisions of IPPC for over three years. IPPC applies to those:

- slaughterhouses with a carcase production capacity greater than 50 tonnes per day;
- installations for the disposal or recycling of animal carcasses and animal waste (other than by rendering or incineration) with a treatment capacity exceeding 10 tonnes per day;
- treating and processing materials intended for the production of food products from animal raw materials (other than milk) at a capacity of greater than 75 tonnes per day; and
- disposal or recycling of animal carcasses or animal waste by rendering at a plant with a capacity of greater than 10 tonnes per day.

Under these arrangements the EA regulates some 74 sites (belonging to a smaller number of companies). The project team analysed the EA pollution inventory database for these 74 sites, and the results are shown in Figure 4 below.

**Figure 4:** Pollution inventory (tonnes)



The data indicate:

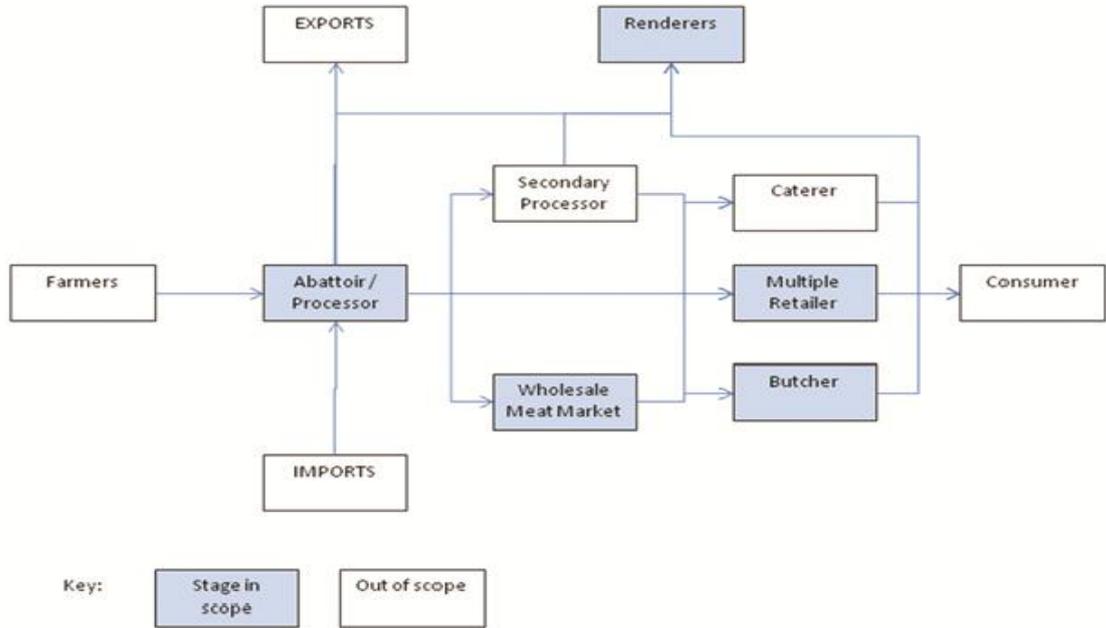
- In 2008 the majority of waste, some 86%, was recovered, compared with 14% which was disposed of to landfill.
- The total amount of waste arisings (waste that was either disposed of or recovered) during the three year period 2006-2008 progressively decreased by 16% over the period.
- The amount of waste that was recovered during the three-year period increased by 4%, while the amount of waste disposed of reduced by 62%.

The single most important recovery operation involves land spreading of sludges, liquids and solid wastes for agricultural benefit, followed by composting and using the waste material as a fuel to generate energy. The most important disposal operation is incineration in a dedicated facility, but the volumes involved are less than the three most significant recovery operations. Some 159,600 kgs (160 tonnes) or 0.85% of the total waste disposed of in 2008 was landfilled.

### 1.5 Industry structure

There is a complex supply chain that delivers meat products to the retail customer. An overview is shown in the diagram below. Each stage in the supply chain is then reviewed.

**Figure 5:** Fresh meat supply chain



#### 1.5.1 Farming

Although livestock farming is not included within the scope of this study, it does have a considerable impact on the resources considered in this report.

There are literally hundreds of native cattle, sheep and pig breeds in this country, though only a handful of each matter commercially. Around one-half of all beef originates from the dairy herd. Farmers aim to provide abattoirs with animals of a given weight and conformation, though in practice there are considerable variations due to natural as well as management factors. These variations will cause processing issues for abattoirs, and may have a significant impact on their efficiency and the amount of by-products that are produced from their cutting operations.

In June 2010 the Scottish Government launched a project to examine what could be done to reduce the volume of cattle not meeting specification, because they are larger or fatter than necessary when they arrive at abattoirs. Another issue is that farmers can feed animals right up to the hour before they are brought to the abattoir. This means that the abattoir has to get rid of excess stomach contents and lairage material.

Agriculture is directly responsible for about 7% of total UK greenhouse gas emissions, which can be broken down as follows:

- 3.5% is due to nitrous oxide from the nitrogen cycle in soils including fertilisers, excretion by grazing animals, manure management and incorporation of crop residues;
- 2.8% is due to methane from enteric fermentation in livestock and stored manures; and
- 0.7% is carbon dioxide from direct energy use in farming.

Under the Government's 'Low Carbon Transition Plan', English farmers have been set a target to reduce emissions by at least 6% by 2020. Work conducted on the environmental burdens and resource use in the production of agricultural commodities suggests that poultry production is the most environmentally efficient, followed by pig, sheep and beef.

### 1.5.2 *Abattoirs*

Traditionally abattoirs were located near to centres of population. But today it is cheaper to transport meat than livestock, so many of the larger abattoirs and processing plants built more recently are in rural areas.

In 2010 the Food Standards Agency licensed 283 abattoirs in the UK to deal with red meat, of which 211 were in England. In addition there were 100 in the UK dealing with white meat, of which 82 were in England. Abattoir numbers have approximately halved over the past ten years.

Based on 2008-09 Agriculture and Horticulture Development Board (AHDB) data:

- For cattle, eight companies operating 23 plants in GB account for 56.3% of the total kill. These companies are the main suppliers to the multiple retailers, the large foodservice suppliers and most are also exporting. There is a second group of nine companies which account for 16.5% of total kill that are also significant suppliers to the retail market.
- For sheep, seven companies operating 17 plants in GB account for 42.6% of the total kill. These companies are the main suppliers to the multiple retailers, the large foodservice suppliers and most are also exporting. There is also a second group of 10 companies, which account for 28.5% of the kill who are significant suppliers to the retail market.
- For pigs, four companies operating 112 plants in GB account for 72.4% of the total kill. These companies are the main suppliers to the retail market.

Many of the large plants specialise in killing one or two of the four species. There is currently only one company killing all four animals considered in this report. Many of the small and medium-sized abattoirs are multi-species red meat plants. There are five large chicken companies, which slaughter over 1M birds per week.

Abattoirs slaughter livestock and, apart from chicken, most cut the carcass into quarters. Further cutting into primals, de-boning and preparation into cuts of meat supplied to customers requires a separate cutting licence.

### 1.5.3 *Cutting plants*

Following the 2006 re-licensing conducted by the FSA, many companies that were previously operating as catering butchers under local authority control were re-defined as cutting plants, and today the number of licensed cutting plants is 817 for red meat and 570 for white meat. A very large proportion of these deal with small volumes of meat, but for the sector as a whole there is no information available on total meat usage.

Some abattoirs hold cutting plant licenses, although many cutting plants are not linked to abattoirs. Cutting plants are sometimes co-located with abattoirs, but in the majority of cases they are in separate locations. Only eleven cutting plants cut more than 1,000 tonnes per week, while 150 cut less than 2 tonnes.

Many of the companies with licensed cutting plants are also licensed to produce mince (for sale or to make products), meat preparations (burgers, sausages, breaded and coated products for example), and for meat processing (ready meals for example).

### 1.5.4 *Food processors*

Food processors that use meat require approval by the local authority (also responsible for enforcement through environmental health officers in whose area the operation is located). Many processors will use combinations of raw product to make specific products, for example, sausages. These companies will obtain meat for processing (usually minced and diced product) from a variety of sources. Nationally this sector uses a great deal of imported product, particularly those processing beef and pig-meat. No information is available on meat usage.

### 1.5.5 Wholesalers

Today most of the remaining meat wholesale markets, like Smithfield in London, primarily serve the foodservice sector and are outside the scope of this project. More generally, there is a complex network of companies wholesaling meat and meat products to both processors and final customers (retailers and foodservice companies). This does not include national companies like Booker and 3663, who provide a service across all grocery products. There are no UK statistics on how many meat wholesale companies currently trade.

The majority of abattoirs, abattoir/cutting plants and stand-alone cutting plants will wholesale meat in their own right. One role of this activity is to sell the parts of the meat that their main customers do not want, and to top up on additional requirements if they are short.

Some wholesalers are specialists in areas such as organic meat, some are importers (and exporters) and, to an extent, all are 'traders', servicing the needs of many companies in the processing sector as well as the independent butcher. Some of these businesses are accredited to supply the major multiples but do not do so directly; instead they provide product to one or more of the larger companies who then pack for their retail customers.

### 1.5.6 Retailers

According to IGD, the grocery market was worth £146.3bn for the calendar year 2009. Major multiples (with a turnover greater than £1bn) dominate the market, particularly the 'big five' – Tesco, Sainsbury's, Asda, Morrisons, and the Co-op, which together account for 84% of grocery sales.

A spectrum of retail formats exists, ranging from hypermarkets to convenience stores, and forecourts to home delivery. These are intended to serve different customer segments and tend to stock different product ranges, but all include fresh meat and a variety of meat products.

Table 8 below presents household purchases of fresh and frozen meat by volume for GB in 2008 by main retail outlets. Although the relative importance of different market channels in NI will vary compared to GB, across the UK as a whole the multiple retailers dominate the market.

**Table 8:** Retail channels, GB 2008

	<i>Beef</i>	<i>Mutton and lamb</i>	<i>Pork</i>	<i>Bacon</i>	<i>Poultry</i>
<b>Multiple retailers*</b>	83.7	79.0	83.7	84.6	84.9
<b>Butchers</b>	10.1	12.7	9.7	5.4	4.4
<b>Freezer centres</b>	2.6	4.9	3.5	3.8	5.3
<b>Independent grocers</b>	0.2	0.4	0.2	0.9	0.4
<b>Other local retail outlets</b>	3.4	3.1	2.9	5.2	5.0
	100.0	100.0	100.0	100.0	100.0

\* Multiples include Tesco, Asda, Sainsbury, Morrisons, the Co-op, Waitrose, Budgens, Lidl, Netto, Aldi, M&S plus other smaller regional supermarkets.

Source: Kantar Worldpanel

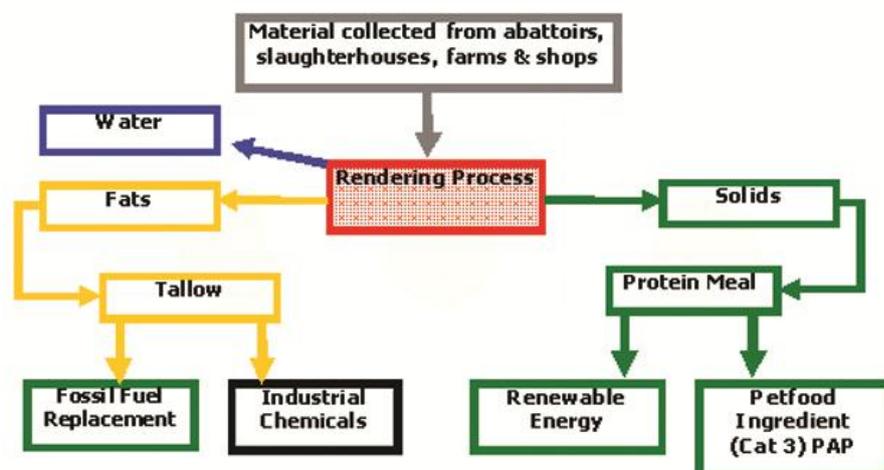
The AHDB estimates that there are about 6,800 operators trading as independent butchers in GB (we have no separate estimates for NI). Their numbers have declined significantly over the recent past, although there has been a recent revival in, for example, farmers' markets and farm shops. Although their share of the market is very small, they serve a growing consumer interest in meat products differentiated by, for example, provenance and production system.

### 1.5.7 Rendering industry

Rendering uses the residual material, including bone, fat and feathers, that is produced when animals are slaughtered, cut and prepared to produce purified fat and protein products. This residual material is cooked at high temperatures to remove moisture, kill bacteria and separate out the fat and protein.

Figure 6 below shows the simplified rendering process.

**Figure 6:** Simplified rendering process diagram



Source: Foodchain & Biomass Renewables Association (FABRA)

The number of rendering companies has declined substantially over the last 30 years, and today the sector is in effect an oligopoly of four main companies. They benefited from a significant investment in capacity by Government, who used the rendering industry to dispose of carcasses infected with BSE and during the foot and mouth disease (FMD) outbreaks. Today, with a decline in the animal kill, the sector is increasingly looking to diversify and the leading companies are starting to deal with food waste arising from retailers and households.

Rendering plants are located in England, Scotland and NI, and can now only accommodate waste in Categories 1 and 3 (all Category 2 waste is therefore treated as if it were Category 1). In Great Britain, two red meat companies and one poultry company have their own rendering facility. The Scottish Government has recently provided funds to retain what are expected to be largely dormant rendering facilities for future emergencies, which would otherwise have been closed.

The Foodchain & Biomass Renewables Association (FABRA) estimates that about 2m tonnes of material are rendered each year.

Renderers either charge for their operations or make a payment, depending on market conditions and the type and quantity of material collected. Prices vary, but between 2007 and 2009 charges, in general, have fallen, while payments for a limited amount of material have increased. In April 2010 the 'Meat Trade Journal' reported rendering charges of £31 per tonne for Category 1 material (with a range from £9 to £54), but payment of between £5 and £165 per tonne for best red meat fat, and £126 per tonne for chicken carcasses, for collections in excess of 50 tonnes. For smaller collections the charges were higher and the payments lower.

Until 2009, typical charges for Category 1 material would have been around £80 per tonne. The significant reduction in charges (and increase in payments) is a result of over-capacity in the industry. This in turn has caused more competition to secure a declining amount of animal by-products, due to lower livestock numbers and better markets for some residual products, which are being sold rather than rendered.

Rendering produces meat and bone meal and fats which are used for fuel, pet food, oleochemicals, fertilisers and cement in varying proportions. Although the rendering industry produced small amounts of material (largely ash), which in the past had been disposed to landfill, this practice has now been phased out with the ash going for cement manufacture.

The rendering industry has had an important role in aiding governments across the UK to deal with animal disease outbreaks, control strategies, and the safe disposal of affected livestock. As a process, it is difficult to switch off a rendering facility, or to run it at a reduced volume, or keep it mothballed and expect it to be ready for use should another animal disease outbreak occur.

### 1.5.8 Other support services

The other main groups of disposal agent are:

- Farm sites with low capacity incinerators (the term 'low-capacity incineration plant' refers to an incineration plant with a throughput of less than 50 kg of animal by-products per hour that does not have to comply with the full strictures of the EU Waste Incineration Directive). Today it is increasingly common for large poultry production units to have such facilities, and to use them to dispose of waste from others, site permitting. Such incinerators are suitable for small carcasses but not whole cattle.
- Hunt kennels with low capacity incinerators and/or collection centres (see below) that assemble material for transshipping (to renderers), and also recover some parts (for example non-contaminated flesh and offal) for feeding to hounds.
- Pet animal, veterinary facilities and pet crematoriums with incinerators – low capacity (unless stated as high capacity) and /or intermediate plants (that collect material for transshipping), some will also handle material from farms.
- Collection centres and intermediate plants and despatch agents (with or without incinerators). This covers many of those previously referred to as 'knacker' companies, that assemble material for transshipping (to renderers), and also recover some parts (for example non-contaminated flesh and offal) for feeding to hounds or zoo animals.

## 1.6 Households

WRAP has examined in detail the amount of household food waste. Table 9 below shows the amount of meat waste by different product types (beef cannot be reported separately because the confidence intervals of the sample are too broad for the data to be valid, and is shown together with other fish waste in the 'all other' category).

**Table 9:** Household meat waste in the UK

Food Type	Weight (tonnes per annum)				Avoidable waste value per annum)
	Total	Unavoidable	Possibly unavoidable	Avoidable	
Poultry	300,000	190,000	33,000	81,000	£350M
Pork/ham/bacon	120,000	5,000	20,000	93,000	£440M
Lamb	32,000	20,000	4,000	8,000	£51M
All other meat (and fish)	120,000	17,000	24,000	79,000	£500M
Total	570,000	230,000	81,000	260,000	£1,300M

Source: WRAP, Household Food and Drink Waste in the UK, 2009

According to WRAP<sup>1</sup>, the proportion of each type of meat that is unavoidable is a reflection of the amount of carcase meat sold. For poultry and lamb, a large fraction of the meat entering the home is carcase meat, which contains a substantial amount of inedible (or unavoidable) material. This accounts for the relatively high proportion of inedible waste for poultry and lamb – around two-thirds of the total waste. In contrast, much of the pork entering the home is in the form of non-carcase products – bacon, sausages, and ham. The inedible material associated with these does not enter the household, and hence the proportion of pork waste that is unavoidable waste is much lower (<5%).

Of the 260,000 tonnes of avoidable meat and fish waste generated annually, the majority is disposed of because it was not used in time. Information from the Kitchen Diary research indicates that the vast majority of this waste is associated with households adhering to date labelling, that is, not using or freezing fresh meats and fish before the end of the use-by date. Only a very small amount of waste was associated with food that looked, smelt or tasted bad.

To help reduce household food waste, WRAP's 'Love Food Hate Waste' campaign and its partners have been providing storage and freezing guidance, as well as ideas for using leftovers. Developing portioned packs or different pack sizes are other strategies that are being tested to address household meat waste.

A number of local authorities are also trialling food waste collection services.

## 1.7 Policy Context

The new Government is carrying out a full review of waste policy in England, looking at the most effective ways of reducing waste, maximising the money to be made from waste and recycling, and how waste policies affect local communities and individual households. The results of the review are due out in early summer 2011.

The review will include:

- the effect of waste policies on local communities and individual households, and how local authorities can best work with people to make the best decisions;
- maximising the contribution of the waste and recycling industries to the UK economically and environmentally;
- how we work towards the "zero waste economy", and drastically reduce the amount of waste created and valuable resources sent to landfill, looking at the entire process from source to end of life; and
- new approaches to dealing with commercial waste and promoting 'responsibility deals', reducing the amount of waste generated by production and retail.

Announcing the review, Environment Secretary Caroline Spelman said:

*'There is an economic and environmental urgency to developing the right waste strategy. We have been slowly moving in the right direction with recycling rates. The direction of travel is right – it's the pace that's the problem. We need to go faster and we need to go further.'*

*'We need a new approach to waste – one which works for the new economy. We cannot keep putting recyclable and biodegradable material into landfill. It threatens the environment and wastes what are incredibly valuable natural resources.'*

The Scottish Government launched the Scotland Zero Waste Plan in June 2010. It aims to make the most efficient use of resources by minimising Scotland's demand on primary resources and maximising the reuse, recycling and recovery of resources instead of treating them as waste. The plan notes that over two million tonnes of food waste is produced every year from all sectors in Scotland. If just half of this food waste was captured and treated through anaerobic digestion, the electricity generated could power a city the size of Dundee for six months, provide heat for local homes and businesses, and produce enough fertiliser for ten per cent of Scotland's arable crop needs.

The Welsh Assembly launched its strategy, Towards Zero Waste, in 2010. It is a long term framework for Wales that describes the social, economic and environmental outcomes that resource efficiency and waste management will achieve, and how they will contribute to a sustainable future. The strategy envisages that food waste will be collected separately and managed in anaerobic digestion facilities to generate valuable renewable energy and fertiliser.

## 2.0 Methodology

### 2.1 Introduction

Complex meat supply chains provide a wide range of fresh meat products to consumers. To capture data from all parts of the supply chain, a methodology was designed that provided for the analysis of both quantitative data, to establish the magnitude of waste arising, and qualitative data, to identify and understand the causes and potential solutions to reduce waste.

### 2.2 Definition of waste

Legally, waste is defined by the EU Waste Framework Directive as 'any substance or object the holder discards, intends to discard or is required to discard'. This includes all facets of physical waste including product and packaging.

In commercial terms, what is regarded as waste varies from business to business, as there are no standards beyond the legal definition. Under the Courtauld Commitment 2, WRAP is working with signatories to develop a baseline on waste arisings. Reporting under this 'responsibility deal' will follow the definitions adopted by the Environment Agency under the Waste Framework Directive (and on which IPPC returns are based), distinguishing between 'recovery' and 'disposal' routes, for example. The Efficient Consumer Response (ECR) work group on Food and Packaging Waste managed by IGD are working closely with WRAP to quantify food waste and develop initiatives to reduce it.

In its response to this research, the meat industry told the project team that it regards waste as comprising the following:

- products that are marked down by retailers and thereby do not achieve their full selling price;
- products that, for whatever reason, are out of their use by or sell by dates;
- products returned by shoppers;
- products that cannot be sold but are passed to charities, such as FareShare;
- products sent for anaerobic digestion;
- products returned from retailers to suppliers which have to be re-worked;
- products that do not meet the specification of the intended customer;
- products that are stolen; and
- product that is sent for rendering.

Currently data that is disaggregated in these ways is either commercially sensitive or not collected widely by the industry. The project team has been unable to collect information by this type of breakdown and analyse it in this report. The poor availability of data on food waste has several causes, which we return to later in this report.

#### 2.2.1 Water

This research has also examined water use. Water is essentially a renewable resource and its "use" may not affect the potential of other users to make use of it. For example, water that is evaporated still exists, and will eventually fall in precipitation, but the location of that is influenced by weather and climate and may occur in another country. Water can be degraded by pollution so that it needs purification or dilution before use by others, the extent of which will be specific to the pollution and location.

Here the focus is on measuring water use in the slaughter and processing of meat, together with the associated discharge of effluent.

The research does not examine the environmental impacts of water use, which relate to the opportunity costs of maintaining a supply to all users (whether domestic, industrial, agricultural or wildlife), which may be in direct competition with each other; or the energy (and associated GHG emissions) of treating and delivering water, and specific emissions relating to water treatment (for example nitrous oxide from nitrate removal).

### 2.2.2 Greenhouse gas emissions

The approach taken for this report has been to limit analysis to emissions directly associated with product and packaging wastes, so that upstream emissions of animal production have not been included. It has not been straightforward to apply simple emission factors to the processes used, because recycling, energy recovery and product transformation are all typical practices in the industry. Credits have thus been estimated to offset resources used in processes. A life cycle perspective has been used to inform this analysis, but it must be stressed that we have not conducted a formal Life Cycle Assessment (LCA).

Technical details of this calculation are included in Appendix 2.

### 2.2.3 Waste prevention reviews

As part of the project, Envirowise (now part of WRAP) conducted four waste prevention reviews at plants owned by participating companies. These reviews comprised:

- advice from an expert in waste minimisation in the meat processing sector;
- a process review identifying how processing, handling and storage on site create inefficiency, including product waste, water, packaging and energy;
- help to identify ways to optimise packaging; and
- help to identify how product processing, handling, storage and packaging affect waste further down the supply chain.

The output was an action plan with priorities for prevention. These reviews were made available to the project team on a confidential basis and the results have been incorporated into the report.

## 2.3 Data collection

There are no published sources of data that fulfil all of the questions posed by the project objectives. However, Government statistics have been widely used for context and to provide totals, both to sense check data from the survey and to provide a sampling framework.

Data to fulfil the research objectives could only be obtained from individual companies operating at different stages of the meat supply chain. Their support and co-operation was vital to the success of this project. The main trade bodies, including the BPC, BMPA, AIMS and FABRA, were all involved in this research and gave their support to it. Only a very small number of companies that were approached to take part in this research refused to do so.

At the outset of this research, the project team contacted the Environment Agency (EA), which holds a 'pollution inventory' database that comprises the returns made by companies subject to IPPC controls. Under this regime, the EA regulates some 74 meat-processing sites (belonging to a smaller number of companies). This data inventory was made available to the project team and is reported in Chapter 1. Coincidentally, the EA were conducting an environmental performance review of these sites, in preparation for its input to a forthcoming review of the relevant BREF: the European Reference Document on the Best Available Techniques in the Slaughterhouse and Animal By-Products Industries. The results of this review have also been made available to the project team and its results are incorporated within this report.

The project team conducted over 50 interviews with 45 separate organisations covering over 150 plants in the UK, using structured questionnaires that were developed and tailored to different parts of the supply chain, for example rendering, abattoirs, cutting plants and retailers. All the interviews were conducted between January and June 2010, and lasted between one and three hours. Each interview enabled the project team to quantify waste for the particular company, establish its views on the causes of waste, and record how it approached resource efficiency within the business.

The interview process involved the following approaches, depending on how individual companies responded:

- face to face interviews with key individuals in multi-plant and single plant companies, through which data was collected from central records;
- in some cases, following an initial interview, a template was developed for companies with multi-plants to circulate amongst their plants to complete and return;

- telephone calls, which in a few instances replaced face to face interviews and which served to clarify the company's data and/or views for multi-plant operations; and
- self-completion of the questionnaire by environmental managers in single plant companies.

All companies interviewed were given assurances that their data and views would remain anonymous. In certain cases the project team signed confidentiality agreements.

Companies were selected for interview on size criteria. Like most industries, meat production is heavily skewed to larger businesses but there are significant numbers of small abattoirs, cutting plants and retailers, for example. The interview programme aimed to cover 80% of all animals killed in the UK, and a similar proportion of the fresh meat products sold through retail channels. This necessitated a bias towards the larger businesses, which were targeted first for interview. Small abattoirs, cutting plants and retailers have also been covered by this research.

Table 10 below shows the number of abattoirs interviewed and their percentage of the kill. Most of the companies are multi-plant, some are multi-species and most have their own cutting operations. In addition nine separate cutting plants were interviewed.

**Table 10:** Abattoir interview profile

<b>Chicken</b>		<b>Cattle</b>		<b>Pigs</b>		<b>Sheep</b>	
<b>No. of companies</b>	<b>% of kill</b>						
6	78	16	62	9	78	13	46

Source: Project Team Research

In practice, the research reported here covers all the rendering industry, 78% of the chickens killed, 62% of the cattle killed, 78% of the pigs killed and 46% of the sheep killed.

The 18 products derived from these four animals account for between 75% and 89% of fresh meat sales by volume (depending on species) through the major multiple retailers, all of whom contributed to this research. A number of smaller retailers and retail butchers were also interviewed.

In addition, a number of existing sources of information were used in this research, and these are attributed as appropriate in the report. These included:

- Courtauld Commitment returns to WRAP, from which it is possible to derive an estimate of the type and weight of retail meat packaging<sup>1</sup>;
- AHDB data which levy-payers provide to the Board on their throughput – note these are confidential and have only been seen by certain members of the project team who have legitimate access;
- Kantar World Panel data purchased by the AHDB covering market shares and promotions tactics; and
- ECR (UK) on-shelf availability survey data for fresh meat which has been provided by IGD.

## 2.4 Data analysis

All the data and insights provided in this report were collected during the structured interviews, and thus their accuracy and completeness is reliant on the honesty and openness of participants. Data from the sample has been adjusted onto a UK basis to provide estimates (and ranges) for the industry as a whole. This was done using the extrapolation method as described below in 2.4.1. The aggregated data from the interviews has been checked against the confidential returns made by abattoirs to the AHDB, which show throughput in terms of the number of animals killed in each plant. As a result the project team is confident that the results are representative of the whole industry.

<sup>1</sup> Only aggregated information was shared with IGD, no information on individual signatories was shared due to data confidentiality requirements.

The data has then been synthesised into four 'resource maps' shown in Chapter 3. These track how the animal is used for a wide range of products, of which fresh meat is only one. By weight the majority of the animal is not meat (chicken is the exception), but what we have called 'residual material'. There are significant variations in these proportions for any single species, and these differences give rise to variations in resource use. The four resource maps also show the main causes of product loss and waste. Chapter 4 examines packaging, water and greenhouse gas emissions in more detail.

### *2.4.1 Resource Map Data Extrapolation*

The data collected for the resource maps were analysed and extrapolated following WRAP's guidelines. Confidence intervals were estimated at a 95% confidence interval using the following formula:

$$95\% \text{ confidence interval} = 1.96 \times \text{standard deviation} / \sqrt{(n - 1)}$$

where  $n$  is the number of respondents in a sample.

Where an estimate was the sum of other estimates, the following equation was applied:

$$(\delta a)^2 + (\delta b)^2 + (\delta c)^2 = (\delta t)^2$$

where  $\delta a$ ,  $\delta b$ , and  $\delta c$  are confidence intervals around estimates  $a$ ,  $b$  and  $c$ , and  $\delta t$  is the confidence interval around the total of  $a$ ,  $b$ , and  $c$ .

## 3.0 Animal Resource Maps

### 3.1 Introduction

The four animals considered in this report are 'disassembled' to produce fresh meat and other meat products for consumers. The 'disassembly' process includes slaughter and related processing, followed by de-boning and then further cutting, each producing meat and what we have called 'residual material' derived from the live animal. The residual material includes both edible and non-edible products that in general have a lower commercial value (or higher disposal cost) than meat. The majority of material derived from the live animal is residual material, not meat.

For each of the four animals the amount of, and uses for, residual material are considered. Each part of the animal has a potential use and in no case does residual material derived from the slaughter of animals go for landfill (unless use if made of a derogation available for remote areas). Companies will vary in the extent to which they fully separate material into its component by-product categories. For example, the amounts of material in ABP Categories 1, 2 and 3 will vary between abattoirs because of different management practices. There is evidence, for example, from work undertaken in Scotland to show that significant amounts of Category 3 and edible products are leaving abattoirs as Category 1 by-products, which attract a higher rendering charge.

Each resource map also covers fresh meat, although it has not been possible to collect specific resource use data for each of the 18 products identified in Chapter 1.

The leading causes of waste at each stage of the supply chain have been included in the resource maps, with more detailed discussion after each map. It has also not been possible to attribute causes to individual products. However, our strong view is that the causes identified are generic.

The resource maps also include water use, which is discussed in more detail in Chapter 4.

All the data in the resource maps are derived from the interview programme and are presented in tonnes (unless otherwise stated). The numbers have been adjusted from the sample onto a UK basis, using the extrapolation method in 2.4.1. While the data relate primarily to 2008, significant annual variations are considered to be unlikely.

In this chapter we look in more detail at the different uses for parts of each animal, and have produced a benchmark against which the industry can judge its performance. The benchmark is an 'optimal target' and is derived from published information, working knowledge of the industry and previous research undertaken by members of the project team. It includes all sources of residual material from abattoirs, cutting plants as well as imports. Of course, every abattoir and cutting plant will be different and what may be possible for one may not be for another because of location. For example, those in urban areas may have little room to expand, while the more remote ones may attract considerable transport costs, which make it uneconomic to split the waste streams. There may also be issues with recruitment of skilled staff as well as scale issues.

The benchmark is not derived from the survey undertaken as part of this research. Instead the results from the survey can be compared with the benchmark, both to indicate current performance and to judge how resources could be used to increase value.

## 3.2 Chicken resource map

The UK 'broiler' industry is highly integrated. All the major processing companies own or control all stages of production, from supply of day-old chicks, through feedstuff manufacture and supply, to delivery of the finished product to the retail customer. Further characteristics include:

- all commercial chickens in the UK are hybrids, bred specifically for the purpose;
- chickens are reared to about 2-3kg and slaughtered at an average of 40 days (up to 56 days for free range birds);
- over 60% of chickens are grown on farms owned directly by processors, the rest are grown by independent farmers almost all of whom are contracted to a processor;
- more than 90% of the UK parent breeding birds are sourced from two companies who operate worldwide; and
- the main integrated processing companies each slaughter over 1M birds per week, with five key suppliers accounting for 75% of all chicken killed.

According to Defra the UK slaughters over 831 million chickens each year. In addition the UK imports both live chicks and processed chicken in approximately the same quantity (around 406,000 tonnes dressed carcass weight). These go to produce a range of fresh products, from whole birds to portions, as well as being incorporated into ready meals and a wide range of other food items and distribution channels.

The average live-weight of a chicken in 2009 was 2.19kg. Since 2005 average live-weights have varied annually between 2.17 and 2.24kg, and during 2009 they varied between 2.17 and 2.23kg. During this period and over the longer term it is difficult to discern any real trend.

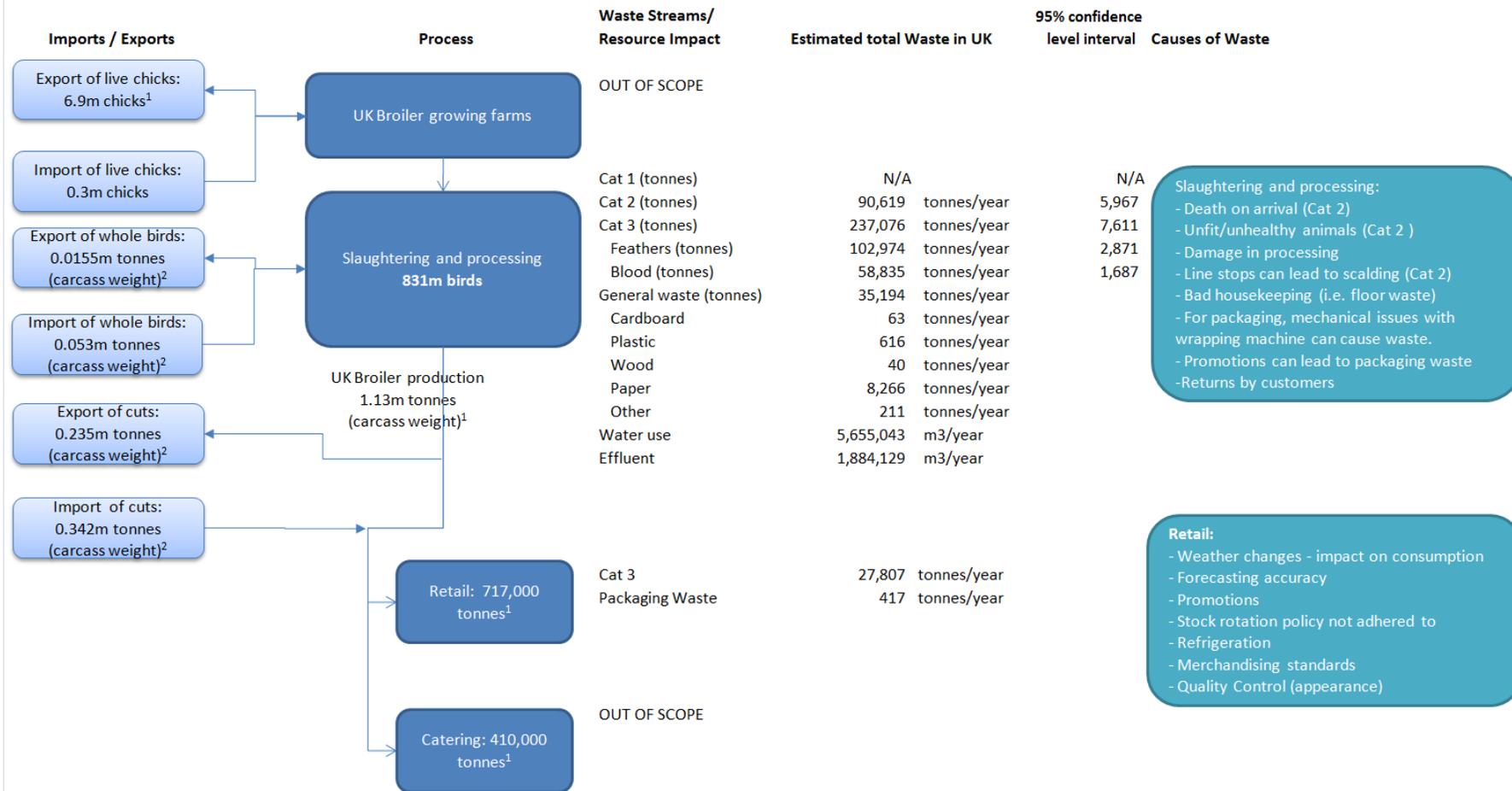
The number of birds killed each month shows little variation during the year. All interviewees in the research indicated there were no marked seasonal trends other than a slight fall in December, and maybe a small uplift in the summer if we have a barbecue season. Otherwise demand is stable through the year.

The main products derived from the carcass are whole birds, breasts and legs. These three products make up around 89% of fresh chicken sales. The market is primarily a 'fresh' market and, although most suppliers freeze chicken, it is seen as a last resort and is typically less than 5% of the total.

The chicken resource map is shown in Figure 7 below.

Figure 7: Chicken resource map

## Poultry Resource Map



Sources:

1. Defra (2009) "Chicken supply chain diagram", available from <http://www.defra.gov.uk/foodfarm/food/industry/sectors/eggspoultry/statistics/flow1.htm>, accessed 19 April 2010.
2. Defra (2010) "UK Poultry Trade Data", available from <http://www.defra.gov.uk/evidence/statistics/foodfarm/food/poultry/index.htm>, Updated 25 March 2010, accessed 19 April 2010

Table 11 below shows the main types of residual material from chicken, based on data gathered from the survey.

**Table 11:** Residual Material Tracking - Chicken

<b>Material</b>	<b>Survey (% of total live weight)</b>	<b>Weight (tonnes)</b>
Cat 1	0	0
Cat 2	5.18	90,619
Cat 3	13.55	237,076
Feathers	5.88	102,974
Blood	3.36	58,835

Source: Project team research

The four types of material shown in the table comprise some 490,000 tonnes, of which Category 3 is the largest. Chickens do not produce Category 1 material (except birds contaminated with Avian flu, which have to be disposed of this way). No Category 1 material was recorded during the project. Category 2 material comprised 5% and Category 3 material 14% by weight of the bird.

There was considerable variation in the proportions of material in Categories 2 and 3 produced by different plants – both between companies and between plants belonging to the same company. In part this was due to the proportion of edible products harvested from the bird. Some plants in the survey were not separating livers, hearts and necks for example (around 4.5% of the weight of the bird), all of which are edible. Instead this material is rendered primarily to produce pet food, for which there is an increasing market.

On average feathers comprise around 6% by weight of the bird. All feathers are rendered as Category 3 material. They are most likely to be turned into animal feed, although fertiliser is also produced for sale outside the EU. A number of plants do not separate feathers from other Category 3 material, and are unaware of the final usage after the product has been rendered. Chicken feather meal is processed at high temperatures with steam, and has high percentage of protein and nitrogen. In the US researchers have paid attention to the 12% fat content of the chicken feather meal, and believe it has potential as an alternative, non-food feedstock for the production of bio-fuel.

On average blood comprises 3% by weight of the bird. A number of plants send blood for incineration to produce electricity. In the main, most chicken blood is rendered and used to produce a fertiliser. Some plants are unaware of the final usage after rendering.

### *3.2.1 Causes of processing waste*

Chicken slaughtering, processing and packing is a highly integrated operation, which takes place in the same plant through a continuous process. A typical process involves stunning, killing, bleeding then scalding to remove feathers, followed by evisceration, washing, chilling and then cutting.

Poultry processing is unlikely to generate Category 1 waste, which would only arise if chickens were found to be infected with a notifiable disease (for example Avian flu).

For chicken, Category 2 waste will include chicks that are dead on arrival, chicks found to contain residues (for example of veterinary medicines) in excess of permitted levels, and manure and digestive tract contents. All other parts of the chicken are classified as Category 3, for example poultry necks and poultry intestines, or are potentially edible.

The project team found significant variations between processing plants in the amount of material that is assigned to Category 2 and Category 3 disposal streams. Some plants were found to be sending tonnages a

multiple greater than others under Categories 2 and 3. The differences arise because some processors have found markets, mostly outside the UK, for certain parts of the chicken that are edible by humans, but for which there is little or no UK demand. However, the economic incentive to recover these products is not great because there is a strong demand from pet food manufacturers for Category 3 material, for which the rendering industry is paying above £100/tonne. Other processors have therefore continued to assign materials to Categories 2 and 3, even where not strictly necessary.

Processing operations nevertheless give rise to product that cannot be used for customers, and which is therefore assigned to either the Category 2 or Category 3 bins. A number of processors keep very detailed records of product loss from processing operations, as yield is a widely used performance measure. However, there are commercial reasons for not releasing these data. A number of processors in this research, but not all, deploy lean manufacturing principles to reduce 'waste' in its broadest sense.

The main causes of product loss in slaughtering and processing are:

- unfit/unhealthy animals which have to be assigned as Category 2;
- chickens which are dead on arrival have to be assigned as Category 2;
- damage in processing;
- line stops leading to scalding, and the chickens are then assigned to Category 2;
- floor waste (bad housekeeping); and
- returns by customers.

Inevitably there are bound to be some small-scale losses arising from even the most efficient operation. In the main, a continuous improvement programme, using lean manufacturing principles, would best address these issues. Preventative maintenance is likely to be part of these programmes.

### *3.2.2 Key supply chain characteristics*

The research found the following main characteristics associated with the processing of chickens to produce fresh meat:

- Suppliers pack according to their own forecast of the next order. This means that the majority of work is completed before their customers confirm the order. With multiple customers and different order confirmation times, this practice can lead to re-work if orders are below expectation, or a second run if orders exceed those expected. While this would not result in wasted product (for example whole birds could be re-worked into portions or frozen), it is a practice that consumes additional resources and thereby increases costs and the environmental impact of production.
- Shelf life varies between eight days typically and a maximum of 12 days in exceptional circumstances, such as at Christmas. This was consistent across suppliers. There was no variation between suppliers, though some commented that shelf life was based on the use of modified atmosphere packaging. Typically shelf life is set by scientific methods in agreement with customers.
- Lead times were 24 hours, with orders being received on day one for delivery either the same day or on day two. Deliveries were made by road to customers' depots and from there to store. Retailers expected to provide their customers with at least seven days' product life.
- Stock levels were low, with suppliers saying it was not policy to hold stock, other than perhaps over weekends when typically the processing lines were not operating. There was some freezing of product which could then be held for up to three months, but all regarded this as a 'last resort' for supplying what they regarded as a fresh market.
- Water use in poultry processing is intrinsically high because of the need to meet the requirements of meat hygiene legislation. Water used across the whole process in these integrated plants approximates to 3.23m<sup>3</sup>/t, which is about seven litres per bird.
- There were 35,194 tonnes of general waste generated by poultry processing and packing operations. This includes primary, secondary and tertiary packaging – the data available does not allow us to break this down further.
- Some 490,000 tonnes of material (27% of the total weight) from the carcase was sent for rendering and other uses. The vast majority of this was Category 3 material, which can be used to produce high-grade pet food.

Retail waste is discussed in Chapter 5.

### 3.3 Cattle resource map

Beef is derived from the dairy herd and from the beef herd in almost equal proportions.

Animals supplied for beef production from the dairy herd are either pure-bred dairy calves that are not required to maintain the herd (mostly bull calves), or calves that are born of a dairy cow that has been crossed with a beef breed. These animals are usually sold by dairy farmers on to beef farmers who will grow the animals on ready for slaughter (finishing). Beef is also produced from cull cows from the dairy (and the beef) herds.

Animals supplied for beef production from the beef herd tend to be borne of beef cows that suckle the calf for between 7 and 10 months. After weaning the calves are finished through a variety of feeding systems.

Whatever their origin, animals that are being grown for beef tend to be referred to as calves up until the age of about 6-9 months, a process known as rearing. Thereafter they are known as stores - animals that are suitable for finishing.

Cattle movement data<sup>2</sup> show that approximately one third are slaughtered between three and 24 months, another third between 24 and 30 months, and the remainder after 30 months.

Rearing and finishing can be done under a number of differing feeding strategies. These can range from extensive grassland systems, through to those based on a higher plane of nutrition, where the stock consumes more concentrate (for example barley) and less bulk feed (grass or silage). The complex mix of potential rearing and finishing systems and different breeds contribute to the wide diversity in the quality and price of beef.

There has been a consistent fall in the size of the English breeding herd over many years (by 27% between 1990 and 2007), and this is forecast to continue. This decline in the breeding herd, together with tighter cattle supplies and lower slaughtering, means that domestic beef production is declining. Consequently, there has been an increasing reliance on imports to meet the shortfall in domestic supplies.

Further characteristics include:

- The beef sector accounts for around 12% of the value of output of UK agriculture, and employs about 125,000 on English cattle farms.
- There were 77,774 premises in Great Britain recorded as holding cattle on 1 June 2008.
- Around 21% of cattle were on premises that keep over 500 cattle, but these premises accounted for only 3% of all premises. However, nearly 50% of premises kept fewer than 50 cattle.
- Between 1 June 2003 and 1 June 2008 there was an 11% fall in the number of cattle premises, but only a 6% fall in the number of cattle.
- The majority of cattle are concentrated in the south-west and north-west of England, Yorkshire and Humberside, and in the north-east and south-west of Scotland.
- The majority of the dairy herd are concentrated in central and south-west England, and south-west Wales and Scotland.

In 2008, the UK slaughtered around 2.7 million cattle. In addition the UK imports around 295,000 tonnes, mostly from the rest of the EU, and exports 100,000 tonnes, thereby increasing domestic supply by 195,000 tonnes. From this beef a wide range of products are produced and sold through different distribution channels.

Minced beef is the most important product, accounting for over a half by weight of all beef sales (though only around one-third by value). Mince has benefited from consumers cooking from scratch, strong promotions and its flexibility as an ingredient in many recipes. Other major products are burgers, roasting joints, steaks and stewing beef. Beef sales are weather dependent, particularly in the summer BBQ season when sales of burgers and steaks will increase, whereas in winter sales of roasting joints increase. As a result, different parts of the animal are used at different times of the year, and this poses a challenge for suppliers who have to find markets for all the meat cuts (an issue known as carcass balance, which applies to all species).

Across the year there does not appear to be significant fluctuation in the amount of meat sold, rather the mix of products changes. Even for some of the larger suppliers who have a wider range of products, carcass balance is a constant issue. One major supplier believed there would have to be a re-balancing of prices, with those for mince increasing while those for steaks should decrease.

Cattle slaughtering and processing are generally separate activities often carried out in different plants, which are sometimes located in different parts of the country.

The cattle resource map is shown in Figure 8.

Figure 8: Cattle resource map

## Beef Resource Map

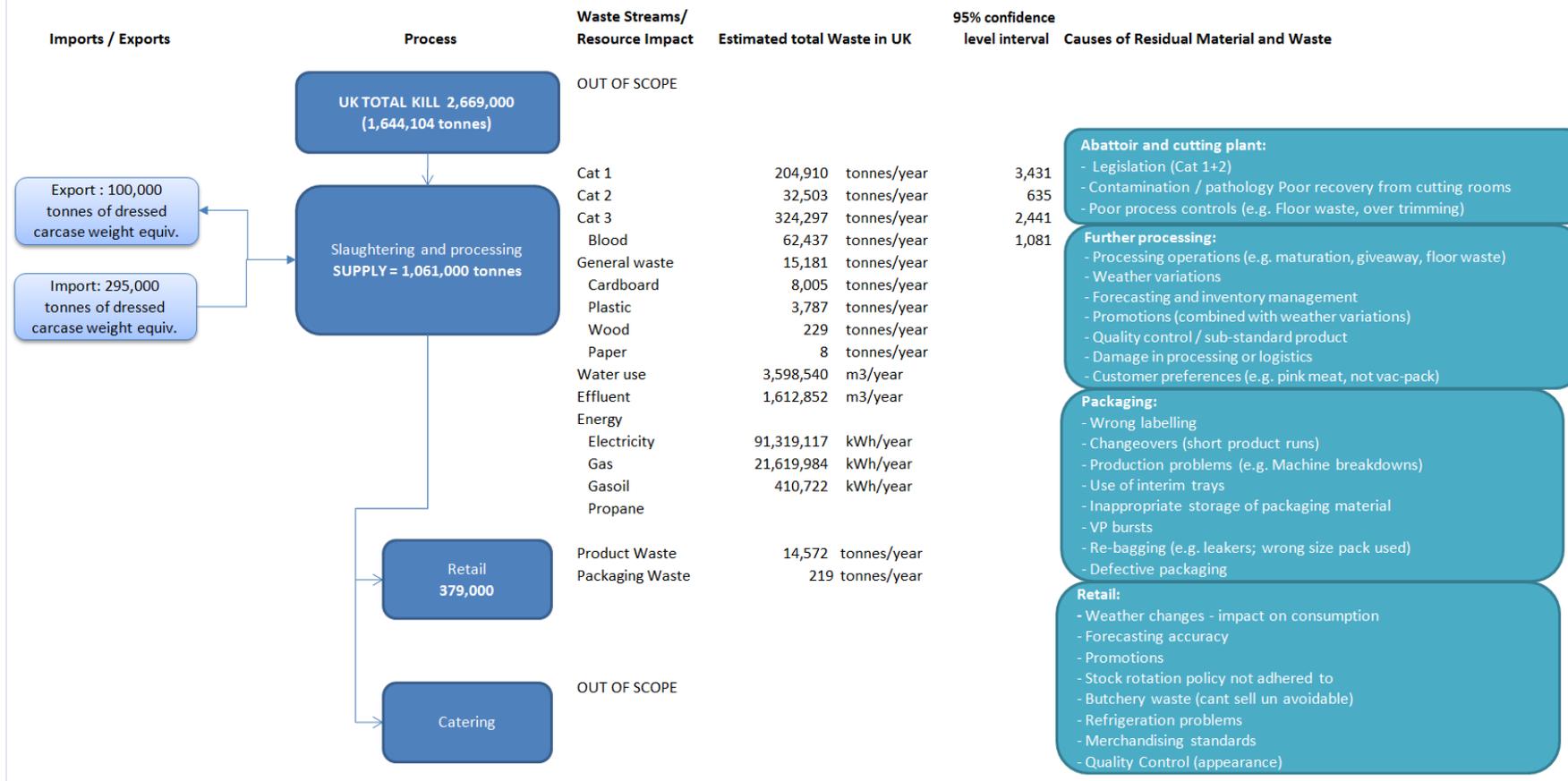


Table 12 below shows the main types of residual material from cattle based on data gathered from the survey.

**Table 12:** Residual Material Tracking - Cattle

Material	Survey (% of total live weight)	Weight (tonnes)
Cat 1	12.19	204,910
Cat 2	1.93	32,503
Cat 3	19.29	324,450
Blood	3.71	62,437

Source: Project team research

The four types of material shown in the chart comprise some 625,000 tonnes, of which Category 3 is the largest. Category 1 material poses a risk to human or animal health and includes all specified risk material (SRM). The constituents of SRM vary by age, and are constantly being updated and reviewed as scientists assess the risk of infection posed by these items. Around 2% of residual material was defined as Category 2, which also poses a risk to human or animal health, though in practice rendering facilities can now only accept Category 1 or Category 3 material. All Category 2 material is, therefore, downgraded to Category 1. Around 19% of residual material is Category 3 by-products.

Unless it comes from an animal with a communicable disease, blood is classified as a Category 3 by-product. It must be hygienically collected at the point of slaughter, stored in a suitable container and collected preferably daily, but at least once a week, by an approved contractor. Blood cannot be disposed of to the public sewer or landfill. While many of the large abattoirs have blood storage facilities, small ones often do not and dispose of their blood with Category 1 material. Blood from cattle has to be sent for rendering (or incineration). Collected blood is used in effect to replace water in the rendering process. Cattle blood can be used to produce higher value products but currently this is not exploited in the UK.

It has not been possible to produce data from the survey on the weight of hides, as most abattoirs outsource the collection of hides to specialist companies. Cattle hides produce both nappa and doubleface leather, and are used in jacket production, upholstery leather, shoe production (sole leather, shoe upper leather and lining) as well as all other leather products. The market for hides is global and very volatile, and most hides from the UK are exported to Egypt and Italy.

### 3.3.1 Causes of processing waste

Cattle slaughtering, processing and packing are often carried out in different plants (sometimes on different sites and even countries). A typical process involves animals being housed in a lairage for a short time only, then stunning (it should be noted that certain religious practices do not permit this), bleeding, head removal (which is checked for disease), hoisting for evisceration and spinal cord removal, inspection of meat and main organs for disease, and then refrigeration before cutting. If cutting is done in a separate plant, then the meat may be packed or transferred 'naked'.

Beef production generates some 237,000 tonnes of residual material in Categories 1 and 2. This is combined by the rendering industry with similar material from each of the other three animals, for the production of fats and protein. Category 3 material from cattle is combined with that from sheep by the renderers to produce protein (as well as some fats).

The provisions banning the use of processed protein as feed for animals such as pigs, poultry and fish (non-ruminants) could be removed without lifting the prohibition on intra-species recycling (for example poultry meal could be fed to pigs and pig meal to poultry, but not pig meal to pigs). If this happens, there may be some potential benefits to industry.

Although there are legal requirements in relation to Category 1-3 animal by-products, most abattoirs regard this legislation as the main cause of their waste. With the onset of BSE the traditional outlets for this material (for

example blood for fire extinguishers, and tallow for cosmetics) became closed. However, the industry has increasingly lost many of the skills required to exploit opportunities that could re-open in the near future.

Processing and cutting/packing operations give rise to product that cannot be used for customers, and which is thereby assigned to Category 2 or 3 disposal streams. Processors keep detailed records of yield, and generally processing operations are improved by deploying lean manufacturing principles to reduce waste in its broadest sense.

The main causes of product loss in slaughtering and processing are:

- contamination / pathology;
- poor process controls (for example, floor waste, over trimming, maturation); and
- customer preferences (for example meat aged as carcasses and not in vacuum packs).

Burger producers commented that mince can build up in machines that produce them, and will be wasted when the machine run is completed. No supplier commented that product waste (other than meat) associated with the production of burgers was significant.

### *3.3.2 Key supply chain characteristics*

The research found the following main characteristics associated with the processing of cattle to produce fresh meat:

- Suppliers pack to their own forecast of the next order. This means that the majority of work is completed before their customers confirm the order. With multiple customers and different order confirmation times, this practice can lead to re-work if orders are below expectation, or a second run if orders exceed those expected. While this did not result in wasted product (for example, products could be minced), it is a practice that consumes additional resources and thereby increases costs and the environmental impact of production.
- Shelf life varies according to product and packaging, with frozen beef having a shelf life in excess of one year, but more typically it varied from a minimum of seven days for burgers, mince and cooked meats, to between 30-42 days for matured steaks (over the whole product lifecycle, starting as primal cuts in vacuum packs, before further cutting into consumer size portions and retail packing). Some burgers and cooked meats had a shelf life of up to 14 days. Roasting joints typically had a range of between 18-28 days. The use of vacuum and skin packs for certain products, for example mature steaks in certain retailers, has helped extend shelf life over that provided by modified atmosphere packs.
- Lead times were 24 hours, with orders being received on day one for delivery either the same day or day two. Deliveries were made by road to customers' depots and from there to store.
- Stock levels were low, with suppliers saying it was not policy to hold stock, other than perhaps over weekends when typically the processing lines were not operating. There was some freezing of product which could then be held for up to three months, but all regarded this as a 'last resort' for supplying what they regarded as a fresh market.
- Water use in beef production is high because of the need to meet the requirements of meat hygiene legislation. Water use approximates to 2.14m<sup>3</sup>/t, which is about 1,348 litres per animal.
- There were 15,181 tonnes of general waste generated by the production of beef. This includes all types of contaminated packaging that cannot be recycled.
- Some 625,000 tonnes of residual material from the carcass were sent for rendering and other uses. The vast majority is Category 3 but significant proportions are Category 1 and 2, which showed the largest variation between companies. This suggests opportunities exist for diverting this material into a less costly disposal route, or in some cases an alternative market.

Retail waste is discussed in Chapter 5.

### 3.4 Pig resource map

The UK pig industry comprises around 1,400 commercial farms, on which around 92% of all pigs are kept (with the remainder on 10,000 small holdings and farms). Pig farms and processing operations are mainly owned by separate organisations. Other characteristics include:

- the average pig herd is around 500 breeding sows;
- the majority are killed before they reach six months of age, and sows have an average productive life of about four to five years;
- the majority of pig herds are located in Yorkshire and Humberside and the east of England;
- the industry is highly cyclical, although in the long term there has been an erosion of competitiveness; and
- recently there has been a slight upturn in the number of pigs slaughtered.

According to Defra, the UK slaughters around 9 million pigs each year. In addition, the UK imports around 813,000 tonnes mostly from the rest of the EU, and export 150,000 tonnes, thereby increasing domestic supply (including residual material) by 663,000 tonnes. Most pig meat is sold as bacon, sausages or cooked hams. By contrast pork chops and steaks together account for only 10% of sales volume.

Of the three red meat species, pig production is the most highly concentrated and integrated, though not to the same degree as chicken. Around 45% of the total weight of pig meat is derived from imported product, which will go straight to cutting and packing operations.

The pig resource map is shown in Figure 9 below.

Figure 9: Pig resource map

## Pork Resource Map

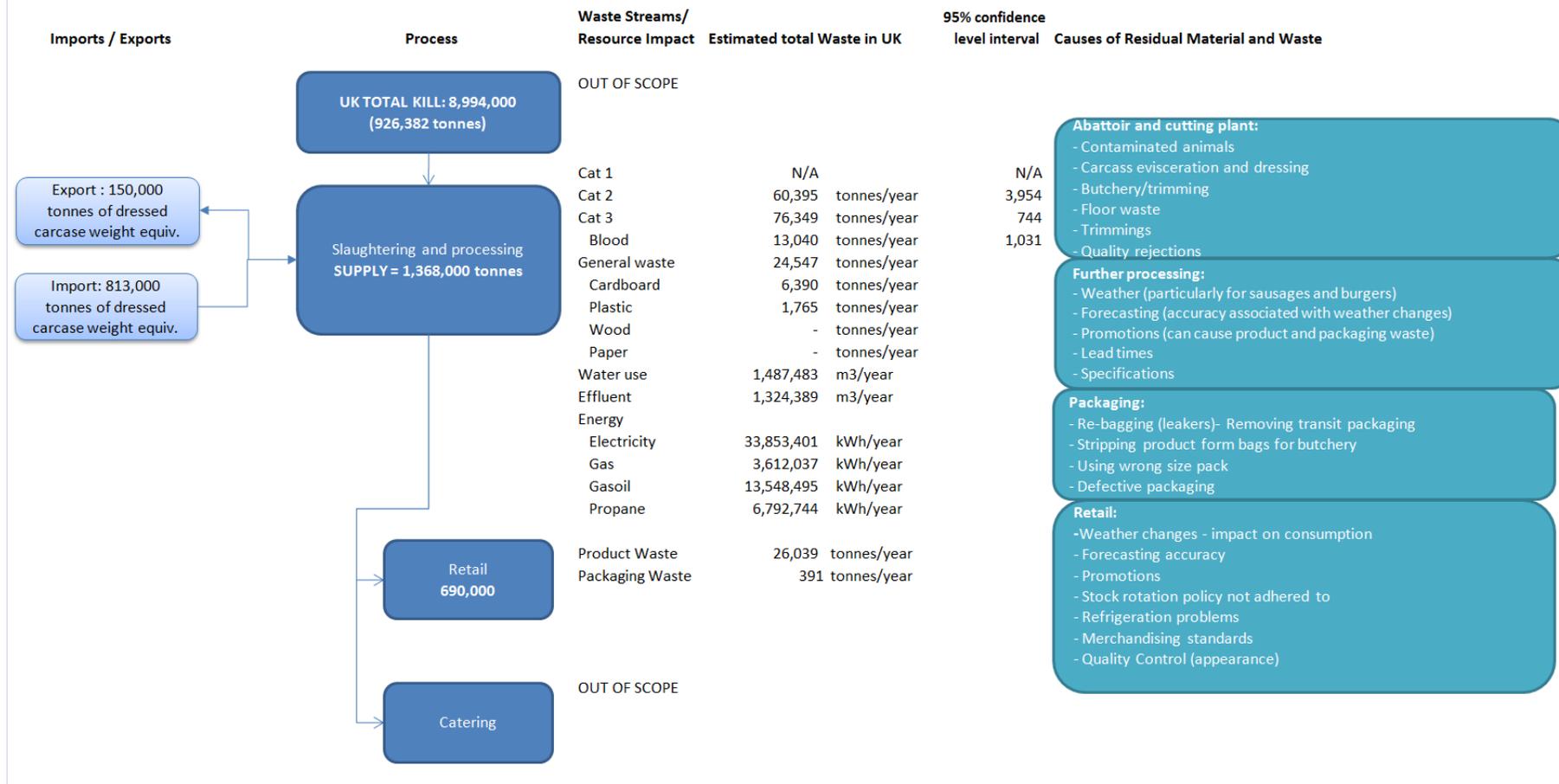


Table 13 shows the main uses of residual material from a pig based on data gathered from the survey.

**Table 13:** Residual Material Tracking – Pigs

<b>Material</b>	<b>Survey (% of total live weight)</b>	<b>Weight (tonnes)</b>
Cat 1	0	0
Cat 2	6.65	60,395
Cat 3	8.41	76,369
Blood	1.44	13,040

Source: Project team research

The three types of material shown in the table comprise some 150,000 tonnes, of which Category 3 is the largest. Pigs do not produce Category 1 material. Some abattoirs were sending Category 3 material direct to third party users, for example pet food manufacturers, rather than rendering.

Pig blood can be used to produce higher value products unlike sheep and chicken blood, which by comparison is of lower quality, though chicken blood is used extensively as a fertiliser. Some pig's blood is used directly for manufacturing black and white puddings. Pig blood is also being turned into plasma and haemoglobin for the world markets in a joint venture between PDM and the American Protein Company. There is currently a shortage of pig blood to meet the needs of these markets.

Sow and boar skins are used for hide leathers. However, the majority of pigs that are slaughtered are not "skinned" as the skin stays on the product, as for example with bacon, pork and crackling. Some pig hides will be turned into different kinds of finished leather, such as grain leather, split leather, nappa leather and suede leather. Pig skin together with the subcutaneous fat is also used as the raw material for pork scratchings.

Artificial sausage casings made from collagen are produced from the protein in pig and beef hides. They have been made for more than 50 years and their share of the market has been increasing. Continuous development means the casings are now preferred by consumers in many sausage applications. Usually the cost to produce sausages in collagen is significantly lower than making sausages in natural casing produced from the intestines of pigs and sheep, because of higher production speeds and lower labour requirements. However, with the interest in more natural products in recent years, the demand for natural casings made from processed intestines has increased.

### *3.4.1 Causes of processing waste*

Pig slaughtering, processing and packing can be done in single multi-plant companies, which produce fresh pork as well as bacon and sausages, or in separate companies, which specialise in, for example, bacon or sausage production. Typically the latter companies do not kill pigs but buy in legs, shoulders and loins which they then cut and further process. There are a large number, for example, of small-scale sausage manufacturers.

Pig slaughtering involves four main steps: stunning and hoisting for exsanguination; scalding to loosen the hair for subsequent removal; evisceration; and finally inspection of head and vital organs for disease. The carcass is then cut into two halves, washed and chilled prior to cutting.

Pigs do not produce Category 1 material, though in practice all the 60,000 tonnes of Category 2 material will be rendered in Category 1 plants. The 76,000 tonnes of Category 3 material is rendered in separate plants and is valuable as a component in pet food. Some abattoirs sold all their Category 3 material directly to, for example, pet food manufacturers, fertiliser producers and blood plasma manufacturers.

Processing operations also give rise to waste, although in significantly smaller quantities than material in Categories 1 to 3. It has not proved possible to quantify these amounts with any precision.

There were clear differences on the causes of waste between pig abattoirs/cutting plants, and those companies that did not kill pigs but produced bacon and sausages. The latter companies are 'closer to the market' and had views similar to the retailers on the causes of waste.

The main causes of waste identified by pig abattoirs were:

- contaminated animals;
- carcase evisceration and dressing;
- butchery/trimming;
- floor waste;
- trimmings; and
- quality rejections.

All of the respondents saw these as relatively minor operational issues.

In contrast, the causes of waste identified by 'stand-alone' bacon, sausage and ham producers were different and gave those businesses that responded greater operational problems. Those causes were as follows:

- Weather was viewed as the main cause of waste and thereby cannot be controlled. This was particularly the case for sausages because they are a BBQ product. However, some pork products like bacon have potentially a long shelf life, and suppliers could flex the shelf life that they would normally provide to customers if anticipated plans could not be realised.
- Forecasting accuracy particularly associated with weather changes. However, many commented that if the forecast proved inaccurate, it was unlikely that product would be wasted. Instead the product would be re-worked and not wasted while the labels and packaging would still be disposed of, in most cases to landfill.
- Promotions could result in more waste, particularly towards the end of campaigns. There was a strong view that promotions worked best when managed by suppliers, as they typically resulted in greater volumes being sold with less waste.
- Lead times were directly related to waste, with a number commenting that short lead times increase waste.
- Specifications generally include size of product (for example, two chops of equal size, colour of meat, absence of blood), all of which require attention to detail otherwise mistakes can be made. Generally, suppliers fully understood their customers' specifications and had been involved in their determination.

Several of these companies had advanced lean manufacturing programmes in operation.

#### **Case Study 1:** Vion Food Group – benefiting from lean production methods



Four shop floor operators at Grampian Country Foods in Cheshire, now Vion Food Group, implemented a lean manufacturing project over a six-month period, focused on production line four. They were supported by the company training and continuous improvement manager, and facilitated by an external RMIF consultant. Production line four is the busiest line, supplying product to Asda. Some of their changes to this line saved the company well over £100,000.

By learning how to collect reliable data that gave an accurate picture of what was actually happening on the production line, the team discovered some areas for improvement. For instance, out of a hundred primals going through the production line to be cut into pork chops, only seven came out right first time and more than 20% of product was reworked at least once.

Ever-changing agency staff and an inconsistent product exacerbated some of these problems. While they might have consistent staffing for a few days, the following week they may have completely new staff that needed training from scratch. Equally on the product side, they were faced with under-weight and overweight primals.

By adjusting the cutters on the cutting machines, they have reduced the need to rework from 20% down to less than 10%, and by improving the layout of the shop floor they have improved the efficiency of the operation. The operators have also introduced ways to collect accurate data so that they can get a snapshot of what is happening every day.

The project has developed communications skills right across the company, and has given the team the ability to understand value added versus non-value activity.

### *3.4.2 Key supply chain characteristics*

The research found the following main characteristics associated with the processing of pigs to produce fresh meat:

- Suppliers pack to their own forecast of the next order. This means that the majority of work is completed before their customers confirm the order. With multiple customers and different order confirmation times, this practice can lead to re-work if orders are below expectation, or a second run if orders exceed those expected. While this did not result in wasted product (for example bacon or sausages could be sold on the wholesale market), it is a practice that consumes additional resources and thereby increases costs and the environmental impact of production.
- Shelf life varies according to product and packaging, with frozen pork having a shelf life in excess of one year. Bacon varied between 21 and 42 days depending on degree of curing as well as packaging, where certain retailers use innovative formats. Sausages typically had a shelf life between seven and 20 days, while cooked meats varied between seven and 40 days. Fresh pork (chops for example) had a shelf life within the range of seven to 15 days. BBQ products are sold with an eight to 10 day shelf life.
- Lead times were 24 hours with orders being received on day one for delivery either the same day or day two. Deliveries were made by road to customers' depots and from there to store.
- Stock levels were low with suppliers saying it was not policy to hold stock, other than perhaps over weekends when typically the processing lines were not operating. There was some freezing of product, which could then be held for up to 3 months, but all regarded this as a 'last resort' for supplying what they regarded as a fresh market.
- Water use in pig processing is intrinsically high because of the need to meet the requirements of meat hygiene legislation. Water use approximates to 1.63m<sup>3</sup>/t, which is about 165 litres per pig.
- There were 24,547 tonnes of general waste, including contaminated packaging. The waste streams going into the general skip are not separated, so it is not possible to break down this amount into its components. It is likely that the majority is secondary packaging.

Retail waste is discussed in Chapter 5.

### 3.5 Sheep resource map

Sheep production is highly fragmented, with around 79,000 holdings applying different systems of production to suit the local geography and climate. It is largely a geographically structured industry, with approximately two-thirds concentrated on hill and upland areas (over 300m above sea level), which are dominated by extensive grazing land and are usually not suitable for other types of agricultural production. In simple terms, the sheep flocks in the hill and upland areas produce lambs for finishing in the lowland areas where the pastures are better. A third are kept in lowland areas where the sheep enterprise is integrated with other agricultural production systems.

Further characteristics include:

- there are more than 60 different breeds of sheep in Britain;
- the UK's self-sufficiency in sheep meat has fallen from 103% in 1995 to 85% in 2007;
- most lambs are sold between 36-42kg live-weight;
- the majority of lambs for human consumption are slaughtered before they reach 12 months of age, and the majority of ewes between three and five years; and
- sheep are most prominent in south-west and northern England, Wales and the Scottish borders.

According to Defra, the UK slaughters around 17 million sheep each year. In addition, we import around 135,000 tonnes, mostly from New Zealand, and export 95,000 tonnes, thereby increasing domestic supply by 40,000 tonnes.

Lamb is the most expensive overall of the red meats, all of which have seen price increases since 2008. Roasting joints account for the most significant share of the market by volume, though consumers are switching to frying and grilling cuts, including mince.

Lamb has the least concentrated and least integrated retail supply chain of the four species covered in this research. As a result, the sample, although representative of the sector, covers a smaller proportion of the kill.

The sheep resource map is shown in Figure 10.

Figure 10: Sheep resource map

## Lamb Resource Map

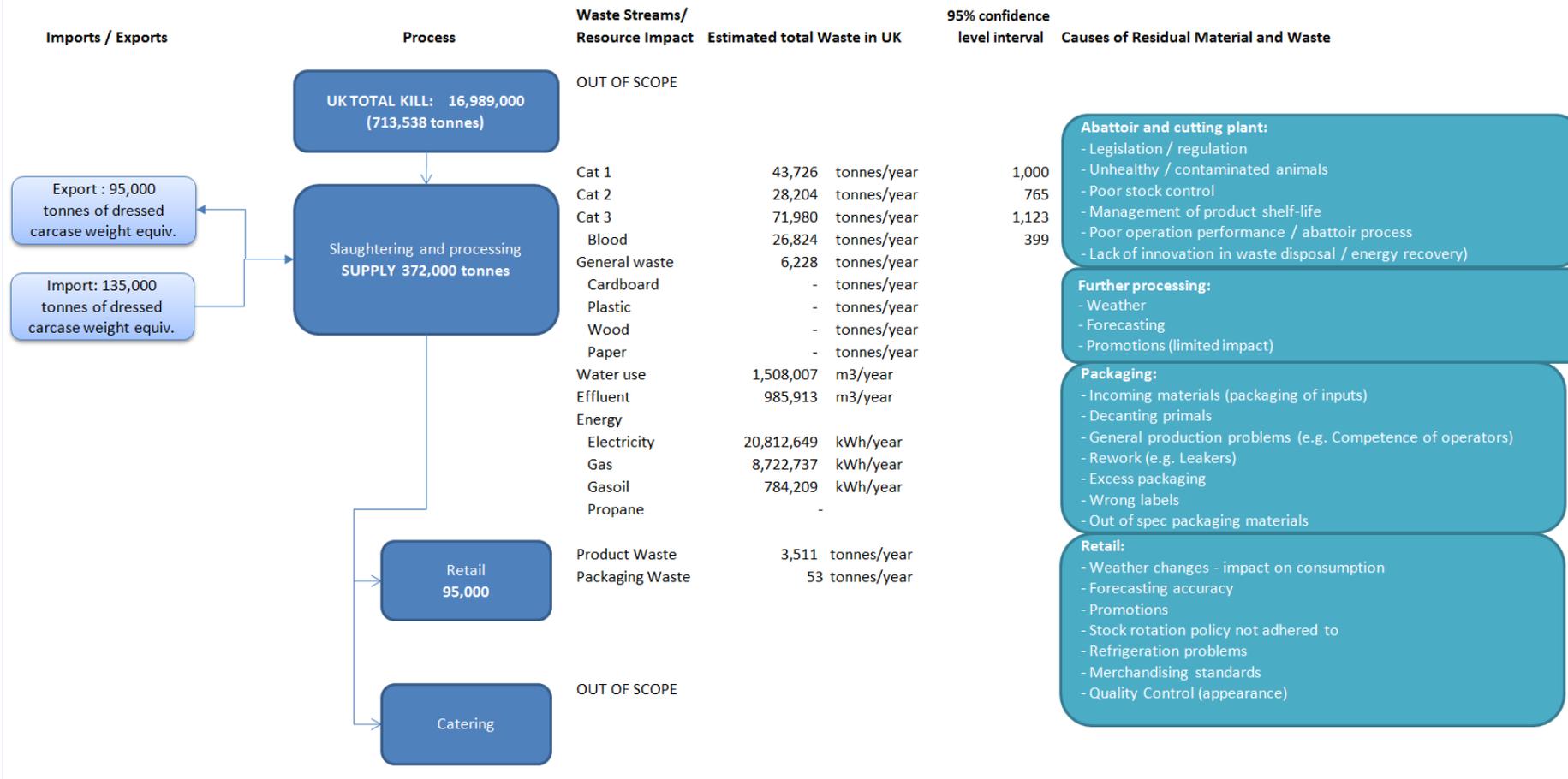


Table 14 below shows the main uses of residual material from a sheep based on data gathered from the survey.

**Table 14:** Residual Material Tracking – Sheep

<b>Material</b>	<b>Survey (% of total live weight)</b>	<b>Weight (tonnes)</b>
Cat 1	6.28	43,726
Cat 2	4.05	28,204
Cat 3	10.33	71,980
Blood	3.85	26,824

Source: Project team research

The four types of material in Table 14 comprise some 171,000 tonnes, of which Category 3 is the largest.

Sheep blood is generally classified as a Category 3 by-product. It must be hygienically collected at the point of slaughter, stored in a suitable container and collected preferably daily, but at least once a week, by an approved contractor. Sheep blood cannot be disposed of to the public sewer or landfill. While many of the large abattoirs have blood storage facilities, small ones often do not and dispose of their blood with Category 1 material. Blood from sheep has to be sent for rendering. Collected blood is used in effect to replace water in the rendering process.

Wool is a modified form of hair that grows with a waviness (called the crimp), which is characteristic of the breed of sheep. Fleeces of British sheep can be classified into three main types: carpet wools, down wools and long wools, each with differing end uses.

Today the UK remains an important producer of wool (7<sup>th</sup> largest in the world) exporting around one third of the annual 60,000 tonne clip. However, with wool prices at about 50 pence per kilogram, the value of the raw wool that is exported is little more than £10M, and for most farmers the value of the wool does not cover the cost of shearing.

Most wool in the UK is marketed through the British Wool Marketing Board, which co-ordinates the collection and sale of wool from around 70,000 registered producers. Wool is graded, pooled and sold throughout the year at public auction, some of which are live online. The fleeces from the skins of slaughtered sheep make up the “skin wool” trade.

Nappa leather is the highest quality and most expensive leather type derived from lamb, kid, sheep and goat skins. It can be used for garment (clothing), chamois and decoration (rugs).

### *3.5.1 Causes of processing waste*

The lamb slaughtering process comprises five main steps: stunning and blood removal, removal of fleece from legs and breast, hanging and full removal of fleece, washing and evisceration, inspection of head, meat and vital organs for disease. Once lambs have been slaughtered, their carcasses are usually hung in a refrigerated area to chill (although many carcasses of older sheep entering the halal trade are dispatched hot after slaughter to specialist halal wholesale cutting plants and retailers). Once cooled, carcasses are then taken for cutting to be prepared for sale.

Lamb production generates some 171,000 tonnes of material in Categories 1 to 3. All material in Categories 1 and 2 is combined with similar residual material from cattle and rendered to produce protein and fats. In a similar way – but in different plants – Category 3 materials from sheep and cattle are also combined to produce products mostly destined for the pet food industry, and increasingly for bio-diesel production. Most respondents viewed the regulations on animal by-products as the main cause of processing waste.

Processing and cutting/packing operations give rise to product which cannot be used for customers, and which is thereby assigned to Category 1, 2 or 3, and principally sent for rendering. The amount of this material sent for

disposal to landfill is very significantly less than that which is sent for rendering, where the main opportunities for diversion occur. Processors keep detailed records of yield, and generally processing operations are improved by deploying lean manufacturing principles to reduce waste in its broadest sense. The main causes of waste identified were:

- unhealthy / contaminated animals;
- poor stock control;
- management of product shelf life;
- poor operation performance / abattoir process; and
- lack of innovation in waste disposal.

### *3.5.2 Key supply chain characteristics*

The research found the following main characteristics associated with the processing of sheep to produce fresh meat:

- Suppliers pack to their own forecast of the next order. This means that the majority of work is completed before their customers confirm the order. With multiple customers and different order confirmation times, this practice can lead to re-work if orders are below expectation, or a second run of orders exceed those expected. This is a particular problem for New Zealand lamb, which is at sea for over a month. While this did not result in wasted product, it is a practice that consumes additional resources and thereby increases costs and the environmental impact of production.
- Shelf life for frozen lamb was in excess of one year. For fresh lamb, UK sourced product had a shelf life of 12 to 17 days. New Zealand lamb had a shelf life from kill of 63 days, of which typically 35 days were at sea.
- Lead times were 24 hours, with orders being received on day one for delivery either the same day or day two. Deliveries were made by road to customers' depots and from there to store.
- Stock levels were low, with suppliers saying it was not policy to hold stock, other than perhaps over weekends when typically the processing lines were not operating. There was some freezing of product, which could then be held for up to three months, but all regarded this as a 'last resort' for supplying what they regarded as a fresh market.
- Water used in lamb production is intrinsically high because of meat hygiene requirements. Water use approximates to 2.16m<sup>3</sup>/t, which is about 89 litres per sheep.
- There were 6,228 tonnes of general waste produced, including packaging, most of which will be landfilled.
- Some 171,000 tonnes of material is in Categories 1 to 3, and disposed of to rendering where it is combined with cattle material to produce fats and proteins.

### 3.6 Breakdown of a slaughtered animal

The research has shown that, typically, abattoirs will judge their own performance by the amount of meat they recover from the animal. Meat yield is closely monitored and any exceptions investigated. This research has also demonstrated that abattoirs do not analyse their residual material in any depth, except primarily to record materials falling under Categories 1, 2 and 3, which are subject to a disposal charge or payment. From a waste management objective, a more detailed analysis is required to improve resource efficiency.

This section therefore considers in more detail a breakdown of the animal. Residual material arises from slaughter, cutting operations and, to gain a complete picture, will include an adjustment for imports and exports. Based on usage it is possible to recognise the following materials derived from the slaughter of the four animals:

- carcase meat both retail and wholesale for human consumption;
- offal sold for human consumption; for example hooves, lungs, liver, kidneys, cheek meat, tendons, blood, soft bones;
- edible co-products not suitable for human consumption in their unprocessed state (for example stomachs, bladders, intestines and fat);
- animal by-products suitable for pet food when processed (Category 3). This can include offal and edible co-products once the decision has been made that they will not go as human food;
- animal by-products which are sent for rendering (Categories 1, 2 and 3);
- gut contents (Category 2 which does not need to be rendered but can be composted); and
- hide, feathers and skin, which have a variety of uses (Category 3).

The proportion of the animal that goes for human consumption (i.e. meat) includes the edible products such as carcase meat and offal, and edible co-products. These are different from animal by-products and must not be mixed with them, otherwise they are downgraded to animal by-products.

The regulations on the usage of edible products, edible co-products and animal by-products are complicated, and each material stream requires separate identification in the abattoir. Companies will vary both in the extent to which they harvest offal and edible co-products for human consumption, as well as the extent to which they are fully separating material into its component by-product categories. If one company has developed markets for such edible products in the UK or abroad, then it will reduce its economic loss compared with using such products in their next best alternative market (which may be rendering). Cost, of course, enters this equation and the current low collection costs for animal by-products may mean that it is uneconomic for the abattoir to divert resources to recovering potentially saleable products.

We have developed an overall 'optimal target' for dealing with residual material. To do this it has been assumed that all animals slaughtered are passed fit for human consumption, so that all the various offals and co-products can be recovered without loss. It is acknowledged, however, that this can be difficult to achieve in practice.

Although the benchmark has been developed to help individual companies, it can only be a guide as there are several reasons why any individual abattoir could differ from the standard we have developed:

- the estimates do not allow for the relatively small total tonnage of condemnations of whole or part animals on public hygiene grounds;
- if there is no suitable market, or the plant does not have the means to recover offal or edible co-products, then these may be treated as a by-product;
- there may be no market or collection service for material suitable as Category 3, which therefore has to be assigned to Categories 1 or 2;
- there are differences in cutting specifications, which may affect the amounts of material in Categories 1 to 3;
- it is assumed that the contents of stomachs and intestines are not emptied before disposal. For example, cattle intestines are disposed of as Category 1 without being emptied; and
- a proportion of residual material from cutting operations, for example fat and lean trim, could be recycled into meat products, particularly beef and pork (chicken processors are also able to mechanically recover meat).

The table below assembles total volumes for each of 13 categories of residual material that arises from the slaughtering and cutting of domestic and imported material. These figures can be reconciled with domestic production tonnages, adjusted for imports and exports.

**Table 15:** Total estimated weight of residual material ('optimal target' in tonnes)

<b>Groups</b>	<b>Cattle</b>	<b>Sheep</b>	<b>Pigs</b>	<b>Chickens</b>
Edible offal	49,078	28,881	22,845	83,100
Edible co-products	53,643	49,268	34,357	-
Main edible fats	70,381	39,584	10,253	58,170
Category 3 - slaughter	66,255	54,411	23,204	224,370
Category 3 - cutting	149,623	36,438	56,223	121,571
Category 3 - imports	26,604	13,191	19,875	5,087
SRM – slaughter	95,681	5,221	-	-
SRM - cutting	10,652	119	-	-
Stomach and intestinal contents	230,692	86,814	91,289	-
Hide and skins	109,582	79,169	-	-
Hair, scrapings	-	-	9,084	-
Feathers	-	-	-	108,030
Blood	51,915	32,789	36,965	49,860
a) All residual material	914,106	425,885	304,095	650,188
b) Recycled material for meat (3)	117,484	21,269	177,562	126,665
c) Meat	584,498	267,625	442,775	1,027,251
d) Total Meat (b+c)	701,982	288,894	620,337	1,153,908
Total live weight (a + d)	1,616,088	714,779	924,432	1,804,096

Notes:

- i. Calves have been excluded from the calculation above in relation to cattle
- ii. There are minor rounding errors compared with Table 3 in Chapter 1
- iii. Derived from the estimated Category 3 cutting and imports

The relative proportions indicated by the data serve as a benchmark for the industry, against which individual company performance can be judged. It is acknowledged that new data would need to be collected by the industry to enable these comparisons to be made, but our judgement is that it would be beneficial and lead to improvement opportunities that are currently being missed.

The data suggest several opportunities for improving value from the residual material derived from the slaughter and cutting of animals. It is acknowledged that regulatory changes could also impact on residual material use, for example, by allowing protein derived from by-products to be fed to livestock (avoiding intra-species recycling). However, all the examples presented below could be delivered within the current legal framework.

- From current understanding of abattoir practices, in the order of 200,000 tonnes of material is being assigned unnecessarily to Categories 1 or 2, some of which could either attract a lower disposal cost as Category 3, or a financial benefit if a market can be found.
- The emptying of all stomach and guts alone produces over 400,000 tonnes of material, and there are opportunities to use this as feedstock for biogas plants or composting.
- The market for offal (primarily liver and kidney), although stable in the UK with about 16,000 tonnes consumed annually and a value of £40m, is growing both in Eastern Europe and Asia, and represents an opportunity currently under-exploited. A national 'meat waste task force' is being formed by EBLEX and BPEX to take forward this issue for the red meat sector.
- There are 9m dogs and cats in the UK in 2010, up by over 9% from 2008. The pet food market is worth over £2bn, supplying some 1.286 million tonnes of product, of which just under 800,000 tonnes is for dogs. Dry dog food in particular is increasing its share of the market at the expense of moist dog food, because it appeals to pet owners who focus on quality.

- The export market for edible co-products (for example tripe and casings) is growing, especially to the Far East, as is the export market for more exotic cuts (for example paddywack and cartilage).
- In order to economically supply the pet food and the export markets for offal, volumes of products are needed and there are opportunities to collaborate to bulk up material.

### 3.7 Rendering

The total amount of animal by-product material identified in the project survey was about 1.4m tonnes. This compares with about 2m tonnes estimated by FABRA. These varying estimates can be reconciled as follows:

- FABRA estimates that 200,000 tonnes of fallen stock, which originates on farms, are included in their total;
- Animal by- products are directly imported into the UK by the rendering industry which are not covered in our survey;
- The rendering market is currently very competitive, with the result that market shares for each plant are probably being over-reported;
- Our sample for cutting plants underestimates the amount of animal by-product material, because we have focused on the larger, more efficient plants to achieve scale;
- Sheep abattoirs are less inclined to recover residual material because markets are generally not available; and
- Smaller abattoirs are less likely to segregate their material, have Category 3 or pet food collections.

The rendering process involves taking mainly the inedible parts of animals, cooking them at high temperatures to remove moisture, kill bacteria and separate out the fat and protein. Edible fat is also rendered and used to supply oil for fish and chip shops, for example. This process produces two main products: processed proteins and rendered fats. The breakdown of these products into their different uses has been provided by FABRA and is shown in Table 16 below together with their final usage.

**Table 16:** Uses of rendered material

Rendered Product	2009 (tonnes)	Usage	
1. Edible co-product	18,500	Animal fats	
2. Processed Protein Categories 1 and 2	257,000		
		189,000	Solid fuel
		55,000	Cement
		15,000	Fertiliser
		12,000	Landfill – ash
Category 3	181,300	Pet food	
3. Fats Categories 1 and 2	152,600		
		81,500	Liquid fuel
		11,500	Bio-diesel
Category 3	136,350	Oleo-chemicals Soap Animal Feed Pet food	
4. Waste water	1,600,000	Land spreading	

Data Source: FABRA

Notes:

- Ash is produced from the combustion of Category 1 and 2 meat and bone meal, produced under Government schemes that have now closed. It was disposed of to landfill, but in future any ash produced will be used in mineral aggregates or as a fertiliser component.
- The only significant oleo-chemical company (Croda) shut its UK operation in January 2010. When operational, it used to take UK and EU Category 2 and 3 rendered fat and also imported rendered fats, which are now being used in bio-diesel production.
- Waste water treatment produces water of river quality. The resultant biological sludge is injected into land.

### 3.7.1 Proteins

Category 1 and 2 proteins are used in two principal ways: first, as a fuel in specialised combustion units to produce combined heat and power, and secondly as a component of a mixture to produce cement. The protein can be both fuel for the process and can add some mineral components to the final cement product. Category 3 proteins are used as an ingredient in compound dry extruded pet food, and as an ingredient for fertiliser. There is a high level of research being conducted to develop control tools that will allow EU regulators to re-authorise the use of some species-pure processed animal protein for use in farm animal feeds. Such regulatory changes may have some potential to provide some benefits to industry.

### 3.7.2 Fats

Category 1 and 2 fats are used as fuels either directly in steam raising boilers and thermal oxidisers, or as a component in biodiesel. There is currently strong demand for tallow as a component in bio-diesel because it is preferred to palm oil. Category 3 fats are also used as an ingredient in animal feed and pet foods, as well as soap

manufacture and the oleo-chemical industry. Many abattoirs also collect fats as edible co-products. These are rendered and used to manufacture edible fats such as bakery ingredients, lard, cooking oil and edible greaves.

### 3.8 Anaerobic Digestion (AD)

Anaerobic Digestion is a route for dealing with Category 2 and 3 animal by-products (Category 1 material has to be rendered or incinerated). At present the AD process is being encouraged by capital grants and by double renewable obligation certificates (ROCs) if electricity is produced and sold into the grid. However, an AD facility has to be approved and incorporate a number of criteria relating to particle size and temperature. There are also restrictions on location; for example, an AD plant taking animal by-products cannot be located on the same premises as livestock.

Animal bones are not wholly suited to the AD process, and previous work has demonstrated that not all animal by-products are suitable as a feedstock. Blood, gut contents and lairage waste constitute a good raw material for AD, however blood needs to be heat treated (pasteurised) before the process, which balances out the heat and energy which can be produced by the methane.

Several AD plants are also offering a potential management route for slurry from Dissolved Air Flotation (DAF) plants as well as Category 3 animal by-products.

It seems likely that more animal by-products will be used in AD plants, though the economic and environmental benefits are currently unclear. AD is less energy intensive than rendering, while rendering produces a wider range of marketable products. However, renderers are investing in AD, including development of a feedstock source from food waste (case study 2).

#### **Case Study 2:** PDM – Investing in food waste AD



The large rendering companies are establishing AD facilities, and in 2008 PDM announced it had plans to become the UK's largest AD operator. PDM's first plant at Doncaster became operational in 2010, and will enable the company to generate energy from general food waste (not animal by-products) collected from a diverse range of local businesses. The new plant will handle 45,000 tonnes of food waste each year - material that would otherwise have been sent to landfill - and be capable of producing enough renewable energy to power 4,000 homes.

*"We are delighted to launch ReFood to the area and be able to help local businesses of all sizes recycle their food waste. Until now, we've worked mainly with businesses that are part of the food chain but with ReFood we're better placed to service organisations, such as schools and hotels, where food isn't their core business. We've already had a great response from local businesses in the South Yorkshire region as people are keen to find sustainable ways to recycle their waste."*

Source: PDM

The AD plant will also produce a nutrient-rich organic fertiliser. However, there are potentially significant issues for users of fertiliser derived from slaughterhouse waste (for example, in relation to product assurance schemes and the grazing of animals).

Tesco is working with the PDM Group to supply renewable energy generated from its 5,000 tonnes of unsold meat products, which is being used to generate enough electricity to power more than 600 homes for a year.

Sion Stanfield, Head of Waste & Recycling, at Tesco said:

*"As renewable energy technologies now become mainstream, there is no excuse for sending waste to landfill that could actually be put to positive use. Working with PDM provides Tesco with a nationwide solution that operates across all our stores and allows us to fulfil our environmental objectives by maximising our resources to reduce our carbon footprint."*

Under this arrangement, PDM collects meat waste from Tesco's 11 regional recycling service units, which is then recycled at one of four facilities in the UK.

**Case Study 3:** A K Stoddart – diverting material into new markets



AK Stoddart is an independently owned family business supplying high-quality beef to major retailers, food manufacturers and food service providers across the UK. At the abattoir in Ayr they have introduced a new production and packing area, which enables them to process products that used to go as pet food, or even Category 1 animal by-products, at a cost to the business. With the investment they have reduced their animal by-products and increased the amount of product they sell. These edible co-products tend to go for export.

This project was part of the Quality Meat Scotland 5th quarter project, which has reduced the load to Category 1 rendering by over 50%. During the past two years (from 2008 - 2010) it is estimated that due to several factors, including the falling cost of rendering and less product going to rendering, Scottish red meat processors have turned the £2.2 million cost of safely disposing of "fifth quarter" carcass parts into a £13.3 million revenue stream - a £15.6 million improvement.

## 4.0 Packaging, Water and Greenhouse Gas emissions

### 4.1 Introduction

This chapter examines the packaging and water used to produce fresh meat, and the greenhouse gas emissions associated with product and packaging waste. Data on packaging and water are derived primarily from the survey, while the greenhouse gas emissions are estimated based on a life-cycle approach.

### 4.2 Fresh Meat Packaging

Meat packaging has two main functions: to protect and preserve the product; and to carry information about the product. There are many packaging systems in use, and the choice depends on many factors including cost, the volume of product, and presentation.

Optimising the use of packaging requires the right materials in the right quantities across the supply chain, in a way that minimises waste. Successful examples can reduce costs while adding shelf life to products, and give rise to distribution efficiencies as well as reductions in carbon. The multiple retailers (with the exception of Morrisons for their own brand fresh meat) all rely on their suppliers to pack fresh meat.

The Government's strategy is to minimise the environmental impact of packaging without compromising its ability to protect the product. The Producer Responsibility Obligations require all companies (with an annual turnover greater than £2m and which handle more than 50 tonnes of packaging) to recover and recycle a proportion of the packaging they handle. The Regulations are enforced by the EA, and companies can discharge their obligations individually or through one of around 40 compliance schemes. There is no single compliance scheme for the meat industry. It has not been possible to obtain an estimate of the total amount of packaging used by the meat industry.

In 2005 the major multiple retailers and their suppliers signed up to the Courtauld Commitment (now in its second phase), a voluntary agreement to tackle the amount of packaging waste generated by the food industry. Fifty companies have signed up to the second stage of the Courtauld Commitment, but with the exception of Moy Park, there are currently no fresh meat suppliers who are party to the agreement.

Consumers have come to accept that fresh meat has a reddish colour, rather than the brownish colour that it would have in its natural state. There has been a wholesale switch by the industry to modified atmosphere packs, which help oxygenate meat to maintain its reddish colour. These packs have also provided longer shelf life, and therefore have been beneficial to consumers and the retail supply chain.

#### 4.2.1 Retail fresh meat packaging

The data in Table 17 below are sourced from retailers who have signed the Courtauld Commitment, and include a slightly wider set of products than those covered in this project. They have also been scaled to the overall grocery market from individual retailer returns. 'Other' in the table includes sliced and cooked meats. Packaging associated with fresh meat sold through specialist butchers is not included.

**Table 17:** Retail packaging for fresh meat

Category	Paper/ card	Glass	Alu	Steel	Plastic	Other	Total
Fresh meat and poultry	5,955	91	354	23	42,260	50	48,733
Frozen meat and poultry	3,246	0	7	0	2,394	3	5,651
Sausage and bacon	1,679	76	45	320	11,891	2	14,014
Other (inc. sliced & cooked meat)	1,802	521	67	116	16,363	2	18,872
Total	12,683	687	473	460	72,907	57	87,268

Source: WRAP

Table 17 shows an estimate of the total amount of primary packaging associated with fresh meat found in UK retail. It shows that in 2008 there were approximately 87,000 tonnes, approximately 2.6% of all retail primary

packaging. Looked at another way, this packaging represents under 5.0% of the total weight of fresh meat sales – this proportion will of course vary considerably depending on product and pack size.

Plastic is the main packaging material (84%) followed by paper/card (15%). All other types of packaging are insignificant in the context of this project. A proportion of this packaging (and its associated product) will be disposed of by retailers for a variety of reasons, for example because the product is out of the 'sell by date'. However, the majority ends up with households who then dispose of it through local authority collection systems.

There are hundreds of different packing formats, different packaging materials (trays, top skins and labels), different sizes and different colours. These add to the packaging waste at the retail packing companies. The supermarkets tend to trial and change these formats frequently, sometimes without adequate liaison with their suppliers to give them time to use up all of their stock. Consequently significant amounts of packaging and labels end up being discarded in the supply chain.

Although there is no definitive information, it is likely that around 80% of red meat is sold in high oxygen modified atmosphere (MAP) packs to help maintain the reddish colour of meat, and with the presence of carbon dioxide which helps to inhibit the growth of aerobic bacteria.

No retailer separates packaging from meat products that cannot be sold. Instead waste management operators separate the packaging. It has not been possible to obtain an estimate of the weight of this packaging or insight into the main disposal routes, although it is likely that the majority is used as a fuel as part of the rendering process. It is also likely that the weight of this packaging is in the region 1,000-3,000 tonnes based on the amount of product waste discarded by retailers.

In terms of the overall packaging weight that is being discarded, the majority of primary packaging will arise in households and elsewhere in the supply chain, while secondary and tertiary packaging will arise at cutting and packing plants that prepare the meat for sale.

#### 4.2.2 'Light-weighting'

Data provided by WRAP indicates that there is significant variation in the weights of primary packaging used for fresh meat products. From time to time a technological breakthrough, such as the introduction of a new material or manufacturing process, enables a step change to be made. In most cases however, light-weighting involves shaving off small amounts of existing material. The table below illustrates the difference in weight between the lightest and heaviest packs in use for selected fresh meat products.

**Table 18:** Pack weights

Individual Pack weights (gm)	Beef			Fresh Lamb	
	Mince 500gms	Steak 1 kg	Burgers 500gms	500gms	1 kg
Heaviest	20	14	30	32	52
Lightest	8	10	15	20	10

Source: WRAP/DHL

The data are sourced from the DHL compliance scheme and cover a wide range of pack sizes for the years 2005-2008 on around 50,000 products. The table shows that there are very significant differences in pack weights used for the five products shown.

It is possible that a small number of products account for the majority of sales, which could therefore have a significant impact upon reducing the amount of packaging generated. Further analysis based on the highest selling product shows that the potential exists to save packaging weight if a lighter packaging concept was applied. Although this analysis is based on historic packaging weights, it does suggest that further opportunities are available across a wide range of fresh meat products.

#### Case Study 4: Tesco – lighter shrink-film



*'We have worked with our main chicken supplier, 2 Sisters and the packaging supplier Multivac, to introduce an innovation in poultry packaging replacing the standard tray and film pack with a new patented 68% lighter shrink-film pack. The new format represents a large savings in materials and cost. Improved shelf life also contributes to reduced food waste. We plan to roll this pack out to other meat products.'*

Tesco  
CSR Report

#### 4.2.3 Recycled content and recyclability

WRAP has been encouraging the use of recycled food grade PET, HDPE and potentially PP, and considerable effort has been made by the industry to use more recycled content, although there is no specific data to show how much recycled content is currently being used in primary fresh meat plastic packaging.

The following are some examples of recent and current initiatives:

- rPET produced with a minimum of 50% post-consumer recycled content in place of expanded foam polystyrene (EPS); and
- PP trays with 15% post-consumer recycled high density polyethylene (HDPE) content.

The on-pack recycling label (OPRL) scheme run by the BRC, and supported by WRAP, provides brand owners and retailers with a standardised label format, based on the Recycle Now iconography, to inform consumers what packaging is currently collected for recycling.

#### 4.2.4 Vacuum packs

One key trend is the increased use of vacuum packs and skin packs, which reduce packaging weight and extend shelf life. However, in both cases there can be a problem of consumer acceptance because the lack of oxygen in these packs turns the meat a darker colour. While some retailers are pursuing this type of packaging, recently Asda announced it was withdrawing its vacuum packed meat less than a year after launching it, due to issues with customer acceptance and microbial growth.

#### Case Study 5: Marks & Spencer – new lighter skin packs



Under Plan A launched in 2007, Marks & Spencer made a commitment to reduce the weight of its packaging by 25% and to recycle all packaging material arising under its control. Marks & Spencer has been working to optimise its packaging having regard to the sustainability of resources from which packaging material is derived. It is well on the way to reaching its targets.

Beef steaks were typically packed in modified atmosphere trays, which helped maintain a reddish colour to the meat. Around 18 months ago Marks & Spencer looked for an alternative packaging solution that would help achieve Plan A objectives whilst also protecting the high level of embedded carbon.



The solution adopted, which has now been rolled out across all stores, was to use skin packs that had previously been used for fish products. The new packs are 30% lighter than the ones used previously, increase shelf life by five days, and improve eating quality of the meat (independently assessed).

The new packs have been well received by Marks & Spencer's customers and deliver both operational and environmental benefits.

#### Case Study 6: Waitrose – new 'flow pack' technology

## Waitrose

Waitrose has replaced its polystyrene trays with 'snip and slide' packaging using 'flow pack' technology, already used for foods such as bagged salads and crisps. According to Waitrose, the new pouches will remove 90 tonnes of plastic waste from customers' bins every year.



Minced and diced meat will be the first products to be re-packaged by the retailer.

EBLEX and the University of Bristol are conducting research (funded by the industry and Defra) to see whether MAP pack sizes can be reduced without compromising meat colour and shelf life. The research will also compare MAP with vacuum skin packs and vacuum skin pack bloom – a new development which combines both types of packaging technology – to assess the advantages and disadvantages of each for beef and lamb products.

#### 4.2.5 Supply chain packaging

After slaughter, most meat is transferred from abattoirs to cutting and packing operations (it is only in chicken slaughter and processing that this is an integrated process). Meat primals for cutting will be moved, sometimes to different parts of the country, in lined dolavs (large tray containers) and cardboard boxes, some 'naked', others vacuum packed. A proportion of this meat will be matured in vacuum packs before it is re-packed for sale. Cutting operations also use imported meat, some of which will be transported in vacuum packs, again using lined dolavs or sometimes cardboard crates. Fewer liners are now being used, and where they are, they tend to be light and washable.

The processing of meat generates significant additional packaging before it is packed and labelled for sale. Some of the products considered in this report require further processing, for example burgers and sausages. These require additional ingredients, which are transported in plastic bags and cardboard boxes.

Once packed for sale the meat is transported in returnable crates to retailers with, in some cases, additional shelf-ready packaging.

## Case Study 7: Aubrey Allen

# AubreyAllen

Aubrey Allen run a small wholesale butchery supplying both butcher's shops and catering establishments. They purchase lamb and pig carcasses, beef quarters and primals as well as venison and poultry. Aubrey Allen have recently introduced "a no cardboard policy" into their supply chain.

Working with their customers and suppliers, they have purchased reusable plastic crates to bring product in, to store it on site, and also to deliver product. They have almost eliminated cardboard coming into the plant and have reduced waste to landfill and recycling.

The main saving for the investment is the reduction of landfill and recycling costs. They have also made savings by reusing the crates over and over again. In fact, a 25kg cardboard box costs £1.50 whereas a reusable plastic crate costs £5.00. Once they have used the crate over four times there is little additional cost attached to it. The cost of cleaning these crates is minimal. Their suppliers have benefited from a reduced cost of supply of £50,000 per annum, while there is an annual benefit to Aubrey Allen of £30,000. There is also a reduced cost to all their customers who do not have to pay as much for cardboard removal, leaving more cash across the supply chain.

Vacuum packs are widely used in the supply chain for transporting meat and enabling maturation. A typical pack can be multi-layered, and during use becomes mildly contaminated with blood as it is in direct contact with the meat. Several cutting plants indicated that disposing of these vacuum packs was a major issue for them because they are typically disposed of to landfill. Individual processors have undertaken trials to have these packs cleaned but the costs have proved prohibitive. It is widely believed there are no recycling facilities for this material, although one waste management company is examining other potential disposal routes.

The amount of supply chain packaging generated therefore varies for several reasons:

- The extent to which products are matured; this is a process that takes place both to improve the flavour and texture and is a 'point of difference' for retailers. Most chicken is sold without maturation, while for beef, and to a lesser extent lamb, products could be matured for up to one month. Bacon is also 'cured' for a considerable time but fresh pork typically is not matured. Although there are traditional ways of maturing meat, modern processing involves vacuum packs that are then discarded prior to retail packing.
- Imported meat can arrive in vacuum packs; for example, pig loins are imported this way, while pig legs are imported in dolavs without packaging. Imported meat has been increasing as a proportion of total weight slaughtered, and this trend is increasing the amount of packaging that has to be discarded. Typically, unlike some other fresh products, retail packing does not take place at source.
- The amount of shelf-ready packaging that is used to facilitate shelf replenishment in store. Although this type of packaging was not widely used, it was prevalent for certain products, and a number of respondents indicated they were considering either introducing it or extending the number of products covered. This type of packaging, where used, is back-hauled to retailers' depots and collected for recycling. In the absence of shelf-ready packaging, products are typically decanted from returnable crates.

**Figure 11:** Shelf-ready Packaging



#### 4.2.6 Packaging waste

Packaging waste includes primary, secondary and tertiary packaging. It is not segregated into these categories on disposal, but instead by type of material (for example plastic, cardboard). These data are sourced primarily from packing operations associated with cutting plants. The general waste stream cannot be disaggregated into its component parts because there is no segregation at source.

Some 110,530 tonnes of packaging are wasted annually in the UK by the sector, of which 73% (81,150 tonnes) are disposed to landfill. It is not possible to break down the proportion that is landfilled, because all the material that is disposed of this way is skipped together. Approximately 43% is associated with chicken production, 30% with pork, 19% with beef and 8% with lamb. In practice, over half the weight of packaging that is landfilled is likely to comprise contaminated plastic and cardboard.

The remaining amount (29,380 tonnes) is recycled. Of the recycled amount, some 57% is wood, 27% cardboard, 15% plastic and the remainder paper and other material.

In addition to contaminated materials, the main causes of packaging waste are broadly similar across all products, and include the following reasons:

- Leaking vacuum packs, which in some cases could be as high as 2% of all vacuum packs, causing re-work and the defective pack to be discarded. In most cases the packs just burst. Re-packing also has to be carried out when incorrectly sized packs have been used, which is also a frequent cause of packaging waste.
- Machine breakdowns occur occasionally in all production processes, and while preventative maintenance can help reduce these occurrences, they cannot stop them happening altogether. Changeovers associated with short production runs can also result in wasted packaging.
- Defective packaging was cited as a cause of waste for all products. In part we believe this to be a commentary on the first bullet point above.
- Labelling changes resulting from regulations (just impacting on beef), voluntary agreements (for example in relation to country of origin), product differentiation, promotion and design lead to the use of incorrect labels which, when corrected, leads to the packaging being discarded.
- Poor storage of packing materials was also cited as a cause of waste.

Although of less significance in weight terms, the volume of discarded labels was frequently mentioned by suppliers. Label changes were frequent, and causes given included promotions and the media coverage on welfare in the rearing of chickens.

#### 4.2.7 Retail packing lines

Although cutting plants undertake packing operations for their retail customers, these are relatively recent additions to their work in comparison to slaughter and butchery skills. Previous work undertaken by IGD and the Red Meat Industry Forum on packing lines<sup>3</sup>, found that one major plant was operating at 26% efficiency (using a measure known as 'Overall Equipment Effectiveness'), though an average of 40% for eight plants examined was found.

In comparison, world-class manufacturing operations operate at around 85% efficiency. If plants could move from 40% to 60% efficiency, then packing lines could be scheduled for 33% less time, requiring less labour, less space and less reworked product. Lean practices, including introducing standard operations and improving changeovers, were key to reducing labour and energy input and wasted reworked product.

### 4.3 Water

The food industry is a major water user. According to Defra (Food Industry Sustainability Strategy, 2007) food and drink processing consumed 307M m<sup>3</sup> of water, more than many other sectors of the economy but less than half that used by agriculture. Several sectors of the industry are particularly heavy users of water, as shown in Table 19.

**Table 19:** Water usage by industry type

Sector	Water use millions m <sup>3</sup> (tonnes) per year
Dairies	39.0
Breweries	35.2
Soft Drinks	27.5
Distilleries	25.9
Meat	7.2

Source: Defra 2007

Although meat processing is not a heavy user of water compared with, for example, dairies or the drinks industry, according to the Environment Agency water consumption and emissions to water are the most significant environmental impacts of meat processing. The project did not examine water usage by retailers.

Typically the industry uses a lot of water, partly because of the hygiene requirements set by UK and EU meat regulations, which require potable water to be used for almost all washing and rinsing operations. In any abattoir, the major factor affecting water consumption is the amount of floor area used. To comply with the hygiene regulations, all process floor areas must be washed down with fresh water at least once a day, thereby limiting the scope for the re-use of water.

The vast majority of the companies participating in this research obtain their water from the public supply. Only in a limited number of instances (two companies) are bore-holes the main source, although in more cases they are relied on to top up the mains supply where licenses are granted. Bore-hole water may not be potable but instead usable for functions such as yard or vehicle washing.

In total, we estimate the fresh meat industry uses 12,249,073m<sup>3</sup> of water per annum in the animal slaughtering and cutting process, of which poultry slaughter and processing accounts for 49%. It is noted that this estimate of water use is considerably above that prepared as part of the Food Industry Sustainability Strategy. The project team is not aware of any other benchmarks against which to compare this estimate.

Table 20 below shows water usage in the processing for each species. The data are all derived from the research and adjusted onto a national basis.

**Table 20:** Water usage by species

Species	Water usage m <sup>3</sup> /t	Water and Effluent discharges m <sup>3</sup> /t
Chicken	3.23	4.31 (5.85)
Cattle	2.14	3.09 (1.94)
Pigs	1.63	3.09 (2.88)
Sheep	2.16	3.58 (2.42)
Mixed	-	4.33
Rendering	-	1.1

Source: Project team/Environment Agency

Notes:

a) The data in the second column in brackets are estimates derived by the Environment Agency as part of its recent review of the meat-processing sector.

b) The differences with the Environment Agency sample can be accounted for by sample sizes, and by the focus of the Agency on regulated sites only.

These data show that water use is highest for processing chicken as compared to the other three species covered in this report. Water consumption is highly dependent on the layout of individual slaughterhouses, and in poultry slaughterhouses will also depend on, for example, the size of bird, the method of slaughter, carcase dressing, carcase cooling and the degree of automation. Large quantities of water are consumed in poultry slaughterhouses for evisceration, cleaning and washing operations, which typically account for more than 60% of total water use and effluent volume.

The unit cost of water is lower than that for energy inputs such as electricity and gas. Most participants monitored by cost rather than any other way, and so are only aware of their consumption from utility bills. There was no indication of pre-treatment, such as softening, being used in processes, which can increase the embedded cost of water. The main cost in relation to water will be in the treatment of effluent before it leaves the plant, which could be up to 75% more expensive than mains water supply charges.

Most multi-plant companies monitor water usage by plant. For multi-species plants this means that it is not possible to split water usage accurately by species. Because floor area is a significant determinant of water use, benchmarking of water use is not widely practised between plants, which are typically of very different sizes. There are only a handful of plants that participated in the survey practising any form of sub-metering within a plant – though a number said they aspire to do this. Some processors have recently begun to sub-meter water and energy consumption by process area, and expect to make substantial cost savings through monitoring and targeting programmes. There was insufficient data available by species to publish the results from any sub-metering exercise without breaching confidentiality.

**Case Study 8:** Jaspers – introduced EMS



Jaspers are a family run abattoir which slaughters beef and lamb at their premises in Cornwall. Jaspers have recently introduced an environmental management system that includes two on-site effluent treatment plants.

These plants are designed to clean, filter and rid the water of any bacteria, viruses or pathogens. The treated effluent produced can be reused onsite for washing down external areas such as the lairage, for hauliers and farmers to wash their vehicles and can also be used in the toilet systems.

The main saving for the investment is the elimination of discharge costs for the wastewater, which was previously deep injected into land. Mains water usage has also reduced by about 30% with further savings predicted. Together there is an annual benefit to Jaspers of over £100,000.

#### *4.3.1 Water treatment*

Waste water from abattoirs and cutting plants comprises a mix of water, blood, faeces, urine and wash water. In certain cases effluent can be discharged direct to sewer, and the water company will levy a charge based on the Mogden Formula<sup>4</sup>. This uses an average effluent strength in terms of Chemical Oxygen Demand (COD) and Suspended Solids (SS) to calculate costs. Where it is not possible to discharge effluent to sewer, it can be pre-treated. According to the EA around half of the permitted installations have no on-site effluent treatment plant, and discharge effluent to foul sewer after basic screening only, a finding with which our survey broadly concurs.

On site effluent treatment offers opportunities to recycle treated water for some cleaning activities, which will reduce water consumption. The contamination of waste water can be minimised by collecting by-products and waste as close to the source as possible, and by preventing their contact with water. Minimising the water use in slaughter and carcase dressing can also reduce the actual contaminant load, by reducing the opportunities for the entrainment of organic matter such as fat or faeces. If by-products are entrained in water, the opportunities for their re-use are limited.

Some of the larger abattoirs have installed biological treatment plants that convert soluble and colloidal materials into bio-solids. These are usually activated sludge plants and can be high-rate or conventionally loaded plants, preceded by sedimentation or dissolved air flotation (DAF), or extended aeration plants or oxidation ditches treating screened effluent. Bio-solids produced by the treatment plant may be dewatered prior to land spreading as soil conditioner, or digested to yield biogas.

Total effluent discharged by abattoirs varied by +5% to -15% of the amount of water used, with the former reflecting rain water collections while the latter reflect losses primarily due to evaporation and the inclusion of water with blood, slurry and other wastes.

#### *4.3.2 Water efficiency*

There is considerable scope to improve water efficiency and, in particular, to reduce water consumption. One company did anecdotally share that they had saved considerable amounts of water and money by introducing sub-metering and investigating anomalies weekly. Envirowise (now part of WRAP) has published a number of general and specific guides on minimising water use, which provide the foundation for improvement. Our survey indicates that the majority of companies do not have water-related key performance indicators, however the industry is beginning to increase its focus on water use efficiency, most notably through the very recent production of water use guidance leaflets by EBLEX, HCC (Meat Promotion Wales) and QMS.

The list below suggests a series of measures that could be used for benchmarking between plants.

**Table 21:** Potential KPIs for measuring water efficiency

KPI	Units	What is it?	What does it reflect?
Total water consumption	Total m <sup>3</sup> consumed	Total water use on site (excluding cooling water)	Total volume of water consumed in any given time period
Process water	m <sup>3</sup> / tonne of product	Water used in processing operations	Volume of water used in any given time period to produce a normalised unit of production
Cleaning water	Total m <sup>3</sup> consumed	Water used for cleaning purposes	Volume of water used for cleaning (which could be broken down by different operations)
Cooling water	Total m <sup>3</sup> consumed	Water used as a coolant	May be difficult to determine
Water reused/recycled	% by volume	Proportion of water recycled on site	Level of water reuse/recycling being achieved

Source: Envirowise

Based on a number of waste prevention reviews that were done by Envirowise as part of this project, the following examples of operational improvements would result in considerable savings for the industry. One key finding of these reviews was that sites generally did not have an accurate water distribution plan for their buildings, although some steps were being made under IPPC permits. The picture in Figure 11 below shows neatly installed pipework, but it is not easy to follow the flow of water (hot, cold or steam) without labelling.

**Figure 11:** Example of water pipework



Other recommended water improvement plans included the following activities:

- Install key sub-meters (for example to abattoir, boning halls and vehicle wash areas).
- Check pressure of hot and cold supplies.

- Reduce flow to knife sterilisers.
- Eliminate unnecessary use of water (for example to gut rooms).
- Modify vehicle washing.
- Install flow controls on urinals.

### 4.3.3 Federation House Commitment

The Federation House Commitment (FHC) is a voluntary agreement under which signatories in the food and drink industry contribute to a target to reduce the sector's water usage by 20% by 2020 against a 2007 baseline. WRAP is responsible for working with signatories to achieve the target and extend the coverage within the food and drink sector. New and existing signatories to the FHC benefit from a package of support to help them identify and realise water savings and associated benefits. This includes:

- up to three days implementation support from a technical water expert. This could be used to help draft a water mass balance, to develop an action plan or to advise on implementation actions;
- access to a number of on-line tools to support water saving activities. This includes a Water Monitoring Tool, a Water Accounting Tool and a tool to calculate charges for effluent treatment and disposal;
- access to benchmarking information and Good Practice Guidance;
- opportunity to participate in a peer working group to share best practice, address specific issues and drive success;
- opportunity to promote success through the development of case studies and industry events; and
- access to a dedicated FHC team by telephone and e-mail and website [www.fhc2020.co.uk](http://www.fhc2020.co.uk).

While the FHC potentially covers the fresh meat sector, there are currently only four signatories from the sector; Cranswick Food Group, RWM Food Group, Moy Park and Tulip.

*"We are proud that Cranswick was the first company in the meat sector to sign up to the FHC. It is a long-term commitment, which demonstrates to our retail customers, financial investors and the end consumer of our products, that we operate our business with the utmost care for the environment."*

Bernard Hoggarth  
CEO, Cranswick Food Group

## 4.4 Greenhouse gas emissions

Research from New Zealand has calculated the carbon footprint of the whole life chain for lamb. It calculated that 80% of emissions come from the farm, 3% from meat processing, 5% from transport and 12% from consumers, although the proportions will differ systematically between species. In New Zealand, sheep farmers produce more lamb by weight now compared with 1990 from a 43% smaller flock. Meat processing comprises only 3% of the lamb footprint, but the study identifies opportunities for meat processors to reduce this contribution further, particularly in energy used for refrigeration, water-heating and operation of machinery, and wastewater management. It must be also remembered that NZ electricity has a much higher proportion of renewable sources in its mix than that of the UK. So if processing in the UK uses the same energy per unit weight, it will emit more CO<sub>2</sub>e per unit weight.

In the UK, more research has been focused on the production side (for example by Cranfield University<sup>5</sup>), although parts of the processing and distribution systems have been analysed (for example Defra-funded research by Cranfield, AEAT, ADAS, and Campden BRI<sup>6</sup> and Brunel University<sup>7</sup>). The Cranfield-AEAT study found that the GHG emissions from processing and delivery to retailer depot for lamb, beef and chicken were 5%, 1% and 11% of the total (that is, from UK production to depot) respectively.

For the UK there are estimates by Brunel University<sup>7</sup> of greenhouse gas emissions in food retailing for various products, including packed fresh meat. The work only covers the retailers' depots and stores, and does not distinguish between different types of meat. Results from this study indicate that refrigerant leakage and display cabinet refrigeration account for the majority of emissions.

Work to develop carbon footprint estimates for the beef and lamb supply chain in England are underway by EBLEX. If the New Zealand figures are borne out in the UK, then only 8% of emissions will come from the retail

supply chain, with the remainder coming from production and consumption. However, it will be important to ascertain where in the retail chain the main reduction opportunities are available. The EBLEX work is limited to beef and lamb, and there do not appear to be plans in place to compile similar whole life cycle approaches for the pig and poultry retail chains.

To date, life-cycle assessment or carbon footprint studies of the UK rendering industry are incomplete. Research at Harper Adams University College, however, is being conducted to determine the energy use and GHG emissions of the UK rendering industry, and to develop a toolkit that can be used to evaluate different rendering processes.

The GHG emissions associated with rendering depend on the category of animal by-product processed (Categories 1 or 3 only). The research at Harper Adams will calculate the energy use and GHG emissions of each plant. Energy use in the rendering process varies between plants with most using electricity, natural gas, tallow and fuel oil as energy carriers to convert animal by-products to protein and tallow. The project will also examine whether GHG emissions associated with aqua-feed production would be reduced if they were based on Category 3 protein meal as opposed to fishmeal.

#### 4.4.1 Estimated emissions

Our analysis is limited to producing an estimate of GHG emissions associated with product and packaging waste, so that upstream emissions of animal production and downstream emissions from households have not been included. While a life cycle perspective has been used to inform this analysis, it does not amount to a formal life cycle assessment. To date no formal LCAs have been completed for any animal species in the UK. The results have been split into meat processing, including retailing, and rendering. Technical details of the calculation are included in 2.4.1.

The main source of emissions from meat processing is energy use, followed by solid waste disposal, while effluent treatment generates a GHG credit. A summary is shown in Table 22 below.

**Table 22:** Summary of GHG emissions from both abattoirs and meat processing

<b>Abattoirs</b>	<b>Beef</b>	<b>Pigs</b>	<b>Lamb</b>	<b>Poultry</b>	<b>All Species</b>
Conversion of flows to CO <sub>2</sub> e emissions	kt CO <sub>2</sub> e / year				
Electricity	61.1	22.6	13.9	244	342
Gas	5.00	0.84	2.02	42.3	50.1
Gasoil	0.12	4.04	0.23	0	4.40
Propane	0	1.90	0	0	1.90
Total energy	66.2	29.4	16.2	287	398
Water	0.90	0.44	0.42	2.14	3.90
Effluent	-0.34	-0.28	-0.21	-0.39	-1.21
Lairage	6.18	2.81	2.64	0	11.62
Packaging wastes					
General waste (landfill)	3.33	5.38	1.37	7.72	17.8
Cardboard (recycled)	12.6	10.0	0	0.01	22.7
Plastic (recycled)	0.22	0	0	0	0.22
Paper (recycled)	0.013	0	0	0	0.013
Wood (recycled)	0.00	0	0	0	0.001
Packaging wastes sub-total	16.13	15.41	1.37	7.82	40.72
Grand total	89.0	47.8	20.9	296	454
CoV	5.3%	6.7%	5.7%	6.4%	4.4%

Note:

- a) Where data uncertainties arise, estimates have been made using 'monte-carlo' simulations with the resultant uncertainty expressed as the coefficient of variation (CoV) – the standard deviation divided by the mean and expressed as a percentage.

b) Data on poultry energy use has been checked against industry sources.

Poultry generates considerably more GHG emissions compared with the three red meat products. This contrasts markedly with the production stage, where previous research has shown poultry production to be more efficient. Poultry processing is much more mechanised than red meat slaughter and so uses more electricity per head, though electricity is used for refrigeration in all plants. Packaging wastes still make a substantial contribution to overall emissions, particularly as a proportion for the three red meat species.

GHG emissions associated with rendering are based on simplified data, as the subject is being considered in detail at Harper Adams University College. The estimates produced in Table 23 below are thus intended to be only broadly indicative of the scale of the industry's activities. The industry is complex and very diverse at plant level, thereby increasing the uncertainty over the data.

**Table 23:** Summary of estimates of emissions and emission credits from the rendering industry

Item	Emissions, kt CO <sub>2</sub> e	CoV	Credit, kt CO <sub>2</sub> e	CoV
Collection of materials	50	21%		
Energy and water use	1262	26%		
Plastic packaging disposal from retail	0.04	30%		
Rendered oils			284	25%
PAP - pet food			1584	25%
MBM and ash in cement			53	16%
MBM as fertiliser			39	31%
Total	1,312	25%	1,959	20%

The rendering industry creates larger emissions compared to slaughter and processing, owing to the need for energy to maintain processes, but it also creates large credits through the conversion of what are nominally wastes into useful products. Fats derived after rendering from animal by-products can be used to supply liquid and solid bio-fuels to industry (which can replace fossil fuels such as oil and coal for steam and power generation), and be used in biodiesel production. Proteins produced in the same way can be used to produce protein meal, which can replace soya meal. While the credits from rendering appear to exceed the total emissions, the results are not statistically significant. The results suggest that the value of useful outputs from rendering is broadly equal to the emissions incurred.

These data from our research are the first available and should be regarded as provisional until more detailed results are available from the research at Harper Adams.

#### 4.4.2 Reduction Strategies

The UK Climate Change Act, which came into force in 2008, puts in place a legally binding target of an 80% cut in greenhouse gas emissions against 1990 levels by 2050. That target is for emissions from production across all sectors of the economy.

It is widely accepted that the UK and other countries should also seek to reduce the GHG emissions associated with their consumption. This consumption approach excludes emissions associated with products that are produced in the UK for export, but includes those associated with products and services produced in other countries and then imported. On a consumption basis, research by the Food Climate Research Network<sup>2</sup> puts food-related emissions at 18% of the UK's total footprint, with livestock products accounting for 8% of the total or 43% of food-related emissions. With imports of meat increasing, it is likely that livestock will account for a growing proportion.

Since 2001, the Climate Change Levy (CCL) has been paid by industry on certain energy sources used for lighting, heating and power. Climate change agreements are available to all food and drink businesses, and give an 80% discount on the CCL as long as additional CO<sub>2</sub> reduction targets are met. A new Carbon Reduction Commitment

<sup>2</sup> <http://www.fcrrn.org.uk/>

(CRC) Energy Efficiency Scheme started in April 2010, through which all businesses that use more 6000MWh of electricity have to register with the EA, in preparation for a GHG emission pricing scheme aimed at capping total emissions and incentivising reduction. Approximately 175 plants have signed up for the CCL through the British Meat Processors Association scheme, comprising abattoirs, cutting plants and retail packing plants. Only the larger players with multiple sites will tend to be affected by the CRC.

In 2009 EBLEX produced the English Beef and Sheep Production Roadmap, 'Change in the Air'<sup>8</sup>, which sets out how to reduce GHG emissions from livestock production. In planning to achieve the required savings, emissions of CO<sub>2</sub> per kilogram of meat are taken as the key parameter in measuring real gains in the efficiency of livestock production (rather than reductions in stock numbers). Under the EBLEX plan, emissions will be based on improving productive efficiency. This will be based primarily on improving the feeding efficiency of stock, coupled with improving the fertility and longevity of breeding stock.

In the next phase of development, EBLEX are working with the BMPA to compile a whole chain road map of GHG emissions and develop reduction strategies.

Similarly a roadmap for the English Pig industry, 'Advancing together – towards better performance' was very recently published by BPEX<sup>9</sup>, setting out the targets the industry has established to reduce its environmental impact. Again, the findings from this roadmap are focused not only on sustainability and reducing environmental impact but also on deriving operational efficiencies that directly benefit producers.

One retailer - Sainsbury's – plans to extend its CO<sub>2</sub> audit of dairy farmers to include beef, lamb, pigs and poultry. In due course, all suppliers will be issued with a 'traffic light' report, which indicates where they rank compared to other suppliers. The supplier is shown whether they are in the bottom 25%, the middle 50% or the top 25% in terms of their carbon footprint. The report also provides feedback and recommendations for cutting emissions and achieving cost savings. The carbon initiative is based on a model developed by AB Sustain, a division of Associated British Agriculture, and was the first livestock model to achieve the Carbon Trust's PAS2050 status. Sainsbury's carbon initiative has won industry awards, including the IGD Environmental award and the Green Apple award for the environment.

## 5.0 Retail supply chain for fresh meat

### 5.1 Introduction

This chapter sets out data on fresh meat waste arisings in the retail sector, together with a discussion of the causes. It also includes further insights from interviews on some of the factors affecting waste management across the retail supply chain.

### 5.2 Retail waste

The proportion of fresh meat sold through the multiple retailers varies by species and by cut of meat, but does not fall below 87% by volume of all meat retail sales. Independent butchers make up around 3%-10% of the market depending on product.

The major multiple retailers have developed a wide range of store formats to serve different customer segments, from supermarkets to convenience stores (including garage forecourts, at railway stations, and motorway service stations). Ranging policies for these stores varies considerably, though most sell fresh meat. In addition, the convenience retail sector is served by symbol stores (for example Londis), and a large number of independents who also sell fresh meat.

Most fresh meat is sold as retailer own label. There are very few branded fresh meat products (though sausages, burgers and bacon are exceptions). There is a strong competitive dynamic between the major multiple retailers, who are driven by commercial pressures to increase their market share. Not surprisingly this results in a strong focus on sales and the need to ensure that product is always available for customers to buy.

All the multiple retailers interviewed in the project measure waste, and their stores, supply chain and commercial teams have waste targets. There was a general view both from suppliers and retailers that waste included all products that are marked down, as well as any product or packaging requiring disposal. Some retailers also included theft in their definition of waste. However, it did not prove possible to obtain data on these different waste streams.

Most retailers have a policy to mark down meat products as they approach their 'sell by dates'. In doing so they aim to avoid disposing of the product, which involves a cost, while still generating some income, albeit reduced. Anecdotal evidence suggests that if store managers followed guidance on mark-downs, then the amount of product requiring disposal would be reduced significantly. It has not been possible to obtain any information from retailers on the extent to which meat in general or individual meat products are marked down.

*'In our stores, we've cut food waste by 20% against last year through price discounts on short shelf life products'*

Marks & Spencer  
Plan A, 2009

At present, therefore, there are no accurate benchmarks on meat waste to enable comparisons across retailers or for different store formats.

Retailers combine their meat and fish waste (because they have to be treated as animal by-products) for collection by waste managers, sometimes directly from store, while in other cases it is back-hauled to depots. There was some criticism by waste managers of the extent to which this material is double bagged, which they believe is practised because of mistaken advice given by inspectors. The survey data collected by this research indicates that retailers waste some 72,000 tonnes of fresh meat. Of this about 39% is poultry, 36% pork, 20% beef and 5% lamb.

It has proved difficult to discern any trend in the amount of waste generated during the course of the year. Most respondents believed that waste arisings were fairly even across the year, although there were significant variations in the types of product sold during the summer and winter. One retailer believed that meat waste increased during the summer in response to higher temperatures, which adversely impacted the quality of meat.

The rendering industry estimates that retailers sent 33,000 tonnes of animal by-products to them in 2008, rising to 35,500 in 2009. Retailers may send their material direct to AD plants as well as to renderers. The increase in animal by-products sent for rendering may represent a diversion of material in favour of rendering, or a real

increase in the amount of this type of waste generated. The precise reasons for this change cannot be identified in detail, but it is possible that it has resulted from the increased amount of meat being sold on promotion during 2009, as a response to the economic recession (promotions are considered further below).

The leading causes of waste at each stage of the supply chain were included in the resource maps (Chapter 3) but are discussed in more detail below. It has not been possible to attribute causes to individual products, as retailers and their suppliers do not analyse their waste in this way. Retailers keep detailed information on mark-downs for individual products, but the project team were not allowed access to these data. Retailers typically analyse their waste data by store and will investigate those stores where waste is high.

Waste arises for a wide range of reasons, including demand management, basic shop-keeping and supply chain operations. The main causes are shown below:

- Weather affects the sale of fresh meat, particularly during the summer. When forecast hot spells do not materialise, there is typically an impact on demand and consumption. More often than not in recent years this has been an adverse impact.
- Forecasting has to be carried out by both retailers and suppliers to facilitate order fulfilment. Although forecasts will never be entirely accurate, they are best done jointly by retailers and suppliers working together. Certain retailers are running trials in which they 'fix' the order in time to allow suppliers to produce to order rather than forecast. This approach could help suppliers with their production planning and reduce their waste, though it could also effect on-shelf availability or the amount of product disposed of by retailers.
- More fresh meat has been sold on promotion, and unless well executed this type of activity could increase product that has to be disposed of. Most respondents did not believe that promotions were a significant cause of waste, though it is unclear whether switching between chicken and different types of red meat by consumers was taken into account in their assessment. Promotions were considered to be effective at removing a build-up of stock, and by implication preferential to freezing.
- Stock rotation policy that ensures product nearing its 'sell by' date was presented to customers first can sometimes be over looked, both by store managers and by consumers. Although an issue, it was not considered to be a significant cause of waste.
- Refrigeration systems in some stores can either be less reliable because of their age or put under stress by warm spells. This could affect in particular the shelf life given over to products and thereby the window available for sale. Sometimes an allowance was made to the shelf life given to products because of known weaknesses in refrigeration systems. Catastrophic failure was rare.
- Merchandising standards, while generally very high, sometimes fall short particularly when product is being marked down because it is close to its 'sell by' date, or when major promotions are being run in store.
- Quality Control (appearance) can arise for a variety of reasons as shown in Table 24 below, which was provided by one of the major retailers. The causes cover all types of meat, and while the incidence of any single cause is very low, the wide range of possible quality issues indicates the attention to detail that has to be applied in managing the fresh meat supply chain.

**Table 24:** Potential Quality issues

Leaking packs Incorrect gas levels in packs Product not lasting its shelf life Product stored in incorrect back up Product stored in incorrect display cabinet Refrigeration breakdown Cold doors left open	Refrigeration problems/missed defrosts/inefficiencies Exposure to ultra violet light Temperature abuse prior to receipt into store High microbiological count Production issues
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### 5.2.1 Meat on-shelf availability

Retailers are sales driven and for all those interviewed 'on-shelf availability', which measures how often a product is not on sale, was a key performance indicator. Indeed, availability is a key measure for the whole supply chain and drives supplier behaviour. To paraphrase what many interviewees said, 'the fear of a lost sale is greater than the fear of waste'. Measures of on-shelf availability for individual retailers are commercially sensitive.

IGD's on-shelf availability survey<sup>3</sup> provides a benchmark for the industry, covering 160 stores and a similar number of own label and branded products that make up a typical weekly family shopping trip. Audits take place six times a year and provide a view of how availability differs by day of week, time of day and geographical region. Table 25 below shows availability trends for a range of own label meat products.

**Table 25:** On-shelf availability

SKU	Feb-10	Feb-09	Feb-08
O/L Beef Topside/Silverside Joint	100.00%	85.64%	95.98%
O/L Chicken Breast Fillet Skinless	92.36%	97.44%	91.46%
O/L Pork Chops (Bone-In)	95.14%	96.41%	95.48%
O/L Rump Steak	99.31%	92.82%	99.50%
O/L Standard Beef Mince	99.31%	99.49%	99.00%
O/L Whole Chicken	98.61%	95.38%	99.00%
O/L Thick Pork Sausage	95.83%	93.33%	95.98%
O/L Unsmoked Back Bacon (Rindless)	86.81%	98.97%	96.48%

Source: ECR UK

It is not possible to discern any major trends, though there are current problems with several meat products, including chicken breasts and un-smoked back bacon. It is not clear from the availability survey what is causing these problems.

Suppliers are measured, in part, on their delivery performance, which should be 'on time in full', and they will avoid 'shorting' their customer whenever possible. Achieving a balance between product availability and waste is a key part of store management.

### 5.2.2 Promotions

IGD's consumer research has shown that shopping behaviour changed during the economic recession. One key result is that 36% of shoppers rate price as the main driver of food product choice, making it the top factor, compared to 2008 when price was the fourth most important driver. Many shoppers were also taking more time over their shopping, by shopping around and looking out more for the best deals. Shoppers were also scrutinising the promotion labels closely. In many cases they were comparing different promotions and offers on the same fixture, with some also comparing them with promotions they knew were available at other stores. Some were also changing their shopping routine by buying products in bulk when they saw them on promotion. This added to the attraction of 'multi-buy' promotions such as 'buy one, get one free'.

Retailers have responded accordingly, and on average the proportion of store turnover generated through promotions has increased over the last two years from 28% in 2007 to 32% in 2009. Table 26 below shows the proportion of meat sold on promotion by the multiple retailers, and the type of promotion between 2008 and 2010.

<sup>3</sup> See [www.igd.com](http://www.igd.com)

**Table 26:** Meat on promotion

Promotion Type	Fresh and Frozen Meat		Fresh and Frozen Poultry		Bacon		Sausages	
	w/e May 2008	w/e May 2010	w/e May 2008	w/e May 2010	w/e May 2008	w/e May 2010	w/e May 2008	w/e May 2010
No promotion	69.8	63.5	69.3	69.5	67.5	63.9	65.4	62.3
Price reduction	19.8	21.9	15.5	16.1	15.5	18.7	12.5	20.2
Multi-buy	1.2	1.4	5.1	2.4	3.9	3.6	4.8	1.8
Y for £X	8.7	13.0	9.3	11.9	12.7	13.7	14.5	13.2
Extra free	0.4	0.2	0.8	0.1	0.4	0.1	2.6	2.5

Source: Kantar/AHDB

Analysis of the data shows:

- An increasing proportion of meat is being sold on promotion – with the exception of poultry. Further, more detailed analysis indicates that around half of all mince was sold on promotion between 2008 and 2009.
- The most important type of promotion is a temporary price reduction for all types of meat. This type of promotion is also now used more frequently than other promotion methods.
- Y for £X type promotions have also increased in importance, while multi-buy promotions have reduced and are used infrequently.

The success of a promotion is highly dependent on good forecasting together with an element of 'good luck', for example because the weather turns out as forecast. Meat products are prepared in expectation of a BBQ summer, and when this does not materialise product can end up being wasted.

Promotions do create more unpredictable demand patterns, both for the specific products on promotion and for substitute products that may have their sales impacted, a process known as cannibalisation. Although interviewees said that promotion planning took account of the risk associated with cannibalisation, it was unclear whether it was a significant issue particularly if the product(s) being impacted were those supplied by a competitor.

### 5.2.3 Communications with suppliers

A variety of commercial arrangements exist between retailers and their suppliers. For example Morrisons owns both the slaughterhouse (Woodheads) and meat processing plant (Farmers Boy), though this approach is the exception.

#### Case Study 9: Morrisons – controlling the whole supply chain



*'Instead of buying cuts of meat, Morrisons buys the whole animal: we buy the pig not the pork chop. Our buyers buy 17,000 lambs, 16,000 pigs and 3,000 cattle every single week – and we use every single cut of meat.'*

*Once we have sourced our livestock, we transport them to one of our three Morrisons-owned abattoirs. Large cuts of meat, called primals, are transported from the abattoir to store where one of our 1,000 in store butchers will prepare cuts exactly how the customer wants them. We offer single servings of certain types of meat and are the only supermarket to prepare meat exactly how the customer wants it.*

*What's more, by cutting and preparing the majority of our meat in store, we are able to react very quickly to changes in customer demand.*

Morrisons - Food Waste Factbook

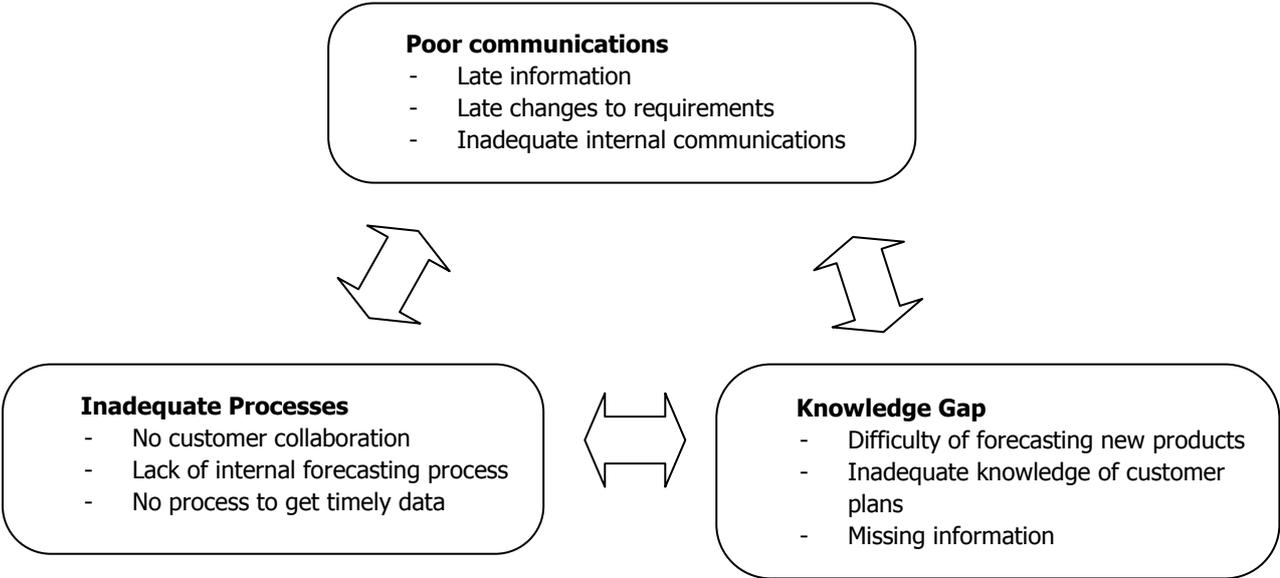
A more widespread practice is for abattoirs and cutting plants to be separate businesses, dedicated to either a single customer or more generally several. This typical approach requires forward planning, because the animals take from 60 days to 24 months (depending on the species) before they are ready for consumption, and good communications are required to ensure the processing operations are geared up to meet customer demand.

Most large abattoirs have 'producer clubs' or similar arrangements with livestock farmers, who provide their animals on a regular and planned basis. Many companies that slaughter chickens, unlike those in the red meat sector, own the breeding and rearing stages.

Part of demand management is accurate planning, particularly in respect of forecasting customers' requirements, both over a yearly cycle and in respect of fulfilling current orders. Typically promotions are planned in advance between retailers and suppliers, but more often than not demand forecasting is conducted separately, with most suppliers producing to forecast rather than actual order. Forecasting practices varied and were not looked at in detail in this research.

According to IGD, forecast accuracy across the whole grocery sector is dependent on three main types of challenges faced by the industry, as shown in Figure 13 below.

**Figure 13:** Forecasting accuracy



Source: IGD

Of these three, poor communication is experienced by a large number of organisations. This includes issues such as changes to market conditions and types of promotion thereby affecting requirements. Inadequate internal collaboration is another challenge. This is more pronounced for those companies who require an early commitment from the customer, owing to the 'long nature' of their supply chain. Most believe that collaborative forecasting is essential to build capability in order to deliver a high level of forecast accuracy.

Such practices appear to be rare in the fresh meat industry. However, certain suppliers have improved communications by having an 'implant' with the retailer whose job it is to forecast and monitor sales. Where this is practiced suppliers said it was very beneficial.

## 5.2.4 Specifications

Shoppers have come to expect exacting standards for the meat they purchase (beyond it being safe to eat). In part this is about presentation, for which retailers set specifications in terms of, for example, size, colour, and lack of blood in the pack. Other specifications affecting the quality of meat, including for example fat content, can also cause waste. However, most suppliers have a thorough understanding of their customers' specifications and will strive to adhere to them as part of their service standards.

Although it is not possible to quantify the number of customer complaints, a number of retailers said that the single largest consumer complaint is 'off meat' - which could include discolouration or actual mould. Product waste arising from these causes is extremely low. The low level of 'off-meat' waste is confirmed by WRAP's own analysis of household waste.

In response to the economic recession, retailers have introduced 'value lines' for a wide range of meat products. For beef, these lines account for about 10% of the market in volume terms, although less for the other products. It is unlikely that the introduction of these products has led to any significant changes in carcass utilisation, though they may have offset imports for certain parts of the carcass.

## 5.2.5 Shelf life

There are significant variations in shelf life, which is influenced by species, product type, packaging and the quality of refrigeration. Determination of shelf life was left to technologists and retailers' trading strategy, with many making use of the services provided by Campden BRI and other food technology specialists.

Table 27 below summarises the variations found by product and species. Particular products could fall outside these ranges, which are presented as averages indicated by participants in the survey. Bacon, for example, has a long shelf life because it is cured with salt and other ingredients, while certain high value products like steaks are matured, which enables them to have a longer shelf life. With lead times typically one-day, retailers and households have the majority of product life.

**Table 27:** Typical shelf life

<b>Beef</b>		<b>Lamb</b>		<b>Pork</b>		<b>Chicken</b>	
Frozen	1 year+	Frozen	1 year+	Frozen	1 year +	Frozen	1 year +
Burgers	7-14 days	Kebabs	9-14 days	Bacon	21-42 days	Whole birds	8-12 days
Mince	7 days	Fresh Lamb	12-17 days	Sausages	7-20 days	Portions	8-12 days
Cooked	7-15 days	NZ lamb	63 days (35 at sea)	Cooked	7-40 days		
Joints	18-28 days			BBQ	8-10 days		
Matured	30-42 days			Fresh pork	7-15 days		

Shelf life has been lengthening, driven largely by the increased use of modified atmosphere packaging and recently by vacuum and skin packs. There were divergent views on the role of shelf life in causing waste. For one retailer lack of shelf was the main cause of waste, for another short shelf life caused waste because consumers perceived the product was not fresh, while another was also sceptical that technologies like MAP led to reductions in waste across the supply chain. Instead extended shelf life tended to optimise on-shelf availability only.

It does not follow that products with longer shelf life are less wasteful. The evidence from this study and previous research suggests that cooked meats are the most wasted product, though we cannot isolate the effect that different sell by dates, store sizes or promotions also have on waste for these. However, longer shelf life increases the retailers' window for sale and gives households more time if products are not consumed as soon as expected.

WRAP research into household food and drink waste shows that of the 260,000 tonnes of avoidable fresh meat waste generated annually, the majority is disposed of because it was not used in time. Information from consumption diaries that supported the research indicated that the vast majority of this waste was associated with confusions around date labelling. For example, consumers were not using or freezing fresh meat before the end of the use-by date, and so were discarding meat when it was still safe to freeze.

### 5.2.6 Labelling

Country of origin rules are complex, and under the present food labelling legislation, foods such as beef and certain fruit and vegetables must have labels saying which country they have come from. However, foods such as ham, pies, sausages and ready meals need only include this information if it is misleading to the consumer without it.

Beef labelling is an EU wide scheme, which is intended to provide buyers with clear, reliable information about fresh and frozen beef (including veal) on sale. All beef and beef products must be labelled to ensure full traceability back to the point of origin at all stages of production and sale. The rules of this compulsory scheme require that an enforcement system be established in each Member State, to ensure that beef labelling procedures are being correctly applied. Ministers have decided that in England and Wales this should be achieved through a system of inspection managed by the Rural Payments Agency (part of Defra), covering those slaughterhouses and cutting plants that are not checked by local authority trading standards officers.

With the exception of beef – which is regulated very closely – fresh meat does not have to display its country of origin. Because of the increase in imports, particularly of pork, there is on-going debate over whether consumers are misled into buying foreign meat because it is being labelled as though it were British.

The significance for this project rests in both the amount of labelling that is required and the frequency with which changes take place. Retailers have different product tiers, which result in different labels to reflect these different standards. With regular product changes and promotions label waste can increase substantially. Typically labels are on rolls with liners and these will also be wasted. One respondent to the survey said that over 1 million labels are thrown away annually.

Labels can be light-weighted, for example by reducing their size and thickness (from say 650 to 500 microns).

## 6.0 Discussion and recommendations

The following recommendations are not in order of significance. Taken together, they offer the fresh meat industry an opportunity to reduce all types of waste, reduce costs and benefit the environment.

### 6.1 Resource management

The project team did not find any strong evidence of leadership by the meat industry to address the resource management issues considered in this project. There are several reasons for this: the industry is fragmented across species with all meats in competition; there are different trade bodies covering the four species; and there are different regulatory approaches, as IPPC only covers poultry and pigs farms, and only the large meat processing plants. In trying to combat this there is a considerable amount of secrecy within the industry, and initiatives that would give a company a competitive advantage tend not to be broadcast.

However, there are some very encouraging developments. For example, the BMPA and EBLEX in a joint project are developing a 'meat road map' to give the industry the tools it needs to address a broad range of environmental issues, in addition to its carbon footprint, across the product supply chain. It will do this by identifying practicable areas of improvement and challenging the industry through short, medium and longer-term objectives. This work covers cattle and sheep and will build on the EBLEX on-farm work<sup>8</sup> and on similar road mapping work undertaken by BPEX<sup>9</sup>. EBLEX and BPEX, as part of AHDB, have also set up a new 'national meat waste task force' covering all three red meat species, that will look at residual material from slaughter in some depth.

Three further issues are covered below: availability of data for the resource maps; management responsibilities within companies; and the use of performance measures.

None of the companies that participated in this research were able to provide all the quantitative information necessary to meet WRAP's ambition for resource maps at the outset of this project. The results that are reported are based on the best available information, and as such are a step forward in relation to other published work. There is a wide range of reasons why detailed data have not been provided, of which commercial sensitivity is only one. Other reasons include:

- the data required for the resource maps span several different functions in the companies (product, packaging and water) and are not pulled together in one place because they are managed as separate entities;
- multi-plant companies have either just embarked or not started to centralise their records, with plants being run autonomously and responsible for their own waste streams, which means data gathering is complex;
- some data are simply not collected by companies, for example a detailed breakdown of residual material, or water use by function as sub-metering was the exception rather than the rule;
- IPPC and PRN compliance drives data collection, but the information derived does not lend itself to the requirement of resource maps. Furthermore, these collection systems are viewed as bureaucratic requirements and tend not to be used for management purposes, with customer requirements, for example in relation to carbon reduction, driving change; and
- it is very difficult to extract accurate weight based information of waste streams by individual product from current retailer replenishment information systems.

Reporting under the Courtauld and Federation House Commitments is providing an impetus to improve data availability, but their reach into the meat industry is low. Both WRAP and IGD have run workshops to explain waste data requirements, and progressively these should lead to improved data transparency. However, at the current time it would be a huge, if not impossible job, to compile complete resource maps for fresh meat production in the way desired at the outset of this research.

The EA returns examined in this project were complicated to understand, and it was difficult to ascertain exactly to which products they were referring. If there were more standardised references for this industry, the information they collect would be more useful.

In the same way, there is a range of management approaches towards waste streams that have been developed by participating companies. Typically the facets of a resource map are managed as separate entities (for example packaging and water), and there were few instances where any single function has responsibility for resource management across the business. Instead several functions could be involved, from health and safety, environmental and plant management. Some companies are now developing a 'fifth quarter' business driven by animal processing economics, which has the potential to maximise use of the carcass. Typically waste quantities are not analysed in depth, whether this is in relation to residual material or packaging disposed to landfill. There was good intent, but other business objectives took priority.

Retailers have key performance indicators (KPIs) for waste, but these are not prevalent in other parts of the supply chain where service standards and meat yields dominate. Within processing operations, the resources considered in this project are managed by input bills and few companies had waste or water KPIs. Yield information is widely monitored, and the project team found very detailed information systems in place. Detailed development of waste KPIs is in its infancy, though improvements are starting to be made, primarily because retailers are seeking to reduce the carbon impact of their meat supply chains. To date this is most visible at the farm level.

Unless clear commercial advantages are demonstrated (for example by sharing good practice and case studies, or the introduction of new regulatory requirements), the motivation to collect waste KPIs will remain poor.

Recommendations:

- The meat supply chain should improve data on product (weights and costs) and packaging waste throughout the supply chain, to provide KPIs against which to track progress and drive improvement.
- Multi-plant companies should centralise their waste data collection and use it more pro-actively to drive improvement. All meat processing companies should analyse in more detail their residual material from slaughter and cutting operations.
- Data required to meet IPPC and Courtauld Commitment requirements need to be better aligned in the meat industry, and more effort is required to make these readily obtainable from retailer and supplier order management systems, if they are to be more widely understood across the industry.
- Best practice should be shared more openly. Meat is a valuable commodity and global populations are growing. Methods of improving yields should be shared.

## 6.2 Product Waste

The amount of residual material arising from the fresh meat retail supply chain is in excess of 1.4M tonnes per year, of which 97% is derived from abattoirs and cutting plants, with the remainder from retailers. The vast majority of this material is recovered primarily through rendering to produce a range of marketable products. Direct landfill of animal by-product material falling under Categories 1, 2 or 3 is prohibited, and only takes place in remote locations where small abattoirs have obtained derogations. However, animal by-products are only one component of what we have termed residual material from slaughter and cutting, and the industry should improve its data collection system to manage all material more closely.

There are many ways in which improvements could be made to the current situation, to move residual material up the waste hierarchy and thereby deliver a better environmental outcome. In doing so, the economics may not always point in the same direction and there may also be environmental uncertainties. What may be best for one abattoir in one location may not be best for another, particularly those with a smaller throughput of animals, or those in rural rather than urban locations.

The best environmental option would be to prevent as much residual material as possible being disposed of through the lowest value, or negative value, disposal routes, such as occurs, for example, when a large volume of material is consigned to Category 1. This would be possible if abattoirs recovered more edible product from the carcass, including meat, tripe, red offal and other edible co-products and higher value products for pet food. Process improvements are widely possible. They include improved control over animal inputs and better line balance, for example, which can help deliver increased yield, thereby making better use of the meat available from the carcass.

The use of lean manufacturing principles offers a proven approach to resource efficiency that has been widely adopted by the industry. It is important that these approaches adopt a whole supply chain view, from farm to shelf, because of the inter-dependencies between each stage. Their application across businesses is rare in

practice. Improvements in replenishment arrangements, including forecasting and promotions management, can also be made at the interface between retailers and their suppliers.

The markets for edible offal, other edible co-products and edible 'exotic' material, are broadly stable in the UK but buoyant in Eastern Europe and Asia. Even in the UK, there have been some high profile celebrity chefs promoting the consumption of these types of product. Quality Meat Scotland (QMS) has run an 'added value' project to help Scottish abattoirs to improve the value of their fifth quarter products and reduce their costs of waste disposal. Offal harvesting of the type being recommended in a new tripe guide could help generate an extra £3m a year for the Scottish red meat industry. EBLEX and BPEX are both promoting the export opportunities, particularly outside the EU.

More research and assistance should go into the investigation of new product development. Other food sectors have developed a wider range of products, for example the dairy sector has developed bio-active fruit flavoured drinks. The meat industry in the UK needs to develop products that can add value and can use products that currently do not appeal to UK palates. Black pudding, haggis and some sausages and burgers are the main products that can include offal; however, in other countries white pudding, chorizo, pâté, blood pudding, mortadella and brawn are popular.

If residual material cannot be diverted to higher value edible uses, then re-using it for animal and pet food may be the next best alternative, and the latter is already widely practised. A great deal of research is being done that focuses on the roles of feed and animal nutrition in improving animal health, and also the quality, safety and wholesomeness of human foods of animal origin. Currently it is prohibited to feed protein derived from animal by-products to livestock and fish. Any relaxation of the regulations in the future may allow protein meal to be used for aqua-feed, although intra-species recycling will remain prohibited.

Recovering energy from animal by-products takes place through rendering, AD or incineration. Rendering operations produce fats that can be used as an ingredient in bio-diesel, or which are used directly to help fuel steam boilers required for the rendering operation. A number of AD plants are now taking Category 2 material to generate electricity for the grid as well as fertiliser. In effect alternative markets are now available to recover energy from residual material, although there is no clear view on whether one recovery route is more environmentally beneficial over another.

#### Recommendations:

- Meat processors should introduce detailed data collection arrangements to measure their residual material, and use these data to make better use of all parts of the animal in line with the waste hierarchy.
- Process improvements that reduce waste, for example by using lean manufacturing principles, should be more widely applied.
- Meat processors should work more closely with their suppliers to improve and incentivise better input quality.
- Retailers and suppliers should improve their communications along the supply chain through structured collaborative pilot programmes..
- Plants should collaborate more often, for example, to bulk up volumes of product suitable for the export trade or pet food supplies.
- There is a need to better understand the relative environmental and resource implications of alternative recovery routes.

### 6.3 Packaging waste

Landfill is still being used as the main route to dispose of wasted packaging. In part this is due to inertia and the economic signals sent by the market to date (in terms of the prevailing rate of landfill tax). However, it is mainly a result of large amounts of mildly contaminated plastic requiring disposal. Further work is desirable to address this industry-wide issue.

The main causes of unnecessary packaging waste appear to be poorly performing vacuum packs requiring material to be repackaged, machine breakdowns, and labelling changes also requiring material to be repackaged.

There is a significant opportunity to lightweight retail packaging by the wider adoption of vacuum skin packs. Some retailers have met with consumer resistance because these packs can change the colour of meat from that anticipated by the consumer, and therefore their introduction requires careful handling.

Looking to the future, smart or intelligent packaging could result either in improvement to existing materials to extend shelf life, or additional design features that may enhance the usability of a product. Examples include tamper evidence and pack integrity, indicators of product safety or quality, and traceability or anti-theft devices.

The role of the intelligent label is to respond to changes in the external environment. A time temperature indicator (TTI) label could be attached to meat packs where changes in temperature affect the state of the label. A food quality indicator (FQI) could measure direct food changes in order to ascertain actual bacterial changes in the product – meat gives off a distinctive aroma when it spoils and this could be detected.

Recommendations:

- Only one major meat processor has signed the Courtauld Commitment and this falls short of WRAP's ambition to include the main category leaders. There needs to be a greater awareness of this agreement within the industry and the benefits that it can bring.
- Increased use of vacuum skin packs. Vacuum skin packs are a win-win for both economics and the environment, and the evidence, in part from discussions with Courtauld signatories, suggests they can also bring eating quality benefits for consumers. However, there is currently consumer resistance when used for red meat, because of the significant colour changes to the meat.
- A solution needs to be found to address the problems of disposing of contaminated plastic.
- Further 'light-weighting' of trays and labels is still possible.
- More general waste could be recycled if there were better separation at source.

## 6.4 Water

The Environment Agency has forecast that by 2050 an 'uncontrolled demand' for water could lead to a 27% increase in demand. This increase is driven by population increase, an increase in single person households and increased water for irrigation. Changing weather patterns due to climate change may result in declining water availability in some areas of the UK.

The EA has also recently published a 'Water Resources Action Plan' for England and Wales, which envisages setting targets for major process industries.

The project revealed that there is considerable scope to improve water efficiency, and in particular to reduce water consumption. The waste prevention reviews conducted by Envirowise as part of this project alone identified potential reductions of water in excess of 80,000m<sup>3</sup> per annum, delivering savings of £250,000. In general, it did not appear that reducing water usage was a high priority, although recent developments have seen the publication by EBLEX, HCC (Meat Promotion Wales) and QMS of a new suite of guidance leaflets including one on increasing water resource efficiency<sup>10</sup>, which makes specific reference to the FHC. These leaflets, in turn, follow on from the 2010 publication of 'Testing the Water'<sup>11</sup>, Phase two of the English beef and sheep production roadmap, which included a focus on water use in beef and sheep production. Additionally effluent disposal is seen to be a growing problem.

Recommendations:

- The FHC provides the basis for the development of a plan for water management within the fresh meat industry. The sector needs improved leadership backed up by support to assist companies develop water reduction plans.
- Sub-metering should be more widely adopted, because it is a cost effective way in which companies can focus on high water usage processes. The project team only found five plants where sub-meters were in place.

## 6.5 Greenhouse gas emissions

Existing research has focused primarily on emissions arising from livestock production, and while this remains the main problem to be tackled, chicken slaughter and processing has been shown by this research to generate around 75% of total emissions arising from processing. The rendering industry is broadly greenhouse gas 'neutral'.

Recommendations:

- Whole chain life cycle analyses are urgent for all four species.

- Further work is required to understand the carbon footprint of the rendering industry.
- Emission reduction strategies should be developed further to build on the progress being made driven by customer requirements.

## 6.6 Economic value

The economic value of waste, whether food or packaging, at any stage in the supply chain is essentially the net cost of waste management. In most cases, the production of waste has a negative value to the waste producers, in that it represents a cost, for example of sending waste to rendering, landfill or AD. While in the case of fresh meat waste management is highly regulated, it remains very difficult for businesses to obtain and compare information about the relative costs of the disposal options available to them.

Table 28 below shows indicative charges for a range of disposal options. All are potentially available to the fresh meat industry within the regulatory constraints of disposing of animal by-products.

**Table 28:** Indicative charges for disposal

Landfill	Rendering	AD	Composting
Gate fee plus £48 per tonne (+ VAT)	From a charge of £31 per tonne for SRM material, to a payment of £165 per tonne for best fats	£30-£60 per tonne gate fee	In vessel charge of £20 to £69 per tonne gate fee

Source: Customs & Excise/Meat Trades Journal/WRAP

Strictly speaking, these data are not comparable because they relate to different time periods and different quantities. Furthermore, there will be different charges even within regions, for example because contract fees will vary depending on local capacity and market conditions. However, they suggest some significant differences in costs particularly when large volumes are involved. On top of this, there will also be differences in the environmental performance of each disposal option, which is only partially understood although it is clear that landfill is the least favoured approach. As a result it is difficult for companies to make efficient economic and environmental choices.

Using the waste hierarchy as a guide, there are two clear opportunities for meat processors in terms of waste prevention and waste diversion, although we acknowledge that companies' individual circumstances will differ. In practice companies are doing this already, but the research suggests that further opportunities are available.

First, if the industry were able to reduce the material it sends as Category 1 to the renderers by, say, 200,000 tonnes, it would make an overall saving of £6.2M using an average cost of £31 per tonne (based on charges prevailing in the summer 2010). In practice, the saving would be greater because charges for the smaller quantities produced by many of the small and medium-sized plants are higher. We believe savings of this magnitude are plausible, based on the 'optimal target' scenario we have outlined in the report for dealing with residual material. However, this approach will reduce the main source of raw material available to the rendering companies, although the sector is increasingly targeting the collection of household waste as a substitute.

Improving the harvesting of residual material for use in the human and pet food markets could significantly increase profits. For example, harvesting more residual material like hearts, liver and stomachs and intestines (to be processed into tripe and casings) for the home market, which is currently worth around £40M, could save disposal costs and increase revenue by £4M if only a 10% change could be achieved. The potential export market is even greater. However, the industry needs to be supported so that it can regain the skills to harvest such material and improve its knowledge of export opportunities. It also needs to look at ways for companies to collaborate to bulk up materials, and grasp market opportunities that require regular higher unit volumes than an individual company may be able to supply. This may be by companies collaborating with a lead company in a particular market (in return for a share of the profits).

The pet food market is worth around £2bn, and through the better harvesting of materials for use in that market, even a 5% increase could give rise to £100M in additional revenue. This could be achieved through a concerted

campaign to increase collaboration between abattoirs, to bulk up supplies to deliver the larger volumes that it is economical for the pet food manufacturers to handle. It is plausible based on work already carried out in Scotland.

Secondly, the energy market in the UK is worth in excess of £100bn, and the generation of renewable technology is being encouraged by Government. There may be opportunities for the fresh meat sector to capitalise on this. Although it is difficult to compare costs, it would appear that at present a typical AD plant will charge more than the rendering sector for suitable material, though regional variations in charges may change this for particular operators. Clearly at present there is no significant economic incentive to divert material to the energy market. In contrast the 'gate fee' for composting is on average lower (between £20 to £69), and while the market is of lower overall value, the immediate potential may be greater than AD. Composting is currently not widely used by the industry.

Further savings are available through more efficient water use. Although perhaps somewhat simplistic, if the savings identified by Envirowise in the waste prevention reviews undertaken as part of this project were theoretically projected to the total number of licensed abattoirs, then there are potential savings of around £23M.

Recommendations:

- Look at opportunities to reduce residual material sent as Category 1 for rendering.
- Improve harvesting of residual material for human and pet food markets.
- Review opportunities for generation of renewable energy.
- Improve efficiency of water use.

## 6.7 Regulatory change

Regulatory change is now on the horizon as the incidence of BSE is declining throughout the EU. There is some potential for such change to benefit the fresh meat sector subject to the appropriate risk assessments. For example, under the current ABPR and TSE regulations, many plants are prevented from emptying the intestinal contents of cattle and harvesting the mesentery fat (which is attached to the intestines) as a 'best fat'. As the renderers pay between £43 and £165 for best fat, but will charge £31 if material is disposed as Category 1, there is a potential overall benefit of almost £200 per tonne for large quantities. This type of fat is rendered into tallow by the renderers and then sold to be used as biodiesel.

Recommendations:

- Continue to review options for recovery as legislation changes.

This research has highlighted the extent to which meat products are wasted or lost in the UK's food supply chain. By identifying how, where and why the products are wasted, these resource maps have enabled the identification of where better management practices, in particular, can be used to develop more resource efficient strategies within the fresh meat sector. Based on the recommendations outlined in this report, the project team estimates that substantial financial savings can be realised throughout the meat supply chain, particularly through improved harvesting of residual material and increased participation in the renewables energy market.

## 7.0 References

- <sup>1</sup> Household Food and Drink Waste in the UK, WRAP (2009)
- <sup>2</sup> British Cattle Movement Service
- <sup>3</sup> An overview of this work can be found at: <http://www.igd.com/index.asp?id=1&fid=5&sid=45&cid=979>
- <sup>4</sup> <http://envirowise.wrap.org.uk/england/Topics-and-Issues/Water/Water-Tools/Mogden-Formula-tool.html>
- <sup>5</sup> <http://www.cranfield.ac.uk/sas/naturalresources/research/projects/is0222.html>
- <sup>6</sup> Comparative Life Cycle Assessment of food commodities procured for UK consumption through a diversity of supply chains. Department for Food and Rural Affairs (2008)
- <sup>7</sup> Greenhouse gas impacts of food retailing, Brunel University (2008)
- <sup>8</sup> Change in the air, the English beef and sheep production road map, EBLEX (2009).
- <sup>9</sup> Advancing together, the English pig industry production road map, BPEX (2011).
- <sup>10</sup> Resource use in the British beef and lamb processing sector: Factsheet 2 – Water (EBLEX, HCC, QMS).
- <sup>11</sup> Testing the water: The English beef and sheep production environmental roadmap - Phase 2. (EBLEX, 2010).

# Appendix 1: Interview Protocol

## Developing Resource Maps for the Meat Supply Chain Interview Protocol

WRAP (the Waste and Resources Action Programme) helps individuals, businesses and local authorities to reduce waste and recycle more, making better use of resources and helping to tackle climate change. Established as a not-for-profit company in 2000, WRAP is backed by government funding from England, Scotland, Wales and Northern Ireland.

Mapping resource use in the meat supply chain is one of the key projects in the Retail Supply Chain Programme, delivered jointly by WRAP and Envirowise. The purpose of this research is to develop detailed 'resource maps' (quantifying food and packaging waste and water consumption and disposal) through the meat retail and wholesale supply chain.

Four animals (cattle, chicken, pigs and sheep) will be considered and the main fresh meat products they give rise to. The reasons for waste arising will be identified and good practice guidance will be developed and disseminated. This work will identify opportunities for improvements all the way through the supply chain bringing about environmental benefits as well as cost savings for industry.

### Purpose of the work

- Generate good quality, in-depth data to understand the amount of waste in the meat industry and identify opportunities to prevent waste and save money. As part of this, data sets will be developed enabling companies to benchmark where they sit against good practice.
- For waste, the project will quantify the types of waste being produced, at what stage, and provide insights as to why and how they can be avoided. The in-depth data collection methodology will enable the project team to ascertain the waste profile, for example avoidable vs. unavoidable food waste, by product and understand how waste is currently managed.
- For water, the project will quantify water usage, broken down by the same product categories/supply chain steps selected for waste, including quantifying the amount of product that is disposed of via the effluent.
- Carbon impact and economic value will also be quantified and the whole data set will be extrapolated to produce findings for England, Scotland and Wales.

### Who is involved

- IGD working with Cranfield University, MLCSL Consulting Ltd and the British Poultry Council have been commissioned to undertake the research.
- In excess of 80% of all animals slaughtered for human consumption in the UK will be covered by this research.
- At least 42 companies across the supply chain are to be approached to participate in the project and provide data. Aggregated results of this survey will be shared with the sector and benchmarks developed.
- At WRAP the Project Manager is Sophie Eastal and the Project Director is Charlotte Henderson. Matthew Rowland-Jones is the lead at Envirowise who is supporting the project through conducting on site waste prevention reviews.
- As this work supports the implementation of English, Scottish and Welsh waste strategies, Defra and the Devolved Administrations are likely to be interested in the results and their implications.

## Timeline

Data collection will commence in October 2009 and research will be completed by May 2010. The findings will then be published in the autumn with guidance on good practice to reduce waste through the supply chain.

The following table presents the stages of the interview process and has been designed as a guide to ensure that all interviews are conducted in a consistent and systematic way.

Before	<ul style="list-style-type: none"> <li>■ Interviews should ideally be conducted face-to-face</li> <li>■ Arrange suitable time (interviews should last around 1h)</li> <li>■ Arrange suitable place (make sure there will be a private area to conduct the interviews)</li> <li>■ Make sure participants are aware of the purpose and benefits of the interview and are comfortable with providing data. Data will be confidential to project team and aggregated for reporting purposes</li> <li>■ Define waste as "Any substance or object the holder discards, intends to discard or is required to discard" based on Waste Framework Directive (European Directive 2006/12/EC).</li> <li>■ Use the three categories identified by the animal by-products regulations (European Regulation (EC) No 1774/2006 and subsequent amendments), namely Category 1 (very high risk), 2 (high risk) and 3 (low risk).</li> <li>■ Send interview protocol (if requested) in advance of interview</li> <li>■ Two researchers should attend each interview for triangulation purposes</li> </ul>
During	<ul style="list-style-type: none"> <li>■ Introduce project and researchers</li> <li>■ Outline purpose of the interview and clarify scope, objectives and benefits (including Waste Prevention Review opportunity)</li> <li>■ Ensure anonymity and confidentiality of information if required</li> <li>■ Complete cover sheet (Section 1)</li> <li>■ Go through questions in sections 2, 3 4 and 5, take notes as appropriate. Questions should serve as a guide and can be adapted or omitted depending on the circumstances. It is also possible to ask additional questions if necessary.</li> <li>■ Summarise main points</li> <li>■ Ask if there are any additional leads or sources of information</li> <li>■ Ask if there are any additional questions and thank for time</li> </ul>
After	<ul style="list-style-type: none"> <li>■ Follow any additional leads</li> <li>■ Prepare an interview report by summarising the notes under each question in this protocol within 48 hours</li> <li>■ Send the interview report to be signed off by company</li> <li>■ Incorporate data into secure database</li> <li>■ Archive interview notes in secure location</li> </ul>

# Abattoirs and Cutting Plants

## 1. COMPANY DETAILS AND POSITION

<b>Company and location</b>		<b>Date</b>	<b>Time</b>	<b>Interviewer</b>
<b>Name</b>	<b>E-mail</b>		<b>Telephone</b>	
<b>Title and responsibilities</b>				
<b>Can we pass your contact details to WRAP to receive details of when the report will be published, events and news on resource efficiency?</b>				
<b>Yes          No</b>				
	<b>Beef</b>	<b>Lamb</b>	<b>Pork</b>	<b>Poultry</b>
<b>1.1 How many animals did you kill in 2008</b>  (Either ask permission to use Levy Board Data or the question). Other animals killed?  <b>1.1.1 How does the kill profile this year compare with last year</b>				
<b>1.2 Do you purchase meat from other companies</b>  <b>1.2.1 What volume comes from the UK</b>  <b>1.2.2 What volume comes from Non-UK</b>  <b>1.2.3 How is this meat packaged</b>  <b>UK</b> <b>Non-UK</b>				
<b>1.3 Where does your outbound meat go (e.g. supermarkets, wholesalers etc.)</b>  <b>1.3.2 How is your outbound meat packaged</b>  <b>1.3.3 What % of this meat is frozen</b>				
<b>1.4 What packaging is used in the plant for different process or between processes</b>  <b>1.4.1 What weight of each type to you buy each year</b>				

<b>1.5 What waste KPI's do you use in the business and how are they communicated/managed</b>				
<b>1.6 Who is the contact to discuss transport?</b>				

## 2. PRODUCT AND PACKAGING WASTE

	<b>Beef</b>	<b>Lamb</b>	<b>Pork</b>	<b>Poultry</b>
<b>2.1 What weight was disposed of as Cat 1 last year and destination?</b>				
<b>2.2 What weight was disposed of as Cat 2 last year</b>  <b>2.2.1 Where does spent lairage material go to</b> <b>2.2.2 How much lairage material did you get rid of last year</b> <b>2.2.3 Do you empty stomachs/intestines</b> <b>2.2.4 Where is this waste disposed</b>				
<b>2.3 What weight was disposed of as Cat 3 last year</b>  <b>2.3.1 Where did the Cat 3 go % by each destination (e.g. rendering, pet food etc.)</b>  <b>2.3.2 Volume of blood</b> <b>2.3.3 How was blood disposed</b>				
<b>2.4 How much packaging was disposed last year (by material type and weight)</b>  <b>2.4.1 Where was packaging disposed</b>				
<b>2.5 What is the pattern of your product/packaging waste during the year</b>				
<b>2.6 Detail any other waste materials during the year</b>				

### 3. CAUSES OF WASTE

	<b>Beef</b>	<b>Lamb</b>	<b>Pork</b>	<b>Poultry</b>
<p><b>3.1 What operational practices give rise to product waste</b></p> <p><b>3.1.1 Are any of the following major causes of product waste</b></p> <ul style="list-style-type: none"> <li>- <b>Unhealthy animals</b></li> <li>- <b>Contaminated animals</b></li> <li>- <b>Chiller failure</b></li> <li>- <b>MHS</b></li> <li>- <b>Dealing with carcass balance</b></li> <li>- <b>Poor process controls</b></li> <li>- <b>Other</b></li> </ul> <p><b>3.1.2 What are the three main causes of waste – please rank</b></p> <p><b>3.1.3 What steps could be taken to reduce waste</b></p>				
<p><b>3.2 What are the <u>three</u> main causes of packaging waste</b></p> <p><b>3.2.1 What steps could be taken to reduce packaging waste</b></p>				

## 4. RESOURCES

<p><b>4.1 How much of the following do you use in the abattoir?</b></p> <p>Water Electricity Gas</p>
<p><b>4.2 What is the source of water you use?</b></p> <ul style="list-style-type: none"><li>· Public supply</li><li>· River</li><li>· Borehole</li><li>· Other</li></ul> <p>Give details of annual quantity used (e.g. m3)</p>
<p><b>4.3 Do you record water usage (how measured, how often, is there a KPI)</b></p> <ul style="list-style-type: none"><li>· By plant</li><li>· By animal type</li><li>· By product</li><li>· By function</li></ul> <p><b>4.3.1 If yes, give details and indicative amounts used</b></p>
<p><b>4.4 What is the volume of effluent per annum?</b></p> <p><b>4.4.1 Where does it go after treatment?</b></p> <ul style="list-style-type: none"><li>· To sewer</li><li>· To river</li><li>· Other</li></ul> <p>Give details of annual quantity used (e.g. m3)</p> <p><b>4.4.2 Any seasonal changes</b></p>
<p><b>4.5 How do you minimise water use</b></p>
<p><b>4.6 'Domestic' water use</b></p> <ul style="list-style-type: none"><li>· If metered separately what is the consumption</li><li>· Are there shower facilities on site (if so what is approx. staff usage)</li><li>· Are there canteen facilities on site (if so what is approx. staff usage)</li></ul>

# Cutting Plants (who do retail packs), Manufacturers, RDC Supermarkets, Retail Butchers, and Wholesalers

## 1. COMPANY DETAILS AND POSITION

<b>Company and location</b>	<b>Date</b>	<b>Time</b>	<b>Interviewer</b>
<b>Name</b>	<b>E-mail</b>		<b>Telephone</b>
<b>Title and responsibilities</b>			
Can we pass your details to WRAP to receive details of when the report will be published, events and news on resource efficiency etc.			
Yes                  No			
<b>1.1 Role in the Supply Chain:</b>			
· Retail pack · Food Manufacturer · Retail Butcher			
· Wholesaler · Supermarket			
<b>(Note: Questions asked will vary depending on the role in supply chain)</b>			
<b>1.2 Who are your major customers for each product?</b>			
<b>(Note: be specific by animal type but it is not necessary to identify individual customers)</b>			
<b>1.3 Product shelf life (days) (total and from RDC)</b>			
E.g. for:			
Frozen meat			
Pre-packed meat			
<b>(Note separately for beef, lamb, pork, chicken)</b>			
Processed meat			
<b>(Note separately if there are differences between beef, lamb etc. products)</b>			
<b>1.3.1 How is shelf life determined</b>			
<b>1.4 What is the typical packaging used (in bound and out bound)?</b>			
<b>1.4.1 What kind of intermediate packaging?</b>			
<b>1.4.2 What kind of 'ready for shelf' packaging?</b>			
<b>1.4.3 What kind of consumer packaging?</b>			
<b>1.4.4 Any particular issue</b>			
<b>1.5 What is the storage life of your product?</b>			
<b>(Note separately for beef, lamb etc. products and for each stage of the supply chain including households)</b>			
<b>1.5.1 How is the product stored</b>			
<b>1.6 Average stock cover (days):</b>			
<b>1.6.1 Stock rotation policy</b>			

**1.7 How is your in –bound product transported (road, air, sea freight, combination)?**

**1.8 Proportion of the product sourced from outside the UK:**

**1.8.1 From which countries do you import products?**

**1.8.2 How are these products transported?**

**1.8.3 How is the chill chain managed?**

## 2 PRODUCT AND PACKAGING WASTE

<b>2.1 How do you define waste</b>
<b>2.2 How is waste managed within the business.</b> <b>2.2.1 What waste KPI's do you use in the business and how are they communicated/managed.</b>
<b>2.3 Percentage of wasted product (over a year) [typical min/max values and range and seasonal changes ]:</b> <b>By function (e.g. RDC) and by product e.g.:</b> <b>Frozen</b> <b>Pre-packed</b> <b>Counter</b> <b>Processed</b> <b>Product</b>
<b>2.4 Tonnage of wasted product (per year):</b> <b>By function (e.g. RDC) and by product e.g.:</b> <b>Frozen</b> <b>Pre-packed</b> <b>Counter</b> <b>Processed</b> <b>Product</b>
<b>2.5 What is the pattern of your products' waste during the year? Are there any specific cycle periods</b>
<b>2.6 Tonnage of wasted primary and secondary packaging waste (including back of store):</b> <b>2.6.1 By material type - what proportion is recycled and what proportion by other disposal routes</b>
<b>2.7 Percentage of wasted packing over a year</b>
<b>2.8 Do you un-box or re-wrap meat or use a body to do this</b> <b>2.8.1 What happens to this meat</b>

### 3 CAUSES OF WASTE

<b>3.1 What is the impact of forecasting practices on waste?</b>		
<b>3.2 What are the positive and negative impacts of promotions on waste for this product?</b>		
<b>3.3 What is the impact of lead-times on waste?</b>		
<b>3.4 What is the impact of shelf life policies on waste?</b>		
<b>3.5 Which processing operations cause most waste?</b>		
<b>3.6 Do specific stacking and shelving policies for this product cause waste?</b>		
<b>3.7 Are there any specific characteristics of this product that make it more susceptible to creating waste?</b>		
<b>3.8 What is the impact of product damage on waste for this product?</b>		
<b>3.9 What is the impact of packaging technology on waste?</b> <b>3.9.1 What is the effect of changing packaging design on waste?</b>		
<b>3.10 What happens to products following a product recall or emergency product withdrawals (EPWs) on wasted product?</b>		
<b>3.11 What is the impact of weather changes on waste for this product?</b>		
<b>3.12 What is the impact of quality control and product specifications on waste for this product?</b>		
<b>3.13 What happens to product that is returned by customers?</b>		
<b>3.14 Have we missed any other important cause of waste for this product (e.g. lessons from the wider world etc.)?</b>		
<b>3.15 Please identify the three main causes of waste in order of their significance</b>		
<ul style="list-style-type: none"> <li>· Forecasting</li> <li>· Shelf life</li> <li>· Packaging changes</li> <li>· Quality control</li> <li>· Other (specify)</li> </ul>	<ul style="list-style-type: none"> <li>· Promotions</li> <li>· Stacking/shelving</li> <li>· Recalls</li> <li>· Meeting specification</li> <li>· Returns</li> </ul>	<ul style="list-style-type: none"> <li>· Lead times</li> <li>· Damage</li> <li>· Weather</li> <li>· Processing</li> </ul>

## 4 DESTINATION OF WASTE

<b>4.1 Amount of product waste that is classified as Category 3</b> <b>4.1.1 What happens to this waste</b>
<b>4.2 Amount of product waste not classified as Category 3 but fit for human consumption</b> <b>4.2.1 What happens to this waste (e.g. FareShare)</b> <b>4.2.2 What quantities by weight go down each route</b>
<b>4.3 Amount of packaging waste</b> <ul style="list-style-type: none"><li>· Cardboard</li><li>· Plastic</li><li>· Wood</li><li>· Paper</li><li>· Other (specify)</li></ul>
<b>4.4 Amount of packaging waste that goes to landfill</b> <b>4.4.1 Proportion of packaging waste that goes to landfill</b> <b>4.4.2 What happens to other packaging waste?</b>

## 5. RESOURCES (Do not use with Retailers)

### 5.1 How much of the following do you use ?

Water  
Electricity  
Gas

### 5.2 What is the source of water you use?

- Public supply
- River
- Borehole
- Other

Give details of annual quantity used (e.g. m3)

### 5.3 Do you record water usage (how measured, how often, is there a KPI)

- By plant/store
- By product
- By function

#### 5.3.1 If yes, give indicative amounts used

### 5.4 What is the volume of effluent per annum?

#### 5.4.1 Where does it go after treatment?

- To sewer
- To river
- Other

Give details of annual quantity used (e.g. m3)

#### 5.4.2 Any seasonal changes

### 4.5 How do you minimise water use

### 4.6 'Domestic' water use

- If metered separately what is the consumption
- Are there shower facilities on site (if so what is approx. staff usage)
- Are there canteen facilities on site (if so what is approx. staff usage)

# Appendix 2: Summary of emissions work

## Summary of emissions work on wastes associated with post-farm management of meat up to retail

### 1. Methods

The approach has been to try and limit the analyses to emissions directly associated with product and packaging “wastes”, so that upstream emissions of animal production have not been included. It has not been straightforward to apply simple emission factors to the processes used, because recycling, energy recovery and product transformation are all typical practices in the industry. Credits have thus been estimated to offset resources used in processes. A life cycle perspective has been used to inform this analysis, but it must be stressed that this is not a formal Life Cycle Assessment (LCA).

Emissions attributed to particular processes were calculated by assuming typical vehicle collection distances for each process and expected vehicle types. A small proportion of material does simply enter landfill as general waste, which arises from the slaughtering and meat processing industries. This would be expected to be a mixture of mainly inert and some biodegradable materials e.g. plastic and cardboard boxes contaminated with blood, protective clothing and general waste. In the larger companies every effort is being made to eliminate this entirely. All other materials are recycled or processed in some ways. Data on emissions estimates and resource use were obtained from several sources, as follows.

Emissions from fuel use came from the European Reference Life Cycle Data System (ELCD). These are all true Life Cycle Inventory (LCI) values and include the overheads of refining and delivery, and the burdens are thus greater than simple end of pipe values. The ELCD was also used for data on cardboard manufacture. Data of plastics manufacture and wood production came from the commercial *Ecoinvent 2* database. Data on emissions from landfill were supplied by WRAP and supplemented by data from other sources. Estimates of the calorific values of products used for combustion came from the literature. Emission factors for wastewater treatment came from the IPCC (2007) guidelines for producing national GHG inventories (Chapter 6).

Manure arisings in lairage were estimated from data from the Cranfield agricultural LCA model (Williams et al., 2006). Part of this was also used to calculate the net emissions from manures and sludges, so that this accounted for nutrient content, energy used for application, field emissions of N<sub>2</sub>O and the fertiliser offset from applying these materials to agricultural land. A small proportion of ruminant sludges are incinerated instead.

### Uncertainties

Uncertainties were calculated using Monte-Carlo simulations. The resultant uncertainty is expressed as the coefficient of variance (CoV), i.e. standard deviation divided by the mean and expressed as a percentage.

### 2. Main pathways and processes modelled

#### Abattoir

Specific wastes here were lairage from cattle, sheep and pigs; gut contents; and effluent. Lairage wastes were assumed to be 5% of normal daily arisings and gut contents are about 11% of live-weight for mammals. These were assumed to be composted and subsequently land spread. The net emissions were obtained using the manure model in the Cranfield agricultural LCA. It was assumed that chickens are passed from crates to the shackle line very quickly so that no separate excreta collection was needed, but what was collected was added to general effluent.

Effluent arisings were estimated from the expected mixture of proteins, fats, blood and bone plus gut contents. Treatment was assumed to be mainly anaerobic, with some aerobic and sludge spread on land. The net emissions from sludge were similarly derived from the Cranfield agricultural LCA.

#### Rendering and related activities

The calculations on GHG emissions from the rendering industry are based on outline, simplified data. The analysis is thus a considerable simplification of the complex realities. The subject is being studied in much greater detail by Harper Adams University, but the results of this are not available at present. The estimates produced are thus intended to be only broadly indicative of the scale of the industry's activities, and much more of a snapshot than

a detailed rigorous study. Values will also change from year to year. These factors are reflected in the high uncertainties of estimates.

The whole rendering industry is quite complex and is probably diverse at the plant level. It takes in materials from abattoirs, meat processors and retail waste. It also takes in general food wastes from retail. The industry uses water and fuels for separation, processing, combustion and the production of various useful by-products from the meat (and retail) sector, including:

- Fat for human consumption
- Fat for use in oleochemicals
- Fat for conversion to biodiesel
- Processed animal protein (PAP) for pet food
- Meat and bone meal (MBM) used as fertiliser
- Dried product in cement manufacturing, and
- Ash for use as:
  - Fertiliser
  - Aggregate in the cement industry.

In addition, effluent is produced, treated and discharged (with consent) to water courses, and some sludge must also be produced and managed in some way. Some wastes also go to landfill, e.g. plastic packaging recovered from retail wastes.

The overall approach taken has been to treat the whole industry as a black box, with input streams of several waste materials, inputs of energy and water, and outputs of useful materials and some wastes. Transport is included for material collection and disposal of wastes to landfill. It is freely acknowledged that this is a simplification of a complex set of activities, and has been aimed at producing a first order estimate of this part of the meat sector. It does not differentiate between the separate categories of by-products under Animal By Products Regulations.

Estimates were made of the GHG emissions incurred from material collection, energy and water use, wastewater treatment, and sludge and solid waste disposal. Estimates were also made of the potential credits from by-product use by comparing them with alternatives (e.g. vegetable fat instead of rendered fat). It must be stressed that (a) this is not a full Life Cycle Assessment (LCA) and (b) the associated uncertainties are high.

### **Processes modelled**

The processes modelled here were wastewater treatment and sludge disposal. The anticipated dry matter concentration in effluents from rendering is much lower than from abattoirs as it is mainly condensate. It was assumed that wastewater was treated by both anaerobic and aerobic processing. All sludge, when produced, is applied to agricultural land. Some renderers operate thermal oxidisers to treat all process gases before condensing, so there is no need to treat condensate and no sludge is actually formed. It was also assumed that the process energy was already accounted for in the national total for rendering.

A composition of untreated effluent was assumed from which biogas production, and hence methane capture and utilisation, were derived. In addition, the composition was used to calculate the N<sub>2</sub>O emissions from aerobic processes. It was assumed that all discharged effluent was treated to meet limits imposed by the Environment Agency.

### **Emissions from energy processes**

The conversion of physical energy units to CO<sub>2</sub>e used values from the European Life Cycle Database. Emissions from mains water use were derived from values produced by Water UK.

### **Emissions from landfill of wastes**

This includes a transport step and the assumption that the biodegradable element would be very small (5%), given that plastics recovered from food wastes were assumed to be the main component. There is a small methane emission from plastics in landfill.

## Valuation of co-products

Valuation of co-products was based on the following approaches.

If Processed Animal Protein (PAP) for pet food did not exist and demand was the same as now, it would be substituted by purpose-produced protein from agricultural production. This would be mainly chicken, but there could be much scope with some crops depending on the species (cats have a much greater need for highly digestible protein than dogs). The potential interpretation of this is wide, e.g. if the standards for feeding pets were slackened, then the yield of edible carcass per slaughtered animal would increase above the present level. Values are thus only indicative.

Fats for human consumption, oleochemicals or for subsequent esterification to biodiesel were equally assumed to be an alternative for oilseed rape oil.

Meat and bone meal (MBM) for use as fertiliser was assumed to substitute for an N, P and K blend, with the proportions of N P and K being derived from bone and declared feed compositions as 5% N, 12% P and 1.2% K. The P and K are as elemental concentrations, not P<sub>2</sub>O<sub>5</sub> or K<sub>2</sub>O. Values for synthetic fertilisers were taken from the Cranfield University Agricultural and Horticultural Life Cycle Inventory (CAHLICI).

When ash is used by the cement industry as an alternative aggregate, it was assumed to substitute for sand. MBM is also used in cement manufacturing as fuel (and residual aggregate), so that the substitution was as thermal energy source (substituting for gas) with the ash being substituted as sand.

Note that when fats or other rendered materials are used internally in combustion processes, no additional credit is given. This is because of the black box approach, which ensures that the actual offset is accounted for in net actual fuel purchases and is balanced by product outputs.

## Cardboard recycling

This included collection of material, energy for processing, sludge treatment, a 20% inclusion of new fibre (from Swedish pine) and avoidance of landfill. The benefits of recycling are about 1kg CO<sub>2</sub>e/kg cardboard (Table 1 and Table 2).

**Table 1 Estimates of GHG emissions from cardboard recycling**

Activity	Emission, kg CO <sub>2</sub> e/kg
Raw material – pine logs from Sweden	0.024
Collection of old card	0.020
Manufacture, high end (typically includes 80% recycled)	1.500
Sludge	0.025
Landfill after use	0.000
Total per kg cardboard	1.6
CoV	24%

**Table 2 Estimates of GHG emissions from new cardboard production**

Activity	Emission, kg CO <sub>2</sub> e/kg
Raw material – pine logs from Sweden	0.1
Manufacture, high end (typically includes 80% recycled)	1.5
Sludge	0.024
Landfill after use	1.0
Total per kg cardboard	2.6
CoV	17%

### Plastic recycling

Several sorts of plastics may be used in packaging, and the data obtained did not discriminate between them. Some are much less easy to recycle, depending on factors like the chemistry of the plastic, contamination etc. It was assumed that the amounts that were claimed to go for recycling are actually recycled. It is plausible that some arrive at recycling plants and are found to be unsuitable, in which case they may be burned with heat recovery or landfilled. Without much more detail, full recycling was assumed and estimates were based on polyethylene. The stages are summarised in Table 3 and show a saving of about 1.3 CO<sub>2</sub>e/kg compared with the use and subsequent landfilling of virgin plastic (2.75 kg CO<sub>2</sub>e/kg).

In processing some wastes, such as contaminated plastics from retail, typically in the rendering industry, plastics are also burned for energy recovery. The heat of combustion of such plastics was assumed to be 35 MJ/kg. This is lower than some estimates, but it was also assumed that the vital need to ensure high temperature combustion and exhaust gases occur means that a lower than maximum efficiency of combustion is possible.

**Table 3 Burdens of plastics recycling**

Activity	Emission, kg CO <sub>2</sub> e/kg,
Collection	0.05
Processing to start material	0.71
Processing to film etc.	0.71
Total	1.46
CoV	18%

### Wood recycling

This occurs in the abattoir sector. The options here depend on possible management scenarios for waste wood. The main positive alternatives seem to be controlled combustion for heating, or combination for use in chipboard or similar products. The negative alternatives are uncontrolled combustion or landfill, with a consequent need for new wood. In either positive case, the main burdens from GHG emissions (as opposed to land demands etc.) are from tree production and wood delivery, compared with collection of used wood. So, the background context is that new wood is still used for making packaging, and some wood by-products would be used for chipboard etc. as a matter of course. Recycling can reduce the need for new wood to be chipped (as long as there is a demand for chipped products). It is understood that larger companies use re-usable pallets, and this has not been included in the analysis.

The use of recycled wood was estimated to create emissions of about 0.006 t CO<sub>2</sub>e/t (CoV = 10%) compared with new wood at 0.05 t CO<sub>2</sub>e/t (CoV = 25%).

## 3. Results

The impacts of waste management are dealt with in order of events: abattoir and processing, rendering and retail.

### Abattoirs and processing plants

The results show that the main sources of emissions in abattoirs are from energy use (Table 4). Solid waste disposal follows while effluent treatment generates a GHG credit from anaerobic digestion (AD). The data on energy use came from a different source for poultry than for mammals, and requires verification. However, each chicken requires proportionately more work applied per unit weight simply because of the small size of chickens compared with farmed mammals. Electricity is used for refrigeration in all plants, but poultry processing is much more mechanised than mammalian slaughtering, and so uses more electricity per head. There are also other processes that differ between species, e.g. skin removal from sheep. There are wider differences with gasoil as pig and chicken slaughtering entails different processes to cattle and lamb.

**Table 4 Summary of GHG emissions from abattoirs.**

Abattoirs	Beef Abattoirs	Pig Abattoirs	Lamb Abattoirs	Poultry Complete (*)	All Species
<b>Conversion of flows to CO<sub>2</sub>e emissions</b>	kt CO <sub>2</sub> e / year				
Electricity	30.5	22.0	7.32	244.5	307
Gas	1.51	0.81	1.25	42.3	45.8
Gasoil	0.12	4.04	0.23	0	4.4
Propane	0	1.90	0	0	1.9
Total energy	34.1	29.2	8.81	287	350
Water	0.90	0.44	0.42	2.14	3.9
Effluent (#)	-0.34	-0.28	-0.20	-0.39	-1.2
Lairage	6.2	2.8	2.64	0	11.6
<b>Packaging wastes</b>					
General waste (landfill)	2.2	1.41	1.18	7.72	12.5
Cardboard (recycled)	8.8	0.88	0	0.099	9.73
Plastic (recycled)	0.22	0	0	0	0.222
Paper (recycled)	0.13	0	0	0	0.013
Wood (recycled)	0.001	0	0	0	0.001
<b>Packaging wastes sub-total</b>	11.2	2.29	1.18	7.82	22.2
<b>Grand total (rounded)</b>	<b>52.0</b>	<b>34.4</b>	<b>12.8</b>	<b>296</b>	<b>396</b>
<b>CoV</b>	6.4%	5.2%	7.7%	6.4%	4.9%

NB data on poultry energy use and mammal energy use came from different sources

(#) the "negative emissions" result from the fertiliser value of sludge and captured methane from digestion exceeding process emissions, and also assume the electricity for treatment has been accounted for in the overall power numbers.

Source: W:\WRAP\RSC009\_Meat\[WRAP\_Meat\_Main\_1.xlsx]Abattoirs

In processing plants, energy use dominates GHG emissions (Table 5). There are wide differences between species, noting that sheep meat is systematically processed less than bovine meat. Bovine meat processing also includes imported produce.

**Table 5 Summary of GHG emissions from meat processing.**

	Beef Processing	Pork Processing	Lamb Processing	Poultry Included above	All Species
<b>Conversion of flows to CO<sub>2</sub>e emissions</b>	kt CO <sub>2</sub> e / year				
Electricity	3.49	0.023	0.767		4.28
Propane	32.1	0.22	7.36		39.63
Total energy	35.5	0.243	8.13		43.9
<b>Packaging wastes</b>					
General waste (landfill)	1.14	3.98	0.186		5.3
Cardboard (recycled)	3.81	9.15	0		13.0
<b>Packaging wastes sub-total</b>	4.95	13.12	0.186		18.3
<b>Grand total</b>	<b>37.0</b>	<b>13.3</b>	<b>7.55</b>		<b>57.9</b>
<b>CoV</b>	4.6%	22.4%	4.5%		4.9%

The total emissions (Table 6) are still dominated by energy use.

**Table 6 Summary of GHG emissions from both abattoirs and meat processing**

Abattoirs	Beef	Pigs	Lamb	Poultry	All Species
<b>Conversion of flows to CO<sub>2</sub>e emissions</b>	kt CO <sub>2</sub> e / year				
Electricity	61.1	22.6	13.9	244	342
Gas	5.00	0.84	2.02	42.3	50.1
Gasoil	0.12	4.04	0.23	0.00	4.40
Propane	0	1.90	0	0	1.90
Total energy	66.2	29.4	16.2	287	398
Water	0.90	0.44	0.42	2.14	3.90
Effluent	-0.34	-0.28	-0.21	-0.39	-1.21
Lairage	6.18	2.81	2.64	0.00	11.62
<b>Packaging wastes</b>					
General waste (landfill)	3.33	5.38	1.37	7.72	17.8
Cardboard (recycled)	12.6	10.0	0	0.099	22.7
Plastic (recycled)	0.22	0	0	0	0.222
Paper (recycled)	0.013	0	0	0	0.013
Wood (recycled)	0.00	0	0	0	0.001
<b>Packaging wastes sub-total</b>	16.13	15.41	1.37	7.82	40.72
<b>Grand total</b>	<b>89.0</b>	<b>47.8</b>	<b>20.9</b>	<b>296</b>	<b>454</b>
<b>CoV</b>	<b>5.3%</b>	<b>6.7%</b>	<b>5.7%</b>	<b>6.4%</b>	<b>4.4%</b>

NB data on poultry energy use came from a different source for poultry than mammals

## Rendering

### *Energy and water use*

Data from FABRA are in Table 7.

**Table 7 Energy and water used in the rendering sector**

	Low end of range	High end of range	Assumed central value for water or weighted average for energy	Comments
Water, m <sup>3</sup> per t ABP processed	0.8	1.5	1.15	April 2010 Data from Fabra members only
Energy kWh per t ABP processed	650	1100	880	

In order to convert process energy use into primary energy use and CO<sub>2</sub>e emissions, it was assumed that the process energy use was as follows:

Electricity	20%
Gas or heating oil	80%

In practice, most plants have dual burners and will burn either gas or heating oil depending on price. Tallow from rendering is also used. For this study, an equal split of gas and fuel oil was assumed (the effect is relatively small).

### *Transport distances and vehicles*

It was assumed that the average distance for each tonne of material collected was 150km and 50km for landfilling wastes. A mixture of medium and large lorries were assumed to be used for landfill and ABP collection from abattoirs and retail.

### *Inward materials*

These are summarised in Table 8.

**Table 8 Summary of materials entering the rendering sector**

Item	Beef & sheep	Pigs	Poultry	Weight, t
Cat 1 and 2 material (all species)				1,105,000
Cat 3	425,300	66,800	492,600	984,700
Retail ABP (*)				35,500
Total ABP				2,125,200
Retail Non-ABP (*#)				400,000
Total material				2,525,200

(\*) Estimates. # included for completeness, but not included in further analysis.

### *Outputs and intermediates*

The main outputs from the rendering industry are shown in Table 9 (noting that is not a comprehensive set of survey data, but more of an indicative snapshot of the last year). Of the rendered fats, about 125,000t were used for steam-raising in the industry. Of the materials that are sold on by the rendering industry, about 11,500t of tallow is used for biodiesel production (by esterification with methanol).

Meat and bone meal (MBM) is used as a fertiliser (about 15,000t) and in cement manufacturing (about 55,000t), in which it is combusted and the ash substitutes for aggregates. About 12,000t of ash from incineration is also used as an aggregate substitute in the cement industry.

**Table 9 Summary of final products from the rendering industry (all values in t).**

	Processed Proteins	Comments	Rendered Fats	Comments
Cat 1 and Cat 2	257,000	Burned as fuel in the industry, with ash as output	152,600	Burned as fuel in the industry
Cat 3	181,300	Pet food and fertiliser	136,350	Oleochemicals, soap, animal feed, pet foods, bio-diesel and some burned as fuel in the industry

All animal products are gathered together, and there are no separate data for the individual flows by species. Collection of materials for rendering emits 50.3 kt CO<sub>2</sub>e annually, with a CoV of 21% (Table 10).

**Table 10 GHG emissions from the collection of materials for rendering per annum**

	weight, t	distance, km	GWP, kt CO <sub>2</sub> e
Abattoir	2,108,200	150	49.2
Retail	35,500	150	1.1
<b>Total</b>	<b>2,143,700</b>		<b>50.3</b>

Energy and water use were converted to GHG emissions (Table 11). Energy clearly dominates. The distribution of energy carriers has been assumed (clarification sought), but electricity is most likely to dominate given that rendering can export PAP and fats as fuels.

**Table 11 Energy and water use in rendering converted to annual GHG emissions**

Energy type	Assumed proportions	Process energy, MWh	Primary energy, TJ	kt CO <sub>2</sub> e
Electricity	20%	377,291	4,372	252
Gas	40%	754,582	2,760	504
Heating Oil	40%	754,582	3,300	504
<b>Total</b>			<b>10,432</b>	<b>1,261</b>
Water				0.74
<b>Total energy +water CoV</b>				<b>1,262 26%</b>

Equal value was applied to rendered fats used for human food, animal feed, pet food, biodiesel and the oleochemical industry. These summed to 284 kt CO<sub>2</sub>e, with a CoV of 26%, (Table 12).

**Table 12 Valuation of fats from rendering used for human food, animal feed, pet food, biodiesel and the oleochemical industry**

kt p.a.	GWP substitution for oilseed rape oil, t/t	GWP substitution for oil, kt CO <sub>2</sub> e	CoV
136	2.1	284	26%

Rendering also produces 181kt of PAP annually for use in pet foods. This is roughly equivalent to 492kt of chicken carcasse at 35% DM, noting that PAP would be about 95% DM. The substitution for processed broilers is 3.9kg CO<sub>2</sub>e/kg, but allowing for a higher yield for pet food than human food, and assuming that spent laying hens that are currently exported would be diverted to pet food, the credit for not producing these birds is 1,584kt CO<sub>2</sub>e (CoV=25%). It must be noted that this is likely to be an overestimate, give that some cereals could be used for dog food (and obesity in dogs is apparently increasing), but it is an indicative value.

The use of MBM as a fertiliser was estimated to be equivalent to 39 kt CO<sub>2</sub>e (CV = 31%), as shown in Table 13. When meal and ash are used in cement manufacture, the combined benefits were estimated to be 5 kt CO<sub>2</sub>e (CV=16%), as shown in Table 14.

**Table 13 Valuation of MBM as a fertiliser**

Credit for fertilisers	Weight of element, t	Credit, t CO <sub>2</sub> e	Transport debit, t CO <sub>2</sub> e	Net benefit, kt CO <sub>2</sub> e
Substitution of P for rock P	1,856	1,860		
Substitution of K for KCl	186	71		
Substitution for ammonium nitrate (but rated at 50% of value of AN)	619	37,797		
<b>Total</b>		<b>39,728</b>	<b>291</b>	<b>39</b>
<b>CoV</b>				<b>31%</b>

**Table 14 Valuation of MBM and ash for cement manufacture**

Material	Weight, t	GWP substitution gas or sand, t CO <sub>2</sub> e	Net GWP substitution, kt CO <sub>2</sub> e
MBM	55,000	53,632	53
Ash from MBM	13,750	33	0.03
Ash from incineration by renderers	12,000	29	0.03
<b>Total CoV</b>			<b>53 16%</b>

**Table 15 Summary of estimates of emissions and emission credits from the rendering industry.**

Item	Emissions, kt CO <sub>2</sub> e	CoV	Credit, kt CO <sub>2</sub> e	CoV
Collection of materials	50	21%		
Energy and water use	1262	26%		
Plastic packaging disposal from retail	0.04	30%		
Rendered oils			284	25%
PAP - pet food			1584	25%
MBM and ash in cement			53	16%
MBM as fertiliser			39	31%
<b>Total</b>	<b>1,312</b>	<b>25%</b>	<b>1,959</b>	<b>20%</b>

The credits from rendering products appear to exceed the total emissions (mainly from energy use) by about 0.6 Mt CO<sub>2</sub>e/year (Table 15), but with the high uncertainties this is not statistically significant. The results of this suggest that the value of useful outputs from rendering are roughly equal to the emissions incurred. This must be set in the context of it being contingent on:

- Animal production continuing, with GB primary production burdens being in order of 19 Mt CO<sub>2</sub>e p.a. (Table 16)
- Abattoir and processing burdens in order of 0.4 Mt CO<sub>2</sub>e p.a.
- Current regulations on rendering and especially pet food etc. applying
- A similar trade existing, and
- Pet food demand staying as is.

Indeed, the analysis of the rendering industry should ideally be seen as part of LCA of livestock production and consumption such that the inclusion of rendering is part of system expansion.

**Table 16 GHG from annual primary production of meat livestock in GB (Audsley et al., 2010)**

	Production, kt	GHG. Mt CO <sub>2</sub> e
Beef	736	8.9
Chicken meat	1,237	3.2
Pig meat	653	2.6
Sheep and goat meat	312	4.6
Turkey meat	200	0.7
GB meat production		19

#### 4. Retail

Most of the material waste from retail is product that must be rendered, and thus enters the rendering stream and has already been accounted for in that section. The only separate stream is cardboard, which is recycled. The emissions incurred from collection and recycling and benefits are shown in Table 17.

**Table 17 Emissions from recycling cardboard from retail (t CO<sub>2</sub>e p.a.) Uncertainties are shown in brackets**

	<b>Beef</b>	<b>Pork</b>	<b>Lamb</b>	<b>Poultry</b>	<b>Sum</b>
Emissions from cardboard recycling	48	86	12	92	237
CoV	(25%)	(25%)	(25%)	(25%)	(24%)
Emissions from cardboard disposal to landfill	81	145	20	155	400
CoV	(20%)	(20%)	(20%)	(20%)	(18%)
Emissions savings by recycling	33	59	8	63	163
CoV	(23%)	(23%)	(24%)	(26%)	(23%)

#### 5. Discussion

In the slaughtering and processing parts of the chain, energy use dominates GHG emissions, but the overall effect is heavily influenced by the poultry sector, which is much more mechanised than the mammalian sector. Packaging wastes still make a substantial contribution, especially when considered as a proportion of the total for mammalian species. The situation would be appreciably worse if cardboard and plastic were not recycled.

The rendering sector creates larger emissions owing to the large need for energy to maintain processes, but it also creates large credits through the conversion of what are nominally wastes into useful products. Given the limited opportunity to examine this area, it appears that the emissions roughly balance the credits, but it must be stressed again that the data are not from an exhaustive, detailed, survey.

The waste from retail contributes relatively little (although some has been addressed in the rendering sector). Again, the benefits of cardboard recycling are considerable. Some other sources of GHG emissions in retail have not been included, e.g. energy for refrigeration, lighting, heating, ventilation and air-conditioning as well as refrigerant leakage. These have been addressed in a Defra-funded study, FO0405.

The approach taken here has been informed by the principles of LCA, but is not an LCA in its own right.

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