Food and drink manufacturing water demand projections to 2050

Main Report – EBPLW12033

October 2013

LIT 8767

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Executive summary

There is a need for longer term planning for water demand due to pressures on water resources from climate change and population growth. This was recognised by the Environment Agency's Water for People and the Environment: Water Resources Strategy for England and Wales (2009) which developed demand projections to the 2050s using a range of socio-economic scenarios. The scenarios have since been updated and used to support the Environment Agency's Case for Change[1] and Defra's Water White Paper[2]. The latter identified the need for a more detailed assessment for high water using sectors including agriculture, energy generation and the food and drink industry.

This study uses a set of socio-economic scenarios to explore how water demand within the food and drink manufacturing sector may change to 2050 under different consumption patterns and levels of governance.

The scenario based approach has enabled us to explore and develop an understanding of the factors that are most likely to drive future water demand within the food and drink manufacturing sector. This has resulted in a description of what the sector and its associated sub-sectors might look like under each of the four defined socio-economic scenarios, and has enabled an assessment of the direction and magnitude of change in demand under these conditions.

The projections show that total water demand for food and drink manufacturing only decreases under the sustainable behaviour scenario (28%). In contrast total water demand was found to increase under the uncontrolled demand (70%), innovation (5%) and local resilience scenarios (5%). A future reduction in overall water demand would clearly be a preferable direction of change. While the initial outcomes of this study are encouraging, forecasting a decrease or only small increase in water demand under three of the four scenarios, they apply to the current water availability. In applying these results to future water availability, as in the Case for Change, there remains significant potential for unmet demand for water.

Looking into the future it is likely that our relationship with food will continue to change and technological advances and innovation will be at the forefront of addressing the issues associated with food security and meeting the requirements of the rising global population. Water and the provision of a good quality supply will continue to be critical to food and drink production. Water resources are already under pressure and in some places, water bodies are being damaged by unsustainable levels of abstraction and constant supplies could become less available. These include key catchments where food and drink manufacturing is located. The change in water demand will depend on how users react to climate change as well as different food consumption patterns. Industry could try to meet the increase in water demand or improve resilience through water efficiency. It is clear that the option to do nothing to change current water demand could potentially increase the impact on future business operations. Food and drink manufacturing therefore needs to consider how it will further reduce its potable water demand and manage its current and future water demand through direct abstraction.

The future is uncertain but the outcomes from this work provide supporting evidence for those that need to consider the scale of future risks associated with the demand for water, such as food and drink manufacturers, water suppliers, regulators and policy makers.

[1] Environment Agency, 2012, *The Case for Change - Current and Future Water Availability*
[2] Defra, 2011, Water for Life.

Contents

1. Introduction

The Environment Agency is working with Defra, WRAP, and the Food and Drink Federation to improve their understanding of how the food and drink manufacturing sector's demand for water may change in the future.

The outputs of this project will provide additional narrative on the food and drink industry to supplement the information already provided to Defra's programme of work to evaluate the options for abstraction reform. It will also help to deliver against the commitment in Defra's Water White Paper to 'develop demand scenarios in partnership with different sectors, and use the outputs to develop a common understanding of the future risks to both the abstractors and the environment and provide advice to Government'.

This project uses a set of socio-economic scenarios to explore how water demand within the sector may change under different consumption patterns and levels of governance, between now and 2050. The Environment Agency has previously used socio-economic scenarios to support projections of long-term water demand in the Water Resources Strategy and the Defra Water White Paper. These socio-economic scenarios have also been used to provide a more detailed assessment of the water demand within the electricity generating sector and the agricultural sector, both of which use large amounts of water.

Section 1 of this report introduces the approach of using socio-economic scenarios for long-term water demand projections, and the current water demand within food and drink manufacturing. Section 2 provides an overview of the process used to project future demand for the sector to 2050. The narrative and water demand projections for each of the manufacturing sub-sectors under the different socio-economic scenarios are provided in Section 3, and Section 4 discusses these outputs. The detailed methodology can be found in the accompanying Methodology Report LIT8886, October 2013.

1.1. Background

Water resources are increasingly under pressure due to climate change and increasing demand due to population growth as highlighted by the Government's Water White Paper. Short duration droughts (12-18 months) similar to the major drought of 1976 are predicted to become more common. Changing rainfall patterns will have an impact on river flows and groundwater recharge, with recent modelling indicating a decrease in river flows in the summer across most of the UK[3].

There are already significant pressures on water resources which affect both the water environment and water supplies and there are many catchments where there is little or no water available for abstraction during dry periods. The Environment Agency's 'Case for Change' report indicates that the impacts experienced now are likely to become more common in the future[4].

[3] Great Britain and Food & Rural Affairs Department for Environment, 2011, *Water for Life.* (London: Stationery Office).
[4] Environment Agency, 2012, *The Case for Change - Current and Future Water Availability*.

1.1.1. Socio-economic scenarios

Recognising the need for longer term planning, Water for People and the Environment: Water Resources Strategy for England and Wales (2009)[5] included an assessment of demand for water in the 2050s. This innovative approach applied foresight techniques to develop socio-economic scenarios and apply them to projections of demand across a range of sectors. This approach has been internationally recognised, receiving the 2010 International Water Association Project Innovation Award for Planning in Europe. The approach used to define the scenarios was based on continuums of consumption patterns and governance styles (Figure 1).

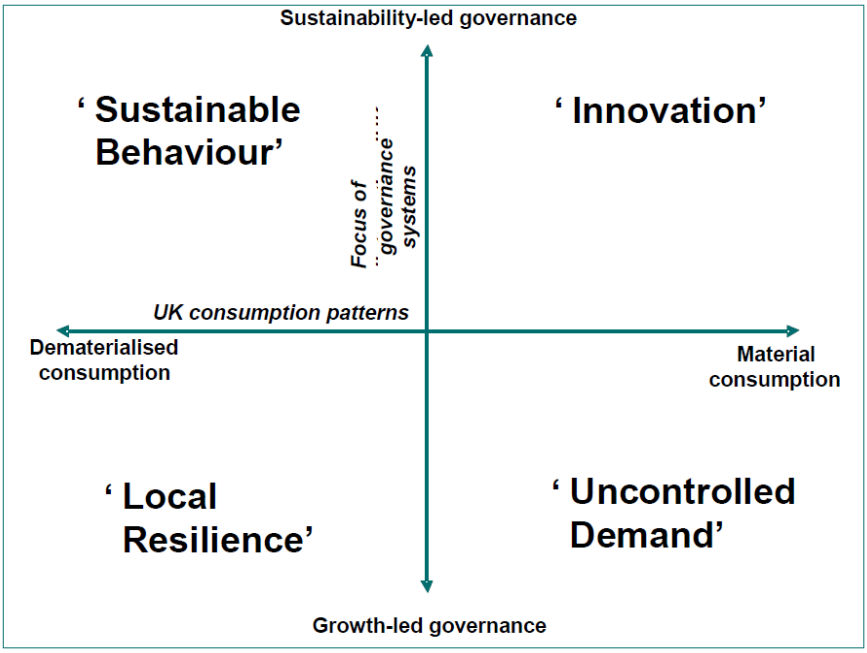

Figure 1 Four scenarios developed along continuums of consumption and governance

The following assumptions were used by participants of the expert workshops and during the modelling for this report[6]:

- Climate change is real, and will start to be felt in the second half of the scenario period
- Energy prices will continue to rise for the foreseeable future
- Overall UK water demand and water stress will increase
- Long-term economic shift from the West towards Asia, Latin America and Africa
- World population levels will continue to grow
- Other resource pressures will emerge

The 2050s assessment was updated for the Environment Agency’s ‘Case for Change’ to support Government’s Water White Paper. The Water White Paper identified that a more detailed understanding is required for key sectors including energy generation, agriculture and the food and drink sector.

[5] Environment Agency, 2009, *Water for People and the Environment - Water Resources Strategy for England and Wales*.
[6] The Futures Company, *Socio-economic Scenarios for Water to 2050 - Reviewed and Updated March 2012* (Environment Agency, 2012).

1.1.2. The food and drink industry

The food and drink industry has been one of the UK's success stories over the last few years. It is the largest manufacturing sector with a turnover contributing around £26.4bn in Gross Value Added and it is one of the few areas which have continued to grow throughout the economic downturn[7]. The sector is a major water user, both through direct abstraction and use of the public water supply; this contributes significantly to the demand being placed upon water resources. Such demands can affect local habitats and biodiversity, water availability and quality. It is estimated that food and drink manufacturing alone uses approximately 190 million m^3 per year of which 78 million m^3 is directly abstracted[8].

Business is increasingly receptive to sustainability messages, the associated net economic savings to be achieved, and potential sensitivities to consumer sentiment. However, the challenge of encouraging the adoption of more resource-efficient practices, while still enabling sound commercial growth in the sector, continues.

Water availability has been recognised as a key issue for this industry[9], which can be divided into the following sectors:

- Food and drink manufacturing (activities that occur after the "farm gate")
- Retail
- Wholesale
- Hospitality and food services

1.1.3. Evidence base

In 2006 the first major report on water use in the whole food and drink sector was produced as evidence to support the Food Industry Sustainability Strategy (FISS). In response to gaps and limitations in this data WRAP commissioned an update based on 2010 data. Total water use in 2010 was estimated to be between 347 million m^3 and 366 million m^3, representing a reduction of up to 15.6% on 2007 figures.

Water use in food and drink manufacture represents 56% of total water use by the industry. A 15-20% reduction in total water use between 2010 and 2007 was reported for this sub-sector with the 2010 estimate between 185 million m^3 and 196 million m^3. Figure 2 illustrates water use for the food and drink manufacturing sector for 2010.

[7] Defra, 2012, *Food Statistics Pocketbook*.
[8] Calculated using WRAP (2013) for total water use and Environment Agency data on abstraction in 2010
[9] Fibarr Livesey et al., 2010, *Future Scenarios for the UK Food and Drink Industry*, University of Cambridge.

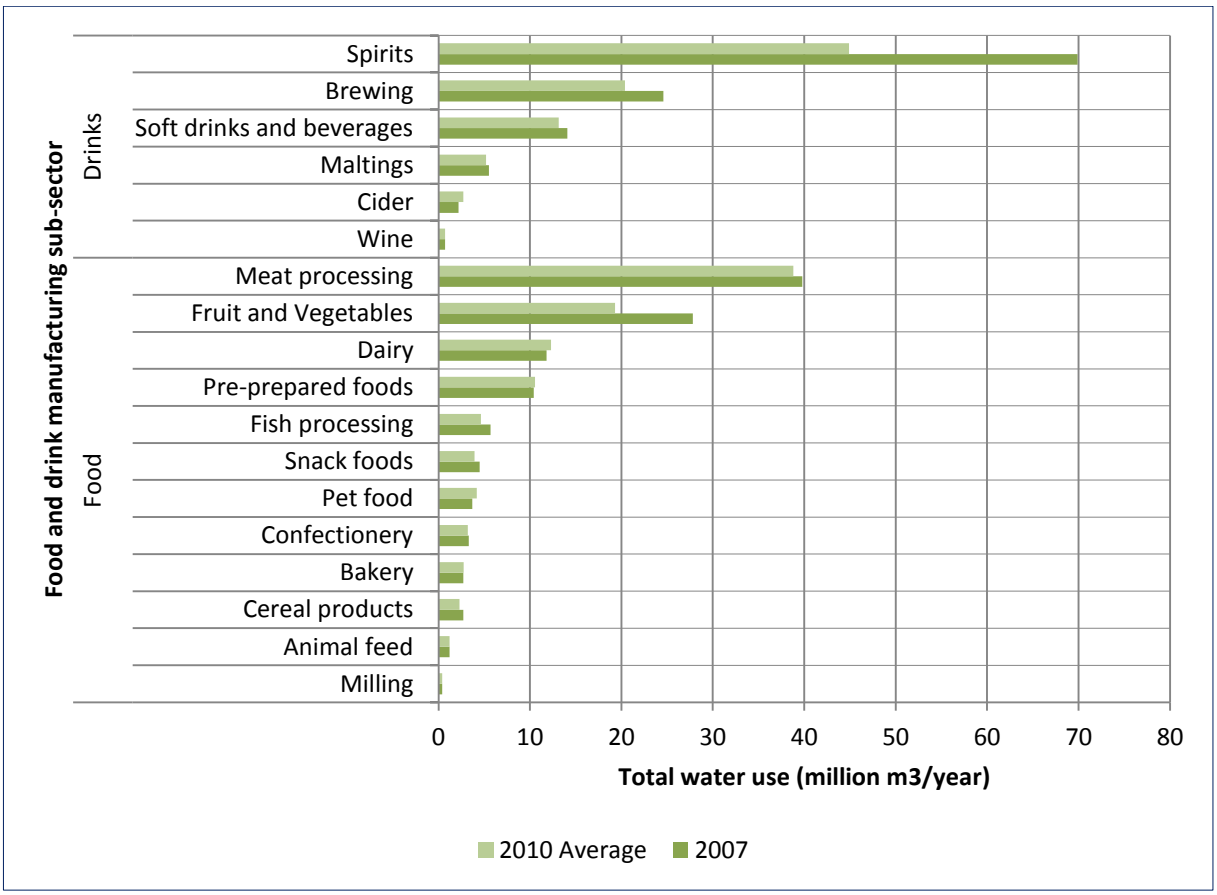

Figure 2 Water use (million m^3 per year) for food and drink manufacturing sub-sectors[10]

The top five water using sectors in food and drink manufacture in 2010 are outlined in Table 1. However, when considering 'in-process' rather than 'in-product' water use fewer drink sub-sectors are included. This is an important consideration in terms of where savings can be made (i.e. often water efficiency gains are greater or easier to implement through process changes than changes to in-product water content).

Table 1 Top five water-using food and drink manufacturing sub-sectors (in order of descending water use), 2010[5]

	2010 Average water use (million m^3 per year)	
	Total Water Use	**Water use excluding that in product**
1	Spirits	Spirits
2	Meat processing	Meat processing
3	Brewing	Fruit and vegetables
4	Fruit and vegetables	Brewing
5	Soft drinks and beverages	Dairy

[10] Adapted from WRAP, 2013, *Water Use in the UK Food and Drink Industry*.

2. Process Overview

The use of socio-economic scenarios is an established approach to supporting projections of long-term demand, and has previously been used effectively in the assessment of future water demand for the electricity generating sector and the agricultural sector.

This project has used a similar approach and has tailored each of the socio-economic scenarios for food and drink manufacturing. The tailoring process identifies the main current water consumption drivers (also known as key demand indicators), and how these might change in the future.

An overview of the five stages for tailoring each of the socio-economic scenarios for food and drink manufacturing is presented in Figure 3.

Views of representatives from the food and drink manufacturing industry were taken into account as part of the tailoring process, specifically during two stakeholder workshops (stages 3 and 4). Industry views are key to developing the narrative describing the impacts of the scenarios, and quantifying the amount of change in water demand.

The detail of the tailoring process used for food and drink manufacturing is provided in the accompanying methodology report. The baseline water use data and information on the definition of sectors, assumptions and limitations behind this dataset are included in the latest WRAP update[11].

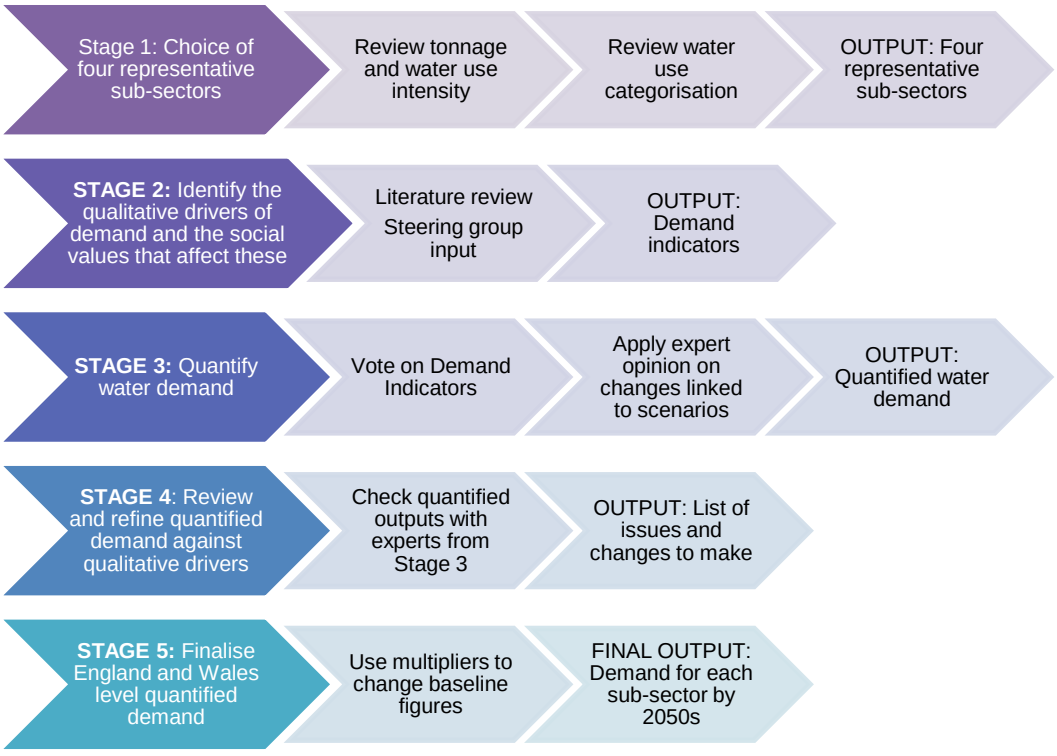

Figure 3 Summary of tailoring process for socio-economic scenarios

[11] WRAP, 2013, Water use in the UK Food and Drink industry.

3. Results

This section of the report provides the key outputs from the tailoring process for each of the four socio-economic scenarios for food and drink manufacturing. Each scenario is described in turn with a summary of the key impacts for each sub-sector. A narrative outlining the projected changes within each of the main food and drink sub-sector groupings is also provided. You will notice a dichotomy of changes, with the overall direction of change illustrated in a chart at the end of each section.

3.1. Sustainable behaviour

"We can cut out resource use through new ways of managing our societies and our relationships"

3.1.1. Summary of scenario: 28% decrease in water demand by 2050

"With growth hard to find, government focused on social welfare as the way to keep citizens content, while environmental disasters in the 2010s provoked international engagement with the low carbon agenda, and tighter regulations. Consumers choose to be green, pushed along by more regulation, which makes products reflect the full costs, including the pollution they cause. The sense of a collective project and collective action around environmental protection for social welfare means they are happier to trust the government to legislate for the national good. There is a greater role for public management, also driven by infrastructure costs that are unattractively high for private sector firms."

The primary impacts on the food and drink manufacturing sector under the sustainable behaviour scenario are:

- **Increased prices** – the focus on sustainability has resulted in increased prices across the board, and reduced purchasing power.
- **Taxation** – increased taxation from the EU has driven technological change. Tax on water has increased price to reflect its true 'value'.
- **Polarisation of food infrastructure** – technology uptake is dependent on whether it aligns with sustainability principles. Innovation has focussed on creating less damaging forms of production.
- **Recycling** – greater uptake of recycling technologies has reduced the impact on the environment.
- **Population growth** – 21% growth in population assumed

The narrative for each of the food and drink manufacturing sub-sectors under this scenario is provided below.

3.1.2. Beverage manufacturing sectors (Wine, Cider, Soft Drinks, Spirits and Brewing)

Demand for each beverage type has driven the market such that products have increased in price and resulted in reduced production / consumption. However, increased local production using UK raw materials and reduced exports resulted in no changes in consumption for brewing. There is a change in demand for certain types of beer and other drinks.

The value of water has increased as a result of stricter policy and regulation measures, requiring new technology to meet water use targets. The technology implemented within the manufacturing process has reduced water use through re-use of process water, alternative cleaning technologies and heat recovery in closed loop systems. New sources of water supply including rainwater harvesting are also being utilised. Environmental drivers (scarcity and drought) have ensured different quality sources are used depending on requirements for the ingredients versus process water use.

3.1.3. Dry food manufacturing sectors (Milling, Animal Feed, Cereals, Bakery, Confectionary and Snack Foods)

A rise in demand for healthy products and increased local production along with reduced demand for unhealthy options were observed. A decrease in water use for the dry foods sector is driven by changing demand for food, where sustainable production has made exports less competitive on global markets but competitive in markets close to shore. Legislation has driven an increase in demand for sustainable practices, increased the value of water and has resulted in industry targets for efficient water use and water budgets.

Water efficiency within the process has increased and new sources including rainwater harvesting and closed loop systems have been implemented.

3.1.4. Wet processing sectors (Fish Processing, Dairy, Fruit and Vegetables, and Meat Processing)

Demand has been driven by global markets with some increased exports of sustainable UK meat products. However, meat volumes produced for the local market have decreased significantly with increasing prices (linked to regulation) resulting in an overall decrease in water use. Dairy and fish products also have similar demand drivers but they are not as pronounced. Demand for fruit and vegetables increases to replace the reduction in protein through less consumption of meat products, although this is limited by home grown produce being consumed.

Increased regulation associated with carbon footprinting, animal welfare considerations, water footprinting and standards for appropriate water use have increased the value of water and have incentivised greater efficiency in water use. Technology has been driven by regulation which has resulted in greater water efficiency in wash down and process operations, and an increase in closed loop sites. Alternative water sources including rainwater harvesting have reduced demand from direct abstraction and public water supplies.

Reduced water availability has led to a reduction in meat production and investment in the sector. Seasonality has increasingly had an impact on availability and demand for products and there is a relationship between demand for product and availability of water. The fish processing sector has seen less impact as fish are now caught or farmed locally but with no increase in tonnage.

3.1.5. Pre-prepared food manufacturing sectors (Pet Foods and Pre-prepared Foods)

Demand has been driven by the availability of local synthetic and value-added foods which have increased in overall production within the sector. There has also been an increase in local demand for sustainable pre-prepared foods. Strong policy and regulation has resulted in increased compliance costs.

Increased food re-distribution and decreased food waste through process improvements have also helped to reduce total water use. Labelling for water and carbon as well as linking carbon and water budgets has increased the value of water.

Technology driven by policy and regulation has increased water efficiency and resulted in greater recycling and closed loop systems. The hierarchy of water use is now considered when allocating water for hygiene versus process uses. Rainwater harvesting is playing an increasing role. Recycling and greater use of the water quality hierarchy (i.e. using a water quality that is appropriate for the end use e.g. lower quality for process versus in-product use) have been supported by changes in public perception. These trends have led to an overall decrease in demand for water.

Water availability has affected the location of processing and different levels of water quality are now being considered for use (enabled by new treatment technologies and changes in public perceptions around wastewater reuse).

3.1.6. Sustainable behaviour quantitative results

An overall 28% reduction in demand compared to 2010 is projected by the 2050s under the sustainable behaviour scenario. Figure 4 illustrates the relative differences for sub-sectors.

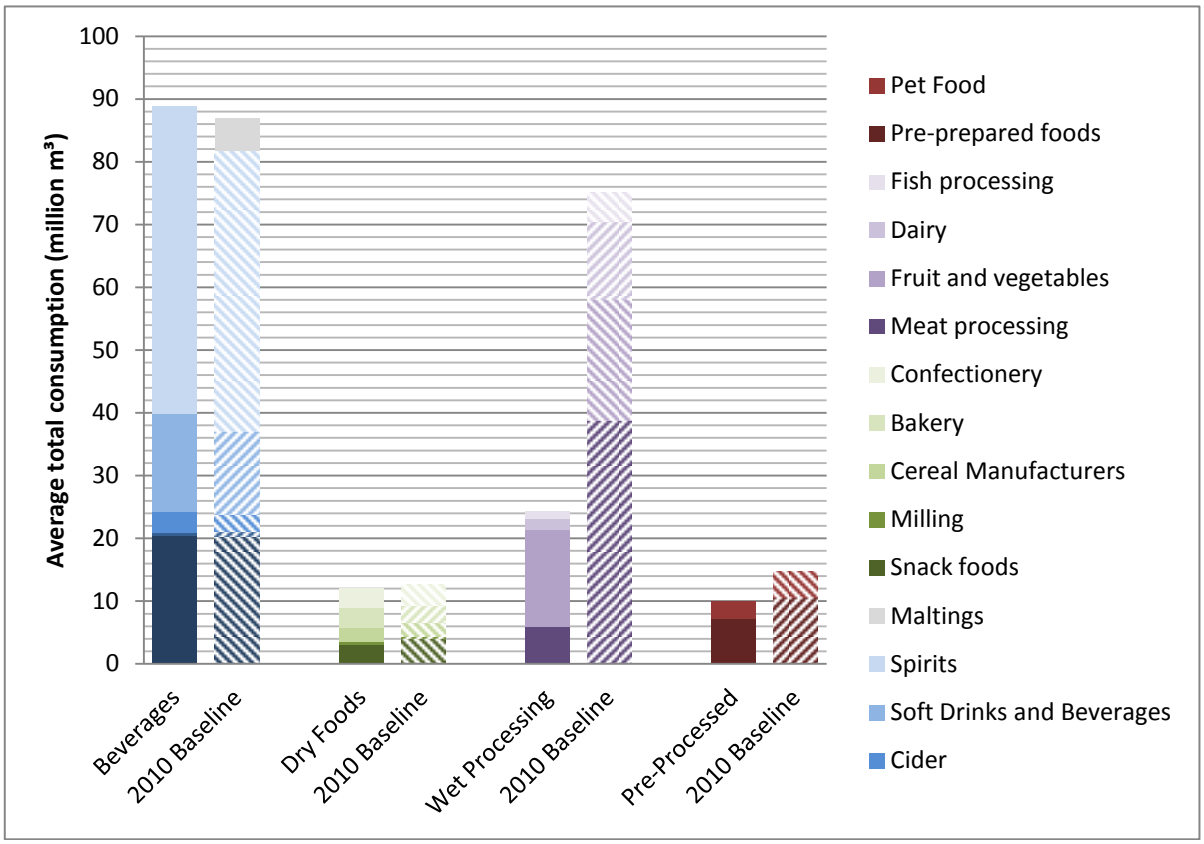

Figure 4 Projected water demand under the sustainable behaviour scenario[12]

[12] Maltings sub-sector was not quantified

3.2. Innovation

“Our scientists and technologists can solve the problems of environmental damage through their ideas and innovation”

3.2.1. Summary of scenario: 5% increase in water demand by 2050

“In response to a stagnating economy, the government chooses to drive the UK into a large scale wave of industrial investment in sustainable technologies, attempting both to kick-start the economy and avoid an impending wave of resource shortage. The result is a world in which sustainable behaviour is ‘designed in’ to urban and social life. One consequence is a ‘corporatist’ world, in which the interests of business and government are aligned.”

The primary impacts on the food and drink manufacturing sector under the innovation scenario are:

- **Increased food production** - demand has increased significantly due to change in lifestyle, fewer ethical issues, and improved food quality. The market has driven production to where it is most efficient.
- **Increased polarisation** - a split between rich and poor has resulted in the rich consuming higher quality products compared to the synthesised foods eaten by the poor.
- **Globalisation of the market** – being driven by the ability to produce food cheaper and quicker.
- **Higher quality standards** - being driven by increased policy and regulation.
- **Increased regulation** – supply side regulation has now become accepted and an integral part of the economy.
- **Population growth** – 32% growth in population.

The narrative for each of the food and drink manufacturing sub-sectors under this scenario is provided below.

3.2.2. Beverage manufacturing sectors (Wine, Cider, Soft Drinks, Spirits and Brewing)

Demand for wine and brewing has increased under the innovation scenario. Despite pubs closing and sector globalisation (labels have been globalised but production has been localised). Exports and imports have shrunk which has been a consequence of more local production. Prices have decreased following the investment phase in new technology. Loss of small producers has resulted from a move to larger more efficient producers. Only large producers have been able to afford the newer and more efficient technology.

Stronger policy and regulation along with increased quality standards have resulted in a reduction in the number of manufacturers. The value of water has decreased as innovation has increased its availability. Technology advances have improved water efficiency within the sector and resulted in alternative water sources becoming available. As such there is a move away from the use of groundwater (previously ~60% of consumption). The location and characteristics of the water source have become less important as technology advances have enabled greater treatment prior to use. Water efficiency targets have been introduced to help progress technology resulting in reduced consumption.

3.2.3. Dry food manufacturing sectors (Milling, Animal Feed, Cereals, Bakery, Confectionary and Snack Foods)

Demand for dry foods has increased under the innovation scenario as global technology has enabled improved logistics. There has been a small overall increase in water use which has been driven by demand however significant progress in water technology limits this increase. Health aspects are no longer an issue as the highly regulated industry has provided new innovative alternatives to unhealthy ingredients.

Significant advances in technology mean further process efficiencies have become more challenging. Technological change has allowed the use of alternative sources of water. Water remains less integral to this sub-sector with only a small amount of water contained in the final product.

3.2.4. Wet processing sectors (Fish Processing, Dairy, Fruit and Vegetables, and Meat Processing)

Demand for products within these sectors under the innovation scenario has increased significantly due to change in lifestyle, less ethical issues, and improved food quality. Water use for fruit and vegetables has decreased while water use for meat processing, dairy and fish processing has increased. The market has driven production to where it has become most efficient. A split between rich and poor has resulted in the rich consuming higher quality meat products whereas the poor are consuming more synthesised products. Economic drivers for dairy and fish processing have become similar to meat production, with a similar direction of travel for the sector but with a different magnitude in change in demand. Demand for fruit is less due to increased production costs. However demand for vegetables is much higher. This will average out the water use for these products.

Stronger government policy has led to an increase in quality standards and investment in process and production. Higher standards have been driven by retailers which have resulted in an increase in the value of water. Improved environmental protection has also been implemented through regulation.

Technological drivers have increased the production of synthesised and genetically modified source foods. Technology advances have enabled use of alternative water sources and water quality has become less of a concern. Water efficiency has increased with production which has become faster, more efficient and cheaper. Investment has required the other processing sectors to achieve automation levels similar to that of meat processing.
Environmental drivers have increased fish farming and changes in processor locations. Alternative sources of water have become available including seawater and grey water, for use in processing. Water availability is no longer a primary concern due to a wider range of sources being accessed, although constraints on availability have driven investment in technology and alternative water sources.

3.2.5. Pre-prepared food manufacturing sectors (Pet Foods and Pre-prepared Foods)

Increased globalisation and demand under the innovation scenario has resulted in production moving location or more efficient local production. Overall water consumption has increased. Exports have increased, and a greater range and choice of pre-prepared meals have become available (alternatively imports have increased as a result of the export of UK production knowledge). Longer shelf lives have reduced wastage and demand. Prices have become reasonable and have good profit margins. Demand has driven a range in product type from premium products with higher prices to value-added products (where low quality raw materials have added economic value) with lower prices.

Policy and regulation have driven higher quality standards and consistency of product. The need for regulation has decreased as water availability has increased. Reduced regulation has the potential to have an impact on water quality and quantity, which may drive an increase in the value of water. This is due to alternative sources becoming available through innovative technology. This technology has also facilitated greatly improved water use efficiencies.

Environmental drivers have led to more water being available from alternative sources such as wastewater reuse/ rainwater harvesting and a reduced impact on river and groundwater abstractions. No real impact on the environment has occurred from processing, and production is located where the skills and labour market is based rather than the water resources.

3.2.6. Innovation quantitative results

Overall a 5% increase in water demand, compared with the 2010 baseline, is projected by the 2050s for the innovation scenario. Figure 5 illustrates the variation between sub-sectors in this scenario. The apparent reduction in water use in the beverage sector under this scenario is explained by the fact that the maltings sub-sector is included in the 2010 baseline but was not considered in the 2050s projection.

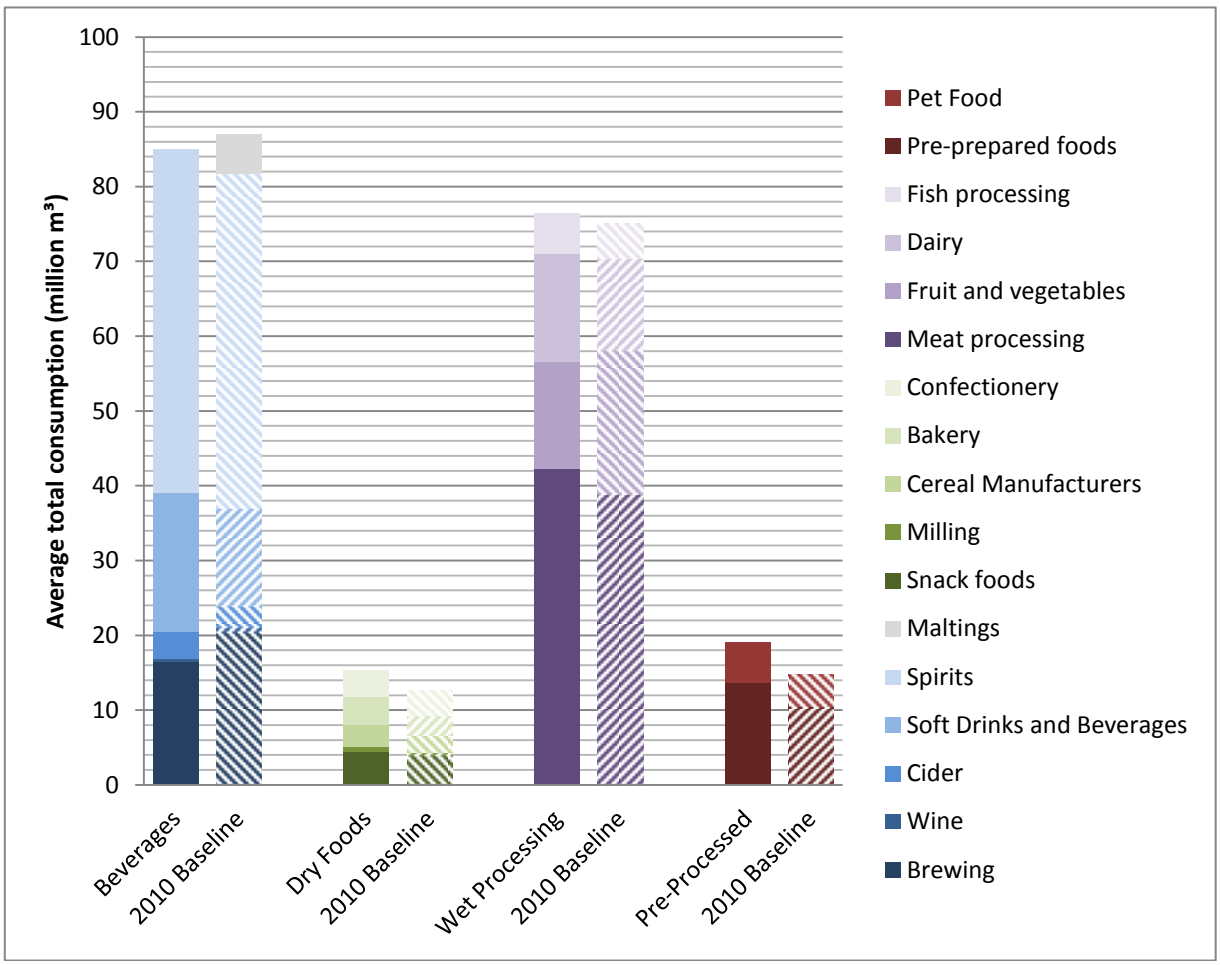

Figure 5 Projected water demand under the innovation scenario[13]

3.3. Local resilience

"It is better to have fewer wants than greater resources"

3.3.1. Summary of scenario: 5% increase in consumption by 2050

"Sustained political and economic crises of the 2010s were not successfully resolved, leaving the UK in a low-growth world despite the best efforts of politicians. Rationing and unwillingness for countries to work together made the UK turn inwards, and local regions focus more on how to solve their own problems. The direction of economic innovation has been away from international financial flows and finance, concentrating on helping money to circulate locally to support local and regional economies. Consumption is less intensive and more focused on local services than expensive (often imported) manufactured products." For the food and drink manufacturing sector this has manifested into the following overarching points:

- **Rise of localism** - there has been a move away from global markets towards regional and local economies with communities becoming more self-sufficient.
- **Localised production** - food production has been driven by growth of small independents with a UK / regional market focus.

[13] The maltings sub-sector was not quantified – if this is removed from the beverages baseline an increase is projected for beverages to 2050 as with the other water use categories

- **Reduced diversity** - due to lack of global ingredients and small batch production that has increased cost.
- **Back to basics** - social behaviour has resulted in low tech home grown raw materials.
- **Population growth** – an 18% increase in population is assumed.

The narrative for each of the food and drink manufacturing sub-sectors under this scenario is provided below.

3.3.2. Beverage manufacturing sectors (Wine, Cider, Soft Drinks, Spirits and Brewing)

Consumption across all beverage manufacturing sub-sectors, except for spirits, has reduced under a local resilience scenario. The reduction has been driven by price increases due to competition with other food stuffs for raw materials. Where the raw materials are not available production has decreased. Alternative ingredients (e.g. apples, pears, and other fruit and vegetables such as potatoes) have become more popular. Brewed products are now only for the local/ UK market and micro-breweries have become more widespread.

High local water quality standards and conflict with other essential uses of water has decreased water use. Social behaviour has resulted in home grown raw materials, with no net change in consumption. Water efficiency has reduced due to the size of breweries. Changes in local water quality have driven changes in the distribution of breweries with local production and a return to refillables greatly increasing water consumption.

3.3.3. Dry food manufacturing sectors (Milling, Animal Feed, Cereals, Bakery, Confectionary and Snack Foods)

Demand for dry foods (except milling and bakery goods) has reduced under the local resilience scenario. Production has been driven by demand for nutritional foods, reducing diversity and the availability of global ingredients and small batch production. This has led to increased costs, reduced water demand but increased water use intensity. Only the milling and baking sub-sectors increase water use in this scenario.

Local policy and regulation standards have driven an increase in the value of water. Existing technology has continued to be used as production within these sectors has declined, despite growth in local water treatment. Environmental drivers have driven up the importance of water availability due to the nature of the process. Water reuse where possible has become more prevalent.

3.3.4. Wet processing sectors (Fish Processing, Dairy, Fruit and Vegetables, and Meat Processing)

Water use for fish processing has decreased under a local resilience scenario while the water demand by the fruit and vegetables and dairy sub-sectors has increased. This has been driven by growth in small independents that have a UK market focus and have limited diversity, depending on the suitability of the local environment. There has been an increase in farming intensity and processor requirements (e.g. in the poultry sector) and land use competition has increased due to the need for animal feedstock. Infrastructure costs have increased and as demand for food has decreased local production has become prevalent but this has resulted in an increase in water use intensity.

Policy and regulation have had little impact in this scenario except for an increase in some land use regulation and issues around access to water. Technology development has reflected changes in farming intensity and size of units. Technology has not increased tonnage due to more home grown produce but water use intensity has increased. Fish production has reduced with a move back to traditional methods and technologies. Some increases in water use for fruits and vegetables have occurred as small scale processes are less efficient. Industrialisation has reduced as food has become more locally produced.

Environmental drivers are linked to strong geographical variations as processors need to be close to farms and the level of water availability is crucial. Pronounced regional differences in the availability and quality of water have affected the location of operations.

3.3.5. Pre-prepared food manufacturing sectors (Pet Foods and Pre-prepared Foods)

Overall water use has decreased under the local resilience scenario. This has primarily been driven by a reduction in demand resulting in little or no actual pre-prepared foods being produced. Economies of scale (small batch production and short supply chains) has increased production costs and reduced demand. A low return on investment at such a local scale has resulted in a cottage industry only. Production has become dependent on the community and local needs.

Water policy has had a low impact on competition although the local protection of water resources has increased. Water use efficiency and reuse technologies have become a high priority dependent on location. Existing knowledge rather than innovation has become more of a focus within the sector and water treatment has focussed on reed bed systems with potential for reuse.

3.3.6. Local resilience quantitative results

Overall a 5% increase in water demand, compared with 2010, is projected by the 2050s under the local resilience scenario. Figure 6 highlights the differences between sub-sectors.

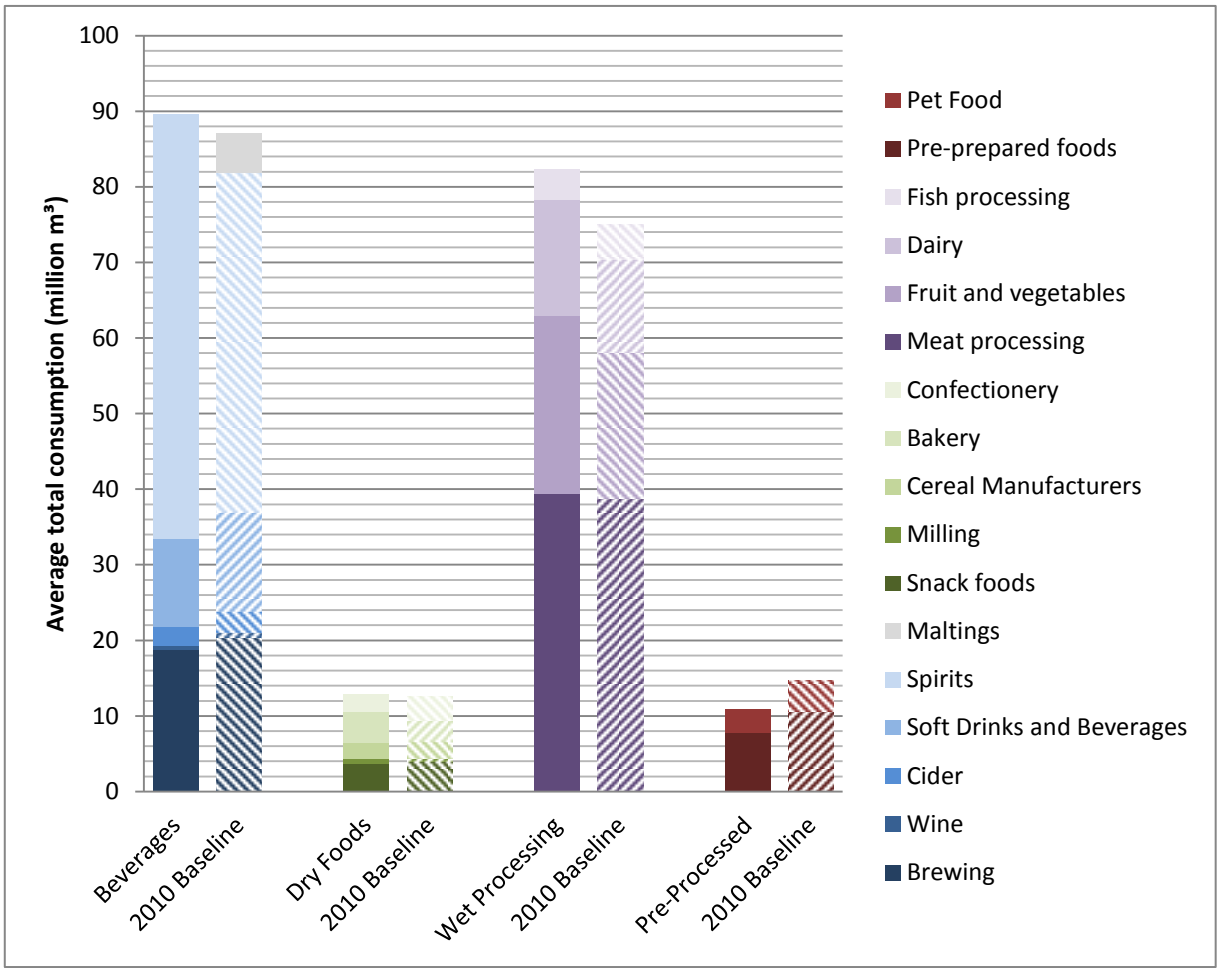

Figure 6 Projected water demand under the local resilience scenario[1]

3.4. Uncontrolled Demand

"The rich shall inherit the earth – because we're worth it"

3.4.1. Summary of scenario: 70% increase in water demand

"Political and economic systems were dominated by the interests of the wealthy, and as a result, they were able to shrug off protests designed to provoke a rethink of prevailing political and economic models. Increasing resource shortage meant that previous patterns of polarisation between the rich and poor intensified. The top 20% continue to consume without moderation, while the less affluent people are squeezed, relying on handed down products and poorer infrastructure. Security, water, energy and health move from being publicly provided to being increasingly privatised, with minimal basic provision levels supplied for all."

The primary impacts on the food and drink manufacturing sector under the uncontrolled demand scenario are:

- **Increased polarisation** - linked to the growing divide between the rich and poor. With poorer people consuming cheaper, low quality products.
- **Maximise profits** – more emphasis on producing food more cheaply and thus more profitably.
- **Low sustainability** – the key focus is on producing food more quickly thus environmental issues not taken into account.
- **Increased production of high value goods for export (UK, EU)** – the wealthiest within society has more disposable income and have a tendency towards luxury products.
- **Population growth** – A 42% increase in population growth is assumed.

The narrative for each of the food and drink manufacturing sub-sectors under this scenario is provided below.

3.4.2. Beverage manufacturing sectors (Wine, Cider, Soft Drinks, Spirits and Brewing)

The large increase in water demand under an uncontrolled demand scenario for each of the beverage sub-sectors has been driven primarily by greater demand. Polarisation in the type and quality of alcoholic beverage has become linked to wealth with poorer people consuming more beer (both high strength and low-strength as a replacement for water) whilst rich people have tended to choose specialty beers. Production in the sector has increased as a result of emerging markets and the impact of more people drinking champagne. An increase in exports has also occurred.

A trend towards larger producers that are more efficient in their production methods has also been observed but has led to an overall increase in water consumption. This demand has not been tax driven (i.e. taxes and regulation reduce consumption in other scenarios). Technology may have improved water efficiency although this has become polarised due to the price-level of the product and the environment has become less important than maintain production. Wine, which traditionally has had less efficient technology employed in Europe compared to the New World wine production, has seen more efficient economies of scale. There is a move from wine concentrate and bottling to UK grown wine being fermented and bottled. Increased demand in fruit drinks has resulted in more fruit processing and water use.

3.4.3. Dry food manufacturing sectors (Milling, Animal Feed, Cereals, Bakery, Confectionary and Snack Foods)

Water use under an uncontrolled demand scenario has increased and has been driven by increased demand for dry foods. Water use has increased in line with production. Price has increased with demand although this has become dependent on the market position of the product. Process use and water use have increased with global demand for products.

The split between healthy and non-healthy foods has become tied to the overarching changes in society. Self-regulation has resulted in better products for some however food quality has declined for the poor with cheaper snacks more readily available.

Private and well off companies have become able to invest in water efficient technologies whilst others have had to adopt a ‘make do and mend’ approach with older equipment (which is less water efficient). Centralisation of production has reduced water use intensity.
Environmental drivers have included upstream (geographically) investment to exploit water resources. Exploitation has also had an impact on water courses.

3.4.4. Wet processing sectors (Fish Processing, Dairy, Fruit and Vegetables, and Meat Processing)

Under the uncontrolled demand scenario demand for water has significantly increased in the wet processing sectors. This links to higher value products and increased demand for meat products with the rich tending to consume good quality foods while the poor consume more 'value-added' processed products (more vegetables if they are the cheapest source of sustenance). A market has been established for meat products that the UK does not currently consume reflecting the polarisation of wealth (i.e. the poor may eat meat products including horse etc. and alternative cuts of meat/ offal). The fish and dairy sectors have similar economic drivers to the meat sector with investment required for automation and similar outcomes in terms of demand. Fish has become a high value product.

Consumer led policy and regulation has ensured quality for the elite whilst government intervention covers lower quality products for the poor. This polarisation sees protein intake increase as wealth increases (less fruit and vegetable consumption resulting in a reduction in water use).

Technology has driven intensification of production and artificial meat production. Genetically modified foods have become commonplace. Less water availability has resulted in technology for efficiency. Technology has significantly reduced water use in the fruit and vegetables processing sector.

Environmental drivers have led to some adaptation to water availability; however the risk of water shortages has increased. The ethics of production are now less relevant than increased production.

3.4.5. Pre-prepared foods manufacturing sectors (Pet Foods and Pre-prepared Foods)

A large increase in demand for water in the pre-prepared foods sub-sector has occurred under an uncontrolled demand scenario (although narrative developed in the stakeholder workshop considered similar demand overall but of different qualities with high value products for the rich). Seasonality has become more important for those less well-off where this impacts on processing. A 90% increase in sales of dry dog food and an 80% increase in dry cat food sales have occurred over the last decade[14].

Technology has focussed on how products look and taste rather than overall water use, thus increasing water use intensity. More water is included in low grade products and existing processing technology continues to be used.

Ethics of production are irrelevant and the quality of water may impact on local sources. Effluent quality is immaterial to processors and factory abstraction has derogated wider abstraction by the local population.

[14] Pet Food Manurfacturers' Association, 2013, "HAS THE MARKET CHANGED OVER THE YEARS?

3.4.6. Uncontrolled demand quantitative results

Overall a 70% increase in water demand, compared with 2010, is projected by the 2050s under the uncontrolled demand scenario. Figure 7 highlights the differences between sub-sectors.

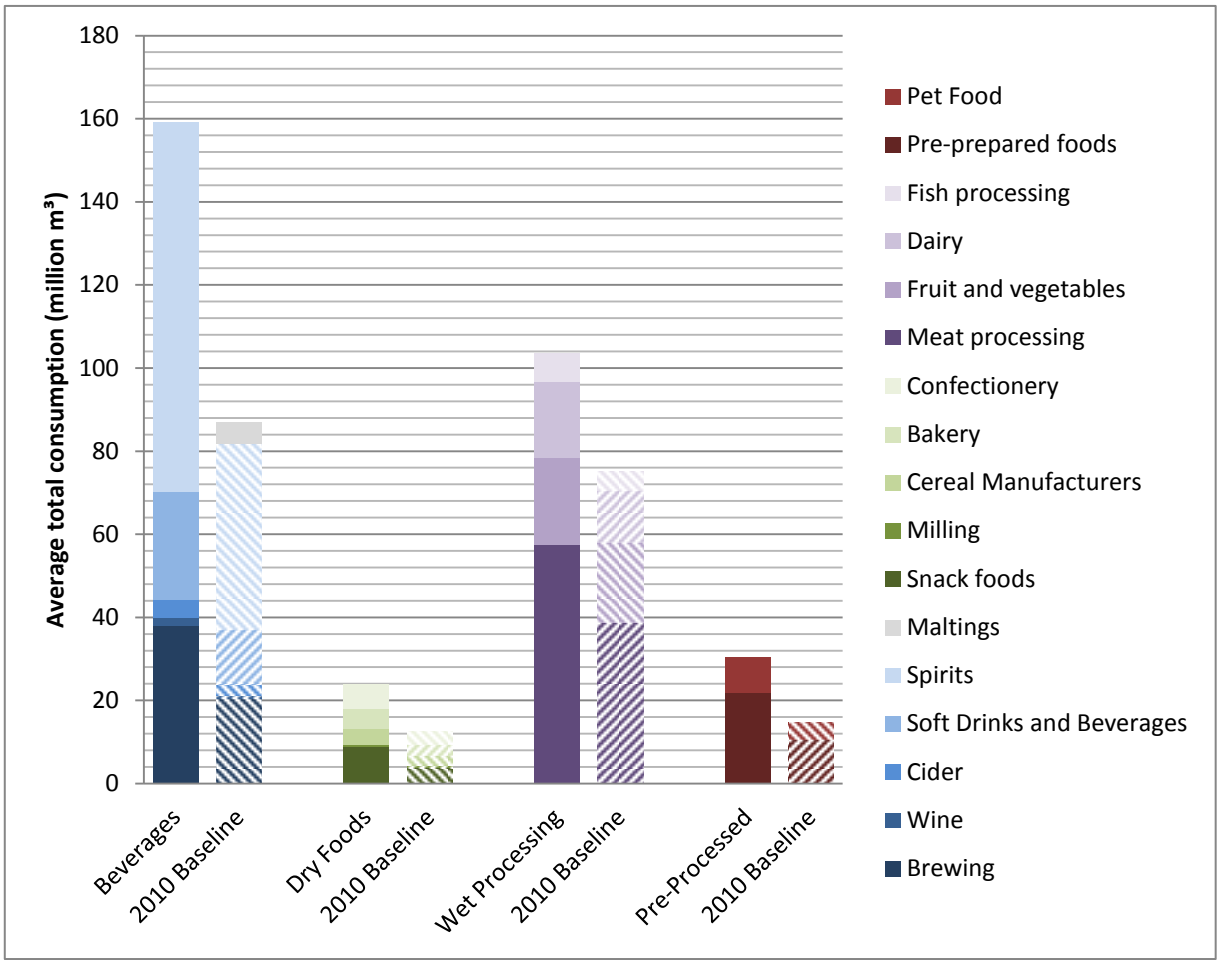

Figure 7 Projected water demand under an uncontrolled demand scenario[15]

3.5. Summary of results

The main current water consumption drivers for each sub-sector and how these might change in the future under each scenario have been described above. The resulting narratives and the quantified water demand projections are well aligned for each of the scenarios.

The total water demand for all food and drink manufacturing sub-sectors in 2050 under each of the socio-economic scenarios is shown in Figure 8. In broad terms, and in comparison to the 2010 baseline, the projections show that total water demand for the food and drink manufacturing sector has decreased under sustainable behaviour only.

The baseline data show the highest water demanding sectors currently to be spirits, meat processing, brewing, and fruit and vegetable processing. In 2050 these sub-sectors have remained the highest water demanding sectors under the uncontrolled demand, innovation and local resilience scenarios. Spirits, brewing, and the fruit and vegetable processing sectors have the highest water demand under the sustainable behaviour scenario; however water demand in the

[15] The maltings sub-sector was not quantified

meat processing sector has reduced considerably which has significantly impacted on the overall water demand reduction for this scenario.

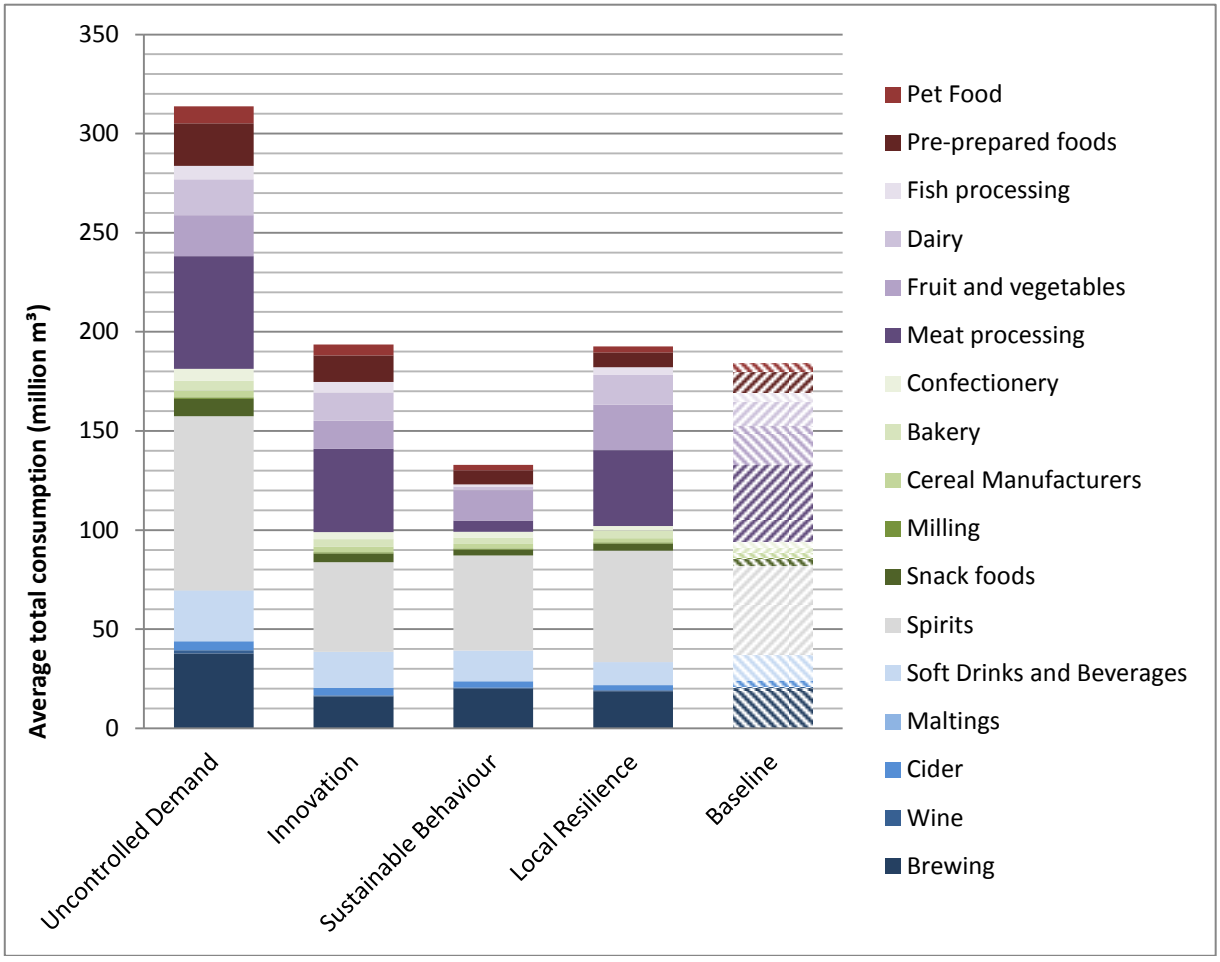

Figure 8 Demand for water in the 2050s for food and drink manufacturing sub-sectors

The baseline data provided by WRAP provides a combined figure for public water supply and abstraction. This cannot be broken down beyond the United Kingdom geographic level for individual sub-sectors. However, an approximation of water use by England compared with other member countries illustrates the potential water demand based on current use (Figure 9). Additionally, the WRAP dataset does not allow the water use projection to be broken down into public water supply compared with direct abstraction.

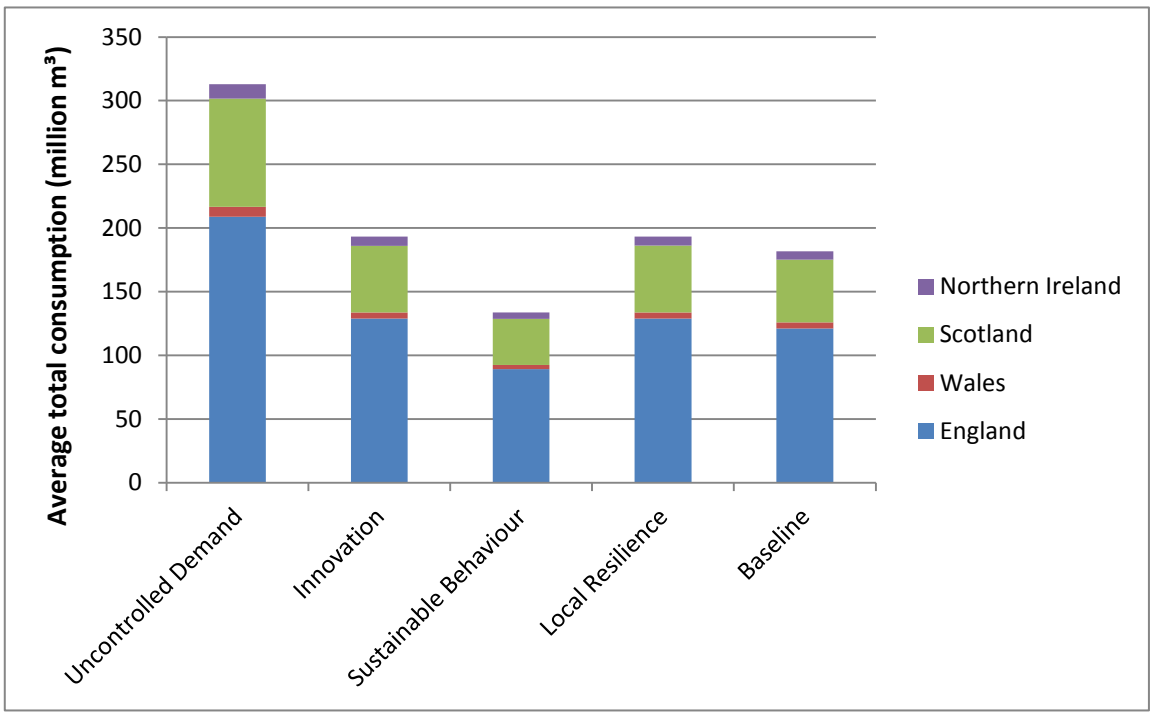

Figure 9 Approximation of demand for water in the 2050s in the United Kingdom compared with the baseline (using 2010 proportions for total water use from WRAP).

3.5.1. Potential limitations of these projections

It is important to bear in mind when considering the results and the quantified changes in future water demand within the food and drink manufacturing sector, that there are a number of limitations associated with this approach.

While the scenario approach is useful for developing an overall 'picture' of the future and to describe the potential magnitude of change; it is not intended to provide accurate quantitative predictions of what will happen. Stakeholder discussion and opinion were vital to developing the demand indicators, the narratives, quantifying the change in production tonnage and water demand that might be expected under each of the socio-economic scenarios. The stakeholder group consulted during this project included a range of representatives from across the food and drink manufacturing sub-sectors.

Further to this, while stakeholders were guided through each of the four scenarios, individuals are unlikely to interpret them in exactly the same manner, and may not have necessarily considered the full range of variables in the same way as others when they form their opinion. This is likely to have led to some variance in how opinions were formed and the final quantified projections. Similarly while the consultative approach in the main reaches a consensus on the overall 'direction of travel' (increase/decrease in demand) and the magnitude of change (percentage) for each of the sub-sectors under each scenario the contributing opinions were subjective.

Finally water demand has been projected using a 2010 baseline which has been derived using data currently available for the food and drink manufacturing sector. However, this data has been drawn from a variety of sources and it is acknowledged that for some sub-sectors it is less reliable than for others. As such the quality and robustness of the baseline has a strong influence on the overall projections.

These limitations support the view that the projections derived from this approach may not be 100% robust and should therefore be considered as estimates based on stakeholder opinion.

4. Discussion

Scenarios are intended to help people imagine, understand and manage the future more effectively. They are not intended to be forecasts of what will happen. Instead they seek to identify what could happen in the longer term if there are changes in values, attitudes, social and economic structures, or in science and technology. Signs of such changes are typically observable today, although they are not always easy to quantify or assess. Scenarios are not visions of what we want to happen; we may not like some of the possible future worlds which emerge from a scenario development process. As such the aim of the process was to improve understanding of one's overall external environment, and to improve one's responsiveness and ability to adapt to change.

The scenario based approach used in this study has enabled us to explore and develop an understanding of the factors that are most likely to drive future water demand within the food and drink manufacturing sector. This has resulted in a description of what the sector and its associated sub-sectors might look like under each of the four defined socio-economic scenarios, and has enabled an assessment of the direction and magnitude of change in demand under these conditions.

The future is uncertain but the outcomes from this work provide supporting evidence for those that need to consider the scale of future risks associated with the demand for water, such as food and drink manufacturers, water suppliers, regulators and policy makers.

4.1. Future change in the food and drink industry

Over the last 100 years the food and drink sector has seen some significant changes. Free trade and improved transport has resulted in a move from local production to globalised markets which have meant that more varieties of food are available and non-seasonal foods are offered all year round.

People's attitudes towards food have also changed, they now do not have time to prepare a meal and they want food quicker and cheaper. Alongside affluence and social changes media, branding and advertising have changed consumer choice; leading to a lack of understanding of food production and a move towards large retail stores rather than locally based markets. Technological advances in refrigeration, packaging and preservation of food have also driven major changes in consumption and demand for the food and drink we buy.

Looking into the future it is likely that our relationship with food will continue to change and technological advances and innovation will be at the forefront of addressing the issues associated with food security and in meeting the requirements of the rising global population. Water and the provision of a good quality supply of water will continue to be critical to food and drink production.

Overall the results show that the total demand for water in the food and drink manufacturing sector is projected to increase in comparison to the 2010 baseline under all but the sustainable behaviour scenario. There are a number of contributing factors that have led to this forecast of overall change in demand, and these are outlined below.

Under the uncontrolled demand scenario greater demand in food and drink products and increased exports are the main drivers for the forecast increase in total water demand. The focus on maximising profits and producing food quicker and cheaper also contributes to a shift in the market towards larger producers and intensification of production.

Brewing and the production of spirits are the sub-sectors that have the greatest impact on the rise in demand which is a reflection in the lifestyle changes under these scenario conditions.

Demand for food and drink under the innovation scenario is set to increase significantly due to change in lifestyles, less emphasis on ethical issues and improved food quality. Despite this, technological advances enable process efficiencies and open up access to new sources of water. Increased regulatory drivers also help in managing water consumption within production.

Under the sustainable behaviour scenario we see polarisation of the food infrastructure and increased prices across the board. This has led to a decrease in the total water demand for food and drink manufacturing sub-sectors. The most significant reduction is seen in the meat processing sub-sector where a move away from the consumption of meat products is driven by changes in diet and lifestyle. Conversely the consumption of fruit and vegetables increases.

Under the local resilience scenario there has been a move away from global markets towards the production of food at a more regional and local level. This has driven the growth of many small businesses operating locally, and seen a reduction in demand for pre-prepared foods and meat products. Overall there is a small increase in water demand under this scenario although local impacts may be more acute and dependent on the size of the local population.

4.2. Water availability and the implications for the food and drink industry

The projections show that total water demand for food and drink manufacturing only decreases under the sustainable behaviour scenario. In contrast total water demand was found to increase under the uncontrolled demand, innovation and local resilience scenarios. A future reduction in overall water demand would clearly be a preferable direction of change. While the initial outcomes of this study are encouraging, forecasting a decrease or only small increase in water demand under three of the four scenarios, they apply to the current water availability.

The availability of water in England is unlikely to be maintained at its current levels into the future. Water resources are already under pressure from combined impacts of climate change, increasing population and changes in lifestyle, and this is set to continue. In some places, water bodies are already being damaged by over abstraction and current supplies could become less reliable.

Figure 10 illustrates that a quarter of water bodies in England and seven per cent of water bodies in Wales will provide a reliable source of water for a new consumptive abstraction for less than 30 per cent of the time.

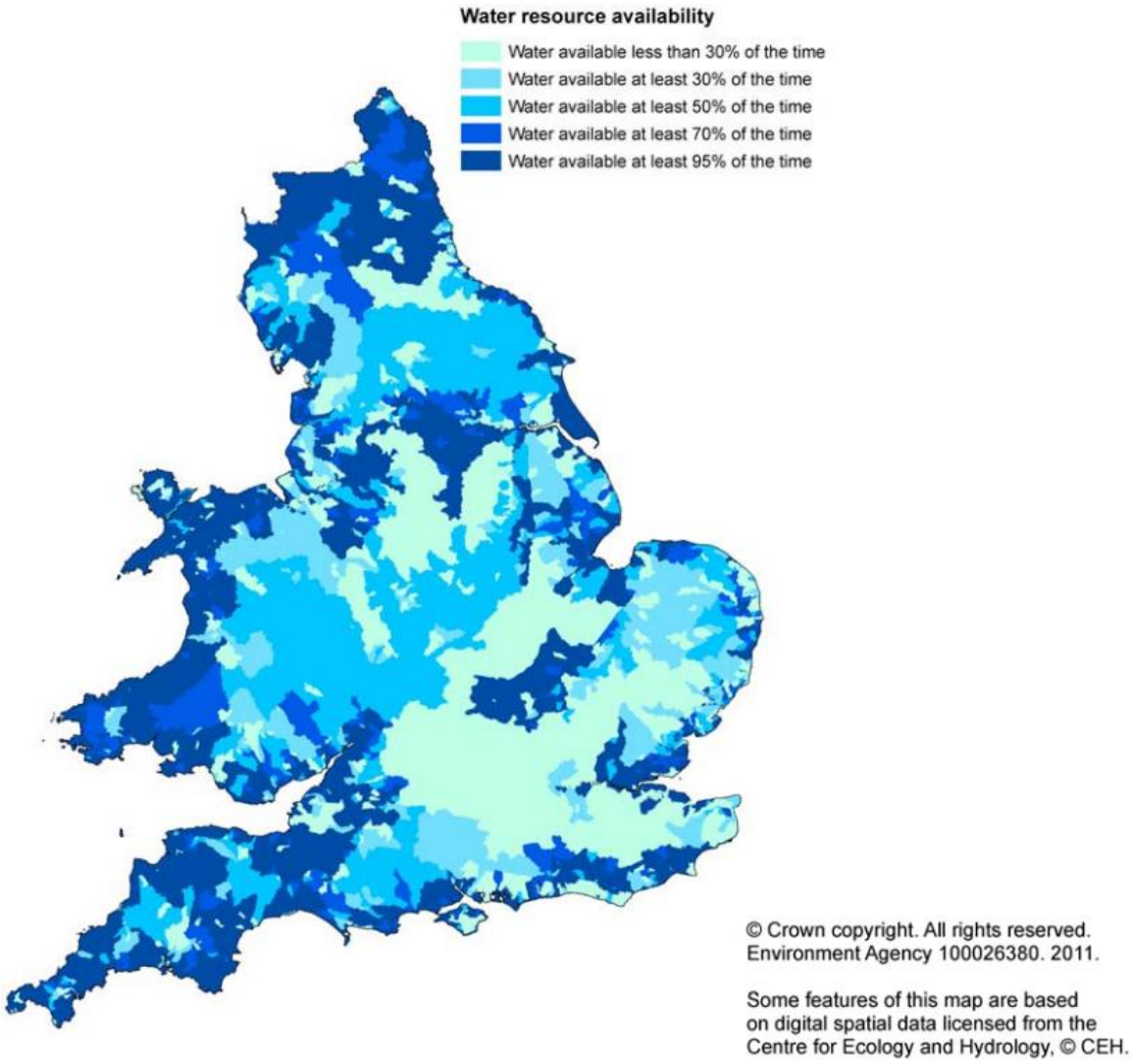

Figure 10 Water resource reliability: percentage of time water would be available for abstraction for new licences[16]

A number of specific catchments have been identified as hot spots in relation to freshwater availability (Table 2). A combination of the sustainability of direct abstraction volumes and narrative on consumptive uses based on Catchment Abstraction Management Strategy (CAMS) areas was used to provide this qualitative assessment.

The effect of projected changes in rainfall and evaporation mean that natural river flows during the summer may decrease by the 2050s almost everywhere across England, thus future water resource availability pressures will not be limited to regions such as the South and East of England which are already under water stress. Wales, the South West and Northern England are also likely to see significant unmet water demand.

To test against future water availability, the changes in water demand were fed into the 'Case for Change' calculations. This quantifies potential water availability in the 2050's against changes due to climate change and likely demand from people, business and environment. The results show a small change for water demand in sustainable behaviour scenario but overall an unmet water demand projections remain the same.

[16] Environment Agency, 2012, *The Case for Change - Current and Future Water Availability*.

Table 2 Potential hot spots for water availability related to the Food and Drink industry[17]

Freshwater availability	Vulnerable Region	Specific catchment
Short term (next four years)	Eastern England	Cam & Ely Ouse (Cambridgeshire) Broadland Rivers (Norfolk) Combine Essex (Essex) East Suffolk (Suffolk) Upper Lee (Bedfordshire, Hertfordshire, Essex) Colne (Hertfordshire)
	Midlands	Grimbsby, Ancholme & Louth (Lincolnshire) Dove (Derbyshire) Idle and Tome (Nottinghamshire) Lower Trent and Erewash (Nottinghamshire) Welland (Leicestershire, Rutland)
	South West England	Hampshire & Avon (West Hampshire, South Wiltshire) Kennet & Pang (North Wiltshire) Upper Thames (South Gloucestershire, West Oxfordshire)
Medium term (four to ten years)	Midlands	Nene Catchment (Northamptonshire) Middle Severn Catchment (Worcestershire) Avon Catchment (Warwickshire)
Long term (more than ten years from now)	South Wales	Whole Region
	Midlands	Whole Region
	South West England	Whole Region

Climate change could also increase the total demand for water. Some activities, such as irrigation or electricity generation, may need more water, as lower average summer rainfall and higher temperatures mean power stations need more water for cooling. Thus competition for water between sectors will be greater and is likely to drive increases in price.

However, the change in demand will depend on how users react to climate change. They could try to meet the increase in demand or adapt to the situation. It is clear that the option to do nothing to change current water demand would increase the risk of impact on future business operations. The food and drink industry therefore needs to consider how it will further reduce its potable water demand and through direct abstraction manage its current and future water demand.

4.3. Managing water demand

As water resources become less available and less reliable the sector will need to take steps to reduce the associated risks to ensure it remains viable and sustainable. There are several approaches that might be adopted to achieve a reduction in consumption, but the likelihood is that a combination of these approaches is applied. They include:

- Innovation and technological improvements to reduce water use during the production process.
- More efficient procedures and practices for wash down. Current hygiene standards within the sector are high and this often results in over-use of water for cleaning and wash down.
- A change in customer / retailer perception over the use of treated wastewater and water from non-potable sources.

[17] WRAP, 2013, *Water Use in the UK Food and Drink Industry*.

- Greater use of alternative water sources, such as rainwater and grey water.
- The treatment of wastewater for reuse within the production process.
- Substitution (or removal) of water with other ingredients. For example, more fruit juice based soft drinks, or dried ready meals (that require the end user to add water).

Water is used in food and drink production as both an ingredient and within the manufacturing process (e.g. for cleaning and wash down, as steam, or as a coolant). The opportunities for reducing water consumption are most likely to be found in processes rather than 'in-product'. However, significant savings could also be achieved through reducing the amount of water in the product for example, through producing better quality food products (e.g. water is introduced into some cheaper meat products to enhance their appearance and add 'bulk' to the product). A breakdown of water use for food manufacturing (excluding in-product) is outlined in Table 3 and based on data from 2007[18].

Table 3 Percentage of water used in process for food manufacturing (excluding in-product use) in 2007 reflecting relative potential for water efficiency measures

Sub-sector	Total (million m3/ annum)	Excluding in-product (million m3/ annum)	% Process
Bakery	2.4	1.3	54%
Cereal	12.5	12.2	98%
Confectionary	3.2	3.1	97%
Dairy	15.6	15.6	100%
Animal feed	0.9	0.9	100%
Fish processing	5.7	5.6	98%
Fruit and vegetables	27.8	27.8	100%
Meat processing	31.4	30.8	98%
Milling	0.3	0.3	100%
Pet food	5.36	4.7	88%
Pre-prepared foods	5.2	4.8	92%
Snack foods	6	5.8	97%

From this it is clear that a reduction in demand in the majority of the food manufacturing sectors is most likely to be made through efficiency gains within the process, rather than a reduction in water within the product. A range of water saving measures in food and drink manufacturing sites has been identified through the WRAP Federation House Commitment (Figure 11). Many of these feature within the scenario narratives for the 2050s and reflect workshop delegates requests for more advice and support to implement effluent re-use, which accounts for around 22% of potential water savings in the sector. Based on a sample of 61 sites visited a saving of over 11.9% could be made based on 2011 water use data[19]. However, this does not reflect the potential for greater innovation and new technology allowing closed loop systems as discussed by stakeholders in relation to the 2050s scenarios.

[18] WRAP, 2013, *Water Use in the UK Food and Drink Industry*.
[19] WRAP, 2013, Water Use in the UK Food and Drink Industry.

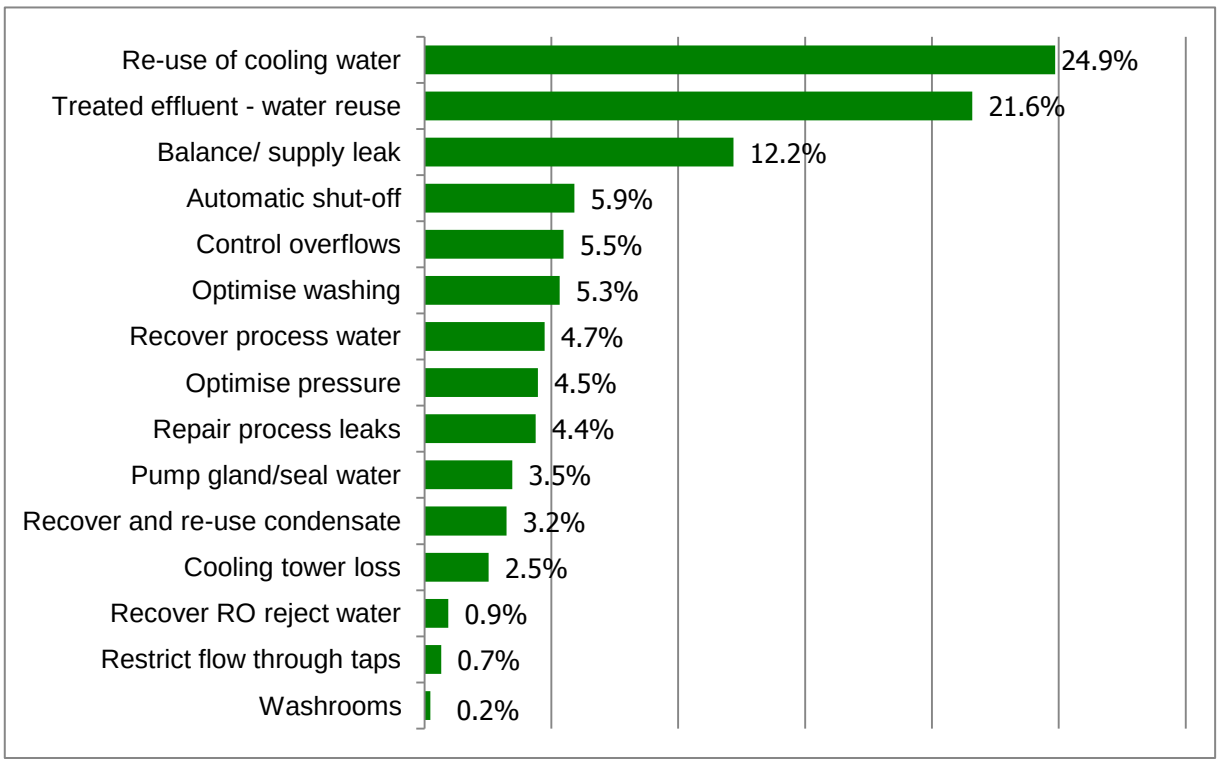

Figure 11 Water saving measures identified (% of total water use savings)[20]

4.4. Comparison with wider studies

The Environment Agency recently updated the future socio-economic scenarios, including a detailed consideration of food and drink manufacturing (Table 4)[21]. The original 2008 percentage changes for water demand in food and drink production are closer to the results from this project. The major reason for the large difference between sustainable behaviour in the Environment Agency internal update of scenarios compared with this project (100% increase vs 28% decrease in water demand) is linked to the wider issue of sustainable transport and the potential for more local food production. This reflects the industry expert focus applied in this project compared with the wider Environment Agency experts in the internal update.

The report on future demand for agriculture also projected increase in water use across all scenarios, reflecting the drive for higher levels of self-sufficiency in food production in the UK. Many of the high level drivers in the scenarios from the agriculture report are similar to this project[22].

A range of references exist on current water use efficiency, benchmarking and past trends for the food and drink manufacturing sub-sectors. These can provide a useful check on the projections, however the very nature of the long term socio-economic scenarios is the likelihood of disruptive changes may not be easily forecast.

[20] WRAP, 2013 *Water Use in the UK Food and Drink Industry*.
[21] The Futures Company, 2012, *Socio-economic Scenarios for Water to 2050 - Reviewed and Updated March 2012* for the Environment Agency.
[22] Defra, 2012, Unpublished Report: Assessing climate change impacts on land use and agricultural water demand and opportunities for farmer adaptation.

Table 4 Summary of water use in food and drink manufacturing from 2012 update of Environment Agency socio-economic scenarios compared with results in this study

Sustainable Behaviour (100% 2012; -20% 2008) -28% projected in this study A large increase in water use is projected under this scenario and is linked to more food being grown in the UK to avoid unsustainable shipping (compared with -20% in the original 2008 projections).	**Innovation (50% 2012; 10% 2008)-** 5% increase projected in this study This increase in demand is due to the 'ready meal' society and selfish attitudes that result in high wastage levels. Strict government controls on water use limit this increase.
Local Resilience (20% 2012; -10% 2008)- 5% increase projected in this study This increase in demand is due to more food being grown and processed in the UK as a result of both greater self-sufficiency and increase in food security.	**Uncontrolled Demand (20% 2012; 20% 2008)-** 70% increase projected in this study This increase in demand is as a result of the poorer population eating higher quantities of cheap, highly processed food and richer population eating 'speciality' processed foods. Some gains in efficiency as aim is to produce food for lower end of the market very cheaply.

5. Application to the wider food and drink sector

This project tailored the future socio-economic scenarios firstly for four representative food and drink manufacturing sub-sectors and then applied the approach to the rest of the sector to establish a forecast for water demand in 2050. There were clear similarities between sub-sectors grouped according to water use and this enabled the experts in the Check and Challenge event to further tailor the narratives and to estimate future water use within these.

The inherent similarities between the different food and drink manufacturing sub-sectors have enabled approach to be applied. However, water use within the wider food and drink industry (i.e. retail, wholesale, hospitality and food service) is significantly different and does not align well with the manufacturing sectors. The total water use for the food and drink industry is presented in Table 5 and is based on the latest data provided by WRAP.

This section sets out options for extending the project outputs to the wider food and drink industry.

Table 5 Total water use in the food and drink industry 2007 and 2010[23]

UK 2007	Total water use (million m3/year)				
	UK	England	Wales	Scotland	Northern Ireland
Food and drink manufacturing	230.9	133.3	9.4	78.3	9.9
Retail	10.1	8.3	0.5	1.0	0.4
Wholesale	1.6	1.4	0.1	0.1	0.1
Hospitality and food service	169.0	145.6	6.7	12.9	3.8
Total food and drink industry	411.7	288.6	16.7	92.2	14.1

UK 2010	Total water use (million m3/year)				
Average	UK	England	Wales	Scotland	Northern Ireland
Food and drink manufacturing	190.6	125.5	7.2	51.0	6.9
Retail	8.5	7.1	0.4	0.8	0.3
Wholesale	1.4	1.2	0.1	0.1	0.0
Hospitality and food service	156.3	135.6	5.8	11.5	3.3
Total food and drink industry	356.8	269.3	13.6	63.3	10.6

5.1. Option 1 Workshop based approach

Water use by sectors other than manufacturing is similar i.e. it is primarily for ‘domestic‘ purposes and in the preparation of food. As such it is possible to build on the existing tailored scenarios developed for the food and drink manufacturing sector through a workshop with representatives

[23] WRAP, 2013, *Water Use in the UK Food and Drink Industry*.

from the wider food and drink industry. The benefits of adopting this approach include the need to link retail with manufacturing (i.e. in this study manufacturers felt that their retail customers were a key driver of their water use) and gaining some insight for the wider industry without the need for more extensive stakeholder engagement to assess demand within these sectors.

Further stakeholder engagement is also suggested in the Cambridge University report 'Future scenarios in the food and drink sector'[24] which suggests that there are clear differences between food manufacturers, suppliers and retailers views on the future. The findings within this report could be adapted to help extend the scenarios for food and drink manufacturing to the wider food and drink industry as proposed here.

5.2. Option 2 Desk based research approach

Another less intensive option with lower costs may be to review the literature on water use in the sector and any existing industry projections (Figure 12). This could be followed by a survey or interview of representatives to tailor scenarios to these sectors. Modelling and projection can then be built on this and a high level check and challenge applied (i.e. with a select panel of external experts or input from Environment Agency experts).

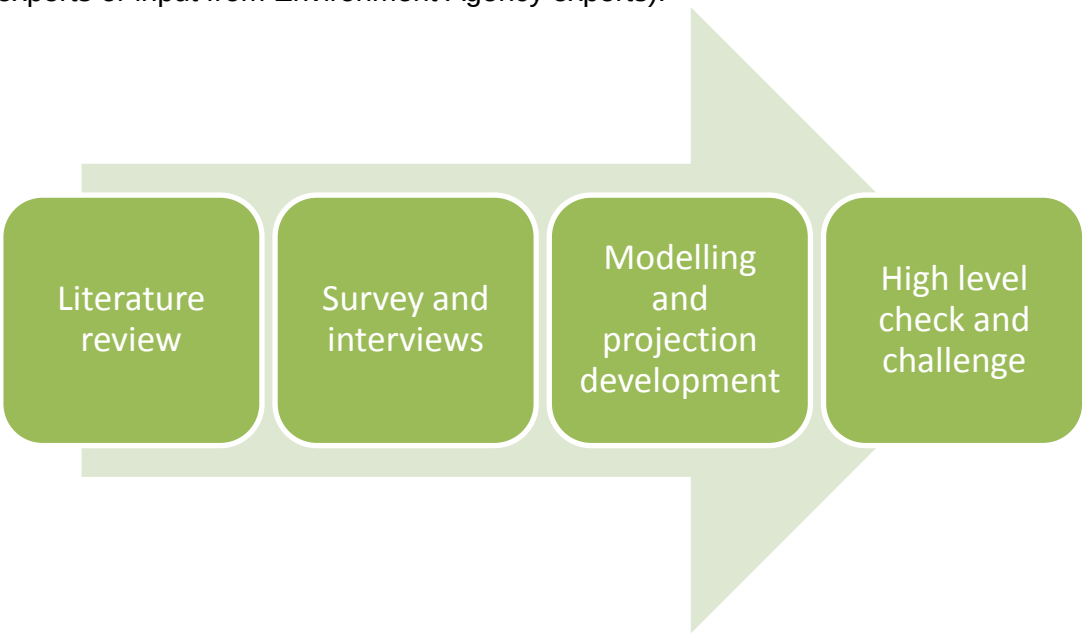

Figure 12 Overview desk based research approach to expand scenarios

The major limitation of this approach is that it is not consistent with the workshop based method used to tailor the scenarios in all other Environment Agency projects. As a result those being surveyed or interviewed will not be able to build up an appreciation of the scenarios individually or within a group environment. The group environment also helps reduce potential bias from one or more stakeholders.

[24] Fibarr Livesey et al., 2010, Future Scenarios for the UK Food and Drink Industry, University of Cambridge

6. Conclusion

We set out to use socio-economic scenarios to explore how water demand within food and drink manufacturing may change under different consumption patterns and levels of governance, between now and 2050. The outputs will provide additional narrative on the food and drink industry to supplement the information already provided to Defra's programme of work to evaluate the options for abstraction reform.

This was not a purely academic exercise but one in which the sector was engaged for their views and recommendations, with a process that encouraged checking and challenging the outputs along the way. Contributions from food and drink manufacturing representatives were sincerely appreciated and a model we would encourage for any future work.

The scenarios were intended to help participants imagine, understand and manage the future more effectively. They are not intended to be forecasts of what will happen. Instead they sought to identify what could happen in the longer term. The direction for managing future water demand is clearly in the uptake of sustainable behaviour. In likelihood there will be a mix of elements from the four scenarios and consideration to these may help prepare businesses to potential changes in water availability for future business sustainability.

It is recognised that food and drink manufacturers have made significant inroads to water efficiency though initiatives like Federation House Commitment. Many of the workshop delegates highlighted the need to drive innovation and new technology to achieve greater efficiency, and look to the industry, water suppliers, regulators and policy makers together to make this happen.

7. Acknowledgements

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