



# Imagine 2050

The future of water, waste and energy

How UK industry will need to adapt for tomorrow

# Contents

Veolia sits at the heart of a changing world, where the demands of water, waste and energy will inevitably shape the businesses of tomorrow.

In this report, we bring together the ideas and innovations that will impact the future of industry in 2050 and release £4 billion in hidden value.



## 6 The global megatrends



Population growth  
Advancing technology

## 10 The forces shaping manufacturing



Hyper-efficient business models  
New generation materials  
Rise of robotics

## 14 The forces shaping pharmaceutical and chemical



New dynamics  
Personalised health  
Biofuture

## 18 The forces shaping food and beverage



Food, but not as we know it  
Emotional investment  
From waste to want

# Contributors

“In a complex and interconnected world, changes in the future can occur faster than ever before, threatening both our existence and way of life. Meeting humanity’s rapidly growing consumption needs, with finite resources on a planet that is already under stress, requires more than greater resource efficiency. With three billion new middle-class consumers anticipated by 2030, new business models must be explored if we are to continue to thrive.”

**Dr Nick Voulvoulis**

*Reader in Environmental Technology, Imperial College London*

## Contributors

**Professor Tony Conway**

University of Sheffield  
Water Centre

**Chris Deakin**

Director  
Chris Deakin Associates

**Steve Evans**

Director of Research  
University of Cambridge

**Dr Morgaine Gaye**

Food Futurologist  
Bellwether Food Trends

**Dr Linda Hilton**

Innovation Process and  
Business Consultant

**Ian Pearson**

Futurologist  
Futurizon

**Dr Nick Voulvoulis**

Reader in Environmental  
Technology  
Imperial College London

**Richard Worzel**

Senior Futurist  
Futuresearch

## Veolia customers

**Virginie Helias**

VP Global Sustainability  
P&G

**Paul Madden**

Senior Purchasing Manager  
Arla

**Brian Quin**

COO of Labs  
Intel

**When industry makes key strategic decisions it must look further than the next five years. I don't have a magic crystal ball to tell the future, so when I look ahead I want solutions that make good business sense for us and our customers.**



“One of the biggest challenges industry will face is ensuring a secure supply chain, as a result of scarcity of resources caused by a rapidly rising global population. If manufacturers want to continue to meet their production schedules in 2050, we believe they must change their mindsets to think circular rather than linear.

At Veolia, finding innovative solutions to resourcing issues are in our DNA. Our role is to anticipate the forces of change and we selected three key customer industries: manufacturing; the pharmaceutical and chemical sectors; and the food and beverage industry, as this is where we believe a technology-driven closed-loop approach will have the biggest impact.

We have envisioned a future where industry has been re-engineered and redesigned so products and manufacturing processes can be completed without waste; where our energy needs to power facilities are met onsite from renewable sources, not taken from the National Grid; and where we stop seeing waste as a cheap commodity and start managing it as the life source it is.

By bringing these three elements together in a network of water, energy and materials, we can save resources and create industries that will be fit for 2050. Come and join us on this journey and see how we can ensure we are manufacturing the future.”

**Estelle Brachlianoff**

Senior Executive Vice-President  
Veolia UK and Ireland

“

If manufacturers want to continue to meet their production schedules in 2050, we think they must change their mindsets to think circular rather than linear.”

**Estelle Brachlianoff**  
Senior Executive Vice-President  
Veolia UK and Ireland



From climate change to autonomous vehicles, the challenges we'll face in the next 35 years will stem from two key megatrends: population growth and advancing technology. Together these will mean more people connecting in new ways, leading to an acceleration of ideas and innovation.

Global megatrends

“

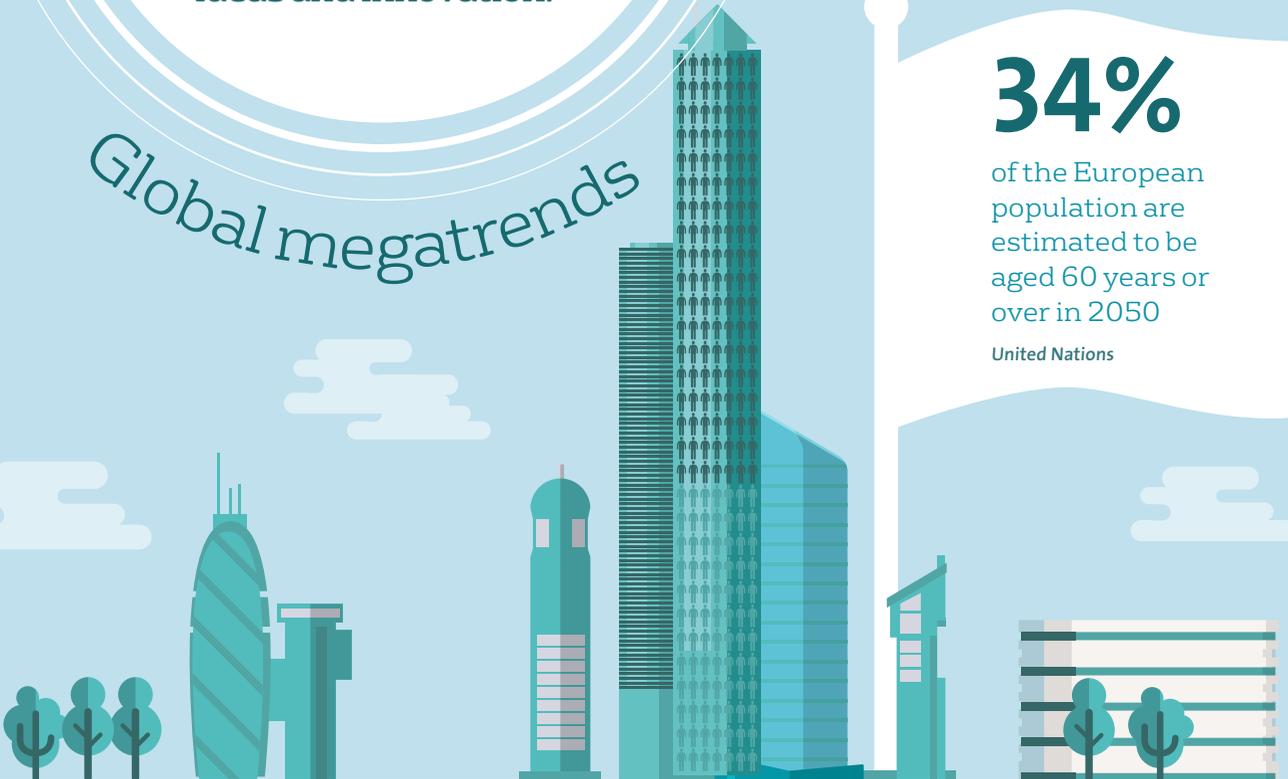
There is a convergence of forces energising the economy, technological innovation, connected humans and a pressure on resource availability that together are driving responsible businesses to include environmental factors as a catalyst for their growth.”

*Richard Kirkman, Technical Director, Veolia*

**34%**

of the European population are estimated to be aged 60 years or over in 2050

*United Nations*





## Can a growing population with declining resources improve efficiency?

Trend #1

### Population growth

Continuing population growth will lead to environmental degradation and changes to how we manage and consume energy, water and food. It is estimated we will double our resource and energy consumption by 2050 if businesses don't change.

# 80%

is the amount the UK has committed to cut its emissions by in 2050, compared to 1990 levels

Roland Berger

### Legislating to regulate

By 2050, advances in big data could lead to companies and governments having a firmer grasp on factors influencing CO<sub>2</sub>. This will make them better at reporting and managing emissions.

Before that we are likely to see changes in legislation. By 2020, COP21 commitments and the interim Kyoto Protocol CO<sub>2</sub> targets will generate the realisation that we're not doing enough. We should already see emissions reducing but evidence suggests this isn't happening quickly enough.

The development of a clear, long-term policy framework is essential for companies looking to progressively invest in low carbon technologies. This will encourage businesses to focus on higher emission reducing activities and longer-term gains.

### More people means more food

Food consumption will rise faster than population as the global middle class expands, leading to increased supply pressure and higher prices. We'll need to establish more dynamic, efficient and agile supply chains.

The pressure of requiring more food will lead to a more joined-up approach to managing water and energy use, creating a food, water and energy network.

"We're already growing enough to feed the future world. We just don't feed people with it. We don't need to grow more stuff and we need to stop throwing away the edible stuff that we do grow."

Steve Evans, Director of Research, University of Cambridge

# 55%

increase in global water demand expected by 2050

OECD (Organisation for Economic Co-operation and Development)



### Smarter ways to use space

Increasing urbanisation will mean a significant squeeze on space, affecting where and how we grow and manufacture. Growing cities will need industries to find more efficient ways of managing and moving urban water, energy and waste.

“The issue of waste management is critical for our industry. We are seeing population growth, increasing consumption and urbanisation which is increasing per capita waste generation – we play an important role in driving innovation to help find efficient ways of managing water, energy and waste.”

Virginie Helias, VP Global Sustainability, P&G

Denser populations within cities will need smart solutions. Japan is experimenting with innovative underground farming. A single 25,000 sq ft site currently produces 10,000 heads of lettuce every day. These space efficient farms use 40% less power, create 80% less food waste and use 99% less water than current practices.

### Changes in healthcare

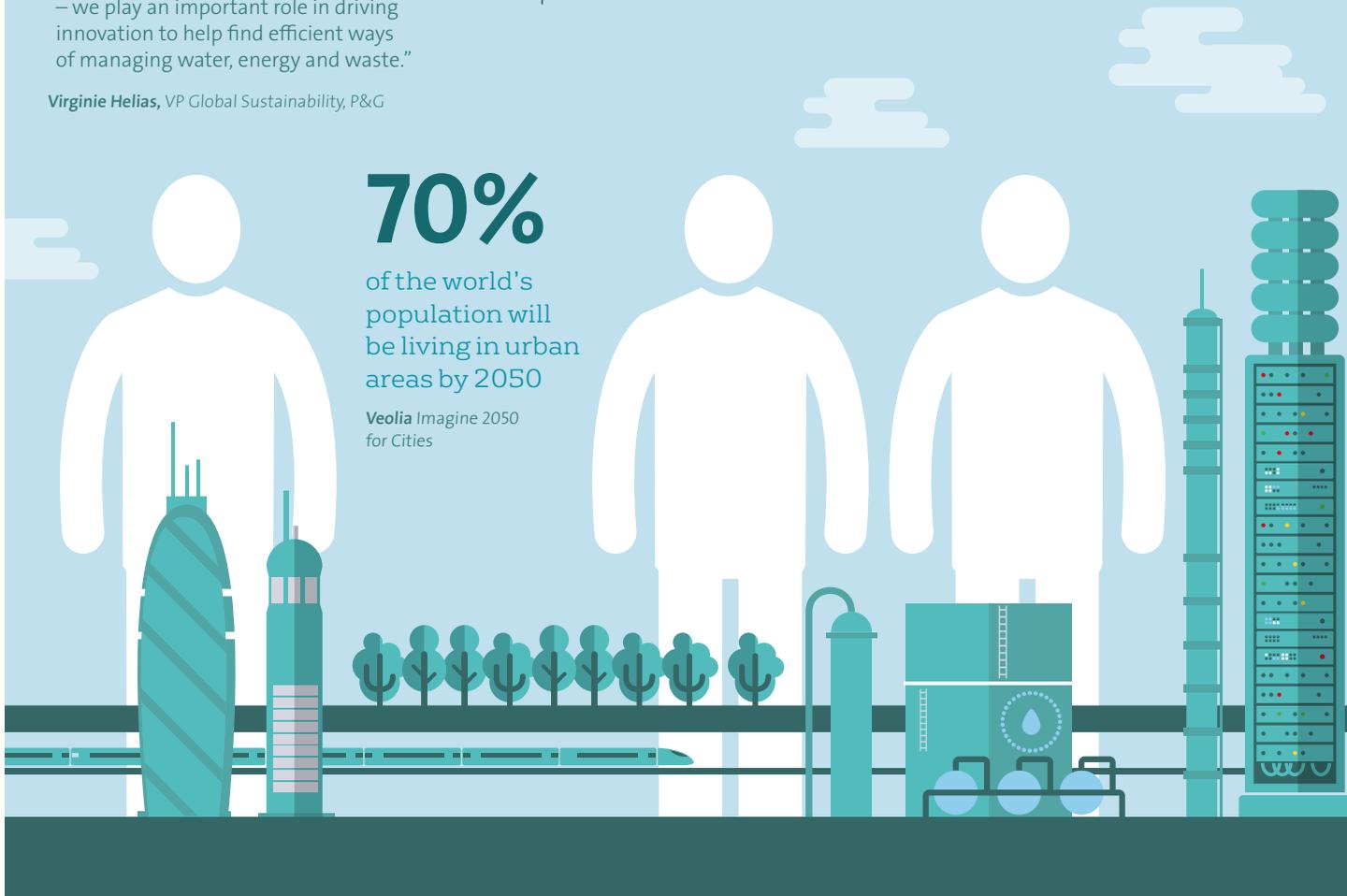
An ageing population, growing costs of treatment and new medical technology will shape the future of healthcare.

The Department of Health and Human Services believes that in the next 35 years, artificial and lab-grown organs will create a more permanent solution for transplants. This means patients will no longer have to wait for life-sustaining organs. Scientists are already trying to grow human organs inside pigs in an attempt to tackle a shortage of donors.

70%

of the world's population will be living in urban areas by 2050

Veolia Imagine 2050 for Cities





## How will advancing technology create new demands on manufacturing and resourcing?

Trend #2

### Advancing technology

**New technology deliverables will be accelerated by more powerful computers, enabling us to find previously impossible solutions.**

“Data processing has already advanced beyond the ability of human analysis and machine learning is now dominating the landscape. A vast amount of data is being collected through the Internet of Things. In the future, we’ll be able to monitor industrial activities more closely to provide a heightened optimisation of resources.”

*Richard Kirkman, Technical Director, Veolia*

### 3D printing and nanotechnology

3D printing will become embedded into supply chains by 2050. The combination of nanotechnology and novel materials will lead to bespoke production lines. Today, tooling and production mobilisation accounts for 70% of production costs and this could be reduced to 10%.

“3D printing is a genuinely disruptive technology. Currently we see it as a way of replacing spare parts but it will eventually be used for finishing operations.”

*Steve Evans, Director of Research, University of Cambridge*

### New skills in the workforce

Robotics and the rise of artificial intelligence will replace many low skill and repetitive job roles. The wider industry impact will see human workforces reskilling and upskilling for the workplace.

“Autonomous machines will be able to handle more complicated decisions and be able to think more quickly and effectively than humans. They may be able to learn from and self-correct mistakes but will still require humans to interact with them.”

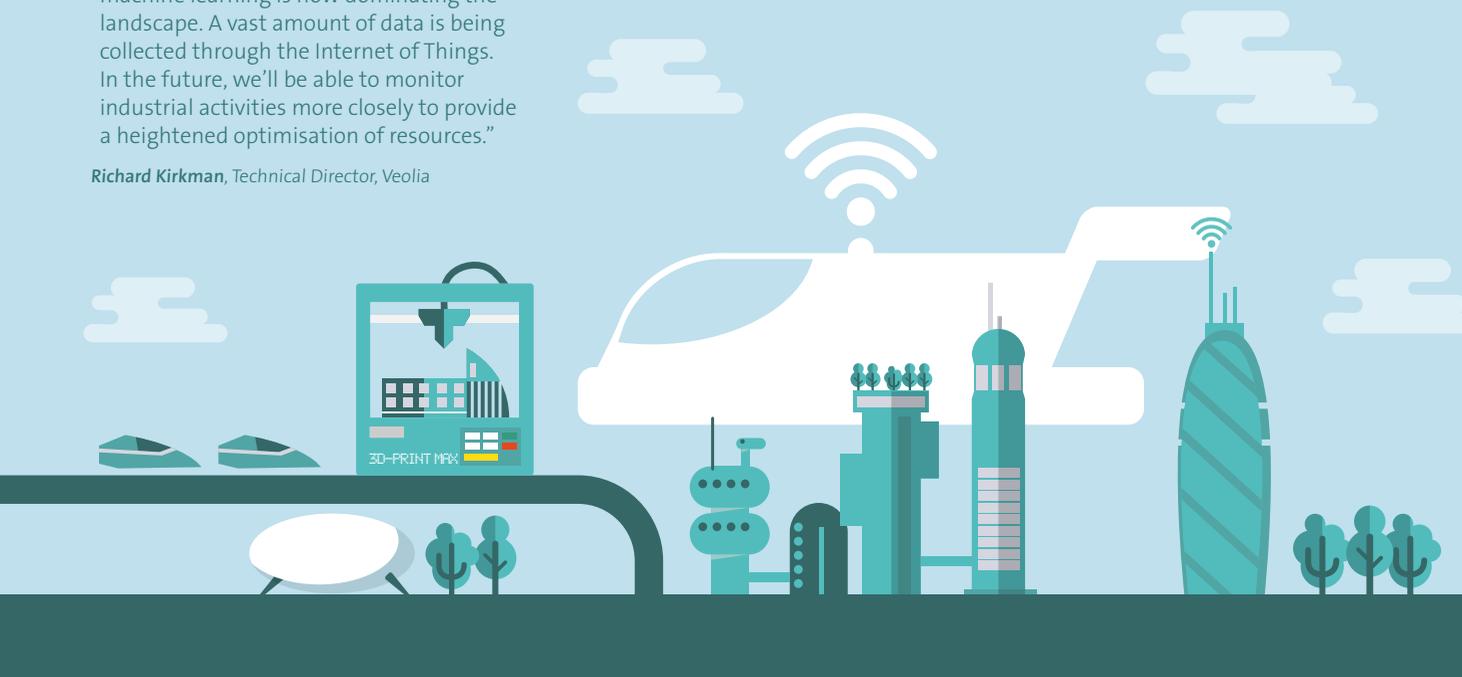
*Brian Quin, COO of Labs, Intel*

### Smarter solutions

Smart utility metering will be taken to a new level, with more intelligent and responsive systems.

“By 2050, these systems will be more intelligent, and will take corrective measures by themselves to optimise utility usage.”

*Mark Coyne, Project Development Director, Veolia*



Advanced new materials and narrowing gaps in international labour costs will create a level playing field for innovation.

Manufacturing



There is

**£2.8** billion

worth of hidden value in unutilised resources within the manufacturing industry



## Where Veolia can add value

By 2050, we see the cost of energy and water becoming a significant burden for expanding UK manufacturing. Businesses will need to think smartly about how they generate, use and recover these resources.

Our Hubgrade smart monitoring centres already monitor heat, electricity and gas usage in real time. Central control centres remotely adjust systems to ensure constant optimisation. Customers can also be identified, prioritised and notified when improvements could be paid for by cost efficiencies.

We believe the miniaturisation of waste treatment systems will reduce centralised plants to facilities, processing rubbish onsite. Smaller businesses could see shared facilities installed and managed by Veolia. Combined with rapid advances in extraction from waste, this could help all businesses achieve a 100% recovery rate.

We're already extracting and selling fertiliser, road salt, paint thinners, glass, fibre, road building materials, plastic polymers for car bumpers, and oils from waste. We're also looking at how we can recover materials like precious metals on a commercial scale and turn sludge into plastics. This means businesses will be able to trade these products on the open market through our existing Veolia brokerage teams.





## How can businesses adapt to bring about new efficiencies?

Trend #1

### Hyper-efficient business models

Manufacturing businesses will need to be increasingly adaptive to prosper, thinking harder about how, where and what they make.

### Relocating around customers and resources

Businesses will need to think about resource use, consumption and transport costs. Manufacturers will have to decide whether to be closer to raw materials to guarantee supply, or closer to customers to meet demand.

“By embracing the revolution in big data, industry will see a step change in how it views and pays for services. This transformation will see complete contract visibility, faster forecasting and flexible payment based on performance that will radically improve the B2B customer experience.”

*Kevin Hurst, COO, Industrial Customers, Veolia*

### Adaptable production lines

Factories will increasingly be able to create a range of different products by physically reconfiguring to meet changing demand.



The same factory might be able to produce an automobile, followed by a washing machine, followed by a dishwasher, followed by an industrial crane. That all comes from the concept of 3D printing.”

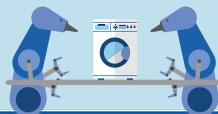
*Richard Worzel, Senior Futurist, Futuresearch*

### Selling benefits, not products

A circular economy requires keeping resources in use for as long as possible, before deconstructing and re-engineering them to create new products. Today, manufacturers only monitor products for the warranty period. In the future, more manufacturers will retain ownership and responsibility for their products and their ongoing performance. Customers will buy the benefits, not the product.

### Assets in the seas

Veolia has developed a unique strategy to decommission rigs that is based around asset recovery. Floating hotels can be made from accommodation units, and boilers and cranes sold on for further applications.





## What will the leaner and greener materials of the future mean for innovation?

Trend #2

### New generation materials

Today's technologies are limited by old materials. Future materials will be lighter, stronger and greener, providing new opportunities for innovation.

### Biological materials

The need for greener products that are cheap, strong and plentiful will lead to new perspectives on naturally sourced materials.

Manufacturing cars uses significant resources, expensive tooling and excessive energy. Phoenix, a concept car designed by Albrecht Birkner and Kenneth Cobonpue, challenges convention by using lightweight and natural materials, such as bamboo, on a frame that is built by hand using minimal tools and energy.



Biology will become really big. I think, by 2050, about half of what we make will be biologically created, which might mean it's grown."

*Steve Evans, Director of Research, University of Cambridge*

### Technological alternatives

Research and development will lead to more lightweight yet durable materials, providing manufacturers with the opportunity to produce structures using less material and energy.

"Graphene and nanotubes are several times stronger than steel and will be fairly cheap by 2050. They'll help us make structures much more elegant, and use far less material."

*Ian Pearson, Futurologist, Futurizon*

### Waste as a tradeable asset

The concept of waste will be radically different in 2050. Manufacturers will see by-products as something of value that they can sell to other businesses or exchange for credit.

"We are likely to see community pooled waste, where manufacturers trade materials that are not useful to them with other businesses. This might take the form of a credit system based on the value of these materials."

*Richard Worzel, Senior Futurist, Futuresearch*





## How should UK manufacturers implement disruptive robotics?

Trend #3

### Rise of robotics

Industrial robots are on the verge of revolutionising manufacturing. As they become smarter, faster and cheaper, they'll be called upon to do even more.

#### Mr Robot

We are using automation technology as part of the deconstruction process of goods. An example is Veolia's new TV recycling facility that uses robotics to ensure safe and complete breakdown and reuse of products back into the economy.

#### A new era of efficiency

As humans move off the production lines and into new engineering roles, factories will be able to operate longer, faster, more safely and with less waste – making way for greater productivity and quality assurance.

Kurion, part of Veolia, creates technology solutions to access, separate and stabilise nuclear and hazardous materials and to safely isolate them from the environment. Through robotics, Kurion eliminates human risk in some of the most dangerous environments imaginable.

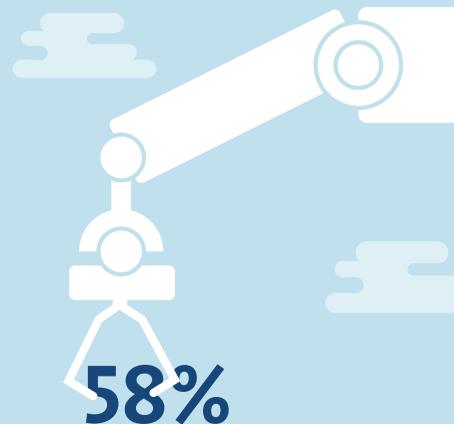
#### Connected thinking

Through the Internet of Things (IoT), data capture will greatly benefit industry. Advanced analytics platforms could enable manufacturers to evaluate big data sourced from connected robotics to improve processes. Sensors will transmit data to alert and initiate preventative maintenance and adjust production speeds according to the market.

#### Onshoring

The advance of robotics could reinvigorate UK manufacturing, making local production more cost effective than importing.

Robotics developments will level the playing field and reduce the advantage enjoyed by China and other low-cost markets. This is already leading to some 'reshoring' of UK production, especially in textiles, an industry particularly affected by emerging markets.



**58%**

of British manufacturers have invested in automation and/or robotics and 68% see potential for future investment

Barclays, Future-proofing UK Manufacturing Report





The pharmaceutical industry will ensure better quality healthcare and the chemical industry will become a key enabler of emission reductions, with both industries enabling wider positive change across other sectors.

Pharmaceutical and chemical

## Where Veolia can add value

By 2050, we see the pharmaceutical and chemical industries facing increasing regulation around how they use and dispose of resources. Veolia is already working within these industries to design efficiency into products from a concept stage – rather than just treating the generated waste at the end.

We are extracting glucose from organic waste to be used as feedstock for production. This reduces costs by avoiding the need to grow and harvest crops.

In the future, our role may evolve to help keep the country healthy. With recent advances in sensor technology, it's possible that local health authorities may work with Veolia to monitor municipal water supplies to detect early signs of contamination and disease. This data could be used to ensure preventative treatments are available by keeping pharmaceutical companies one step ahead of illness.

There is

**£805** million

worth of hidden value in the pharmaceutical and chemical industry in their unutilised resources





## Can new business models subvert expectations?

Trend #1

### New dynamics

Traditional ways of working will give way to more dynamic operations and models. This will include increased collaboration across both industries and reimagining how products are manufactured and sold in order to create new efficiencies.

“

We're likely to see greater collaboration between these specialist businesses and also with outside partners. Brands like Google are already moving into that space.”

*Dr Linda Hilton, Innovation Process and Business Consultant*

### Collaboration and convergence

The convergence of technologies will create opportunities to partner with competitors, customers and businesses in other sectors, leading to more innovative products.

Google has partnered with Swiss pharmaceutical firm Novartis to develop its smart contact lenses. Novartis wants to develop alternatives that include the possibility of 'intraocular lenses' – contacts that are inserted permanently into the eye to correct vision.

### Shifting the value

Within the pharmaceutical industry, increasing costs and declining healthcare investment are creating a squeeze. We expect a growing number of alternative business models like pay-for-performance emerging to forge a closer link between value and effectiveness.

Johnson & Johnson has started to introduce pay-for-performance drugs within Europe. In the UK they have agreed to reimburse Britain's National Health Service when patients don't respond to their blood-cancer drug Velcade. Other companies such as GSK and Roche have also been discussing these models.

The chemical industry is pioneering Chemical Leasing. This means shifting from selling chemical goods to selling chemical services. This idea has received renewed interest and support from the United Nations Industrial Development Organization.

### Mining metals

Veolia has a bespoke process for the recovery of precious metals from obsolete medication such as platinum. The high-grade metal is extracted and can then be reprocessed.



### Localised production

Advances in 3D printing technology might make it possible for the pharmaceutical industry to stop manufacturing entirely, instead focusing on blueprints and leaving most production to chemists.

Bio3D produce advanced robotic 3D printing systems suitable for research and scientific applications, such as printing cells, bacteria, proteins, bio-gels, polymers and food materials. Their aim is to bring affordable and reliable 3D printing and bioprinting to every researcher, scientist, doctor, engineer, educator and student.

“The limitation of producing current drug formulations using 3D printers is that they don’t react well to potential temperature changes and require rapid mass production. It’s something we may see in the future with regards to ‘personalised’ medicine, but it’s not quite ready yet. However, 3D printing remains a fabulous way to rapidly prototype medical devices, for both product evaluation and product development.”

**Dr Linda Hilton**, Innovation Process and Business Consultant

In 2015, the FDA approved the first 3D-printed drug, Spritam, from Aprelia Pharmaceuticals, showing that the technology exists but that regulations will have to change for it to be implemented.



## What impact will personal health have on the pharmaceutical industry?



The number of health apps downloaded has more than doubled over the past 2.5 years

*mHealth App Developer Economics 2014, Research2Research, May 2014*

Trend #2

### Personalised health

In 2050 we expect a shift from generic drugs to customised treatments designed around the patient, rather than the illness.

### Data will drive customisation

We’ll see a considerable increase in the volume and sophistication of data, particularly through wearable devices, such as Fitbit and Apple Watch, which will bring about more tailored treatment plans. The testing and launch of new drugs could also speed up through access to live patient data, reducing dependence on long and costly clinical trials.

“Part of the driver for getting away from mass production is the customisation of medicine. Dosages, and maybe even composition, will be adjusted for our age, sex and weight.”

**Richard Worzel**, Senior Futurist, Futuresearch





## What are the challenges and opportunities to biotechnology?

Trend #3

### Biofuture

Biotechnology is a different way of producing chemicals and pharmaceuticals, harnessing the power of living cells and getting them to work in predictable and controllable ways.

### An evolving opportunity

McKinsey claims that biopharma is growing at more than double the rate of conventional pharma and this is expected to continue into the foreseeable future. We also expect to see companies, particularly those related to food and agriculture, focus on the types of molecules that exist within their waste. These could ultimately be sold to the pharma industry.

“Biotechnology will radically change both industries. For chemicals, it will have a significant impact by creating kinder fertilisers and pesticides for the food industry. In pharma we’ll see drugs that can cure rather than treat serious illnesses.”

*Dr Linda Hilton, Innovation Process and Business Consultant*

### Watchfrog

Veolia and Watchfrog use fish larvae or tadpoles to detect the presence of endocrine disruptors in wastewater treatment plants. Through this innovative tool amphibians fluoresce when they are disturbed by these pollutants.



We need to revolutionise the way we source, produce and consume food to feed a growing population.

Food and beverage

70%

increase in total water demand for food and drink manufacturing by 2050

Environment Agency



## Where Veolia can add value

By 2050, we see cost pressures and concerns around food production leading to major changes across the food and beverage sector. Water and energy will be central to this debate.

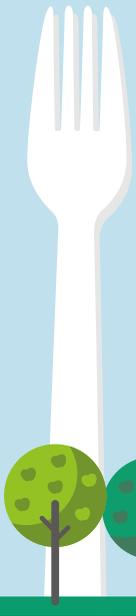
We are already trialling a process to unlock the commercial potential of biomass ash, by turning this into a phosphate-rich fertiliser. If successful, the remains of one whisky batch could eventually help to grow the crops that make the next.

By 2050, we see new technology playing a significant part in helping both businesses and communities keep energy prices to a minimum. Biomass combustion technology, anaerobic digestion processes and water recovery systems can not only produce enough energy to power the factory, but thousands of local homes as well.

There is

**£464** million

worth of hidden value in unutilised resources within the food and beverage industry





## What happens when our appetite for meat exceeds supply?

# 30%

of the world's population already eats insects as part of their diet

Food and Agriculture Organization of the United Nations

### Trend #1

## Food, but not as we know it

The types of food we consume may not change, but where it comes from will be radically different.

### Cultured meat

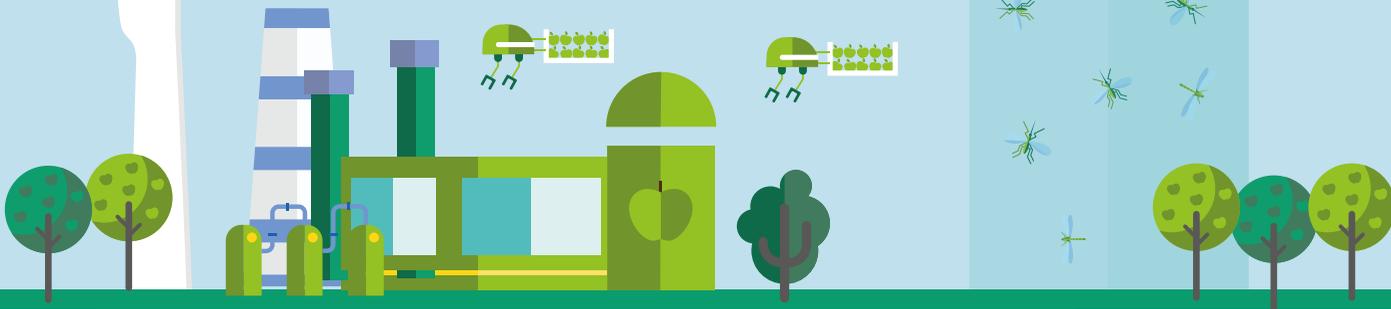
The meat industry accounts for 18% of our total greenhouse gas emissions, according to the Food and Agriculture Organization of the United Nations, which also predicts that the environmental footprint of livestock production will double from its 1999 levels by 2050. Mass producing cultured (lab-grown) meat is seen as a more resource-efficient, cost-effective and ethical alternative.

The world's first lab-grown burger was unveiled in 2013, and carried a \$300,000 price tag. But long-term predictions suggest that cultured meat will be considerably cheaper than cattle sourced beef and will overcome concerns relating to animal welfare and environmental degradation.

### A bug's life

One of the biggest challenges that future food production will face is around protein. Meat has long been the main source of protein for the UK, but given the economic impetus of the industry, we'll need to look for other sources in the future. That could mean a huge emerging market in the cultivation of insects, which are as high in flavour as they are in energy.

The Economist estimates that a cow requires 8kg of feed to produce 1kg of beef, but only 40% of the cow can be eaten. Whereas, crickets require just 1.7kg of food to produce 1kg of meat, and 80% is considered edible.





## At what point will food become personal?

Trend #2

### Emotional investment

The expectation that we will have complete value chain transparency will lead to new production models and enhanced consumer relationships.

### Forming deeper consumer connections

We can already see consumers increasingly demand transparency on how our food is grown, sourced and made. This is likely to evolve into a new type of relationship, where the traditional boundaries of business and customers blur.



Consumers will have a personal investment in products and food. Purchasing will be even more about relationship and trust.”

*Dr Morgaine Gaye, Food Futurologist,  
Bellwether Food Trends*

### Technology will enable bespoke nutrition

Data and advances in precision farming mean that it's increasingly possible to grow, cultivate and produce products that are unique to individual customers. The challenge will be how this is delivered without having a negative impact on the environment.

Technology is already enabling the beginnings of bespoke nutrition. Nima is a portable sensor that quickly tests liquid and solid foods for the presence of gluten. The device connects with a user's smartphone to display the amount of gluten that's present within the food, giving them more control over what they eat.

“We've already got tractors which know exactly where they are on the field, and exactly how much fertiliser each square metre of land needs. But what will happen is that this becomes linked to an individual customer. They will have a few square metres of field, growing their wheat or barley, based on their particular needs.”

*Ian Pearson, Futurologist, Futurizon*





## How will what we throw away today become something we savour tomorrow?

Trend #3

### From waste to want

30-50% of all food currently produced is lost before reaching a human mouth. Current practices waste up to 50% of all food produced. To feed a population of over 9 billion by 2050, we need to get smart about food waste today.\*

\*Source: The Institution of Mechanical Engineers

### Closing the loop

Food and beverage companies need to focus on the recovery and redistribution of the energy and water used throughout their manufacturing processes, while benefiting local communities.

### The power of food

In a process similar to the body converting energy into calories, Veolia can turn food waste into gas to power homes. In Leeming, Veolia is transforming inedible ice cream by-product into biogas through anaerobic digestion. The plant can process up to 80,000 tonnes per year of commercial food waste to generate enough gas to supply nearly 4,000 homes a year.

As part of Veolia's 10-year partnership with Tilmanstone Salads (Bakkavor Group), we've optimised water consumption by recycling wastewater into potable water. The process – one of the first of its kind in the UK – results in reintroducing 72% of the site's recycled wastewater into the production chain. We've also developed a nano-filtration and disinfection system which reduced its water footprint for salad washing by 75%. And more potable water is available locally – enough to supply 5,000 homes.

### From by-product to new product

In addition to reusing and extracting value from waste, we also expect to see highly innovative new uses for by-products.

Piñatex is a natural and sustainable non-woven textile made from pineapple leaf fibre that looks and acts like leather. A by-product of converting the leaves into textile is a biomass which can be converted into fertiliser, giving additional income to the farmers.



5,000

homes have access to potable water as a result of our wastewater recycling solution for Tilmanstone Salads



As one of the UK's biggest providers of water, waste and energy services, Veolia is integral to the future of industry. But this important role also comes with a position of responsibility.

That is why we are actively looking, listening and seeking out answers to some of the significant challenges that will shape the future of our world. And only by working closely with customers like you can we help to make the difference.

Whatever industry you are in, whether it's manufacturing, pharmaceutical and chemical, food and beverage, or any other, speak to us today about how we can help you to get ahead in the future.

To find out more visit:

[www.veolia.co.uk](http://www.veolia.co.uk)







Resourcing the world

[www.veolia.co.uk](http://www.veolia.co.uk)