MarketLine Thematic Report

Climate change & environmental damage:

Examining five of the worst economic problems caused by worsening pollution

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EXECUTIVE SUMMARY

Climate change and the state of the environment are the most important and difficult challenges facing governments, businesses and individuals this century. Having moved into a period where theoretical climate change risks imagined in the past are now actually taking their toll, there are concerns that trends which have been started cannot now be stopped. There needs to be careful management to reduce the impacts on the global economy that climate change and environmental damage will bring and some problems which won't be preventable. Car pollution in cities, coal power stations, plastic pollution in the oceans, rising sea levels and food security are some of the biggest issues of the century and how they are dealt with will affect business in all sectors and markets.

Diesel's bubble slowly bursting: Opportunity for cleaner fuel sources arising

As we become more aware of the damage that the switch to diesel has created, policy makers are beginning to get tough on the fuel source and major cities in Europe and some others world-wide plan to directly ban or fine diesels by 2020. This decision is likely to disrupt the automotive market drastically as consumers will need to move to a new fuel source. This could be a major opportunity for manufacturers of electric, hybrid and hydrogen alternatives to encourage new consumers towards their product. However diesel won't die quickly, because too many people and companies are heavily invested, and the majority of consumers may choose petrol vehicles as their alternative if they do swap, but by 2020 HEV and EV sales will be motoring.

Figure 1: Smog in Shanghai

SOURCE: MarketLine

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Rising global coal demand creates contrasting impact on business

Global coal consumption continues to rise, creating a contrast between businesses in OECD and non-OECD nations. The nature of coal consumption, and the political and business problems which emerge, shape important business dynamics within rich and poor economies. Burning coal in large quantities impacts the wider economy due to multiple environmental knock-on effects springing from local consequences of burning coal for power. Discovering solutions to environmental and political problems relating to coal usage is a major influence on how international and domestic commerce is shaped.

Figure 2: Coal Briquettes

SOURCE: MarketLine

MARKETLINE

The Pacific Trash Vortex: Oceanic plastic pollution and the impact on business

Plastic pollution in the world's oceans covers vast areas. The largest area of plastic pollution, the Pacific trash vortex, covers an area greater than the size of Texas (measurements vary) and according to Greenpeace contains six kilos of plastic for each kilo of plankton. Recent analysis reveals the extent of large pieces of plastic to be much greater than previously thought. Waste plastic trapped in ocean currents presents several problems for businesses, now under pressure to create solutions, adapt to government regulations and embrace corporate responsibility. Despite the issues, many business opportunities are ready to be embraced.

Figure 3: Plastic sea waste

SOURCE: MarketLine

MARKETLINE

Rising sea levels will impact the global economy making some cities uninhabitable

Assuming that current rates of climate change continue, it has been conservatively estimated that there are billions worth of assets and millions of people that will be lost and displaced by the end of the century. Some countries are more affected than others but overall, both developed and developing nations are at serious threat from losing a sizable percentage of their land mass and some of their most economically important and most populated cities. By percentage of population that could be displaced, the Netherlands is most at risk. By total number of people displaced, China is most exposed and by potential monetary assets lost the USA stands to lose the most.

Figure 4: Thames Barrier

SOURCE: MarketLine

MARKETLINE

Climate Change and Food Security: The Global Threat

Security of food supplies remains vulnerable to climate change resulting from greenhouse gas emissions. The deleterious effects of rising temperatures on agriculture and the security of food are legion. Food supplies in large areas of the globe are at high risk of collapsing and those countries most dependent on agriculture are typically of heightened sensitivity to climate change. Crop yields in many regions are already suffering and whilst genetically modified (GM) crops are in development, many unknowns as to the efficacy and side effects of GM food remain. These problems are compounded by political sensitivity to the changing agricultural business environment, frequently resulting in economic upheaval.

Figure 5: Wheat crops

SOURCE: MarketLine

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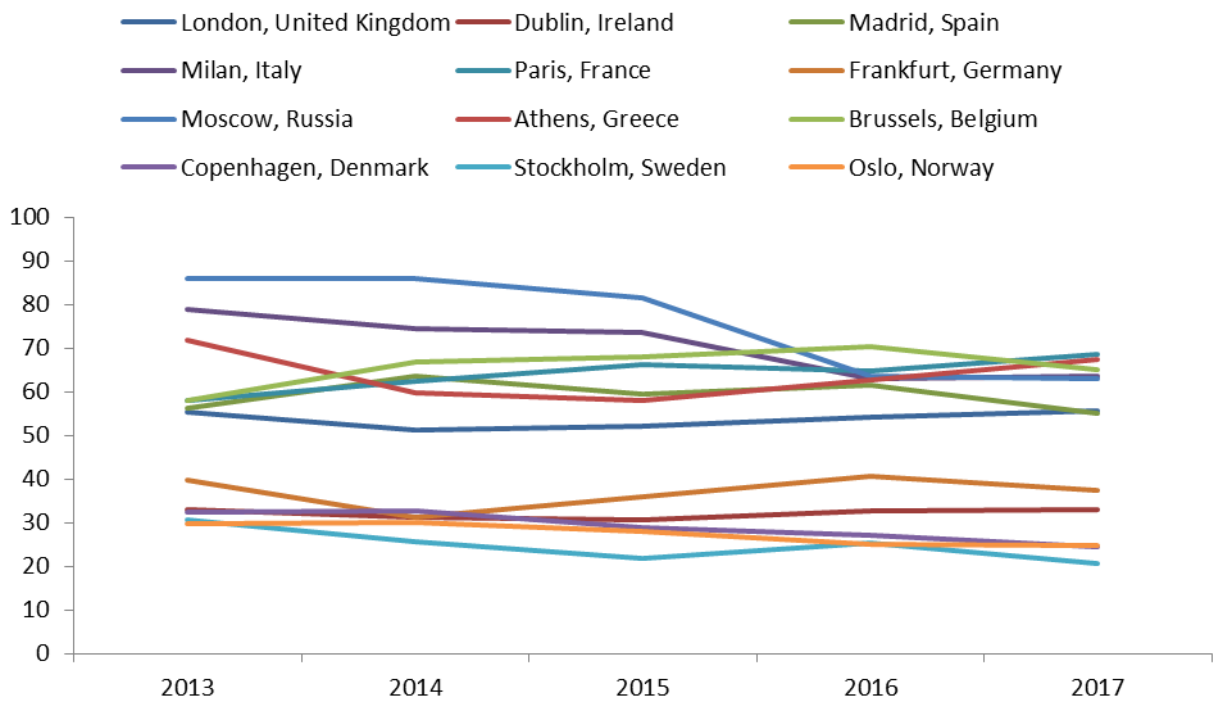
Figure 6: Pollution index in European cities



SOURCE: Numbeo

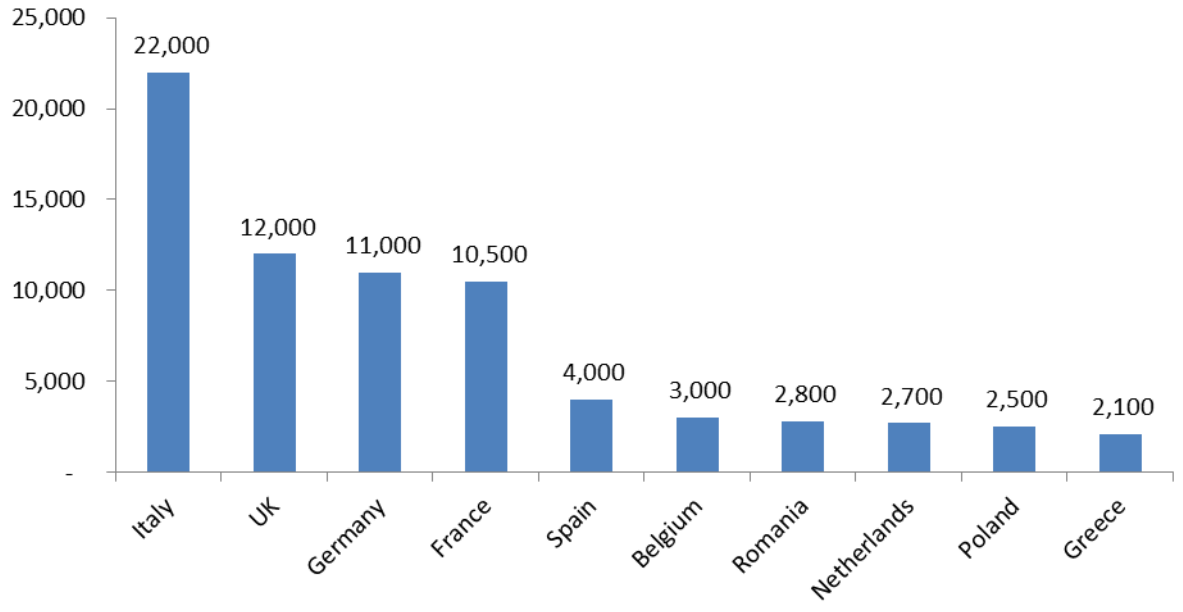
MARKETLINE

World cities are recording high levels of dangerous pollutants

Multiple cities throughout the world have seen the levels of inner city pollution remain at high rates and levels of certain pollutants which are particularly dangerous to public health, climbing to levels which are deemed unacceptable by the WHO. In developed countries the vast majority of this pollution comes directly from vehicles moving around the city, whereas in developing countries traffic is supplemented more heavily by pollution from factories, plants and power stations. Currently there is one particular pollutant which is causing the most concern in environmental policy forums and health organizations, NO2 or Nitrous Oxide. Whilst CO2 levels may be stable or falling, NO2 levels are climbing particularly in Europe, because of diesel engine emissions. The release of this gas from vehicle engines contributes to the production of ground level ozone and fine particulate matter which has been directly linked to respiratory diseases such as asthma and COPD. Recent research has shown that deaths from this pollutant alone, particularly in Europe where diesel vehicles are particularly popular, are in the tens of thousands each year as can be seen in Figure 2.

As a direct result European law makers have begun legislating against diesel vehicles. Many European cities are intending to introduce direct bans whilst others will apply hefty fines if drivers enter certain city zones with a diesel vehicle.

Figure 7: Deaths in Europe 2015 from Nitrous Oxide



SOURCE: Guardian

MARKETLINE

Fines and bans will affect 50% of the European vehicle fleet

Paris, Mexico City, Madrid and Athens intend to ban all diesels from their cities by 2025. However many more have plans in place to fine and discourage diesel drivers from entering the city. In the UK, there are plans for at least five big cities to introduce a clean air zone where diesels and older polluting vehicles will be charged for entering the city center. The UK has had multiple warnings from the EU as it continues to breach pollution safety limits in inner cities, particularly in London which had in January 2017 already exceeded its pollution quota for the entire year. All of this will lead to a rapid reduction in diesel vehicle ownership because drivers have shown themselves to respond quickly to government legislation, particularly that which adds an extra cost to motoring. Consumers are less likely to make any commitment on mass just for the sake of environmental concerns, but have consistently reacted quickly when fines are implemented. When diesels were subsidized and encouraged, consumers quickly recognized the cost saving available and purchased them in much greater numbers than traditional petrol vehicles and similarly with the London congestion charge, which has caused great purchasing of hybrid vehicles amongst taxi drivers.

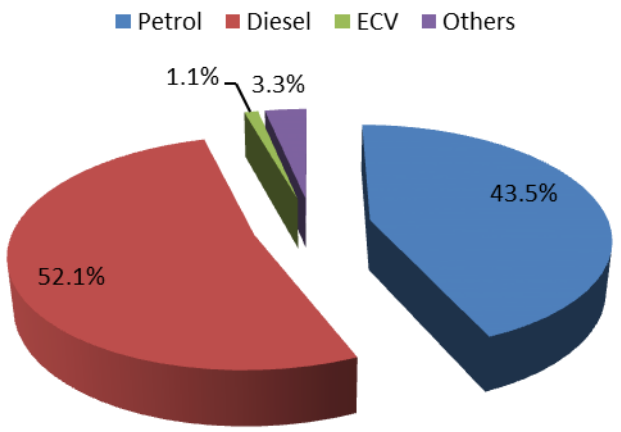
The move from petrol to diesel was encouraged by legislators

Remarkably, considering this recent evidence that suggests diesel emissions are more harmful than their petrol counterparts, diesels have been largely packaged as greener vehicles in the last decade. The reasoning is that diesels release less CO2 than petrol vehicles generally producing better fuel economy; and have been subsidized by governments worldwide but particularly in Europe as lawmakers looked for ways to reduce the CO2 emissions of Europe's vehicular fleet. In the UK many small capacity diesel engines received an emissions tax rate of zero and this led to many consumers choosing diesel for the tax and economic benefits. Therefore despite their packaging as a slightly more premium engine choice, tending to be more expensive than an equivalent sized petrol engine, diesels are now the leading engine choice. In Europe diesels make up 50% of the total fleet. As a comparison diesels make up only 3% of the US vehicle fleet, so this is a particularly European problem encouraged by well-meaning but inaccurate understanding of the pollution problem.

Manufacturers have used dirty tactics to keep up with rules

Manufacturers themselves have had to make large efforts to keep up with the increasing demands of legislators and of consumers. This has led to some underhand tactics as manufacturers try to meet certain tax bands and legislation, with their new models. A number of manufacturers, particularly Volkswagen and Fiat, have been caught doctoring their emissions figures and this has meant that consumers have been effectively cheated in the process. But the more severe problem is that law makers' plans for emissions targets are based around figures that the manufacturers release and so this means that incoming emissions rules such as the current EURO6 may not manage emissions well. For instance previous editions of the EURO rules have encouraged manufacturers to reduce CO2 emissions from the exhaust as much as possible and to do so; many have tuned their engines to release more Nitrous Oxide rather than CO2, which has added to the current pollution problem. Effectively both petrol and diesel fuels are going to cause pollution and the only reasonable way forward is to support and encourage manufacturers to produce HEVs and EVS that are of a similar ability to petrol and diesel vehicles.

Figure 8: Break down of fuel types in Europe in 2015



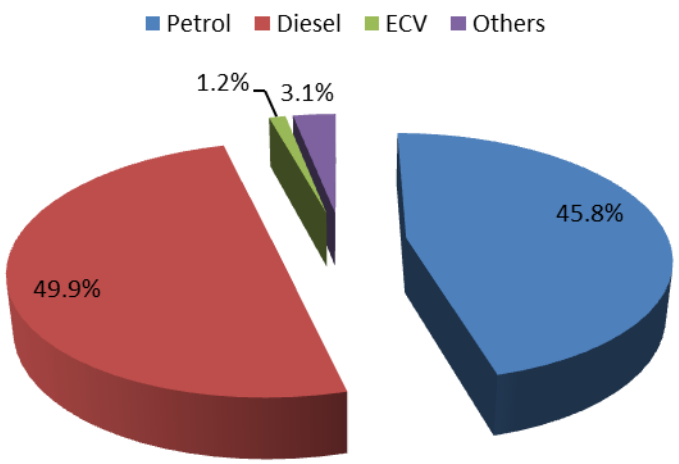
SOURCE: ACEA

MARKETLINE

Some small signs that consumers are moving away from diesel

Between 2015 and 2016 there has been a marginal decrease in diesel vehicles on the road in Europe and this may be an indicator that the market is starting to wake up to the extra costs that regulators want to impose. Diesel is still the dominant fuel source in the market but there was a decrease from 52% to 50% between 2015 and 2016. By 2020 the market will start to reveal the direction that it is travelling in. What seems to be clear is that the bans and fines will have an effect on purchasing choices as similar schemes have in the past, but it will take a number of years before any meaningful number of vehicles has been replaced, due to the expense required by the consumer to do so.

Figure 9: Break down of fuel types in Europe in 2016

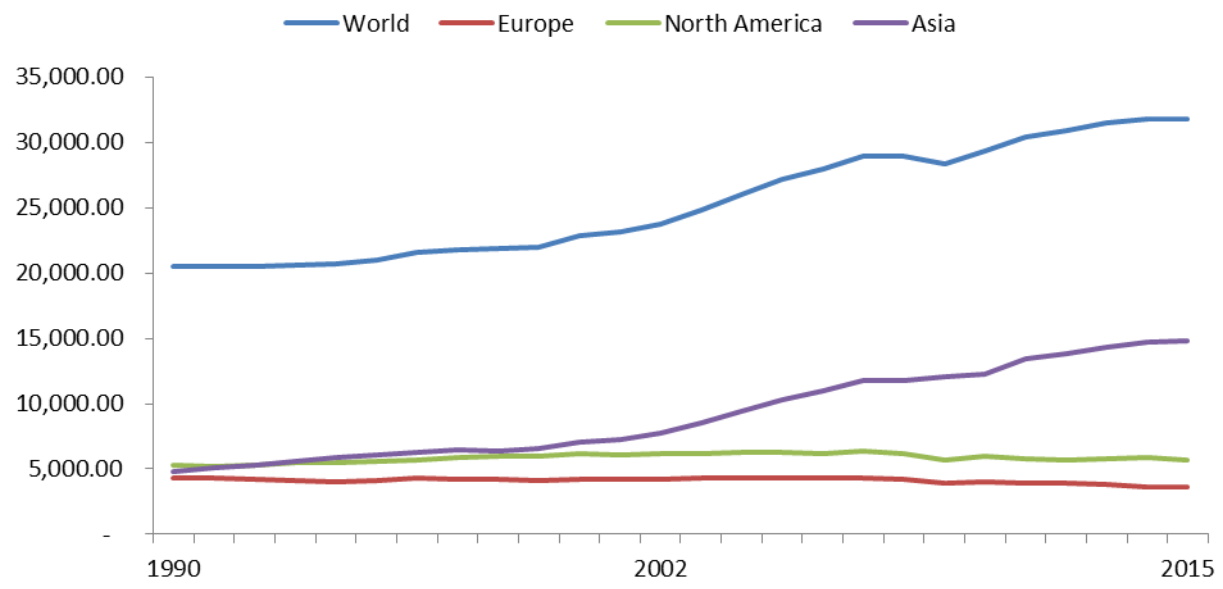


SOURCE: ACEA

MARKETLINE

Manufacturers have been preparing for this change and many have commented on what they think might happen. Renault has stated that it believes diesel will become a premium fuel used only in premium vehicles rather than available for most vehicles and similarly Toyota has stated that it expects diesel vehicles to be more expensive than hybrids. This is significant because Renault is one of the biggest diesel engine manufacturers. Other manufacturers are changing their vehicle line ups to prepare for a depression in diesel sales. In the last decade the popularity of diesels meant that manufacturers provided a large number of diesel engine models and they have been decreasing the range of petrol options, that tide is starting to turn. Recent releases have included a refocus on petrol engines using turbos to push small capacity engines harder and an attempt to return the power and economy figures that might be expected from a modern diesel engine.

Figure 10: Co2 Emissions by world region 1990-2015 million metric tons of carbon



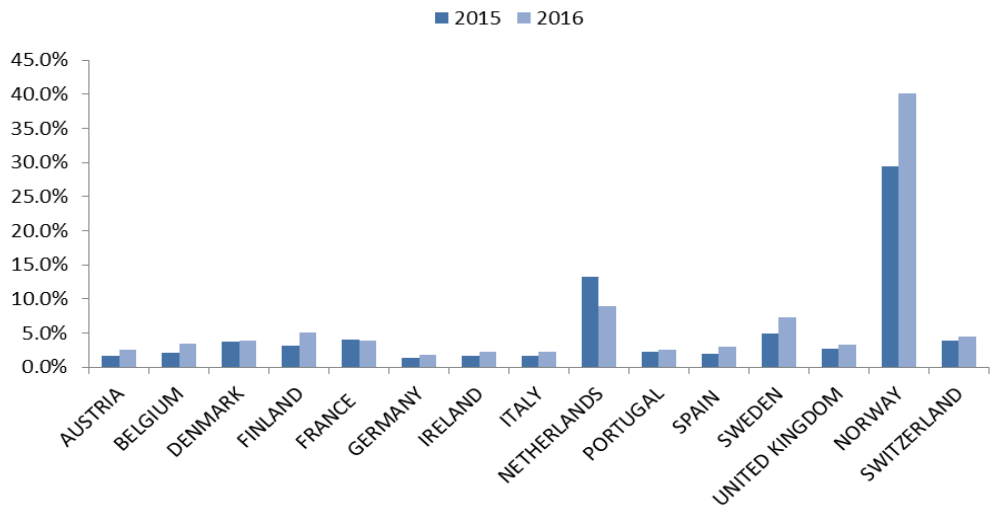
SOURCE: Numbeo

MARKETLINE

Manufacturers are improving their designs in readiness

Manufacturers seem increasingly convinced that they are going to need some strong HEV and EV designs ready for the next decade. Manufacturers which previously have showed no interest in EV design have been releasing multiple models, which are not necessarily expected to do well in sales terms today, but which are preparing the company for the future. Hyundai, Renault-Nissan, BMW, Honda, Fiat, Mercedes, Geely, Mitsubishi, Volkswagen, Toyota, Ford and GM all have models for sale currently and very few are just token gestures, instead being completely specifically designed from the ground up. Other companies such as Tesla have chosen to build only electric cars. Interestingly there are multiple routes the manufacturers have gone down and no single ideal power source has yet emerged which means there will likely be extremely intense competition over the preferred technology. Electric vehicles have been touted for some time as being the solution to the energy and pollution crisis and this recent exposing of the particular dangers of diesel cars is very likely to be the final catalyst that pushes consumers fully down that road, because it will be cheaper, free from fines and more advanced. The likelihood is that when the diesel bans and fines kick in in 2020, particularly in Europe, there will be a large surge in HEV and EV sales.

Figure 11: Market share % of EVs & HEVs in Europe 2015-2016



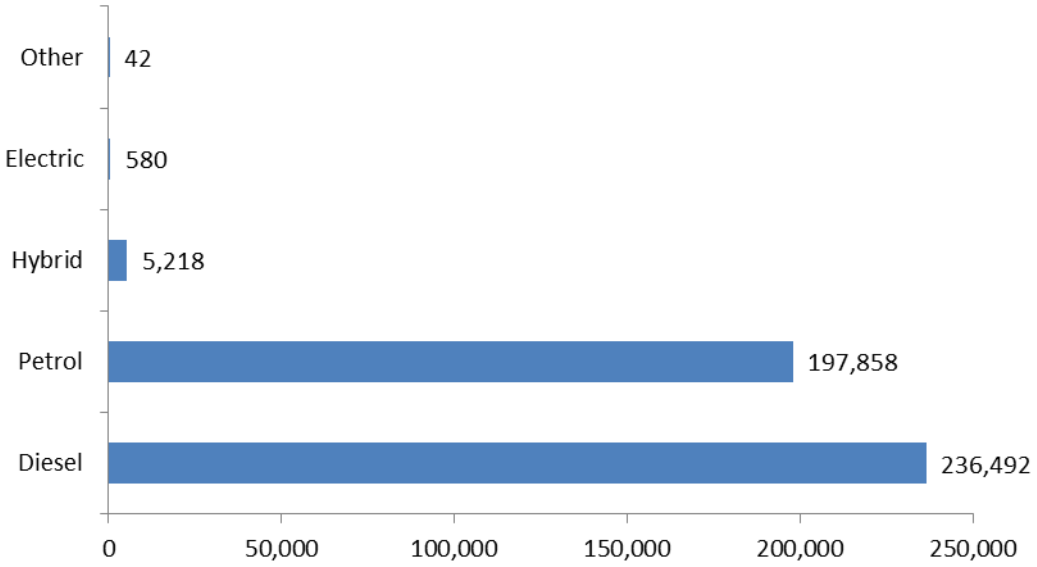
SOURCE: ACEA

MARKETLINE

Europe will become an attractive market for EVs and Hybrids

In Europe most markets have seen some growth from 2015 to 2016 in the electric and hybrid vehicle market, but overall the market share remains very low compared to most fuel sources. Other global markets too are similar in that that there has been some adoption of the newer battery based technologies, but nothing on a scale that is likely to make manufacturers completely commit to EV technology as yet, but the signs are encouraging. Some governments in Europe, particularly in northern Europe, have subsidized the new technology much more substantially and seen very high adoption rates as a result with electric and hybrid vehicles now making up 40% of the vehicle market. However the real driver likely to help spur on EV sales is the inevitable shift away from diesel which is coming. This will place demand on all other fuel source options as there are simply not enough used petrol vehicles in Europe to compensate meaning demand will be raised for all types of vehicles regardless. Manufacturers are evolving their products to include options that are suitable for this new environment. For instance the petrol engines on new vehicles are changing from naturally aspirated engines, to turbo charged small capacity varieties instead with the aim of producing a petrol variant which can match the economy and power of the diesel in the range. Furthermore there are now HEV and EV varieties from almost every manufacturer.

Figure 12: Available new and used vehicles on Autotrader UK by fuel source March 2017



SOURCE: Autotrader

MARKETLINE

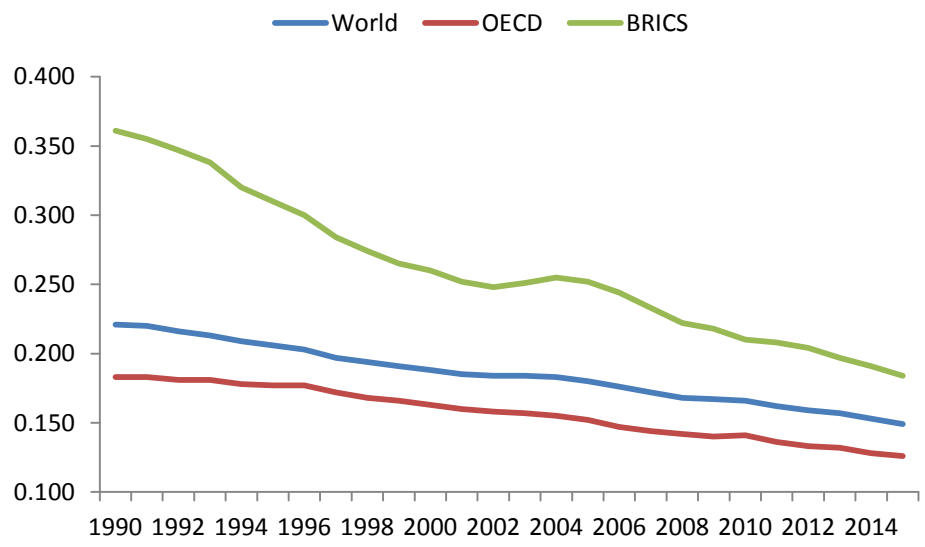
RISING GLOBAL COAL DEMAND CREATES CONTRASTING IMPACT ON BUSINESS

Global coal consumption continues to rise, creating a contrast between businesses in OECD and non-OECD nations. The nature of coal consumption, and the political and business problems which emerge, shape important business dynamics within rich and poor economies. Burning coal in large quantities impacts the wider economy due to multiple environmental knock-on effects springing from local consequences of burning coal for power. Discovering solutions to environmental and political problems relating to coal usage is a major influence on how international and domestic commerce is shaped.

Expensive energy creates contrast in industrial competitiveness with non-OECD nations

The cost of energy is regularly attributed as a primary reason behind the decline of heavy industries across developed economies, most of which have witnessed manufacturing moving overseas, taking advantage of lower costs. Even though large gains in energy efficiency have been made, high costs continue to exert heaping pressure on what remains of industries such as steel production; the UK steel industry, which suffers under the highest energy costs in Europe, is one of the more egregious examples. Combined with adverse industrial policy from countries such as China – widely accepted as having dumped vast amounts of steel on the international market, causing the price per ton to collapse – the cost of energy generated from coal is a major inhibitor for commerce in the OECD. Such are the problems associated with energy costs in the UK, Tony Pedder, chairman of Sheffield Forgemasters, was reported in 2014 as having expectations of shutting down production thirty times during each winter season. Whilst the problems are exaggerated in the UK due to the unique 'triad' price-setting regime, such problems remain common across developed economies.

Figure 13: Energy intensity of GDP at constant purchasing power parities (koe/$ - 2005 prices)



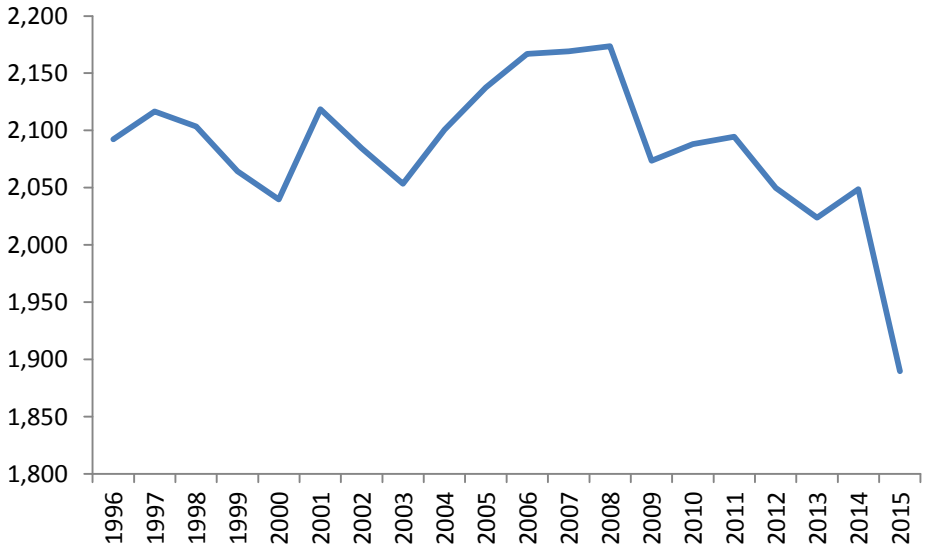
SOURCE: Enerdata

MARKETLINE

A leading cause is the means of producing energy from coal and access to large reserves. Whilst many countries have significant coal reserves, no western nation can match the extraction and consumption costs in India and China. For countries such as Japan, geopolitical consequences of coal use have to be taken into account, raising costs for domestic industry. A government announcement on the construction of 45 new coal power plants has much to do with diversification of energy supply but politics will raise costs for Japanese industry.

Although nearby neighbor China has vast and easily extractable coal reserves, disputes over policy regarding the control of the South China Sea makes relying upon Chinese coal a difficult move to accept. The next obvious option is Australia, a country capable of providing large quantities of coal but at far higher prices than would conventionally be the case in China – Japan is also increasingly buying from the United States. Instantaneously the costs for large consumers of energy in Japan would be higher than those in India or China.

Figure 14: OECD coal and lignite production (mt)



SOURCE: Enerdata

MARKETLINE

Table 1: Coal and lignite production for OECD countries (Mt)

Year	Production	Year	Production
1996	2,092	2006	2,167
1997	2,116	2007	2,169
1998	2,103	2008	2,174
1999	2,064	2009	2,073
2000	2,040	2010	2,088
2001	2,118	2011	2,094
2002	2,084	2012	2,050
2003	2,053	2013	2,024
2004	2,101	2014	2,049
2005	2,138	2015	1,890

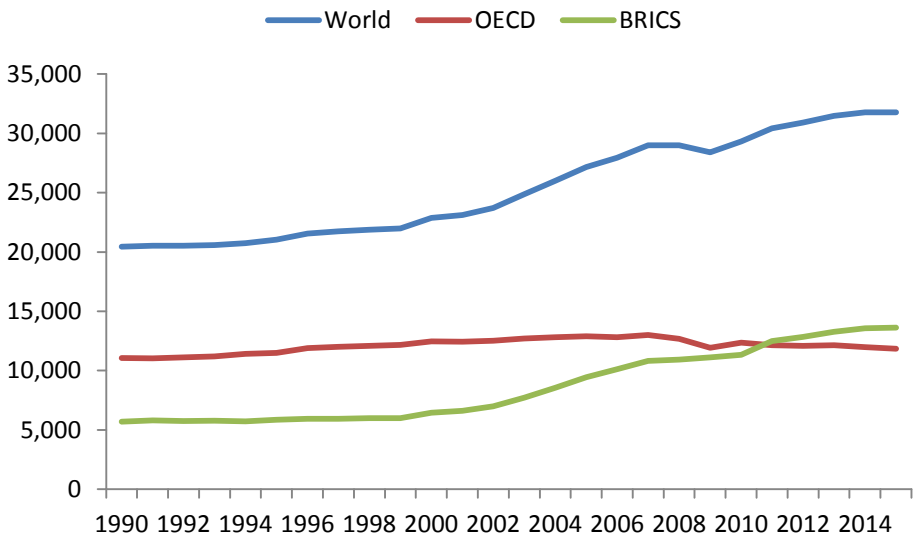
SOURCE: Enerdata

MARKETLINE

Differences in environmental policy and social attitudes raise the price of coal use in OECD countries compared to developing economies which do not yet have as stringent environmental policy or widespread social acceptance of environmental concerns caused by power generation.

The 45 coal power plants Japan intends to build will utilize state-of-the-art HELE (High Energy, Low Emission) technology, raising the costs compared to many coal power plants being built in non-OECD countries which will not be adopting new technology. Whilst alternative sources of energy – solar and wind, for example – undergo swift development, governments and industry still feel the need to have the security of power supply coal can provide. But the need to comply with treaties such as the Paris Agreement and other climate change agreements demands clean but expensive processes are undertaken. For other OECD countries, the immediate consequence of environmental policy on coal is more pressing. By 2025 all eight of the coal power plants in the United Kingdom will be decommissioned unless significant investment into clean coal is made due to environmental carbon targets. A consequence of uncompetitive coal is the potential development of new energy sources.

Figure 15: CO2 emissions from fuel combustion (MtCO2)



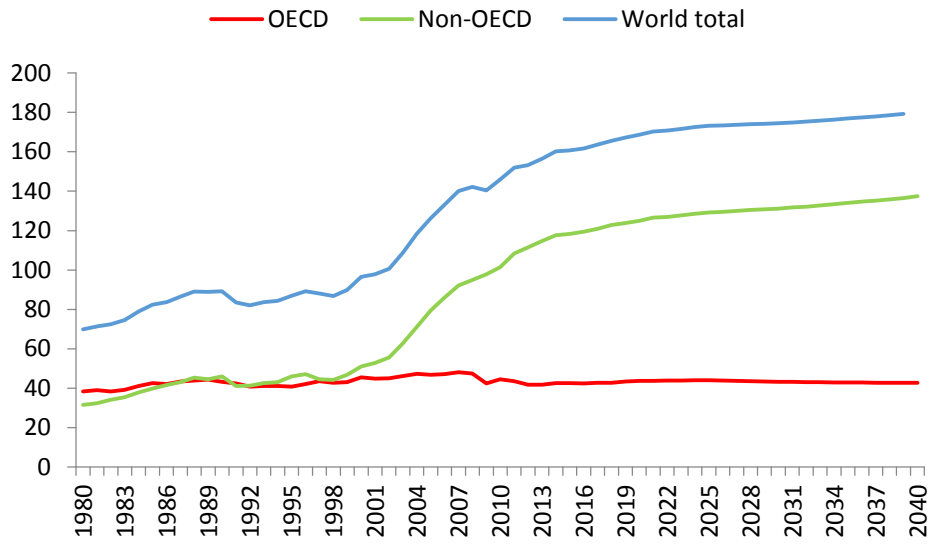
SOURCE: Enerdata

MARKETLINE

Low-cost coal continues to rule in non-OECD countries, helping industry

Whilst ambition exists within governments of developing economies to take advantage of renewable energy following a surprising drop in prices over the past five years, existing coal power stations have provided cheap energy for industry, creating a competitive advantage over OECD economies. Yet there has been an environmental price to pay. Only in 2015 did India undertake an environmental rating of coal power plants, discovering the system to be amongst the least efficient in the world in terms of compliance of pollution norms, use of resources and operating efficiency. (Interestingly, private sector plants are rated higher than those under government control.) Given large coal reserves in India, energy on an industrial scale is cheap relative to developed economy norms. Consequently India accounts for 10% of the increase in global carbon emissions. The lure of cheap energy to produce economic growth remains, driving forward consumption which is predicted to continue to rise for decades to come. Despite technological advances across the energy generation sector, less than half of new plants commissioned in 2015 employed supercritical steam cycles (essential for improving efficiency) and non-HELE plants represent the majority of the global coal fleet.

Figure 16: World coal consumption by region, 1980-2040 (forecast from 2013) in quadrillion Btu



SOURCE: US Energy Information Administration

MARKETLINE

Whilst cutting-edge ultrasupercritical coal plants allow developed economies to continue to use coal and meet environmental regulation, heavy energy consuming industries still have much to gain in non-OECD nations. As countries such as China increasingly turn to cleaner forms of power generation (under pressure from a populace demanding improved air quality) so Vietnam is using low-cost coal energy to drive economic growth. At present Vietnam runs 20 coal-fired power plants, due to grow to 32 by 2020 creating 49% of electricity output. The National Power Development Masterplan for 2011-20 makes it abundantly clear coal is the future of Vietnamese energy policy. Consequently, Vietnam is now directly competing for business from China which is seeing higher costs due to increasing wages and a steadily growing emphasis on environmental impact.

Cheap coal keeps prices down for consumers, encouraging use

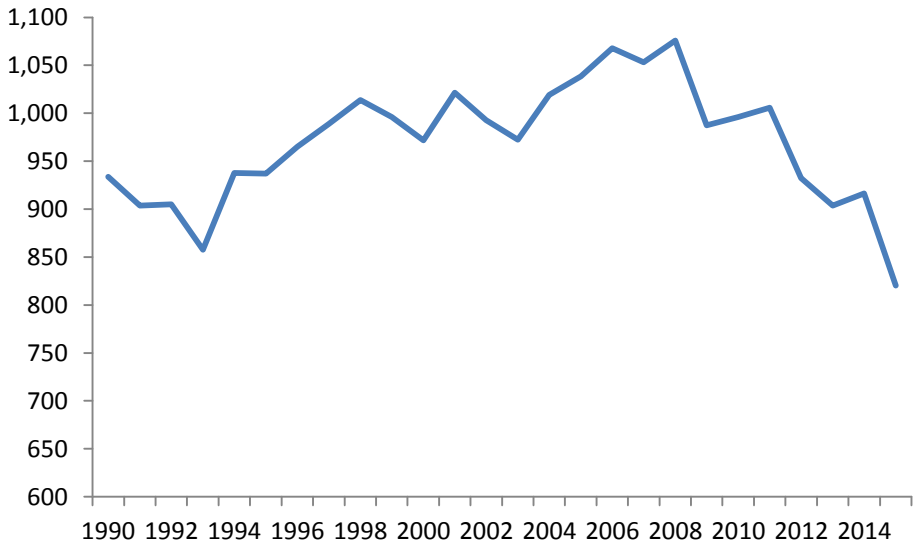
Much of the consumer society is price sensitive, putting pressure on manufacturers and suppliers to keep initial costs, such as energy use, down. Reduced costs at the initial stage of production have a lasting knock-on effect down the supply chain, resulting in lower costs for the end user and helping consumer spending – steel used in car manufacturing, for example. If the steel used to manufacture cars came from countries with high and rising energy costs, an inflationary pressure on the cost of the finished product would occur, possibly leading to reduced sales. To compete, industry in countries producing expensive energy must improve energy efficiency. Two very different means of going about business emerge: one creates lean, efficient companies, whilst the other produces very cheaply but often with a large workforce and minimal regulation.

Decisions regarding which materials to use in a product and how they are produced can depend on the environmental policy of the producing country and that in which the end product will be sold. Many of those decisions come down to manufacturing energy costs, which are eased somewhat by producing in countries where the extensive use of cheaply produced coal energy is commonplace. Indeed domestic production can all but vanish if rivals in other countries can produce goods at significantly reduced costs. One of the leading reasons why Bennet Industries in Lagos declined from 150 employees to just 18 is the dependency on highly expensive diesel power generation due to extensive problems with the power system in Nigeria.

Trump and coal: Dumping waste in water could harm unrelated industries

The Trump view – that increased coal production will help industry across the United States – is helped by the return of industry from overseas which occurred due to falling energy prices caused by the emergence of widespread fracking. To create the desired impact, coal in the United States will have to become much cheaper. But to achieve significant improvements in cost competitiveness the drive towards increased energy efficiency in power plants will have to be at best diluted and maybe abandoned altogether, particularly given the comparatively low cost of natural gas extracted through fracking.

Figure 17: US coal production (millions of ton)



SOURCE: Enerdata

MARKETLINE

Yet many doubt the ability of Trump to revive the coal industry, citing market forces as being responsible for the decline rather than environmental regulations which Trump blames. The potential impact of shedding environmental regulations will have more to do with damage to the immediate environment than reducing the cost of energy. Elsewhere, if fears are realized, costs for certain businesses could rise. Environmental campaigners assert mining companies will now be able to dump waste into streams and waterways. For users of the water system – water companies potentially being the most impacted – the increased presence of waste in water could result in greater consumer concern and demands for improved processes in water treatment, driving up costs. Other industries reliant on water could be placed in a similar business situation. Companies which require large quantities of water for industrial processes, for example, will need to ensure manufacturing processes are not adversely affected by changes in how the coal industry disposes of waste.

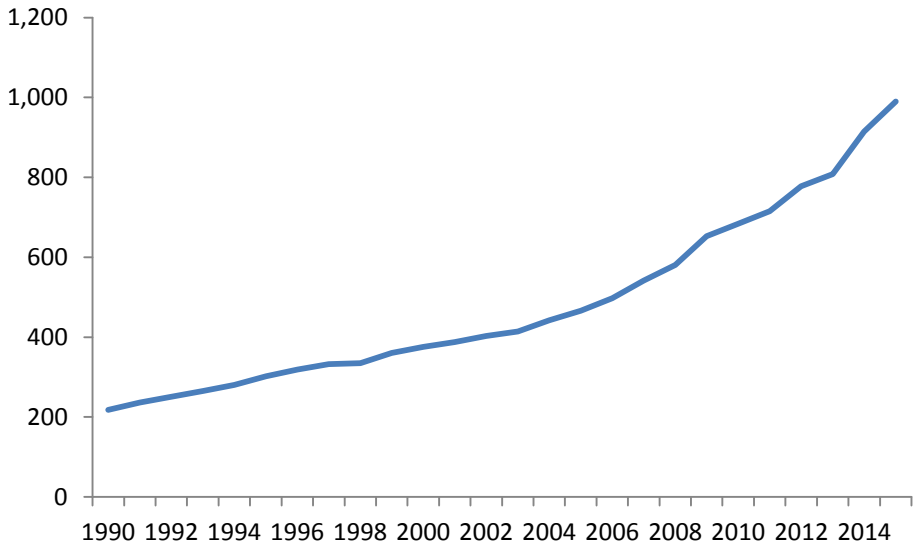
Impact of coal on fresh water has wider ramifications for economies

Extracting coal, opencast mines or otherwise, consumes vast quantities of water. Industrial processes involved in coal production now threaten to create problems which begin with fresh water and trickle down through the agriculture industry. Social cohesion is under pressure in many areas of the world and the ability for companies and entrepreneurs to conduct business can be impacted by the effects of coal on the water system.

The problems begin with the large quantities of fresh water consumed in extracting coal – coal being one of the largest consumers of fresh water in industry. In India the problems are exacerbated by droughts. Fast depleting fresh water resources will be further reduced given plans to construct more coal power plants and increasing coal production.

How long such policies can last given bankruptcies among distribution companies is unknown. Such problems are not just limited to India where 40% of the coal fleet exists in highly stressed water areas. Greenpeace reported in 2016 a quarter of coal power plants proposed to be setup globally are located in regions that are already suffering from severe overdraw of fresh water supplies. The report continued to explain the existing coal power plant network consumes sufficient water to provide for the needs of 1.2bn people and coal will account for half of the growth in global water consumption for power generation over the next 20 years.

Figure 18: Indian coal production (millions of ton)



SOURCE: Enerdata

MARKETLINE

For businesses this is a problem from a purely logistical point of view; power plants in Maharashtra and Karnataka have previously been unexpectedly shut down due to lack of water supplies. Given estimates report at least 80% of the Indian population faces severe water scarcity for a minimum of one month per year, the primary source of power generation has major knock-on effects for the people and commerce. Temporarily shutting down power plants due to excessive water usage creates uncertainty which is bad for business – planning becomes much more difficult and securing an alternative power supply can result in costs so high businesses fail, as has been the case in Nigeria. Worse still, the International Energy Agency reports global water consumption for power generation and fuel production is expected to more than double by 2035. Whilst the problem is far reduced for OECD countries, non-OECD countries will suffer the most from the consumption of water by coal.

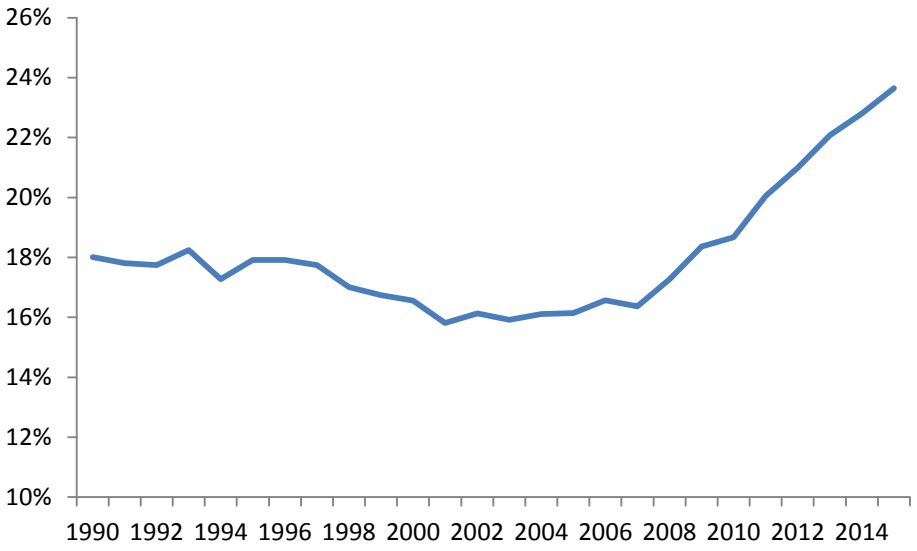
For society the consumption of water by the coal industry can have severe ramifications. As the notion of the 'ecological migrant' has become popularized, greater attention is placed on how depleting water resources harms society. What has been described as a 'mega coal base' constructed in China is accused of having withdrawn so much water the local water table collapsed by 100 meters and the local lake reduced in size by 62%. Although only one example, the extent to which coal power stations use water is likely to have major ecological impacts in the coming decades. The potential to displace large numbers of people poses threats to the development of business through the creation of social unrest. Countries suffering from societal problems become much tougher business environments, making the water crises in coal consumption a major problem. The danger for some countries is a possible impact on consumer habits caused by water shortages, displacement and security of work which can be partly attributed to water consumption in coal.

Environmental laws on coal helps renewable energy across the world

Due to environmental regulations concerning the release of carbon into the atmosphere, coal as a means of generating energy is becoming more expensive, particularly in OECD countries. The direct impact on other sources is technologies once too expensive to be competitive have, partly through cost reductions, become viable sources. New businesses which cater for the renewable energy market have sprung up to take advantage of the movement towards replacing fossil fuels with green energy.

The International Energy Agency announced in late 2016 the capacity of renewable energy had exceeded that of coal and accounted for more than half of the increase in power supply. Reduced costs have helped the expansion; even industry insiders have been surprised at the pace of cost reduction. Policy changes have helped: the renewable sector in Mexico, China and India has undergone rapid expansion partly due to much more favorable policy arrangements provided by governments.

Figure 19: Percentage share of renewables in energy production for OECD



SOURCE: Enerdata

MARKETLINE

Growth is having an effect on prices, too. Solar energy is cheaper in Australia than retail prices in most capital cities following a 58% decline in cost in the past five years – experts predict falling prices are a trend set to continue for years to come. The reducing cost and expanding capacity provides energy security to business which previously slowed uptake of renewable energy sources. Briar Chemicals is expecting to make significant saving on energy bills after signing a 25 year power purchase agreement (PPA) RenEnergy to take energy from a 1.9MW solar farm to be built near Norwich, United Kingdom. Such progress has been made possible due to the continued and immediate reliance upon coal and looming climate change target deadlines to reduce carbon emissions, of which coal is a major contributor.

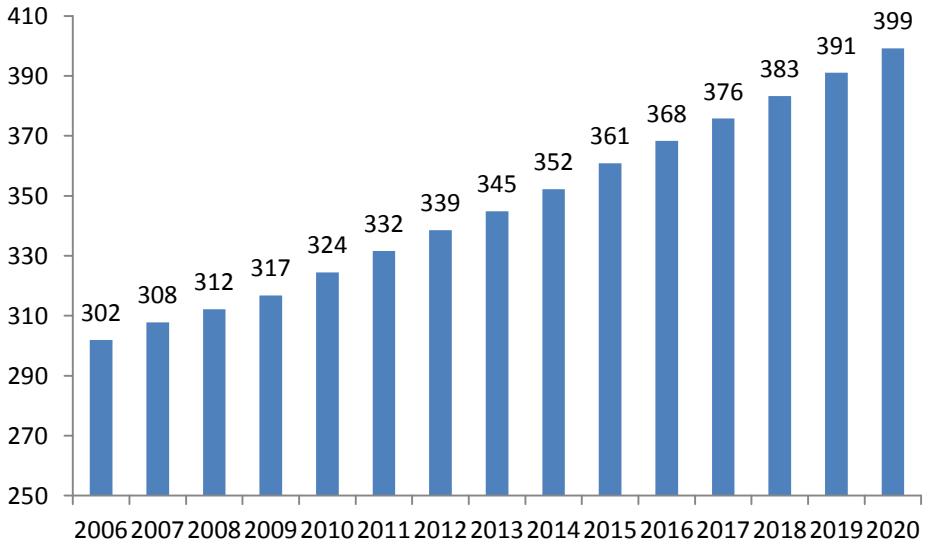
THE PACIFIC TRASH VORTEX: OCEANIC PLASTIC POLLUTION AND THE IMPACT ON BUSINESS

Plastic pollution in the world's oceans covers vast areas. The largest area of plastic pollution, the Pacific trash vortex, covers an area greater than the size of Texas (measurements vary) and according to Greenpeace contains six kilos of plastic for each kilo of plankton. Recent analysis reveals the extent of large pieces of plastic to be much greater than previously thought. Waste plastic trapped in ocean currents presents several problems for businesses, now under pressure to create solutions, adapt to government regulations and embrace corporate responsibility. Despite the issues, many business opportunities are ready to be embraced.

The extent of oceanic plastic pollution is colossal, raising concerns about the use of plastic in the consumer society

New analysis by the United Nations revealed the Pacific trash vortex to span three and a half million square kilometers – the core area covering around one million square kilometers – and that it mostly consists of large items of plastic which have broken down into pieces sufficiently small to be consumed by fish and other marine life, potentially entering the human food chain. Reconnaissance flights from California found large items over half a meter in size had previously been radically underestimated. Once broken down, the number of tiny fragments will soar. Already in 2014 the number of plastic pieces in the ocean was estimated to be around five trillion (approximately 165m tons) and the Ellen MacArthur foundation predicts the weight of plastic in the world's oceans will exceed the weight of fish by 2050 unless significant action is undertaken. The growing use of plastic in consumer products is a leading cause.

Figure 20: Number of plastic packaged goods sold in G7 countries (billions). Forecast from 2016.



SOURCE: GlobalData Consumer

MARKETLINE

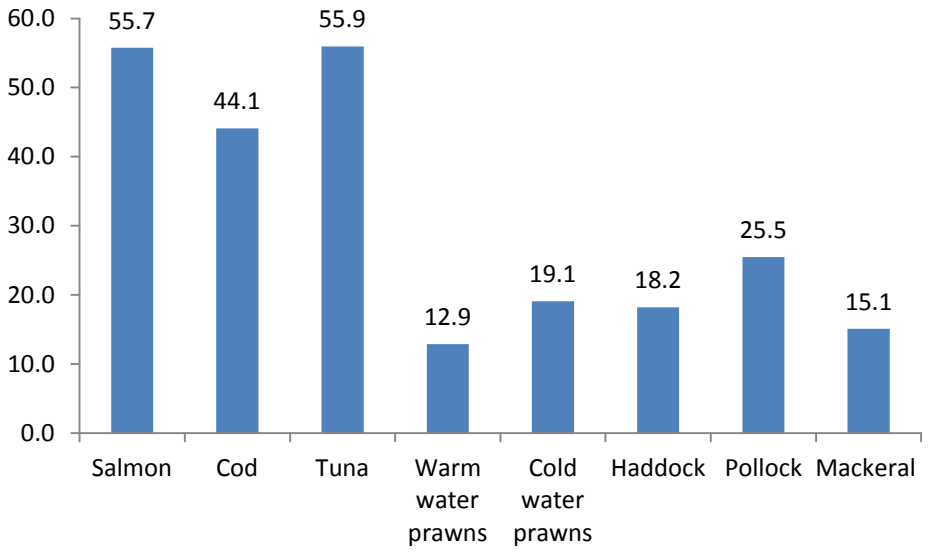
Globally only 14% of plastic is recycled and is the largest source of pollution in the oceans. Annually businesses spend $80bn each year manufacturing new plastics from scratch. Without major change plastic production will consume 15% of global carbon and six percent of global oil supplies by 2050. The threat to business is clear: the use of plastic in the consumer society will come under increasing pressure, forcing changes to business models and changing how consumers of products behave. Nearly all experts agree solving the oceanic plastic problem requires much improved management of waste. New business opportunities are opening up and large organizations are developing business to adapt to a changing commercial world.

Both governments and consumers are changing the international business environment in response to large plastic deposits, particularly so given the potential impact on human health and the food chain.

Microbeads in the oceans could be making fish and marine life toxic, threatening numerous industries

A 2016 study conducted in the North Sea concluded a third of fish caught off the coast of the United Kingdom contained plastic particles. Widespread contamination through microbeads was discovered in cod, haddock, mackerel and shellfish. It is thought fish are feeding on plastics mixed in among plankton. Worse still, research suggests microbeads attract pesticide residues and industrial chemicals released into the oceans, drastically increasing concentrations. A Portuguese study found micro plastics in 20% of 263 variants of commonly caught fish.

Figure 21: 2015 UK fish catch weight (millions of kg)



SOURCE: Seafish

MARKETLINE

Whilst the ramifications regarding public health are as yet unknown, the fishing industry and products containing fish could come under severe public and government scrutiny. For now researchers have yet to prove pollutants consumed by fish can transfer into the human biology system via consumption. Nobody knows how such revelations will impact fishing in the long-term; the worst case scenario would be a near abandonment of fish similar to that which happened to beef in the United Kingdom in the 1990s. A closer impact on industry is the means by which pollutants are disposed of. The production, use and end consequences of pesticides and industrial chemicals will likely be examined by governments and environmental pressure groups, potentially resulting in significant changes to how many industrial sectors operate.

Government policy on plastic waste is forcing companies to change, opening up fresh opportunities

International pressure on the use of microbeads in toothpaste and cosmetic products has gained sufficient strength governments are banning their use. In the United Kingdom alone over 680 tons of microbeads are used in products, initiating a process which will result in a complete ban. Microbeads are already banned in the United States and in 2015 Cosmetics Europe issued a recommendation to discontinue their use in wash off products. Environmental groups have already achieved voluntary bans from some global players in the cosmetic industry. Unilever, Beiersdorf AG and Colgate-Palmolive are already microbead-free. Other big players including, Johnson & Johnson, L'Oreal and Procter & Gamble plan to remove entirely microbeads from product ranges.

Consequently the use of microbeads in the United Kingdom has already declined by over 70% and complete removal is expected in the near future. Changes have taken place with increasing speed: Shiseido, the Japanese company that owns hair and makeup brands like Nars, Tsubaki and Bare Minerals, is among the slowest adapting companies having pledged to end the use of microbeads by 2018.

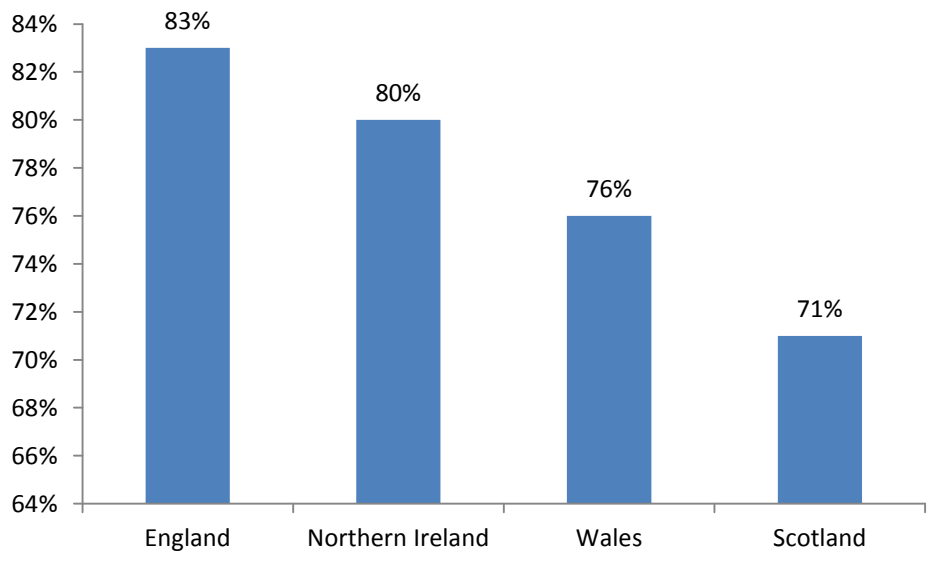
Yet bans commonly produce opportunity. The list of potential ethical alternatives provides plenty of competition between different solutions to the problem, boosting suppliers and allowing companies to refresh marketing to increasingly ethically conscious consumers. Silica, cellulose and jojoba beads are being trumpeted as viable alternatives among some leading players. L'Oreal is backing a mixture of mineral-based perlite and fruit kernels, whilst other companies are pursuing options in hydrogenated castor oil and hydrated silica.

Innovation in the cosmetics industry should prosper given the absence of a clear winner and presence of many competing ideas. Wider consequences of cost, consumer preference and reliability of supply have still to be established, leaving plenty of room opportunity for leading players to improve market position. In the short-term, investment into research and development will harm company balance sheets, especially given the dangers of passing on increased costs to an increasingly price sensitive consumer.

Decline in plastic bag use prompted by government action increases demand for alternatives

Charging consumers for plastic bags resulted in drastic and immediate declines in use in those countries which have introduced such schemes. One of the leading causes of plastic pollution in the oceans, environmental groups rejoice after each charging scheme is introduced. In 2014, plastic bag use topped 7.6bn in the United Kingdom but declined by 83% following the introduction of the five pence charge. Cotton bags and other ethical alternatives underwent a surge in demand, but questions concerning environmental sustainability have cropped up. Paper bags, for instance, are claimed to consume four times more energy than plastic, create 50% more water pollution and 70% more air pollution. Worse still, paper bags are rarely used more than once. Cotton bags, another common alternative, according to the United Kingdom Environment Agency, must be used 171 times to match the carbon dioxide pollution of a typical thin plastic bag.

Figure 22: Decline in plastic bag use six months after introduction of five pence charge



SOURCE: BBC

MARKETLINE

The rather grave assessment and the force of the trend away from plastic bags open up opportunities for innovation. To a new entrant the prize of creating a genuinely sustainable bag is huge. Furthermore, supermarkets and other retail outlets would gain a competitive advantage were a means of evading the plastic bag charge whilst providing the same degree of convenience possible.

As was the case for microbeads, government action has harmed business in on capacity but simultaneously created conditions for business innovation.

Given the growing number of nations introducing variations of plastic bag charging schemes, the scope for innovation in the retail sector grows ever wider.

Industry successfully turned UK government policy away from tough targets on non-recyclable plastic use

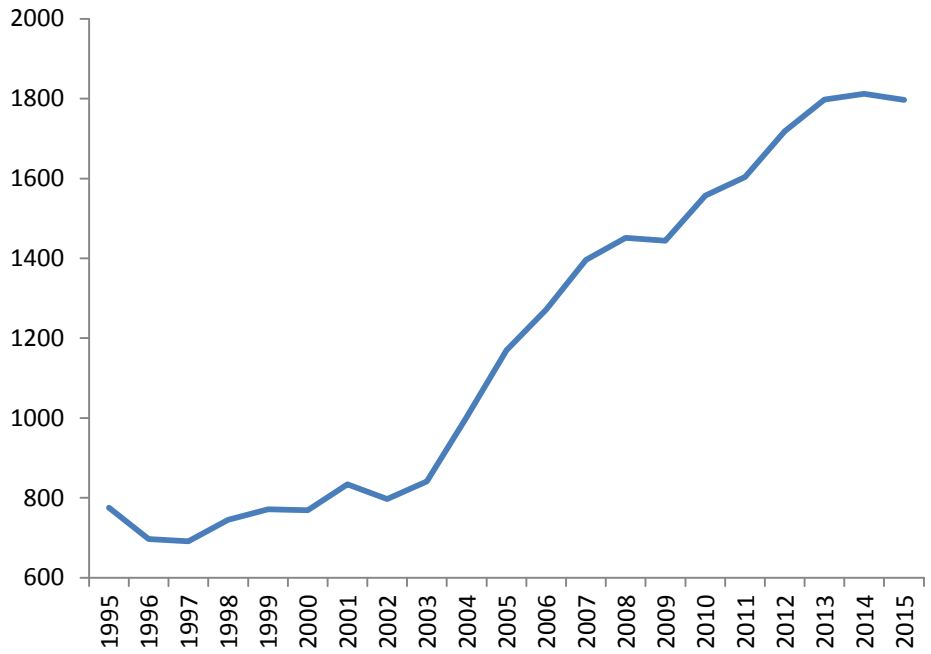
A negative aspect of government targets is the influence invested industries can have on determining the ambition of government policy. In 2016 the government of the United Kingdom came under scrutiny after targets for recycling plastic were reduced form 52% to 49%, only to rise annually by 2% each year until 2020. The Department for Environment, Food and Rural Affairs (Defra) previously insisted the reduction was to reduce the cost burden on business but Greenpeace has subsequently revealed the change came after intense lobbying on behalf of British Plastics Federation (BPF) had taken place. Companies had protested the government target would increase costs.

Influencing government policy marks a major achievement for the plastics industry, keen not to expend resources where it can be avoided. Problematically, innovation is stifled when leading players are able to influence government policy towards a more favorable position. Were research and development into solutions reducing usage of non-recyclable plastic allowed to flourish the contribution business could have in alleviating the pacific trash vortex would grow. New entrants could potentially appear, providing much needed competition. To what extent industry will maintain such a favorable degree of influence is hard to assess, but the more control is asserted the less fresh business opportunities feeding of innovation can thrive.

Growing influence of corporate responsibility the consequence of oceanic plastic pollution

Increasing consumer belief in ethical trading and consumption is leading companies to develop packaging which reduces the use of non-recyclable plastic and placing greater emphasis on biodegradability of packaging. By the end of 2017 Sainsbury's aspires to become the first British retailer to publically commit to removing non-degradable plastic from cotton buds. The supermarket states discussions regarding a new formula to create plastic free cotton buds are ongoing and once a solution is found, other retailers will be able to access it. Motivated by public pressure to develop new products (The Marine Conservation Society recorded cotton buds as the sixth most common type of litter found on Britain's beaches in 2016), the movement towards consumer led packaging is gaining pace. Johnson & Johnson has also announced an end to selling plastic cotton buds.

Figure 23: mmlbs Post-consumer Bottles Recycled / Used by Reclaimers in the United States



SOURCE: NAPCOR

MARKETLINE

Radical changes in the design of products with an emphasis on reducing plastic content demands changes in how businesses think about product design. Consumer attitudes are driving such developments across a broad range of everyday products. Marks & Spencer announced in 2017 plans to develop one recyclable, plastic polymer for use across all its plastic packaging. One notable aim is to solve confusion regarding which plastics local authorities will accept and those which are unacceptable. The challenge of designing a new material will take several years to achieve but is given impetus by the European Union approved target of recycling 70% of waste by 2030. Yet problems remain. Black packaging colored with pigment is frequently unrecyclable but remains in common usage for branding and cost reasons.

Reacting to concern from consumers to environmental problems caused by the consumption and release of plastics into the oceans and natural landscape is creating new opportunities in markets which were otherwise saturated and extremely difficult to enter. Supermarkets, for instance, are facing increasing pressure to begin providing products which are free from plastic. Given the Scottish regional government is considering putting 20p on plastic bottles, reclaimable upon return for recycling, the prospects for success of the 'A Plastic Planet' campaign appear healthy. Such schemes have been in widespread use for many years already in countries such as Germany, Netherlands and Sweden. In all likelihood as soon as one major retailer decides to implement the policy and gains a competitive advantage, the remainder will follow swiftly.

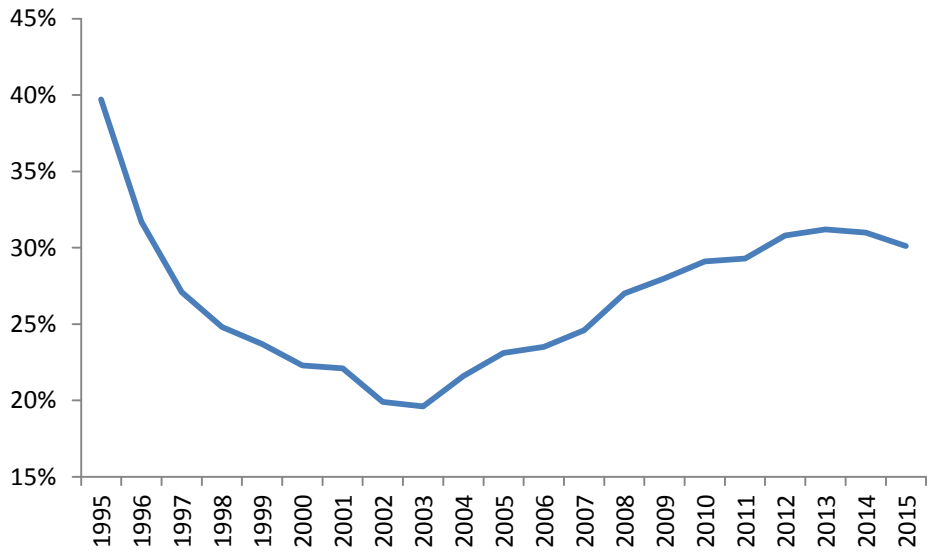
New companies with innovative solutions to ocean plastic pollution enter the market

Established companies are innovating product lines via the use of discarded plastics commonly found in the oceans. Timberland has joined with clothing manufacture Thread International to transform waste plastic collected by workers in Haiti – a nation beset by plastic waste problems – into fabric. According to an impact report, the partnership with Timberland saved over thirty million gallons of water, averted the use of more than 15,000 pounds of pesticides and helped recycle more than 765,000 bottles. Such strategies are making good business sense. The 'Earth keeper' boot, made from sustainable source materials, accounts for 80% of the Timberland product line. Commercial success demonstrates the potential for market share to be increased and for new entrants to enter markets predicted on an environmentally minded product line. The boost to corporate image is difficult to underestimate in a consumer environment ever more concerned with ethical business. Products utilizing wasted plastic perform the task of preventing waste plastic from entering the oceans, reducing the growth of the plastic vortex.

Recycling plastic is also a means of entering a seemingly saturated market. In February 2017, Marcia Kilgore launched the Soaper Duper brand of body wash.

The brand depends upon green credentials as a unique selling point, appealing to a growing group of consumers who value environmental friendliness. The green HDPE bottles are made from 100% post-consumer recycled plastic (PCR), mostly consisting of recycled milk bottles and green bottle tops which provide the color. How the brand will compete against established players, and whether the intended audience will engage, remains to be seen. But niches for new entrants in many market places are being created by the movement towards ethical sourcing with a view to protecting the ocean environment from waste plastic.

Figure 24: Gross plastic bottle recycling rate in the United States



SOURCE: NAPCOR

MARKETLINE

Such is the growing importance of eco-friendly attitudes among consumers, Coca Cola recently dropped opposition to a deposit return scheme created by the Scottish regional parliament in Holyrood, Edinburgh. Similar schemes have already raised recycling rates in Germany and there is a clear movement of governments towards wider acceptance. Coca Cola UK announced the reversal in opinion citing the role major companies have to play in sustainable packaging. The ecological mess resulting from large quantities of plastic entering the ocean is now influencing packaging and sustainability policies of leading companies, changing how products are created, packaged and sold. For businesses the message is becoming clearer: adapting to changing environmental attitudes among consumers is essential for brand image.

New technology seeks to solve environmental problems caused by waste plastic

Whilst environmental problems created by vast quantities of plastic entering the oceans have indirectly resulted in niches emerging, companies changing attitudes and consumer views having a greater impact on business, new markets are in the early stages of development to solve the problems of plastic waste. NatureWorks, a Minnetonka-based company half owned by agribusiness giant Cargill, is a company seeking to become a player in a nascent technology market seeking to compost plastic. Regional governments are helping the market develop. Inflating costs of dumping material in landfill or incinerators allows the prospects for technology capable of composting plastics to drastically improve. Composting plastic reduces costs for businesses, helping the bottom line. Furthermore, waste disposal becomes easier for customers, encouraging engagement.

A plant-based plastic, therefore, suits the problem it seeks to solve. Ingeo, the new plastic, currently costs more than conventional plastics, but the gap is not said to be insurmountable and is closing rapidly. Given the size of the food and drink industry, and the consumption of plastic, a market of staggering size awaits those companies able to create sustainable solutions.

The Ellen MacArthur Foundation claims recycling the remaining 86% of plastics which go unrecycled could generate an industry worth $80bn-$120bn, but the valuation depends upon discovering a means of recycling plastic packaging which is either too contaminated to be recycled or too small to be easily collected. Solving the puzzle of recycling technically troublesome plastic represents a major prize to industry and is a major opportunity for new entrants. One company working on a difficult subject is Agylix. The company is developing technology which breaks down polystyrene foam packing into a liquid which can be refined back into the original material but in a new product. Success could prevent vast numbers of styrofoam cups, packing peanuts and rigid red picnic cups from entering the ocean. The solution to the problem would be an example of an industry developing to solve an ecological problem.

Big industry: Dell converts ocean plastic waste into packing for laptops

Dell customers may well have changed the means by which computers and laptops are packaged in the future. After concerted pressure on social media about excessive packaging made from non-recyclable materials, Dell examined the supply chain and operations systems used in the company. The result of extensive research was a means to convert waste plastic found in the oceans and waterways into packaging for the XPS 13 2-in-1 laptop. Forecasts predict the change will prevent 16,000 pounds of plastic from entering the world's oceans in 2017. Efforts to reduce plastic use extend beyond recycled ocean plastics. Box sizes have been reduced by 10%, bamboo cushioning developed – a fast-growing material which can be composted or recycled – to replace foam and work begun with companies to produce further sustainable packing solutions.

Figure 25: Dell XPS 13 2-in-1 laptop

SOURCE: Dell

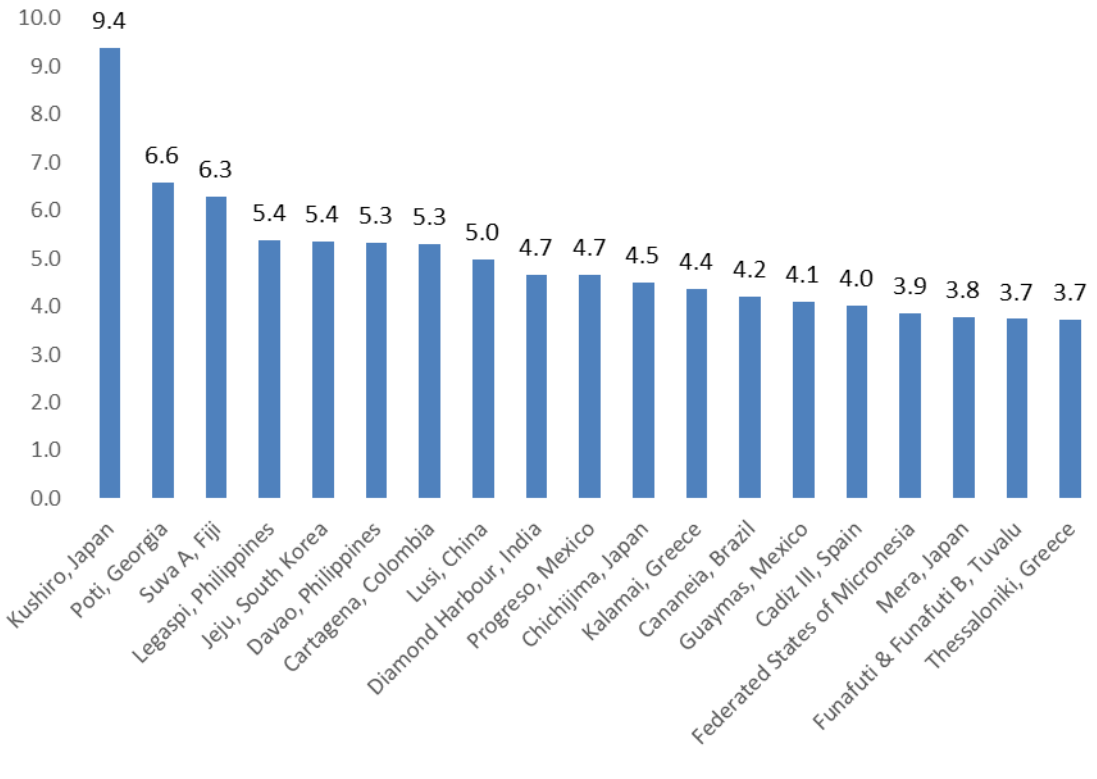
MARKETLINE

The existence of the Pacific Trash Vortex is impacting how consumers feel about the products they purchase and demonstrates a keenness to become involved in the direction companies take regarding plastic waste and environmental impact. Resultantly companies have to reform processes to maintain customer loyalty and gain a competitive advantage in an area of business which is becoming increasingly important to consumers. Waste plastic in the oceans is changing the relationship between customers and companies.

RISING SEA LEVELS WILL IMPACT THE GLOBAL ECONOMY MAKING SOME CITIES UNINHABITABLE

Assuming that current rates of climate change continue, it has been conservatively estimated that there are billions worth of assets and millions of people that will be displaced by the end of the century. Some countries are more affected than others but overall, both developed and developing nations are at serious threat from losing a sizable percentage of their land mass and some of their most economically important and most populated cities. By percentage of population that could be displaced, the Netherlands is most at risk, by total number of people displaced China is most exposed and by potential monetary assets lost, the US stands to lose the most.

Figure 26: Observed sea level change mm per year



SOURCE: Tides and Currents

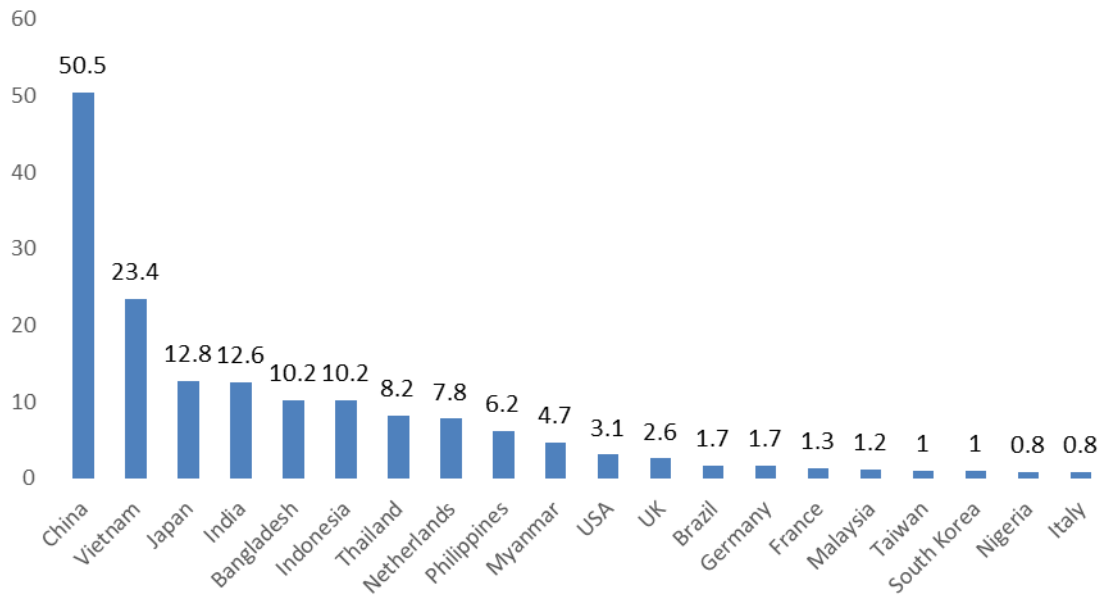
MARKETLINE

Current projections of sea level rise suggest disaster is looming

Current projections of global sea level are extremely difficult to estimate with any complete certainty, this is because exactly what will happen as the ice caps continue to melt and how quickly they will deteriorate is hard to determine. The estimates of sea level rise by 2100 ranges from 0.2 meters to 2.0 meters. However a recent study in 2016 which found that even a sudden elimination of CO2 emissions that lasted up to the year 2100 would still leave more than six million Americans living on “endangered land”. This means that now the trend has begun even significant efforts to hold the rise might be ineffective. Ultimately then the focus should be turning to how this should be effectively managed but there are multiple indicators that suggest that without spending trillions of dollars on defenses and water management schemes many areas will be indefensible and people and assets may have to be relocated long before 2100.

China and Netherlands heavily exposed to population displacement

Figure 27: Population at risk from rising sea levels (millions of people)

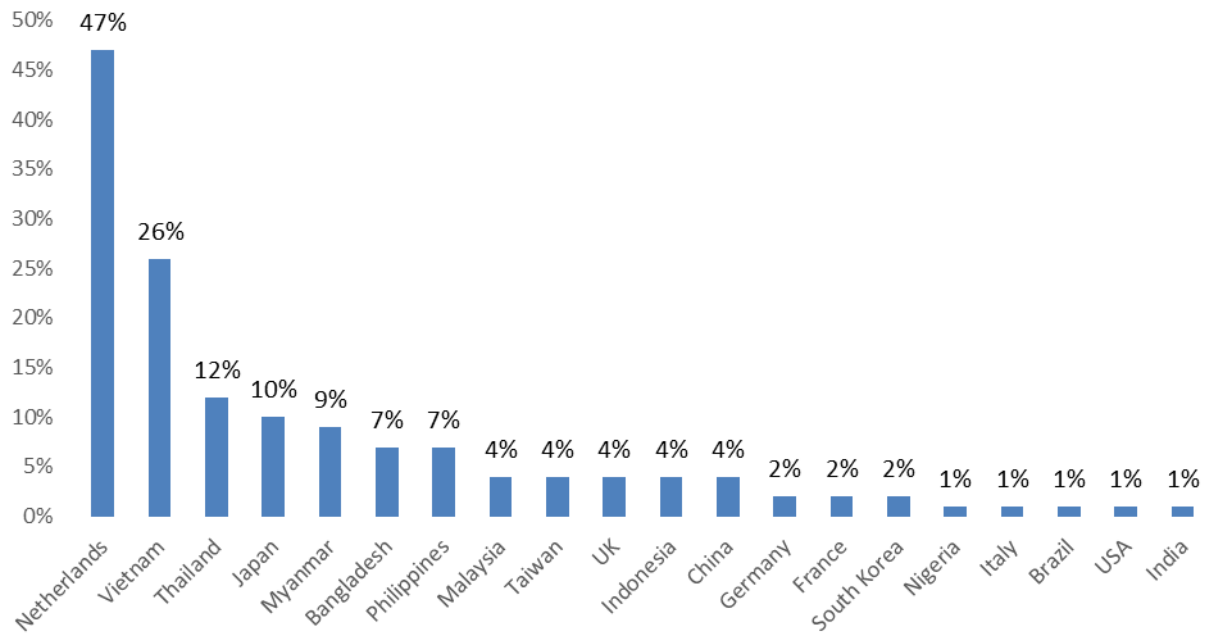


SOURCE: Envirotech

MARKETLINE

Asian countries most definitely bear the brunt of the exposure, on sheer percentage of population alone. By far the biggest at-risk continent is Asia, with all seven top spots of risk (by population) occupied by Asian countries and 12 of the top 20 in total. This is particularly concerning as Asia has some of the largest growers of food internationally and it is possible that the production of key growing areas will substantially decrease as land available for farming becomes unusable. China, in particular, accounts for a large number of the endangered people globally, with around 50 million people expected to be at risk of displacement before 2100. Effectively, the threat varies dramatically from region to region and we cannot say with absolute certainty how the threat will develop and how quickly, but at present it appears to be the most populous areas of the world which are most at theat.

Figure 28: Percentage of population at risk of displacement



SOURCE: Envirotech

MARKETLINE

Netherlands are the clear frontrunners by number of population that could be affected with close to 50% of people likely to be affected and displaced by rising sea levels. Almost half of the population will be underwater by 2100 if emission trends continue in the same way that they are today. About a third of the Netherlands is below sea level; with another third presently at sea level so any further changes to sea level without further advanced and expensive protection will strike disaster for the country. Whilst some countries have further land that can be used in the event that sea level problems occur, the Netherlands relies heavily on its reclaimed land and does not have a vast amount of alternative land that could be used, perhaps making it one of the countries most likely to suffer heavily from major changes in sea level.

US, China and India have billions of dollars of exposed assets

Of particular economic concern is that many of the areas which are most heavily exposed to sea level rise are also some of the most important economic cities on the planet. Miami, New York, Tokyo and Shanghai are just some of the cities which fall into the top ten by assets at risk. But perhaps an even more concerning issue for global markets are the growth cities which are due to become exposed. Guangzhou in China, on current growth trends, is set to become one of the world's wealthiest cities by 2100 and will be providing a substantial portion of China's growth in this century. Already more economically significant than Shanghai, the city is expected to become a $3tn city by the end of the century and its costal location and altitude means it is heavily exposed to sea level rise. A similar situation is likely to affect Kolkata in India, which is also expected to be worth trillions to the global economy by 2100, but which will be largely underwater if current sea level rises continue. These areas might be beyond saving if the cost of protecting them becomes too high and in that scenario much of the assets may not be salvageable.

Table 2: Assets exposed globally to rising sea levels

Rank	Country	Urban Agglomeration	Exposed Assets $bn	Future Exposed Assets $bn
1	USA	Miami	416	3,513
2	China	Guangzhou	84	3,358
3	USA	New York	320	2,147
4	India	Calcutta	32	1,961
5	China	Shanghai	73	1,771
6	India	Mumbai	46	1,598
7	China	Tianjin	30	1,231
8	Japan	Tokyo	174	1,207
9	China	Hong Kong	36	1,164
10	Thailand	Bangkok	39	1,118
11	China	Ningbo	9	1,074
12	USA	New Orleans	234	1,013
13	Japan	Osaka-Kobe	216	969
14	Netherlands	Amsterdam	128	844
15	Netherlands	Rotterdam	115	826
16	Vietnam	Ho Chi Minh City	27	653
17	Japan	Nagoya	109	623
18	China	Qingdao	3	602
19	USA	Virginia Beach	85	582
20	Egypt	Alexandria	29	563

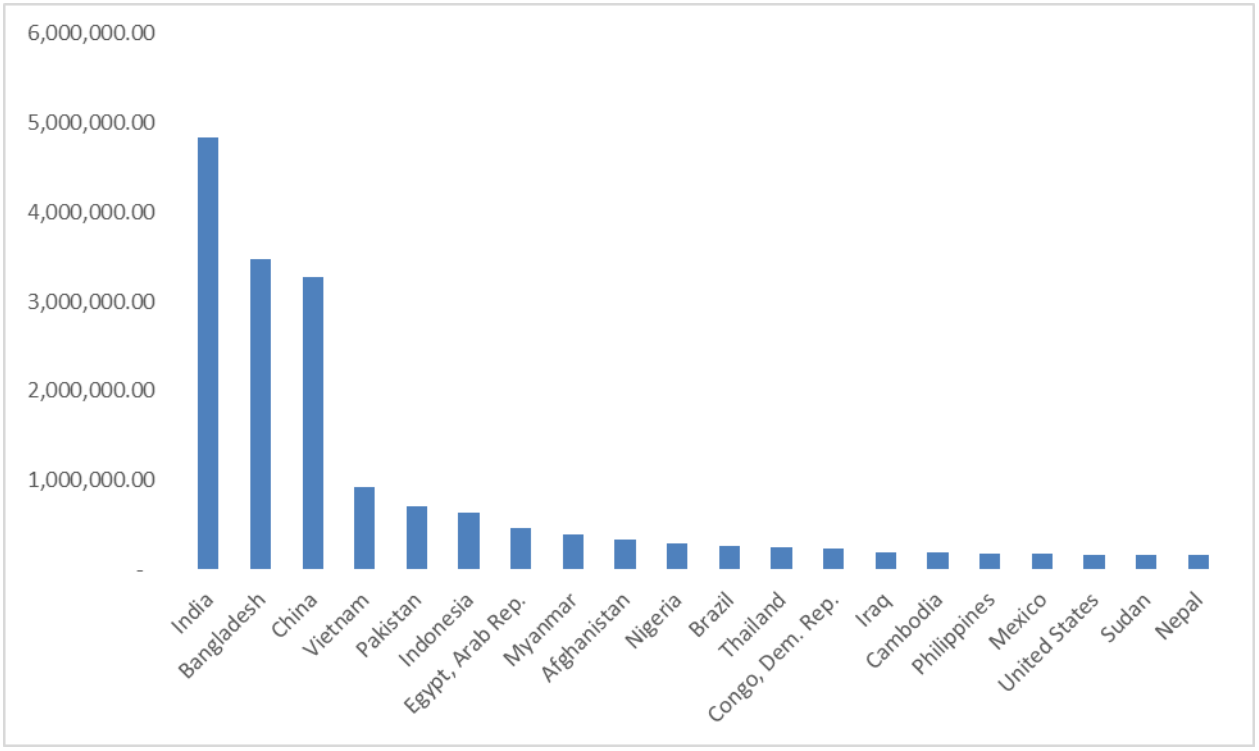
SOURCE: OECD

MARKETLINE

Sea level rises will affect inland areas too through river floods

Cities that lie near rivers are affected by rising sea levels as well. The disruption to weather patterns and more extreme weather caused by rising temperatures means that rivers are much more at risk of seasonal flooding. What has been seen so far globally tends to vary, but countries with cities located on rivers are certainly at risk from flooding damage too. A number of reasons are causing this and they change from location to location but the root cause is rising temperatures. For example in the UK in 2016 December temperatures were 4.1C above the long-term average and this meant that frost and frozen ground that usually helps to absorb the higher winter snow and rainfall was not able to form meaning huge rainfall (also caused by higher temperatures) caused flash floods causing destruction in local areas.

Figure 29: Current population affected annually by river floods millions of people



SOURCE: OECD

MARKETLINE

Avoiding these problems is looking increasingly unlikely

If the worst case scenario is realized by 2100 and sea level rises come in at the high end of the projections (around two meters), there will be many cities whose persistence and efforts to fight the rising tide will be difficult to imagine. For instance, areas of significant importance may be able to find solutions to protect themselves to some degree through barriers and water management. But that may not be of any use anyway when all the land around a city is completely flooded. For instance if New Orleans spent billions protecting itself from flooding, there may be very limited use in doing so if the land around it for tens of miles is under water and all the suburban districts housing those that live and work in the city disappear under water. The practical reality is that many of these cities which are most exposed may slowly die long before the city itself becomes flooded as land for expansion disappears, weather conditions become increasingly difficult and populations and companies leave to cities with less risk. The only way to truly avoid that would be to defend an entire stretch of coastline perhaps hundreds of miles long. The trillions of dollars that would cost mean that countries' economies may be crippled in the process. A key example here is the Venetian flood barrier, which is due to be completed in 2018 and cost $5.4bn, the process to organize this money took 30 years and is not a complete solution to protect the city as it will only help up to a maximum of one meter sea level rise and some predictions suggest two meters is possible. In the instance of two meters of sea level rise, protecting Venice will become irrelevant because a good

portion of Italy would already have been lost.

Companies and governments need to make difficult decisions

Assuming that it is unlikely that global warming will be completely erased in time to avoid some significant changes to the planet's environment, there are going to have to be some very difficult decisions taken to decide how to best manage the situation. For instance, if some cities are unsalvageable as is likely to be the case with areas such as Miami, Guangzhou, Rotterdam, Calcutta and many others, should governments make plans to move populations away from the affected areas and should companies avoid investment in them in the long term? The answer is ultimately yes. Whilst some efforts have been made to avoid climate change, the rate of damage continues to increase year on year and it is unlikely that it will be plausible to save all areas. Some assets could be moved easily, but real estate and fixed investment would most likely be lost if an area became flooded, through sea level rise or river floods and so companies should begin to factor in climate change to their decision making processes.

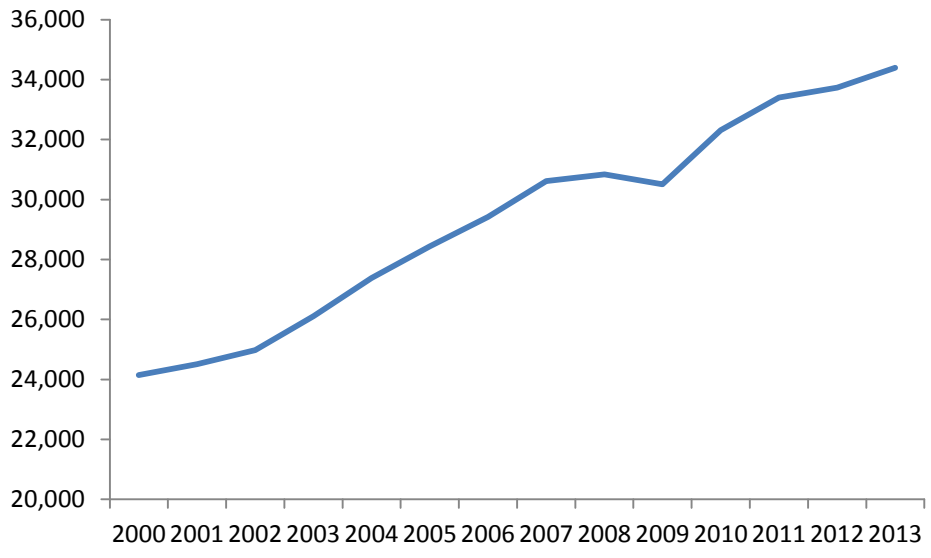
CLIMATE CHANGE AND FOOD SECURITY: THE GLOBAL THREAT

Security of food supplies remains vulnerable to climate change resulting from greenhouse gas emissions. The deleterious effects of rising temperatures on agriculture and the security of food are legion. Food supplies in large areas of the globe are at high risk of collapsing and those countries most dependent on agriculture are typically of heightened sensitivity to climate change. Crop yields in many regions are already suffering and whilst genetically modified (GM) crops are in development, many unknowns as to the efficacy and potential side effects of GM food remain. These problems are compounded by political sensitivity to the changing agricultural business environment, frequently resulting in economic upheaval.

Impact of climate change on agriculture is unevenly spread – tropical regions will suffer the most, threatening supplies

To keep pace with global food demand, supplies have never had to increase at a faster speed. Set against the backdrop of deteriorating conditions for agriculture across large areas of the globe's surface, ever greater need for secure food supplies are going to be increasingly difficult to meet. Tropical regions will be impacted more than most in regards to agriculture, which is likely to alter where large quantities of food are produced. Higher temperatures not only place limitations on how long ground can be worked but the ability for crops to grow too. Worse still, crops such as mango have experienced major shocks already, even though the two-degree centigrade limit on climate change set by the United Nations (UN) has yet to be reached. Whilst the richest economies of the world possess the resources to source cheap food from around the globe, for many countries that is not the case. Critically, forecasts predict much of the growth in the human population is due to take place in the tropics during the next fifty years. Even though regions closer to the poles are expected to experience longer growing seasons for staple crops, predicted increases in production will be insufficient to make up for the shortfall. Globally the trend is particularly damaging; the tropics have traditionally been among the strongest growing areas in the world.

Figure 30: Global Release of Carbon Dioxide excluding land-use change and forestry (metric tons of carbon dioxide equivalent per year)



SOURCE: World Resources Institute

MARKETLINE

Some predictions charting the likely impact of climate change assert consequences of breaching the two-degree Celsius barrier in global temperatures extend far beyond limitations on food production and the security of supply for the planet as a whole.

The journal 'Scientific Reports' published a paper in 2016 stating that were the two-degree limit exceeded, some tropical populations would be forced to relocate, potentially hundreds of miles away. Because the tropics are uniformly hot, even a small rise in global temperatures can have dramatic effects on the ground. Simulations suggest the cooler edges of the tropics would become very crowded, placing extreme pressure on the land and agricultural production, which would already be under pressure. For food production the consequences are stark: agriculture could collapse altogether in certain areas, whilst many will undergo significant decline. Economically such a turn in events would be disastrous for many countries economically dependent on agriculture. Historically countries which rely on agriculture are politically sensitive to extreme weather events shaping the global agricultural market, undermining stability.

Crop yields around the world fail to keep pace as climate change sets in

The need to increase food production up to 70% by 2050 according to some estimates (leaving aside political arguments regarding the distribution of food) is more pressing than ever, but yields around the world are suffering as the frequency of extreme weather events increases. Early theories in the history of climate science believing plant yields would increase due to a greater degree of carbon dioxide in the atmosphere proved to be incorrect. Rather crops will suffer. Yields of staple crops such as wheat and corn, particularly in countries where agriculture performs well, are already under pressure and are below expectations even when the influence of climate change is removed. Scientists now believe variations in yields can only be partially attributed to changes in rainfall patterns. Much of the actual and predicted change in yields of staple crops is due to adverse reactions to temperature. The underlying cause is increased surface drying brought on by greater evaporation due to a warmer atmosphere.

Figure 31: Tanzania, millions of tonnes of wheat per hectare

SOURCE: OECD

MARKETLINE

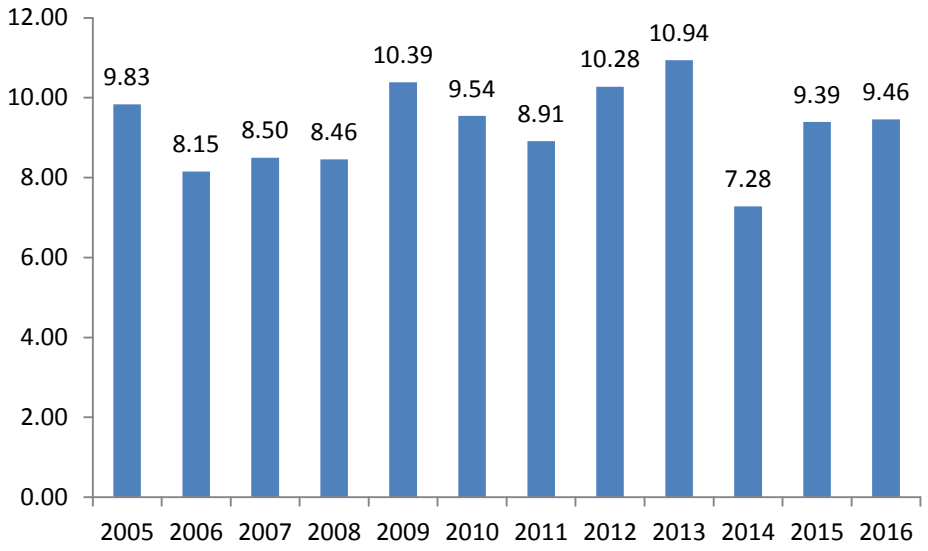
In 2013 agriculture accounted for the employment of roughly half of the workforce in India and created 13% of GDP. Losses, where they occur, in food production do not only harm local populations, many of which are beset by poverty, but the economy as a whole. Maharashtra, one of the largest producers of mangoes in the country, has witnessed an over 50% drop in yield of the fruit since 2013-14. Growers blame the onset of climate change. Predictions for 2016-17 allowed for only a marginal growth in production, far below that which was conventionally the case.

Extreme weather caused fruit to prematurely flower and drop as well as harbor infestations of pests and diseases. Some growers reports trees failing to flower in response to erratic temperature variations between seasons.

Given the dependence the local economy of Maharashtra has on mango fruit, not only is the food security of the largest buyers threatened but the ability of the workforce to secure food supplies also comes under pressure.

Developed economies are also subject to falls in agricultural performance following the onset of climate change, particularly in relation to large swings in seasonal variations. Mungbean production in Australia boomed in 2016 but hot, dry weather has since slashed production from 1-1.5 tonnes per hectare to just 0.1-0.5 tonnes per hectare now. Sorghum and cotton crops fared little better, due to depleted soil water, lack of in-crop rainfall, and extreme heat. Global agriculture is littered with similar examples, exposing the frailties of food supply around the world.

Figure 32: Australian rice production, millions of tonnes per hectare



SOURCE: OECD

MARKETLINE

For retailers this is a major problem. Many in developed economies depend on guaranteed supplies to keep customers. Losing certainty regarding the supply of basic food stuffs potentially hands a competitive advantage to rivals who can provide better security of supply. The rationing of supermarket vegetables in early 2017 in the United Kingdom proves as much. Some outlets limited the number of iceberg lettuce and broccoli customers could buy after farmers in southern Europe experienced deleterious growing conditions. Shortages of supply also raised prices. Yet the problem was not limited to the United Kingdom: 80% of out-of-season fresh produce consumed in European Union countries comes out of Spain. Just as with the tropics, extreme weather in the growing season has grave impacts not just on the local economies of the agricultural regions but on the security of supply for many countries beyond.

Conditions demand a second ‘green revolution’ – this time to create resilience against extreme weather events

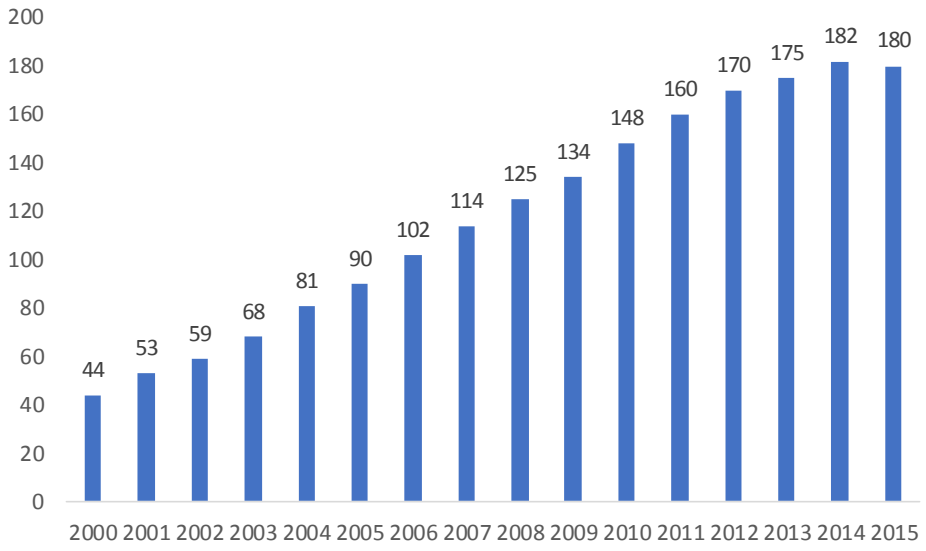
The result of growing insecurity around food supply, and the economic and political problems which emerge, is a need to develop new variants of crops. Scientists have responded. Climate-resilient crops are being developed for highly variable environments which can experience extreme weather conditions. Sorghum, a grain native to Australia, is the shining example of the response to food insecurity brought on by climate change. Now a dietary staple for over 500m people living in 30 countries, Sorghum is the world’s fifth-most-important crop for human consumption after rice, wheat, maize and potatoes. New ‘stay green’ properties are essential. Crops with ‘stay-green’ qualities maintain greener stems and leaves during drought, extending stem strength, grain size and yield. Supplies of the crop are less sensitive to extreme weather events, helping food security in particularly sensitive regions.

Improvements in food security through scientific development are not only occurring in the wealthiest economies, but in developing countries too.

Scientists at Junagadh Agriculture University's (JAU) wheat research station successfully created a new variety of wheat that is heat tolerant and suitable for growing in saline soil conditions.

For local farmers the development greatly improves economic security, as well as that of food. No longer should farmers be subject to small variations in temperature resulting in swinging crop yields. Beyond the walls of laboratories, changes to how rice can be grown during periods of scare water supply have been found. Rather than conventional flooding, alternate wetting and drying irrigation can reduce water demand by a third. Furthermore, maintaining an aerobic environment in the soil methane emissions can be reduced fivefold.

Figure 33: Global area of GE crops (millions of hectares)



SOURCE: Clive James, 2015

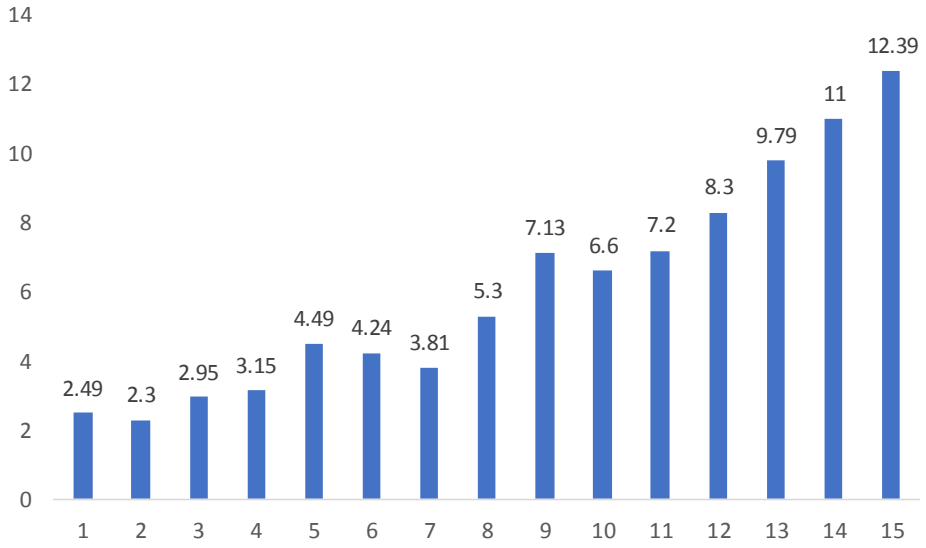
MARKETLINE

The burning question is can scientific developments entirely resolve problems brought on by climate change, or are scientists merely limiting the damage? At present nobody can reliably answer the question but doubts remain as to the veracity of claims genetically modified crops are the solution some claim them to be. Adverse conditions caused by climate change are bringing about concerted efforts to create solutions to maintain food supplies, ensuring economies dependent on agriculture can prosper. For companies with intellectual property in new crops the impact of climate change could become a major boon.

Pesticide use in response to climate change harms food security throughout the world

Rising global temperatures are forecasted to result in greater use of pesticides – indeed the trend has been observed for some time. Elevated levels of carbon dioxide in the atmosphere, resulting from human actions, has created an improved environment for many prevalent pests. New variants are expected to emerge in coming years, exacerbating the problem. Nematodes, harmful bacteria in the soil, will increase and result in greater infestations in banana crops. In response use of pesticides is likely to become more widespread, threatening ground water supplies and furthering the development of ‘dead-zones’ in the oceans and waterways when flushed into the oceans. Pollutants entering fresh water supplies pose a major environmental threat. Tainted water is frequently used as irrigation, potentially harming crop production. Reciprocal problems of this nature are not uncommon.

Figure 34: Brazilian pesticide market ($bn)



SOURCE: Agro News

MARKETLINE

Extensive use of pesticides in areas of soil sensitivity – such as deforested areas of the Amazon – exacerbates soil erosion problems through excessive use of land, resulting in declining agricultural production. The damage done to ecosystems in sensitive areas has lasting effects, particularly in regards to pollination. The World Wildlife Foundation reports during the past 150 years over half of the worlds' topsoil has been lost, initiating plummeting food security. Plunging bee populations do not help matters. Numbers have been in decline following habitat loss, heavy pesticide use, climate change and increasing urbanization. Pollination by insect in the United States, mostly by bees, has been valued at $3bn per year. More than 700 of the 4000 native bee species in North America are believed to be nearing extinction. Damage to pollination extends beyond bees. The United Nations reported animal pollination is directly responsible for between 5-8% of global agricultural production by volume which is valued up to $577bn.

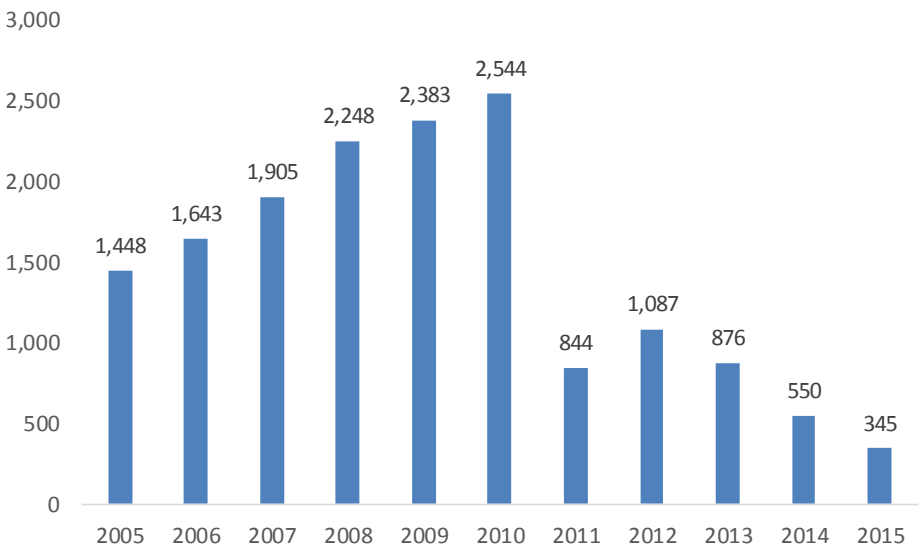
Growing food insecurity is damaging economies and creating political strife

Countries such as Bangladesh are dependent on income from agriculture but many people have tenuous food supplies. Food insecurity is a daily reality for almost 60m people living in urban and rural areas. Nutritional related conditions are commonplace: over 40% of children under the age of five are chronically undernourished and 36% have stunted growth. Dwindling rice supplies not only affect security of food supplies but have ramifications for the wider agricultural industry and the wealth of the people. Losses to agricultural production pose serious threats to many family incomes; climate change entrenches such problems beyond the current point. In the space of 45 years rice production in Bangladesh tripled, outpacing the growth in population. But concerns regarding future growth in the face of damage wrought by climate have emerged. Rice production may have plateaued but the population growth has not, placing pressure on food security. Higher frequency of monsoons and other storms is expected to cause havoc given the large proportion of Bangladesh living barely above sea level.

Agriculture in Africa is sensitive to the effects of climate change, potentially causing political and social mayhem

A common factor in sub-Saharan Africa is the high proportion of people working in agriculture, producing approximately a third of economic output. Changing weather patterns are already interfering in food production, initiating growth in poverty, migration and social instability. Indeed, across countries deemed to be at high-risk from the impacts of climate change, rice and other staple crop production could fall by half in the next 35 years. The threats to economic and political stability are only heightened by climate change impacting food security.

Figure 35: Libyan Agriculture, hunting, forestry, fishing value (LYDm)



SOURCE: OECD

MARKETLINE

Across North Africa social forces which ignited the Arab Spring can in part be attributed to food supply issues. In Russia, extreme drought resulted in wildfires, destroying a third of the wheat harvest. When Russia refused to export the rest of the harvest, a spike in prices on the international market occurred. High prices contributed to social unrest which left governments resisting popular uprisings. A few years previous to the Arab Spring Egypt had experienced food riots after prices soared. The situation was worsened by a quarter of the population of sub-Saharan Africa suffered from severe food insecurity during 2014/15. Politically even the more stable parts of North Africa remain exceptionally delicate and prone to sudden and damaging change – future threats to food security could wreak yet more damage to economies. Chad has experienced such volatility. From March 2016 to October the same year, the rate of food insecurity rose from 15% to 22% in part due to a collapse in livestock prices and problems resulting from displacement.

Desertification will get worse, harming food security, with the onset of climate change

Creeping desertification caused by over working of land and the effects of climate change resulted in 1.3m Kenyans facing starvation in late 2016. In November the government announced 5 million trees would be planted to prevent further expansion of the desert. As of 2010 nearly 11 million Kenyans lived in degraded agricultural areas. The United Nations predicts desertification to worsen; it claims by 2020 over 50m people will be forced to leave their homes by land degrading to desert. Each year over 12m hectares of land are lost to the advancing desert. Declining rainfall is a leading cause, as is over use of the land. Climate change is only going to worsen the plight of agriculture across high-risk areas (which includes almost all of sub-Saharan Africa), leading to lessening security of food supplies. Given the high reliance on agriculture for employment throughout Africa, the potential damage resulting from climate change could be catastrophic.

BUSINESS ACTION POINTS

- There is about to be a big shift away from diesel vehicles as the political culture targets them as polluters. This is a huge opportunity for alternative green fuels of all types to finally gain mass appeal especially in Europe where diesels are so prevalent.
- In developed regions heavy environmental restrictions push the choice of greener energy sources, however in developing nations cheap energy is critical to power domestic manufacturing industries and currently coal remains a strong choice despite the environmental damage that it causes. Consequently, coal will remain in demand for some time to come.
- The amount of plastic in the world's oceans is now at critical levels and legislation is being introduced all over the world to counter the problems it represents. Businesses and industries have been resistant to change so far, but this is at their peril as the change presents business opportunities for companies that area willing to adapt.
- Even conservative estimates suggest that sea level rises due to global warming is likely to swamp some of the wealthiest areas of the global economy and displace millions of people between the present day and 2100. The result is that businesses will need to consider these risks as many areas will not be salvageable.
- Food supplies are not secure enough and climate change is making some of the most important crops produce weaker yields. The only way to effectively manage this will be to use more temperature hardened crops or legislate for GM crops if temperatures continue to rise as they are.

APPENDIX

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MarketLine | John Carpenter House, John Carpenter Street |
London, United Kingdom, EC4Y 0AN
T: +44(0)203 377 3042, F: +44 (0) 870 134 4371
E: REACHUS@MARKETLINE.COM
WWW.MARKETLINE.COM