VALUING THE SDG PRIZE

UNLOCKING BUSINESS OPPORTUNITIES TO ACCELERATE SUSTAINABLE AND INCLUSIVE GROWTH

A paper from AlphaBeta commissioned by the Business and Sustainable Development Commission

January 2017

αlphaβeta

Business and Sustainable Development Commission
c/o Systemiq
1 Fore Street
London ECY 5EJ

info@businesscommission.org

www.businesscommission.org

AlphaBeta
1 Upper Circular Road #04-01
Singapore 058400

Level 7, 4 Martin Place
Sydney NSW 2000
Australia

singapore@alphabeta.com

www.alphabeta.com

FOREWORD

Launched in 2015, the Sustainable Development Goals (SDGs), or Global Goals, as they are commonly known, are 17 goals for ending poverty and hunger, reducing inequality and tackling urgent challenges such as climate change, by 2030. A year on, the focus now is on how to make meaningful progress on the ambitious targets outlined in this agenda.

The Business and Sustainable Development Commission (BSDC) was established in January 2016 to articulate and quantify a compelling business case for the private sector to help deliver the SDGs. The Commission's approach has been to start with the business perspective and ask a simple strategic question: what needs to be different in key sectors and value chains in order to achieve the SDG targets by 2030? We then identify the biggest, most attractive business opportunities that could emerge from the SDGs. Finally, we assess what it will take to unlock those opportunities, including actions from government, investors and businesses. Delivering the SDGs will require combining the best know-how from the public and private sectors, civil society and the investment community. Think of the Commission as creating a strategic roadmap of the fastest growing markets that would result from achieving the SDGs. We believe that the SDG agenda represents a huge opportunity for progressive businesses willing to drive transformative change in their sectors.

Valuing the SDG Prize quantifies the value of business opportunities across four key systems: food; cities; energy and materials; and health and well-being. The findings for these systems will be further elaborated in the Business Commission's flagship report, to be launched in January 2017. The report will quantify the private sector opportunity across the four key systems, identify new associated business models, and estimate the financing required to unlock the opportunities. The Business Commission would like to thank AlphaBeta for providing the analytical support for this project.

Many experts in academia, government and industry have offered invaluable guidance, suggestions and advice. Our particular thanks to Paul Polman, Jeff Seabright, Rianne Buter, Alison Cairns and Ella Mayhew (Unilever); James Gomme, Carina Larsfalten, Fokko Wientjes and Karolina Södergren (World Business Council for Sustainable Development); Janez Potocnik (International Resource Panel and SystemiQ); Daniela Saltzman (Generation Investment Management); Marco Albani (Tropical Forest Alliance 2020); Jessica Alsford (Morgan Stanley); Nakul Saran (Fish Forever); Marc Zornes (Winnow); Jason Eis (Vivid Economics); Elizabeth Stuart (Overseas Development Institute); Ammad Bahalim, Caitlin Smethurst and Miguel Veiga Pestana (Bill and Melinda Gates Foundation); Juliano Assuncao (Climate Policy Initiative); Nick Godfrey (New Climate Economy); Justin Adams (The Nature Conservancy); Mads Nipper (Grundfos); Elisa Moscolin and Samson Kanai (Safaricom); Nedaa Abdulaziz Al-Mubarak (Al Dabbagh Group); Tove Stuhr Sjoblom and Martin Stuchtey (SystemiQ); Jessica Long and Philipp Buddemeier (Accenture); Celine Herweijer, Louise Scott, Gary Sharkey, Daniel Dowling, Jonathan Grant, Jim Stephenson and Laura Plant (PwC); Raimund Bleischwitz (UCL Institute for Sustainable Resources); Geoff Clarke and

Pavel Kabat (International Institute for Applied Systems Analysis); John Elkington (Volans); Peter Head (Ecosequestration Trust); Guido Schmidt-Traub (Sustainable Development Solutions Network); Murray Birt (Deutsche Bank); Homi Kharas (Brookings Institution); Roland Pfeuti (RobecoSAM); Gert Wrigge (Asia Climate Partners); James Campbell and Tana Wuliji (World Health Organization); Chris Masila (Private Sector Innovation Programme for Health); Chad Oliver and Alan Organschi (Yale University); and Nicolas Dennis and Morten Rosse (McKinsey & Company).

We are grateful for all their input. The final report is ours, and any errors are our own.

CONTENTS

OVERVIEW

Key messages

- Business opportunities in the implementation of the SDGs in four systems – food and agriculture; cities; energy and materials; and health and well-being – could be worth more than US$12 trillion annually for the private sector in 2030 (representing 10 percent of forecasted global output in that year). The investment required to achieve these opportunities is around US$4 trillion per year.
- We have identified 60 opportunities that could generate almost 380 million jobs. This represents more than 10 percent of the forecasted labour force in 2030.
- Over 55 percent of the value of the opportunities, and almost 90 percent of the potential jobs would be generated in developing countries. That includes 85 million jobs in Africa and 220 million jobs in developing Asia.
- Action on the SDG agenda by the private sector can help mitigate global burdens – such as violence and armed conflict, obesity, congestion and climate change – which have cumulative economic impacts equal to one-third of global gross domestic product (GDP) today.
- Improvements in other SDG areas, such as gender equality and education, could deliver significant additional economic benefits.

The world faces major environmental, social, economic and governance challenges that the SDGs can help address

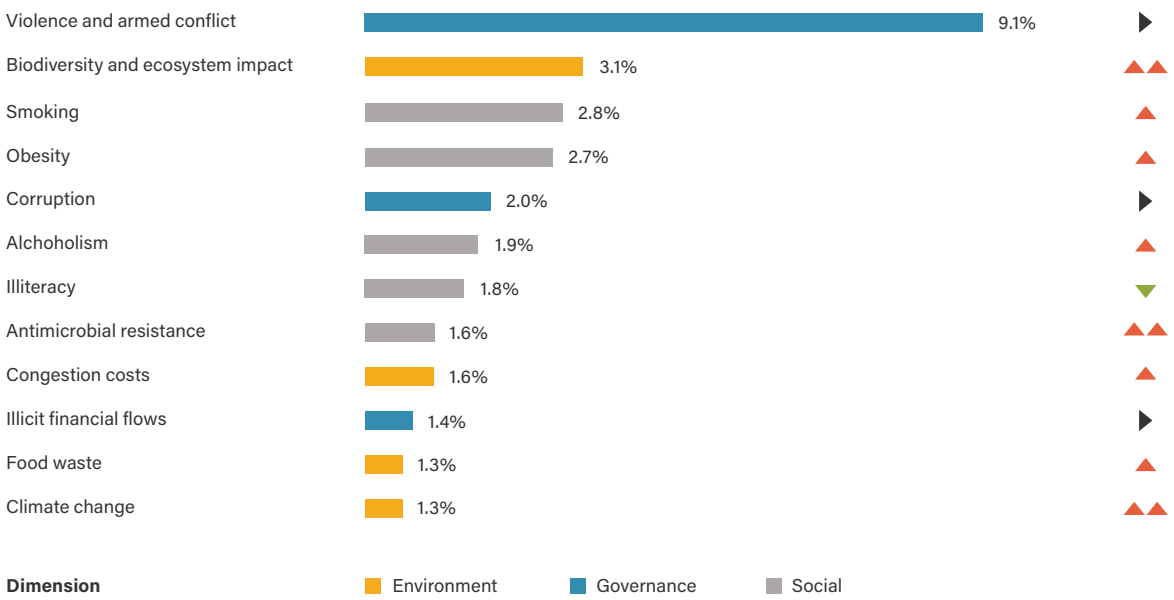
The past 50 years have marked a period of historically unprecedented economic expansion. Average per-capita income almost tripled and the global economy expanded sixfold in GDP terms. However, these headline economic successes have masked major fault lines in our model of economic development. Many of the past drivers of growth are no longer sustainable, and a swelling list of global burdens threaten future stability and shared prosperity. On the environmental front, the world has already 'overshot' four of nine planetary boundaries through human activity: climate change, loss of biosphere integrity, land-system change and altered biogeochemical cycles. On the social front, there remain significant gaps in access to basic services such as healthcare, clean water and sanitation. In middle-income countries, the growing burden of non-communicable diseases (NCDs) is replacing gains made in the treatment of communicable diseases. Tobacco now kills around 6 million people annually, and the global prevalence of obesity doubled between 1980 and 2014. Education systems are failing to deliver access to high-quality education to match the demands of the workforce. Without urgent action, the prospects of more than 124 million children and youth denied access to schools and more than 250 million not learning the necessary skills are severely diminished. Income inequality in OECD countries is at its highest level for 30 years, and Oxfam estimates that 62 people have the same wealth as half the world's population. On the economic front, many of these burdens are beginning to place important constraints on the world's future growth prospects (Exhibit E1).

Exhibit E1

Our current model of economic development has left a legacy of global business

Estimated annual global direct economic impact associated with selected global burdens

Share of global GDP, 2014



Source: Literature review; WHO Global Burden of Disease database; McKinsey Global Institute; AlphaBeta analysis.

* Assumes a "business-as-usual" approach where no concerted action is taken to address these global burdens.

For example, the cost of biodiversity and ecosystem damage could reach 18 percent of global economic output by 2050, up from US$2 trillion in 2008 (around 3.1 percent of global GDP). Finally, there are growing governance and security-related concerns. In 2014, the world spent 9.1 percent of its GDP on costs associated with violence. According to the International Monetary Fund, the cost of bribery is roughly 2 percent of global GDP, and illicit flows from developing countries are over US$1 trillion.

The 17 SDGs offer opportunities for tackling these challenges. They address issues ranging from health and well-being to innovation. If they are realised, there is the potential for higher-quality growth, with stronger environmental, social and governance underpinnings.

The SDGs are all interconnected, which reinforces the need for coordinated action on all SDGs. The largest links are between environmental and economic SDGs. Effective action on climate change, for example, will be critical to ensuring strong economic growth and ending poverty. Education is also a critical enabler for many other SDGs, including economic growth; health and well-being; and peace, justice and institutions.

Analysis of press searches and surveys of businesses reveals that most attention is focused on a subset of the goals. In fact, just five SDGs account for almost half of the press citations. Given the holistic structure of the goals, this narrow focus could undermine efforts for their successful implementation.

The private sector will be crucial to delivering the SDGs, and it stands to benefit from a potential US$12 trillion worth of business opportunities, which could create almost 380 million jobs by 2030

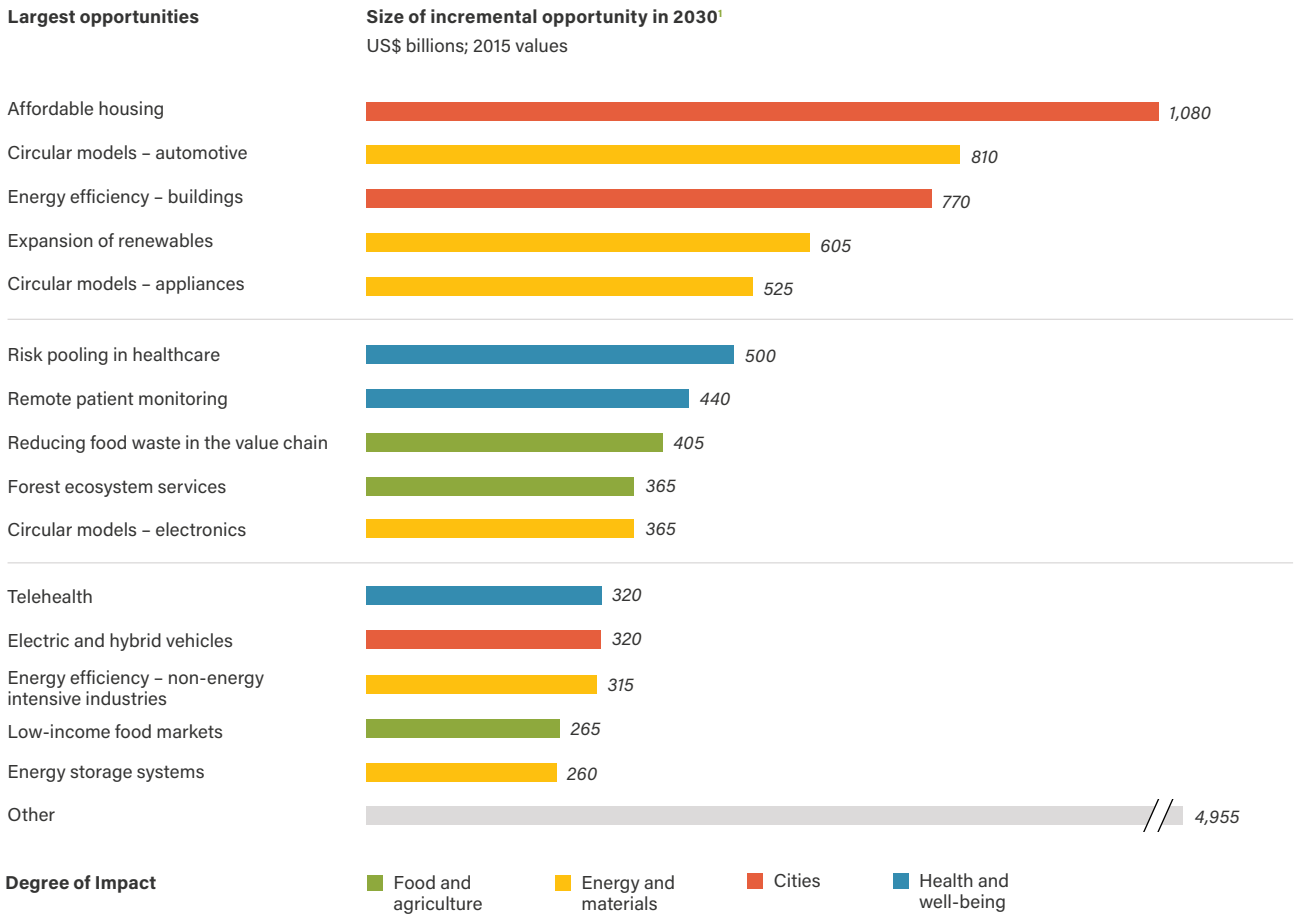
The public sector will play a critical part in creating the enabling environment for the implementation of the SDGs, but businesses will be required to do much of the 'heavy lifting'. In fact, in the four industry systems that we explore (food and agriculture; cities; energy and materials; and health and well-being), businesses can play a key role in delivering over half of the 169 SDG targets.

The participation of the private sector in the implementation of the SDGs can also lead to the development of specific business opportunities. Across the four industry systems, we find 60 opportunities that could be worth collectively more than US$12 trillion annually by 2030. While this is based on revenue and savings rather than value added, it represents around 10 percent of forecast global GDP in 2030. The 15 largest opportunities account for over half of this prize (Exhibit E2). These are: (1) affordable housing, (2) circular models in automotive, (3) improving energy efficiency in buildings, (4) the expansion of renewables, (5) circular models in appliances, (6) risk pooling in healthcare, (7) remote patient monitoring, (8) reducing food waste in the value chain, (9) forest ecosystem services, (10) circular models in electronics, (11) telehealth, (12) electric and hybrid vehicles, (13) improving energy efficiency in non–energy intensive industries, (14) low-income food markets, and (15) energy storage systems.

The geographic distribution of these SDG business opportunities depends on the industry system. In the case of cities, improving the efficiency of buildings is one opportunity where developed and developing economies each have significant potential, but the affordable housing opportunity is most critical in the developing world. The value of opportunities involving energy and materials is distributed quite evenly – while extractive opportunities are primarily in the developing world, circular economy models[1] in durable goods are likely to emerge faster in developed markets. In the case of food and agriculture, there are substantial opportunities in Africa, Latin America and India, which reflects their large share of cropland and tropical forests and the current low levels of productivity. Health and well-being opportunities are concentrated in developing countries, where access is currently low, and also in the United States (US) and Canada, where healthcare costs are highest. Overall, more than half of the value of the opportunities in each industry system will be generated in developing countries.

Exhibit E2

Delivering the SDGs could generate over US$12 trillion worth of business opportunities



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US$5 billion.

The identified SDG-related business opportunities could also create almost 380 million jobs by 2030 (Exhibit E3), which is more than 10 percent of the forecasted labour force in 2030. Given substitution effects, not all of these jobs will translate to net increases in employment. However, almost 50 percent of the jobs are in new infrastructure development and related areas where the net job creation is likely to be high. Almost one-fifth of the total employment potential – around 70 million jobs – comes from just one opportunity: affordable housing. Given annual investment of over US$1 trillion, we estimate this opportunity alone could create 20 million jobs in China, 14 million jobs across Africa and 8 million jobs in India. The job creation potential of the SDG business opportunities is primarily located in the developing world. We estimate almost 90 percent of jobs will be created in developing countries, including 23 percent in Africa and 59 percent in developing Asia. This is because the need for capital investment is much

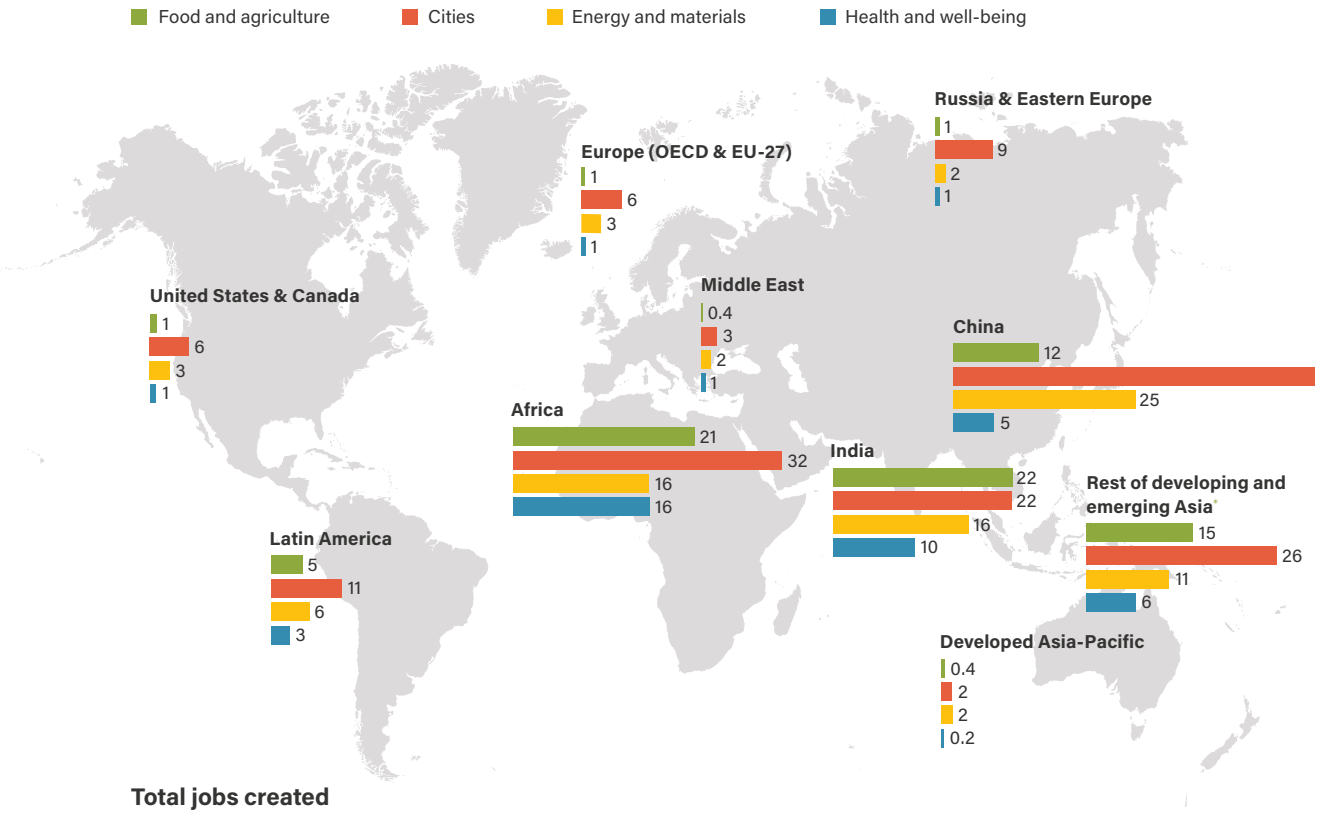
greater in low- and middle-income countries, especially in affordable housing and other critical infrastructure. It is also because the job creation impact of investment is larger given the higher labour intensity of developing economies.

Exhibit E3

Almost 380 million jobs could be created by Global Goals business opportunities in the four systems

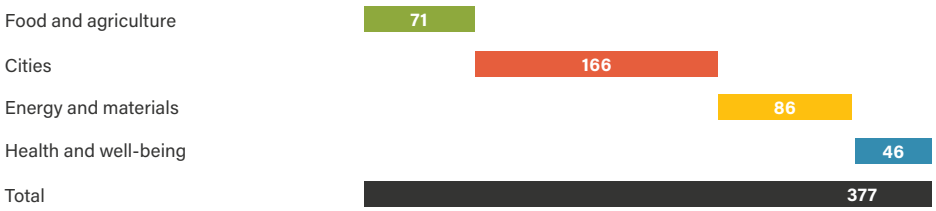
Total jobs created by SDG business opportunities by region and system

Millions



Total jobs created

Millions



Source: Literature search, AlphaBeta analysis

* Rest of developing Asia includes Central Asia (e.g., Uzbekistan), South Asia (e.g., Bangladesh), Southeast Asia (e.g., Laos), and North Korea.

Note: Numbers may not sum due to rounding

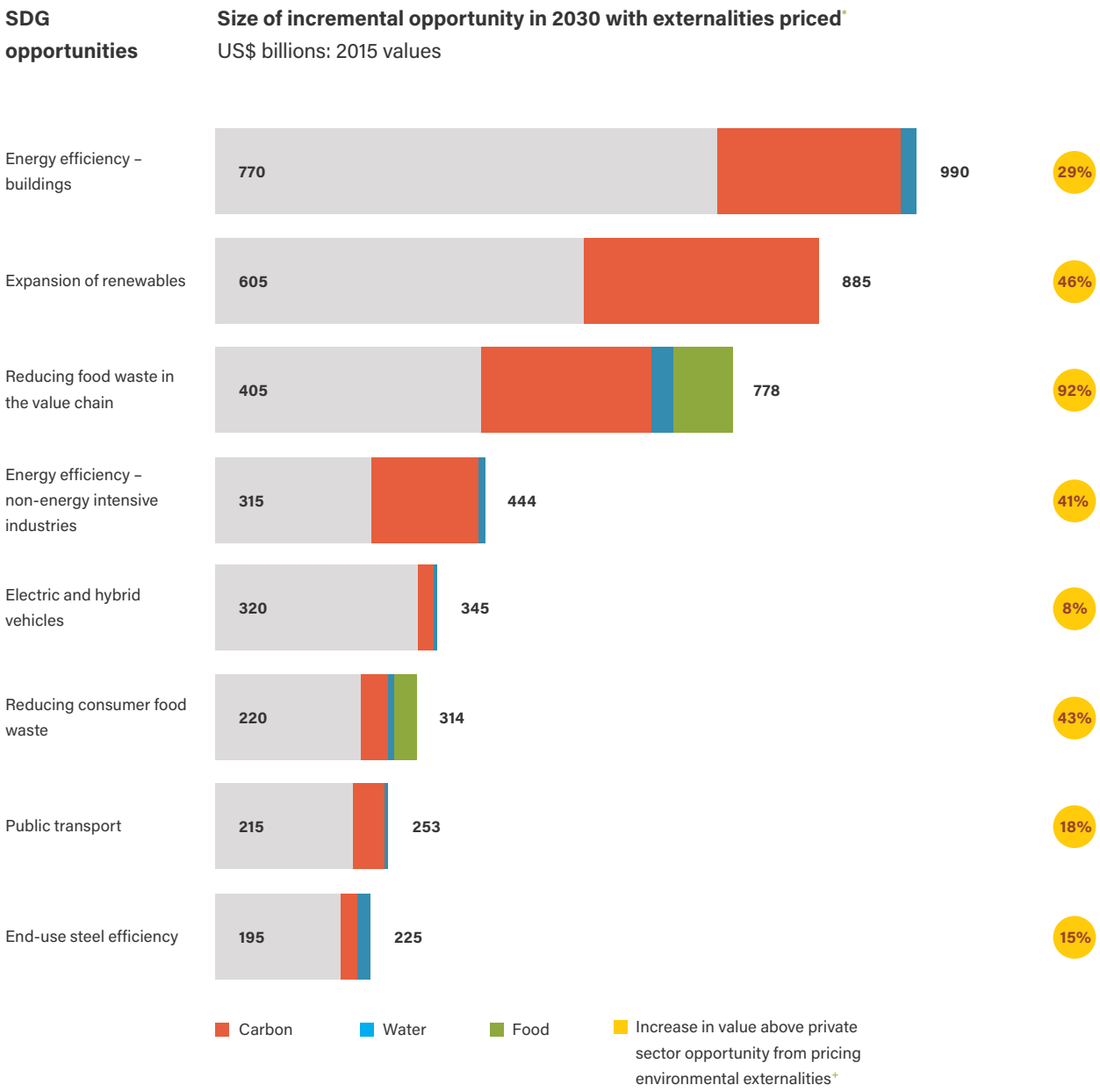
Pricing of externalities could increase the value of opportunities

Our sizing of opportunities is based on current prices. However, these largely do not reflect the cost of a range of externalities, in particular greenhouse gas (GHG) emissions, and they include various subsidised and unpriced resources, including water, fossil fuels and food. The value of these resource subsidies globally is estimated to be over US$1 trillion annually. To understand the impact of removing subsidies and properly pricing resources, we repriced a subset of our top opportunities for three factors for which reliable data is available: carbon, water and food. This increases the overall value of opportunities by almost 40 percent (Exhibit E4). The effects are most profound in the food and agriculture system, where pricing of externalities adds more than 70 percent to the combined value of opportunities to reduce food waste.

Environmental externalities and resource subsidies are increasingly recognised as a challenge to sustainable development, and SDG 12 explicitly calls for the rationalisation of "inefficient fossil-fuel subsidies that encourage wasteful consumption". Health and social externalities typically receive less attention, in part because they are more challenging to accurately evaluate. However, we find that they could have a large potential impact on the value of half of the top 15 opportunities. Our largest opportunity, affordable housing, has significant positive externalities for health and other social factors, including poverty and inequality. In one study in the US, researchers found that housing upgrades can reduce the incidence of common health problems in children by up to 20 percent.

Exhibit E4

Pricing externalities into top market opportunities adds almost 40% to their value



Source: Literature search; Alphabeta analysis

* Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here.

+ Externality sizing assumptions carbon price of US$50 tCO_2e; average water price increased by US$0.08 for agricultural water and US$0.40 for industrial use (based on removal subsidies); food prices increased by US$44/t due to removal of subsidies.

Across four industry systems, the shift to a sustainable development pathway could have a major impact on competitive dynamics

A range of business opportunities associated with the SDGs have been identified across the four industry systems of food and agriculture; cities; energy and materials; and health and well-being (Exhibit E5).

Exhibit E5

We identified 60 SDG-related business opportunities in the four systems

	Food and agriculture	Cities	Energy and materials	Health and well-being
1	Reducing food waste in value chain	Affordable housing	Circular models - automotive	Risk pooling
2	Forest ecosystem services	Energy efficiency - buildings	Expansion of renewables	Remote patient monitoring
3	Low-income food markets	Electric and hybrid vehicles	Circular models - appliances	Telehealth
4	Reducing consumer food waste	Public transport in urban areas	Circular models - electronics	Advanced genomics
5	Product reformulation	Car sharing	Energy efficiency - non-energy intensive industries	Activity services
6	Technology in large-scale farms	Road safety equipment	Energy storage systems	Detection of counterfeit drugs
7	Dietary switch	Autonomous vehicles	Resource recovery	Tobacco control
8	Sustainable aquaculture	Internal combustion engine vehicle fuel efficiency	End-use steel efficiency	Weight management programs
9	Technology in smallholder farms	Building resilient cities	Energy efficiency - energy intensive industries	Better disease management
10	Micro-irrigation	Municipal water leakage	Carbon capture and storage	Electronic medical records
11	Restoring degraded land	Cultural tourism	Energy access	Better maternal and child health
12	Reducing packaging waste	Smart metering	Green chemicals	Healthcare training
13	Cattle intensification	Water and sanitation infrastructure	Additive manufacturing	Low-cost surgery
14	Urban agriculture	Office sharing	Local content in extractives	
15		Timber buildings	Shared infrastructure	
16		Durable and modular buildings	Mine rehabilitation	
17			Grid interconnection	

Food and agriculture

The food and agriculture system faces a number of challenges between now and 2030 related to innovation, demand, supply and regulation. A step change in innovation is needed to meet future demand, given that growth rates in agricultural yields have been declining and are currently below world population growth, and with crop yields approaching theoretical maximums in developed countries. In terms of demand, over 800 million people are hungry, and over 2 billion suffer from micronutrient deficiencies. From a supply perspective, to meet 2030 food, feed and fuel demand would require 175 million to 220 million hectares of additional cropland. However, over half of remaining land is subject to infrastructure or political risks. Four of the nine planetary boundaries that have been exceeded relate to the food and agriculture system (climate change, loss of biosphere integrity, land system change and altered biochemical cycles). Water constraints will also be significant for agricultural production, given roughly 70 percent of global water demand is related to agriculture. At least 20 percent of the world's aquifers are overexploited, including in important production areas such as the Upper Ganges (India) and California (US). From a business perspective, financial returns in the agricultural sector are already low (5 percent). If negative externalities are considered, they become negative (-10 percent). From a regulatory perspective, there is increasing pressure to deal with the obesity impact (which has a social cost of US$2 trillion currently and is rising rapidly) and pricing of natural resource inputs (such as water and energy). Achieving the SDGs could create new growth models that address these challenges. The 14 largest opportunities in 2030 could be worth more than US$2.3 trillion in current prices. They relate to food waste in the value chain, forest ecosystem services, smallholder farm technology, dietary switch and sustainable aquaculture.

Cities

Over the next two decades, nearly all the world's net population growth is expected to occur in urban areas, with about 1.4 million people – close to the population of Stockholm – added each week. Urbanisation is a crucial driver of economic growth. In fact, no country has ever climbed from low-income to middle-income status without a significant population shift into cities. However, this urbanisation also poses a series of challenges to inclusiveness, the environment, economic efficiency, health and cultural heritage. By 2025, one-third of the urban population (or 440 million urban households) could lack access to affordable housing, undermining the inclusiveness of cities. The phenomenal growth of cities could also pose significant environmental challenges – urbanisation could consume an estimated two million hectares of land per year, with about three-quarters of that being agricultural land. The economic efficiency of cities is threatened by urban sprawl, which can double the land per housing unit, increase the costs of providing utilities and public services by 10–30 percent and increase motor travel and associated costs by 20–50 percent. Cities also create challenges for health. Urban air pollution is projected to become the top environmental cause of premature mortality by 2050. Access to clean water and sanitation remains challenging in the fast-growing cities of the developing world, with almost 20 percent of urban dwellers still lacking improved sanitation facilities. Finally, rapid urbanisation can risk the destruction of cultural heritage in cities unless the process is carefully managed. The SDGs could help create new growth models that address these challenges. The 16 largest opportunities could be worth more than US$3.7 trillion (measured

in current prices) in 2030. They include urban mobility solutions, deploying circular economy models (such as the sharing economy, and durable and modular buildings), and improving energy efficiency in buildings.

Energy and materials

The energy and materials system faces significant challenges. Resource demand growth could decelerate due to demographics and China's rebalancing from investment-led growth to a consumption-driven growth model. However, 1.5 billion people are also expected to join the consuming class by 2030. At the same time, great inequities persists – 1.2 billion people still have no access to electricity, for example. In terms of supply, the system faces challenges due to supply moving to more challenging locations. Historically, almost 90 percent of resource investment has been in high-income and upper-middle-income countries. But in the future, the share of resource investment outside these two groups could almost double. And many of these new locations have higher political risk, more environmental management challenges and infrastructure shortages. For example, almost half of new copper projects are in countries that pose high levels of political risk. In addition, water access could significantly constrain output, given that 32 percent of copper mines and 39 percent of iron ore mines are in areas of moderate to high water scarcity. Finally, greater technical complexity of projects has increased costs. For example, the average cost to bring a new oil well online has doubled over the last decade. Continued uncertainty over climate regulation creates further uncertainty in the sector, with over US$300 billion of assets potentially affected. The SDGs could create new growth models that address these challenges. The 17 largest opportunities in 2030 could be worth more than US$4.3 trillion in current prices. They include deploying circular economy models in automotive, appliances and electronics; increasing penetration of renewables in power generation; and improving end-use steel efficiency.

Health and well-being

While the health and well-being system could see large potential for growth from an ageing population, there are nonetheless a series of challenges to 2030. First is the innovation challenge: the efficacy of drugs – especially antibiotics – to treat many major communicable diseases is declining as pathogens have developed resistance to new drugs. The economic cost associated with this could be enormous, potentially reducing global GDP by 2–3.5 percent by 2050, the equivalent of up to US$100 trillion cumulatively. Of particular concern is that the pipeline of potential new antibiotics at various stages of clinical trials numbers only around 40. Second, demographic shifts will change what is asked of our healthcare system. Just as the number of people aged over 60 will increase 56 percent globally to 2030, the 'youth bulge' in developing countries will increase demand for maternal and child healthcare. There is also a shift in need by stage of economic development. About two-thirds of child mortality and deaths related to AIDS and tuberculosis (TB) now occur in middle-income rather than low-income countries. Achieving convergence therefore demands action that goes beyond low-income countries to also focus on poor, rural sub-populations of middle-income countries. At the same time, the burden of NCDs continues to increase. For example, the prevalence of obesity has doubled since 1980, with no recorded decrease in any region, increasing the burden of diabetes

and heart disease. Third, basic medical services and supplies are missing in developing countries. For example, among the poorest countries in Asia and Africa, basic antibiotics are unavailable in 40–60 percent of health facilities, and basic medication to treat NCDs is unavailable in up to 80 percent of facilities. There are also looming skill gaps in the medical profession, particularly in aged care. The World Health Organization estimates a shortfall of around 14 million skilled healthcare workers in developing countries by 2030. The SDGs could create new growth models that address these challenges. The 13 largest opportunities in 2030 could be worth US$1.8 trillion in current prices, and include risk pooling, telehealth, remote patient monitoring, low-cost surgery models and tackling counterfeit drugs.

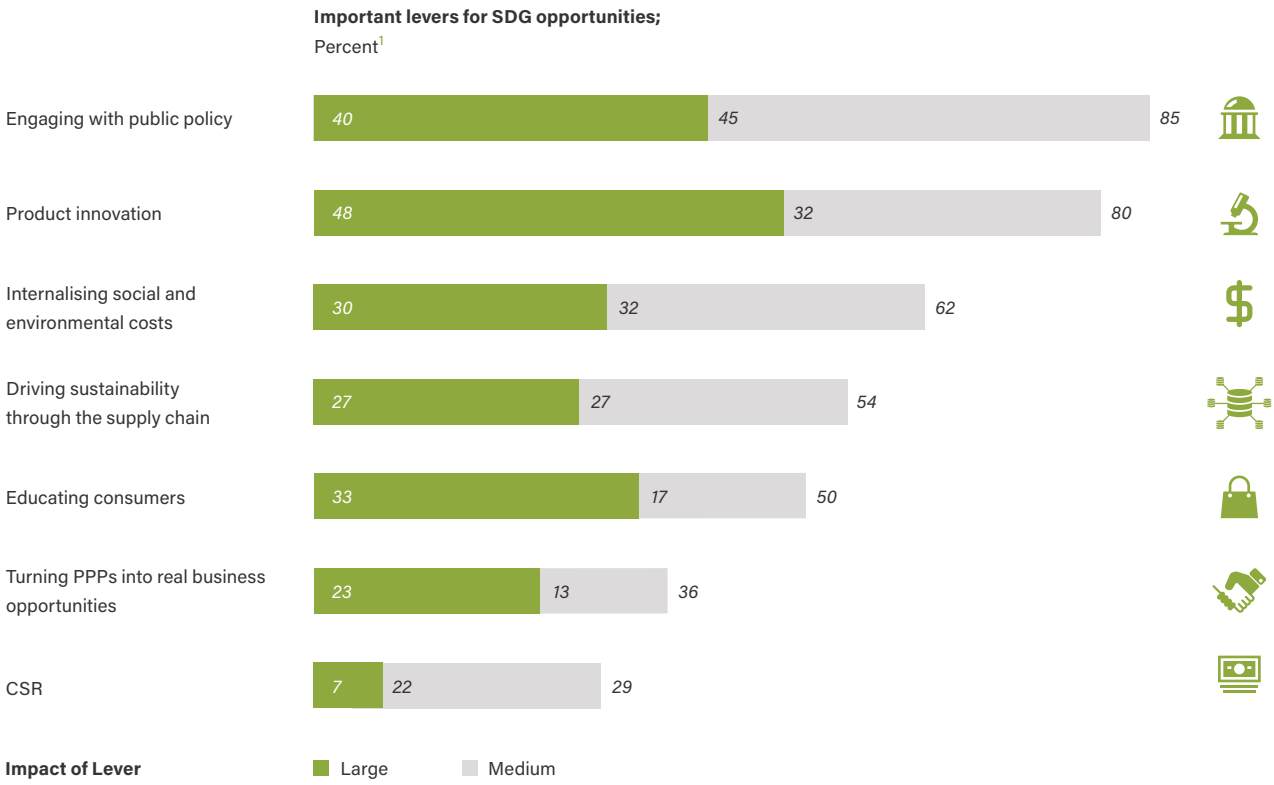
Achieving the SDGs will require significant investment and a new approach from businesses

Substantial investment will be needed to capture the SDG opportunities. We estimate that the total annual investment required for all 60 opportunities across the four systems is around US$4 trillion. By far the largest capital requirements are in cities – in particular, expanding the supply of affordable housing, which would demand up to US$1.1 trillion each year to 2030. Expansion of renewable energy is also highly capital intensive, with estimated incremental investments of over US$300 billion annually. Though these investment costs are large, more than US$20 trillion in sustainable investment assets are under management globally already, and the size of this asset pool is growing fast. It already accounts for 30 percent of total global assets under management, up from 21 percent in 2012. We expect that while the global supply of capital will be adequate to achieve these business opportunities, it will be challenging to ensure the investment reaches the regions where it is most needed, especially in the developing world.

Beyond capital investment, there will need to be additional radical departures from current approaches. The largest required shifts are in engaging with public policy and product innovation (Exhibit E6).

Exhibit E6

Engaging public policy and product innovation are the most important levers for business



Source: AlphaBeta analysis

[1] Refers to the percentage of SDG-related business opportunities identified in cities where this lever could have either a medium or large impact on the likelihood of successful implementation of the opportunity.

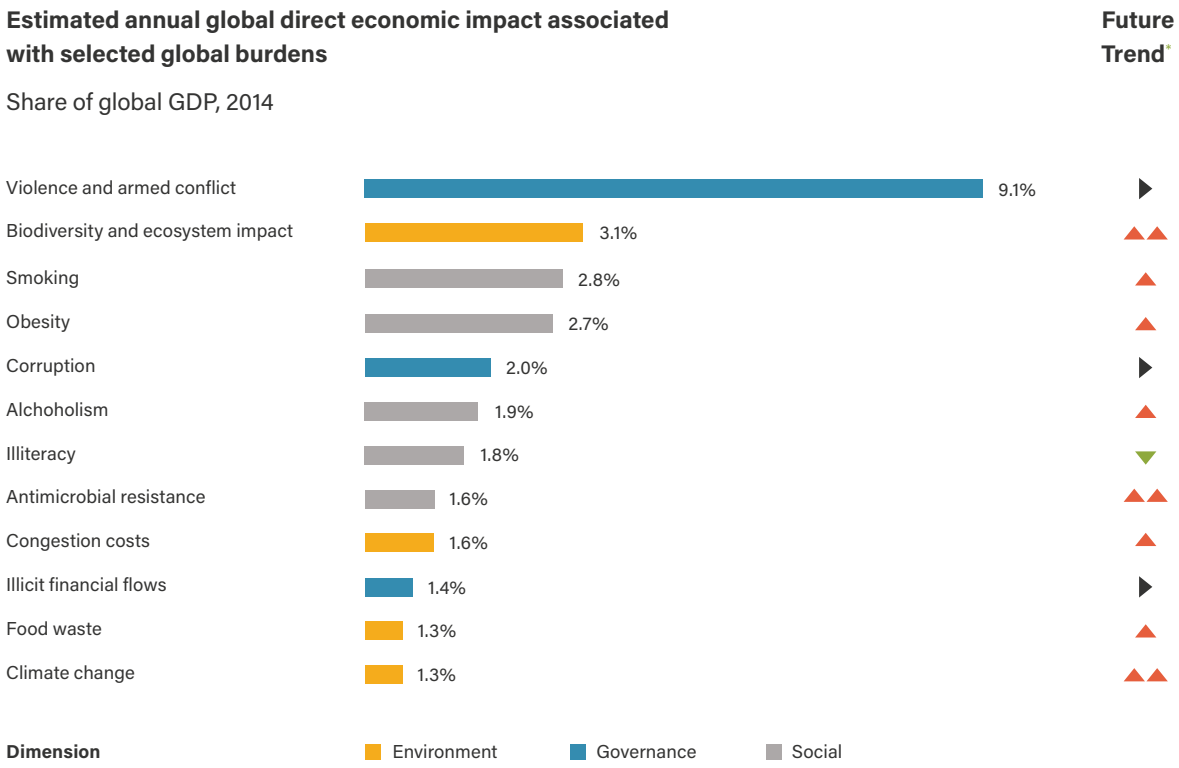
1. UNDERSTANDING THE POTENTIAL IMPACT OF THE SDGS

The current model of economic development is broken

The past 50 years marked a period of historically unprecedented economic expansion. Average per capita income almost tripled, and the global economy expanded sixfold in GDP terms. However, these headline economic successes have masked major fault lines in our model of economic development. Many of the past drivers of growth are no longer sustainable, and a swelling list of global burdens threaten future stability and shared prosperity (Exhibit 1, see Appendix A for methodology).

Exhibit E1

Our current model of economic development has left a legacy of global business



Source: Literature review; WHO Global Burden of Disease database; McKinsey Global Institute; AlphaBeta analysis.

* Assumes a "business-as-usual" approach where no concerted action is taken to address these global burdens.

Across the environmental, social, economic and governance dimensions, we face serious challenges:

- **Environmental.** Our current model of economic development has created enormous environmental stresses. The world has already overshot four of nine planetary boundaries as a result of human activity (climate change, loss of biosphere integrity, land-system change and altered biogeochemical cycles).[2] As a consequence, loss of biodiversity has dramatically increased, with scientists now identifying this as a period of mass extinction.[3] Around one-quarter of the world's land area is degraded and over 5 million hectares of forests are lost annually.[4] Based on a study by the United Nations Environment Programme (UNEP), the cost of biodiversity and ecosystem damage could reach 18 percent of global economic output by 2050, up from US$2 trillion in 2008 (around 3.1 percent of global GDP).[5] The impacts of climate change, in particular, are likely to be persistent and profound, including reduced food security and increased risk of natural disasters. Environmental problems also have increasingly serious impacts on human health – every year, 5 million people die prematurely as a result of air pollution, and climate change may already be responsible for 400,000 deaths annually.[6]

- **Social.** While many aspects of health have improved over the last few decades, significant inequities in access to healthcare persist. The maternal mortality rate in developing countries remains almost 15 times higher than in the developed world.[7] The costs of healthcare can be crippling – 150 million people annually are faced with catastrophic medical expenses.[8] Access to clean water and sanitation remains inadequate, with around 2.4 billion people worldwide still lacking improved sanitation facilities.[9] In middle-income countries, the growing burden of non-communicable diseases (NCDs) is replacing gains made in the treatment of communicable diseases. Tobacco now kills around 6 million people annually, and the global prevalence of obesity doubled between 1980 and 2014.[10] Combined, the current economic impact of the major NCDs is almost 10 percent of global GDP. Antimicrobial resistance has been estimated to already cost up to 1.6 percent of GDP, and to be responsible for 700,000 deaths annually.[11] Rates of hunger have reduced since 1990, but an estimated one in four children globally are still affected by stunting from malnutrition.[12] Education systems are failing to deliver access to high-quality education to match the demands of the workforce. Without urgent action, the prospects for more than 263 million children and young people out of school and a further 274 million not learning the basic primary-level skills are severely diminished. By 2030, 435 million children will lack education in basic skills.[13]

- **Economic.** Most of the benefits of past growth have been highly concentrated. In most OECD countries, the gap between rich and poor is at its highest level for 30 years.[14] The rise in inequality has been even more pronounced in the developing world, with an 11 percent increase over the two decades to 2010.[15] Oxfam estimates that 62 people have the same wealth as half the world's population.[16] This has consequences for equity and social cohesion, as well as growth, with increasing evidence that a greater income gap to the bottom 40 percent of the population weakens economic growth.[17] It also undermines efforts to reduce poverty and extreme poverty. Low growth since the economic crisis has led to persistent unemployment, with almost 200 million worldwide without jobs. This figure is projected to rise in coming years.[18]

- **Governance.** There are growing governance and security-related concerns. In 2014, the world spent 9.1 percent of its GDP on costs associated with violence.[19] According to a World Bank study, in many developing countries the losses associated with corruption may exceed 100 percent of current GDP. Globally, the World Bank estimates the cost of bribes to be 3 percent of GDP. Based on the Global Financial Integrity report, "illicit flows from developing countries" in 2013 were US$1.09 trillion.[20]

The impact of the SDGs could be transformative

Many commentators have (incorrectly) perceived the SDGs to be divorced from these important global challenges, or even worse, to represent an additional headwind to growth and development. The reality is that the SDGs offer a new (and higher-quality) model for economic growth. It is a new global development contract based on needed systemic change. It emerges from a mutual understanding that the economic, social and environmental systems are currently not sustainable.

Given the high degree of interlinkages between the SDGs, it is useful to group them based on similarities in the focus of desired outcomes. The SDGs are holistic by design, with each incorporating diverse targets addressing a range of outcomes, so any simple categorisation is inevitably imperfect. However, it does help to highlight the different dimensions on which the SDGs operate. The approach we have adopted groups the 17 SDGs into four clusters (Exhibit 2).

Exhibit 2

The SDGs have been divided into four clusters based on similar end outcome focus

It is difficult to precisely estimate the impact on the world of a shift to a SDG-compatible pathway, due to challenges in understanding the counterfactual scenario, complex feedback loops, interlinkages between SDGs and data issues. However, our initial analysis of the literature related to each of the SDGs suggests the benefits would be transformative.

- **Environmental.** The SDGs include goals related to the environment, spanning land, water, air, minerals, cities, energy and carbon. There are significant benefits in implementing these goals, in addition to them being the foundation for successfully achieving many of the other SDG goals. The target of halving food waste, for example, could reduce carbon emissions by 1.65 $GtCO_2e$ annually, realise savings of about US$500 billion each year and moderate global food demand growth.[21] The shift to circular models for a range of durable and fast-moving consumer goods could generate an opportunity of over US$3 trillion by 2030.[22] The International Energy Agency (IEA) estimates that additional energy-efficiency measures could reduce global final energy consumption by almost 11 percent in 2030. Based on weighted average energy prices, this equates to an impact of US$1.45 trillion.[23] The International Renewable Energy Agency (IRENA) estimates that renewables could reach 45 percent of total global power generation by 2030 – which equates to US$605 billion per year more in revenue for renewables generators compared to a business-as-usual scenario.[24] This major shift would reduce emissions by 4.8–5.6 $GtCO_2e$ annually. For the cost of adapting to climate change, the UNEP estimates that investments of US$140–300 billion annually will be required by 2030 to adapt to a world temperature that is 2 degrees Celsius warmer than pre-industrial levels.[25] Replacing today's inadequate housing and building the additional units needed by 2025 would provide affordable housing for up to 440 million households, and generate US$8.4–10.3 trillion in construction spending alone.[26]

- **Social.** The SDGs within the social cluster span food, health, education, gender quality, and water and sanitation access, and have the potential to transform social conditions worldwide. For example, the SDGs aim to reduce mortality from NCDs by one-third, which would avoid around 13 million deaths annually.[27] Universal provision of basic education would ensure an additional 59 million children of primary school age and 65 million young adolescents are in school.[28] There are also opportunities to improve productivity. The largest of these estimated impacts is related to gender equality. McKinsey Global Institute estimates that in the 'full-potential' scenario in which women participate in the economy identically to men, this could create incremental annual GDP impact of US$28 trillion in 2025 compared with a business-as-usual scenario.[29] The Economist estimates that promoting rural development (including a focus on infrastructure, land rights and policy) has the potential to unlock US$2 trillion of annual economic output in 2030, providing stable employment for billions of people living in rural areas.[30] Some areas such as education will have tremendous importance for long-term growth, but may have more limited impact to 2030. For example, the OECD estimates an aggregate GDP gain of US$115 trillion over the lifetime of the generation born in 2010 if all OECD member countries boost their average Programme for International Student Assessment education scores by 25 points over the next 20 years. That's less than what Poland achieved in just six years as the most rapidly improving education system in the OECD.[31] By 2030, the impact would still be substantial, but a significantly lower number of around 1.5 percent of 2030 GDP.

- **Economic.** The economic cluster covers SDGs related to decent work, infrastructure, innovation, inequality and poverty. The emphasis in this cluster is on improving productivity, employment and growth, and investment in infrastructure and technology. Sustaining stronger GDP growth of 7 percent per annum in the least developed countries could yield an incremental economic impact of US$277 billion by 2030. There are estimates that in the G19 and Nigeria, annual productivity growth could be boosted by as much as 2 percent.[32] By 2030, we estimate this could deliver an additional economic impact of up to US$25 trillion. An report by the McKinsey Global Institute (MGI) on infrastructure productivity finds that historically, infrastructure investment has grown at US$2 trillion per annum.[33] In comparison, MGI estimates that keeping pace with projected global GDP growth will require an estimated US$55 trillion in infrastructure investment between 2015 and 2030, which equates to incremental spend above historical rates of US$1.7 trillion per year. Implementation of the economic cluster would also transform the conditions of work for millions of people worldwide. SDG 8 aims to eradicate forced labour and modern slavery and end child labour in all forms by 2025. The Global Slavery Index estimates that over 45 million people are enslaved today, while around 168 million children are engaged in child labour, and more than half in hazardous work.[34]

- **Governance.** The governance cluster of the SDGs is difficult to isolate in terms of impact given that, like the environmental cluster, it underpins the achievement of many of the other SDGs. Reducing illicit flows from developing countries could equate to US$1.7 trillion in 2030 based on forecasted global GDP growth.[35] There are also significant growth opportunities within the governance cluster. If the ratio of official development assistance (ODA) to gross national income (GNI) were to grow to 0.9 percent in developed countries by 2030, versus growing at its historical rate, there could be around US$113 billion additional funds by 2030. The target to double the least developed countries' share of global exports by 2020 could represent US$326 billion of incremental trade by 2030.

The SDGs are interconnected so a coordinated approach is crucial

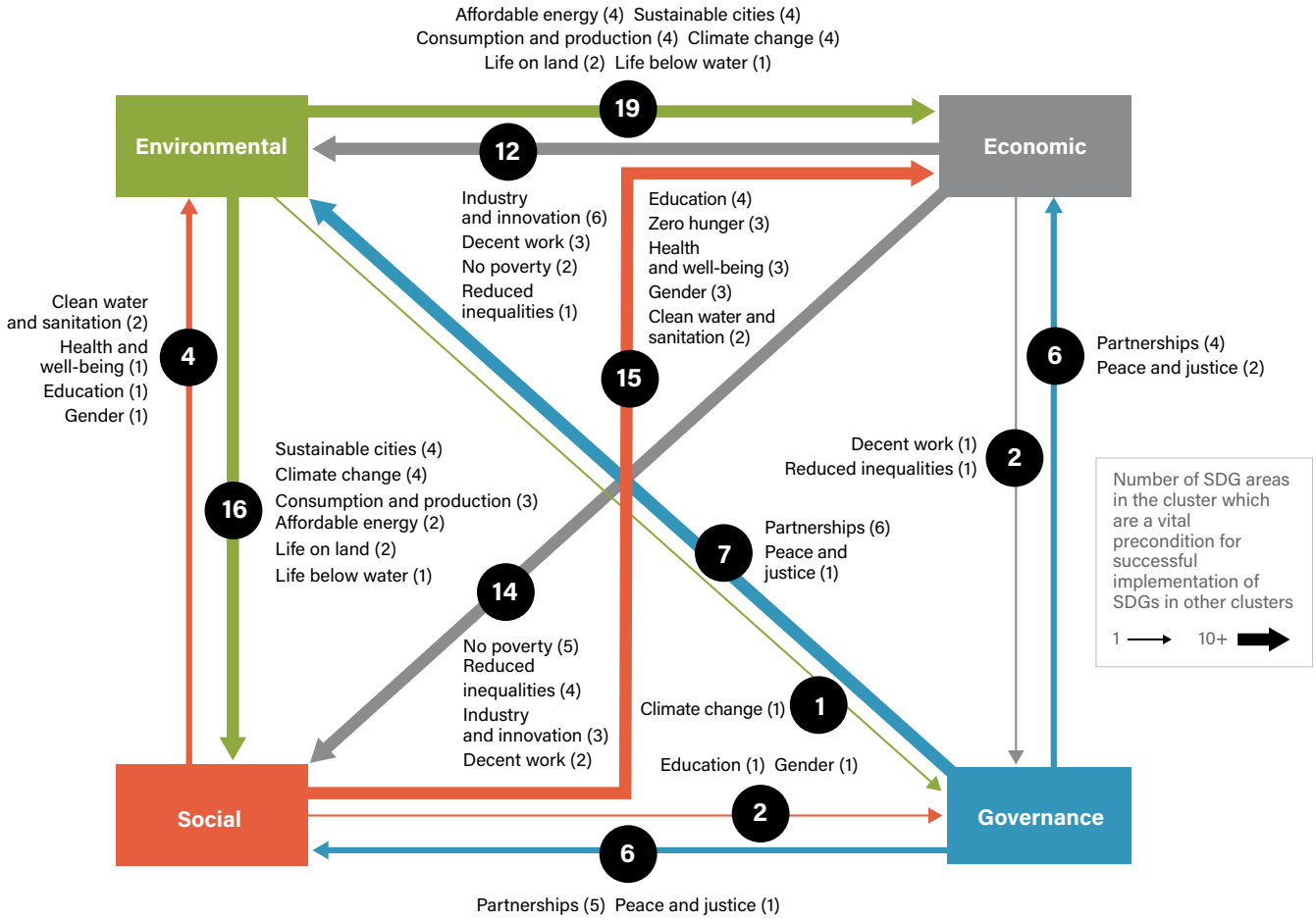
Given the large number of SDGs, it may be tempting to prioritise them based on their potential economic impact. This would be a mistake because all the SDGs are interconnected, and so a coordinated approach is needed to achieve progress. The largest links are between the environmental and economic clusters (Exhibit 3). Effective action on climate change will be essential to achieving the objectives of strong economic growth and ending poverty, while access to affordable energy will help reduce inequality and support sustainable industrialisation in the developing world. At the same time, major investments in infrastructure and innovation will be needed to meet the environmental goals set in the SDGs.

Links between the social and environmental clusters are also critically important: sustainable management of land and water ecosystems will help improve agricultural productivity and eliminate hunger and malnutrition, while climate action, better housing and less polluted cities will have widespread benefits for health and well-being.[36] Education, however, is perhaps most fundamental to the ability to achieve many of the other SDGs – it is the most consistent driver

of economic growth, it improves infant and maternal health and reduces overall mortality, aids food security, reduces malnutrition and enables participatory decision-making and the rule of law. There is also increasing evidence that education reduces vulnerability to climate change by enhancing people's adaptive capacities.[37]

Exhibit 3

There are significant linkages among SDG, implying coordinated action is needed to achieve progress

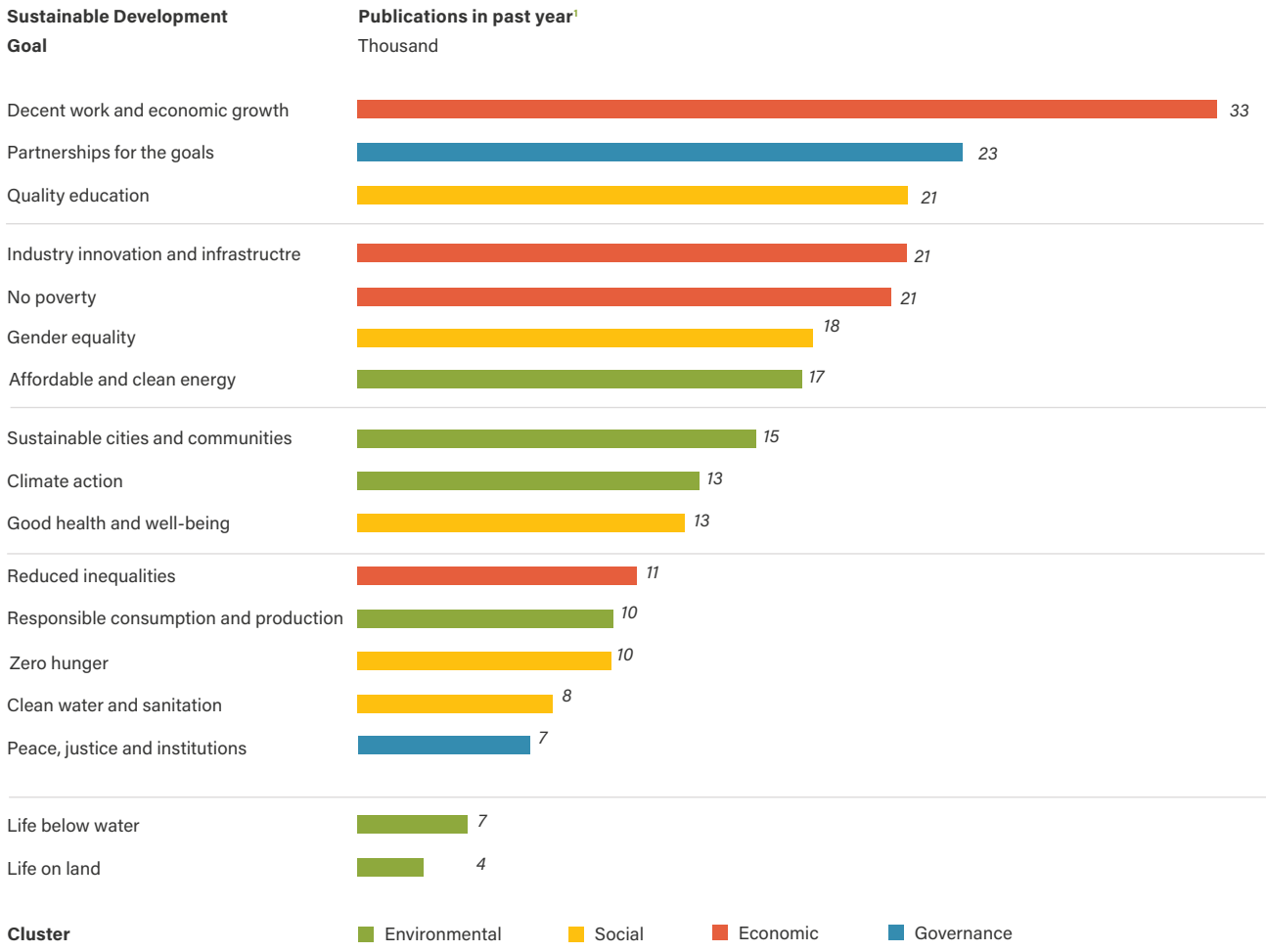


Source: Factiva Dow Jones Database; Google Labs; AlphaBeta analysis

[1] Number of times subject appeared in major publications within the past year. Data obtained by performing Boolean searches for relevant terms. Results were evaluated for level of relevance

Exhibit 4

Public attention is only focused on a subset of the SDGs



Source: Factiva Dow Jones Database; Google Labs; AlphaBeta analysis

[1] Number of times subject appeared in major publications within the past year. Data obtained by performing Boolean searches for relevant terms. Results were evaluated for level of relevance

Public and business attention on the SDGs is very uneven

Given the high degree of interlinkages, it is important that there is coordinated action across the 17 SDG areas. Unfortunately, evidence shows that the public focus is very unevenly distributed across the 17 SDGs. In particular, the SDGs in the environmental cluster are lagging somewhat compared to other clusters (Exhibit 4). This evidence, based on press searches, matches well with surveys of business leaders, which also show uneven focus across the SDG areas.[38]

2. THE ROLE OF BUSINESSES IN ACHIEVING THE SDGS

Businesses, for the most part, did not focus on the Millennium Development Goals (MDGs) as they were largely aimed at developing countries. However, the 17 SDGs are very different given they have a truly global focus and are far broader – they aim to fundamentally transform the economic growth model.

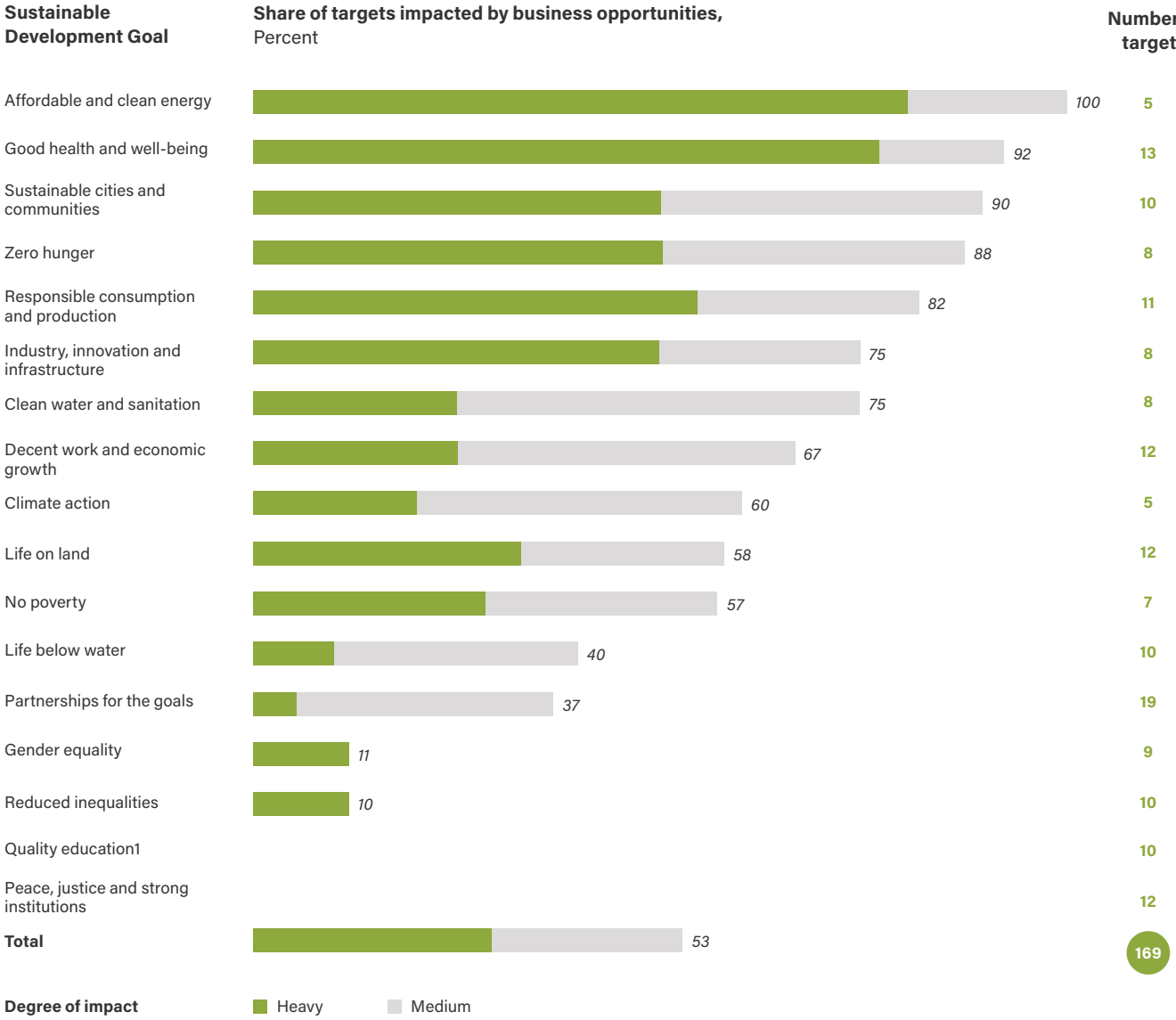
If businesses choose not to engage with the SDGs, this is likely to lead to two undesirable consequences. Firstly, the costs of global burdens outlined in chapter one will only increase, resulting in less stable and less equitable societies, an irreversibly damaged environment and poorer governance. Increased volatility will weaken business conditions and further curtail growth. Secondly, as the private sector resists cooperation to develop a new growth model, governments will be forced to enact strong regulations to attempt to avert the worse impacts of the challenges we face.

While the private sector can't afford to ignore the SDGs, it is also true that the world cannot afford the private sector to ignore them. Across four industry systems that we analysed in detail (food and agriculture; cities; energy and materials; and health and well-being), we find that the private sector can play a crucial role in delivering over half of the 169 SDG targets (Exhibit 5).

Photo credit: Flickr/unwomen

Exhibit 5

The business opportunities significantly impact more than half of the 169 SDG targets



Source: AlphaBeta analysis

[1] Not directly impacted as this analysis covered only four systems: food and agriculture, cities, health and well-being, and energy and materials.

The SDGs will also reshape the business landscape through three main channels (Exhibit 6):

- **Providing new growth markets.** The SDGs offer a pathway to create new markets or accelerate the growth of existing markets. These include the impact on existing product ranges (e.g., increasing the supply of affordable housing); growth of a new consuming class (e.g., transition of markets below poverty line to reach consuming class level); changing incomes of existing consuming class (e.g., reductions in inequality); and enhancement of existing products to achieve price premium (e.g., more energy efficient devices).
- **Production and supply chain improvements.** This relates to shifts in production systems and supply chains that are called for in the SDGs agenda. These include capturing efficiencies (e.g., circular production models lead to reduced losses in material value and lower consumption of resources); reducing waste (e.g., tackling food waste); improving labour productivity (e.g., through universal education initiatives and gender empowerment); and raising input productivity (including agricultural yields and water-use efficiency).
- **Initiating regulatory changes.** The SDGs could engender a range of regulatory interventions, which would require businesses to respond. These include environmental regulation to address GHG emissions and encourage resource efficiency; measures to protect labour rights and address discrimination in employment; regulations to tackle negative social externalities (e.g., sugar taxes aiming to reduce obesity); and measures to strengthen governance (e.g., tackling corruption and land rights).

Photo credit: Flickr / kouam

Exhibit 6

The SDG agenda could impact business through three main channels

	Sub-channels of impact	Description	SDG examples
Growth markets	▪ Supply-driven innovation (e.g., FDI, skilled workers) ▪ Demand-driven innovation (e.g., customer sophistication, market size) ▪ Product differentiation for consumers ▪ Composition and location of demand	▪ Factors that influence the ecosystem supporting innovation, such as access to finance, technology and skilled workers ▪ Factors that incentivise innovation through creating large potential gains from sizeable end-product markets. ▪ Factors that can help create product differentiation and thereby impact demand and/or price premiums. ▪ Factors that change the scale and/or geographical location of demand.	▪ Support access to ICT; support domestic technology development; genetic diversity of seeds. ▪ Reduce transaction costs on worker remittances; provide access to affordable housing; provide access to safe and affordable transport; promote sustainable public procurement. ▪ Strengthen cultural and natural heritage; halve per capita global food waste. ▪ Focus on reducing inequality and addressing poverty; rationalise energy subsidies; promote open trade.
Production and supply chain improvements	▪ Human capital and worker productivity ▪ Natural capital and material inputs ▪ Physical capital (including infrastructure)	▪ Physical capital (including infrastructure) ▪ Physical capital (including infrastructure) ▪ Physical capital (including infrastructure)	▪ Physical capital (including infrastructure) ▪ Provide access to energy; reduce waste generation; integrate sustainability reporting for large businesses. ▪ Increase the access of small-scale industrial and other enterprises to financial services.
Regulatory change	▪ Environmental regulation ▪ Governance / law and order / security ▪ Social outcomes regulation ▪ Economic outcomes regulation	▪ Regulations impacting businesses use of environmental resources, including resource subsidies. ▪ Factors related to good governance. ▪ Regulations impacting businesses related to social negative externalities (e.g., sugar taxes to combat obesity) ▪ Regulations related to workers and taxes.	▪ CO_2 and water pricing; producer responsibility requirements. ▪ Tackle corruption; promote land rights; promotion of rule of law. ▪ Tackle obesity ▪ Minimum wage levels; migrant worker rights; taxes; gender discrimination.

Source: McKinsey Global Institute; World Tourism Organization; IHS global construction outlook; AlphaBeta analysis

[1] Mobility includes revenue size of the automotive market from McKinsey Global Institute (MGI) disruptive technologies; transport includes the historical investment in roads, rail, airports and ports estimated by MGI; residential and non-residential data is from IHS on market size of global construction segment ; water infrastructure is the historical spend on infrastructure estimated by MGI; tourism is the international tourism receipts in 2014.

The delivery of the SDGs could create specific business opportunities worth over US$12 trillion by 2030

The participation of the private sector in the implementation of the SDGs can also lead to the development of specific business opportunities. Based on an extensive literature scan and deep engagement with experts across four industry systems (food and agriculture; cities; energy and materials; and health and well-being), we have identified the 60 largest business opportunities (Exhibit 7, see Box 1 for further details on the methodology).

Exhibit 7

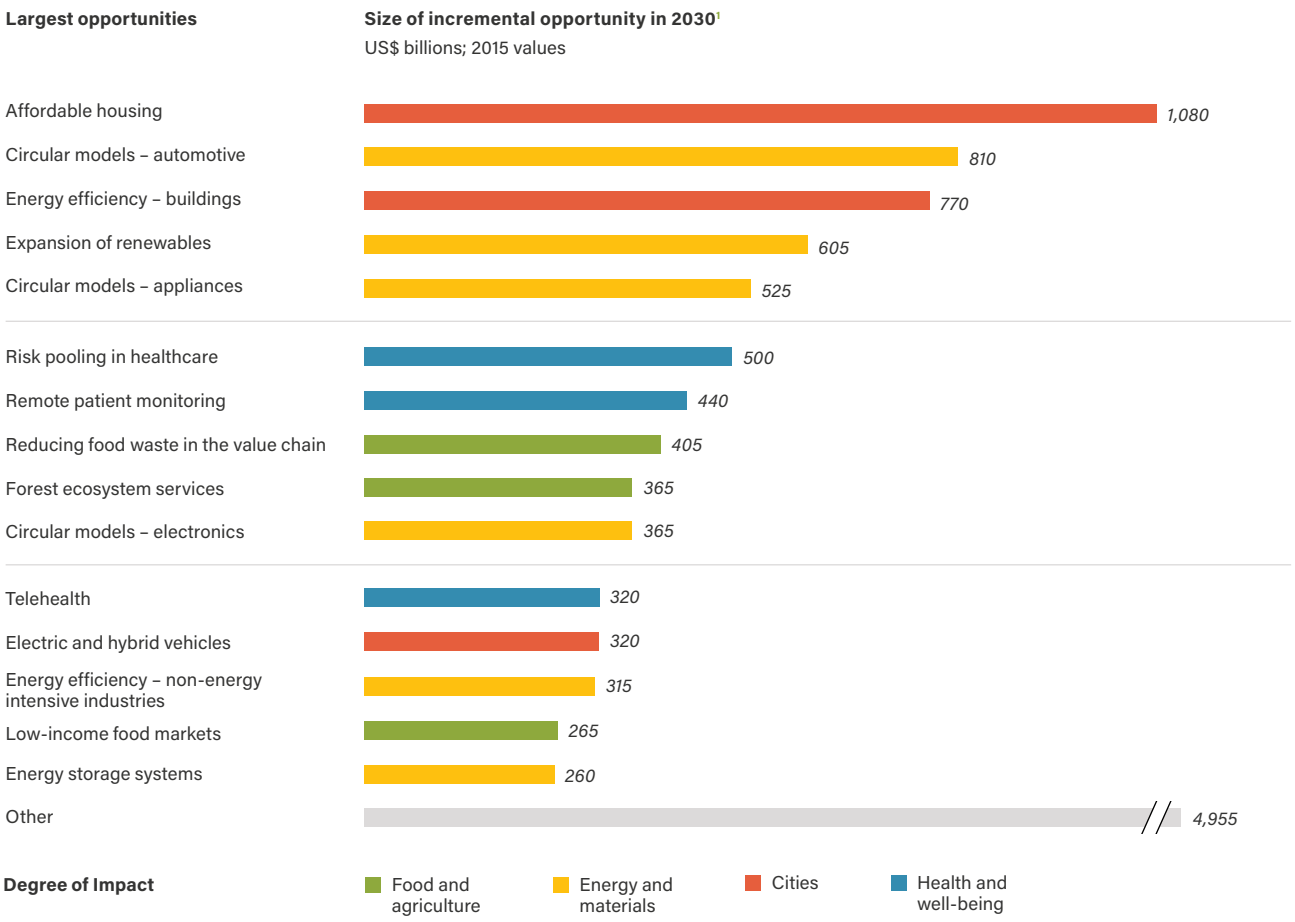
We identified 60 SDG-related business opportunities in the four systems

	Food and agriculture	Cities	Energy and materials	Health and well-being
1	Reducing food waste in value chain	Affordable housing	Circular models - automotive	Risk pooling
2	Forest ecosystem services	Energy efficiency - buildings	Expansion of renewables	Remote patient monitoring
3	Low-income food markets	Electric and hybrid vehicles	Circular models - appliances	Telehealth
4	Reducing consumer food waste	Public transport in urban areas	Circular models - electronics	Advanced genomics
5	Product reformulation	Car sharing	Energy efficiency - non-energy intensive industries	Activity services
6	Technology in large-scale farms	Road safety equipment	Energy storage systems	Detection of counterfeit drugs
7	Dietary switch	Autonomous vehicles	Resource recovery	Tobacco control
8	Sustainable aquaculture	Internal combustion engine vehicle fuel efficiency	End-use steel efficiency	Weight management programs
9	Technology in smallholder farms	Building resilient cities	Energy efficiency - energy intensive industries	Better disease management
10	Micro-irrigation	Municipal water leakage	Carbon capture and storage	Electronic medical records
11	Restoring degraded land	Cultural tourism	Energy access	Better maternal and child health
12	Reducing packaging waste	Smart metering	Green chemicals	Healthcare training
13	Cattle intensification	Water and sanitation infrastructure	Additive manufacturing	Low-cost surgery
14	Urban agriculture	Office sharing	Local content in extractives	
15		Timber buildings	Shared infrastructure	
16		Durable and modular buildings	Mine rehabilitation	
17			Grid interconnection	

These business opportunities could generate significant revenue for the private sector. Collectively, the opportunities are worth over US$12 trillion by 2030. While this is based on revenue and savings rather than value added, it represents around 10 percent of forecast global GDP in 2030. The 15 largest opportunities account for over half of this prize (Exhibit 8). These are: (1) affordable housing, (2) circular models in automotive, (3) improving energy efficiency in buildings, (4) expansion of renewables, (5) circular models in appliances, (6) risk pooling in healthcare, (7) remote patient monitoring, (8) reducing food waste in the value chain, (9) forest ecosystem services, (10) circular models in electronics, (11) telehealth, (12) electric and hybrid vehicles, (13) improving energy efficiency in non–energy intensive industries, (14) low-income food markets, and (15) energy storage systems.

Exhibit 8

Delivering the SDGs could generate over US$12 trillion worth of business opportunities



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US$5 billion.

Box 1. Quantifying the business opportunities related to the SDGs

To understand the business opportunities, we focus on specific 'industry systems'. We define industry systems as areas of economic activity with common value drivers. For example, one industry system is food and agriculture, which relates to all the economic activities (e.g., fertilisers, farm production, logistics and retail) that deliver value in the provision of food to consumers. Using industry systems is more relevant than traditional business sectors as the latter tend to be too narrowly defined and fail to capture the dynamic changes in the business landscape that could occur from the SDGs, particularly in the broader value chain. Based on several criteria (including economic impact, geographical relevance, and importance for the achievement of the SDGs), we prioritised these industry systems:

- Food and agriculture (including food production, fertilisers, distribution and retail)
- Cities (including vehicles and transport-related sectors, housing, construction and utilities)
- Energy and materials (including mining, oil and gas, renewable energy, power generation and durable goods)
- Health and well-being (including pharmaceuticals, primary and secondary care, gyms, and prevention and well-being).

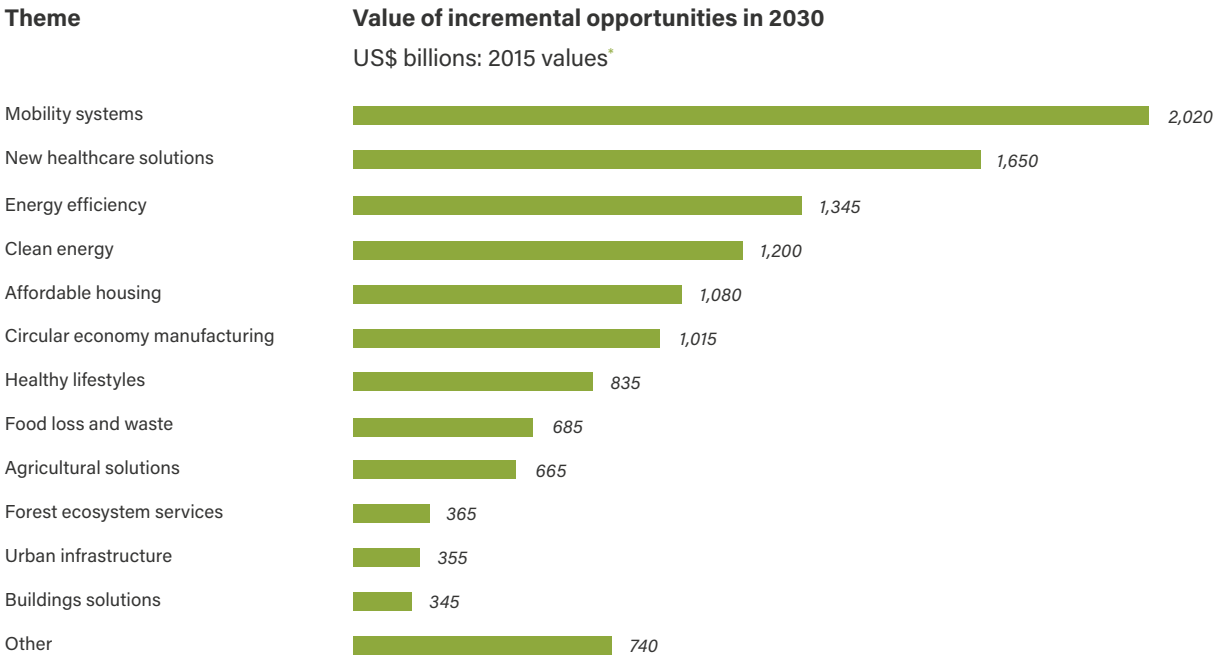
In each industry system, the team engaged extensively with industry and academic experts, industry reports and academic literature to identify and size the major opportunities (worth at least US$25 billion in 2030) for the private sector. Some of the benefits of implementing the SDGs are diffuse across the economy, such as increased workforce participation through gender equality. We focused instead on concentrated shifts in profit pools, generating specific opportunities for business. The opportunities that we selected are based on existing, commercialised technology, though we note that many important opportunities in the implementation of the SDGs will arise from technologies as yet unknown or embryonic in their development.

The sizing reflects the annual opportunity in 2030 (calculated in 2015 US dollars and rounded to the nearest US$5 billion), based on the estimated savings (e.g., value of land saved from improving smallholder yields) or market size (e.g., food market demand from low-income consumers who move above the extreme poverty line). In each case, we have measured the incremental size of the opportunity in an SDG versus business-as-usual (BAU) scenario. For example, the opportunity to improve smallholder farm yields is calculated as the additional productivity improvement opportunity from implementation of the SDGs, above that expected in a BAU scenario. The SDG scenarios are based on achieving all relevant SDG targets and a 2-degree pathway, but do not build in pricing of carbon or other externalities (except for forest ecosystem services, where carbon pricing is a principal revenue source). The BAU scenarios are derived from existing policies and policy announcements. Where possible, we have used multiple sources for each opportunity to generate a range. The sizings are a bottom-up microeconomic perspective and do not take into account interaction and general equilibrium effects.

The diverse group of business opportunities we found across the four systems can also be grouped by sector or theme (Exhibit 9). The two largest themes, which account for more than one-quarter of the total value of the opportunities, are mobility systems, including public transport, circular economy in automotive and electric and hybrid vehicles, and new healthcare solutions, such as remote patient management and low-cost surgery. Clean energy is also a major theme, incorporating both expansion in renewables, and carbon capture and storage, and related supporting opportunities such as energy storage and grid interconnection. Healthy lifestyles are important across multiple systems, with opportunities including activity services, dietary switch and tobacco control.

Exhibit 9

The largest themes across all four systems are mobility systems and new healthcare solutions



Source: Literature search; AlphaBeta analysis

* Based on estimated savings or project market sizings in each area. Rounded to nearest US$ billion.

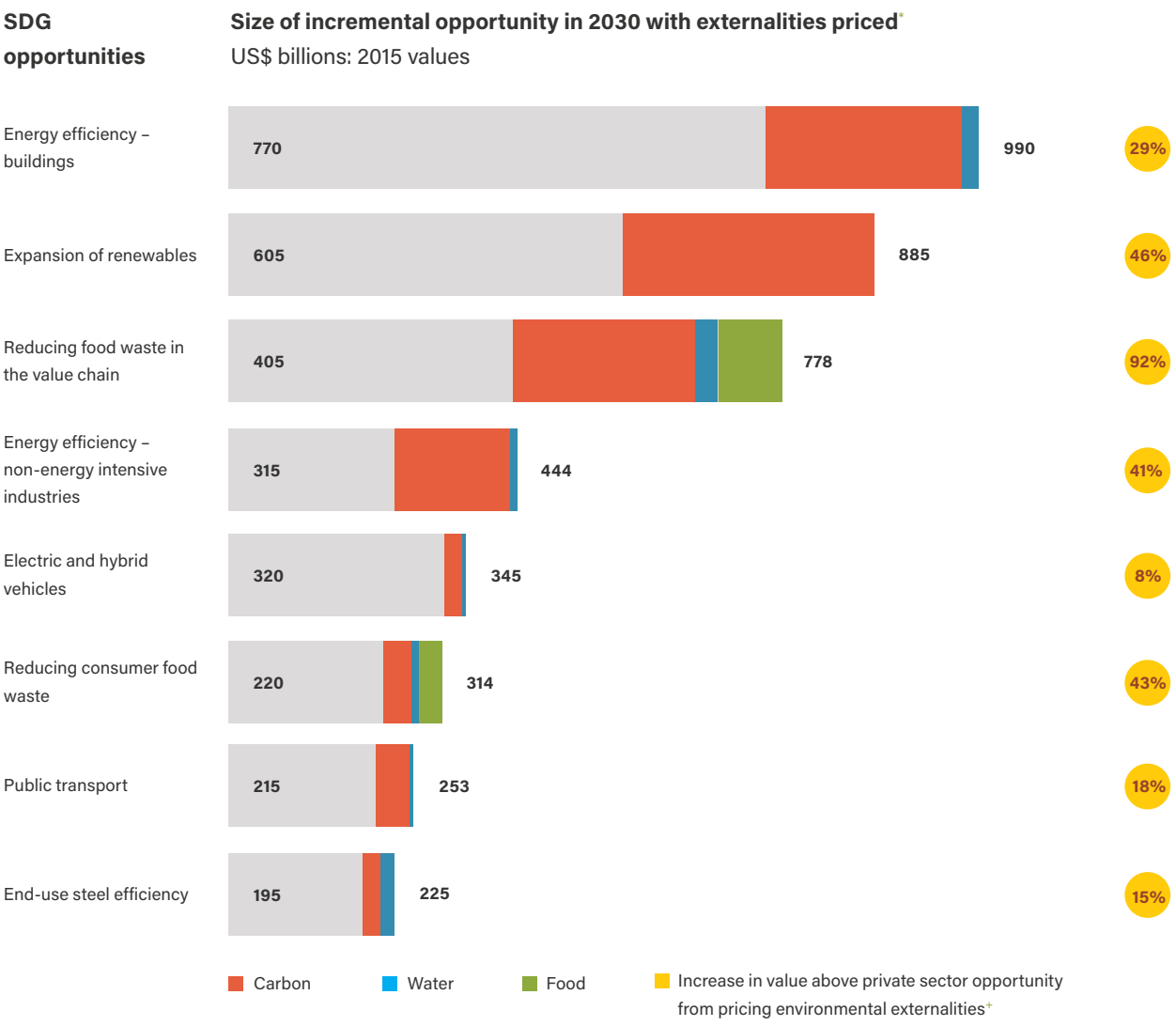
Pricing of externalities could increase the value of opportunities

Our sizing of opportunities is based on current prices (except for forest ecosystem services, which includes carbon pricing). However, these largely do not reflect the cost of a range of externalities, in particular GHG emissions. They also include various subsidised and unpriced resources, including water, fossil fuels and food. The value of these resource subsidies globally is estimated to be over US$1 trillion annually.[39] To understand the impact of removing subsidies and properly pricing resources, we repriced a subset of our top opportunities for three factors for which reliable data is available: carbon, water and food (Exhibit 10). This increases the overall value of opportunities

by almost 40 percent. The effects are most profound in the food and agriculture system, where pricing of externalities adds over 70 percent to the combined value of opportunities to reduce food waste. Impacts on energy and materials opportunities are also significant: the size of the prize in renewables rises by 46 percent, driven by carbon pricing, and by a similar amount in energy efficiency in non–energy intensive industries.

Exhibit 10

Pricing externalities into top market opportunities adds almost 40% to their value



Source: Literature search; Alphabeta analysis

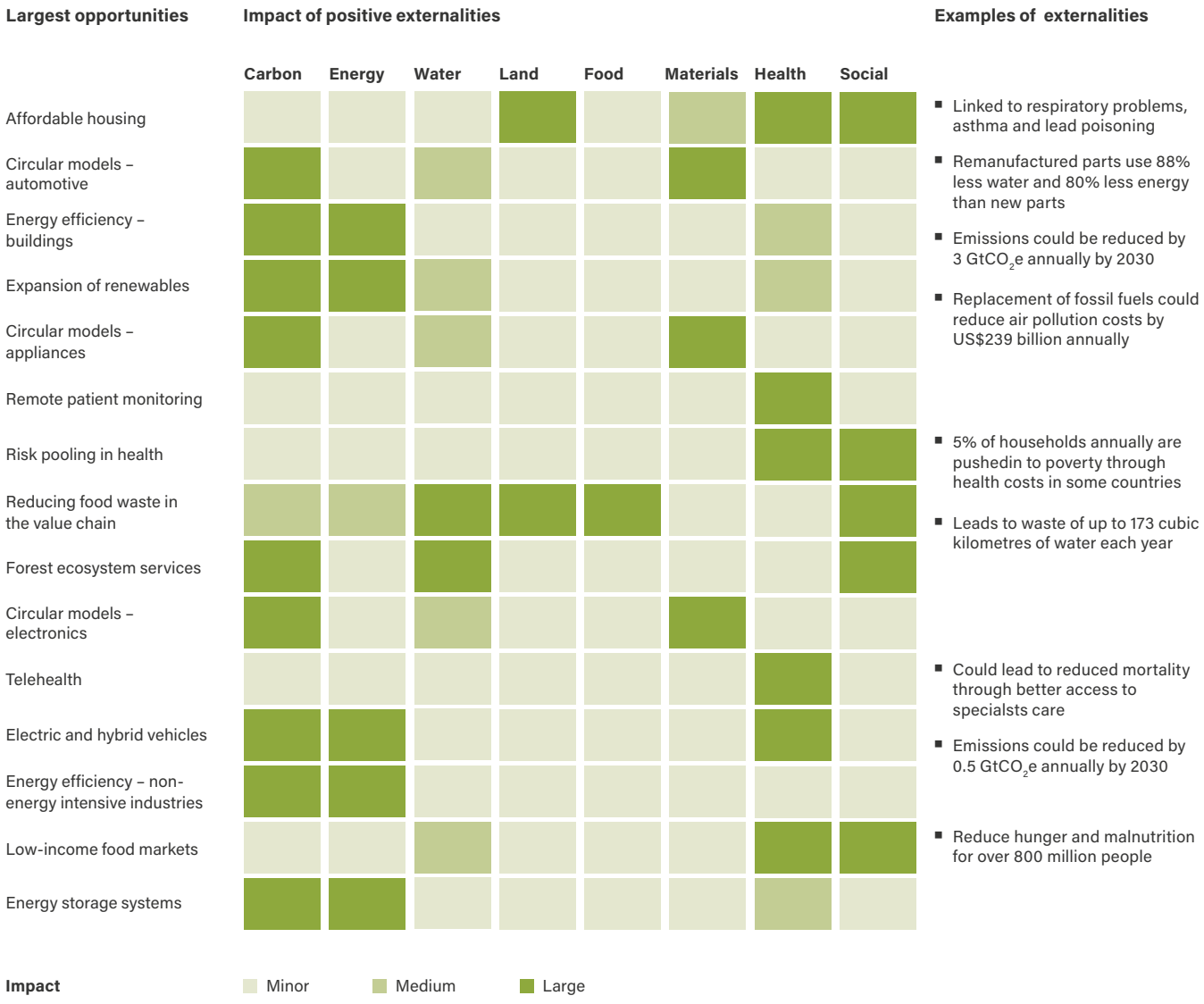
* Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here.

+ Externality sizing assumptions carbon price of US$50 tCO_2e; average water price increased by US$0.08 for agricultural water and US$0.40 for industrial use (based on removal subsidies); food prices increased by US$44/t due to removal of subsidies.

Environmental externalities and resource subsidies are increasingly recognised as a challenge to sustainable development, and SDG 12 explicitly calls for the rationalisation of "inefficient fossil-fuel subsidies that encourage wasteful consumption".[40] Health and social externalities typically receive less attention, in part because they are more challenging to accurately evaluate. However, we find that they could have a large potential impact on the value of half of the top 15 opportunities (Exhibit 11). Our largest opportunity, affordable housing, has significant positive externalities for both health and other social factors, including poverty and inequality. In one study in the US, researchers found that housing upgrades can reduce the incidence of common health problems in children by up to 20 percent.[41]

Exhibit 11

Some externalities are difficult to price, but could have a significant impact on the size of the opportunities



Unlike the MDGs, the potential impact of the SDGs is truly global

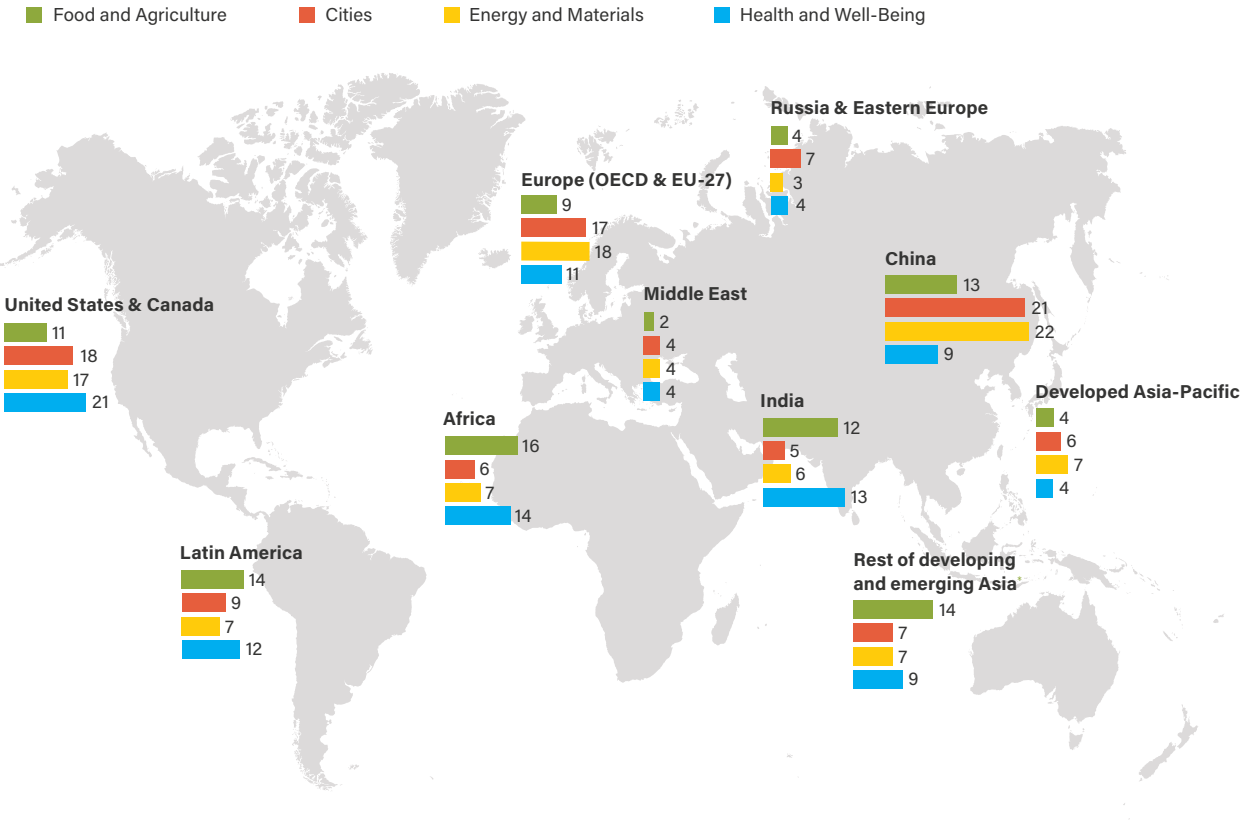
The geographic distribution of the value of SDG business opportunities depends on the industry system. In the case of cities, improving the efficiency of buildings is one opportunity where developed and developing economies each have significant potential, but the affordable housing opportunity is most critical in the developing world. The value of energy and materials opportunities is distributed quite evenly – while extractive opportunities are primarily in the developing world, circular economy models in durable goods are likely to develop first in developed markets. In the case of food and agriculture, there are significant opportunities in Africa and India, which reflects the large share of cropland and the current low levels of productivity. Health and well-being opportunities are concentrated in developing countries, where access is currently low, and in the US and Canada, where healthcare costs are highest (Exhibit 12).

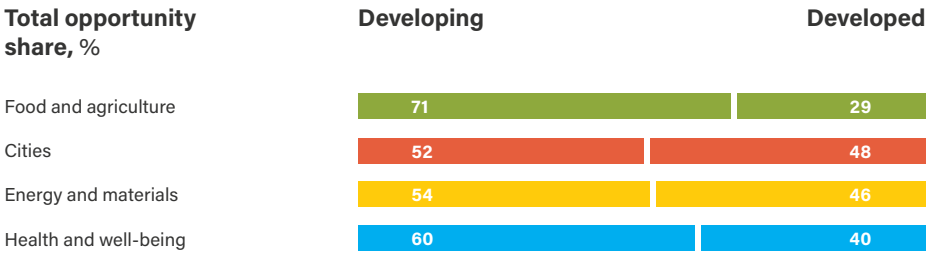
Photo credit: Flickr/usacehq

Exhibit 12

Developing countries account for more than half of the value of the SDG business opportunities

Share of value of SDG business opportunities by region and system; Percent





Source: Literature search, AlphaBeta analysis.

* Rest of developing Asia includes Central Asia (e.g., Uzbekistan), South Asia (e.g., Bangladesh), Southeast Asia (e.g., Laos), and North Korea.

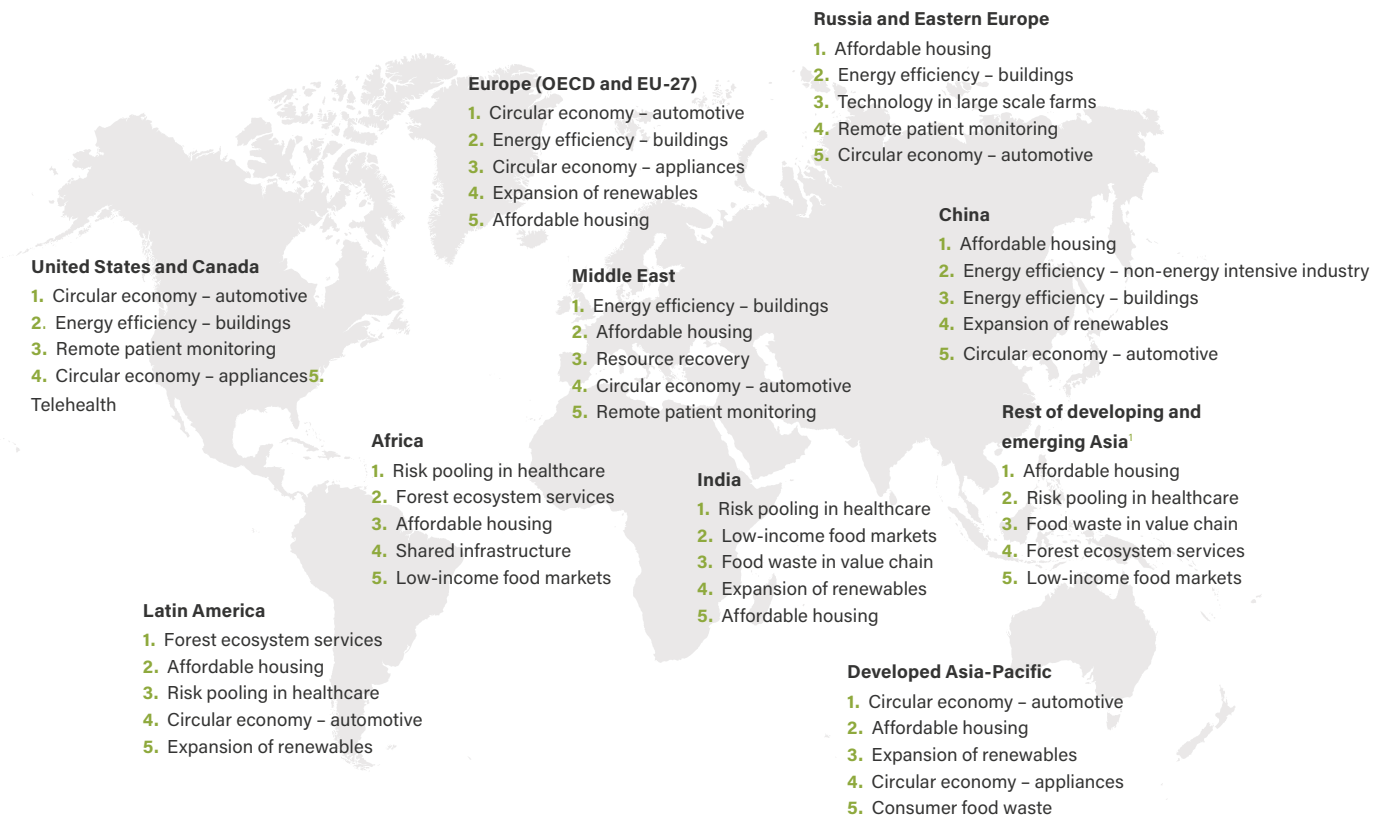
Note: Numbers may not sum due to rounding

The importance of individual opportunities also varies by region, with stark differences between developed and developing countries (Exhibit 13). Affordable housing is the largest opportunity in three regions – Russia and Eastern Europe, China and the rest of developing and emerging Asia. The circular economy shifts in durable goods are the largest opportunities in the US and Canada, Europe and developed Asia-Pacific. Energy efficiency in buildings is a major opportunity in half of the regions, concentrated primarily in the northern parts of the world where heating costs are high. Expansion of renewables is the one opportunity that has importance across regions of different income levels, which points to the global nature of the transformation required in electricity generation.

Exhibit 13

The main business opportunities vary somewhat by region

Top business opportunities by region



Source: Literature search; AlphaBeta analysis

[1] Rest of developing Asia includes Central Asia (e.g., Uzbekistan), South Asia (e.g., Bangladesh), Southeast Asia (e.g., Lao PDR), and North Korea.

These business opportunities could also create almost 380 million jobs.

The SDG opportunities could make a substantial contribution to job creation over the next 15 years. We estimate that the 60 opportunities could collectively generate almost 380 million new jobs by 2030, which is more than 10 percent of the forecasted size of the labour force in 2030.[42] For some opportunities, such as energy access and energy efficiency in buildings, this additional employment will be primarily associated with the investment needed. Economists estimate that each US$1 billion in investment spending in the US can create 10,000 to 28,000 jobs.[43] Other opportunities will create jobs through the ongoing operation of new businesses and value chains. The development of low-income food markets, for example, will lead to increased employment in food processing, distribution and retail trade, and potentially some growth in agricultural workforces. Almost one-fifth of the total employment potential – around 70 million jobs – comes from just one opportunity, affordable housing. Given annual investment of over US$1 trillion, we estimate this opportunity alone could create 20 million jobs in China, 14 million jobs across Africa and 8 million jobs in India.

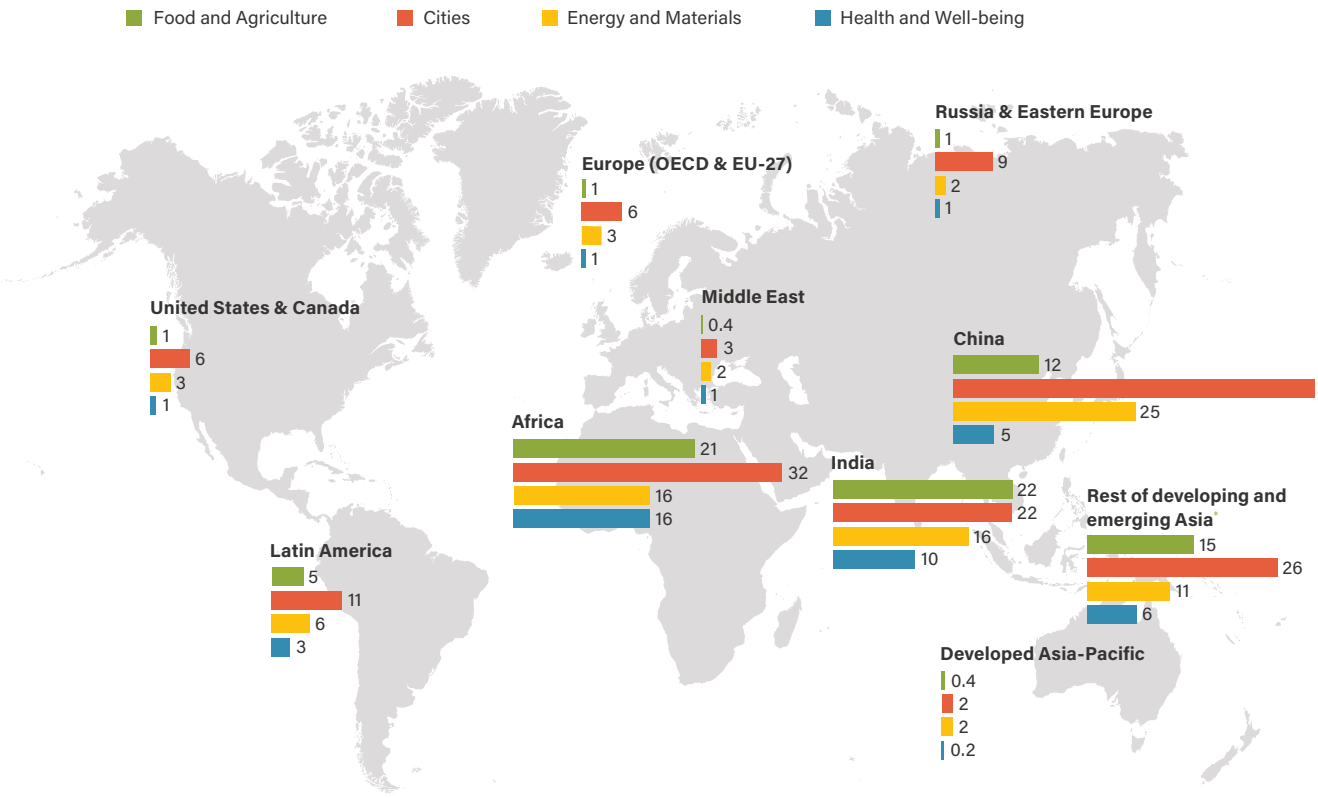
The job creation potential of the SDG business opportunities is primarily located in the developing world (Exhibit 14). We estimate almost 90 percent of jobs will be created in developing countries, including 23 percent in Africa and 59 percent in developing Asia. This is because the need for capital investment is much greater in low- and middle-income countries, especially in affordable housing and other critical infrastructure, and because the job creation impact of investment is much larger given the higher labour intensity of developing economies.

Exhibit 14

Almost 380 million jobs could be created by Global Goals business opportunities in the four systems

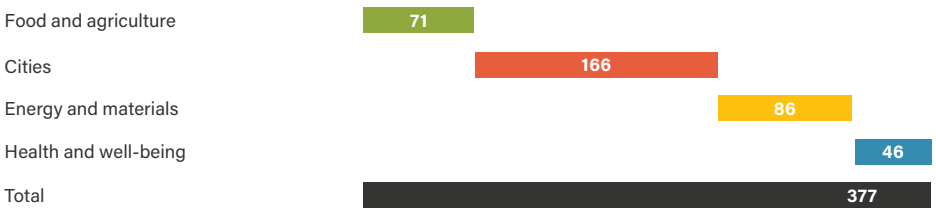
Total jobs created by SDG business opportunities by region and system

Millions



Total jobs created

Millions



Source: Literature search, AlphaBeta analysis

* Rest of developing Asia includes Central Asia (e.g., Uzbekistan), South Asia (e.g., Bangladesh), Southeast Asia (e.g., Laos), and North Korea.

Note: Numbers may not sum due to rounding

It is difficult to accurately estimate the net impact of this job creation across economies. However, we find that almost 50 percent of the jobs are in new infrastructure development and related areas where the net job creation is likely to be high. A further 30 percent of the gross jobs are more likely to result from some substitution, but still generate net employment growth. The expansion of renewable energy, for example, is forecast to add 9.4 million new jobs above a business-as-usual scenario in 2030. However, substitution of jobs in fossil fuel energy production and other parts of the economy leads to a forecast net employment growth of around 8 million.[44] For the final 20 percent of job creation, the degree of substitution is likely to be high. This includes opportunities such as green chemicals, and EV and hybrid vehicles, where the new, more sustainable products are direct substitutes for existing products.

In the following chapters we explore the impact of the SDGs on the four systems (food and agriculture; cities; energy and materials; and health and well-being) in further detail.

Photo credit:
Flickr/ilosasiapacific

3. FOOD AND AGRICULTURE

The challenges in the food and agriculture system

The food and agriculture system is currently at a critical juncture. Past food demand growth has been met primarily through significant gains in productivity. However, productivity growth is slowing and the pressures on food and agriculture are becoming increasingly severe. Addressing the current undernourished population and the rapid demand for food and feed – and competing demand for fuel – will require a radical rethink of past practices. There are important challenges in innovation, demand, supply and regulation:

- **Innovation.** Despite rapid demand for food in the 20th century, prices actually fell by an average of 0.7 percent a year.[45] The main driver of this was not cropland expansion (which increased by just 0.1 percent a year), but rather crop yield improvements. These grew at above 2 percent a year, largely as a result of greater use of fertilisers and capital equipment, and the diffusion of better farming technologies and practices. However, yield growth has steadily fallen due to a combination of land degradation, yield growth approaching current agro-ecological potential in many countries, and a lack of investment in innovation. This underinvestment in agricultural innovation is sizeable – for example, agriculture represents 10 percent of global GDP, but AgTech accounts for only 3.5 percent of global venture capital funds.[46]

- **Demand.** The unmet food demand at present is still substantial. Almost 800 million people worldwide are hungry, and over 2 billion suffer from micronutrient deficiencies, in particular vitamin A, iodine, iron and zinc.[47] Meeting future food needs will be complicated by growing demand for feed in the developing world as livestock production increases. Feed consumption is forecast to grow 0.7 percent faster per annum than cereal production to 2030.[48] First-generation biofuels could add further stresses on cropland, requiring the equivalent of an additional 15 million hectares of land by 2030.[49]

- **Supply.** The supply challenge to meet future food demand will be equally significant. By 2030, roughly 175–220 million hectares of additional cropland will be needed to meet projected food, feed and fuel demand (even with continued 1 percent improvement in annual yield growth). Whilst there is sufficient arable land to meet this need, over half of this land is in places with limited infrastructure and/or high political risk. In addition, the environmental degradation of agricultural systems will make future production increases more challenging. Four of the nine planetary boundaries that have been exceeded relate to the food and agriculture system (climate change, loss of biosphere integrity, land system change and altered biochemical cycles).[50] Furthermore, 33 percent of soils are moderately to highly degraded due to erosion, nutrient depletion, acidification, salinisation, compaction and chemical pollution; while 61 percent of 'commercial' fish populations are fully fished and 29 percent are fished at a biologically unsustainable level and therefore overfished. Water constraints will also be significant for agricultural production, given roughly 70 percent of

global water demand is related to agriculture. At least 20 percent of the world's aquifers are overexploited, including in important production areas such as the Upper Ganges (India) and California (US).[51] Overall, industrialised farming practices are estimated to cost the environment some US$3 trillion per year.[52]

- **Regulation.** Finally, there a range of broader social issues confront the food and agriculture system that could be catalysts for regulatory change. Currently, over 2 billion people are overweight or obese. If the prevalence of obesity continues on its current trend, almost half of the world's adult population could be overweight or obese by 2030. As a result, there is an increasing public policy focus on tackling obesity, including the consumption of high-sugar and high-fat food. Sugar taxes have been proposed or implemented in many countries. While the impact varies across geographies, and the taxes are still fairly nascent so it is difficult to understand long-term effects on demand, there are signs that the consequences of sugar taxes could be significant. In Mexico, for example, early studies indicate that after the introduction of a 10 percent sugar tax, annual sales of sweetened soft drinks declined 6 percent in 2014.[53] There are other important societal pressures on the food and agriculture system given that over 60 percent of people who live in extreme poverty work in agriculture, and there have been calls for increases in minimum wage levels. The system is also heavily affected by resource subsidies, which are an increasing financial strain for many governments. A range of subsidies currently distort food markets, including US$490 billion of agricultural subsidies, US$35 billion in fishery subsidies and roughly US$455 billion in water subsidies (with agriculture accounting for about 70 percent of global water demand).[54] The impact on competitive dynamics in the food and agriculture system of subsidy reform and/or carbon pricing could be dramatic. Analysis by Trucost and McKinsey shows that if the environmental impact of production of food was included, the prices of soft commodities could increase by 50–450 percent.[55]

A vision for a sustainable food and agriculture system

The SDG agenda proposes to meet these profound challenges by shifting the food and agriculture system onto a sustainable development pathway. This shift will transform the entire food and agriculture system, with major impacts throughout the value chain. Mapping these impacts provides a vision for a new, SDG-compatible food and agriculture system (Exhibit 15).

- **Inputs.** The inputs to the agricultural and fisheries sectors will be transformed by the SDGs' emphasis on ending hunger, improving agricultural productivity and adapting to climate change. While traditional fertilisers may face constraints to volume growth, there could be a shift in value towards microbial fertilisers. New breeding techniques will be needed to develop crops appropriate to changing environmental conditions. Aquaculture disease control and feedstock innovation could transform the inputs to protein production.

Exhibit 15

A sustainable development pathway could result in significant shifts in the food and agriculture system

Value Chain Area	Current Value US$ billions[1]	From...	To...
Inputs	520	▪ Traditional fertilisers ▪ Limited public/private collaboration ▪ Basic cross-breeding ▪ Aqua and land-based feedstocks operating in silos	▪ Microbial fertilisers ▪ New PPPs focused on adapting technology to local conditions ▪ Precision phenotyping and bioinformatics ▪ Consideration of sustainability of blended approach of aqua and land
Production	2,175	▪ Water-, energy- and land-intensive products (e.g., beef) ▪ Forest degradation through unsustainable farming practices ▪ 'Products contributing to heavy deforestation (e.g., unsustainably sourced palm oil) ▪ Arms-length dealings with smallholder farmers ▪ Loss-making fishing fleets ▪ Limited monitoring of animal welfare ▪ Low–water efficiency agriculture ▪ Limited innovation in production ▪ Low-data, traditional farming ▪ Farming remote from markets	▪ Focus on crop and meat selection with lower environmental footprint ▪ Sustainable forestry management (e.g., agroforestry, reduced-impact logging) ▪ Sustainable agriculture approaches (e.g., holistic grazing; low till/no till agriculture) ▪ Contract farming and new partnership models ▪ Sustainable fishery models/aquaculture ▪ Animal health monitoring & diagnostics ▪ Micro-irrigation techniques ▪ Precision agriculture ▪ Big-data farming ▪ Urban farming
Food processing	1,377	▪ High-waste food processors ▪ High-sugar/fat products ▪ Unfortified food production	▪ Low-waste food processors ▪ Product reformulation, low-fat/sugar products ▪ Food fortification
Logistics	>300	▪ Limited storage systems ▪ Limited traceability	▪ Cold storage systems ▪ Fully traceable product systems
Retail & disposal	7,180	▪ Limited consumer differentiation for sustainable products ▪ Low food-safety focus ▪ High levels of food waste	▪ Sustainably sourced and fair trade products ▪ Food safety as business opportunity ▪ Composting and energy capture

Source: McKinsey Global Institute; World Tourism Organization; IHS global construction outlook; AlphaBeta analysis

[1] Mobility includes revenue size of the automotive market from McKinsey Global Institute (MGI) disruptive technologies; transport includes the historical investment in roads, rail, airports and ports estimated by MGI; residential and non-residential data is from IHS on market size of global construction segment ; water infrastructure is the historical spend on infrastructure estimated by MGI; tourism is the international tourism receipts in 2014.

- **Production.** The production area of the value chain will experience some of the largest shifts as the SDGs are implemented. Water-, energy- and land-intensive products (e.g., beef) will face constrained growth from rising costs caused by reductions in resource subsidies and the pricing of environmental externalities. In their place, less resource-intensive food groups, such as cereals, fish and poultry, will experience faster growth. There will be shifts towards sustainable agriculture approaches including holistic farming, no-till agriculture and micro-irrigation, as well as an increased focus on animal health and welfare. Contract farming and new partnership models with smallholder farmers will become increasingly prevalent and there will be a step change in the application of technology to farming, with increasing use of big data to enable precision farming. The SDGs also call for the end of overfishing and unregulated fishing, which will further drive the development of aquaculture.

- **Food processing.** There will be a shift of value towards low-waste producers given a combination of cost concerns and consumer focus, supported by increasing sustainability reporting requirements for food retailers. Concerted efforts to reduce the impact of non-communicable diseases (NCDs), including obesity, are an important element of the SDGs and a growing concern for governments and consumers. In response, producers will need to focus on product reformulation to reduce fat and sugar and improve the nutritional content of processed food.

- **Logistics.** The SDGs aim to reduce food losses along production and supply chains. Logistics will therefore need to change, with the rapid growth of cold storage systems and full traceability of products to address consumers' food safety and sustainability concerns.

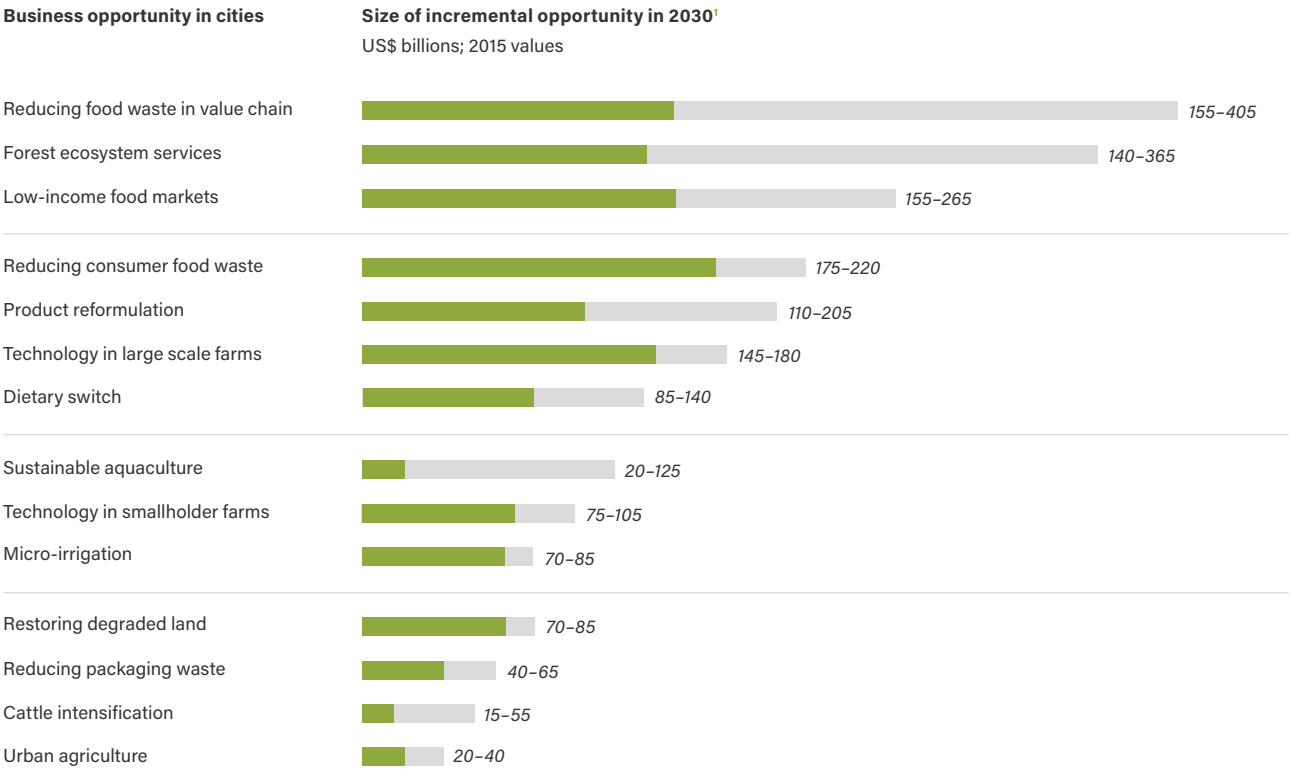
- **Retail and disposal.** The retail sector will undergo one of the biggest transformations in the value chain, with opportunities for new markets serving low-income consumers, and sustainably sourced products emerging from a niche category to the industry standard. According to Nielsen's Global Health and Wellness Survey – a survey of 30,000 consumers in 60 countries – young people are much more interested in sustainably sourced food and willing to pay a premium for it. Among consumers under 20 years of age, 41 percent said they would willingly pay a premium for sustainable products, compared to 21 percent of Baby Boomers (aged 50 to mid-60s).[56] Consumers are also increasingly concerned with animal treatment, animal-welfare standards and overall farming conditions. At the end of the value chain, traditional waste management will be replaced with improved composting and energy capture processes (e.g., biogas production).

Business opportunities in an SDG-compatible world

These system-wide changes along the food value chain will lead to the emergence of a number of disruptive business opportunities (Exhibit 16).

Exhibit 16

The largest business opportunities in the food and agriculture system could be worth more than US$2.3 trillion in 2030



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or project market sizings in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest US$5 billion.

- **Reducing food waste in the value chain (US$155–405 billion).** Between 20 percent and 30 percent of food is wasted somewhere along the value chain, even before allowing for food waste at the point of consumption.[57] The majority of losses in the value chain occur in developing countries, where poor storage facilities and inadequate transport infrastructure mean that a significant share of food is wasted after harvest. Basic technologies, such as

plastic storage bags, small metal silos and plastic crates, can have a major impact through improved storage and transportation of food. Pilot efforts in Benin, Cape Verde, India, and Rwanda have documented reductions of food loss by more than 60 percent during field trials of a variety of low-cost storage techniques and handling practices.[58] 81 percent of the techniques increased the incomes of smallholders by more than 30 percent. Key barriers relate to capital requirements (particularly for cold storage systems) and the need for significant behavioural change of key actors, particularly smallholder farmers.

- **Forest ecosystem services (US$140–365 billion).** Reducing deforestation and forest degradation will be critical to achieving the greenhouse gas abatement needed to avoid the worst impacts of climate change. At present, deforestation and forest degradation account for 17 percent of global emissions, which is more than the transport sector.[59] The natural capital in forests is closely linked to the resilience of the food and agriculture system: forests play a critical role in soil management, nutrient cycling and water systems. It is estimated that the production of soy, beef, paper and pulp, and palm oil account for about half of the world's current tropical deforestation. Some companies have already made commitments to eliminate deforestation from their supply chains for agricultural commodities by 2020 through the New York Declaration on Forests.[60] The business opportunity in forest ecosystem services is a combination of sustainable forestry management approaches and payment mechanisms for ecosystem services. The New Climate Economy (NCE) has estimated that reduced deforestation and forest degradation can achieve carbon abatement of 2.8–7.3 $GtCO_2e$ by 2030.[61] Assuming a carbon price of US$50, which is broadly consistent with that used by many leading companies today, as well as estimates of the required internal rate of return for private sector participants, the total opportunity could be US$140–365 billion by 2030.[62] The further development of payment for ecosystem services, including climate change mitigation, watershed services and biodiversity conservation, will be essential for enabling private sector participation in this opportunity, particularly as many sustainable forestry approaches have long payback periods.

- **Low-income food markets (US$155–265 billion).** The world's poorest people spend as much as 60 percent of their income on food.[63] Despite this, calorie deficiency and malnourishment persist as populations cannot access or afford enough of the right kinds of food.[64] Populations in Sub-Saharan Africa and South Asia face deficits of 300–500 kCal per day.[65] Consumer goods companies can play a role in addressing this gap by investing in supply chains and food innovation to make available food products that are more nutritious and accessible. If the SDG target of ending extreme poverty is met, an additional 800 million people could emerge as consumers with incomes capable of addressing their food needs.[66] The recognition of this market power by consumer goods companies will be a vital step in meeting the SDG target of ensuring universal access to "safe, nutritious, and sufficient" food. Understanding local food demand patterns will be a key barrier to realising value from this consumer pool. For example, populations continue to consume locally popular grains (e.g., rice in Asia) even though more calorie-efficient and cheaper grains (e.g., millets) may be available.[67]

- **Reducing consumer food waste (US$175–220 billion).** According to the FAO, total food waste is worth about US$1 trillion today. The World Resources Institute (WRI) estimates that roughly 35 percent of food is wasted at the consumption level.[68] Most of this occurs in developed countries: for example, one third of fruits and vegetables purchased by consumers in North America and Oceania are thrown away, whereas only 5 percent is wasted in Sub-Saharan Africa.[69] Given the SDG goal of halving consumer waste, this implies an opportunity of around US$175 billion annually at present, which could increase to US$220 billion by 2030 if food demand continues to grow at historical levels.[70] A range of technologies and business models can be harnessed to reduce consumer food waste. These include packaging solutions to avoid spoilage (like BluWrap and ethylene-removal technology); retrofitting dining facilities to switch to trayless dining (smaller plates and trayless dining can nudge customers to waste less in all-you-can-eat settings); better tracking of waste within restaurants and food service; and the promotion of 'secondary retailers' who can make products from the still-usable produce.[71] Key barriers include low consumer incentives (given food is a relatively low-budget item for consumers in developed countries) and the need for behaviour change among consumers, retailers and restaurateurs.

- **Product reformulation (US$110–205 billion).** Reformulating meals and processed food products to rebalance nutritional content is one of the major levers to tackle NCDs such as obesity and cardiovascular disease. Product reformulation has been successfully applied to reduce salt intake in the UK, Australia, New Zealand and Canada, and there is strong evidence for its efficacy.[72] Given the largest beneficiaries are disadvantaged groups in the population, it also plays a role in reducing health inequality. In the UK, product reformulation was estimated to have the potential to save 1,709 thousand of disability-adjusted life years (DALYs) at an average cost of US$2,600 per DALY.[73] Product reformulation could provide food manufacturers with the ability to tap new markets of health-conscious consumers. However, there are barriers to overcome including boosting R&D investment, ensuring consumer acceptance, and adapting manufacturing and supply chain processes. For instance, substitution of sugar for sweetener can impact baking time, shelf life and other inputs.

- **Technology in large-scale farms (US$145–180 billion).** Large-scale farms (farms with more than two hectares of land) account for an estimated 70 percent of global land under cultivation.[74] While large-scale farms have on average double the yields of equivalent smallholder farms, academic evidence shows their yields can be improved by a further 40 percent over the next 20 years.[75] One of the key strategies is to improve the diffusion of technologies. For example, the Brazilian Agricultural Research Corporation, known as Embrapa, has pioneered more than 9,000 technology projects to develop Brazilian agriculture, including designing tropical strains of the soybean and other crops that can thrive in Brazil's climate.[76] Other applications of technology associated with this opportunity include using big data techniques to optimise crop yield, fitting tractors with global positioning systems (GPS) and multispectral sensors (to allow precise application of nitrogen), farm-management software, drone technology and advanced robotics.[77] The critical barriers relate to capital requirements (and gaps in local financial systems) to support

investment in precision farming; lack of basic infrastructure connecting farms to markets; and the need to manage potential negative impacts on the environment through appropriate use of fertilisers and soil management.

- **Dietary switch (US$85–140 billion).** The environmental footprint of vegetarian diets is substantially lower than diets based on animal consumption – less land, water and fertiliser are required. Similarly, the resource intensity of producing beef is estimated to be 10 times larger than a calorie-equivalent amount of poultry and pork: up to 26 times more land, 10 times more water and five times the GHG and nitrogen emissions.[78] The resource difference is such that the production of meat – and beef in particular – often requires subsidies to be viable. While meat production may decline, the shift to less resource-intensive diets could generate considerable growth for the private sector in other areas of agricultural production. Consumer preferences are already starting to change in some developed countries, and may be further pushed by price signals as resource subsidies are removed. Better education of consumers will also be important – there is an information failure related to the benefits of different diets, including the ability of plant-based diets to provide the required amount of nutrients and protein.[79] The Chinese government, for example, has recently issued new dietary guidelines and begun a public education campaign aimed at reducing meat consumption by up to 50 percent.[80] Capital investment would also be required to increase the productive capacity for cereals and vegetables, and/or pork and poultry. This cost may be offset by increasing land values as pasture land is transformed to crop land.

- **Sustainable aquaculture (US$20–125 billion).** High-value aquaculture is a promising source of sustainable nutrition. Overfishing of wild caught fish combined with increasing demand for food mean that aquaculture is a growing industry, projected to almost double in size in the next 15 years.[81] At the same time, aquaculture is a relatively immature practice with large scope for technological improvement. Compared to livestock production, the feed, disease control, waste management and other farming techniques are underdeveloped in aquaculture. The increased productive capacity that will be enabled through technological improvements and improved waste management systems alone implies a US$20 billion supply opportunity. There is also strong potential for growth in the sustainable aquaculture market to accelerate as communities adopt more sustainable diets.

- **Technology in smallholder farms (US$75–105 billion).** Some 1.5 billion people are dependent on smallholder farm production (defined as farms with less than two hectares of land). They are still operating at a low-income, subsistence level, and are vulnerable to ongoing environmental risk.[82] Helping these farmers to raise yields is important for not only food production and environmental stewardship (given they account for 30 percent of cropland), but for tackling rural poverty. The scope for improvement is large. For example, smallholder Indonesian palm oil producers account for one-third of production and achieve yields that are approximately 50 percent lower than large plantations.[83] Academic evidence shows there is the potential to double current yields – more than on large-scale farms.[84] The range of levers for achieving this yield improvement include extension services, new technology for greater connectivity, improved access to capital (to fund acquisition of necessary equipment), aggregation mechanisms (to achieve economies of scale among smallholders) and better links to markets. A meta-study of smallholder extension services

found a median rate of return of 58 percent, and the available case study evidence demonstrates the large potential impact on total factor productivity (through more capital per worker, better use of fertilisers and improved farming practices).[85]

- **Micro-irrigation (US$70–85 billion).** Many farms continue to rely on the outdated technique of flood irrigation to water their crops, whereby water is delivered to the surface of the cropland and allowed to be absorbed by the plants. This sees a large amount of water loss due to evaporation and runoff. Sprinkler and drip irrigation systems deliver a lower amount of water more efficiently. The use of sprinklers can improve yields by 5–20 percent and reduce the water required by 15 percent. Drip irrigation is even more effective, improving yields by 15–30 percent while reducing the water required by 20–60 percent. Together, these levers have the potential to save net withdrawals of 250 billion to 300 billion cubic metres of water in 2030.[86] Barriers include capital requirements, lack of information about the benefits of irrigation techniques, and high subsidies for water in many countries.

- **Restoring degraded land (US$70–85 billion).** Land degradation can be physical (such as soil erosion), chemical (such as leaching and salinisation) or biological (through loss of vegetation and deforestation).[87] The FAO found that 33 percent of land globally is moderately or highly degraded.[88] Each year about 12 million more hectares are degraded. Research indicates that soil degradation could reduce the yield of soils currently in agricultural production by about 30 percent by 2050.[89] The net rates at which land degradation is occurring can be reduced either by preventing ongoing degradation through more conservational farming practices, such as no-till agriculture, or restoring degraded land through such practices as terracing and topsoil replacement. This can have short-term productivity costs, but the academic evidence suggests that over the longer term (5–10 years), yields are likely to increase and could come close to or reach conventional tillage yields. Moreover, when practised together with residue retention and crop rotation in the context of conservation agriculture, there could be further improvements in land productivity.[90] In some cases, rural incomes have more than doubled after implementation of land rehabilitation programmes. Key challenges include the capital-intensive nature of the process (particularly for severely degraded land), lack of clear land ownership and the need for significant behaviour change and capability building among smallholder farmers to adopt practices such as no-till or low-till agriculture.

- **Reducing packaging waste (US$40–65 billion).** Over 95 percent of the economic value of plastic packaging is lost, with only 15 percent of produced material collected for recycling, and a recycling value yield of only 30 percent. The plastic packaging economy is meanwhile expected to double in value by 2030.[91] With a third of produced plastic lost to pollution in ocean and land ecosystems, and just under half placed in landfills, there are ample opportunities to increase the amount of material that is recycled. Recovering the amount currently lost to landfills and pollution will require a major change in consumer behaviour. Public policy and business initiatives will need to cooperate to identify the most effective means to change recycling habits. Success in improving recycling rates in other resources suggests there is good reason to believe improvement is achievable – for example, over 60 percent of the value of paper is captured through recycling.[92]

- **Cattle intensification (US$15–55 billion).** Around 70 percent of the grains used by developed countries are fed to animals. Overall, livestock consume an estimated one-third or more of the world's cereal grain, with 40 percent of such feed going to ruminants, mainly cattle.[93] There are opportunities to improve productivity and reduce the impact of cattle on forests, through control of transmissible diseases, adopting smart supplements (the productivity of ruminant animals can often be boosted with supplements, some of which encourage microbes in the rumen to grow quickly and to provide better nutrition), and selection of marginal areas (e.g., mountainsides or low-lying wet grasslands) for grazing.[94] Experts suggest that there is an opportunity for a 15–20 percent feed efficiency improvement through feed additives and improved practices.[95] Academic evidence also suggests that cattle stock intensification leads to reduced deforestation. For example, between 1996 and 2006, the productivity of cattle grew by 57.5 percent in the average Amazon municipality, and this was associated with reduced deforestation.[96] Continued research to support innovation in feed additives and disease control will be essential to support this opportunity.

- **Urban agriculture (US$20–40 billion).** An estimated 800 million people grow food in urban and peri-urban environments, both for their subsistence and as a supplementary source of income.[97] Urban agriculture improves the food security of the urban poor by increasing the supply of food to growing urban populations, and lowering costs due to reduced transportation and storage. In addition to catering to growing demand, urban agriculture also increases resource efficiency, improves the economic independence of women, and may help to mitigate climate change.[98] The vast majority of urban agriculture currently occurs at small scale, and yields are low. Productivity could be significantly increased by connecting urban farmers to regional supply chains and offering training and better equipment. For example, in recent years, several cities in Latin America have improved the incomes of households involved in urban agriculture by facilitating the growth of networks and businesses that provide productivity-enhancing services.[99]

What is not on this list? Some opportunities may have long-term impact, but minimal impact by 2030. For example, second-generation biofuels, also known as advanced biofuels, can be manufactured from various types of biomass (i.e., any source of organic carbon that is renewed rapidly as part of the carbon cycle). Second-generation biofuels are not yet produced commercially, but a considerable number of pilot and demonstration plants have been announced or set up in recent years, with research activities taking place mainly in North America, Europe and a few emerging countries (e.g., Brazil, China, India and Thailand). The IEA has estimated that second-generation biofuels could account for 90 percent of biofuels by 2050, but uptake before 2030 is likely to be low.[100]

Benefits of a more sustainable food and agriculture system

The realisation of these business opportunities in the food and agriculture system could also help deliver a wide range of societal benefits (Exhibit 17).

Exhibit 17

Business opportunities in food and agriculture could also deliver a range of societal outcomes, linked to the SDGs

Challenge	Business opportunities	Relevant SDGs	Societal outcomes
Food security	▪ Sustainable aquaculture ▪ Low-income food markets ▪ Technology in large scale farms ▪ Urban agriculture	  	▪ Ensure food security ▪ Reduced malnutrition impacting over 800 million people that are hungry
Poverty alleviation	▪ Technology in smallholder farms ▪ Restoring degraded land	 	▪ Potential to double incomes of 1.5 billion smallholder farmers
Addressing climate change	▪ Dietary switch ▪ Cattle intensification ▪ Forest ecosystem services	 	▪ Reduction in the 24% of GHG emissions that come directly from food production ▪ Potential to mitigate total emissions by up to 10% by 2030 through improved forestry management
Reducing waste	▪ Micro-irrigation ▪ Reducing food waste in the value chain ▪ Reducing consumer food waste ▪ Reducing packaging waste ▪ Dietary switch ▪ Restoring degraded land	   	▪ Agricultural water consumption falling by 15% ▪ Halving of consumer food waste ▪ Reduction of food wasted in the supply chain ▪ Plastic waste reduced in the oceans ▪ Zero further degradation of cropland
Better health and well-being	▪ Product reformulation ▪ Dietary switch ▪ Low-income food markets		▪ Global obesity in 2030 falls from projected 41% of population to Japanese levels (5%), implying over3 billion less people that are obese ▪ Reduction in child mortality, 45% of which is attributable to poor nutrition

Source: McKinsey Global Institute; New Climate Economy; WHO; AlphaBeta analysis

These include:

- **Food security.** Improved technology in large farms would substantially increase agricultural yields and productivity, helping to better feed over 800 million people who are hungry. Growth of sustainable aquaculture could also support food security by expanding the supply of efficient, affordable protein in developing countries. Adequacy of food supply, however, is only one element of the food security challenge. Distribution is also critical to ensure safe and affordable food is available to all people all the time. Stronger private sector participation in low-income food markets could enhance distribution systems and better ensure access for the poor.

- **Poverty alleviation.** The world's 1.5 billion smallholder farmers have the highest incidence of the poverty amongst all sectors of the global economy. Better technology in smallholder farming through aggregation, extension services, access to capital and other levers could increase yields and productivity, which would lower poverty rates. While smallholder farmers only account for a relatively small share of global agricultural output, in some developing countries they contribute up to 90 percent of agricultural production and over half of all employment.[101] Improving their livelihoods would make a major contribution to poverty reduction efforts worldwide.

- **Addressing climate change.** A number of opportunities could reduce the impact of the food and agriculture system on greenhouse gas emissions and hence climate change. Switching to vegetarian diets or diets including pork and poultry – which have a lower carbon intensity than diets rich in red meat – could lower emissions by a factor of six. Intensification of cattle production could reduce land demands and associated deforestation. Halting all deforestation and reversing forest degradation could mitigate up to 10 percent of total emissions globally by 2030.[102]

- **Reducing waste.** More sustainable and efficient use of resources will be critical to meeting growing food demand. Food waste in both the supply chain and at the consumer level – which amounts to about 24 percent of all calories produced for human consumption – could be reduced by up to 50 percent.[103] Use of micro-irrigation techniques could lead to savings of 15 percent in agricultural water consumption. The food packaging system is also a major source of waste and resource inefficiency. The move to a more circular model could significantly decrease landfill waste and ocean pollution. Restoration of degraded land would also lessen waste and inefficiency in land usage, and prevent deforestation by increasing the supply of quality land for agriculture.

- **Better health and well-being.** Obesity is estimated to have a global social cost of over US$2 trillion at present.[104] Product reformulation – and other levers – have the potential to lower obesity levels in 2030 from a projected 41 percent of the global population to around 5 percent, the level in Japan. Reduced malnutrition and undernutrition through improved food security would have significant benefits for health and well-being – poor nutrition is responsible for 45 percent of deaths in children under five.[105]

4. CITIES

The challenges in cities

By 2030, 60 percent of the world's population will live in cities, up from about 54 percent today – adding over 1 billion people to cities over the next 15 years.[106] Over the next two decades, nearly all of the world's net population growth is expected to occur in urban areas, with about 1.4 million people – close to the population of Stockholm – added each week.[107]

Urbanisation is a crucial driver of economic growth. In fact, no country has ever climbed from low-income to middle-income status without a significant population shift into cities.[108] The underlying causes of this include the scale benefits to economies from larger cities, as well as the higher wages that people typically receive as they shift from farming to urban manufacturing and services. However, this urbanisation also poses a series of challenges to inclusiveness, the environment, economic efficiency, health and cultural heritage:

- **Inclusiveness.** The growth of cities can lead to inclusiveness challenges, particularly as housing becomes increasingly expensive. By 2025, one-third of the urban population (or 440 million urban households) could lack access to affordable housing.[109]
- **Environment.** While the environmental footprint of individuals tends to be significantly lower in cities than in rural areas, the phenomenal growth of cities could still pose significant environmental challenges. Urbanisation could consume an estimated 2 million hectares of land per year, with about three-quarters of that being agricultural land.[110] In addition, cities are responsible for around 70 percent of global energy use and energy-related GHG emissions.[111] Many cities are also highly exposed to natural disasters and environmental concerns, particularly rising sea levels. A UN assessment found that more than 70 percent of the world's major cities are already highly vulnerable to flood-related mortality and economic losses.[112]
- **Economic efficiency.** A large share of urban growth around the world involves unplanned, unstructured urban expansion, with low densities and high rates of car use. This not only increases the land requirements of cities, but also adds to congestion. The number of cars could almost double, from 1.2 billion today to 2 billion by 2035.[113] Congestion is already close to unbearable in many cities and can cost as much as 5 percent of national GDP, by measures such as lost time, wasted fuel and the increased cost of doing business.[114] Urban sprawl could further increase these costs. This can double the land per housing unit, increase the costs of providing utilities and public services by 10–30 percent or more, and increase motor travel and associated costs by 20–50 percent.[115]
- **Health.** Almost 3 million premature deaths each year are attributable to ambient air pollution.[116] Urban air pollution is projected to become the top environmental cause of premature mortality by 2050. Access to clean water and sanitation remains challenging in the fast-growing cities of the developing world, with almost 20 percent of urban dwellers still

lacking improved sanitation facilities.[117] In addition, poor urban planning could also increase the incidence of non-communicable diseases. Obesity is three to four times more prevalent in cities than in rural areas, linked to changes in diets and lack of exercise.[118]

- **Cultural heritage.** Rapid urbanisation can risk the destruction of cultural heritage in cities unless the process is carefully managed. In a speech in 1995, Singapore's founding father, Lee Kuan Yew, reflected: "We made our share of mistakes in Singapore [...] In our rush to rebuild Singapore, we knocked down many old and quaint Singapore buildings. Then we realised we were destroying a valuable part of our cultural heritage."[119] Many other cities, particularly in Asia, have also lost significant cultural heritage due to rapid urbanisation.

A vision for sustainable cities

The SDG agenda proposes to meet these serious challenges by shifting cities onto a sustainable development pathway. This shift will transform the whole cities system, with major impacts across the value chain. By mapping these impacts, a vision for a new, SDG-compatible cities system becomes clear (Exhibit 18).

- **Mobility.** Some of the most fundamental shifts in cities through the implementation of SDGs will occur in mobility. The SDGs aim to improve access to transport systems and reduce the adverse environmental impacts of cities, including air pollution. In the transition required to meet these challenges, the traditional, low-efficiency vehicles with internal combustion engines that are most commonly used for private transport will experience slow decline in favour of public transport, cycling, walking, and electric and hybrid vehicles. One of the biggest winners will be software companies. Consumers can already use apps on their electronic devices to find out about real-time traffic conditions and reroute journeys away from heavy traffic; access car sharing, e-hailing and on-demand private shuttles; find appropriate routes for cycling and walking; and enable public transit agencies to analyse and improve network performance.[120] Transport systems will increasingly become more multimodal, on-demand and shared, increasing consumer choice and convenience.

- **Transport infrastructure.** Transport infrastructure will also need to evolve to sustainably manage access and respond to changing mobility systems. Smart pricing for the use of road infrastructure is one likely option to manage congestion and vehicle traffic in cities. As improving access to public transport becomes a priority, the construction of roads for private vehicles will slow in favour of bus rapid transit systems, rail and metro.

- **Non-residential buildings.** Improving energy efficiency is an important objective of the SDGs. In non-residential buildings, energy-efficiency interventions will become mainstream, including more energy-efficient heating and cooling systems, and better lighting technology, and will be incorporated into building design processes. New approaches will develop to improve the use of existing office and non-residential buildings, including office sharing and telecommuting.

- **Residential buildings.** Various aspects of residential buildings will be transformed in the implementation of the SDGs, with a focus on increasing the supply of affordable housing, less wasteful construction and design techniques, and more efficient energy use. Construction will shift towards more modular and durable designs and materials. Energy savings will be achieved by using more energy-efficient cooking, cooling, heating and lighting appliances. Increasing penetration of smart meters will also help consumers manage their energy use. District energy systems will be deployed at scale, enabling the use of low-grade waste heat from electricity generation and free cooling sources such as seawater.
- **Water and sanitation infrastructure.** Water and sanitation infrastructure will need to rapidly expand to ensure universal access to clean water and sanitation in the world's cities. Utilities will also focus on actively monitoring and addressing water leakage to improve efficiency, and using technology to better match wastewater generators with potential users.
- **Tourism.** The SDGs aim to improve the protection of cities' cultural heritage, while growing opportunities for sustainable tourism. This creates an opportunity to enhance the focus on heritage-linked tourism, especially given the strong forecast growth in tourism. Cities – particularly those expanding quickly – will need to shift from current attitudes of indifference to their existing heritage to ensure they take advantage of this growth.

Exhibit 18

A sustainable development pathway could result in significant shifts in cities

Value Chain Area	Current Value US$ billions[1]	From...	To...
Mobility	4,000 (Automotive)	▪ Individual car ownership ▪ Traditional ICE vehicles ▪ Self-driven vehicles ▪ Truck-based transportation ▪ Low vehicle connectivity ▪ Private vehicle ownership ▪ Basic safety devices	▪ Shared mobility options ▪ EVs and hybrids ▪ Autonomous vehicles ▪ Multi-modal transport models ▪ In-vehicle connectivity ▪ Public transport ▪ Active and advanced safety equipment
Transport infrastructure	1,500	▪ Free road usage ▪ Road and freeway construction	▪ Smart pricing for usage of road infrastructure ▪ Growth in rail and metro construction
Non-residential buildings	2,497	▪ Using halogen and inefficient lighting solutions ▪ Fuel-intensive methods for water and space heating ▪ Vacant office space ▪ Low resilience to climate-related weather events ▪ Building-level heating and cooling systems	▪ Energy-efficient lighting solutions in building ▪ Using electricity/renewables for space and water heating ▪ Office sharing ▪ Climate-resilient buildings ▪ District heating and cooling systems
Residential building	2,997	▪ Lack of low-cost housing ▪ Resource-inefficient construction ▪ Fuel-intensive methods for water and space heating ▪ Energy inefficient appliances ▪ Inefficient use of energy for consumers	▪ Affordable housing models ▪ Durable and modular design in buildings ▪ Using electricity/renewables for space and water heating ▪ Energy efficient appliances ▪ Smart metering
Water and sanitation infrastructure	565	▪ Poor infrastructure in developing countries ▪ Lack of investment in managing water leakage rates	▪ Universal access to quality infrastructure ▪ Water efficiency/leakage prevention systems
Tourism	1,245	▪ General tourism	▪ Promoting heritage and cultural tourism

Source: McKinsey Global Institute; World Tourism Organisation; IHS global construction outlook; AlphaBeta analysis

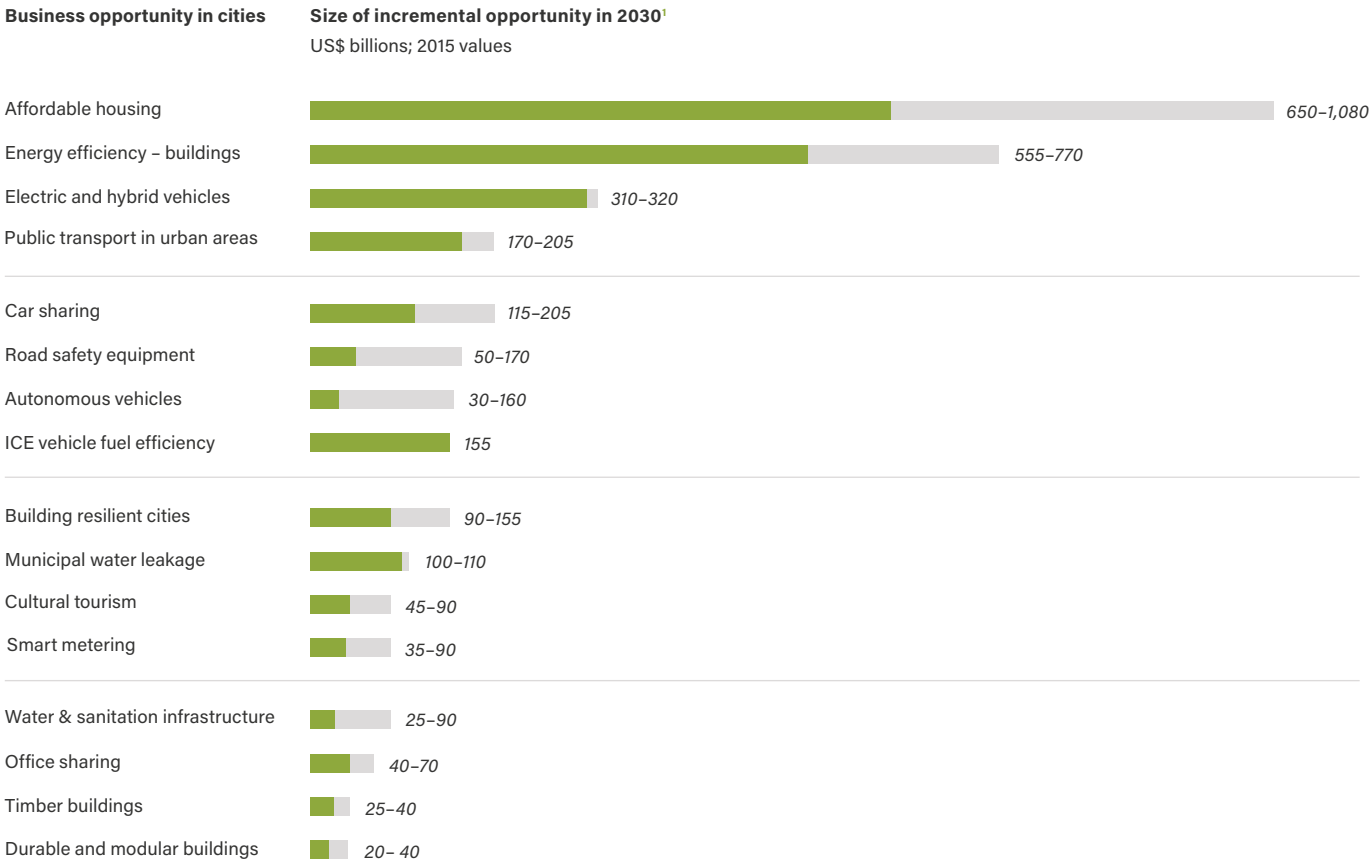
[1] Mobility includes revenue size of the automotive market from McKinsey Global Institute (MGI); transport includes the historical investment in roads, rail, airports and ports estimated by MGI; Residential and non-residential data is from IHS on market size of global construction segment ; water infrastructure is the historical spend on infrastructure estimated by MGI; Tourism is the international tourism receipts in 2014.

Business opportunities in an SDG-compatible world

These extensive changes throughout the cities system will lead to the emergence of a number of disruptive business opportunities (Exhibit 19).

Exhibit 19

The largest opportunities in cities could be worth more than US$3.7 trillion in 2030



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or project market sizings in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest US$5 billion.

- **Affordable housing (US$650–1,080 billion).** As of 2012, 330 million urban households were living in inadequate housing. This is expected to increase to 440 million by 2025. To replace today's inadequate housing and build the additional units needed by 2025 would require US$9 trillion to US$11 trillion in construction spending alone. With land, the total cost could be US$16 trillion.[121] The current housing affordability gap is US$650 billion, which is the difference between the income available for housing and the annualised market price of a standard unit.[122] This affordability gap is set to grow as the number of households needing affordable and adequate housing will increase by 2030. Realising this opportunity will require efforts to unlock new land through innovative mechanisms (e.g., providing density bonuses to developers that permit them to increase the floor space on a plot of land in return for providing land for affordable units); employing available efficiency techniques to reduce costs by up to 30 percent; reducing operations and maintenance costs through energy-efficiency retrofits and consolidated supply purchasing; and supporting access to lower-cost financing options for developers and purchasers.[123]

- **Energy efficiency – buildings (US$555–770 billion).** The building sector currently accounts for around one-third of total final energy consumption and more than half of all electricity demand.[124] There are large opportunities to improve building energy efficiency through two main channels. Firstly, heating and cooling performance can be improved by retrofitting existing buildings and installing more efficient technology in new buildings. An alternative approach is to shift from building-level installations towards the expansion of district heating and cooling, which can deliver operational efficiency gains of up to 90 percent by linking electricity and heating sectors through cogeneration.[125] Secondly, switching to efficient lighting, appliances and electronics can reduce demand. There are, however, challenges in implementing these reforms in existing buildings, since significant capital and product innovation are required to replace existing heating, cooling and lighting appliances in buildings. The key to achieving substantial reductions in building energy use is to analyse the building as an entire integrated system, rather than focusing on incremental improvements to individual energy-using devices.[126] A range of levers could be applied to help tackle these barriers, including enacting energy-efficiency standards in new construction and developing innovative financing mechanisms to help overcome capital constraints.

- **Electric and hybrid vehicles (US$310–320 billion).** Market research predicts that annual sales of battery-powered electric vehicles (EVs) and hybrid vehicles will increase from about 2.3 million units in 2014 to 11.5 million by 2022, or 11 percent of the global market.[127] Assuming an average lifespan of 15 years, the total global passenger vehicle fleet will turn over completely by 2030, leaving ample opportunity for a huge increase in EV and plug-in hybrid electric vehicle (PHEV) penetration. It is estimated that electric and hybrid vehicles could comprise 62 percent of new light-duty vehicle sales in 2030, though that depends on significant and continued falls in the cost of batteries.[128] Along with innovation in battery technology to improve range and reduce cost, investment would also be required for the development of charging infrastructure to facilitate the smooth running of these vehicles.

- **Public transport in urban areas (US$170–205 billion).** In modern, denser cities with medium- and high-density housing, public transport is the most effective solution to urban mobility needs. Jeffrey Zupan of the New York Planning Association has suggested that public transport becomes viable at a threshold of around seven dwellings per acre.[129] If a quarter of passenger kilometres were shifted from light-duty vehicles to a mix of public transport modes, it could reduce energy consumption by 5 QBTU in 2030.[130] Investment in public transport has also been shown to cut congestion costs and reduce household transport expenditure by 20 percent.[131] The spread of bus rapid transit (BRT) to over 160 cities since the first system was introduced in 1974 indicates the potential of lower-cost systems in enabling greater access to public transport, particularly in developing countries where cities' fiscal capacities are more limited.[132] There is an opportunity for the private sector to both build and operate public transport systems, in close partnership with government.

- **Car sharing (US$115–205 billion).** Evolving mobility options are set to change the landscape of the current automotive industry and private-vehicle ownership patterns. According to a study by McKinsey, most cars sit idle 90 percent of the time or more.[133] It is expected that car sharing could improve vehicle usage significantly, and may also reduce the number of cars on the roads at the same time. Widespread car sharing would also mean more intensive use of each vehicle, increasing average annual mileage from 11,700 to 20,400. Car-sharing services have grown at roughly 35 percent a year in the US alone, reaching 1.6 million members in 2014.The future pace of growth for this opportunity will depend on how the technology and product evolve to facilitate 'ease of use' for customers, together with capital investment to ensure that the infrastructure (e.g., car fleets) is in place.

- **Road safety equipment (US$50–170 billion).** Road accidents are the leading cause of death among people aged 15–29, and in developing countries are responsible for economic losses of up to 5 percent of GDP.[134] The SDGs have an ambitious target of halving the number of deaths and injuries from road accidents, and increasing the penetration of new road safety devices will be critical to reaching that goal. Safety control devices in cars will constitute 32 percent of global auto electronics sales in 2016, and there remains significant further opportunity for investment in new technologies.[135] The introduction of Car2X, which enables cars to communicate with their surroundings, could prevent up to 60 percent of road traffic accidents and related fatalities and injuries.[136] Continuous innovation and talent development will be needed to ensure that road safety devices and equipment are seamlessly integrated into vehicles, and hence accepted by consumers.

- **Autonomous vehicles (US$30–160 billion).** The use of autonomous vehicles is expected to grow significantly over the next two decades, with some estimating that 12 million fully autonomous vehicles will be sold globally by 2035.[137] The benefits of autonomous vehicles include fewer road accidents, reduced need for parking spaces and also less congestion in cities. By reducing the human error factor in driving, it is estimated that autonomous vehicles could cut accidents by as much as 90 percent.[138] To realise this opportunity, the private sector would need to invest significantly in developing the technology, reorganising supply chains and training personnel.

- **Internal combustion engine fuel efficiency (US$155 billion).** Continued improvement in the fuel efficiency of internal combustion engines (ICE) will be particularly important for cities, not only because of the fuel savings for drivers but also because of the impact on air pollution. By 2030, vehicle manufacturers could potentially reduce fuel consumption by an additional 0.6 litres per 100 kilometres, resulting in a final consumption rate of 4.3 litres per 100 kilometres, or nearly 40 percent below today's levels. Light-duty vehicles could therefore travel the same distance as a car from 1975 with only one-quarter of the fuel. Medium-duty trucks have the potential to improve their fuel efficiency by 11 percent and heavy-duty trucks by 13 percent.[139] Capturing these opportunities will require strong regulatory frameworks from government and coordinated investment in research and development.

- **Building resilient cities (US$90–155 billion).** Urban resilience is defined as the capacity of individuals, communities, institutions, businesses and systems within a city to survive, adapt and grow no matter what kinds of chronic stresses and acute shocks they experience.[140] While the chronic stresses are mostly due to growing urbanisation, the acute shocks are mostly likely to come through events caused or exacerbated by climate change. Previous global estimates of the costs of adaptation have been placed at US$70–100 billion annually for the period 2010–50. However, in its latest report, the United Nations Environment Programme (UNEP) indicates that the annual costs of adaptation in developing countries alone could range from US$140 billion to US$300 billion by 2030.[141] The World Bank has estimated that up to 80 percent of these costs could be concentrated in cities. The private sector has the opportunity to participate in the adaptation process in cities by innovating technical solutions to climate challenges and building climate-resilient infrastructure. Barriers include large capital investments and the need for strong coordination with the public sector to achieve this opportunity.

- **Municipal water leakage (US$100–110 billion).** The rate of leakage in municipal water systems varies widely, even among developed economies. While Germany has a leakage rate of just 5 percent, the United Kingdom's rate is 25 percent. MGI estimates that between 100 billion and 120 billion cubic metres of water could be saved annually by 2030 through reducing leaks in the supply of bulk water in commercial, residential and public premises. While returns from water efficiency investments are often attractive (at above 20 percent), the high capital costs and a lack of awareness among utilities about the benefits of reducing leaks can act as barriers to change.

- **Cultural tourism (US$45–90 billion).** Cultural tourism is estimated to account for 40 percent of total international tourism, according to the World Tourism Organization, and could grow to a US$90 billion opportunity by 2030.[142] It also has a number of important advantages for countries. It is a labour-intensive sector that can provide significant opportunities for low-skilled workers. It can also engender the development of a more liveable city that can also become a comparative advantage in attracting a highly mobile and skilled workforce. Cities such as Agra in India and George Town in Malaysia have generated significant growth from cultural tourism. A key challenge for cities is to put in place a balanced blend of regulation and incentives to preserve urban heritage and to support coordination of tourism providers along the supply chain.

- **Smart metering (US$35–90 billion).** Smart meters are electronic measurement devices that maintain two-way communication between the consumer and the utility and also manage the electrical system of the consumer. By 2014, there were close to 45 million smart meters already installed in Finland, Italy and Sweden[143], while 50 million smart meters had been deployed in the United States, covering more than 43 percent of homes.[144] The advantages associated with smart metering include improved accuracy in meter reading, advanced data recording and energy consumption tracking. By providing consumers with real-time feedback on their energy usage, it helps them to reduce and 'time shift' their consumption to off-peak periods when prices are lower. Switching to smart meters requires considerable upfront investment to replace conventional meters, and education of consumers to use the tool effectively.

- **Water and sanitation infrastructure (US$25–90 billion).** Increasing urbanisation has created additional pressures on already lacking water and sanitation infrastructure, especially in the developing world. Currently, 828 million people live in slums or informal settlements that are scattered around the world's cities. Providing adequate water and sanitation facilities for them is a major challenge and an important effort in improving public health.[145] There is a significant opportunity for the private sector to collaborate with governments in building and maintaining this infrastructure. However, large and long-term capital investments will be needed to match water and sanitation facilities to the growing urban population. A major barrier to these investments is the subsidised prices of both water and wastewater treatment in many countries, which do not reflect the societal cost of managing this important resource.

- **Office sharing (US$40–70 billion).** It is estimated that approximately 40 billion square metres of floor space globally remains under-used during office hours.[146] This points to a significant opportunity to better use existing office and commercial space in cities to meet emerging demand. This will reduce the need for new office space to be constructed and improve the productivity of precious urban land. New shared office and co-working models provide tenants with greater flexibility, reduce upfront costs and foster new forms of collaboration. Further development of technology platforms (e.g., applications and websites) will be necessary to make office sharing easily accessible to customers, and tenants may need to be educated to accept a different style of office environment with reduced privacy and less customised facilities.

- **Timber buildings (US$25–40 billion).** Increasing the supply of affordable housing and other urban infrastructure will generate greater demand for construction materials. However, the production of concrete and steel – the most commonly used materials – is highly carbon intensive and is collectively responsible for almost one-tenth of global GHG emissions.[147] Wood-based building materials, in contrast, can be produced with fewer emissions and are able to store carbon dioxide during the life of the building. Life cycle analysis indicates that substituting 1 kilogram of timber leads to average savings of 3.9 kilograms of carbon dioxide (CO_2).[148] The development of composite timber building products, such as glulam and cross-

laminated timber, has widened wood's ability to replace steel and concrete by enabling the production of larger structural members.[149] The greater application of timber in construction may also provide a business model to stimulate investment in reforestation. In this regard, it is preferable to other wood uses, such as paper, that capture carbon for shorter time periods and are more likely to experience structural decline in demand.[150] To achieve this opportunity, further investments in product innovation will be needed to develop a wider range of wood construction products.[151] Governments and the private sector will also have to ensure that additional timber is sustainably supplied from plantations and reforested areas, and does not lead to increased pressure on existing natural forests.

- **Durable and modular buildings (US$20–40 billion).** Better modularity and durability of buildings could help address traditional factors in housing obsolescence, such as changing lifestyles, shifting demographics, an ageing population and poor construction quality. Modularity and durability go hand in hand: modular design enables about 80 percent of the components in the envelope of a building to be re-used and refurbished, which makes investment in more durable components cost-effective.[152] Modularity can also reduce the amount of materials used through more efficient construction processes. It is estimated that 10–15 percent of building materials are wasted during traditional construction methods. Capturing this opportunity would require moving away from traditional construction materials and methods, and innovating in techniques as well as materials. Some reorientation of the existing supply chain would also be necessary.

Some opportunities haven't been included, or have been incorporated within other opportunities. Urban densification, for instance, has been considered as an overarching process affected by public transport, the energy efficiency of buildings and affordable housing. Air pollution is a major challenge for cities, a large social cost and a key goal in the SDGs. Addressing this challenge generates a number of separate opportunities that have been included, such as affordable housing, public transport, electric and hybrid vehicles, and ICE vehicle efficiency. Other related opportunities, including retrofitting factories and air purification, were found not to be individually significant. Residential sharing was also assessed, but the incremental opportunity (in a SDG versus a BAU scenario) is estimated to be relatively small.

Benefits of more sustainable cities

The realisation of these business opportunities in cities will also help deliver a wide range of societal benefits (Exhibit 20).

Exhibit 20

Business opportunities in cities could also deliver a range of societal outcomes, linked to the SDGs

Challenge	Business opportunities	Relevant SDGs	Societal outcomes
Economic development	▪ Affordable housing ▪ Public transport ▪ Cultural tourism	 	▪ Improved urban densification, leading to higher labour and capital productivity
Access to housing	▪ Affordable housing ▪ Durable and modular buildings	 	▪ Addition of **440 million** new units in cities, providing affordable housing to approximately **1.6 billion** people in 2025
Addressing climate change	▪ Energy efficiency – buildings ▪ Public transport ▪ Electric and hybrid vehicles ▪ ICE vehicle fuel efficiency ▪ Smart metering ▪ Timber buildings	 	▪ Energy efficient buildings reduce 2030 energy demand by **4.6%** ▪ Efficient transport systems remove **1.5 billion** tonnes of carbon dioxide annually by 2030 ▪ Substitution of timber for steel and concrete in construction reduces CO_2 emissions by **500 million** tonnes each year
Reducing waste	▪ Car sharing ▪ Office sharing ▪ Durable and modular buildings ▪ Municipal water leakage rates	 	▪ More efficient use of existing vehicles, office and residential space can reduce the cost of new infrastructure ▪ **120 cubic kms** of water saved from reducing water lost from leaking pipes
Better health and well-being	▪ Autonomous vehicles ▪ Road safety ▪ Public transport ▪ Electric and hybrid vehicles ▪ Water infrastructure ▪ Resilient cities	   	▪ Potential for **90%** less road deaths ▪ Reduce the **5 million** premature deaths annually attributable to air pollution ▪ **Universal** clean water and sanitation ▪ Minimise loss to urban infrastructure and human lives due to climate related events

Source: McKinsey Global Institute; New Climate Economy; WHO; AlphaBeta analysis

These societal benefits include:

- **Economic development.** Upgrading slums into affordable high-density housing would enable urban densification to increase. Denser cities are more productive in their use of labour, capital and land, and support increased use of public transport, which also enhances productivity. Research from 261 Chinese cities in 2004, for example, suggested that labour productivity would rise by 8.8 percent if employment density doubled.[153] Urban sprawl, on the other hand, can increase the capital costs of providing utilities and public services by 10–30 percent or more and increase motor travel and associated costs by 20–50 percent.[154] Increasing the productivity of cities, which generate more than 80 percent of global GDP, would stimulate economic growth and prosperity.[155] Expansion of cultural tourism could also support job creation.

- **Access to housing.** Investment in affordable housing could expand the housing stock, upgrade slums and provide approximately 1.6 billion people with adequate and safe housing. Affordable housing helps reduces poverty through multiple channels, including by providing people with an investment asset that can be used as collateral for investment in small business.

- **Addressing climate change.** Opportunities in cities would have a substantial impact on reducing global GHG emissions and mitigating climate change. Improvements to the energy efficiency of buildings could lower total final energy consumption by 4.6 percent in 2030. More efficient transport systems, based on increased public transport and electric and hybrid vehicles, could help avoid 1.5 billion tonnes of carbon dioxide emissions annually. Substitution of wood-based construction materials for concrete and steel could reduce emissions by a further 500 million tonnes per year. Smart metering, by enabling consumers to manage their electricity use more efficiently, could also lead to reduced electricity demand.

- **Reducing waste.** The growth of the sharing economy could significantly improve the efficiency and sustainability of resource use in cities. In car sharing and office sharing in particular, sharing models would better use existing resources and lessen the need for wasteful additional construction and manufacturing. In Europe, shifting to circular (including sharing) economy models in cities could reduce urban sprawl up to 30,000 square kilometres by 2050.[156] A shift to more durable and modular buildings can decrease construction waste and improve reusability of building components. Waste can also be mitigated by reducing leaks in the municipal water systems, saving 100–120 billion cubic metres of water in 2030.[157]

- **Better health and well-being.** The quality of cities is a critical driver of health and well-being, and the SDGs create significant opportunities to improve the health of urban populations. Investments in water infrastructure could ensure clean water and improved sanitation for 828 million people who live in slums or informal settlements scattered around the world's cities.[158] Safe and adequate housing also has a major impact on improving health and well-being. Public transport and electric vehicles could reduce ambient air pollution, including NOx and other emissions, which caused 2.9 million deaths in 2013, most of them in cities.[159] Increasing use of autonomous vehicles could play an important role in reducing road accidents, which are predicted to become the seventh leading cause of death by 2030.[160]

5. ENERGY AND MATERIALS

The challenges in energy and materials

The energy and materials system is at a critical juncture. An intense and broad commodity 'super cycle' temporarily obscured a resource revolution that is now accelerating, driven by technological, macroeconomic and environmental factors. This revolution will create new opportunities and challenges in the form of slower demand growth, more diverse and flexible supply, and new forms of partnership between extractive companies and resource-rich countries.

Some of the challenges include:

- **Uncertain demand.** Resource demand is sensitive to global GDP growth, which could decelerate from its 50-year average of 3.6 percent p.a. to ~2 percent, driven by demographic change and China's transition to a more consumption-driven economy.[161] In addition, consumers are increasingly concerned with the social and environmental impact of products, with greater focus on traceability to ensure production is compliant with environmental and worker rights standards. While overall demand may face some headwinds, over 1.5 billion people are expected to join the consuming class by 2030.[162] In addition, 1.2 billion people still lack access to electricity.

- **More challenging supply.** The world is not running out of energy and mineral resources, but the remaining reserves are increasingly difficult to extract. Proven conventional oil reserves and recoverable unconventional reserves (such as tar sands) can meet expected demand for the next 55 years. In addition, more than 300 years of untapped potential exists in unconventional resources that are currently uneconomical to recover. A similar case exists for mineral resources. However, production is shifting to more complex supply sources, including tar sands and deep-water oil in the case of energy; and to more remote locations with weak infrastructure and higher political risk in the case of mineral resources. Water access could also significantly constrain output given that 32 percent of copper mines and 39 percent of iron ore mines are in areas of moderate to high water scarcity. This not only increases the risk of disruptions to supply but also makes supply even more inelastic. Historically, almost 90 percent of that investment has been in high-income and upper-middle-income countries. But in the future, the share of resource investment outside these two groups – to low-income and lower-middle-income countries – could almost double.[163] These changes will mean that extractive companies will not only have to increasingly focus on improving cost efficiency (which is already starting to happen given the current state of the commodity cycle), but also form stronger partnerships with developing countries that can address the political risks and other concerns that have plagued previous relationships.

- **A difficult regulatory environment.** The extractives sector faces a number of regulatory challenges. Climate regulation could impact capital investment in energy, creating potential stranded asset risk affecting US$300 billion of assets 2035.[164] Pricing of carbon and water would significantly alter cost curves for major resources and fuels. For example, pricing

water to reflect its 'shadow cost' (i.e., the economic value of the water if put to its best alternative use) could increase iron ore costs by 3.3 percent across the industry.[165] There is increasing focus on reducing more than US$400 billion of global fossil fuel subsidies, which could significantly impact demand by increasing end-user prices. Furthermore, supply of municipal solid waste may increase by 70 percent to 2025, increasing the cost for governments and using valuable land resources. In response, extended producer responsibility (EPR) regulations are increasingly being put in place, requiring manufacturers to handle the waste generated from their products. More than 30 US states now have at least one EPR law in place.

A vision for a sustainable energy and materials system

The SDG agenda proposes to meet these profound challenges by shifting the energy and materials system onto a sustainable development pathway. This shift will be transformative, with major impacts throughout the energy and materials value chain. Mapping these impacts generates a vision for how a new, SDG-compatible energy and materials system could look (Exhibit 21).

- **Extraction.** The SDGs aim to reinforce natural resource ownership rights and support value addition to commodities in developing countries. As a result, extractive industries will need to evolve their business models to ensure they maintain their 'licence to operate'. Closer engagement with local communities through increasing the local content in their supply chains and partnering to develop shared infrastructure with be critical. A renewed focus on resource efficiency in the SDGs will also drive higher recovery rates in fossil fuels and key metals through improved mechanisation and new recovery technologies. The shift to gas is likely to continue as climate change measures in the SDGs are implemented, given it has a lower carbon intensity than coal or oil.

- **Production.** Manufacturing processes will be transformed by the emphasis of the SDGs on reducing waste and improving energy efficiency and resource efficiency through sustainable production patterns. Circular models based on recycling and remanufacturing may displace linear models in durable goods and automotive, driving changes in product design. Low-visibility supply chains will be replaced with systems offering improved traceability to allow sustainability reporting. Lightweight and high-strength materials will create opportunities to improve material efficiency, reducing waste and energy use. Energy efficiency is also a major objective of the SDGs, which will lead to process changes across the traditional energy intensive (e.g., steel, cement) and non–energy intensive industries.

- **Generation.** Power generation will undergo major shifts as the SDGs call for the share of renewables to increase substantially. The share of coal in global generation may reduce from more than 40 percent to 25 percent, while renewables climb to almost 50 percent.[166] This will have massive impacts on generation infrastructure, spurring demand for smarter grids with increased storage capacity and more interconnection to manage the variable output of the major renewable energy sources. At the same time, the efficiency of fossil fuel generation will

increase as coal plants move to supercritical technology and combined cycle gas turbines become the norm. Remaining coal generation will make increased use of carbon capture and storage to reduce emissions. These shifts will be supported by the rationalisation of inefficient fossil fuel subsidies.

- **Retail.** As value chains become more circular in response to the SDGs, consumers will no longer be end-points but important links. Consumer durables will be leased out or sold back to manufacturers and recyclers at end-of-life. The growth of distributed renewable energy solutions (e.g., rooftop solar PV) will allow consumers to sell energy back into the grid. Consumers' awareness of sustainability and concern with the supply chain of the products they consume will also increase.
- **Disposal.** The importance of disposal and recovery processes in the value chain will grow significantly. The SDGs call for a substantial reduction in waste, and better management of waste and chemicals throughout their life cycle. This will lead to further regulation of end-of-life responsibility and increased collection rates, as well as the development of new facilities for disassembly and remanufacture of products.

Photo credit:
New Belgium Brewery

Exhibit 21

A sustainable development pathway could result in significant shifts in the energy and materials system

Value Chain Area	Current Value US$ billions[1]	From...	To...
Extraction	5,400	▪ Low recovery rates in some fossil fuel extraction ▪ Low levels of local content in supply chain ▪ Weak infrastructure in many resource-driven countries ▪ Coal and oil extraction ▪ Inadequate remediation of mine and well sites	▪ Higher recovery rates based on improved mechanisation ▪ Higher local content, stronger licence to operate ▪ Development of shared infrastructure with local communities ▪ Continued shift to gas ▪ Rehabilitation of post-extractives sites and communities
Production	12,450	▪ Energy inefficiencies in energy and non-energy intensive production ▪ High levels of material waste ▪ Wasteful industrial use of water ▪ Traditional linear production models ▪ Fossil fuel generation equipment ▪ Low visibility along supply chains ▪ Subtractive manufacturing ▪ Traditional chemicals	▪ Improved energy efficiency across production processes ▪ Greater materials efficiency ▪ Improved water efficiency ▪ Circular models ▪ Growth of renewables equipment manufacturing ▪ Supply chain traceability ▪ Additive manufacturing ▪ Green and renewable chemicals
Generation	1,880	▪ Coal-powered generation ▪ Basic gas turbines ▪ Negligible emissions captured ▪ Traditional grids with limited storage capacity from pumped hydro ▪ Centralised, disparate grids	▪ Renewables generation ▪ Combined cycle gas turbines ▪ Capture and storage of emissions ▪ Automated smart-grids with higher storage capacity from batteries ▪ Distributed, interconnected grids
Retail	>1,000	▪ Buying goods, single transaction ▪ Low consumer awareness of product sustainability ▪ Large gaps in energy access	▪ Buying services, circular models ▪ Informed consumers seeking information from business ▪ Universal access to modern energy
Disposal and recovery	860	▪ Landfill disposal ▪ End-of-life destruction	▪ Collection and recycling ▪ Disassembly for remanufacturing

Source: World Mining Congresses; Research and Markets; AlphaBeta analysis

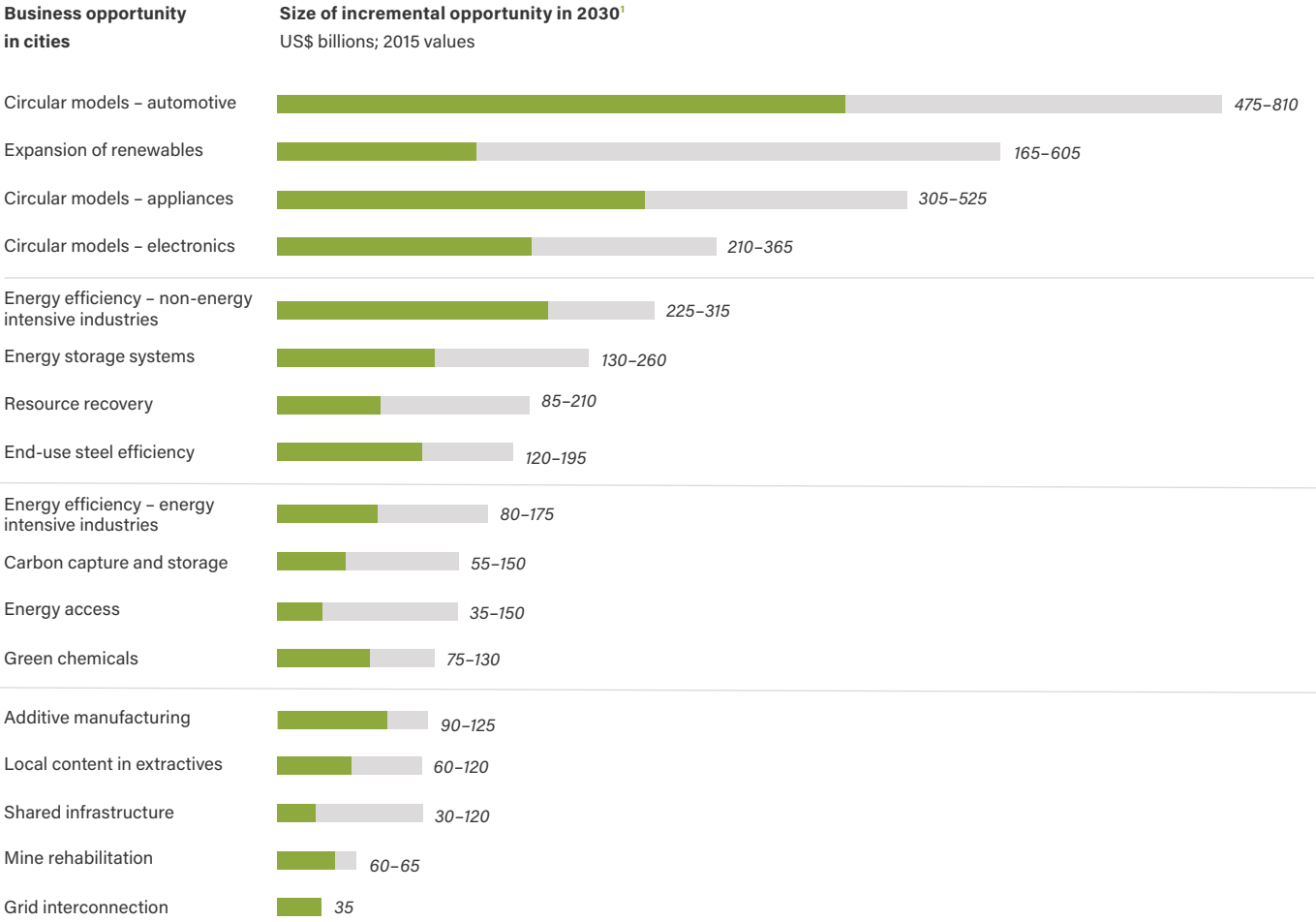
[1] Extraction is the value of total minerals production (excluding diamonds) in 2014, published by World Mining Congresses; Production based on manufacturing share of global GDP (16%); generation size based on global power generation industry revenues in 2014, from Research and Markets; retail is estimated based on multiple sources of value of retail in durable goods and automotive; disposal & recovery is the value of the global industrial waste management market in 2014, from Markets and Markets.

Business opportunities in an SDG-compatible world

These system-wide changes along the energy and materials value chain will lead to a number of disruptive business opportunities emerging (Exhibit 22).

Exhibit 22

The largest business opportunities in the energy and materials system could be worth more than US$4.3 trillion in 2030



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or project market sizings in each area. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest $5 billion.

These include:

- **Circular models – automotive (US$475–810 billion).** Collection rates for vehicles at end-of-life are generally very high – in the EU, for example, they exceed 70 percent.[167] However, most collected vehicles are recycled into base materials, which is energy-intensive and results in loss of value. Given only a small number of 'weakest-link' components are typically responsible for the vehicle's end-of-life, it is possible to significantly extend useful life by increasing rates of refurbishment and remanufacture. This increases the efficiency of material and energy use, and better retains the residual value of the vehicles. However, shifting to a circular model is challenging. Designs will need to better prepare vehicles for disassembly, and capital investment will be required to establish centralised refurbishment plants. Consumers may also resist purchasing refurbished vehicles, though warranties should partly assuage their concerns.

- **Expansion of renewables (US$165–605 billion).** The shift to reduce the carbon intensity of electricity by increasing the share of renewables in the power sector creates a significant business opportunity. In Europe in particular, renewables penetration is already growing quickly – in Denmark in 2015, wind supplied 42 percent of power consumption, while annual global investment in solar PV has been between US$100 billion and US$150 billion over the last five years. IRENA's REmap scenario forecasts that renewables' share of generation could be increased to 45 percent by 2030, against a reference case of 30 percent.[168] Under this scenario, wind would more than quadruple from 3 percent of global generation in 2013 to 14 percent in 2030, and solar PV from less than 1 percent to 7 percent in 2030. This represents a massive opportunity for renewable generators and equipment manufacturers. However, investment would need to grow by 9 percent per annum, and continued investment in innovation will be required to bring down costs, particularly in solar PV. Increasing the penetration of variable renewable energy also poses challenges to grids, which could be met through increasing energy storage capacity and more interconnection.

- **Circular models – appliances and machinery (US$305–525 billion).** Many domestic appliances and industrial machinery are well suited to circular models, in that they are subject to technological innovation and contain multiple parts that can be disassembled and reused. Collection rates at present are lower than for vehicles – generally below 50 percent – so the opportunity to capture more material for recycling and refurbishment is high. A washing machine, for example, typically contains 30–40kg of steel – a refurbished machine could reduce material input costs by 60 percent.[169] To ensure that collection and refurbishment capture as much value as possible, business models may need to shift from purchasing to leasing or performance-based arrangements. This will also encourage manufacturers to design products with lower obsolescence risk.

- **Circular models – electronics (US$210–365 billion).** Electronic devices and gadgets also offer large potential for increased circularity, with huge volumes and large numbers of parts that can be reused and refurbished. For example, annual shipments of smartphones now exceed 1.4 billion devices per annum.[170] Secondary markets involving a degree of refurbishment are already established, but collection rates are generally 15 percent or less and there were still 3 million tonnes of small IT e-waste globally in 2014.[171] Some collected

material is also transported to developing countries for processing using crude techniques in conditions dangerous to workers. While some countries have regulated e-waste systems, industry-wide collection and treatment systems need further development. To further sustainable circularity, manufacturers will also need to move from highly integrated product designs to more standardised and modular component design.

- **Energy efficiency – non–energy intensive industries (US$225–315 billion).** While significant improvements in energy efficiency have been achieved in energy-intensive industries, there has been less progress in non–energy intensive industries. Energy has a smaller share of production costs, and so both awareness and the incentives to invest in efficiency measures are lower. This is particularly true in small and medium-sized enterprises (SMEs). Recent measures by governments – including the EU's Energy Efficiency Directive, and the Bureau of Energy Efficiency in India – attempt to encourage SMEs to undertake energy audits. IEA estimates that additional opportunity in non–energy intensive industries could reduce final energy consumption by more than 3 percent in 2030. However, awareness and technical capabilities, as well as capital investment requirements, remain real barriers.

- **Energy storage systems (US$130–260 billion).** Energy storage has an important role to play in facilitating increased penetration of variable renewable energy in power grids. It can also reduce the need for increased peak capacity by storing excess power generated during off-peak periods. Currently, 99 percent of the world's storage capacity is in pumped hydro. However, a number of battery and other storage technologies are developing quickly, and are expected to become cost competitive with hydro on a levelised basis by 2030.[172] IRENA estimates an additional 150 GW of battery storage may be required by 2030 to support the increased penetration of renewables.[173] Further investment in innovation will be required to capture this opportunity.

- **Resource recovery (US$85–210 billion).** Small mining operations – and many oil and gas fields – leave a significant portion of the resource in the ground. Application of new technologies and increased mechanisation could enhance recovery rates by up to 50 percent in some cases. In oil and gas, higher recovery rates can lengthen the productive life of fields, mitigating the need for new exploration. Improving resource recovery can provide attractive long-term returns, but in the short-term it can actually increase costs. As a result, unlocking these opportunities often begins with some form of regulatory requirements, often linked to non-resource concerns, such as China's focus on raising safety standards.

- **End-use steel efficiency (US$120–195 billion).** Production of steel is highly energy-intensive, consuming 5–7 percent of total final energy worldwide.[174] Improvements in energy efficiency have been significant – the production of one tonne of steel today requires on average 40 percent less energy than in 1980 – but the rate of improvement is slowing.[175] An alternative, complementary approach is to focus on material efficiency. This can be achieved through light-weighting (use of higher-strength steel), increased use of scrap and recycling, and improvements in the life of steel components. In construction, substituting higher-strength steel can reduce weight by up to 30 percent. The automotive industry is already focused on weight reduction because of fuel efficiency benefits. Further

improvements of 20–25 percent could be possible through design optimisation. Given low awareness of higher-strength steel in emerging markets, government standards could play a role in accessing this opportunity.

- **Energy efficiency – energy-intensive industries (US$80–175 billion).** Energy-intensive industries (steel, cement, chemicals, paper and aluminium) are responsible for about two-thirds of total industry energy demand today.[176] Major gains have been made since 1980 in reducing the energy intensity of these industries. Cement today requires at least 40 percent less energy per unit, paper requires 20 percent less and aluminium around 14 percent less. While rates of improvement are slowing, there is still significant opportunity to improve energy efficiency in energy-intensive industries. The IEA identifies measures that could reduce final energy consumption by around 0.8 percent in 2030, with a cost of conserved energy that is less than one-third of the average energy price. Continued investment in R&D and talent development will be important to fully realise this opportunity.

- **Carbon capture and storage (US$55–150 billion).** Carbon capture and storage (CCS) technology separates and captures CO_2 emissions from power generation and industrial sources, and then stores the CO_2 in deep underground formations. This makes possible significant reductions in net CO_2 emissions from fossil-fuel power plants and industrial processes, providing a bridge to the scaling up of low-carbon generation and processing techniques. Even under IRENA's most aggressive case for the expansion of renewables, fossil fuels will still account for 44 percent of global power generation in 2030.[177] CCS may prove especially important in carbon-intensive industries, such as cement, and iron and steel where avoiding emissions is more difficult than in power. The development of CCS has been slow to date – existing CCS installations only having the capacity to capture around 25 Mt of CO_2 annually, which is not significant.[178] Two main challenges are the need to bring down the costs to competitive levels, and uncertainty about the availability of suitable geological storage sites. Investment will also need to increase sharply from current low levels of US$70–100 billion annually by 2030.[179]

- **Energy access (US$35–150 billion).** An estimated 1.2 billion people have no access to electricity, and more than 2.7 billion still rely on solid biomass for cooking.[180] Providing universal access to modern energy by 2030 may require annual investments of over US$40 billion.[181] However, the poor already spend up to 10 percent of their monthly household income on inefficient traditional fuels, such as kerosene, wood and charcoal.[182] The International Finance Corporation estimates that even without major investments in grid infrastructure, energy access could be significantly improved through low-cost household products, such as solar lanterns and improved cookstoves, and community-level mini-utilities. These products need to be sold through financing arrangements that recognise the circumstances of the poor. In Bangladesh, for example, Grameen Shakti provides large-scale home solar installations for a small upfront cost, then monthly payments over three years.

- **Green chemicals (US$75–130 billion).** The chemicals industry faces challenges from increasing regulation of its health and environmental impacts, and is also highly dependent on fossil fuels as feedstock. Green chemistry is an emerging collection of techniques and approaches that reduce the use and generation of hazardous substances in the manufacture

of chemical products, including bio-based chemicals, renewable feedstocks, green polymers and alternative low-toxicity chemical formulations.[183] Green chemicals have environmental benefits throughout their life cycle. For example, use of biomass feedstock as an alternative to petroleum in polymer production has been found to reduce GHG emissions by 30–50 percent and ensure safe recyclability of products.[184] Further investment in product innovation and talent development will be required to increase adoption of green chemistry.

- **Additive manufacturing (US$90–125 billion).** A range of additive manufacturing processes, including 3D printing, has developed swiftly in recent years. By depositing material only where required – as opposed to traditional subtractive techniques, which cut parts by removing material – additive manufacturing can substantially improve both material and energy efficiency.[185] Some estimates place the material use and cost savings at up to 90 percent. Additive manufacturing is already being used in the aerospace industry, particularly in jet engines, where it enables the production of higher-precision and lighter-weight parts. It also has potential application in building moulds and tools for use in traditional manufacturing processes. Investments in talent development will be necessary for companies to fully commercialise additive manufacturing processes. The ability to easily replicate third-party tools and moulds raises intellectual property concerns, so governments may need to regulate to provide certainty.

- **Local content in extractives (US$60–120 billion).** In the oil and gas sector and the mining sector, extractive companies spend 40–80 percent of their revenue on the procurement of goods and services.[186] In some cases, that exceeds tax and royalty payments. Some of the largest categories, including manual and low-skilled labour and basic materials, can be localised easily even in countries with low levels of development and industrialisation. Other categories, such as high-complexity equipment, can be localised only in certain countries. In Western Australia, more than 90 percent of total spending is potentially amenable to local content in mining, and a slightly lower share in oil and gas.[187] But in the case of South Africa, based on expert interviews we estimate that 70–85 percent of mining spending is amenable to local content. In underdeveloped countries that have not yet industrialised and have relatively new resources sectors – Guinea being an example – very little of overall spending is amenable to local content, at least initially. Capturing the opportunity requires strong partnerships between the government and the extractive sectors to identify the largest opportunities amenable to local content, and to address bottlenecks such as access to appropriate skills in the local workforce.

- **Shared infrastructure (US$30–120 billion).** McKinsey Global Institute estimates that extractive companies are likely to account for almost 9 percent of the US$1.3 trillion of annual infrastructure spending needed in resource-driven countries, equating to around US$111 billion a year.[188] A substantial portion of this infrastructure could be potentially shared. In general, power infrastructure is one of the best types for multi-user sharing, especially in cases where it can be plugged into a functioning national grid. Infrastructure such as railways and ports may be more amenable to sharing among extractive companies. Capital needs for shared infrastructure are high, and effective partnerships with the public sector will be needed to achieve this opportunity.

- **Mine rehabilitation (US$45–65 billion).** The post-extraction remediation of mine sites, and oil and gas wells, and the restoration of land for other purposes, is an often neglected stage of the extractives life cycle. Abandoned mines and wells can have negative impacts on human and animal health, both through environmental contamination and site safety, as well as curtailing alternative land uses. While there is a lack of reliable and comprehensive data on the adequacy of existing rehabilitation activities, estimates from the US and Australia suggest that only 20–25 percent of closed mines may be properly restored.[189] Governments are increasingly concerned about the legacy of extraction and the liability for rehabilitation.[190] Given expected increases in mine closures over the next decade, the scale of this challenge will only grow. Mine and well closure should also aim to rehabilitate local communities by preparing them for the loss of employment and other economic benefits. Increased environmental remediation will provide new jobs for a period after closure, but ensuring the long-term sustainability of post-mining communities will require additional capital investments, and partnerships between the extractives industry and the public sector.

- **Grid interconnection (US$35 billion).** Grid interconnectors allow electricity to be transmitted between regional grids, improving economies of scale and helping to balance demand during peak periods. Interconnection is particularly important as the penetration of variable renewable energy increases. In Europe, the most advanced continent in interconnection, ENTSO-E already connects grids in 35 countries, allowing import and export of electricity. However, the capacity of these interconnectors varies widely. The Global Green Growth Forum estimates that additional interconnectors in Europe could generate annual savings of US$10 billion by reducing the need for back-up capacity in national grids to meet peak demand.[191] Construction of new interconnectors is capital-intensive, however, and it is often difficult to agree how costs of interconnectors should be distributed between grids, and the private and public sectors. Planning regulations and concerns about the health impacts of high-voltage transmission can also be barriers to this opportunity.

Some opportunities emerging from R&D may have long-term effects, but their impact by 2030 is less certain. Advanced materials, an emerging category that includes a range of hi-tech materials, covers many of these new developments: nano-materials, 'green' materials (e.g., low CO_2 concrete) and advanced composites. They have great disruptive potential, but their ability to scale to commercial use is still unclear. Probably the most developed category is nano-particles for use in drug delivery, which has been assessed as part of the health and well-being system. Other materials are yet to be fully commercialised. Graphene, for example, is a new carbon material that has attracted considerable attention in recent years, with possible applications in batteries, solar cells and water filtering. However, it is still prohibitively expensive, and perfecting production techniques may take some time.

Benefits of a more sustainable energy and materials system

The realisation of these business opportunities in the energy and materials system will also help deliver a wide range of societal benefits (Exhibit 23).

Exhibit 23

Business opportunities in energy and materials could also deliver a range of societal outcomes, linked to the SDGs

Challenge	Business opportunities	Relevant SDGs	Societal outcomes
Economic development	▪ Local content in extractives ▪ Shared infrastructure	 	▪ Stronger and more sustainable economic developing in resource-driven countries
Poverty alleviation	▪ Local content in extractives ▪ Shared infrastructure ▪ Energy access	 	▪ **540 million** people in resource-driven countries lifted out of poverty
Addressing climate change	▪ Energy efficiency in industry ▪ Expansion of renewables ▪ Carbon capture and storage ▪ Grid interconnection ▪ Energy storage systems	 	▪ Improved energy efficiency across industry reduces total energy consumption by **4%** ▪ Up to **45%** of total global power generation provided by renewable energy ▪ 2.5 Gt of CO_2 is captured annually, more than **10%** of forecast emissions
Reducing waste	▪ Circular models, related to automotive, appliances and electronics ▪ Additive manufacturing ▪ Green chemicals ▪ End-use steel efficiency	 	▪ Reduction in landfill through reuse, recycling and remanufacture combined approaching **100%** in durables goods
Better health & well-being	▪ Energy access ▪ Green chemicals ▪ Mine rehabilitation	 	▪ Modern cooking fuels reduce household air pollution, which kills over **2 million** people a year ▪ Lower levels of chemical toxicity in the environment and food supply

Source: McKinsey Global Institute; New Climate Economy; WHO; AlphaBeta analysis

These societal benefits include:

- **Economic development.** Increasing the local content in the extractives supply chain and building shared infrastructure would support the economic development of resource-driven economies through stronger and more sustainable growth rates. Local content and diversification allow resource-driven developing countries to better capture the upstream and downstream benefits of resources. Through shared infrastructure, developing countries are able to access both new investment capital and the expertise of extractive companies. Additional infrastructure spending could also create more than 5 million jobs over the period to 2030.[192]

- **Poverty alleviation.** Enabling universal access to electricity would improve the livelihood of 1.2 billion people worldwide by supporting small-scale economic activity, improving agricultural productivity and reducing the burden of accessing traditional forms of energy. Almost 70 percent of those in extreme poverty worldwide live in resource-driven countries. Changes to the extractives operating model through shared infrastructure and local content could help lift more than 500 million people out of poverty.

- **Addressing climate change.** Efficiency gains and new technologies across the energy and materials system would deliver major reductions in GHG emissions. Improvements in energy efficiency in industrial production could reduce total final energy consumption globally by 4 percent in 2030. The efficiency of fossil fuel power generation could also be significantly improved through shifts to newer technologies such as ultra-supercritical coal and combined cycle gas turbines. Increased material efficiency in energy-intensive materials would also help reduce emissions. Higher-strength steel and design modifications could reduce steel use by 20–30 percent in key steel-consuming sectors. Increasing the share of renewables in power generation to almost half by 2030 would reduce GHG emissions by around 5 Gt, while 2.5 Gt of C02 could be captured and stored annually.[193]

- **Reducing waste.** The move to circular manufacturing processes would decrease waste, and improve the sustainability of resource supplies. Collection rates for reuse, recycling and remanufacturing could be lifted towards 100 percent in key categories of durable goods, substantially reducing the 35 million tonnes of durable goods waste that is currently generated annually worldwide.[194] Increased use of additive manufacturing processes could further reduce waste in production by up to 90 percent in some sectors through more precise and efficient material use.

- **Better health and well-being.** Shifting 2.7 billion people to modern cooking fuels and improved stoves could avert up to 2.6 million premature deaths annually that are caused by exposure to household air pollution. That benefit would be especially felt by women and children, who are most affected – the deaths of up to 600,000 children annually are attributed to pollution from traditional biomass cooking.[195]

6. HEALTH AND WELL-BEING

The challenges in health and well-being

While the healthcare sector could experience substantial growth from an ageing population and new technologies, there are many challenges to 2030. Some of the key challenges include:

- **Innovation.** The efficacy of drugs – especially antibiotics – in treating many major communicable diseases is declining. Pathogens, such as bacteria, parasites and viruses, have always evolved so that they can resist the new drugs that medicine has used to combat them. Resistance has become an increasing problem in recent years because the pace of discovery of new antibiotics has slowed, while antibiotic use is rising.[196] Antimicrobial resistance (AMR), or the prevalence of so-called 'super bugs', is impacting not just antibiotics (which attack bacteria) but drugs against diseases caused by parasites (e.g., malaria) and viruses (e.g., HIV). Around 700,000 people die each year from infection by drug-resistant pathogens and parasites. Without action, the number dying from AMR could rise to 10 million by 2050. The economic cost would be enormous, potentially reducing global GDP by 2–3.5 percent by 2050, which is cumulatively up to US$100 trillion.[197] Of particular concern is that the number of potential new antibiotic products at various stages of clinical trial is only around 40.[198] Low-cost innovation is also required to make health services more affordable and accessible. In developing countries, low-cost healthcare remains unavailable to many, with 100 million people falling below the poverty line each year due to health expenditures.[199] In developed countries, increasing costs are testing the sustainability of healthcare systems.[200]

- **Demand.** Demographic shifts will change what is asked of our healthcare systems – just as the number of people aged over 60 will increase 56 percent globally to 2030, the 'youth bulge' in developing countries will increase demand for maternal and child care.[201] There is also a shift in need by stage of economic development. About two-thirds of child deaths, and those from AIDS and tuberculosis now occur in middle-income rather than in low-income countries.[202] Achieving convergence therefore demands action that goes beyond low-income countries to also focus on poor, rural populations of middle-income countries. At the same time, the burden of NCDs continues to increase – for example, the prevalence of obesity has doubled since 1980 with no recorded decrease in any region, increasing the burden of diabetes and heart disease. The current cost of obesity is estimated at approximately US$2 trillion.[203] If the prevalence of obesity continues on its rising trend, almost half of the world's adult population could be overweight or obese by 2030. In addition, climate change is assessed by the WHO to pose a "significant risk" to health – increasing burdens in the immediate aftermath of weather catastrophes and through long-term consequences of drought. Finally, high rates of maternal and child mortality persist, especially in rural areas of developing countries – 2.7 million children died within the first 28 days of life in 2015, with 75 percent in the first week.[204] Poor access to clean drinking water and decent sanitation contributes to health complications, particularly in rural areas. For example, one in four rural

families across India draws water from untreated taps and uncovered wells, and diarrheal diseases account for one in six deaths annually among Indian children.[205]

- **Supply.** Basic medical services and supplies are missing in developing countries – for example, among the poorest countries in Asia and Africa, basic antibiotics are not available in 40–60 percent of health facilities, and basic medication to treat NCDs is unavailable in up to 70–80 percent of facilities.[206] There are also looming skill gaps in the medical profession, particularly in aged care. The WHO estimates that 4.45 skilled health workers are needed for every 1,000 people, a level so far above current global numbers that a shortfall of around 14 million personnel is estimated by 2030.[207]
- **Regulation and financing.** Global health emergencies, especially infectious disease outbreaks, pose a challenge to global surveillance and coordination mechanisms. In addition, health systems in poorer countries receive inadequate public financing – low-income countries spent 2.5 percent of their GDP on health systems, compared to a global average of 4 percent.[208]

A vision for a sustainable health and well-being system

The SDG agenda proposes to meet these profound challenges by shifting health and well-being onto a sustainable development pathway. This shift will transform the entire health and well-being system, with major impacts all along the value chain. Mapping these impacts provides a vision for a new health and well-being system that can meet the SDG targets (Exhibit 24).

Photo credit: Flickr/morganmorgan

Exhibit 24

A sustainable development pathway could result in significant shifts in the health and well-being system

Value Chain Area	Current Value US$ billions[1]	From...	To...
Research and development	170 (Life sciences)	▪ High-cost innovation ▪ Atomised R&D between public and private sectors ▪ Underinvestment in antibacterials and developing-world infectious diseases	▪ Frugal innovation models ▪ Strong public–private partnerships ▪ New commitment to antibacterial R&D and vaccine development
Inputs & devices	1,200 (Pharma) 290 (Biotech) 360 (Medtech)	▪ Products designed for developed-country consumers ▪ Traditional drug delivery ▪ Poor availability of drugs and other equipment in developing countries ▪ High rates of drug counterfeiting	▪ Low-cost products, e.g. accessible sanitary and contraceptive products ▪ Advanced drug delivery systems ▪ Low-cost medical supplies and stronger distribution systems ▪ Track-and-trace systems in supply chains
Primary care	6,500	▪ Low levels of access outside the developed world ▪ Childbirth without skilled assistance ▪ Regular in-person check-ups ▪ Cumbersome, paper records ▪ High levels of child mortality from preventable diseases ▪ Lack of insurance coverage ▪ Doctor-centred health systems	▪ Deployment of "lean" models to deliver low cost healthcare access ▪ Skilled birth attendants for all childbirths ▪ Remote monitoring of patients ▪ Digital, cloud-based records ▪ Low-cost interventions for major childhood illnesses ▪ Universal health coverage & risk pooling ▪ Task-shifting to other healthcare workers
Secondary care		▪ High-cost surgical interventions ▪ Travelling long distances to see specialist physicians ▪ Piecemeal treatments for NCDs ▪ Standardised drug therapies	▪ Lean surgical interventions ▪ Specialists available anywhere through telehealth ▪ Low-cost packages of interventions ▪ Personalised genomic medicine
Lifestyle management	~250 (incl. gyms)	▪ Exercise equipment ▪ Basic exercise monitoring	▪ Smart fitness equipment ▪ Tracking & feedback systems, e.g. wearables ▪ Weight management programmes

Source: IRI; Deloitte – SAM; AlphaBeta analysis

[1] R&D market size from Industrial Research Institute 2016 forecast; Pharma, Biotech and Medtech market sizes from Deloitte 2015 Global Life Sciences outlook; Primary and secondary care market size from WHO estimate for global health expenditure; Lifestyle market size from SAM.

- **Research and development.** The R&D pipeline could shift significantly in an SDG scenario. First, the volume of funding for R&D could rise significantly. *The Global Health 2035* report, by the Lancet Commission on Investing in Health, has called for the international community to double its current R&D spending from US$3 billion to US$6 billion annually by 2020, with half of this additional amount coming from middle-income countries. In particular, there could be a new commitment to antibacterial R&D and vaccine development. Not only could the volume of funding change, but also the approach. The R&D-driven innovation model in healthcare today is costly and rigid. A shift to 'frugal' innovation, which favours simplicity over sophistication and leverages new digital technologies, could transform innovation.

- **Inputs and devices.** An SDG scenario could also lead to a significant shift in inputs and devices in the healthcare sector. Products have traditionally been designed for consumers in developed countries, with poor availability of drugs and other equipment in developing countries. Low-cost products, particularly contraceptives, could transform the healthcare landscape in developing countries. For example, Netra, a US$2 clip-on device developed at the Massachusetts Institute of Technology fits over the display screen of a smartphone and can diagnose eye conditions. The adoption of track-and-trace packaging could significantly reduce counterfeiting in the supply chain, which accounts for up to 30 percent of drugs in some regions today.

- **Primary care.** Primary healthcare provision could be transformed through telehealth and remote monitoring of patients, combined with new financing approaches (such as risk pooling) to support universal healthcare access. Skilled workers could be developed at an unprecedented scale through deploying new technologies to cut training times. One of the biggest areas of benefit could be the training of skilled birth attendants.

- **Secondary care.** Secondary care could be transformed through 'lean' surgical interventions that take the discipline of the automotive assembly lines to healthcare, enabling greater access to a range of low-income consumers. Cheaper and faster gene sequencing could make possible new treatments and therapies for chronic diseases.

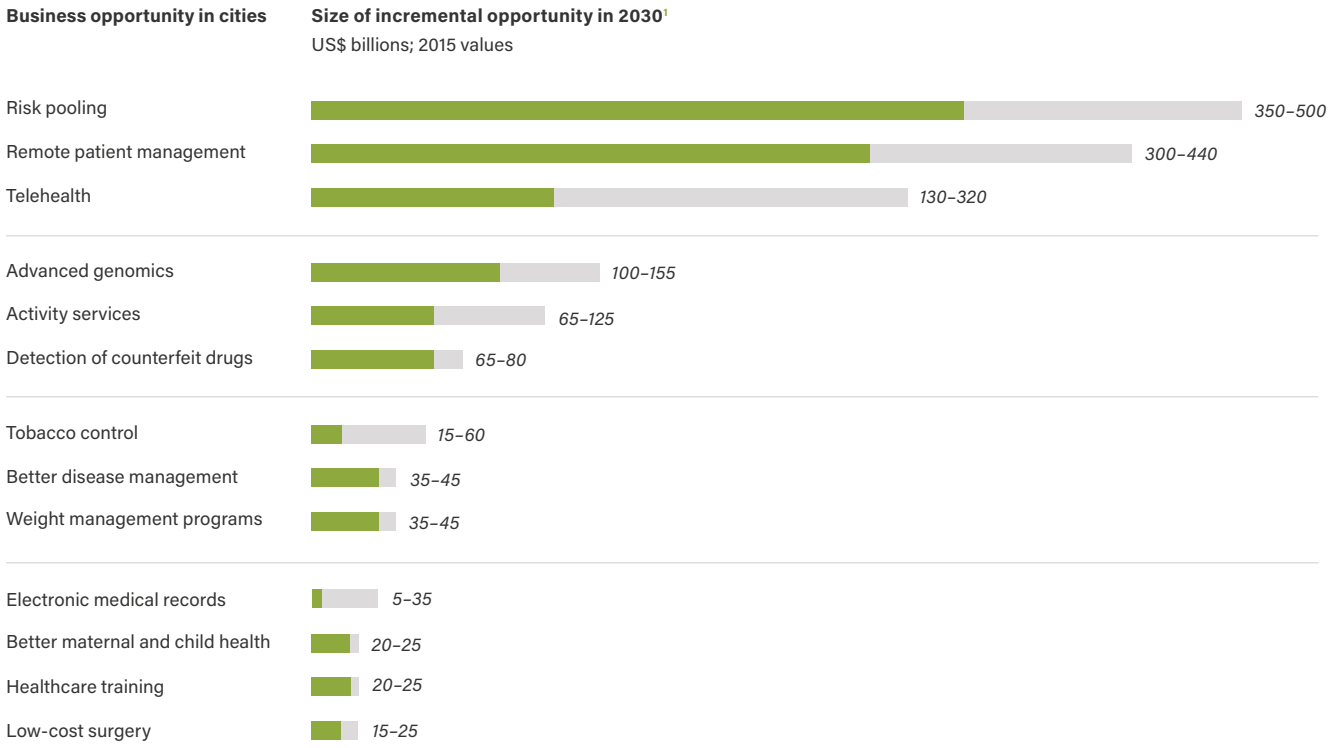
- **Lifestyle management.** The lifestyle sector will continue to grow in importance, with the emphasis on preventative care leading to a renewed focus on weight management and fitness. Smart fitness equipment, exercise equipment, and weight management programs could be particular beneficiaries.

Business opportunities in an SDG-compatible world

These system-wide changes along the health and well-being value chain will lead to the emergence of a number of disruptive business opportunities (Exhibit 25).

Exhibit 25

The largest business opportunities in the health and well-being system could be worth US$1.8 trillion in 2030



Source: Literature search; AlphaBeta analysis

[1] Based on estimated savings or project market sizings in each area. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest $5 billion.

These opportunities include:

- **Risk pooling (US$350–500 billion).** Increasing the penetration of private, public–private and community insurance schemes is an essential step to making healthcare affordable and meeting the target of universal healthcare coverage. In Africa, half of total health expenditure is still financed 'out-of-pocket'.[209] Out-of-pocket payments push up to 5 percent of households in low-income countries below the poverty line annually and require them to make inefficient economic choices, such as selling their limited stock of assets or removing children from education.[210] Since the poor pay a disproportionate share of their income in unavoidable health costs, it is also an inequitable system. In addition to better distributing health risks across communities, risk pooling often includes organised contracting functions that purchase healthcare on behalf of the individuals covered, which in turn encourages the development of higher-quality private sector providers. Despite these benefits, coverage remains low in most developing countries, especially in Sub-Saharan Africa, where penetration rates are as low as 2 percent.[211] Expansion of risk pooling will require educating

consumers to invest in their future health needs, and building the analytical talent to operate risk-pooling arrangements, especially given the lack of good-quality health statistics in many development countries.

- **Remote patient monitoring (US$300–440 billion).** The imperative to lower healthcare costs and build sustainable health systems is increasing the demand for remote monitoring systems, which can reduce unnecessary hospitalisation and make preventative care more effective. Using sensors that read the vital signs of patients at home, nurses and doctors can be alerted to problems before they worsen. Emerging technologies include wearable patches that can diagnose heart conditions, sensors that monitor asthma medication intake and detect poor air quality, and glucose monitors that send diabetics' data straight to their smartphones.[212] McKinsey Global Institute estimates that remote monitoring could reduce the cost of treating chronic diseases in health systems by 10–20 percent by lowering the frequency of emergency room visits and unnecessary hospitalisation.[213] While the size of this opportunity is largest in the developed world, where hospital costs are higher, it has important potential applications in developing countries as well, allowing better management of patients in remote areas with low access to care. Some of the barriers include managing patient acceptance of this new form of health delivery and privacy issues, given the risk that the data collected via health monitoring could be abused.

- **Telehealth (US$130–320 billion).** Telehealth facilitates greater access to health care through the expansion of remote consultation and diagnosis of patients. Using basic mobile internet technologies, such as videoconferencing, doctors and patients – or doctors and local health workers – are able to discuss symptoms and determine treatment without having to travel or queue for services. Mercy Health Systems in the US state of Missouri has built a Virtual Care Center, staffed by hundreds of healthcare providers, that provides telehealth capabilities across a four-state region.[214] In remote Andhra Pradesh in India, the non-profit Health Management and Research Institute provides an Internet-based video chatting system that allows pregnant women to consult obstetricians and gynaecologists in Hyderabad city. A community health worker joins the expectant mother for the call and helps the patient carry out the doctor's instructions. The system has helped raise the rate of safe deliveries by 50 percent.[215] There are private sector opportunities both in the development of technology tools and platforms, and delivery of telehealth services. Barriers include patient trust in telehealth, and access to technology and network infrastructure.

- **Advanced genomics (US$100–155 billion).** Patients respond to medicines differently. Genetic analysis can help deliver personalised medicine that works more efficiently, saving costs and making people healthier faster. For example, the presence of the KRAS gene mutation renders ineffective a common method of treating colorectal cancer.[216] Testing for this can save patients as much as US$50,000 in ineffective treatment.[217] Next-generation sequencing can allow entire DNA profiles to be created for citizens, even before they are diagnosed with a cancer or other NCDs.[218] This can allow therapists to identify at-risk populations and recommend preventative or more timely interventions that reduce morbidity and mortality. As more is known about the genetic mutations and markers that are responsible for the development of NCDs, this opportunity is expanding diagnostic services to include the research required to develop more tailored medicines.[219] In addition to product innovation, capital investment and talent development will be critical levers in advanced genomics.

- **Activity services (US$65–125 billion).** The desire for healthier lifestyles and better management of NCDs could lead to increasing use of gyms, and personal fitness equipment and technology. As governments and private insurers invest more in prevention to stem the rising costs of treating NCDs, gyms and fitness centres are likely to benefit from subsidies and incentives. The fitness centre industry alone is currently worth around US$70 billion, but is still relatively nascent and fragmented. In the US alone, there are close to 38,000 fitness clubs and the market penetration is still below 20 percent.[220] The largest growth opportunities are in Asia, where penetration is less than 10 percent. As populations urbanise, lower activity levels and changing diet are driving faster growth of obesity – and an emerging interest in exercise and sport. The expansion of activity services will require significant capital investment and land, which is scarce in urban centres.

- **Detection of counterfeit drugs (US$65–80 billion).** Counterfeit drugs deprive the private sector of revenue and pose a health risk to patients. In 2013, Interpol estimated that one million people die annually from counterfeit drugs and that up to 30 percent of drugs sold in many parts of the world are counterfeit. The use of electronic tagging and tracking technologies in supply chains can improve traceability and reduce counterfeiting. Under a track-and-trace system, producers, distributors and retailers could be required to upload product data to a central database, and pharmacists who dispense products that do not have the correct identification are not reimbursed. This technique is widely applicable to many types of pharmaceuticals, and is estimated to reduce counterfeiting by 80–100 percent. Other lower-cost technologies may be applicable while track-and-trace systems reach scale, including portable testing devices such as PharmaCheck.[221] Capturing this opportunity will require strong coordination along the supply chain, and development of talent and innovative systems to track drugs at low cost.

- **Tobacco control (US$15–60 billion).** Tobacco use causes the death of nearly 6 million people annually, with one-fifth of the world's adult population smoking. An estimated 10 percent of the deaths are estimated to be from second-hand smoke.[222] WHO projects that this burden will grow to 8 million people by 2030.[223] It is increasingly borne by the developing world, with 80 percent of the world's 1 billion smokers living in low- and middle-income countries. Offering people help to quit tobacco use is one of the key components of the WHO's MPOWER strategy to combat the tobacco epidemic. However, a quarter of low-income countries have no cessation assistance programs. Nicotine replacement therapy has been shown to increase the chance of quitting by 50–70 percent.[224] Products such as patches, chewing gum and nasal sprays, combined with counselling, are already popular cessation strategies in the developed world. Accessing this opportunity will require continued product innovation, including drug development, and the education of consumers about the utility of nicotine replacement therapy and other tobacco control interventions.

- **Better disease management (US$35–45 billion).** The greatest burden of disease falls on low- and lower-middle-income countries.[225] Yet much of the mortality associated with this burden is preventable through relatively low-cost interventions.[226] In NCDs, a package of screening, immunisations and basic existing drug therapies costing US$1–3 per capita annually in low- and middle-income countries, could reduce the global burden of cardiovascular disease and diabetes by 37 percent, and cancer by 6 percent.[227] These

interventions can largely be delivered without complex infrastructure. Existing prevention and treatment techniques can be scaled up for major communicable diseases such as HIV, malaria and tuberculosis. Most of these are well-suited to private sector participation, including increasing the penetration of antiretroviral therapy for HIV, and providing long-lasting insecticidal nets to prevent malaria. In addition, new investments in research and development will be required to maintain the efficacy of therapies – for example, the Review on Antimicrobial Resistance estimates US$1.6–3.7 billion of incentives are needed annually to generate new antibiotics.[228] Various other new drugs that could make a significant impact on disease management are also at advanced stages of development, such as long-acting injectable antiretrovirals and a single-dose antimalarial drug candidate known as OZ439.[229] While there is a large opportunity for the private sector in improving disease management in the developing world, it will require strong partnership with governments and engagement with public policy.

- **Weight-management programs (US$35–45 billion).** Obesity has been estimated to cost the global economy over US$2 trillion per year, and to account for 2–7 percent of national health budgets in high-income countries.[230] The SDG agenda recognises the importance of combating NCDs, which will require addressing the obesity epidemic. As the prevalence and social cost of obesity increases rapidly, the demand for provision of weight-management programs, involving goal setting, counselling and tracking, rapidly increases. While there are rebound effects, there is robust evidence to support the use of well-delivered weight-management programs to combat obesity. These could have significant reach in potential DALYs saved, relative to other obesity interventions.[231] Despite the growing concern with obesity, the industry is still small. To grow, it will need to educate consumers about the benefits of weight-management programs, and develop innovative products that better harness technology.

- **Electronic medical records (US$5–35 billion).** Implementing cloud-based systems to store easily accessible and consistent records can provide large potential benefits in treatment. When combined with big data techniques to merge with medical evidence reports and clinical trials, this can be used to compare each patient's individual symptoms, vital signs, family history and medications to diagnose and recommend a treatment plan with the highest probability of success, and to avoid misdiagnoses. It can also save time for doctors and nurses, and reduce costs by avoiding unnecessary or duplicative tests and procedures. MGI estimates that in India more than 100 million redundant tests are ordered every year.[232] In the US, where electronic medical records have been widely implemented, there have been challenges in interoperability and user acceptance.[233] This experience highlights that the full benefits of this opportunity can only be capture when staff are properly equipped and trained to take advantage of new technologies.

- **Better maternal and child health (US$20–25 billion).** Improving child and maternal health outcomes is a major health objective of the SDGs, and a range of affordable products and interventions, from family planning through to food fortification for improved nutrition, can have a major impact. An estimated 70 percent of women in India need sanitary products.[234] Over 222 million women globally demand but cannot access contraceptive products.[235]

Catering to these markets with low-cost innovations such as washable menstrual pads and injectable contraceptives could drastically improve women's quality of life. Similar opportunities exist to treat a variety of pregnancy and neonatal health complications. Skilled birth attendants can use low-cost handheld devices to measure both blood pressure and other factors during pregnancy that can provide early detection of preeclampsia and other hypertensive disorders.[236] Diarrhoea and pneumonia, the two major causes of child mortality after childbirth, can be better identified and managed through low-cost interventions such as rehydration therapies, water treatment methods, portable pulse oximeters and respiratory rate monitors.[237] However, effective delivery of this package of interventions where it is needed most is challenging, and will require extensive talent development, supply chain management and partnership with the public sector.

- **Healthcare training (US$20–25 billion).** The World Health Organization estimates that in 2030 there will be a shortage of around 14 million health workers in the developing world. This is despite the supply of health workers being projected to almost double from today's stock.[238] This shortage is particularly acute in low-income countries, with some estimates suggesting that Sub-Saharan Africa would need to scale up its workforce by at least 140 percent to meet demand.[239] Given the size of this challenge, there is clearly a role for the private sector in increasing the supply of healthcare training in developing countries, as noted recently by the High-Level Commission on Health Employment and Economic Growth.[240] These investments will need to be coordinated with the public sector and driven by strong partnership, especially to support financing. Governments may also need to strengthen quality standards for healthcare education to facilitate the development of this opportunity.

- **Low-cost surgery (US$15–25 billion).** Access to affordable surgical and anaesthesia care in low- and lower-middle income countries is still very limited. It is estimated that 143 million additional procedures are required annually to save lives and prevent disability.[241] While this gap is sizeable, the development of low-cost surgical approaches has demonstrated the potential application of lean strategies to improve access to critical care. Hospitals practising these high-volume, low-cost approaches tend to be in high-density areas and target low-income groups requiring basic medical care. Since the services available are limited, patient throughput is extremely high (up to 100 patients per day per doctor). Examples include R-Jolad Hospital in Nigeria, Selien Hospital in Tanzania and the Nsambya Hospital in Uganda.[242] Despite the low cost, quality is high, with complication rates comparable to procedures in developed countries.[243]

What is not on the list? Some opportunities (e.g., workplace wellness) were sized but were not found to have sufficient impact by 2030 to warrant inclusion. Other opportunities are likely to have significant impact, but lack clear data for sizing. Technology-enablement of healthcare workers, for example, includes the use of portable devices and cloud-based apps to improve patient diagnosis, treatment and management. Indonesia has experimented with mobile ultrasounds, operated by trained midwives, to improve prenatal care in rural areas.[244] However, the total size of this opportunity is difficult to assess at present.

Benefits of an SDG-compatible health and well-being system

The realisation of these business opportunities in the health and well-being system will help deliver a wide range of societal benefits (Exhibit 26).

Exhibit 26

Business opportunities in health and well-being could also deliver a range of societal outcomes, linked to the SDGs

Challenge	Business opportunities	Relevant SDGs	Societal outcomes
Universal access to healthcare	▪ Low-cost surgery ▪ Remote patient management ▪ Telehealth ▪ Risk pooling ▪ Electronic medical records ▪ Community health workers		▪ Provide access to primary care for 2.5 billion people in rural areas of developing countries ▪ Improve access to specialist doctors through expansion of telehealth ▪ Increase supply of surgical procedures in the developing world by up to 140 million annually ▪ Generate economic returns of US$3 for every US$1 invested through healthier workforces
Child and maternal health	▪ Better maternal and neonatal health	  	▪ Provide access to family planning to an additional260 million women, and 400 million women with menstrual health products ▪ Reduce the global maternal mortality ratio to less than 70 per 100,000 live births ▪ Alleviate child malnutrition, which causes 3 million deaths annually
Non-communicable diseases	▪ Weight loss programs ▪ Activity services ▪ Tobacco control ▪ Better disease management		▪ Contain and reduce the rapid growth in obesity prevalence, which has doubled since 1980 ▪ Halving of smoking rates worldwide ▪ Prevent 3 million deaths annually by reducing mortality from NCDs in the developing world
Communicable diseases, especially in the developing world	▪ Better disease management ▪ Detection of counterfeit drugs		▪ Avoid 1.4 million deaths and 3 million new infections annually from tuberculosis and HIV ▪ Significantly reduce the 1 million deaths annually from falsified or substandard drugs

Source: McKinsey Global Institute; New Climate Economy; WHO; AlphaBeta analysis

These societal benefits include:

- **Universal access to healthcare.** Access to healthcare could be transformed with universal access to high-quality, low-cost services. Adequate insurance programs would make healthcare more affordable for the world's poor, and help alleviate poverty. An additional 140 million surgical procedures annually in the developing world would significantly reduce preventable deaths. Providing primary care access through community healthcare workers for 2.5 billion people in rural areas of developing countries could have a major impact across all key of health outcomes.

- **Child and maternal health.** Child and material health could be significantly improved with the ending of all forms of malnutrition, and a reduction of the global maternal mortality ratio to less than 70 per 100,000 live births. This would be a significant reduction from the current mortality ration of 239 per 100,000 live births in developing countries. In addition, 260 million women could get access to family planning, and 400 million to low-cost menstrual health products. Food fortification could alleviate child malnutrition, which causes about 3 million deaths per year, while other interventions can reduce preventable deaths from diarrhoea and pneumonia.

- **Non-communicable diseases.** The SDGs aim to reduce by one-third mortality from NCDs, and to strengthen the treatment and prevention of substance abuse. This could be a major impact on health and well-being given that NCDs have overtaken infectious diseases as the primary cause of illness and death around the world, accounting for about two-thirds of all mortality. Better management of NCDs in developing countries through low-cost interventions could reduce mortality by 3 million annually.[245] Preventative services, such as gyms, and early treatment through weight management programs could curtail the obesity epidemic that is increasingly spreading to the developing world.

- **Communicable diseases.** The SDGs aim to end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases, and combat other communicable diseases. Better treatment of these major communicable diseases in low- and lower-middle-income countries could reduce the number of deaths by 1.4 million and new infections by 3 million annually.[246] Improving the reliability of drug supply could aid the treatment of communicable diseases and prevent up to 1 million deaths annually from falsified or substandard drugs.

Box 2. What about gender?

One of the most significant economic impacts of the implementation of the SDGs flows from SDG 5 Gender Equality. There is clear evidence at the economy, sector and firm-wide levels that promotion of gender equality is valuable. Research by McKinsey Global Institute examines the economic impact of workforce parity between men and women, and concludes that closing the gender gap completely in the labour market could add US$28 trillion to global GDP in 2025.[247] Even partially closing the gap, in which countries improve at the rate of the best performer in their region, could deliver US$12 trillion in GDP benefit. This increase in output is driven by three factors: increases in labour-force participation rates, increases in hours worked and a change in the sector mix of employment. Other analysis has reached similar conclusions about the scale of the opportunity in gender equality in the workforce.[248] Sector-specific analysis of agriculture has identified a productivity gap in farms owned by woman, owing to their reduced access to markets, capital and other supporting infrastructure. Achieving gender equality here could increase agricultural productivity by 2.5–4 percent.[249] In addition, the degree of female representation in firm leadership seems to be positively correlated with improved firm performance.[250]

Despite these massive potential gains, our work has identified relatively few specific private sector opportunities related to gender emerging from the SDGs. Better maternal and child health is the most significant gender-related opportunity we have identified. In particular, improved access to family planning and menstrual health products gives women greater opportunities to work and remain in the workforce if they choose. Other opportunities in the food and agriculture system, such as technology in smallholder farms and urban agriculture, will benefit women due to strong representation of women in the agricultural workforce and greater room for productivity improvements, and may include products and services designed especially, but not exclusively, for female smallholders.

The reason for the lack of gender-related opportunities in this report is that our analysis has focused on concentrated shifts in profit pools within parts of a system that could be captured by individual private sector actors. In contrast, the value of gender equality is very large but diffuse across different sectors of economies. It also requires significant societal change. For example, increasing the productivity of female-owned farms will require a transformation in how societies value the work done by women, not simply capital investments or changes in agricultural methods. It is important to recognise, however, that there are initiatives that all businesses can undertake to improve the participation and productivity of women, and their own bottom line. These include embedding gender diversity in hiring practices, ensuring wage equality and engaging women as partners in value chains – both upstream and downstream.[251]

7. MAKING IT HAPPEN

Making this happen will require a new approach from business, and development of new business models. In many cases, insurgents enjoy the advantage of being able to start with a clean sheet, whereas incumbents may be less free to take risks with their brands and capital. Yet there is also a growing number of 'radical incumbents' who are learning how to be as agile and innovative as their new 'attackers'.

Given the transformative nature of the change required across the global economy, substantial investment will be needed to capture the SDG opportunities (Exhibit 27). We estimate that the total annual investment required for all 60 opportunities across the four systems is around US$4 trillion. By far the largest capital requirements are in cities, in particular expanding the supply of affordable housing, which would demand up to US$1.1 trillion each year to 2030. Expansion of renewable energy is also highly capital intensive, with estimated incremental investments of over US$300 billion annually.[252] These estimates are larger than some others because they represent gross incremental investment, and do not consider reduced investment in declining sectors – for example, due to reduced fossil fuel use in electricity generation.[253]

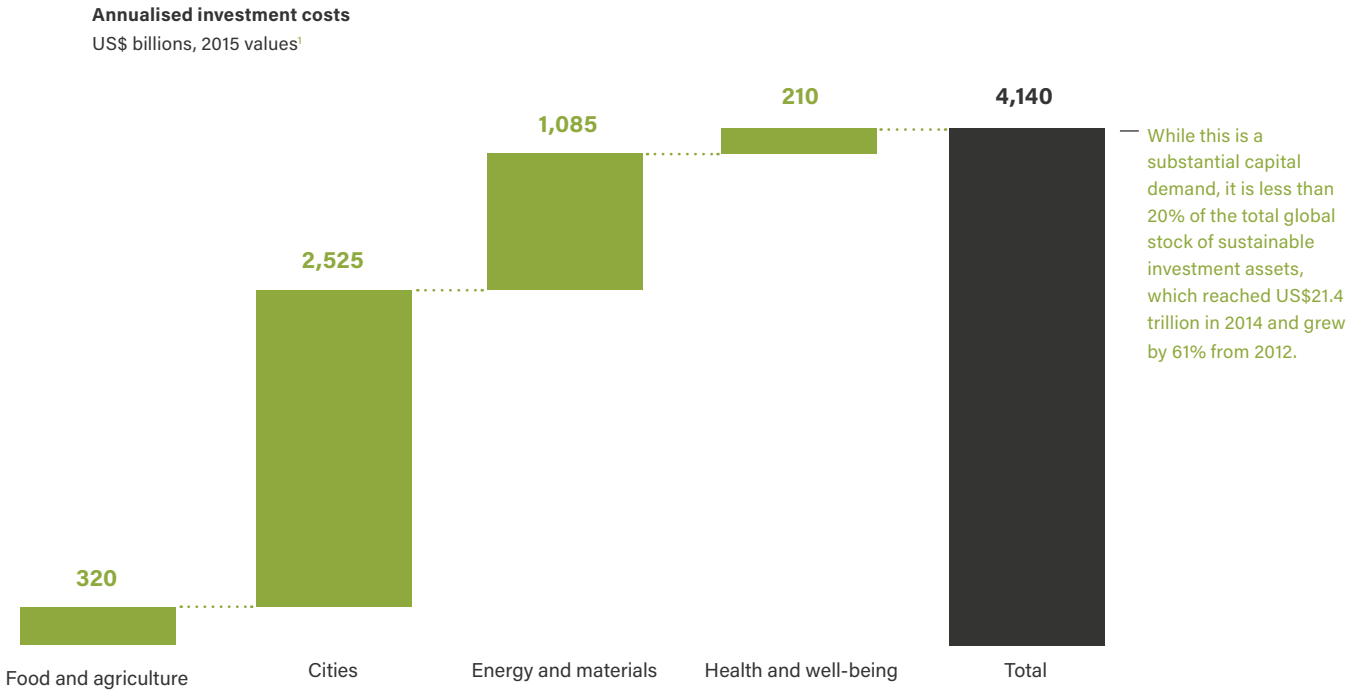
Though these investment costs are large, there are over US$20 trillion in sustainable investment assets under management globally already, and the size of this asset pool is growing fast. It already accounts for 30 percent of total global assets under management, up from 21 percent in 2012.[254] We expect that while the global supply of capital will be adequate to achieve these business opportunities, it will be challenging to ensure the investment reaches the regions where it is most needed, especially in the developing world.

Capital is not the only challenge. Several other levers will be important for the private sector in unlocking these business opportunities:

- **Engaging with public policy.** Actions by governments will be critical to fully capturing the value of many of the SDG opportunities, and businesses need to work with governments to ensure the requisite policy tools are in place. These include regulatory frameworks, such as energy-efficiency and labelling standards, demand stimulation and market access, measures to catalyse investment, infrastructure, and pricing of social and environmental externalities. In affordable housing, for example, the public sector has an important role to play in unlocking urban land for development through efficiently releasing public land, ensuring access to infrastructure and providing clear legal title systems. UN-Habitat estimates that 70 percent of land in developing countries is unregistered, which discourages investment and reduces access to finance.[255]
- **Product innovation.** Businesses will need to understand potential opportunities emerging from the SDG areas in their sector and how to better partner with governments (and particularly research agencies) on developing new solutions. In health and well-being, a focus on 'frugal' innovation will be important for extending access to medical products and services into the developing world. Some of these innovations will also require a

Exhibit 27

Capital investment required to capture opportunities in the four systems is around US$4 trillion annually



Source: New Climate Economy: Driving sustainable development through better infrastructure: key elements of a transformation program.

[1] Based on estimated investment requirements to capture the identified SDG opportunities in each system. Rounded to nearest US$5 billion.

fundamental rethink of business models. For example, realising the full potential of the circular economy would require companies to shift business models from 'consumer' to 'user' strategies, take a full life-cycle perspective when they are designing products and consider new collaborations across different industries to capture opportunities.

- **Driving sustainability through supply chains.** Companies will need to rethink supply chain management, focusing more on transparency, partnering with local producers, and driving efficiency gains. For example, partnering with local producers will be particularly crucial in agriculture (with smallholder farmers) and in energy and materials (to develop local supply chains). Companies will also need to apply the same discipline to resource efficiency as they did in the past to labour. Consumer packaged goods manufacturers have been able to achieve savings of up to 50 percent on their energy and water costs by pulling productivity levers with payback after less than three years.[256]

- **Internalising social and environmental costs.** While governments have for the most part made limited progress in reforming tax systems to price environmental and social costs (and benefits) accurately, the most progressive companies are forging ahead with internal 'shadow pricing' to increase the value on positive social and environmental outcomes. The Carbon Pricing Leadership Coalition, which brings together the public, private and social sectors to build momentum for carbon pricing, reports that more than 1,000 companies globally are already disclosing their current or intended internal carbon pricing.[257] There is also increasing pressure from investors for businesses to disclose their environmental impacts, through mechanisms such as the Carbon Disclosure Project. Incorporating social costs in economic activities could help stimulate incentives for change. For example, McKinsey Global Institute found that removing water, energy and agriculture subsidies and putting a price of US$30 on each tonne of C02-equivalent emissions would make the vast majority of resource-efficiency opportunities attractive to the private sector.[258]

- **Educating consumers.** Unlike insurgents, incumbents have already built their brands, and can ally them with sustainability to capture market share. Consumer preferences on sustainability are changing fast. In 2015, 66 percent of consumers in 14 countries were willing to pay more for sustainable products, compared to 50 percent in 2013 – and incumbents can be better placed to serve them.[259] In many areas, businesses will need to educate consumers around new SDG-related business models. For example, a circular economy requires a consumer shift from purchasing goods to purchasing services. Tackling consumer waste requires educating people about the relevance of these issues, particularly when price signals are often insufficient to drive change in many developed markets. In healthcare, consumers will need to be encouraged to manage their risk of suffering from NCDs through preventative healthcare, such as activity services, weight management programs and tobacco control.

- **Turning public–private partnerships into real business opportunities.** Partnerships have already yielded combined social benefit and private sector opportunity in many contexts. Consider, for instance, the Global Alliance on Vaccines and Immunization, which has since 2000 vaccinated half a billion children, saved 7 million lives and achieved US$80–100 billion in economic benefits. Or consider urban planning, where partnerships like the Rockefeller Foundation's 100 Resilient Cities initiative brokers collaboration between city governments and companies in sectors from flood defence to financial risk management in pioneering ways. The challenge for businesses is how to identify areas where a public–private partnership (PPP) would make sense (and not make sense), and ensure that the partnership is designed appropriately to capture the opportunity. The Global Green Growth Forum (3GF) has developed a framework for helping with this question in regards to environmental issues, which can be easily broadened to SDG issues (Exhibit 28).[260]

Exhibit 28

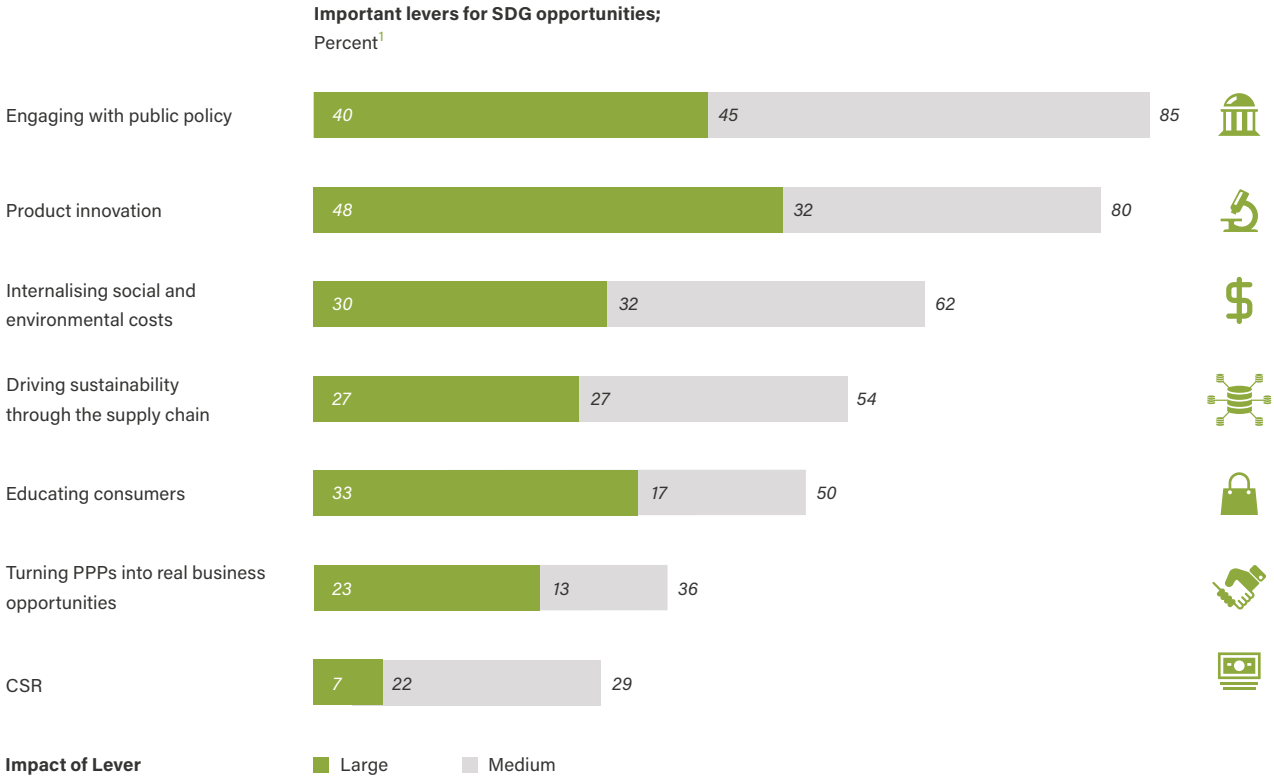
5 key questions for understanding the potential of PPPs to support the capture of SDG business opportunities

1	**Is the opportunity suitable for a PPP?**	▪ Is there a significant business opportunity related to this area? ▪ Are there significant barriers blocking capture of the opportunity? ▪ Is a PPP the most appropriate way to address these barriers?
2	**What should be the PPP's scope and design?**	▪ What are the binding barriers to capturing these opportunities? ▪ Given these barriers, which of the 5 PPP archetypes is best suited to address the key barriers to the opportunity? – Awareness raising and behavioural shift – Policy, regulation, and planning – Capital mobilization – Product development – Coordination ▪ What is the degree of geographical variation in these barriers?
3	**Who should be involved in the PPP?**	▪ Amongst which stakeholders (companies, NGOs, governments, etc) does the critical expertise, influence, financing capability, etc, lie to address the binding barriers? ▪ What would be the roles of these different stakeholders? ▪ What are the incentives for each of these stakeholders to become involved? ▪ What is the geographic scope of actors that should be involved?
4	**How will this PPP achieve meaningful global scale?**	▪ What are the relevant channels that the PPP could use to maximise impact globally? – Penetrate new markets – Form partnerships – Shape standards – Open-source key materials – Provide demonstration effects – Influence value chains – Create tipping points
5	**How can the PPP be designed to maximize sustainable development?**	▪ Within the relevant channels, is the PPP designed to maximise economic growth and avoid potential hindrances to growth? ▪ Is the PPP designed to take an integrated approach, minimising trade-offs and maximising co-benefits?

So which levers are most important? Assessed against the 60 identified business opportunities in an SDG-compatible world, across the food and agriculture, cities, energy and materials, and health and well-being systems, we find the most important levers are around engaging with public policy and product innovation models (Exhibit 29). Some are particularly important for certain systems – for example, educating consumers is crucial for driving change in food and agriculture, and health and well-being because of the critical role of consumer behaviour in diet and health choices. In cities, partnerships with the public sector are especially fundamental because of the focus on infrastructure. What is also interesting is what doesn't matter – philanthropic CSR[261] initiatives are a side issue to achieving the main business opportunities identified.

Exhibit 29

Engaging public policy and product innovation are the most important levers for business



Source: AlphaBeta analysis

[1] Refers to the percentage of SDG-related business opportunities identified in cities where this lever could have either a medium or large impact on the likelihood of successful implementation of the opportunity.

APPENDIX A: METHODOLOGY FOR SIZING THE COST OF INACTION

Below is the methodology and the list of sources used to estimate the annual global direct economic impact associated with selected global burdens as a share of global GDP in 2014:

1. Violence and armed conflict

The economic impact of violence on the global economy was US$7.16 trillion in 2014, which represents 9.1 percent of world GDP.[262] The total impact includes the cost of four main categories: military spending; crime and interpersonal violence; conflict; and internal security.

2. Biodiversity and ecosystem impact

The impact of biodiversity and ecosystems has been calculated based on a study by The Economics of Ecosystems and Biodiversity (TEEB)[263]. TEEB estimated the cost of biodiversity and ecosystem damage to be 3.1 percent of global GDP in 2008. We conservatively assume that this remains constant in 2014.

3. Smoking

The impact of smoking on GDP is calculated by McKinsey Global Institute based on productivity losses, direct medical costs and investments in mitigation.[264] Productivity losses are based on disability-adjusted life years (DALYs) attributable to tobacco use, as reported by the Global Burden of Disease assessment, and the per capita GDP in each country.[265] Direct medical costs are based on The Tobacco Atlas.[266] Estimated investment in smoking cessation is based on a literature review of a subset of public health systems.

4. Obesity

The impact of obesity on GDP is calculated by McKinsey Global Institute based on productivity losses, direct medical costs and investments in mitigation.[267] Productivity losses are based on DALYs attributable to obesity, as reported by the Global Burden of Disease assessment, and the per capita GDP in each country.[268] For direct healthcare costs, World Health Organization estimates were used. Investment devoted to mitigating obesity is calculated based on government investment in prevention programs, and commercial weight-management markets.

5. Corruption

The International Monetary Fund's most recent estimate put the annual cost of bribery alone at about 2 percent of global GDP.[269]

6. Alcoholism

The impact of alcoholism on GDP is calculated by McKinsey Global Institute based on productivity losses, direct medical costs and investments in mitigation.[270] Productivity losses are based on DALYs attributable to alcohol use, as reported by the Global Burden of Disease assessment, and the per capita GDP in each country.[271] Global healthcare and law enforcement

costs are from research published by *The Lancet*.[272] Research by the Drug and Alcohol Review was used to estimate the cost of criminal damage, drunk driving and unemployment related to alcoholism.[273]

7. Illiteracy

The impact of illiteracy on GDP is estimated by the World Literacy Foundation based on loss of productivity.[274]

8. Antimicrobial resistance

The estimated cost of antimicrobial resistant diseases in 2005 was up to 1.6 percent of GDP. We conservatively assume that this cost remains constant to 2014.[275]

9. Congestion costs

The New Climate Economy finds that congestion is already imposing costs as high as 3.4 percent of GDP in Buenos Aires and 2.6 percent in Mexico City, and even in the developed countries of the European Union, congestion costs average 1 percent of GDP.[276] Using these estimates, the overall impact is estimated to be 1.8 percent of GDP.

10. Illicit financial flows

Illicit financial flows in developing countries are estimated at US$1.09 trillion in 2013, which is 1.4 percent of global GDP.[277]

11. Food waste

The impact of food waste on GDP has been calculated using a 2011 estimate that US$1 trillion worth of food is wasted globally.[278] Applying a growth rate of demand for food of 1.5 percent implies that US$1.04 trillion worth of food was wasted globally in 2014, which was 1.34 percent of GDP.

12. Climate change

The impact of climate change on GDP is calculated by McKinsey Global Institute based on productivity losses, cost of climate adaptation and the non–health related economic impacts of climate change.[279] Productivity losses are based on estimated loss of DALYs attributable to climate change in 2000 (i.e., famine, vector-borne diseases and waterborne diseases) using the WHO's analysis.[280] This was then scaled to 2010 terms using an estimate of the rate of increase in deaths attributable to climate change. The World Bank has estimated that the cost between 2010 and 2050 of adapting to a world temperature that is 2 degrees Celsius warmer than pre-industrial levels by 2050 will be between US$70 billion and US$100 billion a year. The estimate of the economic impact of climate change is based on the DARA assessment of the 2010 economic impact of environmental disasters, habitat change and industry stress. This does not include the health impact used by DARA, which is already captured in the number of DALYs lost.

APPENDIX B: METHODOLOGY FOR SIZING BUSINESS OPPORTUNITIES

The value of each opportunity is calculated as the difference between an estimate of the business-as-usual scenario (BAU) in 2030 and the SDG scenario in 2030. The dollar amount therefore represents the incremental annual value in 2030. In some instances, we use multiple methods of estimation to inform our range.

FOOD AND AGRICULTURE

Reducing food waste in the value chain (US$155–405 billion)

Description	Sizing Assumptions	Sources
Reduction in supply chain food waste, including post harvest	**BAU:** The Food and Agriculture Organisation (FAO) estimates US$1 trillion worth of food is wasted globally at present. Applying a growth rate of demand for food of 1.5% implies US$1.25 trillion worth of food will be wasted globally in 2030. The World Resources Institute (WRI) estimates that 65% of waste occurs in the value chain. **SDG:** WRI estimates that food waste is reduced by 50%, in keeping with SDG targets. An alternative estimate by McKinsey Global Institute (MGI) is used to form our estimated range.	FAO Food Loss (2011)[281] WRI Reducing Food Loss and Waste (2013)[282] MGI Resource Revolution (2011)

Forest ecosystem services (US$140–365 billion)

Description	Sizing Assumptions	Sources
Reduced deforestation and forest degradation	**BAU:** Emissions from deforestation and forest degradation continue based on forecasts from the International Panel on Climate Change and the United Nations Environment Programme (UNEP). **SDG:** New Climate Economy (NCE) estimates that halting deforestation and restoring 350 hectares of degraded forests will lead to annual GHG mitigation of 2.8–7.3 $GtCO_2e$ by 2030. Assume a carbon price of US$50 tCO_2e, which is broadly consistent with that used by many leading companies today, as well as estimates of the required internal rate of return for private sector participants.	NCE Emissions Reduction Potential (2015)[283]

Low-income food markets (US$155–265 billion)

Description	Sizing Assumptions	Sources
Development of better products and distribution systems to meet the food demand of low income consumers Reduction in supply chain food waste, including post harvest	**BAU:** Around 800 million people living in extreme poverty, with an average income of US$1 a day. They spend 35–60% of their income on food. **SDG:** The average income of those living in extreme poverty increases to US$2.50 a day, leading to an aggregate increase in income of US$438 billion per year. Their spending on food remains at the same proportion of their income as they reduce their calorie deficiency and improve their nutritional intake.	UN DESA Bottom of the Pyramid (2009)[284]

Reducing consumer food waste (US$175–220 billion)

Description	Sizing Assumptions	Sources
Fifty percent reduction in food thrown out at the consumption level	**BAU:** FAO estimates US$1 trillion worth of food is wasted globally at present. Applying a growth rate of demand for food of 1.5% implies US$1–1.25 trillion worth of food wasted globally in 2030. WRI estimates 35% of waste occurs at consumption. **SDG:** WRI estimates that food waste is reduced by 50%, in keeping with SDG targets.	FAO Food Loss (2011)[285] WRI Reducing Food Loss and Waste (2013)

Product reformulation (US$110–205 billion)

Description	Sizing Assumptions	Sources
Decreasing incidence of obesity by amending the composition of foods so they are healthier (e.g., sugar-free varieties)	*Method 1* **BAU:** No product reformulation interventions. **SDG:** MGI estimates that in the UK the most cost-effective product reformulation strategy will save 1.7 million disability-adjusted life years (DALYs) and require spending of US$4.4 billion. This is scaled to a global opportunity with reference to UK's share of global spending to combat obesity. A global economic growth rate of 3.2% to 2030 is then applied.	MGI Obesity (2014)[286]
	Method 2 **BAU:** The reformulated food market, estimated by Sustainable Asset Management (SAM) to be worth US$60 billion in 2009, grows at the lower end of the estimated 3–6% rate range, implying a US$112 billion value in 2030. **SDG:** The market is worth US$204 billion, growing at the higher end of SAM's estimated range at 6%.	Healthy Living, SAM AG (2012)[287]

Technology in large scale farms (US$145–180 billion)

Description	Sizing Assumptions	Sources
Improving yields on large-scale farms (more than 2 hectares) by adopting new technology and farming practices	**BAU:** Yields grow at current rates. **SDG:** MGI estimates intervention will lead to yield improvements over base case of 15% in developed countries, and 50% in developing countries. Producing the same amount of food will therefore require between 150 million and 180 million fewer hectares.	MGI Resource Revolution (2011)[288]

Dietary switch (US$85–140 billion)

Description	Sizing Assumptions	Sources
Reducing the global consumption of beef with a shift toward pork/ poultry products, or substituting meat entirely with vegetarian diets, to reduce the resource intensity of food production	*Method 1 – Shift to pork and poultry* **BAU:** 2030 consumption pattern remains at 2009 distribution. **SDG:** WRI assumes that consumption of beef is reduced by 30% in regions where beef consumption is currently above the global average, substituting pork and poultry products. Assume 170 million hectares of pastureland is saved as a result, valued at US$500–740 per hectare. *Method 2 – Shift to vegetarian diet* **BAU:** 2030 consumption patterns remain at 2009 distribution. **SDG:** WRI models a scenario where 50% of the North American and European population shifts to a vegetarian diet. Assuming a reduction in demand for pastureland (valued at US$500–740 per hectare) by 113 million hectares, and for cropland (valued at US$1,250 per hectare) by 37 million hectares	WRI Shifting Diets (2016)[289]

Sustainable aquaculture (US$20–125 billion)

Description	Sizing Assumptions	Sources
Increase in use of aquaculture to satisfy food demand	**BAU:** Aquaculture meets a baseline demand of 93.6 million tons. **SDG:** We assume a growth in demand of 10– 30%. Lower end of range assumes improvements in aquaculture practices (e.g., waste management). Higher end of range assumes an increase in consumer demand for higher value aquaculture (mainly from China).	World Bank Fish to 2030 (2013)[290]

Technology in smallholder farms (US$75–105 billion)

Description	Sizing Assumptions	Sources
Improving yields on smallholder farms (less than 2 hectares)	**BAU:** Yields grow at current rates. **SDG:** MGI estimates intervention will lead to yield improvements over base case of 15% in developed countries, and 50% in developing countries. Producing the same amount of food will therefore require between 75 million and 105 million fewer hectares of land.	MGI Resource Revolution (2011)

Micro-irrigation (US$70–85 billion)

Description	Sizing Assumptions	Sources
Adoption of more efficient irrigation techniques (sprinkler and drip irrigation systems, instead of flood irrigation)	**BAU:** Yields and the rate of adoption increase at current levels. **SDG:** In sprinkler irrigation systems, MGI assumes a yield improvement of 15%, with a 10% increase in adoption over base case. With regard to drip irrigation systems, MGI assumes a yield improvement of 45%, with a 10–20% increase in adoption over base case. These lead to water savings in a range of 250–300 cubic kilometres, as well as energy savings and higher food production.	MGI Resource Revolution (2011)

Restoring degraded land (US$70–85 billion)

Description	Sizing Assumptions	Sources
Reducing the degradation of land and restoring land that is already degraded	*Method 1* **BAU:** 10% of cropland degradation is prevented, with no restoration of previously degraded land. **SDG:** MGI estimates that 45% of cropland degradation is prevented. MGI estimates it is possible to restore 80% of land suffering low to moderate levels of degradation; and 60% in the case of severe to very severe degradation.	MGI Resource Revolution (2011)
	Method 2 **BAU:** No change to rate of degradation or recovery of value. **SDG:** We assume that the value currently lost to degradation is recaptured. Around 33% of global agricultural land is currently degraded (with a further 12 million hectares being degraded each year to 2030), at an economic cost of US$125 per hectare.	FAO World Soil (2015);[291] Living with the Earth, 3rd ed. (2007)[292]

Reducing packaging waste (US$40–65 billion)

Description	Sizing Assumptions	Sources
Increased recycling of plastic food and beverage packaging	**BAU:** The market for packaging plastics in 2030 grows to US$170–250 billion. The proportion of value recaptured through recycling remains at the current 5%. **SDG:** The value captured by recycling is grown to 30%. This increase in value capture is composed of an increase in amount captured for recycling from 15% to 50%, and increase in yield of recycled product from 30% to 60%.	New Plastics Economy (2016)[293]

Cattle intensification (US$15–55 billion)

Description	Sizing Assumptions	Sources
Sustainable cattle intensification, including through improved feed supplements	*Method 1* **BAU:** Feed efficiency improves 10% above current rates. **SDG:** MGI estimates a 15–20% feed efficiency improvement through feed additives and improved practice.	MGI Resource Revolution (2011)
	Method 2 **BAU:** Cattle management practice remains at current levels. **SDG:** TNC estimates a US$54 per year per hectare annuity from cattle intensification intervention. A 20% penetration rate of this intervention is assumed.	TNC, Cattle intensification in Para (2015)[294]

Urban agriculture (US$20–40 billion)

Description	Sizing Assumptions	Sources
Improving the scale and efficiency of food grown in urban environments, especially in developing countries	**BAU:** The productivity of urban farms remains constant, while population grows at current rates. Academic estimates are that a quarter of the 800 million people engaged in urban agriculture earn an income from it. Average of African and Latin American case studies by the FAO indicates an annual income of US$600–1,300 per household. Population is estimated to grow at 1.3% and a household is assumed to include four people. **SDG:** We assume a 50% yield improvement (using the MGI estimate of smallholder yield growth potential in developing countries).	FAO Urban Agriculture (2016)[295]; Urban Agriculture: A Review (2013)[296]; MGI Resource Revolution (2011)

CITIES

Affordable housing (US$650–1,080 billion)

Description	Sizing Assumptions	Sources
Providing adequate, safe and affordable housing to the population currently living in inadequate housing	**BAU:** The affordability gap is the difference between the annualised current market price of a basic standard unit and what households earning 80% or less of the median income in that area could pay for housing. This gap is not addressed and continues to grow at current rates. **SDG:** The housing gap is closed in 2030. The cost of the global affordable housing gap is estimated at about US$650 billion in 2012; the need for affordable housing will increase from 330 million units to 440 million units from 2012 to 2025, which is an annual increase of 2.6%. This will grow the affordability gap in 2030 to over US$1 trillion.	MGI Tackling the world's affordable housing challenge (2014)[297]

Energy efficiency – buildings (US$555–770 billion)

Description	Sizing Assumptions	Sources
Improving energy efficiency in buildings by using more energy efficient lighting, cooking methods, cooling solutions and appliances	*Method 1* **BAU:** Energy efficiency improves in line with the New Policies scenario from the International Energy Association (IEA). **SDG:** IEA estimates additional energy efficiency in buildings could be achieved through energy efficient lighting, cooking methods, cooling, appliances, and space and water heating, which could reduce total final energy consumption by 3.8–4.6%. Assume average weighted energy price is US$1,000–1,800 per tonne of oil equivalent (toe) and total final energy consumption before efficiencies of 11,221 million tonnes of oil equivalent (Mtoe).	IEA World Energy Outlook (2015)

Energy efficiency – buildings (US$555–770 billion) (continued)

Description	Sizing Assumptions	Sources
	Method 2 **BAU:** Energy efficiency improves in line with the IEA's 4DS Scenario. **SDG:** NCE estimates energy cost savings from incremental improvements in efficiency in residential and commercial buildings based on three levers: new building heating efficiency, heating retrofits, and appliances and lighting. (A fourth lever, solar PV, is included in a separate renewables opportunity in the energy and materials system, in a forthcoming report.) NCE also assumes energy price increases of 2.5% per year, but this has been excluded for consistency with other opportunities.	NCE Cities Low-Carbon Development (2015)[298]
	Method 3 **BAU:** Energy efficiency improves by roughly 14% in residential buildings and 12% in commercial buildings. **SDG:** MGI estimates a further improvement in energy efficiency in residential and commercial buildings of 20% above the BAU improvements. This due to improved heating and cooling as a result of retrofitting existing buildings and improved energy efficiency in new buildings, and switching to efficient lighting, appliances and electronics.	MGI Resource Revolution (2011)[299]

Electric and hybrid vehicles (US$310–320 billion)

Description	Sizing Assumptions	Sources
Energy savings from increased penetration of electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs) and hybrid EVs	*Method 1 – Resource efficiency approach:* **BAU:** Sales penetration of PHEVs is 15% and sales penetration of EVs is 4%. **SDG:** Assuming aggressive policies could mean that EVs comprise 62% of new light-duty vehicle sales in 2030 (51% PHEV and 11% EV) versus base case of 15% sales penetration for PHEVs and 4% for EVs in 2030.	MGI Resource Revolution (2011)

Electric and hybrid vehicles (US$310–320 billion) (continued)

Description	Sizing Assumptions	Sources
	Method 2 – Market size approach: **BAU:** Electric vehicle market size in 2019 is forecast to be US$272 billion. This is assumed to grow at 4.4% in line with McKinsey's forecast of global automotive industry growth. **SDG:** According to Navigant Research, global EV sales will grow at 10%, which is the SDG case; while according to McKinsey, global automotive industry growth will be 4.4% (the BAU case).	Transparency Market Research[300]; McKinsey Automotive revolution (2016)[301]; Navigant Research[302]

Public transport in urban areas (US$170–205 billion)

Description	Sizing Assumptions	Sources
Increasing penetration of public transport in cities	*Method 1 – Resource efficiency* **BAU:** Public transport adoption remains at current levels. **SDG:** MGI estimates the energy saved from shifting nearly 23% of passenger kilometres from light-duty vehicles to public transit buses and bus rapid transit (BRT); shift of nearly 3% of passenger vehicle kilometres to metros.	MGI Resource Revolution (2011)
	Method 2 – Investment needs **BAU:** Investment in new transport infrastructure is projected based on the IEA's 4DS Scenario. **SDG:** NCE estimates that the total incremental investment needed to enable expansion in public transport use – leading to a 20% lower per kilometre mode share for light-duty vehicles – is US$6.9 trillion between 2015 and 2050, which is then annualised.	NCE Cities Low-Carbon Development (2015)[303]
	Method 3 – Investment needs **BAU:** Investment in new transport infrastructure continues at historical rates based on the baseline scenario by the Institute for Transportation and Development Policy (ITDP) and University of California Davis (UC Davis). **SDG:** The ITDP/UC Davis forecasts the additional annual capex investment required under their 'high-shift' scenario (including infrastructure and equipment purchases) for BRT, metro, trams and buses over 2010–50. We calculate the 2030 opportunity based on the difference between the baseline and 'high-shift' scenario.	WRI (2010)[304]

Car sharing (US$115–205 billion)

Description	Sizing Assumptions	Sources
Increasing use of ride and car sharing services to improve vehicle utilisation and efficiency	**BAU:** Private vehicle use remains at current rates. **SDG:** Ellen MacArthur Foundation estimates the primary resource benefit from car and ride sharing in Europe in 2030. The European Union (EU) accounts for 27% of global GDP and 39% of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation (2015)[305]

Road safety equipment (US$50–170 billion)

Description	Sizing Assumptions	Sources
Improving car safety devices and equipment to reduce the number of road accidents	**BAU:** Car safety equipment market grows at the rate of global automotive industry growth (4.4%). **SDG:** The market for car safety devices and equipment is expected to grow by more than 10% annually given the current trends. According to market research firms, the market size would be US$153 billion by 2020. Strategy& estimates that the car safety devices market in 2021 will be €50 billion globally. We have scaled this opportunity to 2030 using the expected growth in the market size. The opportunity is the difference between the expected market size and the rate of growth of the overall global automotive industry (4.4–10%).	McKinsey Automotive Revolution (2016)[306] Market and Markets[307] (2015) Strategy& (2015)[308]

Autonomous vehicles (US$30–160 billion)

Description	Sizing Assumptions	Sources
Increasing the use of autonomous vehicles	*Method 1 – Market size* **BAU:** The Boston Consulting Group (BCG) estimates that the market size for autonomous vehicles in 2030 will be approximately US$60 billion. **SDG:** Lux Research estimates that the market size could be US$87 billion. *Method 2 – Economic impact* **BAU:** BCG estimates that the market size for autonomous vehicles in 2030 will be approximately US$60 billion. **SDG:** MGI estimates that the potential economic impact for autonomous vehicles could be US$200 billion in 2025, which is scaled to 2030 based on global car sales growth projections. The difference between the market size and the potential impact is the opportunity.	Autonomous vehicle adoption study, BCG (2015)[309]; Lux Research Inc. (2014)[310] MGI Disruptive technologies (2013)[311]

Internal combustion engine vehicle fuel efficiency (US$155 billion)

Description	Sizing Assumptions	Sources
Improvements in fuel efficiency of internal combustion engines (ICEs) in light-duty, medium duty and heavy-duty vehicles	**BAU:** The fuel efficiency of light-duty vehicles improves to just under 5 litres per 100 kilometres. Fuel efficiency of medium duty and heavy-duty vehicles increases by 15% of SDG case. **SDG:** MGI estimates that the fuel efficiency of light-duty vehicles can be improved by an additional 0.6 litres per 100 kilometres above the base case by 2030. For medium duty and heavy-duty vehicles, improvements of 11% and 13% respectively are assumed.	MGI Resource Revolution (2011)

Building resilient cities (US$90–155 billion)

Description	Sizing Assumptions	Sources
Increasing the use of autonomous vehicles	*Method 1* **BAU:** Expenditure on explicit adaptation activities, which was US$23–$26 billion in 2012–2013, does not increase. **SDG:** Required climate adaptation expenditure is estimated to be US$140–300 billion annually by 2030. According to UNEP, 80% of the adaptation costs for 2010–50 could be carried by urban areas.	UNEP Adaptation Gap (2016)[312]
	Method 2 **BAU:** Expenditure on explicit adaptation activities, which was US$23–26 billion in 2012–2013, does not increase. **SDG:** UNFCCC (United Nations Framework Convention on Climate Change) estimates that by 2030 the world will be spending an additional US$36–135 billion each year to address impacts associated with climate change. This is adjusted for the adaptation cost impacting urban areas and for the amount that is already being spent on climate adaptation.	Economics of Climate Adaptation (2009)[313]

Municipal water leakage (US$100–110 billion)

Description	Sizing Assumptions	Sources
Reducing water use by controlling leaks in municipal water systems	**BAU:** Current rates of leakage in municipal water systems continue. **SDG:** MGI estimates that the volume of water that can be saved through better controlling water leaks is 100–120 cubic kilometres. This is based on analysis of country case studies where actual leakage estimates are available, and then scaling these to the global level. The average price of water saved is US$0.90 per cubic metre.	MGI Resource Revolution (2011)[314]

Cultural tourism (US$45–90 billion)

Description	Sizing Assumptions	Sources
Opportunities from growing cultural tourism	**BAU:** Annual revenue from cultural tourism grows at current growth rates. SDG: Annual revenue from cultural tourism grows 0.5–1.0% faster than current rates. This is then adjusted for cities' share of cultural tourism (60%).	UNWTO (2015)[315] World Travel and Tourism Council

Smart metering (US$35–90 billion)

Description	Sizing Assumptions	Sources
Increased use of smart metering to reduce energy consumption and costs	*Method 1* **BAU:** Navigant Research estimates the market size for smart meters in 2030 as US$20 billion. **SDG:** Market and Markets estimates the size of the smart meter market to be US$18.2 billion in 2019 and growing at a 10.2% compound annual growth rate (CAGR) from 2014 to 2019. We projected this growth forward to get the 2030 market size.	Market and Markets (2013)[316]; Navigant Research (2013)[317]
	Method 2 **BAU:** Navigant Research estimates the market size for smart meters in 2030 as US$20 billion. **SDG:** McKinsey has estimated the value of advanced metering and consumer applications in the US, which is scaled globally based on the US's share of OECD GDP (assuming benefits are concentrated in more developed countries).	McKinsey, US smart grid value at stake (2010)[318]

Water and sanitation infrastructure (US$25–90 billion)

Description	Sizing Assumptions	Sources
Increasing the provision of clean water and sanitation to unserved or underserved areas	*Method 1* **BAU:** No additional investment to close the gap of required water and sanitation infrastructure. **SDG:** MGI estimates the annual incremental investment needed in water and sanitation infrastructure. Adjusted for cities' share of infrastructure needed, which is 60%.	MGI Infrastructure report (2013); Global Water Intelligence[319]
	Method 2 **BAU:** No additional investment to provide access to the unserved urban population. **SDG:** Copenhagen Consensus Center estimates the annual cost to provide universal access to water and sanitation to the unserved urban population.	Copenhagen Consensus Center (2015)[320]

Office sharing (US$40–70 billion)

Description	Sizing Assumptions	Sources
Increasing use of office sharing and telecommuting to increase building use efficiency	**BAU:** Office space remains utilised at current rates. **SDG:** Ellen MacArthur Foundation estimates the primary resource benefit from office sharing and telecommuting in Europe in 2030. EU accounts for 27% of global GDP and 39% of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation (2015)

Timber buildings (US$25–40 billion)

Description	Sizing Assumptions	Sources
Substituting steel and concrete in building construction for wood to reduce emissions	**BAU:** Indufor's baseline scenario forecasts that plantation timber supply will increase to 800 million cubic metres (m3) annually in 2030. **SDG:** Oliver et al. use a scenario for greater use of timber in construction based on increasing the rate of wood growth harvesting from 20% to 34%, which implies a doubling of construction timber (from plantation and other sources) from around 1 billion m3 to 2 billion m3 annually. We constrained this potential demand growth to plantation timber only. Indufor's most aggressive scenario forecasts that supply could increase to around 1100 million m3 annually in 2030. We assume average raw timber prices (industrial roundwood) of US$90–130 per m3.	Indufor Plantation Review (2012)[321] Oliver et al (2014)[322]

Durable and modular buildings (US$20¬–40 billion)

Description	Sizing Assumptions	Sources
Resource saving from shifting to more durable and modular designed buildings	**BAU:** The take-up of durable and modular designed buildings remains at current levels. **SDG:** Ellen MacArthur Foundation estimates the annual primary resource benefit in 2030 from shifting to more durable and modular buildings in Europe. EU accounts for 27% of global GDP and 39% of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation (2015) [323]

ENERGY AND MATERIALS

Circular economy – automotive (US$475–810 billion)

Description	Sizing Assumptions	Sources
Adoption of circular economy models in automotive sector through shift from recycling to refurbishing vehicles at end-of-life	**BAU:** Collection and refurbishment rates remain at current levels. **SDG:** Collection rates in EU for vehicles are maintained, but refurbishment rate is lifted to 50%, with remaining 50% recycled. In the EU, Ellen MacArthur Foundation (EMF) estimates this could generate net material cost savings of US$170–200 billion. EU has 27% share of global GDP and 39% share of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation Towards the Circular Economy Vol. 1 (2011)[324]

Expansion of renewables (US$165–605 billion) (continued)

Description	Sizing Assumptions	Sources
Increasing penetration of renewable energy in electricity generation	*Method 1* **BAU:** Share of renewable energy in electricity generation increases from 23% today to 30%. Total global electricity generation is forecast to be 36,800 Twh/year in 2030. **SDG:** In its REmap case, IRENA forecasts that the share of renewable energy could increase from 23% today to 45% in 2030. Total global electricity generation is forecast to be 38,000 Twh/year in 2030. Assume average wholesale price of US$100/Mwh.	IRENA Roadmap for renewable energy (2016)[325]
	Method 2 **BAU:** Renewables share of global electricity generation increases to around 30%, in line with the IEA's "New policies" scenario. Total global electricity generation is 33,214 Twh/year in 2030. **SDG:** Renewable's share of global electricity generation increases to around 40%, in line with IEA's 450 Scenario. Total global electricity generation is 29,682 Twh/year in the 450 Scenario. Assume an average wholesale price of US$100/Mwh..	IEA Energy and Climate Change Special Report (2015)[326]

Circular economy – appliances and machinery (US$305–525 billion)

Description	Sizing Assumptions	Sources
Adoption of circular economy models in the machinery and equipment sectors (including domestic appliances) by combining new leasing models with increased refurbishing activities	**BAU:** The collection rate in EU for machinery and equipment remains at 40%. **SDG:** The EU collection rate for machinery and equipment increases to 95%, with half recycled and half refurbished. In the EU, EMF estimates this could generate net material cost savings of US$110–130 billion. The EU has 27% share of global GDP and 39% share of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation Towards the Circular Economy Vol 1 (2011)

Circular economy – electronics (US$210–365 billion)

Description	Sizing Assumptions	Sources
Adoption of circular economy models in the electrical machinery sector (including electronic devices and gadgets) through improved recycling, remanufacture and reuse built into product design	**BAU:** The collection rate in the EU for electrical equipment remains at 20%. **SDG:** The EU collection rate for electrical equipment increases to 95%, with half recycled and half refurbished. In the EU, EMF estimates this could generate net material cost savings of US$75–90 billion. EU has 27% share of global GDP and 39% share of OECD GDP, so the estimate is scaled globally based on this range.	Ellen MacArthur Foundation Towards the Circular Economy Vol 1 (2011)

Energy efficiency – non-energy intensive industries (US$225–315 billion)

Description	Sizing Assumptions	Sources
Improving energy efficiency, particularly in SMEs, in industries that are not energy intensive and have therefore not focused on energy efficiency so far	*Method 1* **BAU:** Energy efficiency improves in line with the IEA's New Policies scenario. **SDG:** IEA estimates the additional energy efficiency opportunity in non–energy intensive industries, where energy-efficiency gains have been less realised, could reduce total final energy consumption by 3.0–3.2%. Assume average weighted energy price of US$900/toe and total final energy consumption of 11,221 Mtoe.	IEA World Energy Outlook (2015)[327]
	Method 2 **BAU:** Energy efficiency improves at or near historical rates. **SDG:** MGI estimates the energy-efficiency opportunity in non–energy intensive industries, based on a variety of levers, to be US$224 billion in 2030.	MGI Resource Revolution (2011)[328]

Energy storage (US$130–260 billion)

Description	Sizing Assumptions	Sources
Increasing energy storage capacity to reduce peak capacity needs and allow more penetration of renewables	*Method 1:* **BAU:** Battery storage increases to 100GW, with low penetration of variable renewable energy in grids. **SDG:** Levelised cost of battery storage will fall toward US$100–200/MWh, driven by improved technology. IRENA forecasts that demand for additional battery storage to enable increased penetration of variable renewable energy will reach 150GW by 2030.	World Energy Council E storage (2016)[329] IRENA Energy storage (2015)

Resource recovery (US$85–210 billion)

Improvements in the recovery rates of coal mines, oil and gas fields, and iron ore and copper mining by increased mechanisation and enhanced practices	**BAU:** Up to 75% of the opportunity is captured through the current progression of investment and technology adoption. **SDG:** Increased mechanisation to enhance recovery rates by 50% in some small coal mines in developing countries. In oil recovery, assume that in poorly performing wells representing 23% of production, well life can be increased by 10%. In gas, iron ore and copper, a range of new techniques improve recovery rates.	MGI Resource Revolution (2011 & 2016 (forthcoming))

End-use steel efficiency (US$120–195 billion)

Description	Sizing Assumptions	Sources
Increasing the efficiency of steel use in construction, machinery and automobile sectors through higher strength steel and design optimisation	*Method 1* **BAU:** Efficiency in end use of steel improves at historical rates. **SDG:** Increased penetration of 500 MPa (10%) and 450 MPa (30%) rebars in developing countries. Additional weight saving of 30% for beams and columns, and 50% penetration. Additional weight savings of 15% for cars and 20% for commercial vehicles.	MGI Resource Revolution (2011)
	Method 2 **BAU:** Material efficiency improves in line with the IEA's New Policies scenario. **SDG:** IEA estimates that material efficiency measures, including light-weighting and increased scrap recycling, could reduce steel requirements globally by 550 Mt in 2040. To avoid overlap with other opportunities that include recycling, assume only half (construction's share of steel use) this reduction is achievable, but in 2030. Assume steel price of US$716/t based on MGI Resource Revolution.	IEA World Energy Outlook (2015)

Energy efficiency – energy-intensive industries (US$80–175 billion)

Description	Sizing Assumptions	Sources
Improving energy efficiency in industries that are energy-intensive – steel, cement, chemicals, paper and aluminium	*Method 1:* **BAU:** Energy efficiency improves in line with the IEA's New Policies scenario. **SDG:** IEA estimates the additional energy-efficiency opportunity in energy-intensive industries could reduce total final energy consumption by 0.7–0.9%. Assume average weighted energy price of US$900/toe and total final energy consumption of 11,221 Mtoe.	IEA World Energy Outlook (2015)
	Method 2: **BAU:** Energy efficiency improves at or near historical rates. **SDG:** MGI estimates the energy-efficiency opportunity in iron, steel, chemicals and cement industries, based on a variety of levers, to be US$174 billion in 2030.	MGI Resource Revolution (2011)

Carbon capture and storage (US$55–150 billion)

Description	Sizing Assumptions	Sources
Increasing use of carbon capture and storage (CCS) technology to abate CO_2 emissions	*Method 1* **BAU:** CCS penetration remains low, in line with the IEA's New Policies scenario, and abatement is negligible in 2030. **SDG:** Under the IEA's 450 scenario, CCS penetration increases rapidly during the 2020s, leading to the incremental abatement of 2.1 Gt of CO_2 in 2030. The cost of abatement is estimated to be US$25–60 per tonne of CO_2, based on various sources.	IEA World Energy Outlook (2015); CCS Association[330]
	Method 2: **BAU:** $C0_2$ abatement from CCS continues to grow at current low levels. **SDG:** McKinsey estimates the incremental CO_2 emissions that can be captured through CCS in 2030 to be 2.5 Gt. The cost of abatement is estimated to be US$25–60 per tonne of CO_2, based on various sources.	McKinsey Global Greenhouse Gas Abatement Cost Curve (2009)[331]

Energy access (US$35–150 billion)

Description	Sizing Assumptions	Sources
Providing universal access to reliable, modern energy – electricity and modern cooking fuels	*Method 1* **BAU:** No specific policies or targets to increase access to electricity and modern fuels. **SDG:** The International Institute for Applied Systems Analysis (IIASA), Global Environment Facility (GEF) and the United Nations Industrial Development Organization (UNIDO) estimate that almost universal access to electricity and modern fuels is achievable by 2030 with annual capital investments of around US$37–42 billion.	IIASA/GEF/ UNIDO Access to Modern Energy (2012)[332]
	Method 2 **BAU:** The current demand gap for modern lighting, cooking fuels and electricity remains unaddressed. **SDG:** IFC estimates that there are 274 million households without modern lighting and electricity, and 426 million without modern cooking fuel (IEA estimates that under BAU, this will remain steady to 2030). Using those households' current energy expenditures, the addressable market is estimated at US$40 billion based on various technologies.	IFC Business Models for Scaling Up Energy Access (2012)[333]
	Method 3 **BAU:** The current demand gap for cooking fuels and electricity remains unaddressed. **SDG:** Bazilion et al. used levelised costs – capex, opex and fuel costs – to estimate annualised cost of providing universal electricity access at US$12–134 billion (2010 USD) and universal clean cooking at US$1.4–2.2 billion.	Bazilion et al. (2010)[334]

Green chemicals (US$75–130 billion)

Description	Sizing Assumptions	Sources
Increasing adoption of green chemistry techniques and processes	**BAU:** Pike Research forecasts that the global green chemicals market could reach US$104 billion in 2020. We assume this increases to 2030 at the forecast chemical industry growth rate of around 4%. **SDG:** Given the implementation of the SDGs, assume this grows much faster (8.2–10.6%) based on forecast CAGRs for green chemicals industry.	Pike Research (2011); Technavio (2014); Roland Berger (2015); BCC Research (2016)[335]

Additive manufacturing (US$90–125 billion)

Description	Sizing Assumptions	Sources
Increasing use of additive manufacturing techniques (e.g., 3D printing) to reduce material use and waste	**BAU:** In direct product manufacturing, MGI estimates an addressable market of US$770 billion in 2025. Assume 30% of this is captured at 40% cost saving. For tools and molds, addressable market is estimated at US$360 billion in 2025. Assume 30% of this is captured. **SDG:** We assume that 50% of the direct product market is captured at 40–55% cost saving. For tools and molds, we assume 50% of the market is captured, at cost saving of 30%. Then scale conservatively at global GDP growth rate to 2030.	MGI Disruptive Technologies (2013)[336]

Local content in extractives (US$60–120 billion)

Description	Sizing Assumptions	Sources
Increasing the use of local content in the extractives value chain	**BAU:** No increase in local content. **SDG:** 36–78% of mining spend can be potentially localised, and 40–68% of oil and gas spend. Annual mining spend forecast to be US$215 billion, and oil and gas spend to be US$445 billion (both in a climate response scenario). Assume that 25% of the potential is captured by local content.	MGI Reverse the curse (2014)[337]

Shared infrastructure (US$30–120 billion)

Description	Sizing Assumptions	Sources
Developing shared use models for critical infrastructure used in oil and gas, and mining, which can enable others to access	**BAU:** No shared infrastructure development. **SDG:** Resource-driven countries need to spend more than US$1.3 trillion per year on infrastructure, about 9% of which relates to resources (represents a US$117 billion annual opportunity). Assume that at least 25% and as much as 100% of spending related to resources can be shared, resulting in US$30–120 billion opportunity.	MGI Reverse the curse (2014)

Mine rehabilitation (US$45–65 billion)

Description	Sizing Assumptions	Sources
Improving environmental remediation of mines and wells, and ensuring long-term sustainability of local communities	**BAU:** The global remediation and industrial services market was worth US$39.5 billion in 2011, according to EBI. Assume that around half of this is attributable to mine, and oil and gas remediation (the remainder is industrial site remediation), and that the market grows to 2030 at historical growth rate of 3.8%. **SDG:** Estimates suggest that only 20–25% of mines are properly rehabilitated. Assume that all mines and wells can begin being properly rehabilitated by 2030, and that the size of the market increases proportionally.	Environmental Business International (2012)[338] US BLS (2014); Independent Australia (2016)[339]

Grid interconnection (US$35 billion)

Description	Sizing Assumptions	Sources
Increasing interconnection of regional electricity grids to reduce peak capacity needs and allow more penetration of renewables	**BAU:** Less upgrading of grids to improve interconnection, in line with ECF's Less Transmission scenario. **SDG:** Increased interconnection between grids in Europe results in a forecast reduction in levelised cost of electricity of 2 Euros/MWh in 2030. These savings are extrapolated globally based on Europe's share of global energy production, and the proportion of the world's production occurring in countries with greater than 25% renewable penetration.	3GF Accelerating Green Growth (2012)[340] ECF Power Perspectives 2030 (2012)[341]

HEALTH AND WELL-BEING

Risk pooling (US$350–500 billion)

Description	Sizing Assumptions	Sources
Reducing out of pocket (OOP) health expenses by providing insurance programs	**BAU:** Around 40% of health spending in low- and lower middle-income countries is OOP, while WHO's target rate to avoid catastrophic income shocks is 25–30% (OOP is 15% of total health spending in high income countries). There has been little historical change in the proportion of OOP health expenses in these countries, so assume no reduction in the gap. **SDG:** Assume OOP expenses meet WHO's target rates. In low-income countries, annual health spend per capita is US$102, growing at 7.6% per year. Population is 650 million, growing at 2.7% per year. In lower-middle-income countries, annual health spend per capita is US$310, growing at 6.5% per year. Population is 3 billion, growing at 1.5% per year.	WHO Universal Health Care (2015)[342]

Remote patient monitoring (US$300–440 billion)

Description	Sizing Assumptions	Sources
Application of remote monitoring systems to improve patient care	*Method 1* **BAU:** GSMA and McKinsey estimate the potential savings from remote health management to be US$175–200 billion. This is grown to 2030 based on historical healthcare expenditure growth. **SDG:** Goldman Sachs estimates that in the near term, remote patient monitoring could save the US healthcare system US$202 billion annually. Scaled globally based on the US's share of global healthcare expenditure (39%), this is assumed to be achievable in 2020 and is grown to 2030 based on historical healthcare expenditure growth.	GSMA & McKinsey m-Health (2007)[343]; Goldman Sachs IoT in US Healthcare (2015)[344]
	Method 2 **BAU:** Same as method 1. **SDG:** MGI estimates the adoption rate for patients who would be affected by remote healthcare is 70–80% and the application of remote healthcare can reduce the cost of chronic disease treatment by 10–20%. The cost of chronic disease management in 2030 is expected to be around US$14 trillion based on current trajectory.	MGI Disruptive Technologies (2013)[345]

Telehealth (US$130–320 billion)

Description	Sizing Assumptions	Sources
Increasing use of internet and mobile technologies for medical consultations	**BAU:** Goldman Sachs estimates that in the near term, telehealth could save the US healthcare system US$104 billion annually. Scaled globally based on the US's share of global healthcare expenditure (39%), this is assumed to be achievable in 2020. This is grown to 2030 based on historical healthcare expenditure growth. **SDG:** The savings opportunity is instead grown based on various near-term forecasts for the CAGR of telemedicine.	Goldman Sachs IoT in US Healthcare (2015); Grand View (2014)[346]; Zion (2016)[347]

Advanced genomics (US$100–155 billion)

Description	Sizing Assumptions	Sources
Better diagnostic and treatment options based on the study of individual genetic patterns	**BAU:** The current market size of the advanced genomics industry (including diagnostics and personalised drugs) is estimated at US$103 billion. We assume this grows to 2030 at the forecast global GDP growth rate. **SDG:** We assume instead that the market grows at forecast CAGR levels estimated in market reports (8–11%).	KellySciPub (2016)[348]; GrandView Research (2014)[349]

Activity services (US$65–125 billion)

Description	Sizing Assumptions	Sources
Increasing penetration of gyms and fitness clubs	**BAU:** Statista reports that the global health club market has grown from US$67 billion in 2009 to US$81 billion in 2015, an implied CAGR of 3%. Assume this continues to 2030. **SDG:** SAM forecasts potential growth in this market of 6–8%. Assume these higher growth rates are possible from 2015 to 2030.	Statista; SAM Healthy living (2012)

Detection of counterfeit drugs (US$65–80 billion)

Description	Sizing Assumptions	Sources
Use of technology, including track and-trace systems, to reduce drug counterfeiting	**BAU:** No increased effort to reduce drug counterfeiting. **SDG:** MGI estimates the potential cost of drug counterfeiting in 2025 at US$400 billion worldwide. Assume that 40% of drugs are suitable for sensor-based tracking systems, and 50% penetration of systems by 2030. Success rate of sensors in reducing counterfeiting is estimated to be 80–100%.	MGI Disruptive Technologies (2013)

Tobacco control (US$15–60 billion)

Description	Sizing Assumptions	Sources
Providing better access to nicotine replacement therapy and other tobacco control products	**BAU:** The current market size for nicotine replacement products is estimated at US$7 billion. We assume this grows to 2030 at the forecast global GDP growth rate. **SDG:** We assume instead that the market grows at forecast CAGR levels estimated in market reports (8–18%)	WHO Tobacco Control (2016)[350]; WHO Global Health (2010)[351]; Transparency Market Research (2016)[352]; Grand View Research (2016)[353]

Better disease management (US$35–45 billion)

Description	Sizing Assumptions	Sources
Improving management of communicable and non-communicable diseases (NCDs) in the developing world through low-cost interventions	**BAU:** No additional investment in disease management above current levels. **SDG:** The following needs are addressed: *HIV, tuberculosis and malaria* Lancet Commission on Global Health estimates that the incremental cost of improving prevention and treatment of HIV, tuberculosis and malaria in low- and lower middle income countries will be US$18 billion in 2025, and US$26 billion in 2035.	Lancet Commission on Global Health 2035 (2013)[354]
	Research and development Lancet Commission on Global Health estimates that investment in research for infections and reproductive, maternal, newborn and child health disorders affecting mostly low- and middle-income countries needs to double by 2020 to US$6 billion annually. The Review on Antimicrobial Resistance finds that US$1.6–3.7 billion annually will need to be invested to provide the required 'pull incentives' for new antibiotic therapies. The overlap between these two estimates is minimal.	Review on Antimicrobial Resistance (2015)[355]
	Non-communicable diseases WHO and WEF estimate the cost of scaling up a core set of NCD best-buy intervention strategies in low- and middle income countries at US$11.4 billion.	WHO & WEF NCD "Best buys" (2011)[356]

Weight management programs (US$35–45 billion)

Description	Sizing Assumptions	Sources
Expansion of weight management programs to address growing prevalence of obesity	**BAU:** No specific intervention occurs. **SDG:** In the UK, MGI forecasts that weight management programs could save 967,000 DALYs annually, at an average cost of US$1300 per DALY. This equates to a total intervention cost of US$1.3 billion. Assume this is scaled based on UK's share of global obesity costs (4%) and grown to 2030 based on forecast annual growth in obese populations worldwide (1.5%, from Kelly et al.).	MGI Obesity (2014); Kelly et al. on Global Burden of Obesity 2005–2030 (2008)

Electronic medical records (US$5–35 billion)

Description	Sizing Assumptions	Sources
Expansion of cloud-based electronic medical record systems	*Method 1* **BAU:** Juniper Research estimates that there are cumulative savings opportunities from adopting electronic health records (EHR) of US$78 billion from 2014 to 2019. The annualised amount is then grown to 2030 based on a forecast global growth rate. **SDG:** The annualised amount is instead grown at the forecast growth rate of the fastest growing region (Asia-Pacific), according to research by Accenture. *Method 2* **BAU:** MGI estimates that widespread adoption of EHR in India could yield US$3 billion per year by saving 3–4 percent of physician and nursing time and reducing duplicated tests by 10–15% by 2025. This is scaled globally using India's share of global healthcare expenditure (1.3%), then grown to 2030 at a global forecast growth rate for EHR. **SDG:** The annual economic impact is instead grown at the forecast growth rate of the fastest growing region (Asia-Pacific).	Juniper Research Electronic Health Records (2014)[357] Transparency EHR Market (2016)[358] Accenture EHR Global Market (2014)[359] MGI India's Technology Opportunity (2014)[360]

Low-cost surgery (US$15–25 billion)

Description	Sizing Assumptions	Sources
Meeting the unmet demand for surgery with the aid of low-cost surgical procedures	**BAU:** The Lancet Commission estimates that in regions where there is unmet demand for surgery, 242 million procedures are demanded and only 100 million supplied. We assume the rate of demand increases at the rate of population increase, with no increase in supply. This implies a 2030 gap of 200 million surgeries. **SDG:** We assume supply increases to meet the gap. The average unit cost of low-cost surgeries is estimated by the Lancet Commission to be US$180–220.	Lancet Commission Global Surgery 2030 (2015)[361]

Healthcare training (US$20–25 billion)

Description	Sizing Assumptions	Sources
Expanding training in the developing world to fill the gap in the supply of healthcare workers	**BAU:** WHO projects that the number of healthcare workers will increase from 43.5 million in 2013 to 67.3 million in 2030. **SDG:** Based on a composite measure of minimum density of healthcare workers, WHO estimates that there will remain a shortage of 14.5 million healthcare workers in 2030 (down from 17.4 million in 2013). Assume that this shortage can be closed by 2030 through increased training, with the total cost annualised over 15 years. Training costs for different regions and types of healthcare workers (physicians, nurses/midwives and other cadres) are estimated based on The Lancet Commission on Medical Education.	WHO Health Workforce Draft Strategy 2030 (2016)[362] Lancet Commission Medical Education (2010)[363]

Better maternal and child health (US$20–25 billion)

Description	Sizing Assumptions	Sources
Improving health outcomes for women and children through a package of low cost interventions	**BAU:** No additional investment in contraceptives; menstrual health; maternal, newborn and child health; and immunisation services above current levels. **SDG:** The following markets are addressed: *Contraceptive products* Assuming 262 million people across the world will have an unmet demand for contraceptive products in 2030. Low-cost injectable contraceptives (e.g., Sayana) are US$1–US$2 per dose, and require 4 doses per year. *Menstrual health products* Around 400 million people will experience unmet demand for menstrual health products in 2030. Low-cost reusable packs of sanitary pads (e.g., Uger pads) cost US$4–6 per person per year. *Maternal and neonatal health, immunisation and treatment of childhood illness* Lancet Commission on Global Health estimates that the incremental cost of providing pregnancy-related interventions, immunisations and treatment of childhood illness in low income and lower-middle-income countries will be US$17 billion in 2025 and US$22 billion in 2035.	IC2030 Innovations (2015)[364] Team analysis of low-cost products Lancet Commission on Global Health 2035 (2013)[365]

ENDNOTES

1 A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

2 "Planetary Boundaries: Guiding human development on a changing planet", Steffen et al., *Science*, Vol. 347 no. 6223, 2015.

3 "Accelerated modern human-induced species losses: Entering the sixth mass extinction", Gerardo Ceballos et al., Science Advances, Vol. 1, June 2015.

4 *A Stronger UNCCD for a Land-Degradation Neutral World*, United Nations Convention to Combat Desertification Secretariat, 2013; FAOSTAT, Food and Agriculture Organization, 2013.

5 *The Economics of Ecosystems and Biodiversity (TEEB)*, United Nations Environment Programme, 2010.

6 *Climate Change Vulnerability Monitor: A guide to the cold calculus of a hot planet*, DARA and the Climate Vulnerable Forum, 2012.

7 *Trends in Maternal Mortality: 1990 to 2013*, WHO, 2014.

8 "Protecting households from catastrophic health spending", K. Xu et al., *Health Affairs*, Vol. 26, 2007.

9 *Progress on sanitation and drinking water – 2015 update and MDG assessment*, UNICEF and WHO, 2015.

10 Fact sheet: Tobacco, WHO, June 2016; *Fact sheet: Obesity and overweight*, WHO, June 2016.

11 *Tackling drug-resistant infections globally: Final report and recommendations*, The Review on Antimicrobial Resistance, May 2016.

12 *Health in 2015 from MDGs to SDGs*, WHO, 2015.

13 *The Learning Generation: Investing in education for a changing world*, The International Commission on Financing Global Education Opportunity, 2016.

14 *Focus on Inequality and Growth: Does income inequality hurt economic growth?*, OECD, 2014.

15 *Humanity Divided: Confronting inequality in developing countries*, United Nations Development Programme, November 2013.

16 *An Economy for the 1%: How privilege and power in the economy drive extreme inequality and how this can be stopped*, Oxfam, January 2016.

17 *Focus on Inequality and Growth: Does income inequality hurt economic growth?*, OECD, 2014.

18 *World Employment Social Outlook: Trends 2016*, International Labour Organization, 2016.

19 *Global Peace Index 2015*, Institute for Economics and Peace, 2015.

20 *Illicit Financial Flows from Developing Countries: 2004-2013*, Global Financial Integrity, December 2015.

21 *Seeking an end to loss and waste of food*, Food and Agriculture Organization (FAO), 2011; *Food wastage footprint, Full-cost accounting: Final report*, FAO, 2014.

22 *Towards the Circular Economy Vol. 1*, Ellen MacArthur Foundation, 2011; Towards the Circular Economy Vol. 2: opportunities for the consumer goods sector, Ellen MacArthur Foundation, 2013.

23 *World Energy Outlook 2015*, IEA, 2015.

24 *Investing in the Clean Trillion*, IEA, January 2014.

25 *The Adaptation Gap Finance Report 2016*, UNEP, 2016.

26 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

27 *Health in 2015: From MDGs to SDGs*, WHO, 2015.

28 *A growing number of children and adolescents are out of school as aid fails to meet the mark: Policy paper 22*, UNESCO Institute for Statics and Education for All Global Monitoring Report, July 2015.

29 *How advancing women's equality can add $12 trillion to global growth*, McKinsey Global Institute, September 2015.

30 "Unleashing rural economies", *The Economist*, February 2016.

[31] *The High Cost of Low Educational Performance: The long-run economic impact of improving PISA outcomes*, OECD, 2010.

[32] *Can long-term global growth be saved?*, McKinsey Global Institute, January 2015.

[33] *Infrastructure productivity: How to save $1 trillion a year*, McKinsey Global Institute, January 2013.

[34] Global Slavery Index, Walk Free Foundation, 2016; *Marking progress against child labour: Global estimates and trends 2000-2012*, ILO, 2013.

[35] *Illicit Financial Flows from Developing Countries: 2004-2013*, Global Financial Integrity, December 2015.

[36] See, for example, "Climate policies can help resolve energy security and air pollution challenges", David L. McCollum et al., *Climate Change*, Vol. 119, February 2013.

[37] "Demographic scenarios by age, sex and education corresponding to the SSP narratives", Samir KC and Wolfgang Lutz, *Popular Environment*, Vol. 35, 2014.

[38] See, for example, *Make it your business: Engaging with the Sustainable Development Goals*, PwC, 2015.

[39] *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

[40] *Transforming our world: the 2030 Agenda for Sustainable Development*, UN, 2015. See, for example, Decoupling 2: technologies, opportunities and policy options, International Resource Panel (UNEP), 2014.

[41] *Housing and Health: Partners Against Poverty*, Habitat for Humanity, 2011.

[42] *The world at work: Jobs, pay and skills for 3.5 billion people*, McKinsey Global Institute, June 2012.

[43] This range is based on estimates by the United States Federal Highway Administration of the employment impact of capital expenditure on highways. See *Employment impacts of highway infrastructure investment*, Federal Highway Administration, 2007. Other studies on the US economy have found broadly similar estimates. See, for example, James Heintz, Robert Pollin & Heidi Garrett-Peltier, *How infrastructure investments support the US economy: Employment, productivity, and growth*, Political Economy Research Institute and Alliance for American Manufacturing, January 2009. This report found that $1 billion of infrastructure investment generates around 18,000 jobs. This is likely to be a conservative number when extrapolated to global investment, given the lower wages and higher labor to capital ratios in most other countries.

[44] *Renewable Energy Benefits: Measuring the Economics*, IRENA, 2016.

[45] *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

[46] *Transforming the way we produce, move, and consume food*, Anterra Capital, March 2016.

[47] *The State of Food Insecurity in the World. Meeting the 2015 international hunger targets: taking stock of uneven progress*, FAO, International Fund for Agricultural Development and World Food Programme, 2015.

[48] *World Agriculture: towards 2030/2050*, FAO, June 2012.

[49] *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

[50] "Planetary boundaries: Guiding human development on a changing planet", W Stefen et al., Science, Vol. 347, 2015.

[51] *Food systems and natural resources*, International Resources Panel, June 2016.

[52] *Natural Capital Impacts in Agriculture*, Trucost, 15 October 2015.

[53] *Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study*, BMJ, January 2016.

[54] Information sourced from the OECD and the International Monetary Fund.

[55] Resource revolution: Meeting the world's energy, materials, food, and water needs, McKinsey Global Institute, November 2011.

[56] USA Today, 9 Jan 2015.

[57] Global food losses and food waste, FAO, 2011.

58 *Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia. Part 2: Postharvest Loss Assessments*. Lisa Kitinoja and Marita Cantwell, World Food Logistic Organization, 2010.

59 About REDD+, UN-REDD Programme, May 2016.

60 *UN Climate Summit New York Declaration on Forest*, UNDP, September 2014. New public–private partnerships like the Tropical Forest Alliance 2020 have also been created with the aim of reducing tropical deforestation associated with the sourcing of commodities.

61 *Estimates of Emissions Reduction Potential for the 2015 Report: Technical Note*, New Climate Economy, 2015.

62 This estimate is based only on carbon payments and does not include additional revenues from agroforestry and reduced impact logging. Robust estimates for the potential value of these activities are difficult given available data.

63 *Global Consumption Database*, The World Bank.

64 *The state of food insecurity in the world 2015*, FAO, 2015

65 *Undernourishment around the world 2015*, FAO.

66 *An Update to the World Bank's estimates of consumption poverty in the developing world,* World Bank, 2012.

67 *The Economic Lives of the Poor*, A.V. Banerjee & E. Duflo, Abdul Latif Jameel Poverty Action Lab MIT, October 2006.

68 *Reducing food loss and waste*, World Resources Institute and UNEP, June 2013.

69 *Global food losses and food waste*, FAO, 2011.

70 *World Agriculture: towards 2030/2050*, FAO, June 2012.

71 *A roadmap to reduce US food waste by 20 percent*, ReFED, 2016.

72 *Effectiveness of product reformulation as a strategy to improve population health: Rapid review of the evidence*, National Health Foundation of Australia, 2012.

73 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

74 Note that individual countries apply different definitions for large and small-scale farms. In Brazil, for instance, smallholder farms can be up to 40 hectares.

75 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

76 *Agropastoral systems for the tropical savannas of Latin America*, Elcio Perpétuo Guimarães et al., eds, International Center for Tropical Agriculture and Brazilian Agricultural Research Corporation, 2004.

77 "The future of agriculture", *The Economist*, June 2, 2016.

78 G. Eshel, A. Shepon, T. Makov & R. Milo, *Land, irrigation, water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States*, Proceedings of the National Academy of Sciences, Vol. 111, No. 33, June 2014.

79 *Shifting Diets for a Sustainable Future*, World Resources Institute, April 2016.

80 "China's plan to cut meat consumption by 50% cheered by climate campaigners", *The Guardian*, 20 June 2016.

81 *Fish to 2030: Prospects for Fisheries and Aquaculture*, The World Bank, December 2013.

82 "Science review: SR25, A future for small-scale farming", Julian Quan, Foresight Project on Global Food and Farming Futures, 2011.

83 *Indonesia Country Appraisal: Opportunities for UK support to Forestry and Climate Change*, D. Elsom, Unpublished consultancy report for DfID, 2011.

84 *Resource Revolution: Meeting the world's energy, materials, food, and water need*s, McKinsey Global Institute, November 2011.

85 *A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?*, Julian M. Alston, Connie Chan-Kang, Michele C. Marra, Philip G. Pardey, TJ Wyatt, International Food Policy Research Institute, 2000.

86 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

87 *The investment case for ecological farming (white paper)*, Paul McMahon, SLM Partners, January 2016.

88 *Status of the World's Soil Resources*, FAO, 2015.

89 '"Peak Soil" Threatens Future Global Food Security', *Reuters*, 17 Jul 2015.

90 "When does no-till yield more? A global meta-analysis", Cameron M. Pittelkowa, Bruce A. Linquist, Mark E. Lundy, Xinqiang Liang, Kees Jan van Groenigen, Juhwan Lee, Natasja van Gestel, Johan Six, Rodney T. Ventereae and Chris van Kessel, *Field Crops Research*, Vol. 183, November 2015

91 *The New Plastics Economy: Rethinking the future of plastics*, Ellen Macarthur Foundation, January 2016.

92 *The New Plastics Economy: Rethinking the future of plastics*, Ellen Macarthur Foundation, January 2016.

93 *Food and Agriculture Organization of the United Nations World Agriculture: Towards 2015/2030*, FAO, 2002.

94 "Agriculture: Steps to sustainable livestock", Mark C. Eisler et al., *Nature*, Vol. 507, 5 March, 2014.

95 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

96 *The conservation versus production trade-off: does livestock intensification increase deforestation? Evidence from the Brazilian Amazon*, Petterson Molina Vale, Grantham Research Institute on Climate Change and the Environment, Working Paper No.174, December 2014.

97 *Urban Agriculture*, FAO, 2016.

98 *Urban Agriculture*, FAO, 2016; *Women Feeding Cities, Practical Action Publishing*, 2009; *Integrating Urban Agriculture into climate action plans: Lessons from Sri Lanka and Argentina*, RUAF Foundation, January 2015.

99 *Growing Greener Cities in Latin America and the Caribbean*, FAO, 2014.

100 *Sustainable production of second generation biofuels*, IEA, February 2010.

101 *Sub-Saharan Africa: The state of smallholders in agriculture*, Geoffrey Livingston, Steven Schonberger and Sara Delaney, International Fund for Agricultural Development, January 2011.

102 *Estimates of Emissions Reduction Potential for the 2015 Report: Technical Note*, New Climate Economy, 2015.

103 *Reducing food loss and waste*, World Resources Institute and UNEP, June 2013.

104 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

105 "Maternal and Child Nutrition", *The Lance*t, Vol. 382, August 2013.

106 Based on UN global population forecast of 8.5 billion in 2030.

107 *World Urbanization Prospects, the 2014 revision*, UN Department of Economic and Social Affairs, Population Division, 2014.

108 Michael Spence, preface to *Urbanization and growth*, Michael Spence, Patricia Clarke Annez & Robert M. Buckley, eds, Commission on Growth and Development, 2009.

109 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

110 Shlomo Angel, Stephen C. Sheppard & Daniel L. Civco, *The dynamics of global urban expansion*, World Bank, September 2005.

111 *Better Growth Better Climate: Synthesis report*, New Climate Economy, September 2014.

112 *Risk of Exposure and Vulnerability to Natural Disasters at the City Level: A Global Overview*, UN Population Division, 2015.

113 *Transportation Forecast: Light Duty Vehicles 2015-2035*, Navigant Research, 2014.

114 *Transport in Asia and the Pacific: 12 Things to Know*, Asian Development Bank, March 2012.

115 *Better Growth Better Climate: Synthesis report*, New Climate Economy, September 2014.

116 *Global Burden of Air Pollution: Deaths from air pollution in 2013*, Institute for Health Metrics and Evaluation et al., 2016.

117 *Progress on sanitation and drinking water – 2015 update and MDG assessment*, UNICEF and WHO, 2015.

118 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

119 Heng Chye Kiang, *From architectural heritage to identity in Singapore*, paper presented at 'The conservation of urban heritage: Macao Vision' conference in Macao, China, 2002.

120 *Urban mobility at a tipping point*, McKinsey & Company, September 2015.

121 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

122 ibid.

123 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

124 *World Energy Outlook*, IEA, 2015.

125 *District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy*, UNEP, 2015. District energy enables the use of low-grade waste heat from electricity generation or free cooling sources such as seawater. Investments in district energy may be more economical than further retrofits where buildings are already relatively efficient. District energy has not been separately sized as it is difficult to accurately estimate how it would substitute for building-level investments in energy efficiency. However, its potential contribution is significant.

126 *Global Energy Assessment*, International Institute for Applied Systems Analysis, 2012.

127 *Urban mobility at a tipping point*, McKinsey & Company, September 2015.

128 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

129 David Owen, *Green metropolis: Why living smaller, living closer, and driving less are the keys to sustainability* (New York: Riverhead Books, 2009).

130 *Resource Revolution: Meeting the world's energy, material, food and water needs*, McKinsey Global Institute, November 2011.

131 Access*ibility in Cities: Transport and Urban Form, NCE Cities Paper 03*, LSE Cities, London School of Economics and Political Science, 2014.

132 *Better Growth, Better Climate: Cities, New Climate Economy*, September 2014. The cost of BRT is estimated to be less than 15 percent of the cost of a metro system with comparable capacity.

133 *Urban mobility at a tipping point*, McKinsey & Company, September 2015.

134 *Global Status Report on Road Safety,* WHO, 2015.

135 *Trends and outlook of the auto electronics industry*, Deloitte, October 2013.

136 "Intelligent Safety Warning and Alert System for Car Driving", *Tamkang Journal of Science and Engineering*, 2010.

137 *Autonomous Vehicle Adoption Study*, Boston Consulting Group, 2015.

138 *Urban mobility at a tipping point*, McKinsey & Company, September 2015.

139 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

140 *100 Resilient Cities*, Rockefeller Foundation.

141 *The Adaptation Finance Gap Report*, UNEP, 2016.

142 *Tourism trends: The convergence of culture and tourism*, NHTV University of Applied sciences, November 2014.

143 *Benchmarking smart metering deployment in the EU-27 with a focus on electricity*, European Commission, 2014.

144 *Utility-scale smart meter deployments: Building block of the evolving power grid*, IEI Report, September 2014.

145 *Water and Cities: Facts and Figures*, UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC).

146 Estimated based on European floor space numbers and vacancy assumptions, which have been scaled globally based on GDP; *Growth within: A circular economy vision for competitive Europe*, Ellen MacArthur Foundation, 2015.

147 *World Greenhouse Gas Emissions in 2005*, Tim Herzog, World Resources Institute, July 2009.

148 "Carbon, Fossil Fuel, and Biodiversity Mitigation With Wood and Forests", Chadwick Oliver et al., *Journal of Sustainable Forestry*, Vol. 33, 2014.

149 *Timber City: Prospectus*, Gray Organschi Architecture, 2016.

150 *Outlook to 2060 for World Forests and Forest Industries: A Technical Document Supporting the Forest Service 2010 RPA Assessment*, Joseph Buongiorno et al., Southern Research Station, April 2012.

151 Composite timber building products add substantial value to wood that has not been fully incorporated in the estimate of the size of this opportunity. Glulam, for example, costs up to five times more than industrial roundwood (*Forest Products Annual Market Review 2011-2012*, FAO and UNECE, 2012).

152 *Growth within: A circular economy vision for a competitive Europe*, Ellen MacArthur Foundation, 2015.

153 "Industrial Agglomeration and Difference of Regional Labor Productivity: Chinese Evidence with International Comparison", J. Fan, *Economic Research Journal*, 11. 73–84, 2006.

154 *Better Growth Better Climate: Synthesis report*, New Climate Economy, September 2014.

155 *The Economic Role of Cities*, UN Habitat, 2011.

156 *Growth within: A circular economy vision for a competitive Europe*, Ellen MacArthur Foundation, 2015.

157 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

158 *Water and Cities: Facts and Figures*; UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC).

159 *Global Burden of Air Pollution*, Institute for Health Metrics and Evaluation, 2016.

160 *Global Status Report on Road Safety 2015*, WHO, 2015.

161 *Can long-term global growth be saved?*, McKinsey Global Institute, January 2015.

162 *Urban world: Cities and the rise of the consuming class*, McKinsey Global Institute, June 2012.

163 *Reverse the curse: Maximizing the potential of resource-driven economies*, McKinsey Global Institute, December 2013.

164 *World Energy Investment Outlook*, IEA, 2014.

165 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

166 *Roadmap for a renewable energy future*, IRENA, 2016.

167 *Towards the Circular Economy Vol. 1*, Ellen MacArthur Foundation, 2011.

168 *Roadmap for a renewable energy future*, IRENA, 2016.

169 *Towards the Circular Economy Vol. 1*, Ellen MacArthur Foundation, 2011.

170 *Apple posts 20% YOY growth and record profits despite Q4 smartphone slowdown*, Juniper Research, February 2016.

171 *The Global E-Waste Monitor 2014: Quantities, flows and resources*, United Nations University and Institute for the Advanced Study of Sustainability, 2015.

172 *E-storage: Shifting from cost to value, Wind and solar applications*, World Energy Council, 2016.

173 *Renewables and electricity storage: A technology roadmap for REmap 2030*, IRENA, June 2015.

174 *Global Energy Assessment: Towards a Sustainable Future*, IIASA, 2012.

175 *World Energy Outlook 2015*, IEA, November 2015.

176 *World Energy Outlook 2015*, IEA, November 2015.

177 *Roadmap for a renewable energy future*, IRENA, 2016.

178 *Better Growth, Better Climate: Synthesis report*, New Climate Economy, 2014.

179 *Energy and Climate Change: World Energy Outlook Special Report*, IEA, 2015.

180 *World Energy Outlook 2015*, IEA, November 2015.

181 *Access to modern energy: Assessment and Outlook for Developing and Emerging Regions*, IIASA, UNIDO & GEF, 2012.

182 *From Gap to Opportunity: Business Models for Scaling Up Energy Access*, IFC, 2012.

183 A related but smaller opportunity is chemical leasing, introduced by UNIDO, in which chemical companies sell services rather than products, encouraging more efficient use of chemicals and greater responsibility for consequences of their use.

184 *The Business Case for Green & Sustainable Chemistry*, Ecochem, 2013.

185 *Additive manufacturing: Pursuing the promise*, US Department of Energy, 2012.

186 *Reverse the curse: Maximizing the potential of resource-driven economies*, McKinsey Global Institute, December 2013.

187 Ian Satchwell, *Building mining services clusters in Australia*, International Mining for Development Centre, May 2012.

188 *Reverse the curse: Maximizing the potential of resource-driven economies*, McKinsey Global Institute, December 2013.

189 "Abandoned Mine Lands", Bureau of Land Management, US Department of the Interior, April 2014; "Who will pay the more than $17.8 billion mining rehabilitation bill?", Lachlan Barker, *Independent Australia*, 1 June 2015.

190 For example, the Western Australian state government in 2012 established a Mining Rehabilitation Fund and imposed levies on holders of tenements to address unfunded liabilities.

191 *Accelerating Green Growth through Public Private Partnerships*, 3GF, June 2012.

192 *Reverse the curse: Maximizing the potential of resource-driven economies*, McKinsey Global Institute, December 2013.

193 *Roadmap for a renewable energy future*, IRENA, 2016; *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*, McKinsey & Company, 2009.

194 *The Global E-Waste Monitor 2014: Quantities, flows and resources*, United Nations University and Institute for the Advanced Study of Sustainability, 2015.

195 *Global Burden of Air Pollution*, Institute for Health Metrics and Evaluation, 2016.

196 *Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations*, The Review on Antimicrobial Resistance Chaired by Jim O'Neill, December 2014.

197 *Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations*, The Review on Antimicrobial Resistance Chaired by Jim O'Neill, December 2014.

198 "Antibiotic resistance: The grim prospect", *The Economist*, May 21, 2016

199 *Health in 2015 from MDGs to SDGs*, WHO, 2015.

200 *The financial sustainability of health systems: A case for change*, World Environment Forum, 2012.

201 *World Population Ageing 2015*, UN Department of Economic and Social Affairs, 2015.

202 *The Lancet Global Health Report 2035*, The Lancet Commission on Investing in Health (CIH), 2013.

203 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

204 *Children: Reducing Mortality Fact Sheet*, WHO, 2016.

205 *Integrated Management Information System reports of the Ministry of Drinking Water and Sanitation*, Government of India, December 2013.

206 *Health in 2015 from MDGs to SDGs*, WHO, 2015.

207 *Global strategy on human resources for health: Workforce 2030, Draft for the 69th World Health Assembly*, WHO, 2016.

208 *Health in 2015 from MDGs to SDGs*, WHO, 2015.

209 *The Business of Health in Africa: Partnering with the Private Sector to Improve People's Lives*, International Finance Corporation (IFC), 2008.

210 *Designing health financing systems to reduce catastrophic health expenditure*, WHO Technical Policy Brief, 2005; and Coping with out-of-pocket health payments: empirical evidence from 15 African countries, Bulletin of the WHO, November 2008.

211 *The Business of Health in Africa: Partnering with the Private Sector to Improve People's Lives*, IFC, 2008.

212 *IoT: Digital Revolution comes to US healthcare*, Goldman Sachs, 2015.

213 *Disruptive technologies: Advances that will transform life, business, and the global economy,* McKinsey Global Institute, May 2013.

214 *Shaping your healthcare strategy*, EY, 2013.

215 *India's tech opportunity: Transforming work, empowering people*, McKinsey Global Institute, December 2014.

216 "KRAS mutation testing in colorectal cancer", *Advances in Anatomical Pathology*, Vol. 16 No. 4, July 2009.

217 *Personalised Medicine: The Path Forward*, McKinsey & Company, 2013.

218 *An introduction to next-generation sequencing*, Illumina, 2016.

219 *Human genomics in global health*, WHO, 2016.

220 *Healthy Living Obesity – A Heavy Burden*, SAM Study, 2012.

221 "Technologies for Detecting Falsified and Substandard Drugs in Low and Middle Income Countries", *PLoS One*, Vol. 9, March 2014.

222 *Tobacco Control*, WHO, 2016.

223 *Fact Sheet on Tobacco*, WHO, 2016.

224 *Nicotine replacement therapy for smoking cessation*, Cochrane Tobacco Addiction Group, 2012.

225 *Disability adjusted life year rates by World Bank income group*, WHO, 2014.

226 *The Lancet Global Health Report 2035*, The Lancet Commission on Investing in Health, 2013.

227 From Burden to "Best Buys": *Reducing the Economic Impact of Non-communicable Diseases in Low- and Middle-Income Countries*, WHO & World Economic Forum, 2011; The Lancet Global Health Report 2035, The Lancet Commission on Investing in Health, 2013.

228 *Securing new drugs for future generations: The pipeline of antibiotics*, The Review on Antimicrobial Resistance, May 2015.

229 *Reimagining global health: 30 high-impact innovations to save lives*, The IC2030 report, July 2015.

230 *Overcoming Obesity: An initial economic analysis*, McKinsey Global Institute, November 2014.

231 "Efficacy of Commercial Weight-Loss Programs: An Updated Systematic Review", Annals of Internal Medicine, Vol. 162, April 2015; *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

232 *India's tech opportunity: Transforming work, empowering people*, McKinsey Global Institute, December 2014.

233 "The Ups and Downs of Electronic Medical Records", *The New York Times*, 8 October 2012.

234 *Sanitary Protection: Every woman's health right*, AC Nielson, 2011.

235 "Why 222 million women can't get the birth control they need", *New York Times*, 26 September 2015.

236 *Reimagining global health: 30 high-impact innovations to save lives*, The IC2030 report, July 2015.

237 *Reimagining global health: 30 high-impact innovations to save lives*, The IC2030 report, July 2015.

238 *Global strategy on human resources for health: Workforce 2030, Draft for the 69th World Health Assembly*, WHO, 2016.

239 "The health worker shortage in Africa", *Bulletin of the World Health Organization*, 2009.

240 *Working for Health and Growth: Investing in the health workforce,* High-Level Commission on Health Employment and Economic Growth, 2016.

241 "Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development", *The Lancet*, Vol. 386, August 2015.

242 *The Business of Health in Africa: Partnering with the Private Sector to Improve People's Lives*, International Finance Corporation, 2008.

243 *Understanding the India Low Cost Model of Healthcare Delivery: A Review of the Literature*, Private Sector Innovation Programme for Health, December 2014.

244 *Three paths to sustained economic growth in Southeast Asia*, McKinsey Global Institute, November 2014.

245 From Burden to "Best Buys": *Reducing the Economic Impact of Non-communicable Diseases in Low- and Middle-Income Countries*, WHO & World Economic Forum, 2011.

246 *The Lancet Global Health Report 2035*, The Lancet Commission on Investing in Health, 2013.

247 *How advancing women's equality can add $12 trillion to global growth*, McKinsey Global Institute, September 2015.

248 See for example: *Empowering the Third Billion: Women and the World of Work in 2012*, Booz & Company, 2012; *Close the gap! The cost of inequality in women's work*, ActionAid, January 2015.

249 *The State of Food and Agriculture 2010–11: Women in Agriculture—Closing the Gender Gap for Development (Rome)*, Food and Agriculture Organization of the United Nations, 2011

250 *Is Gender Diversity Profitable? Evidence from a Global Survey*, Marcus Noland, Tyler Moran and Barbara Kotschwar, Peterson Institute for International Economics, February 2016.

251 *How advancing women's equality can add $12 trillion to global growth*, McKinsey Global Institute, September 2015.

252 *Roadmap for a renewable energy future,* IRENA, 2016.

253 See for example: *Investment Needs to Achieve the Sustainable Development Goals: Understanding the Billions and Trillions*, Guido Schmidt-Traub, SDSN Working Paper, Sustainable Development Solutions Network, November 2015. SDSN estimates incremental annual investments in low- and middle-income countries of at least $1.4 trillion.

254 *2014 Global Sustainable Investment Review*, Global Sustainable Investment Alliance, 2015.

255 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

256 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

257 "CPLC highlights internal carbon pricing at 'Pathways to Impact' Conference", Carbon Pricing Leadership Coalition, 8 July 2016.

258 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

259 *Global Sustainability Report*, Nielsen, October 2015.

260 *Accelerating Green Growth through Public Private Partnerships*, 3GF, June 2012.

261

262 *Global Peace Index*, Institute for Economics and Peace, 2015.

263 *The Economics of Ecosystems and Biodiversity (TEEB)*, United Nations Environment Programme, 2010.

264 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

265 *Global Burden of Disease 2010*, Institute for Health Metrics and Evaluation.

266 *The Tobacco Atlas, fourth edition*, Michael Eriksen, Judith Mackay & Hana Ross, American Cancer Society and World Lung Foundation, 2012.

267 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

268 *Global Burden of Disease 2010*, Institute for Health Metrics and Evaluation.

269 *Corruption: Costs and Mitigating Strategies*, International Monetary Fund, May 2016.

270 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

271 *Global Burden of Disease 2010*, Institute for Health Metrics and Evaluation.

272 *Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders*, Jürgen Rehm et al., The Lancet, Vol. 373, number 9682, June 2009.

273 *The global economic burden of alcohol: A review and some suggestions*, Drug and Alcohol Review, Vol. 25, number 6, November 2006.

274 *The economic and social cost of illiteracy: A snapshot of illiteracy in a global context*, Final Report, World Literacy Foundation, April 2012.

275 *Antimicrobial Resistance, Global Report on Surveillance*, WHO, 2014.

276 *Better Growth, Better Climate: Cities*, New Climate Economy Report, 2014.

277 *Illicit Financial Flows from Developing Countries: 2004-2013*, Global Financial Integrity, December 2015.

278 *Seeking an end to loss and waste of food*, FAO, 2011.

279 *How the world could better fight obesity*, McKinsey Global Institute, November 2014.

280 *Climate change and human health: risk and responses*, WHO, 2003.

281 *Seeking an end to loss and waste of food,* FAO, 2011.

282 *Reducing Food Loss and Waste*, World Resources Institute, 2013.

283 *Estimates of Emissions Reduction Potential for the 2015 Report: Technical Note*, New Climate Economy, 2015.

284 *The Bottom of the Pyramid Strategy for Reducing Poverty*, UN Department of Economic and Social Affairs, 2009.

285 *Seeking an end to loss and waste of food*, FAO, 2011.

286 *Overcoming obesity: An initial economic analysis*, McKinsey Global Institute, November 2014.

287 *Healthy Living: Obesity – A Heavy Burden*, Sustainable Asset Management AG, 2012.

288 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

289 *Shifting Diets to a Sustainable Future*, World Resources Institute, 2016.

290 *Fish to 2030: Prospects for Fisheries and Aquaculture*, The World Bank Group, 2013.

291 *Status of the World's Soil Resources*, FAO, 2015.

292 *Living with the Earth, Third Edition: Concepts in Environmental Health Science*, Gary Moore, CRC Press, Google books, 2007.

293 *The New Plastics Economy*, Ellen Macarthur Foundation, 2016.

294 *Green growth and sustainable cattle intensification in Para*, The Nature Conservancy, 2015.

295 *Urban Agriculture*, FAO, 2016.

296 *Urban Agriculture in the developing world: a review, Agronomy for Sustainable Development*, 2013.

297 *Tackling the world's affordable housing challenge*, McKinsey Global Institute, October 2014.

298 *Accelerating Low-Carbon Development in the World's Cities: Working Paper*, New Climate Economy, 2015.

299 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, 2011.

300 *Electric Vehicles Market – Global Industry Analysis, Size, Share, Growth, Trends and Forecast*, 2013 – 2019, Transparency Market Research, 2015.

301 *Automotive revolution – perspective towards 2030: How Convergence of disruptive technology-driven trends could transform the auto industry*, McKinsey & Company, January 2016.

302 *Electric Vehicle Market Forecasts*, Navigant Research, 2015.

303 *Accelerating Low-Carbon Development in the World's Cities: Working Paper*, New Climate Economy, 2015.

304 *The Trillion Dollar Question II: Tracking Investment Needs in Transport*, World Resources Institute, 2010.

305 *Growth within: A circular economy vision for a competitive Europe*, Ellen MacArthur Foundation, 2015.

306 *Automotive revolution – perspective towards 2030*, McKinsey and Company, January 2016.

307 *Car Safety Market by System Type, Safety Regulations by Region, Impact Analysis – Trends & Forecast to 2020*, Markets and Markets, 2015.

308 *Connected Car Study 2015: Racing ahead with autonomous cars and digital innovation*, Strategy&, September 2015.

309 *Autonomous Vehicle Adoption Study*, Boston Consulting Group, 2015.

310 *Self-driving Cars an $87 Billion Opportunity in 2030, Though None Reach Full Autonomy*, Lux Research Inc., 2014.

311 *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey Global Institute, 2013.

312 *The Adaptation Gap: Finance Report*, UNEP, 2016.

313 *Shaping Climate – Resilient Development*, Economics of Climate Adaptation, 2009.

314 *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, 2011.

315 *Tourism highlights*, UNWTO, 2015.

316 *Smart Meters Market worth $18.2 Billion by 2019*, Markets and Markets, 2014.

317 *Smart Electric Meters, Advanced Metering Infrastructure*, Navigant Research, 2013.

318 *U.S. smart grid value at stake: The $130 billion question*, McKinsey & Co, 2010.

319 *Infrastructure productivity: How to save $1 trillion a year*, McKinsey Global Institute, 2013.

320 *Benefits and Costs of the Water and Sanitation Targets for the Post-2015 Development Agenda*, Copenhagen Consensus Center, 2015.

321 *Strategic Review on the Future of Forest Plantations*, Indufor & Forest Stewardship Council, October 2012.

322 "Carbon, Fossil Fuel, and Biodiversity Mitigation With Wood and Forests", Chadwick Oliver et al., *Journal of Sustainable Forestry*, Vol. 33, 2014.

323 *Growth within: A circular economy vision for competitive Europe*, Ellen MacArthur Foundation, 2015.

324 *Towards the Circular Economy Vol. 1*, Ellen MacArthur Foundation, 2011.

325 *Roadmap for a renewable energy future*, IRENA, 2016.

326 *Energy and Climate Change: World Energy Outlook Special Report*, IEA, 2015.

327 *World Energy Outlook 2015*, IEA, November 2015.

328 *Resource Revolution: Meeting the world's energy, materials, food, and water needs,* McKinsey Global Institute, 2011.

329 *E-storage: Shifting from cost to value, Wind and solar applications*, World Energy Council, 2016.

330 *Affordability of CCS*, CCS Association.

331 P*athways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*, McKinsey & Company, 2009.

332 *Access to Modern Energy: Assessment and Outlook for Developing and Emerging Regions*, IIASA, GEF & UNIDO, 2012.

333 F*rom Gap to Opportunity: Business Models for Scaling Up Energy Access*, IFC, 2012.

334 "Understanding the Scale of Investment for Universal Energy Access", Morgan Bazilian et al in *Geopolitics of Energy*, Vol 32, 2010.

335 *Green chemistry*, Pike Research, 2011; *Global Green Chemicals Market 2014-2018*, Technavio, 2014; *Chemicals 2035 – Gearing up for growth*, Roland Berger, 2015; *Global markets for Renewable Chemicals Manufacturing*, BCC Research, 2016.

336 *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey Global Institute, May 2013.

337 *Reverse the curse: Maximizing the potential of resource-driven economies*, McKinsey Global Institute, December 2013.

338 In "Environmental Goods and Services: Export Opportunities and Challenges especially for developing economies", Jane Drake-Brockman, International Trade Centre, August 2014.

339 "Abandoned Mine Lands", Bureau of Land Management, US Department of the Interior, April 2014; "Who will pay the more than $17.8 billion mining rehabilitation bill?", Lachlan Barker, *Independent Australia*, 1 June 2015.

340 *Accelerating Green Growth through Public Private Partnerships*, 3GF, June 2012.

341 *Power Perspectives 2030: On the road to a decarbonised power sector*, European Climate Foundation, 2012.

342 *Tracking Universal Health Care*, WHO, 2015.

343 *M-Health – a new vision for healthcare*, GSMA & McKinsey, 2007.

344 *IoT: Digital Revolution comes to US healthcare*, Goldman Sachs, 2015

345 *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey Global Institute, May 2013.

346 *Home healthcare market*, Grand View Research, 2014.

347 *Telemedicine market 2014-2020*, Zion Research, 2016.

348 Personalised Medicine, Targeted Therapeutics and Companian Diagnostic Market to 2019, KellySciPub, February 2016.

349 *Genomics Market Analysis By Product, By Application, By Technology, And Segment Forecasts to 2020*, GrandView Research, August 2014.

350 *Tobacco Control*, WHO, 2016.

351 "Enabling access to new WHO essential medicines: the case for nicotine replacement therapies", *Global Health*, Vol. 6, No. 22, November 2010.

352 *Smoking Cessation and Nicotine De-addiction Products Market – Global Industry Analysis, Size, Share, Growth, Trends and Forecast, 2013 – 2019*, Transparency Market Research, January 2016

353 *Smoking Cessation and Nicotine De-addiction Market Analysis By Product And Segment Forecasts To 2024*, Grand View Research, June 2016u

354 *The Lancet Global Health Report 2035*, The Lancet Commission on Investing in Health, 2013, published as "Global health 2035: a world converging within a generation", The Lancet, Vol. 382, December 2013.

355 *Securing new drugs for future generations: The pipeline of antibiotics*, The Review on Antimicrobial Resistance, May 2015.

356 *From Burden to "Best Buys": Reducing the Economic Impact of Non-communicable Diseases in Low- and Middle-Income Countries*, WHO & World Economic Forum, 2011

357 *Digital Health, Remote Monitoring and EHR Cost Savings, 2014-2019*, Juniper Research, 2014.

358 *Electronic Health Records Market*, Transparency Market Research, 2016.

359 *Global market for EHR*, Accenture, 2014.

360 *India's tech opportunity: Transforming work, empowering people*, McKinsey Global Institute, December 2014.

361 "Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development", *The Lancet*, Vol. 386, 2015.

362 *Global strategy on human resources for health: Workforce 2030, Draft for the 69th World Health Assembly*, WHO, 2016.

363 *Education of Health Professionals for the 21st Century*, The Lancet Commission on Medical education for the 21st century, 2010, published as "Health professionals for a new century: transforming education to strengthen health systems in an interdependent world", The Lancet, Vol. 376, November 2010.

364 *Reimagining global health: 30 high-impact innovations to save lives*, The IC2030 report, July 2015.

365 The Lancet Global Health Report 2035, The Lancet Commission on Investing in Health, 2013, published as "Global health 2035: a world converging within a generation", *The Lancet*, Vol. 382, December 2013.

About the Business and Sustainable Development Commission

The Business and Sustainable Development Commission aims to accelerate market transformation and advance the world's transition to a more prosperous, inclusive economy. Our mission is to make a powerful case—supported by sound evidence, rigorous research and compelling real-world examples—for why the private sector should seize upon sustainable development as the greatest economic opportunity of a lifetime. Our flagship report, launched in January 2017, will show how the Sustainable Development Goals (SDGs) —17 objectives to end poverty, reduce inequality and tackle climate change and other urgent challenges by 2030—provide the private sector with the framework for achieving this market shift. The report serves as the foundation for launching initiatives to inspire and mobilise businesses to achieve the SDGs.

www.businesscommission.org

About Alphabeta

AlphaBeta is an economic strategy firm with offices in Singapore and Sydney. By integrating strategy and economics, AlphaBeta aims to help solve the world's most important economic, environmental and societal challenges. In the area of sustainable development, AlphaBeta works with corporations, investors, governments and NGOs on areas such as natural resource productivity, food supply, renewable energy development, and sustainable management of natural resources, including forests and water.

www.alphabeta.com