UNITED ARAB EMIRATES
MINISTRY OF CABINET AFFAIRS & THE FUTURE

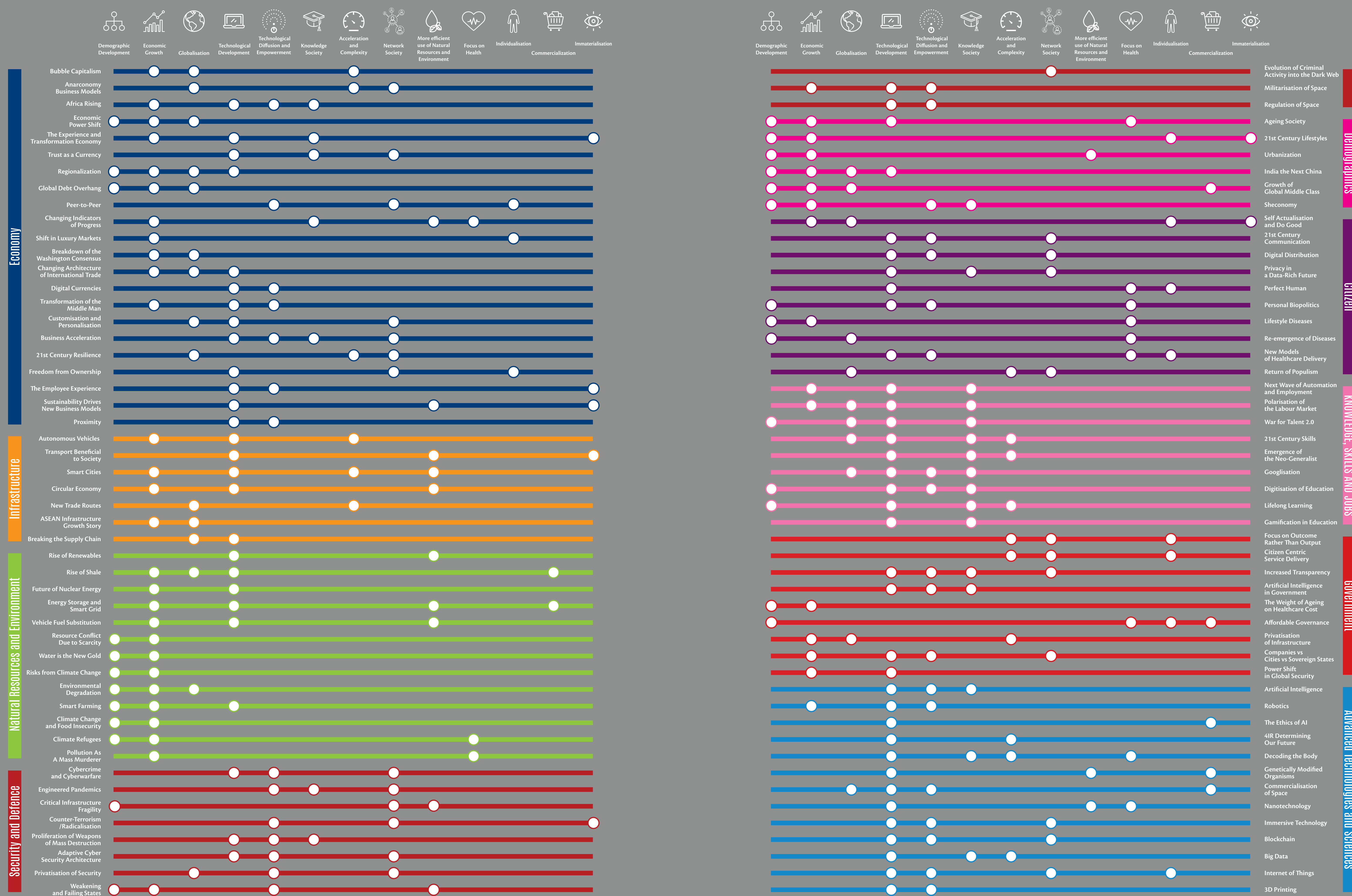
الإمارات العربية المتحدة
وزارة شؤون مجلس الوزراء والمستقبل

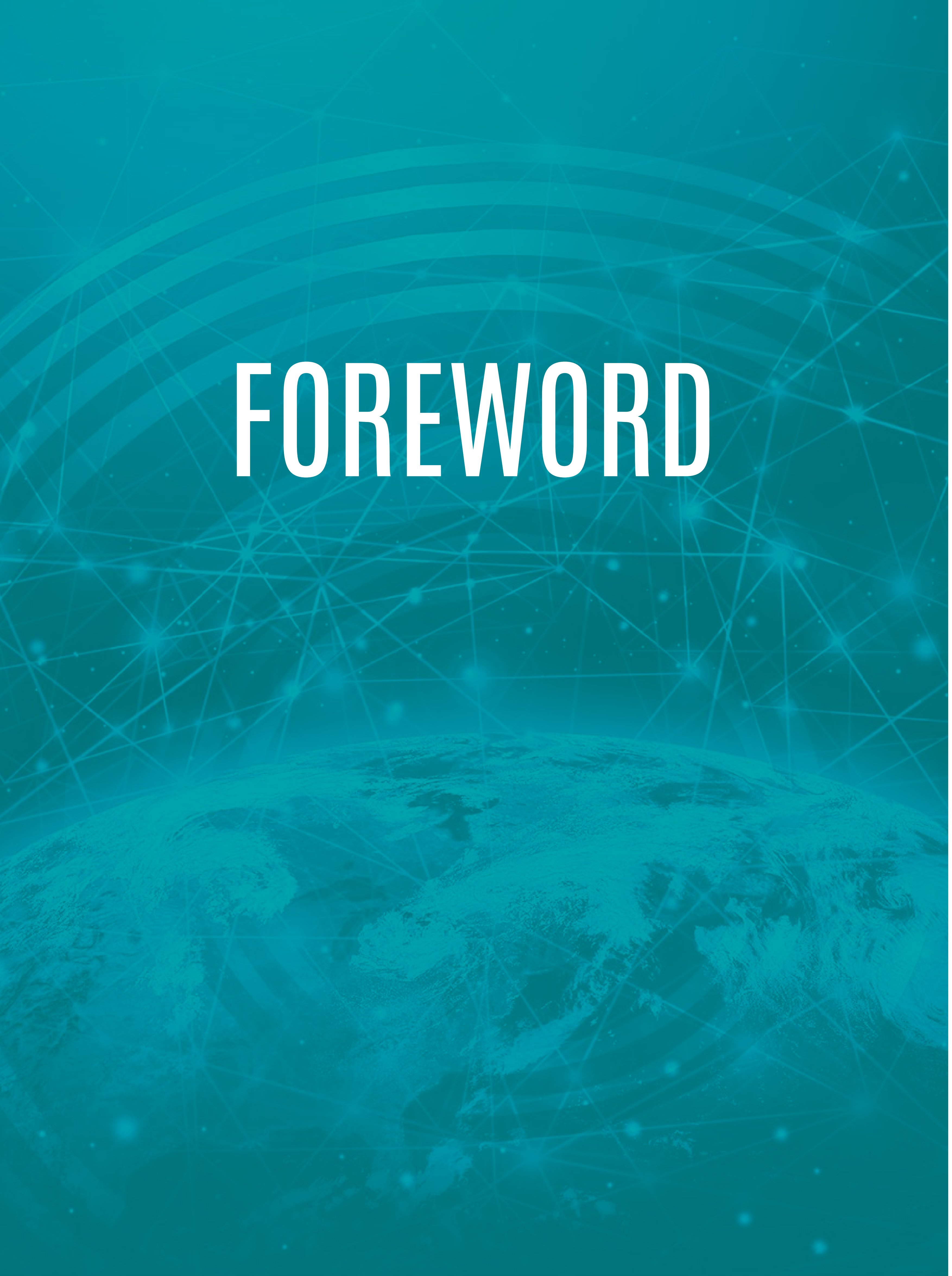
# Future Outlook
# 100
## Global Trends for 2050

First Edition: October 2017

Dubai, United Arab Emirates

# FUTURE DRIVING FORCES MATRIX





# FOREWORD



Humanity has long endeavoured to predict the future. It has been a game to some, an obsession for many. The inherent element of chance dictates that uncertainty will dominate the landscape ahead of us. Shaping the future of an unpredictable world requires foresight, vision and tactical acumen. This is because the pace of change is unprecedented, with rapid evolution in the spheres of technology, natural resources & environment, geopolitics and security in particular. As citizens of an increasingly connected world, our duty is to design a better future, so that humanity inherits an improved quality of life. In the UAE, this should be our mission and our calling.

Planning for an uncertain future requires unwavering positivity and spirit. It is imperative to define challenges and address them proactively, while avoiding anxiety and distraction from our purpose. Key to this is understanding that disruption creates opportunity. I believe that the nature of our response to uncertainty will shape future anticipated outcomes.

If we approach the future with a sense of optimism and excitement, we will be able to seize opportunities, evaluate hurdles and confidently chart the path ahead.

With this book, we attempt to foresee what challenges and opportunities the following decades will present to the world. We firmly believe that this is an ethical responsibility towards the world and its future generations.

Ministry of Cabinet Affairs and The Future

# INDEX

# WHAT WILL THE WORLD LOOK LIKE IN 2050?



The 21st century is an era of growing complexity and accelerating change, and a number of driving forces are creating an environment that is increasingly volatile, complex and uncertain. Maintaining a long-term focus to drive forward societies and economies has always been a challenge for governments and leaders. In the current age of ubiquitous information and rapid change, it is perhaps even more difficult to compartmentalize our responses to current issues, and our long-term plans and expectations.

The contents of this book, which is an exploration of the future's many dimensions from a variety of perspectives, illustrate the shifts that are facilitating changing global paradigms. We can say with some certainty that over the next 30-40 years, there will be radical alterations to the world's natural orders, and that major events will surprise us. Their consequence and timing, however, will have varying degrees of certainty.

What are the major forces in play:

- Demographics will play a defining role. With rising populations, and the growth of specific population segments (such as the aging in developed countries), the world's consumption patterns will transform uniquely.
- Technology, and access to it, will lead improvements in quality of life across society. Technology will permeate everything we do and will become part of our identity. This affects how well and long we live, what we learn, who we know and how we interact. In order to live with these tremendous advances, we will have to accept risks to our privacy and security.
- Computing power and the digital world will change the way we look at, and deliver services in, medicine and education. Data will also form the backbone of intelligent machines' learning. Roles performed by humans will transition into those carried out by robots.
- Cities will become political and economic forces as urbanisation increases. The role of the city will be decisive in terms of resource utilization, infrastructure development and fragility, and climate change.
- We are entering a period of slower global growth, and this will exert pressures on leaders of nations with fast-growing populations. The world population and therefore demand for resources will grow. The balance between natural resources and environment, and economic growth, especially for developing countries with large populations, will have to be carefully handled as we are already on the precipice of calamitous climate-related disasters.
- Finally, the role of the state will be redefined: city-states and non-state actors could increase in prominence, and individuals' identities might be less tied to national causes. National security will need to defend the cyber-physical.

The 100 global trends presented here represent a broad spectrum of challenges, expectations, disruptions, certainties and premonitions. The purpose is to create a window into the future whereby multiple possibilities can be explored and choices can be evaluated. We do this by identifying the trends that will have a significant impact on the future, and follow their trajectories over a long-term timeframe. This helps us study consequences, create possible images of the future, and draw implications for policy-makers. With an enhanced anticipatory capacity, it is possible for government to be more proactive and ready to tackle the future's uncertainties.

The value of studying the future is less in forecasting or predictive accuracy, and more attuned towards creating a flexible and holistic long-term policy outlook. Policy-makers and their key stakeholders are the ultimate audience for this book; we hope that the contents within inform their work and enrich their choices.

# ABOUT THE BOOK

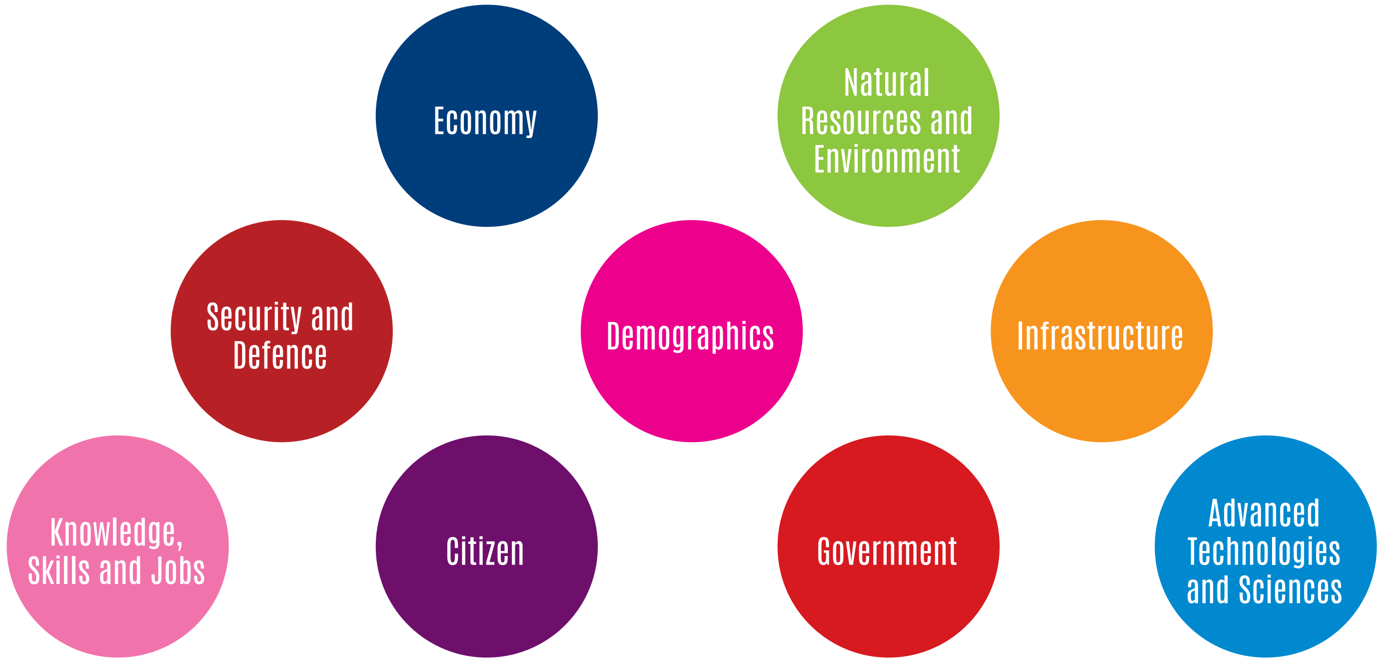


The Prime Minister's Office at the UAE Ministry of Cabinet Affairs and the Future, in collaboration with the Copenhagen Institute for Futures Studies, has developed this book with multiple objectives:

- To detail potential future global developments, as strategic context for developing UAE government plans
- To help re-assess inbuilt assumptions, expectations and uncertainties about what the future holds
- As a starting point for future foresight and related research

The 100 trends do not present predictions for the future, but rather an assessment of relevant trends that will significantly impact the world over the next 30-40 years.

Overall, nine themes have been identified under which the 100 trends are grouped. These are:




Each chapter – which covers one theme – begins with an introduction and overview of the trends that fall under it. The trends have been further divided into sub-sections.

Each trend description is not meant to be a comprehensive guide for understanding a topic, but as introduction and inspiration. Together, the trends serve to provide an understanding of the important dynamics within the theme, and to inform the reader about projected outlooks, salient facts and case examples.

There are some aspects of the future that have a high level of certainty, as well as long-term and cross-cutting impact across most of our nine themes. We term these 'Driving Forces' and they are the major forces which will define socio-economic progress going forward.

# METHODOLOGY APPROACH

The development of the 100 trends was based on an extensive and iterative process involving teams of experts, researchers and reviewers. The approach involved four phases:

1. The research and evaluation phase: Inputs from internal and external expert knowledge, horizon scanning, and targeted desk research and data collection were structured into a long-list of more than 250 trends.

2. The assessment and qualifying phase: Workshops with experts helped vet the collected information by examining sources, combining overlapping trends and identifying redundancies. Ultimately, a short list of 100 relevant trends and overarching thematic areas were determined.

3. Development of the 100 trends: Each trend was detailed with a concise summary and assessment, while taking into account driving forces, influencing factors and inter-linkages. Data on long-term projections, case studies and sharp facts were also curated at this stage.

4. Implications and review: Experts with relevant domain knowledge reviewed each theme in order to fine-tune the narrative for consistency and comprehensiveness. This stage concluded with the development of brief policy considerations.

# HOW TO READ

The trends are a synthesis of deep research into each theme, compilation of viewpoints from extensive and reputed sources, and original analysis and insight. Each trend you will read might consist of a combination of:

- Descriptive summary of the concept or topic
- Linkage to specific driving forces (see section below)
- Examples, case studies and related narratives which establish a qualitative basis
- Quantitative information (data, projections) about the future
- Concluding points of reflection (which we term "Areas to Consider" and "Did You Know")



# Driving Forces

These are synthetic, complex aggregations of trends – pathways of development – that help us make sense of the complexity of our surrounding world and take action. They are forces that impact business, economy, society, culture and personal lives. They represent our assumed, accumulated knowledge about probable futures. They are broad in scope, their effect is large and they have a high certainty of occurring.

The driving forces have been used as one of the tools for identifying and analysing the trends in the catalogue. Each trend in this publication is influenced by one or more driving forces, to varying degrees:

## Demographic development

Demographic developments refer to changes in a range of characteristics, distributions, and sizes in human populations. Demographic measures typically include and examine a range of population statistics such as age, ethnicity, religion, family structures, education, and residence among other things. One of the most important effects in the demographic development is urbanisation, where we see people all over the world, to an increasing degree, moving to and living in cities. Countries have different demographic trajectories. While the global population continues to grow, the vast majority of this population growth will come from emerging and developing countries, while Europe, for example, is projected to shrink. At the same time, all regions will see ageing populations due to increased life expectancy and decreasing fertility rates, but average age and share of working age population will vary substantially from region to region.

Overall, demographic development is a strong and stable driving force in the short and medium terms. However, population growth is expected to slow down in the long term. Pandemics, war, natural disasters and migration flows are factors that may alter current projections – primarily on the local level, but also on regional and global levels in their most extreme developments.

## Economic growth

Economic growth refers to the overall increase in economic productivity and subsequent growth of wealth. It represents an increase in the market value of the goods and services produced in a particular economy over time. Economic growth is typically measured in terms of GDP, though it is often important to consider this growth in relation to income distribution and social and environmental factors. While the impact of the financial crisis is still apparent, global economic expansion is expected in the coming decades, as a growing global middle class in emerging economies – mainly in Asia – continue to shift to Western patterns of consumption. For the same reasons, a rebalancing of economic power is underway, changing the dynamics of the global economy and its accompanying influence in international relations.

Economic growth is one of the strongest and most stable driving forces over the long term. In the medium term, economic growth will also be stable, despite slowed growth and the possibility of stagnation in some regions. In the short term, economic growth is expected to be volatile.

## Globalisation

Globalisation is the process of interaction and integration among the people, companies, and governments of different nations. It has effects on the environment, culture, political systems, and economic development and prosperity. The 2008 global financial crisis illustrated just how integrated and interdependent the world's economies have become. Due to globalisation, in the coming decades, the world will also be characterised by greater complexity, exposing companies and governments to a more varied and complicated risk landscape, where existing and emerging social, environmental, and political challenges will require a more unified response.

Globalisation has been a strong and stable driving force in both developed and developing regions over the past few decades, but is currently being challenged by growing counter-trends, regionalism or nationalism, in some regions. Whereas digital globalisation will be difficult to reverse, trade patterns and physical integration might experience declining growth or setbacks in the short and medium terms in some regions. Globalisation influences and is affected by most other trends.

## Technological development

Technological development is a significant source of change in society. New technology creates new opportunities and new business, and gives us new ways to handle existing challenges. Advances within Information and Communication Technology (computers/smartphones, internet, artificial intelligence, etc.), biotechnology (genetic engineering, gene therapy, neurosciences, etc.), advanced materials (nanomaterials, smart materials, etc.), robotics (self-driving cars, care robots, industrial robots, etc.), energy (new energy sources, energy storage, etc.), and production technology (automation, 3D printers, biosynthesis, etc.) will change the future radically. Technological diffusion will continue at an accelerated rate in the next decades and the importance of technology will increase as new technologies are being adopted faster and innovation cycles become shorter.

Technological development is perhaps the most influential driving force of our times, though it may be difficult to predict exactly which breakthroughs will be made when, and precisely what impacts specific breakthroughs will have. Technology may also often produce unintended negative side effects such as pollution, global warming, and structural unemployment. These unintended consequences often drive the development of new technological solutions. New technology can also give rise to ethical and moral questions about the use of technology and its implications.

## Technological Diffusion and Empowerment

Technological diffusion and empowerment refers to a process of transformation in which the development and diffusion of technology drives greater access and transparency to an increasing number of people around the world. This includes access to information, equality of opportunity, and participatory equality among other things, in personal, social, and civic spheres. In essence, diffusion of technology and of knowledge strengthens empowerment.

The strength and stability of technological diffusion and empowerment is conditional upon demographic contingencies and value system diversity. It is generally seen as a strong, yet unstable driving force in the short and medium terms. Some counter-trends include increased surveillance and the reduction of rights and freedoms by authorities, and the growth of corporate power, particularly in regards to their lobbying capacity.



## Knowledge Society

Knowledge society refers to the shift to a society where knowledge and data – and not least the ability to analyse and extract value from data – constitute primary economic assets. Thus, a well-educated population with the right skills to thrive in the society and labour market of the future becomes paramount for a country's resilience and competitiveness. This causes increased global competition, for companies and countries alike, to attract the best global talent. Regions with attractive working and living conditions could see a "brain gain", while other regions could experience a "brain drain". Essentially, the knowledge society involves increased consumption and production of knowledge as a fundamental pillar of continued social, political, and economic development.

Knowledge society is considered to be both a strong and stable driving force in the short, medium, and long terms. While knowledge is one of the most important resources of the 21st century, however, knowledge is losing its static properties and becoming ever more dynamic.

## Acceleration & Complexity

Acceleration and complexity refers to the fact that change is happening faster than before, which in turn increases complexity – both in relation to business environments and societies in general. Some of the key challenges include shorter business cycles, innovation cycles and product life-cycles, the increasing penetration rate of new products, and maintaining trust and brand loyalty in a hyper-competitive global market. Also, the amount of knowledge and patents accelerates, computer memory and speed increases exponentially compared to prices, and news spreads even quicker, with a greater need to update and adapt education to a more complex society. Society is in many ways changing faster than individuals and companies can manage to adapt.

Acceleration and complexity is a global phenomenon, and the regional differences seen in acceleration are caused by the catching-up effect for countries having been left behind earlier. It is a driving force which is highly context specific, since at any given point some aspects of society accelerate, while others slow down. It is thus less strong and stable in the short, medium, and long terms, when compared with other driving forces.

## Network Society

The idea of a network society describes a modern society where social and media networks are shaping the primary mode of organisational structures. Today, having a large professional and social network is seen as of considerable importance to the individual. The internet is a primary driver for this development, since the web makes it easy for producers and buyers to get directly in touch with each other, bypassing the traditional, centralised distribution channels. P2P markets (powering the sharing economy and collaborative consumption) are one of the most prominent manifestations of the network society. They are part of a socioeconomic system built around the shared creation, production, distribution, trade, and consumption of goods and services by different people and organisations. Network society is also manifesting itself through social media, which are changing communication towards a hyper-connected culture, as they continue to grow and evolve into entirely new forms.

The network society is a strong and stable driving force in the short, medium, and long term. One counter-trend of the network society is centralised government, and increased monopolisation of large corporations, as well as increased surveillance or censorship.

## More efficient use of Natural Resources and Environment

More efficient use of natural resources and environment refers to a balance between on the one hand, economic growth and activity and on the other hand, the effects of climate change and natural resource degradation. Without further efforts to reduce human 'footprint' on the environment, the effect of climate change and resource scarcity is expected to continue, driven by growth in the global population and economic activity. Climate change carries key risks for ecosystems and cultures, crop yields, water availability, biodiversity, and land use at the local, regional, and global level. It is important to note that the consequences of resource appropriation and consumption are mainly a local issue closely tied to the economic interests and industries of a given country (e.g. energy mix of a given economy for electricity production), although they are influenced by global economic trends. Sustainable development and increased environmental focus thus includes the four interconnected domains of economics, politics, ecology, and culture. This driving force includes a range of challenges, some of which are addressed by the market, and others that are not.

More efficient use of natural resources and environment is dependent on personal beliefs and interests, and varies a lot between regions, where the developed countries typically have a wealth surplus allowing them to focus more on the environment. While this may appear to be unstable and uncertain in the short run, the effects of climate changes are expected to become more apparent and hence strengthen this driving force in medium and long terms.

## Focus on Health

Focus on health refers to a global movement towards increased health and well-being. This includes all aspects of public, private, and professional lives. For example, the economic impact of an unhealthy society is becoming increasingly evident as healthcare costs are skyrocketing. The changing perception of well-being, innovations in life sciences as well as personal and government interest to reduce treatment costs through preventative action, will shift treatment-focused healthcare towards preventive healthcare. Also, greater numbers of people are taking responsibility for their own health and people around the world are keen on preventing, examining, improving, monitoring and managing their health.

Focus on health is a value driver. It is strong and stable in the short, medium and long terms. It is, however, susceptible to wild cards like pandemics and to external influences like massive economic recession, which may significantly upset this driving force.

## Individualisation

A central goal of modern life is to distinguish oneself from others and obtain a higher position within a social hierarchy that is based on shared norms and values. This is achieved by focusing on and promoting individual over collective goals. Individualisation is often associated with Western cultures; however, it is spreading all over the world. This results in rising and expanding consumer demands for individual attention and tailored products and services. The emergence of 21st century lifestyles is bringing about relationship changes, emerging behavioural patterns and new social formations.

Individualisation has been a strong and stable driving force in Western societies over history, and this is expected to continue in the short, medium, and long terms in the future. Moreover, it will increasingly spread to other regions, likely resulting in cultural clashes in the short and medium terms.



## Commercialization

Commercialisation occurs when a growing number of areas in society are assigned to commercial business. This not only involves physical products and services, but also increasingly immaterial values like culture, opinion, community, and politics. Commercialisation is both direct and indirect. Direct commercialisation occurs when, for example, public services become privatised or outsourced to a large degree. Indirect commercialisation occurs when the quality of public services is eroded to an extent that private alternatives are consumed. The service economy – promoted by digitisation – is at the centre of business models in order to reflect consumer demands for access to products rather than owning them. Digitisation also enables vendors to provide tailored products and services in a convenient way, thus improving the value for a particular commodity.

Commercialisation has been a strong and stable driving force in both developed and developing regions over the past few decades, and this is expected to continue in the short, medium, and long terms, in spite of the strong counter-trend represented by the growth of the network society.

## Immaterialisation

Immaterialisation is a driving force that includes a greater focus on post-materialism. It consists of three primary dimensions. First, as societies become wealthier and more material needs are satisfied, people increasingly focus their consumption on authenticity through a consideration of design, aesthetics, fashion, culture, storytelling, values, and experiences. Second, with technological development and digitisation, material goods are increasingly becoming immaterial. This is particularly the case in content industries (music, books, film, etc). Due to virtual reality, the tourism industry could become increasingly immaterial. Third, the symbolic associations or immaterial values of material goods consumed are changing, and becoming more important. A broad shift in values increases the focus on the principles of morality, ethical behaviour, and conscious consumerism. Individuals today are increasingly concerned with these value considerations in their consumption, civic responsibilities, and labour market duties.

Immaterialisation is a value driver and generally considered strong and stable in the short, medium, and long terms as the tension between material and immaterial needs are ever present in modern society. With increasing economic growth and technological development, we can expect the immaterialisation driving force to continue.

# ECONOMY



# INTRODUCTION

Towards 2050, global economies will change significantly, with new power centres emerging, caused by changing demographics, resource availability and scarcity as well as changes in countries' productivity and trade patterns. Since economy is an underlying factor in so many personal actions and decisions and is the driving incentive in most companies, the development and distribution of wealth will have major impact on the future society.

The future economy landscape will be characterised by accelerating changes, and even more complexity through increased interconnectedness. Predictions on how markets, trade patterns and future business models evolve will be more difficult than ever. However, there are some characteristics and driving forces that will shape the future economy with some degree of certainty, creating the trends described in this section. One thing we can say with certainty is that the winners in the future economies will be the organisations and governments embracing and exploring the possibilities of tomorrow and possessing the capabilities to change and adapt at a higher pace than their competitors.

The following chapter describes 22 trends shaping the future of the global economy towards 2050. The 22 trends presented can be categorised into the following three areas:

11

## Markets:

- Bubble Capitalism
- Anarconomy Business Models
- Africa Rising
- Economic Power Shift
- The Experience and Transformation Economy
- Trust as a Currency
- Regionalization
- Global Debt Overhang
- Peer-to-Peer (P2P)
- Changing Indicators of Progress
- Shift in Luxury Markets

4

## Trade and Finance:

- Breakdown of the Washington Consensus
- Changing Architecture of International Trade
- Digital Currencies
- Transformation of the Middle Man

7

## New Business Models:

- Customisation and Personalisation
- Business Acceleration
- 21st Century Resilience
- Freedom From Ownership
- The Employee Experience
- Sustainability Drives New Business Models
- Proximity

# BUBBLE CAPITALISM

This trend emphasises global economic instability and volatility. History has proven that bubbles occur and burst - yet it is uncertain when and where, and by definition they are unpredictable for most stakeholders. Bubbles occur when the price of an asset or sector rises to extreme levels, far beyond its fair market value. The effect of bubbles is seen through stock exchange collapses and financial crises. We are seeing an increase in the number of potential bubbles in real estate and mortgages, due to increasingly complex business models based on intangible assets, entangled revenue streams, overflow of investment funds and high levels of debt.

The global economic recession of 2008 has been traced back to the real-estate market in the US and the spread of toxic debt through sub-prime mortgages and tranched debt. Multiple debts were sliced up and bundled together and resold as financial instruments that, at the time, were not understood by the majority of the market players. Bubble capitalism is defined by uncertainties, and through to 2050 it will become increasingly difficult to define the 'real' value of assets, due to increasing complexity seeded by the move toward intangible assets, which can disappear within hours in the future market place.

Current oil, food, and commodities bubbles may have far worse consequences due to their critical use in everyday life for the expanding urban populations who are unable to provide for themselves. Many analysts point to China as a potential bubble that can burst, if they do not manage to make the difficult, but necessary, shift from export-led high-end growth to steady growth led by services and internal consumption.

## Driving Forces

Acceleration & Complexity

Globalization

Economic Growth

## Triple Bubble Economy?

Credit Suisse analysts now call China a 'triple bubble economy', as China faces the third-biggest credit bubble of all time, the largest investment bubble of all time, and the second-biggest real-estate bubble of all time.

RBS economists estimates that China›s non-financial private sector debt has been rising by £4.5 billion every day since 2010.

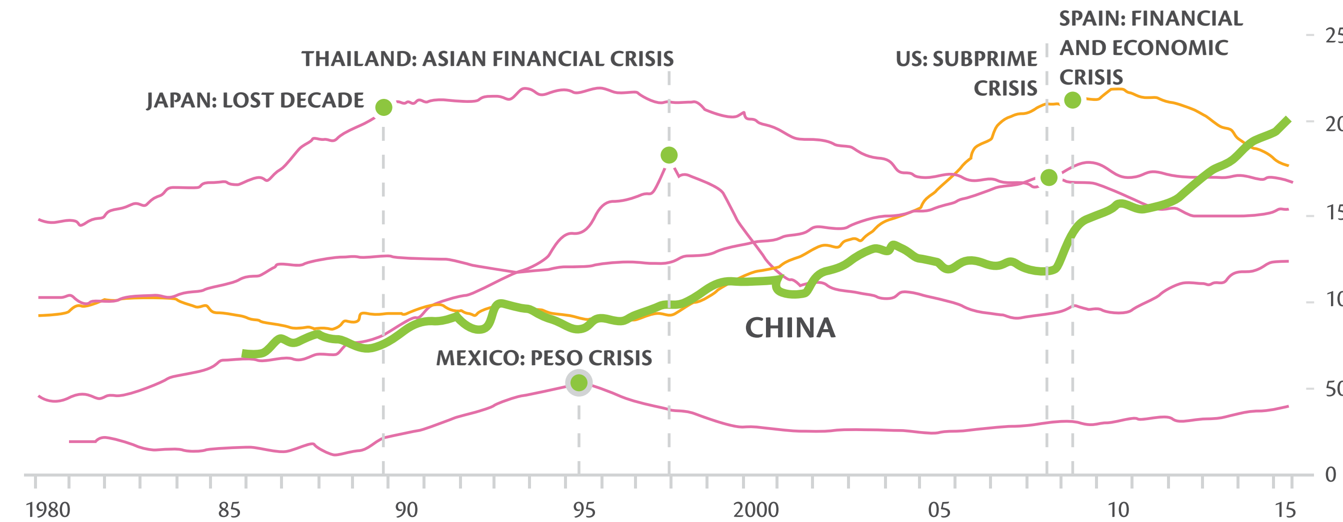

Banking Exposure to China and HK by Country
(% of $1.5 trillion global exposure)



## Assessment

Bubbles will burst. Yet it is uncertain when and where, what the impact will be. The global economy is getting increasingly entangled and complex, and there is no reason to believe that we are getting better at preventing bubbles from occurring, so this trend is expected to continue towards 2050. The collapse of macro-scale bubbles could force another global recession.

## Data & Facts




No boom without a bust / Private non-financial sector credit as % of GDP

Markets, despite their collective expertise, are destined to repeat history as irrational exuberance is followed by equally irrational despair. Periodic bouts of chaos are the inevitable result.

Few economies walk free of economic crises, and the most distinct similarity between crises is that they all vary in the specificities. However, a look at a number of financial crises over the last 30 years suggests a high degree of commonality: excessive exuberance, poor regulatory oversight, dodgy accounting, herd mentalities and, in many cases, a sense of infallibility.

## Areas to Consider

Speculative pricing on many commodities may be causing bubble expansion, as recently seen with oil, but it is still uncertain how oil will recover and whether and how important commodities will experience a price crash.

The negative speculation over Chinese ability to sustain historical growth rates in the coming 3 - 5 years will have very serious consequences for all trade partners. It may also result to short term gain as investments leak abroad and real estate is bought internationally.

## Did you know?

In one of the broadest studies of whether economists can predict recessions and financial crises, Prakash Loungani of the International Monetary Fund wrote, "The record of failure to predict recessions is virtually unblemished." He found this to be true not only for official organisations like the IMF, the World Bank, and government agencies, but for private forecasters as well. Loungani concluded that the "inability to predict recessions is a ubiquitous feature of growth forecasts."Most economists were not even able to recognise recessions once they had already started.

Sources: The Economist (2016), 'Red ink rising'; International Financing Review (2013), '2000th issue: 40 years in review'; Value Walk (2016), 'No Boom Without a Bust'; Business Insider (2013), 'Mauldin: Economists are Totally Clueless About the Economy'; Express (2016), 'China Bubble Burst is just 'months away', warns expert and Britain will feel it first'.

# ANARCONOMY BUSINESS MODELS

Anarconomy is a concept composed of «Anarchism + Economy = Anarconomy» and includes free, non-commercial content and services on the internet, created and offered by the users themselves as alternatives to commercial products. Examples include Wikipedia, Linux, Apache, and LibreOffice.

We are witnessing a pronounced growth of free content and services on the internet, created and distributed by the users in voluntary networks according to rather anarchic principles: open-source software and open-content books, music, films, and design that are made freely available by the creators.

Even traditional, profit-driven companies are conforming to the anarconomy game-rules when exploring new areas, where it is not entirely clear how to generate a profit. This parallels an agenda to generate positive publicity, user loyalty, and insight that eventually could turn into market share and competitive advantage. A company like Facebook, now very profitable, did not emerge out of a vision of how to make profit, but rather focused on generating users.

This challenges and supplements traditional, commercial companies by offering non-commercial alternatives. Towards 2050, anarconomy will move beyond the internet and may radically change the economy in the physical world. For example, using 3D printers and open source blueprints, we may be able to print goods for our own consumption, or offer our services and skills for free. This could be a trend that creates societies where working 10 hours a week is the norm.

## Driving Forces

- Acceleration & Complexity
- Globalization
- Network Society



## Assessment

The impact of potentially free versions of everything online is pervasive, and will make long-term R&D projects vulnerable to the risk of being copied. On the other hand, sharing knowledge enables faster and more widespread innovation. The trend is already influencing society significantly, but will likely grow in strength over the coming decades.

## Video - The Ultimate Anarconomy Content

Video on the internet represents the ultimate form of anarconomy content, as it is increasingly end-user generated and generally available for free (except for premium content platforms).

An estimated 79% of all global consumer web traffic will come from video by 2018, with 7 trillion video clips uploaded in 2020. This equates 2.5 daily video clips per person.

By 2020, mobile video is expected to increase 11x, representing more than 75% of the world's mobile data traffic.

## Areas to Consider

Where some of the anarconomy business models have been rooted in philanthropic values, most of the large players are leveraging on the value of data insights, influence and marketing potential connected to high-user numbers. To prevent digital platforms from exploiting citizens, sound regulation and transparency should be promoted.

## Did you know?

The 5 most popular websites in the world (by November 2016) are Google, YouTube, Facebook, Baidu, and Wikipedia – all sites that offer free content or networks.


Sources: CIFS (2009), 'Members' Report – Anarconomy'; www.alexa.com; www.wikipedia.com

# AFRICA RISING

The rise of Africa describes the next stage of development for Africa, where a greater share of African countries could follow the example of the Tiger economies and move from being aid recipients to self-sustaining, prosperous nations. During the last 10 years, several African countries have seen remarkably high economic growth rates – even during the financial crisis.

Much of the optimism behind Africa's future potential has to do with the strength of its demographics. The population of Africa is growing quickly, and will be young for a long time (younger than traditional developing economies such as China and India). This, of course, portends a significant upswing for Africa as a high-consumption market of the future, but also as a potential hub of global production, innovative business models and trade.

It is worth noting that the rise of Africa is challenged by a number of factors, such as the effects of climate change on the continent, and the potential of automation to undermine low-cost labor (a historic source of economic growth in other developing markets).

Infrastructural development is still at a nascent stage, and this inhibits intra-African trade. However, this is seen as a catalyst for African nations to leapfrog traditional infrastructural investments in certain domains (such as energy, telecommunications and finance) and embrace innovative levers of economic growth.

## Driving Forces

Economic Growth

Technological Diffusion and Empowerment

Knowledge Society

Technological development



## Assessment

In the long term, Africa could see a substantial proportion of its population joining the global middle-class. Africa Rising offers global potential for new markets and new sources of products / services. Furthermore, gains from thriving, decentralized industries such as mobile connectivity and energy could help circumvent traditional barriers to trade and economic growth.

## Africa leapfrogging

Africa has the potential to skip phases of development that high- and middle-income economies have gone through and move directly into a 21st century mobile, digital, and sustainable infrastructure.

The best-known example of Africa's 'leapfrogging' is in mobile communications. Africa adopted mobile communications, bypassing landline connections and began using mobiles to transfer money, consult farm prices, and more.

Impact of the mobile economy – Africa leapfrogging traditional telecommunications infrastructure

| Indicator | Description | 2015 Status | 2020 Projections |
|---|---|---|---|
| Penetration rate | Number of mobile connections | 965 million (80% penetration) | 1.3 billion (93% penetration) |
| Mobile economy size | Contribution to Africa's GDP | US $ 153 billion (6.7% of GDP) | • US $ 214 billion (7.6% of GDP)<br>• Operators will invest $72 billion of CAPEX from 2015-2020 |
| Number of smartphones | Calculation of the move to mobile broadband networks | 226 million | 720 million |
| Employment | Number of jobs created by the mobile economy | 1.3 million (plus 2.4 million additional jobs supported indirectly by the mobile economy) | 2.7 million (plus 3.4 million jobs indirectly supported) |

## Areas to Consider

The African market is largely untapped and could see some of the highest global growth rates over the next 25 years, fueled by a rapidly expanding and increasingly consuming young population.

As a matter of foreign policy, Africa holds high economic potential. However, governments will have to navigate the challenges associated with seeing Africa as one homogenous continent, as opposed to dealing with diverse and independent countries with individual trade and economic policies, and unique social structures.

## Did you know?

Leapfrogging could lead to potentially huge benefits in the energy sector. Currently 621 million people, two-thirds of the population, have no access to electricity. This limits economic growth, leads to high prices for African consumers, and negative health consequences due to pollution from burning wood, biomass, and kerosene stoves.

Kenya is considered to have the most mature mobile money market in the world.

Sources: Intergovernmental Panel on Climate Change (2014) 'Climate Change 2014 - Synthesis Report'; IEA (2016), 'World Energy Outlook'; Users of Mobile Money in Africa: World Bank/GSMA; GSMA Intelligence: Africa Mobile Economy 2016.

# ECONOMIC POWER SHIFT

A global economic rebalancing is underway, and the global centre of gravity is transitioning away from the North Atlantic region (North America and Europe) towards Asia. Around 2030, China will likely overtake the United States as the world's largest economy.

The consequences of this economic power shift are already being felt in a number of areas, including attractive consumer markets, origins of foreign direct investment, financial and economic governance (shares in voting in IMF and World Trade Organisation), development of free-trade arrangements, and the relocation of company headquarters.

For example, the urbanised Asian consumer class is increasingly central to the global economy, driving production, investment, and consumption patterns.

It is predicted that by 2020, the Asia Pacific region will contain the world's largest middle class, accounting for 54 percent of the world's middle-class population and as much as 59 percent of total global consumer spending.

Towards 2050, the economic power shift will reshape trade and reserve currencies and affect geopolitical power structures.

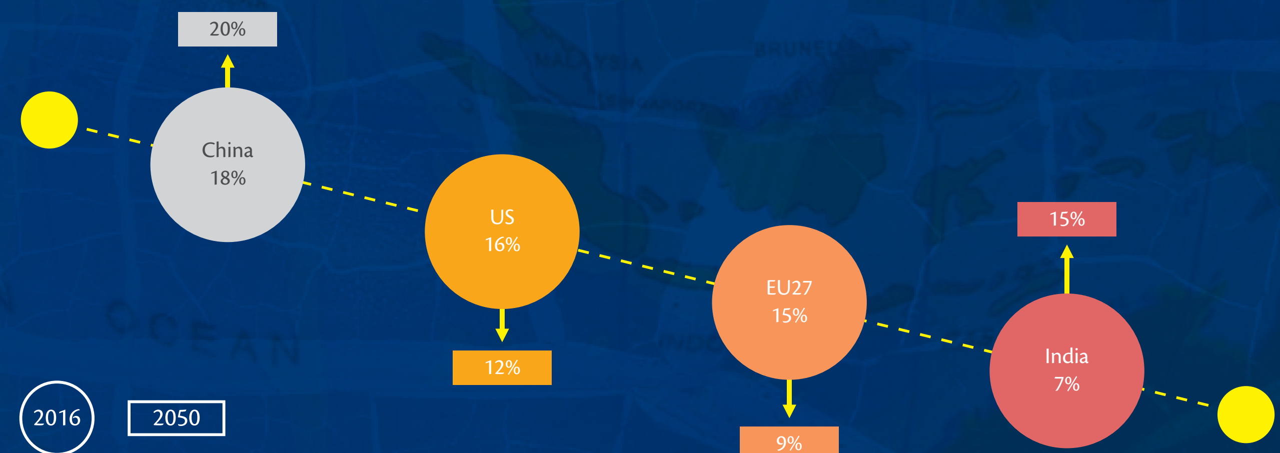
Countries will increasingly shift attention away from the US, which entails breaking with 50 years of foreign policy and global power structures that many global institutions rest upon. An example of this shift was seen when the BRICKS countries established The New Development Bank. The RCEP trade agreement supported by China, which would include most of East Asia and 30% of global GDP, is another.

This shift will have consequences for global finance. The United States has benefited immensely from its currency being the global reserve currency, as this has reduced US borrowing rates. As a result, the Chinese government has aggressively pushed the Chinese yuan as an alternative to US currency. In 2013, the Chinese yuan has overtaken the Euro as the second-most commonly used currency in trade finance. Part of this shift is for geopolitical reasons. For example, due to Western sanctions on Russia following the invasion of Ukraine, Russian companies began trading using the Chinese yuan – a transition supported by the Chinese government.

## Driving Forces

- Economic Growth
- Globalization
- Demographic Development

## Share of world GDP (PPPs) 2016-2050:



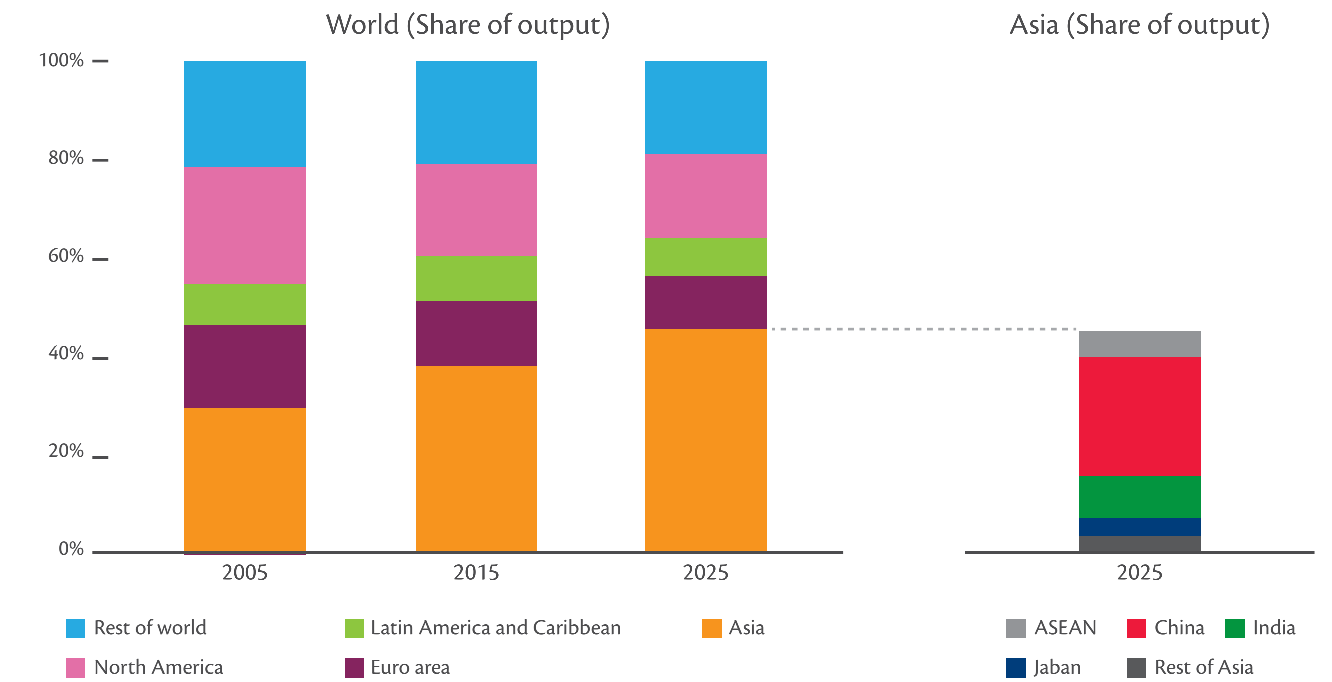

Over the next three decades, the United States and Europe will likely experience a decline in economic power as China and India mark their rise towards global economic prominence.



## Assessment

Economic power shift will be the foundation for many of the geopolitical shifts that will occur. The power shifts will most likely happen, but predictions of when it will happen are quite uncertain.

## Data & Facts:




Share of World Economic Output

Growth in Asia will drive global economic output over the next decade, with special focus on China, India and ASEAN countries.

## Areas to Consider

The economic power shift is and will continue to alter the geopolitical landscape towards 2050.

This could lead to a multipolar world that will lead to a much more dynamic and challenging security environment.

Countries need to find the right balance between superpowers, which might have deviating views, both economically and geopolitically.

## Did you know?

China has almost as many companies (103) on the Fortune Global 500 as the United States (134).

In 2016, Beijing overtook New York as 'billionaire capital' with 100 people with a 10-figure bank balance (in USD), compared to 95 in New York. Other Asian cities also ranked highly: Hong Kong was fourth, Shanghai fifth, Shenzhen sixth, and Mumbai eighth.

Sources: Miller, D. T., (2015), 'Defense 2045 – Assessing the future security environment and implications for defence policymakers'; AT Kearney: "2020-Seven" Growth Economies'; PWC (2015), 'The World in 2050'; BBC (2016), 'The economic outlook 2016'; United States Department of Agriculture (2016); 'International Macroeconomic Dataset'; IMF (2016), 'World Economic Outlook Database'; OECD, (2010) 'GDP Long-term forecast'.

# THE EXPERIENCE AND TRANSFORMATION ECONOMY

As societies in the 21st century become more complex, and citizens grow wealthier, people direct their focus towards immaterial values. Immaterial goods, services, and experiences are those that create stories of an emotional nature rather than services and products of a functional nature. As a result, economic value generation is shifting from products and services, to experiences and transformation. Public and private organisations must creatively use storytelling and staging that are aligned with the immaterial values the organisation seeks to project. The experience economy is about generating individually memorable events, and the transformation economy is about generating a series of experiences that transforms users by assisting them self-actualise and realise their goals and aspirations.

This combination will create immaterial experiences that are authentic and establish a deeper emotional bond with users. This trend is also represented by the growing movement towards concept selling, where you are no longer selling a product or service, but rather selling a vision or fulfilling a purpose. Towards 2050, organisations are expected to become masters of using immaterialisation to their advantage as consumers will continue to move in that direction. Organisations will need to set a service culture, stage experiences, and use physical assets to better engage with the emotional needs of end-users.

This is not only important in private, spiritual arenas, but in all aspects of our lives, including work and consumption. Developments like the experience and transformation economy are now being discussed as reflecting such changes in society. We have entered a new era in which experiences and transformations are the primary economic offerings that are in high demand and generate the highest value returns.

## Driving Forces

- Economic Growth
- Technological development
- Knowledge Society
- Immaterialisation

## The Transformation of Coffees:

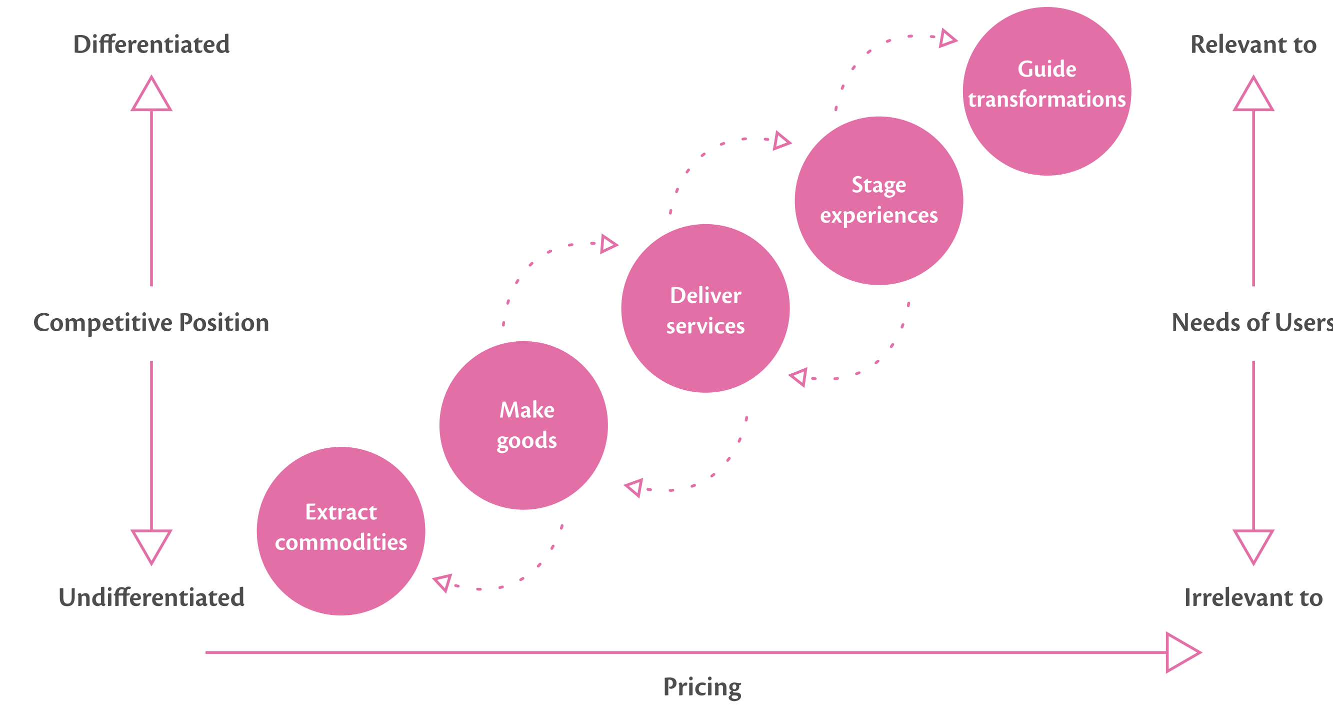
Coffee is the second-most commoditised item after petroleum in traded value. It is also a commodity that has progressed in economic value to now guide transformations for the end-user. As market offerings become commoditised, more value is extracted through a process of customisation. Coffee beans represent the commodity; packaged coffee represents the product; brewed coffee represents the service; and Starbucks represents the staged experience. This, however, is not the final stage in the progression of economic value. The next stage is the transformative process, where new coffee academies and shops train amateur enthusiasts to learn how to consistently make a great cup of coffee. These academies not only provide an experience, they impart new knowledge and skills for their customers – they create highly personalised and impactful experiences that users cannot help but walk away claiming a transformative experience.



## Assessment

This shift in focus will be primarily relevant for populations that have moved out of poverty, and do not only focus on the most fundamental needs. In the developed countries, the trend differentiates those organizations that deliver commoditized services from those who deliver exceptional, transformational ones. This will become more widespread and substantial towards 2050 with technological progress and increased wealth.

## Data & Facts




Progression of economic value

The competition on delivering experiences and servicing immaterial needs leads to service commoditisation. To avoid the service commoditisation trap, where the service offering does not differentiate, organisations continually move higher up the "economic value chain" (reference below in the constant search for profit). According to Pine and Gilmore, the emergence of the transformation economy follows a logical progression of economic value. We already see new business models emerging, and serving this user transformation where increased value generation through experience goes hand-in-hand with the focus on customisation (see Customisation and Niche Markets). For example, FitBit and similar self-tracking gadgets are starting to offer personalized advisors to foster enduring changes in users' lifestyles.

## Areas to Consider

The focus on transformation is a key enabler of citizen centric services. The focus is on identifying population needs and designing services that not only deliver service but help people lead healthier and more satisfying lives.

## Did you know?

A paper published by the psychologists Gilovich and van Boven, "To Do or To Have? That is the Question", presented the findings from a series of experiments where they asked people to think of experiential and material purchases they had made. They found that the research subjects who sought out experiences over material possessions were generally happier.

Sources: Intergovernmental Panel on Climate Change (2014) 'Climate Change 2014 - Synthesis Report'; IEA (2016), 'World Energy Outlook'.

# TRUST AS A CURRENCY

More and more businesses and transactions are going through digital channels, and with the rapid growth of the sharing economy, the ability to convey trustworthiness is becoming increasingly important. Trust-rating and peer-review services such as Yelp and TripAdvisor are being heavily used, while most platform-based businesses (e.g. Airbnb and Uber) are dependent on peer-to-peer trust ratings. Essentially, trust is becoming a new currency and is the reason that someone takes a ride from, or rents out ones apartment to, a stranger.

This trend has been driven by technological development and will be further amplified by e.g. blockchain, which is gaining popularity due to its inherent trust. As we leave more and more decisions in the hands of technology, ways to ensure trust in technology and our human counterparties will become a decisive factor for the adoption of automated services.

## Driving Forces

- Technological Development
- Knowledge Society
- Network Society



## Assessment

Trust as a currency will define the way we engage in transactions online. The trend will gain importance over the coming decades with the continued growth of the sharing economy and driven by e.g. blockchain. Trust will be translated through algorithms and be the enabler for automatic services through internet of things.

## Creating Digital Trust

Yelp is an American multinational corporation publishing crowd-sourced reviews about local businesses, driven by a large community of volunteers called "yelpers". Yelp is ensuring transparency in services and making trust one of the key competitive parameters.

Similarly, Foursquare helps you discover cities and find the perfect places to go with friends based on tips and reviews from millions of other users, forming a global P2P network.

## Areas to Consider

Many sellers on P2P marketplaces now have discretion over who they do business with, which could facilitate discrimination of minority groups based on a name or a photo. This has been evident among Airbnb users, as certain minority groups find it much more difficult to make a booking. This is something that needs to be taken seriously by both policymakers and businesses.

Privacy of data is another important consideration for government.

## Did you know?

The constant evaluations and trust rankings done on Airbnb, Task Rabbit, Amazon, eBay and other transaction-based platforms are building up to an immense amount of individual ratings based on usage of various services. This will compile into a 'digital criminal record', that could be used for other purposes, e.g. assessing your reliability as an employee.

Sources: Botsman, R. (2012), 'TED Talk - The Currency of the New Economy is Trust'; Techcrunch (2016), 'The future is the trust economy'.

# REGIONALISATION

Regionalisation is the result of a combination of interests and state-of-power relations, where large or regional powers choose unilateral strategies to solve challenges. Depending on the conditions within national powers, their interests and strategies and their interactions with one another and with the driving forces (e.g. demographic change, globalisation, and technological development) will drive the future development of the general global framework of international relations away from cooperation towards confrontation and lead to instability within important regions.

This trend is exemplified by the re-emergence of Russia and its assertion of rights in Ukraine and its intervention in Syria, the actions of China and the Philippines in the South China Sea, Great Britain in Europe, and the anti-free-trade political movement in USA. This trend has already interrupted free-trade agreements and led to escalation of regional conflicts, and it could lead to increased isolationism.

In the future, regionalisation could lead to a renewed sense of nationalism and nations going their own way, leading to more protectionist policies. As a consequence, political and economic power will be centred around regional powers – each asserting their power in their spheres of influence. This shift is supported by the rapidly increasing number of regional trade agreements, which pulls away from global free trade.

## Driving Forces

- Globalization
- Demographic Development
- Economic Growth
- Technological Development

## Multilateral Development Banks

The recent creation of the New Development Bank (NDB) – a joint venture among the BRICS countries – and the 'Asian Infrastructure Investment Bank' (AIIB) in 2015 marks a new wave of multilateral development banks, with focus on regional investments. Today, more than 20 multilateral development banks exist.

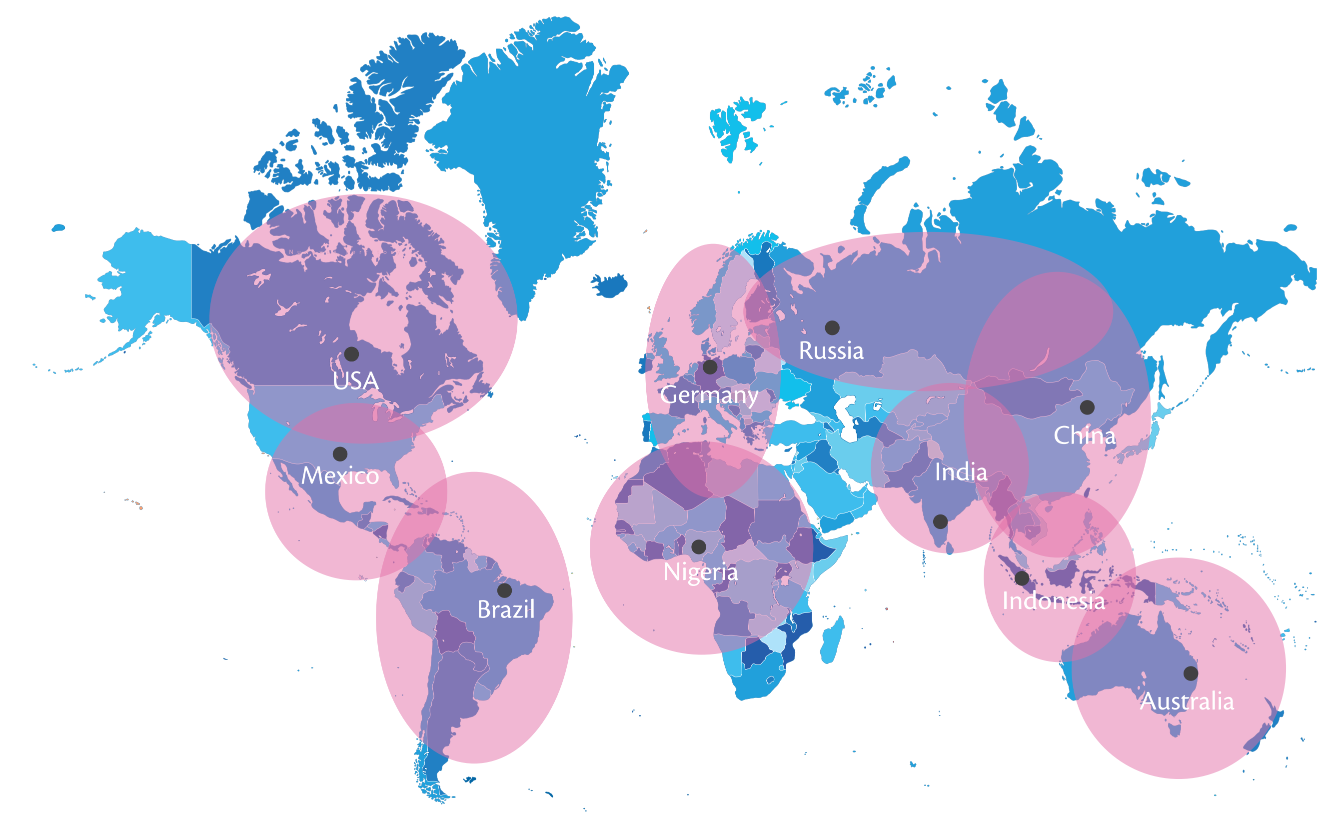
Experts point to the underlying rationale for the creation of the NDB and the AIIB being a desire of emerging economies to reform the existing system of financial governance, as they are critical of the World Bank and other global institutions for underrepresenting them and for imposing the priorities and values of Western donor countries. As such, the new multilateral development banks have been driven by regional interests.



## Assessment

Regionalisation is an critical trend that affects the development of the world economy, the demand for energy, the UN climate change process (and climate and energy policies), and may also affect regional stability. In the future, regionalisation may become a powerful trend with high impact.

## Data & Facts




**Regional power sphere scenario, 2040**

If regionalisation becomes a powerful trend, globalisation will have stalled, and strong regional powers will dominate economically and politically within their 'own' power spheres. There will be overlaps in spheres, and especially Africa – with Nigeria as the regional power – draws interest from other international powers such as China, India, and Germany/Europe.

## Areas to Consider

The geopolitical framework is in a state of flux, and new powers are challenging old ones. Governments will respond to these challenges through a process of adaptation and anticipation that combines national tradition, values, interests, and alliances.

## Did you know?

Of all Regional Trade Agreements in force, only around one in four are 'truly' regional. Most Regional Trade Agreements involve countries that are located geographically apart.

Sources: US National Intelligence Council (2012), 'Global Trends 2030 - Alternative Worlds'; Council of Foreign Relations (2016), 'Global Order and the New Regionalism'.

# GLOBAL DEBT OVERHANG

Global debt is increasing, leveraging governments, citizens and institutions to a historic level. This is resulting in increased sensitivity to interest rates that are being kept at artificially low levels. Negative interest rates policies are spreading like a virus across central banks in the EU, Japan, and Switzerland ,with the federal reserve not far behind. Total global debts rose to more than $217 trillion (£175 trillion) at the end of the third quarter 2016, according to Institute of International Finance, amounting to a record high of more than 325 % of GDP. Governments in mature markets are the biggest borrowers with around $50 trillion of debts. Sovereign debt now accounts for around 115 % of GDP, up from just above 70 % a decade ago. This economic situation has bifurcated governmental strategy between austerity and spending, but still with no major economy reducing their debt-to-GDP ration over the last decade.

Whether or not the debt is kept at high levels, or brought down, it will have a great impact on the global economy towards 2050. Uncertainties are ubiquitous, but high public debt threatens to drive interest rates on sovereign debt up, crowding out public investment and raising price inflation. Nearly all developed countries face ageing populations and rising healthcare costs, and this is certain to put pressure on governments' budgets and their ability to fund their spending.

## Driving Forces

Economic Growth

Globalization

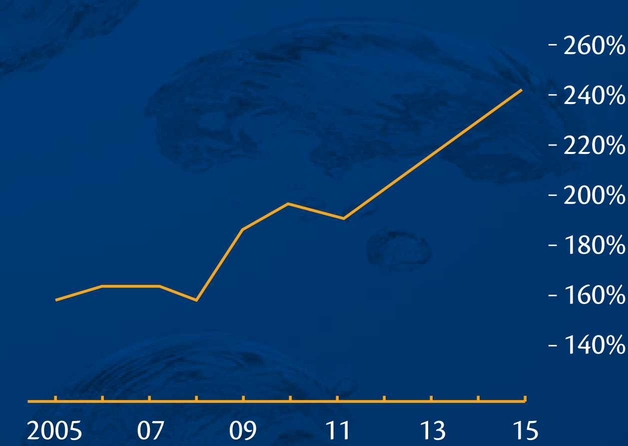
Demographic Development

## China's Debt Overhang

Seven years after the bursting of the global credit bubble, China continues to pump credit into the economy, despite the cooling of the Chinese economy. China's total debt stands at 161 trillion yuan (USD 25 trillion), more than 240 % of GDP. The biggest debtors are state-owned firms, and the biggest creditors are state-owned banks.

As such, some argue that an acute crisis can be avoided byrolling over bad loans when they are due or abstaining from calling them in.

China's total debt as % of GDP

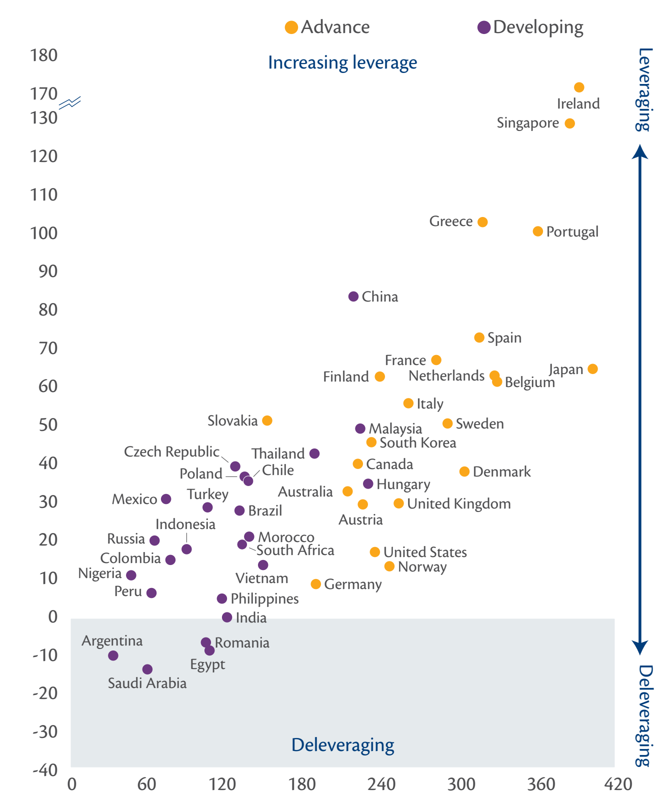





## Assessment

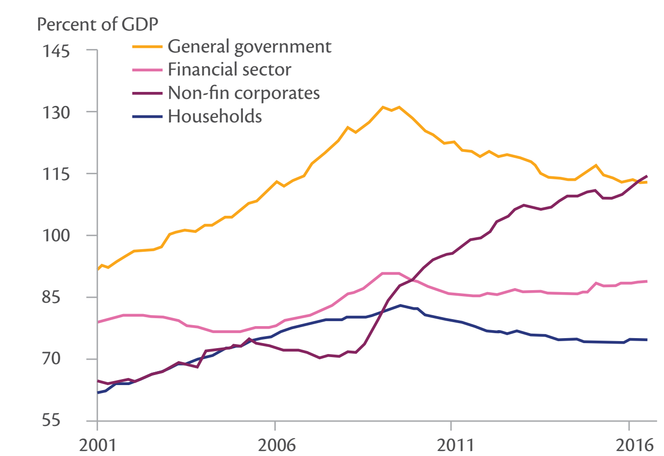
It is virtually beyond dispute that government debt will grow to dangerous and unsustainable levels in most advanced and many emerging economies over the next 25 years, if there are no significant changes in spending. This can result in a debt crisis and in another global recession within the next few years.

## Data & Facts:



Change in debt-to-GDP ratio, 2014 - 2017; percentage points

No major economy has decreased its debt-to-GDP ratio since 2007. High government debt in advanced economies, mounting household debt, and the rapid rise of China's debt, are all areas of potential concern. Especially governments in mature markets have increased debt ratios, together with the ageing society and increasing cost for healthcare, most mature markets will be challenged in the years to come.



Mature markets: sectoral indebtedness

[1]Debt owed by households, nonfinancial corporations, and governments; Q2 2014 data for advanced economies and china; Q4 2013 data for other developing countries.

## Areas to Consider

Governments should consider their exposure to the most indebted economies and stress test how increased interest ratios would effect their trade partners and global trade in general. Inability to pay debt could cause depreciation of currencies that traditionally are considered very stable.

## Did you know?

Only a handful smaller nations that are operating free of debt. Niue in the South Pacific is the most recent country to join the list. A nation of only 2,000 citizens, Niue paid off its USD 4 million debt and declares no intentions to borrow large sums of money again.

Sources: McKinsey&Company (2015), 'Debt and (not much) deleveraging'; The Economist (2015), 'Deleveraging delayed'; Institute of International Finance (2017), 'Emerging Markets Bank Lending Conditions Survey – 2016 Q4'; The Guardian (2016), 'Land that debt forgot: tiny Pacific country of Niue has no interest in loans'.

# PEER TO PEER (P2P)

Peer-to-peer (P2P) is a specific form of relational dynamics and refers to the free cooperation of equals. Over the last decade, the P2P model has been adopted in many applications, ranging from simple not-for-profit transactions between friends and family to worldwide services run either by a non-profit model like Kiva (providing micro loans) or as global corporations like Airbnb, Kickstarter and Uber.

Typically, a P2P marketplace brings people and/or businesses together online to deal with each other directly without having to go through a slow, expensive middle man. This has spawned companies such as Airbnb and Uber, which function as interface owners and intermediaries between peers. The success of these companies relies on not only offering a more attractive service and a larger selection, but an ability to build trust between strangers (see Trust as a Currency). This is now done with great success through online rating systems.

The use of P2P is a game changer, broadening the kinds of trades and transactions people are willing to engage in (see Freedom From Ownership). The P2P model hereby relates to the sharing economy culture, providing more efficient use of assets benefiting both the individual and the society by leveraging on cost savings, expansion of possibilities, and resource scarcity. Continued technology development, resource scarcity, and focus on sustainability are expected to push the P2P accessibility model to prominence towards and could be one of the main drivers for growing wealth in the coming decades.

## Driving Forces

Network Society

Technological Diffusion and Empowerment

Individualisation

## P2P marketplaces

Airbnb and Task Rabbit are examples of peer-to-peer collaborative consumption marketplaces. Airbnb enables people to list or rent short-term accommodation, while Task Rabbit connects people who needs a task done with 'rabbits', who runs these errands for a fee. Both rely on built-in trust ratings in which users continuously evaluate each other. The key enabler behind such marketplaces is using the power of technology to build trust between strangers to allow for the transaction to take place.



## Assessment

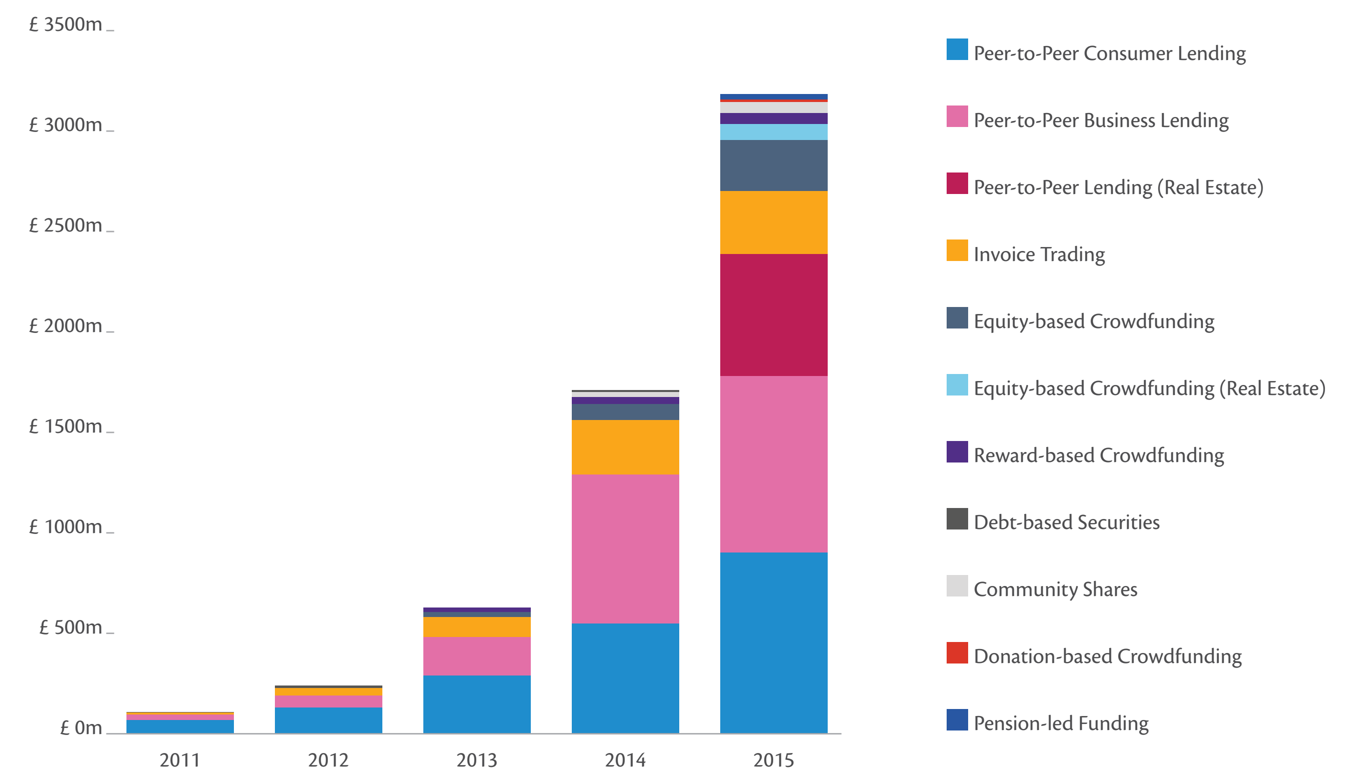
The basics of the P2P system relates to very old social structures. P2P has simply moved onto a digital platform. The P2P trend is already driving many new business models and towards 2050, the P2P model will keep disrupting new markets, and new industries will emerge around the P2P setup.

## Data & Facts

The financial industry is one of the areas that will be seriously disrupted over the coming decades by P2P models.

For example the UK online alternative finance industry has over the course of five years, increased both in market size and in diversity. From 2011 to 2015, we have witnessed a rapid development of alternative financing models such as P2P consumer lending and equity-based crowdfunding as well as the breakthroughs of relatively new and innovative models such as P2P lending for real estate and donation-based civic and community crowdfunding.

This development will likely continue, either with the banks adopting to P2P technologies, or by P2P players continuing to take over market shares.




**UK online alternative finance**

## Areas to Consider

The future citizen will not want to own everything, but to have instant access to everything. This has several implications for policymakers. First, more regulation of the digital P2P markets is needed, especially as they are still in the middle of creation. Secondly, governments could enter the markets as an active third-party player and become both a guarantor of the credibility of the other 'peer' as well as secure the transactions to avoid illegal trade.

## Did you know?

P2P computing or networking is a distributed application architecture that partitions tasks or work loads between peers. For instance, Mozilla Firefox is an open-source internet browser developed by hundreds of volunteer developers. It is in its creators' own words:

"Built for those who build the Web. The only browser made for developers like you".

Sources: CIFS (2013), 'Members' Report – Freedom from Ownership'; Nesta (2016), 'Pushing Boundaries– The 2015 UK Alternative Finance Industry Report'; Abbate, J. (1999), 'Inventing the Internet'.

# CHANGING INDICATORS OF PROGRESS

The vast development and efficiency gains caused by technological development in recent years are not manifesting in traditional measures of economic growth such as GDP. This raises the question of whether future potential gains achieved from the wake of the fourth industrial revolution will be just an illusion.

There are several reasons why dissatisfaction with GDP as a governmental target is gaining traction. Firstly, there is little measurable economic benefit to the majority of the population. As Joseph Stiglitz reminds us, "in the 'recovery' of 2009-2010, the top 1% of US income earners captured 93% of the income growth." Additionally, GDP is notoriously difficult to calculate and malleable to manipulation.

Moreover, new economic models and transactions are operating outside of GDP calculations, including the growing sharing economy or bartering economy, and recycling. Further, there is growing recognition of newer dimensions to progress such as health, new happiness indices and inequality. All of these disappear into the background despite being critical to holistic growth and eventually societal progress. Finally, there is no future aspect: GDP does not take sustainability into account – pollution, consumption of natural resources, or the loss of species or green spaces.

Availability of more advanced measurement tools and methodologies, together with the shortcomings of GDP will likely cause a shifting attention away from real GDP as an economic indicator of progress, towards more qualitative measures that parallel the contemporary efficiency gains and technological development. The Human Development Index is now an accepted metric in non-economic circles, now adjusted for inequality. The UK government has recently been expending significant effort to measure national well-being. Similarly, Bhutan officially measures Gross National Happiness, not GDP, and utilizes it as its official government indicator of progress.

It is widely accepted that we focus on what we measure. Along with GDP gradually losing its credibility as an indicator of progress, a change likely occurring gradually over the next two decades, policy making and credit ratings will adjust, due to clearer and deeper insight into real drivers of advancement.

## Driving Forces

Economic Growth

Focus on Health

Knowledge Society

More efficient use of Natural Resources and Environment

## Human Development Index

United Nations data on GDP indicators and the Human Development Index (HDI) shows that there is little correlation between GDP per Capita (a measure of wealth) and the top ranked countries on the HDI.

| HDI Rank (2015) | HDI Score | Country | GDP/Capita (US$ - 2015) | GDP/Capita Rank |
|---|---|---|---|---|
| 1 | 0.949 | Norway | 61,197 | 8 |
| 2 | 0.939 | Luxembourg | 46,270 | 19 |
| 2 | 0.939 | Switzerland | 61,086 | 9 |
| 4 | 0.926 | Germany | 47,377 | 14 |
| 5 | 0.925 | Denmark | 46,624 | 16 |
| 5 | 0.925 | Singapore | 85,382 | 3 |
| 7 | 0.924 | Netherlands | 48,313 | 12 |
| 8 | 0.923 | Ireland | 65,144 | 7 |
| 9 | 0.921 | Iceland | 46,547 | 18 |
| 10 | 0.920 | Canada | 44,310 | 20 |
| 10 | 0.920 | USA | 56,116 | 10 |



## Assessment

This trend can have significant impact if governance is tailored accordingly to new measures of progress.

GDP is constantly weakening in popularity and effectiveness, and more holistic socio-economic outlooks will likely prevail.

## Data & Facts

The Prosperity Gap, Compiled by the Legatum Institute, measures on a relative scale how well countries turn wealth (using GDP per capita as an indicator), into prosperity.

The Better Life Index is an OECD data compilation project which aims to measure societal well-being and improve the development of well-being metrics. Each of the 11 topics of the Index is currently based on one to three indicators – selected based on relevance and data quality.

| Prosperity Gap Ranking | |
|---|---|
| Ranking | Country |
| 1 | New Zealand |
| 2 | Norway |
| 3 | Finland |
| 4 | Switzerland |
| 5 | Canada |
| 6 | Australia |
| 7 | Netherlands |
| 8 | Sweden |
| 9 | Denmark |
| 10 | United Kingdom |

| OECD Better life index | |
|---|---|
| Quality of Life | Material Conditions |
| Health Status | Income and Wealth |
| Work-Life Balance | Jobs and Earnings |
| Education and Skills | Housing |
| Social Connections | |
| Civic Engagement and Governance | |
| Environmental Quality | |
| Personal Security | |
| Subjective Well-Being | |

## Areas to Consider

Taking new international recognised indices into use, supporting the focus areas for the government, would not only ensure national focus, but could also help in understanding cause and effect of political initiatives and other factors by comparing with other nations.

## Did you know?

Bhutan is the only country in the world that uses a non-GDP economic progress measure as standard. What makes this interesting is that Bhutan is also measured as the world's highest increase in Human Development Index in 2015, increasing more than 3 times the global average.

Source: Harvard Business Review (2012), 'The Economics of Well-Being'; Legatum Institute (2016), 'The Legatum Prosperity Index'; UNDP (2015), 'Human Development Report 2015 – Work for Human Development'; The Economist (2016), 'The trouble with GDP'; Bloomberg (2012), 'Rise of the Barter economy'; IMF (2016), 'World Economic Outlook Database'; OECD Better life initiative.

# SHIFTS IN LUXURY MARKETS

In economics, a luxury market can be defined as a global sphere of consumption for premium priced, non-necessity products often categorised by brands e.g. Mercedes cars compared to Ford. Emerging luxury markets are driven by a growing global middle class and a growing number of Ultra High Net Worth Individuals (HNWI) in countries like Brazil, India, and Russia, with shifts in both geography and taste. In France, the luxury market accounts for over 4 % of GDP, despite one of the largest recent drops in HNWIs. The luxury goods market in UK accounts for over 2 % of GDP with an expected rise by 2020 amounting to 200,000 jobs. Most of the market is situated in London. Yet, the luxury market is just the initial attractor with greater importance in the visibility and demographic shifts it creates, e.g. London has become synonymous with a luxurious lifestyle, attracting many more HNWI and luxury tourists who invest in real estate, land, or business.

In the future, emerging economies will experience increases in 'luxury purchasing power' over the next decades, and we will see new consumer segments emerging in the more mature luxury markets. Growth in luxury markets is strong and will grow faster than global increases in wealth due to an uneven income distribution.

Actors in the luxury markets will need to constantly adapt due to the accelerating globalised markets and new technologies, as well as new and younger consumer segments with different preferences. The 'path-to-purchase' is also evolving, with social networks, payment technology, and security advances. Luxury goods consumers are dictating increasingly when, where and how they engage with luxury brands. The challenge arises on how to keep luxury markets physically connected to a city, with the future compounded benefits of HNWI and investment, rather than merely online.

## Driving Forces

Economic Growth

Individualisation

## Chinese Luxury Tourism

Chinese consumers tend to spend more than three times as much abroad on luxury than what they spend at home, while luxury consumers in mature markets (e.g. Europe, The US and Japan) make most of their luxury purchases at home.

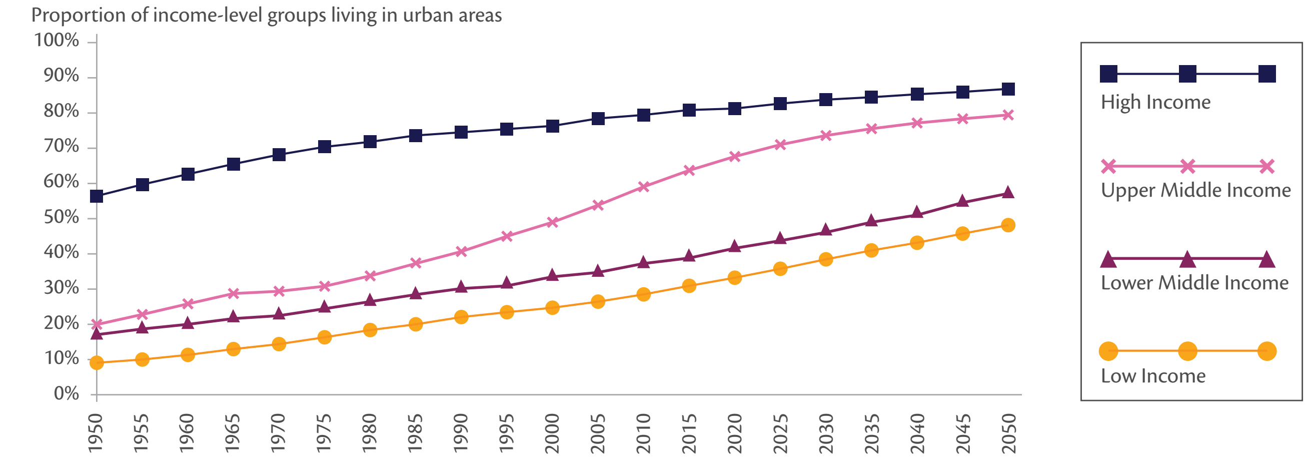
Chinese consumers buy luxury products when abroad for three reasons. First, they can avoid paying Chinese taxes and tariffs, which can add up to 60 % to the price. Second, buying a product abroad creates an experience (story) they can share with friends upon their return. Third, acquiring the purchase while abroad reduces the risk for counterfeit products. Spatial shifts in demand are redefining 'luxury' with brands catering to Chinese HNWI with e.g. Chinese Zodiac by Vacheron Constantin.

## Assessment

Growth in luxury markets is strong and will have a big influence on specific global luxury hubs. The shift in luxury consumption towards emerging markets will continue in the short term, and consumer preferences will develop and mature over time. Uncertainties arise within particular cultural customs, regulation, discounted goods and individual product markets.



## Data & Facts




Growth in luxury markets is being fueled by especially the rise of the global urban upper middle class (see figure). Growth in luxury will be driven by a projected doubling in air traffic over the next 15 years, dominated by increase in travelers from emerging markets who are expected to be much younger. Further, the spread of 4G network and universal connectivity is set to drive Ecommerce growth and access to luxury markets.

As millions of people move into the affluent consumer group, demands change and this has a big influence on certain product groups. The price of fine wines has surged due to the increase in the amount of Ultra High Net Worth Individuals.

## Areas to Consider

Luxury consumption is defined less by proximity than other consumption due to the large price tags and global brand appeal.

Economic polarization is likely to increase the total market share of premium priced products.

Luxury brands are already investing heavily and innovatively in emerging markets, like Ferrari's theme park global expansion.


## Did you know?

Chinese shoppers account for nearly half of the global luxury market, providing invaluable demand to brands in every segment.

Data from Fortune Character Institute, a Shanghai-based luxury research consultancy, show China's luxury spending in 2015 totaled USD 16.8 billion, up 9 %, year on year. Further, 60 % of all overseas spending went on luxury goods.

Sources: CIFS (2014), 'Members' Report – Future Luxury'; World Travel & Tourism Council (2015), 'Travel & Tourism: Economic Impact 2016'; The Economist Intelligence Unit (2016), 'The Chinese consumer in 2030'; Knight Frank (2016), 'Global Cities Trend 2016 Report – The Future of Real Estate in the World's Leading Cities'; OECD (2016), 'An OECD Horizon Scan of Megatrends and Technology Trends in the Context of Future Research Policy'.

# BREAKDOWN OF THE WASHINGTON CONSENSUS

The Washington consensus advocates free trade, floating exchange rates, free markets and macroeconomic stability, but is currently being challenged by a new wave of policies. Dissenting opinion has picked up pace in the wake of the global financial crisis and has led to increasing pressure for inward-looking policies, especially in USA and in EU countries. Free trade and integration of the global economy have put downward pressure on economic players in advanced countries and resulted in a growing discontent of the people due to regional/local industrial decline and unemployment.

Increasing regionalisation of trade and the proliferation of regional trade agreements also pulls away from global free trade. There is a concern that the increasing number of regional trade blocks not only implies trade liberalisation, but also trade discrimination.

However, international organisations such as IMF, WTO and EU warn that the ability of economies to safeguard the benefits of openness to trade and investment is crucial to future growth as global protectionism continues to rise. Essentially, global trade is under pressure, but there are forces pulling in both direction, so the state of the Washington Consensus and global trade in the future remains uncertain.

## Driving Forces

Globalization

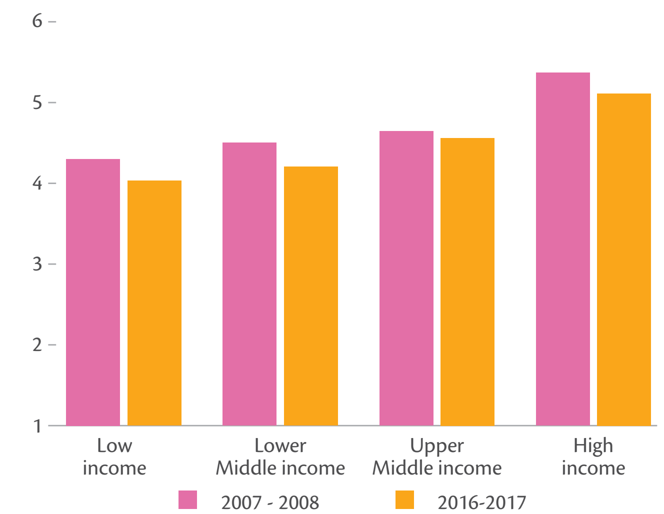
Economic Growth



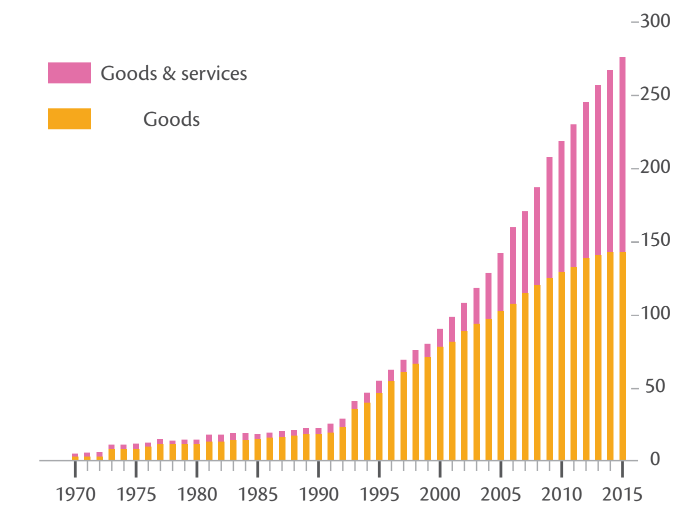
## Assessment

Global free trade is currently under increased pressure, but this trend is shrouded with uncertainties in the longer term, as political priorities are not necessarily long term.

## Data & Facts




Openness perception score (1 - 7)




Number of trade agreements

According to the World Economic Forum 2016 - 2017 Global Competitiveness Survey, protectionist measures, especially non-tariff barriers, have increased. Economies in all income groups have become less open since 2007.

Regional free trade agreements that operate alongside WTO global trade agreements have spread rapidly since the 1990's.

## Areas to Consider

Re-export hubs around the world might be relatively more vulnerable to rising protectionism if global trade slows down. Even more so, it will be important for policymakers in re-export hubs to maintain pro-trade and pro-investment policies.

## Did you know?

From mid-October 2015 to mid-May 2016, G20 economies applied 145 new trade-restrictive measures – an average of almost 21 new measures a month. This is the highest monthly average registered since the WTO began monitoring this in 2009.

Sources: World Economic Forum (2016), 'The Global Competitiveness Report 2016-2017'; World Trade Organization (2016), 'Regional trade agreements and the multilateral trading system'; The Economist (2015), 'Why everyone is so keen to agree new trade deals'; Financial Times (2016), 'WTO warns on rise of protectionist measures by G20 economies'.

# CHANGING ARCHITECTURE OF INTERNATIONAL TRADE

Structural developments such as the growth slowdown and rebalancing of the Chinese economy, weakening of global value chains, new regions with rapid population growth, and a general transition from manufacturing to service economies will significantly change the architecture of international trade towards 2050.

Automation-led development of companies moving production closer to markets will continue, causing a weakening effect on global value chains. As China is trying to rebalance from an export-led economy towards focusing more on domestic consumption, Chinese manufacturers increasingly produce intermediate parts that they once imported for assembly. However, there are opposing effects, and there are marked differences across industries, as many companies still have incentives to establish themselves in China/Asia in order to have access to the huge market. Additionally, global services trade is rapidly increasing and is expected to rise from USD 1.6T in 2012 to USD 8.7T in 2035, according to world trade organization (WTO).

The majority of world trade continues to be clustered around Europe, North America, and East Asia, but the overall increase in the past decade (though slowed down by the financial crisis) has largely been driven by increased trade between developing countries: South-South trade. The significance of South-South trade will continue to grow, e.g. because of the growing middle class in emerging markets, especially in Asia, which likely will emerge as the centrepiece of the global trade architecture.

## Driving Forces

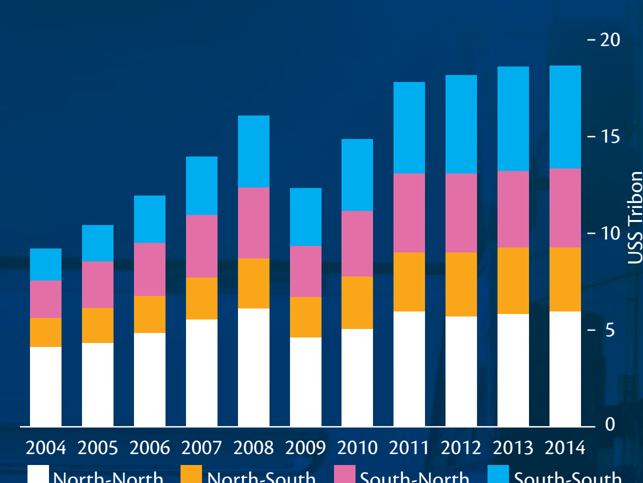
Economic Growth

Globalization

Technological Development

## Increasing South-South Trade

The figure shows the surge in South-South trade in recent years. This development has been supported by an increasing number of South-South Regional Trade Agreements (RTAs) to provide market access and allow for deeper integration. RTAs between developing countries make up more than half of all RTAs in place, with Asia in the lead. This trend is likely to continue.



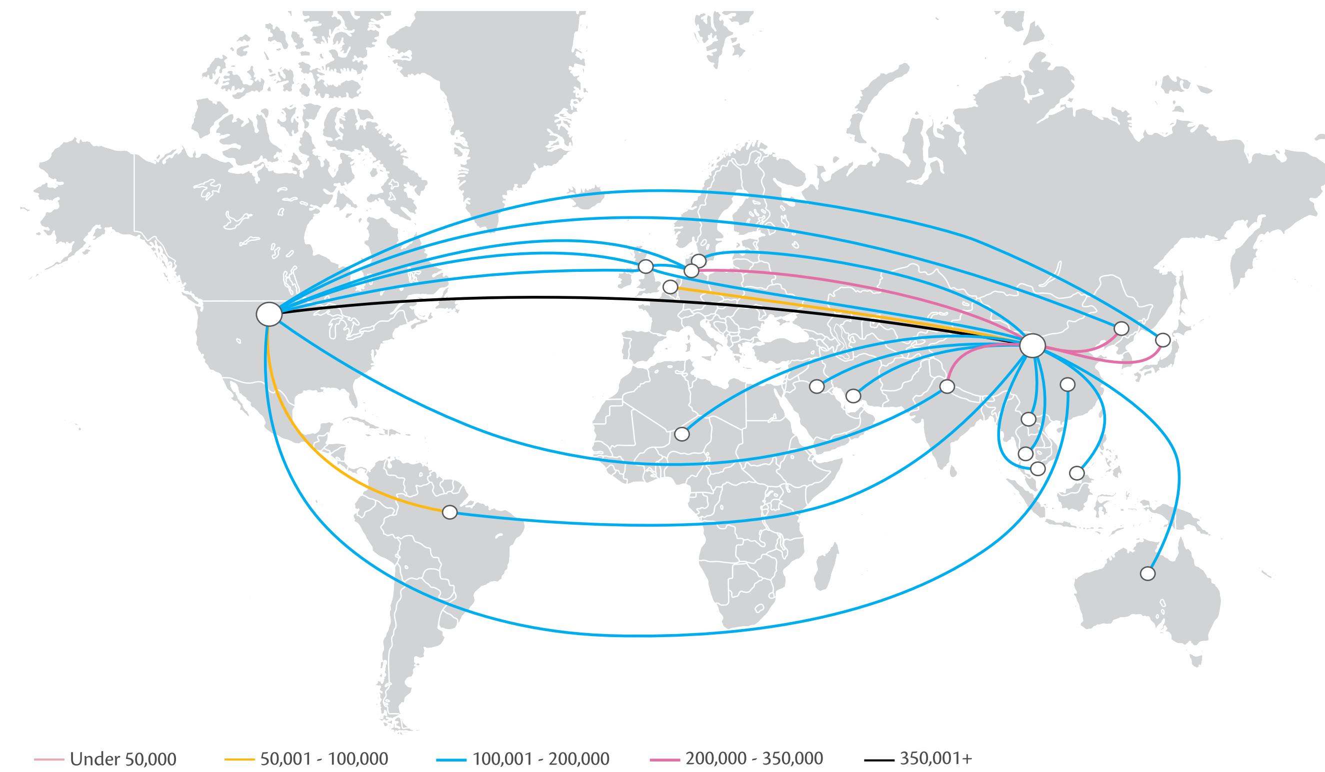



## Assessment

A series of structural developments heralds changes to the international trade landscape in the medium to long term. The impact will vary across industries and countries.

## Data & Facts

The trade network map illustrates the importance of bilateral trade pairs in 2030. The divergence in economic growth prospects between emerging and developed economies is expected to be mirrored in future trade patterns. Trade routes between emerging economies and developed economies and between emerging economies and other emerging economies are expected to become more significant towards 2030. Trade relating to East Asia will generally grow, but trade relating to the MENA region is also expected to grow substantially.




**Top 25 sea and air freight bilateral trade pairs in 2030 (US $ Millions)**

## Areas to Consider

Global businesses will need to be proactive in adjusting their strategies to reflect the changing patterns of world trade.

It is encouraging that MENA trade with Asia has grown substantially, suggesting that MENA is becoming more economically integrated with Asia.

## Did you know?

The rebalancing of the Chinese economy is a work in progress. The structural transformation from export to domestic demand in generating growth, has already caused a slowdown in global trade by e.g. reducing imports from other regions. The rebalancing of the Chinese economy will influence trends in world trade in the future.

Sources: CIFS (2016), 'Members' report – Automation'; UNCTAD (2015), 'Key statistics and trends in international trade'; World Trade Organization (2013), 'World Trade Report 2013 – Factors shaping the future of world trade'; PWC (2011), 'Future of World Trade – Top 25 sea and air freight routes in 2030'; Financial Times (2016), 'Global trade: structural shifts'.

# DIGITAL CURRENCIES

The emergence of digital currencies is creating new possibilities for, and patterns of, payments. The most popular digital currencies like Bitcoin use a cryptographic technology called blockchain that builds a shared and publicly verifiable database of transactions (see Blockchain). A digital currency has the potential to morph into a global system that streamlines trade, eliminates exchange rates, and ends currency speculation. Despite its potential, its emergence and implementation is surrounded by uncertainty. Digital currencies both have the potential to lead to increased transparency and efficiency, or to enable the shadow economy. As a result, digital currencies will probably need to develop under strong regulation in order to become a trusted payment system.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

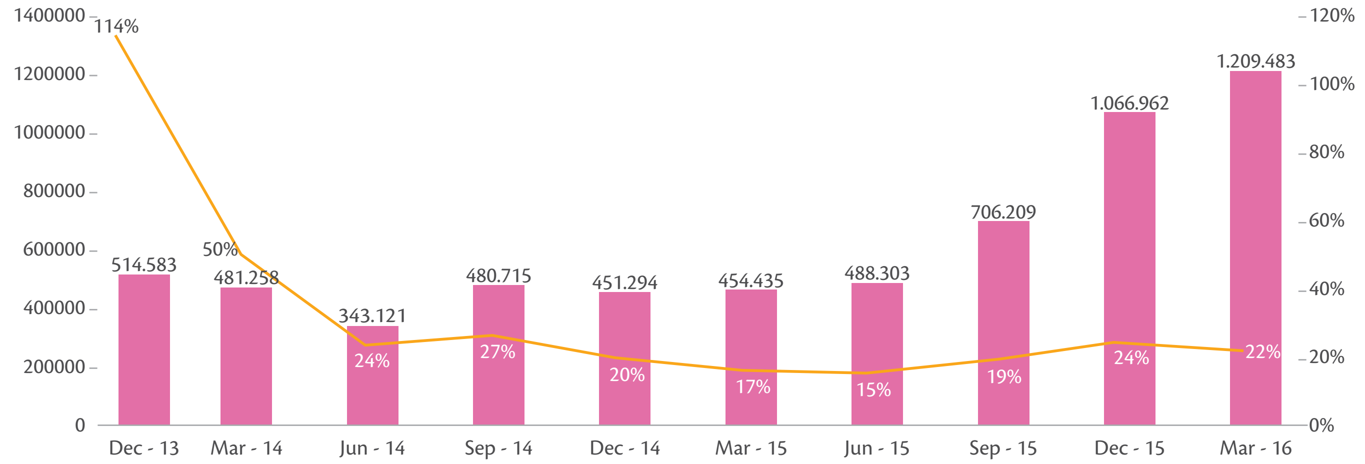


## Assessment

Digital currencies could drive efficiency gains within the financial and other transactions across countries. Digital currencies will likely take over the role of traditional currencies at some point. The question is what form they will take and whether they will be government-backed or not. We already see the adaptation of new payment methods in both developed and developing countries.

## Digital Currency 'Wallets'

Quarterly growth in digital currency 'wallets' is increasing, with 6 million wallets opened in the last 2 years alone. An annual growth of 7 % for the digital currency market is project towards 2020.




**Number of new wallets added each quarter**

## Areas to Consider

Regulation will be critical to control the impact of digital currencies and their use in illicit trade. It is even more important to consider how to integrate digital currencies into the financial infrastructure. Many countries are in the process of developing regulation for digital currencies, including the EU and Japan.

Digital currencies have the potential to dramatically reduce remittance costs and are already widely used for this purpose.

## Did you know?

The African nation of Senegal is preparing to issue an official blockchain-based legal tender for a digital currency. The eCFA franc as it will be called will be in circulation in parallel to the current physical CFA franc bank notes. The CFA franc is the name of two currencies used by fourteen countries, mainly formerly French-colonies in Africa.

Sources: European Parliament (2016), 'Virtual currencies: what are the risks and benefits?'; CoinMarketCap (2016), 'Crypto-Currency Market Capitalizations'; Sandler research (2016), 'Global Digital Coin Market 2016-2020'; Iafrikan (2016), 'Senegal To Introduce A New Blockchain-Based National Digital Currency, The Second Such Currency in The World' CoinDesk: State of BitCoin and BlockChain 2016.

# TRANSFORMATION OF THE MIDDLE MAN

Technology such as Blockchain and Artificial Intelligence give broader possibilities for connecting the buyer and the seller directly, cutting out the Middle Man. This was expected to happen with the introduction of the internet, but instead we saw a wave of digital platforms transforming the role of the middle man (like e.g. p2p facilitators).

The ability of new technologies to connect buyers and sellers and facilitating a seamless transaction flow will create much more efficient and transparent markets, once again transforming the middle men. The AI personal assistant could be your very own Middle Man, finding everything you need and arranging the deal, while Blockchain could handle practicalities around payment and legal documentation – all with close to no effort.

Towards 2050, advanced algorithms will make sure the individual's needs are met and will provide access to everything people want. Eventually, this will render the current concept of the Middle Man obsolete across most sectors and transform current physical transaction markets.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Economic Growth



## Assessment

The transformation of the Middle Man will have significant impact on the user phase and shopping experience. We expect that the change will happen in steps and 5-10 years from know significantly start to have an impact.

## Will Physical Stores be Outdated?

Physical stores lose their practical value. 'Spring' is a mobile app that allows users to browse and order from 700 fashion brands. The 'single shopping destination' is a step on the road towards removing the physical Middle Man. The Middle Man now has to offer additional experiences to survive, like e.g. Ralph Lauren flagship stores with customisation options and a sense of being in a historical place with museum worthy surroundings.

## Areas to Consider

New technologies like artificial intelligence, virtual and augmented reality, and 3D-printing are already cutting out middle men in supply chains all around the world. As these and other technologies continue to develop, governments need to adapt their communication and possible regulate these new platforms to prevent monopolistic or undesirable market conditions.

## Did you know?

450 million people already visit "buy and sell" groups on Facebook, and Facebook is introducing Marketplace, which is supposed to be a friendlier version of Craigslist. Integration with Facebook Messenger lets you haggle or arrange a meet-up, and you know more about who you're dealing with than on anonymous sites like Craigslist.

Source: Business.com (2015), 'Is Wholesale over? Death of the Middle Man'; Techcrunch (2016), 'Facebook launches Marketplace, a friendlier Craigslist'.

# CUSTOMISATION AND PERSONALISATION

Advances in technology, more efficient business processes, and a willingness to pay for additional services are causing a shift away from mass production towards customisation. There is a steadily growing request for deeper levels of customisation amid rising user expectations for individual attention and tailored products, processes, and services that satisfy unique needs.

Users are interested in receiving directed solutions to the challenges they are faced with. Linked with the proximity trend (see Proximity), demand is becoming much more diverse, and niche markets are flourishing within all markets that offer consumer goods. We are also seeing the emergence of hyper-niche markets that cater for a very defined user base in a certain product area, such as Detroit vs Everybody apparel. This trend is also reflected in geo-specific marketing and offers like the recent Snapchat geo-filters. Market places on the internet are facing a global customer base, making it possible to create high sales volumes within almost any niche market as long as you are providing good service.

The market is evolving to meet the increasing expectations through new business models, governance structures and partnerships. Consumers are becoming more involved in service design and service delivery through decentralisation and new co-creation processes. Customisation can be seen as a premium service and will shift consumption from generic outlets or counterfeit items to stores and brands that offer this 'experience'. Movement towards more customisation is likely in the coming decades (except for fashion, which likely will see a reverse trend). Tomorrow's winners will be the companies who are able to meet customers' exact needs – and knowing their needs, even before the customers themselves. The next crucial step in personalization is innovation.

## Driving Forces

- Individualisation
- Technological Development
- Network Society
- Globalization

## Personalisation in G2C

Estonia's use of modern information and communication technologies in public sector and governance has placed the country at the forefront of states that are aiming to modernize their public sector and provide transparent governance.

Driven by convenience, most of the services offer efficiency in terms of money and time saved by the individual users as well as public officials. For example, selling a car in Estonia can be done remotely with less than 15 minutes and filing an online tax declaration takes an average person no more than five minutes because of the digital personalisation ensuring that the citizen only needs to consider areas of importance for her/his situation.

ID-cards are compulsory for all citizens and they are equally valid for digital and physical identification. This allows government to provide to provide personalized services and information via online means i.e., reviewing individual health records or checking the validity of car insurance.



## Assessment

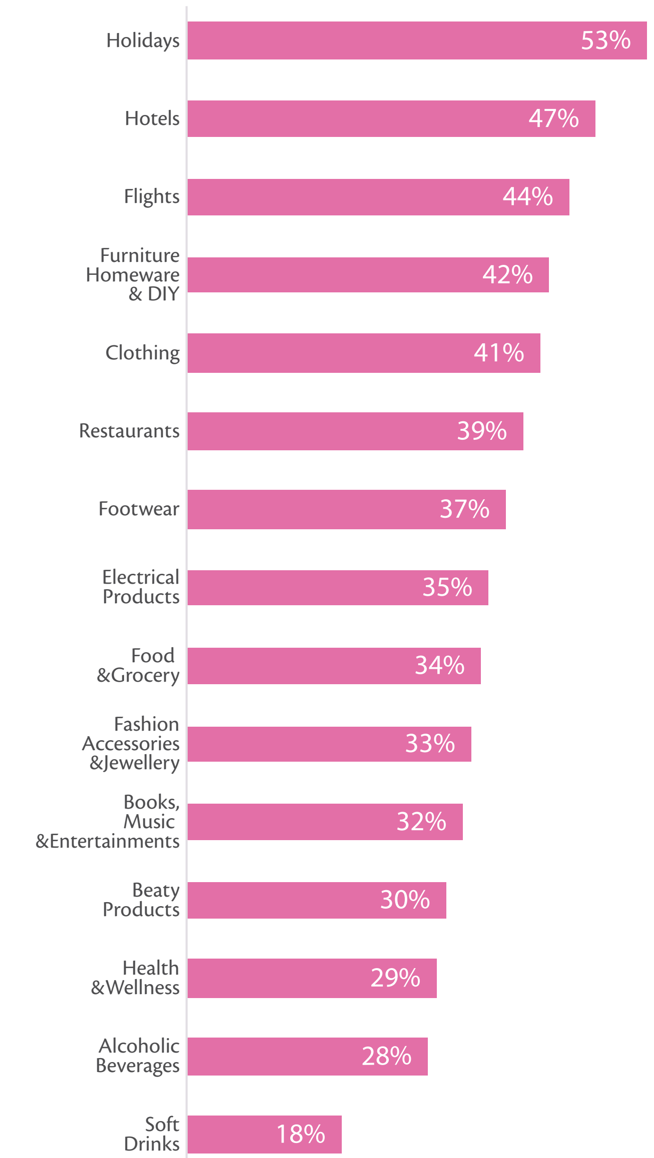
The trend is expected to be important for international competitiveness, and shape expectations toward public service.

In the coming 5 years major progress in the offering of customisation and personalisation is expected, and the development will likely continue and be even more subtle along with increasing technological possibilities.

## Data & Facts

In a 2015 consumer survey by Deloitte, on average 36% of the consumers expressed an interest in purchasing personalised products and services. However, it differs widely across products/service categories (see the figure) and age groups. Moreover, the survey finds that not only would the majority of consumers be willing to pay more for a customised product or service, they would also like to be actively involved in the process.

The survey concludes that consumers are increasingly dictating what they want, when and where they want it – empowered by social media and their digital devices – and companies are discovering the value of letting consumers create their own unique products. moving forward, the biggest consumer group will be Millennials, and the fact that customisation is a key word in Millennials' buying habits manifests this trend in the years to come.




**Consumer interest in personalised products and services by category**

## Areas to Consider

At the company level, it becomes increasingly important to explore business models that allows for customisation and consumer interaction. Crowdsourcing on social media has emerged as a popular method for tapping into consumers for ideas on new products.

Business models based on customisation, delivery of individual units, and shorter delivery lead time speak in favour of shorter and more flexible value chains, which in turn can lead to production moving closer to markets.

## Did you know?

The 'Configurator Database' website provides an overview of the world of web-based customisation tools. The database now links to more than 1,000 companies categorised in 16 different industries that sell customised products – From Bugatti cars and Nike sneakers to chocolates.

Sources: Deloitte University Press (2015), 'The Deloitte Consumer Review – Made-to-order: The rise of mass personalisation'; Bain & Company (2013), 'Making it personal: Rules for success in product customization'; Forbes (2013), 'Having It Their Way: The Big Opportunity In Personalized Products'; Vassil, K. (2015), 'Estonian e-Government Ecosystem: Foundation, Applications, Outcomes'.

# BUSINESS ACCELERATION

Business acceleration – driven by accelerating technological development – captures the increasing velocity in the marketplace, creating new services, business models, and products entering the market, and disrupting existing businesses. The amount of knowledge and number of patents created are accelerating, while the penetration rate of new products is increasing. For instance, it took 46 years for electricity to be adopted by 25% of the American population, while it only took 2 years for the smartphone to reach the same penetration level.

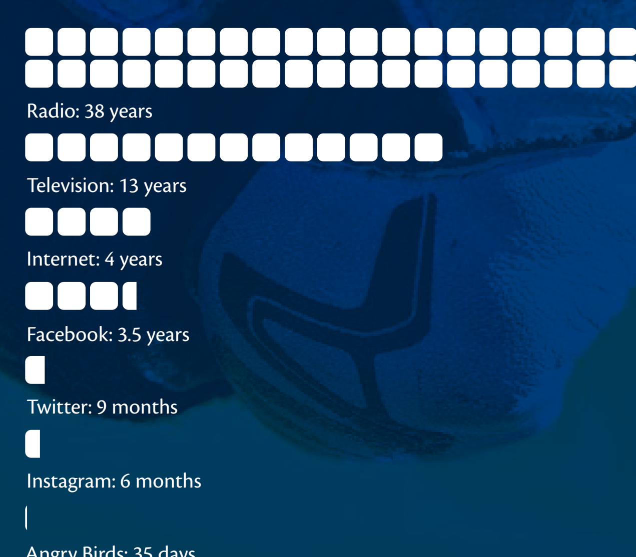
The days when one was able to analyse the market, decide on a strategy and execute the strategy once every 5 years are over. With the accelerated pace of change, companies that are not constantly adapting and proactively adjusting to new needs, technologies, and competitive environments, will be obsolete in a few years.

Acceleration as a trend will only increase in importance, creating new challenges for businesses such as an increasing rate of product replacement, faster employee turnover, changing consumer requirements, regulatory environment and the importance of maintaining trust and brand loyalty in a hyper-competitive global market. Corporations will increasingly be required to focus on developing organisational ambidexterity and agility and embrace the principles of new ways of working. According to Rupert Murdoch, it is no longer the big beating the small, but rather the fast beating the slow.

## Driving Forces

- Technological Development
- Technological Diffusion and Empowerment
- Knowledge Society
- Network Society

## Reaching 50 Million Users

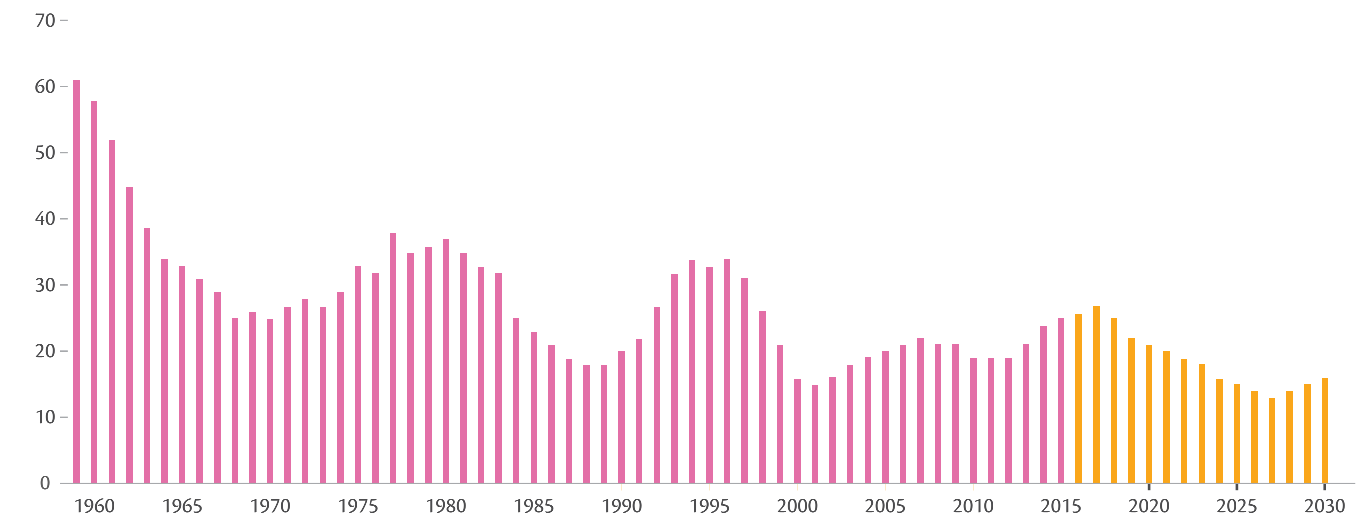





## Assessment

Impact will be high for the business environment, and countries fostering businesses that can manage to navigate in an accelerated society will have a big advantage. Acceleration is already here, and will strengthen in effect going forward.

## Data & Facts




**Average Company Lifespan on S&P 500 Index**

In 1965, the average tenure of companies on the S&P 500 was 33 years. By 1990, it was 20 years. It is forecast to shrink to 14 years by 2026. Many executives express that growth strategy is being determined by day-to-day decisions inside companies and that too many companies lack a coherent vision of the future. About half of the S&P 500 is expected to be replaced over the next 10 years.

## Areas to Consider

Classical approaches to conducting strategies in a predictable environment do not fit into the complex and accelerating future environment we are facing. This not only applies for companies, but also governments.

Focusing on resilience (see 21st Century Resilience) is paramount, and countries should focus on adjusting the bureaucracies and institutional decision processes to adjust for the rising need for fast decision making.

## Did you know?

In the era of business acceleration, experts point to the fact that businesses tend to not emphasise the upside of people enough. Too much focus on technology in reducing product development time can lead to less innovation. At this point in time, only people can develop ideas to improve products and processes. This realisation has dawned as it has become clear that business success generally depends much more on constant innovation than on cost efficiency.

Sources: Tech City News (2015), 'Number of new UK startups increased 4.6% in 2015'; Harvard Business Review (2015), 'Beyond Automation'; Strategy& (2016), '2016 Manufacturing Trends'; Deloitte University Press (2016), 'Patterns of Disruption – Anticipating disruptive strategies in a world of unicorns, black swans, and exponentials'; Innosight (2016), 'Corporate Longevity: Turbulence Ahead for Large Organizations'.

# 21ST CENTURY RESILIENCE

In order to survive and thrive in the new accelerating environment (ref. Business Acceleration), companies and governments need to develop new skill sets. Focus on resilience is becoming a prerequisite for survival, since we live in an increasingly accelerating, volatile, ubiquitous, complex and ambiguous environment. The growing uncertainty and pace of change makes it necessary to organise differently and shift focus from robustness to resilience, where organisations leap forward instead of only bouncing back due to disruptions.

Resilience in the 21st century is a holistic way of thinking that involves society, organisations and the individual. Resilience helps organisations and communities adapt before change occurs, and helps the individuals within the communities and organisations to thrive, and not only survive,. Resilience tools and the resilient mindset are means for reducing risks and creating opportunities and insights into how organizations and communities should organise themselves. Resilient organisations are based on a close cooperation between and coordination of horizon scanning and futures studies, innovation and risk management.

In the years to come, we will see successful organisations change their mindset from typical linear thinking (the analyse-plan-implement approach) towards holistic thinking characterised by resilience. Resilience as a mindset can help countries and organisations to adapt to change and uncertainties towards 2050 and prepare for threats and disruptions in an uncertain environment, while simultaneously making sure they seize and take advantage of opportunities.

## Driving Forces

- Acceleration & Complexity
- Globalization
- Network Society

## Resilience to cope with acceleration

The digital revolution is an important part of the new accelerating business environment, and it drives new, strong, and highly scalable companies. The newest batch of rapidly growing companies are the 'interface owners', such as Airbnb, Uber, Google, Alibaba, Amazon, Facebook and many more. It is noted:

"Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate. Something interesting is happening".

The companies that own the interfaces, own the communication, and are the intermediaries between peers, or between B2C or B2B. Such business models are changing the dynamics in their industries fundamentally and will continue to invade new industries, amplifying the need for resilience among incumbents.



## Assessment

The driving forces of this trend are gaining speed and intensity, and the world is changing faster than ever – and will likely continue to do so. The effect will increase along with the increasing pace of change and degree of complexity. Everyone will need a strategy to adapt before the changes occur and a strategy with the intention of turning the disruptions into opportunities.

## Data & Facts

### The Sustainable Development Goals 2015 - 2030

**Prominence of resilience**

**Goal 1: No poverty**
Build the resilience of the poor and those in vulnerable situation and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
**Goal 2: Zero Hunger**
Ensure sustainable food production systems and implement resilient agricultural practices.
**Goal 9: Industry, innovation and communities**
Buld resilient infrastructure
**Goal 11: Sustainable cities and communities**
Make cities and human settlements inclusive, safe, resilient, and sustainable
**Goal 13: Climate Action**
Strengthen action and adaptive capacity to climate-related hazards and natural disasters in all countries
**Goal 14: Life below water**
Strengthen the resilience of marine and coastal ecosystems

### Sendai Framework For Disaster Risk Reduction 2015 - 2030

**Prominence of resilience**

**Goal**
'Prevent new and reduce existing risk through the implementation of integrated and inclusive... measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience' through:
**Priority 1**
Understanding disaster risk
**Priority 2**
Strengthening disaster risk governance to manage disaster risk
**Priority 3**
Investing in disaster risk reduction for resilience
**Priority 4**
Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction

### Cop21: UN Climate Change Confernacne Beyond 2020

**Prominence of resilience**

**The framework calls for:**
International, regional and national financial institutions on the manner in which development assistance and climate finance programs incorporate climate-proofing and climate resilience measures
Scaling up effort to reduce emissions and/or to build resilience and decrease vulnerability to the adverse effects of climate change
Ensuring the adequate financing of climate-resilient development
The establishment of a global goal or enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change
Building the resilience of communities, livelihoods and ecosystems
Realizing technology development and transfer in order to improve resilince to climate change and to reduce greenhouse gas emissions

Resilience was a prominent theme across the three major future oriented frameworks agreed in 2015 – the Sendai Framework for Disaster Risk Reduction 2015 - 2030, the Sustainable Development Goals, and the COP21 Paris Agreement on climate change. Its inclusion demonstrates the importance of resilience to development finance, policy and practice, making it a priority for governments, policymakers and practitioners alike.

## Areas to Consider

Governments should be very sceptical about the tools applied for decision making, and ensure that they are not only based on assumptions of a predictability only possible in historical contexts.

Strategy development should follow a holistic view and a resilience mindset taking several possible futures into consideration, and include societal, organisational, and individual aspects in the strategy.

## Did you know?

The Rockefeller Foundation has asked cities around the world to be part of the 100 resilient cities program. The program intends to help cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century.

The program is working with resilience in the following way:

"Urban Resilience is 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".

Sources: CIFS (2016), 'Members' Report – How to be Resilient in the 21st Century'; Techcrunch (2015), 'The battle is all for the customer interface'; The Rockefeller Foundation (2016), 'Resilience – the big picture: Top themes and trends'.

# FREEDOM FROM OWNERSHIP

Freedom from Ownership describes the modern consumers' need for flexibility and transparent services – it is not important to own assets, as long as you have access to the services they provide.

Technology is creating new opportunities for delivering services without owning certain assets through peer-to-peer networks or through short-term rental models. Rent and subscription models are on the rise at the expense of purchases of e.g. cars, office space, housing and equipment, as well as in sharing and lending of goods between users. This collaborative consumption (sharing economy) is often organised through third-party platforms on the internet.

Ecological sustainability and more resource-efficient use of assets are some of the basic principles of the sharing economy. However, Freedom from Ownership is based on a need for wider selections, access to latest models and possibilities for greater flexibility through the option for frequent changes and opting easily out of services.

Freedom from Ownership will be an important driver for increased wealth and for greater resource utilisation in the years to come. Progress in technology and trust in this form of consumption can lead to even greater efficiency gains, enabling the future consumer to be much more flexible with wider access to assets that will fit into the exact needs of the moment – without ownership. However, it will also change how we think about employment and investments in assets, since you easily can subsidise your income by sharing your unutilised assets. Even though sharing consumption in many cases will decrease GDP, it can be argued to increase wealth in society (see Changing Indicators of Growth).

## Driving Forces

Individualisation

Technological Development

Network Society

## Flee Floating

The automobile sector is likely the one where the shift from ownership to access will have the greatest effect in the longer term. On average, a car is unused for 23 hours per day (in Germany), and one shared car can replace eight owned cars. In the 'car nation' Germany, the number of

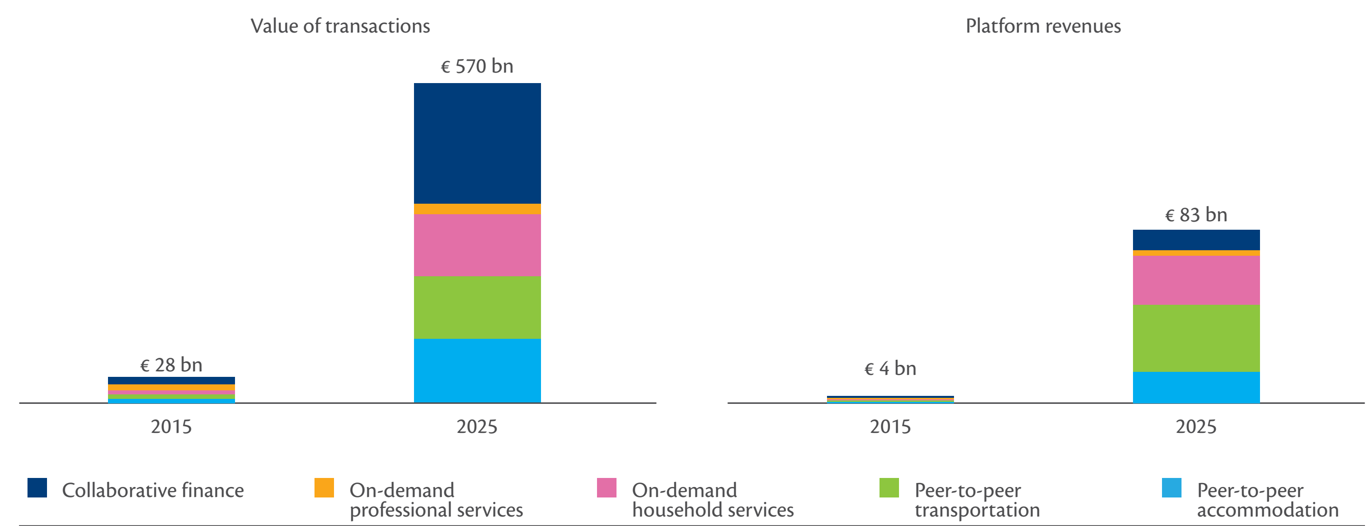
Car-sharing users has increased from 137,000 in 2009 to 1,260,000 in 2016, with 16,100 shared cars in more than 540 cities.



## Assessment

The impact will most likely increase over time and disperse into all areas. Freedom from Ownership will significantly influence the way people and companies organise around ownership today, from consumption of goods to utilization of workforce.

## Data & Facts




**Projected Revenues and total transaction value facilitated by sharing economy platforms in Europe by sector, 2015 - 2025**

Over the coming decade, it is projected that the sharing economy in Europe will grow at around 35% per year – which is around ten times faster than the wider economy as a whole. By 2025, it is estimated that many areas of the sharing economy will rival the size of their traditional counterparts, with platforms in five of the most prominent 'sharing' industries, generating Europe-wide revenues worth over €80bn and facilitating nearly €570bn of transactions. The trajectory towards 2050 will most likely continue, driven by new technological solutions that will enable more frictionless sharing arrangements as well as flexible service offerings.

## Areas to Consider

It will be important to enable the sharing economy as a key driver of government policy, as the sharing economy raises a series of important public policy questions. Governments must focus not only on ensuring an efficient infrastructure and enabling business environment, but also reform tax systems, regulatory frameworks, and employment laws.

The challenge is to address these issues while allowing for a flourishing sharing economy, to the benefit of consumers and society as a whole.

## Did you know?

Arguably, the main criticism of the sharing economy is that many complex tax issues are raised, in large part because of the new collaborative consumption business models enabled by new technology that have not been contemplated by existing tax laws.

Sources: CIFS (2013), 'Members' Report –Freedom of Ownership'; PWC (2016), 'Assessing the size and presence of the collaborative economy in Europe'.

# THE EMPLOYEE EXPERIENCE

The war for talent has never been so fierce. The power has now shifted into the hands of employees. Organisations are changing from places where people need to work, into places where people want to work. The employee experience is what happens when an employee interacts with the organisation. It starts with the experience of people first finding and applying for a job, ending with how they leave and includes everything in between.

The increased focus on the employee experience will cause organisations to shift perspective, from streamlining all processes towards efficiency, to putting more emphasis on how processes will improve the employee experience. This ranges far wider than simply offering fresh fruit and a foosball table, and will cause organisations to offer more flexible solutions for working hours, remote working, working routines, etc. that fit into various life situations and needs. Just as importantly, they must not only adjust the mission statement of the organisation, but the actual mission of the organisation, to parallel the search for purpose inherent in all peoples lives.

It is expected that the war for talent will intensify, making organisations stretch even further to embrace the employee experience. However, we will see a concurrent polarisation of the work force, making the employee experience a concept only available for the best educated and skilled employees. The importance of talent attraction will play an even greater role for governments, acknowledging that access to the global talent pool is a prerequisite for economic prosperity.

## Driving Forces

- Immaterialisation
- Technological Diffusion and Empowerment
- Technological Development

## Employee Benefits

Many of the top ranked companies offer a wide range of alternative financial perks and benefits. For example, Google provides free all-day meals to staffers, Facebook lends employees free bicycles to get around, Salesforce employees receive six days of paid volunteer time off a year. Airbnb, the Best Place to Work in 2016, gives its employees an annual stipend of USD 2,000 to travel and stay in an Airbnb listing anywhere in the world and Netflix offers one paid year of maternity and paternity leave to new parents.



## Assessment

The ability to develop, attract and maintain a talented labour pool will determine the winning organisations and societies. The importance of talent will continue to increase towards 2050 with high certainty, but its distribution and mobility is more uncertain.

The impact will be unevenly distributed among the citizenry, dependent on qualifications – the employee experience will exclusively be for the most educated and talented.

## Data & Facts

| | | We are Here | | |
|---|---|---|---|---|
| The Industrial Corporation | Hierarchical Leadership | Collaborative Management | Network of Teams | |
| Operational Efficiency | Profit, Growth, Financial Engineering | Customer Service, Employees as Leaders | Mission, Purpose Sustainability | **Purpose, Meaning, and Empowerment?** |
| Industrial Age People as workers | Managment by Objective | Servant Leadership Work Together | Empower the Team | |
| Andrew Carnegie Henry Ford | Jack Welch Peter Drucker | Howard Schuls Steve Jobs | Netflix, Google, Facebook, Amazon | |
| The Corporation is King | The Executives are King | The People are King(s) | The Teams and Team Leaders are Kings | |
| <1950s | 1960s - 80s | 1990s | Today | 2020 |

**Historical perspective on performance and management: The Evolution of Management Thinking**

Today, as the chart above illustrates, we no longer think of executives as “kings,” but rather as facilitators, strategists, and team leaders who can inspire and empower teams to succeed. This new concept, which has become fundamental to management books and practices over the last few years, is coming from a realization that the old fashioned, hierarchical leadership models just don’t work today. Together with the increasing war for talent (ref. War for Talent 2.0), the evolution of management thinking is forcing companies towards a more employee focused mindset.

## Areas to Consider

Governments play an important role in talent attraction and retention – not only for governmental jobs, but also for companies. It will increase in importance to provide a framework that makes it as easy as possible for companies to attract, integrate and retain international and national talent – thinking through all aspects from the actual working experience to conditions for the family, etc. Combining knowledge of demographic and lifestyle shifts are essential.

Policymakers also need to be aware of the potential ‘creative destruction’ and job losses that a surge in self-employment can lead to.

## Did you know?

The Employee Experience Index developed by IBM finds that employee experience is strongly linked to performance, effort and retention. Key organisational practices that drive more positive employee experience include: Organisational trust, co-worker relationship, meaningful work, recognition, feedback and growth, empowerment and voice, and work-life balance.

Sources: IBM Analytics (2016), ‘The Employee Experience Index – A new global measure of a human workplace and its impact’; Glassdoor (2016), ‘Top 20 Employee Benefits & Perks’; Deloitte University Press (2016), ‘Global Human Capital Trends 2016 – The new organization: Different by design’; Bersin, J. (2016), ‘The New Organization: Different by Design’.

# SUSTAINABILITY DRIVES NEW BUSINESS MODELS

Sustainability is increasingly setting its mark on the business community, as new business models that serve to prevent, reduce or clean up 'anthropogenic' burdens on the environment are demanded. The notion of the 'Anthropocene' recognizes that we are now living in a geological period, where human activities have started to have a significant global impact on Earth's geology and ecosystems. Increased pressure from an environmentally aware consumer base, external pressure from regulators, and corporate risk associated with, for example, climate change have let to an increasing number of businesses pursuing environmentally sustainable business models. The trend is especially prevalent in Northern Europe and the rest of the Western world.

Companies are adopting life-cycle models, such as cradle-to-cradle which aims to design waste free products that can be integrated in fully recyclable loops, or industrial symbiosis models, through the shared utilization of resources and by-products on a commercial basis among companies. Another approach is business models that use incentive schemes or changed ownership models to reduce environmental footprints. For companies, adopting sustainable business models does not only add value in terms of corporate social responsibility, but also in terms of cost savings through the innovation of more efficient production methods. Truly sustainable development is becoming a mainstream priority for a growing number of markets and climate change and environmental sustainability will remain high on the global agenda.

## Driving Forces:

- More efficient use of Natural Resources and Environment
- Immaterialisation
- Technological Development

## Kalundborg Symbiosis

The Kalundborg Symbiosis is an industrial ecosystem, where the 'waste' product or excess resources from one organization are utilized by another organization on a commercial basis. Organisations exchange resources to optimize economic as well as environmental efficiency. For instance, organic waste from the biotech company Novozymes is made into agricultural fertilizer within the municipality and smoke from DONG Energy is made into gypsum at Gyproc.

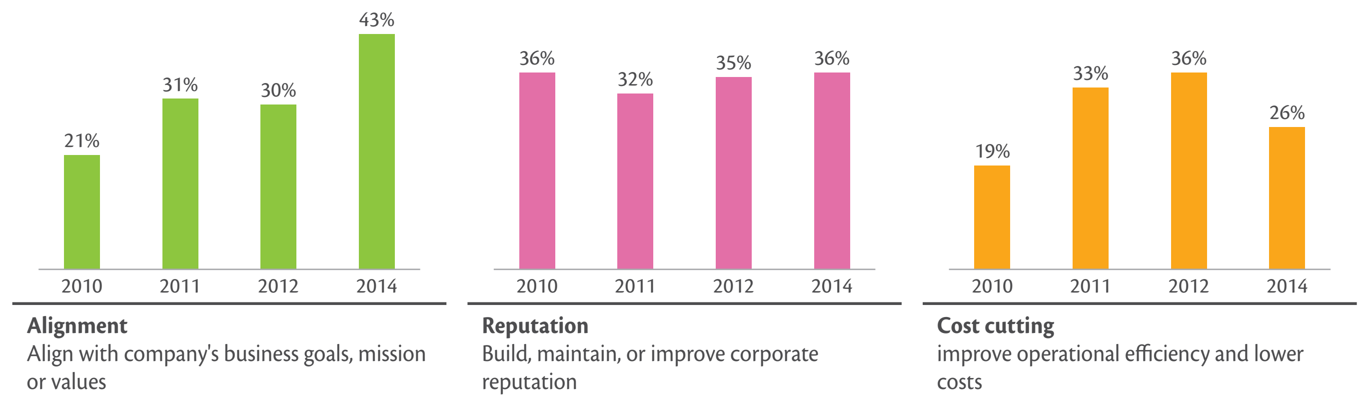


## Assessment

Environmentally sustainable business models have gained ground in many developed countries and consumer preferences have changed. Awareness is rising in other parts of the world as well along with increased wealth, higher education and general public focus on environment.

## Data & Facts

Top 3 reasons that organisations address sustainability




The figure shows that sustainability is increasingly becoming a more strategic and integral part of companies' core business, suggesting that green business model innovation continues to gain ground. Sustainability as a strong value trend will continue to drive businesses towards adapting 'greener' business models going forward, with focus on climate change, resource scarcity and eco-security.

## Areas to Consider

The establishment of national regulatory and policy frameworks that enable business and industry to advance development priorities was supported in the outcome to COP20 in Rio. In post-2015 consultations, engaged businesses stressed that governments would be best off encouraging corporate sustainability on a systemic basis, rather than being limited to specific public-private partnerships or campaigns. Businesses further expressed the view that government should draw more on important corporate resources such as expertise, technology, capacity for innovation and resource management.

## Did you know?

On the annual list of the world's 50 most sustainable companies – released by Corporate Knights and World Economic Forum – BMW takes the top spot in 2016. The company earned particularly high marks for efficient use of water, energy and lack of waste.

Remarkably, 87% of the companies on the list provided a 'monetary bonus' to executives that met sustainability goals.

Sources: Bisgaard, T. et al. (2012), 'Green Business Model Innovation – Conceptualisation, Next Practice and Policy'; OECD (2012), 'The Future of Eco-Innovation: The Role of Business Models in Green Transformation'; McKinsey&Company (2014), 'Sustainability's strategic worth: McKinsey Global Survey results'; World Business Council for Sustainable Development (2016), 'Unlocking More value with Fewer Resources'; www.symbiosis.dk.

# PROXIMITY

Proximity is defined by the distance between the consumer and the supplier. The importance of proximity is being driven by increasing customer demand for receiving everything in real-time, on the spot, and without any access restrictions or frictions. Companies are accommodating this by applying the newest advancements in technology within e.g. IoT and beacon technology, as well as being present on the newest social media platforms.

Especially in retail, sensors enhance in-store interactions or offer new features for a growing number of smart services, reacting with customers based on the combination of their physical presence and individual preferences. The future customer will expect to get customized situational and digitized advice whenever they have the need – standing in line or looking for personal service in a shop will not be associated with an acceptable shopping experience.

Although digitization has already streamlined a lot of our daily processes, many are still cumbersome and any friction in the daily experience is a potential service for future companies. Today the proximity trend is primarily affecting retail and communication. However, in the coming decade it will likely merge together with the infrastructure of smart cities (see Smart Cities), and offer new services to citizens. In the field of mobility, the proximity trend is already changing infrastructures and services, as the success of car sharing shows. Towards 2050, it is expected that there will be greater demand for proximity and a continued pressure for quicker delivery and access, but uncertainties arise in the security area. Only when, or if, secure solutions are developed that can ensure that data can be shared when needed, wanted, and at the same time secured against exploitation, will the trend will gain traction in the broad public.

## Driving Forces

Technological Diffusion and Empowerment

Technological Development

## San Diego Airport

In 2016, 35 % of the top airports in U.S. have implemented beacons, internationally speaking this number is expected to hit the 84 % mark by the end of 2019. Proximity marketing enables a better traveller experience and serves the entire ecosystem of the San Diego Airport, travellers, airlines, concessioners, and the airport itself. Travellers can use the flight information feature on the AwaytoGo app to receive timely and relevant messages about their schedule and luggage. The staff can use it in order to quickly solve IT-related issues. Therefore the IT personnel uses a wearable so whenever there is an issues, the nearest person in duty gets notified.

The next step will see the expansion of services and assist the user starting from their home, to the curb at the airport, throughout the departure airport and finally at the arrival airport.

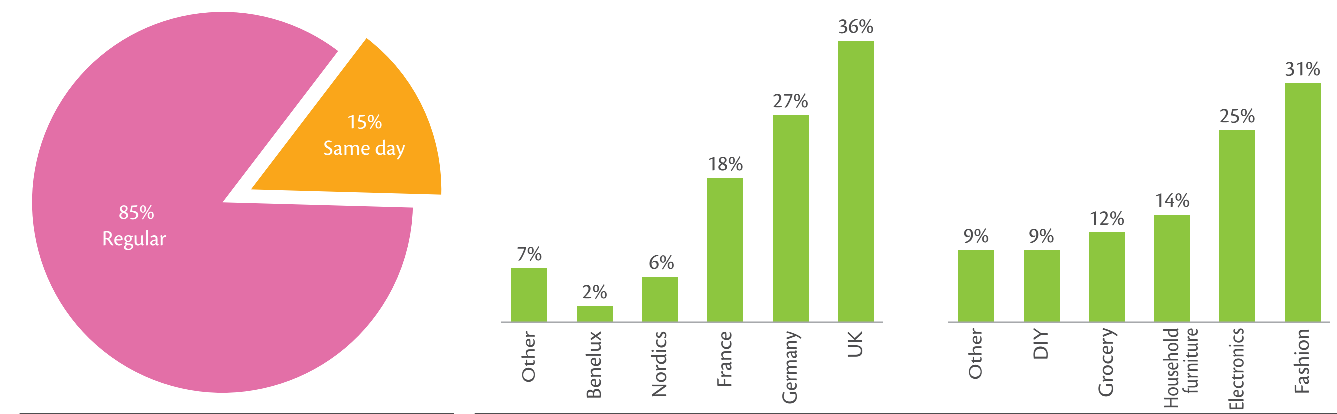


## Assessment

The proximity trend will drive changes in the consumer landscape and remove more and more unnecessary frictions and delays in our consumption of experiences and services. This is already happening today, and will continue towards 2050. The pace and range of changes will depend not only on the technological possibilities but also the degree of compatible solutions and security solutions.

## Data & Facts

By 2020, the same day delivery market is expected to be around €3 billion in Western Europe.




100% = (€ 20 billion) Breakdown by country and category 100% = (€ 3.1 billion)

Anywhere, anytime – online purchases have increased especially due to new supportive mobile devices. However, mobile 1-click buys are not enough to satisfy consumers demand for proximity. Instead, they want the whole process to be "now", from buying to getting it. This is why we see an enormous increase of same delivery services, which is also driven by new logistics technologies such as drones and robotic, or growth of Ebooks and streaming.

## Areas to Consider

Citizen expectations and requirements for proximity in the service delivery will evolve and reflect their expectations towards government.

Government can enable solutions related to the proximity trend through regulation and infrastructure – e.g. engaging with companies in structuring regulations with regards to air space, in order to accommodate for drone delivery and making high speed internet connection available everywhere.

## Did you know?

Eddystone is a Bluetooth Low Energy beacon profile released by Google in July 2015. The platform includes the Proximity Beacon API, designed to associate content with individual beacons. The Google beacon platform enables you to manage your beacons remotely, integrate with Google services and help users› devices to discover content and functionality across Android, native apps, and the web.

Sources: Financial Times (2013), 'Incubators: Start-ups enjoy benefit of proximity'; McKinsey&Company (2014), 'Same-day delivery: The next evolutionary step in parcel logistics'; Tech Hive (2015), 'Amazon Dash Button lets you insta-buy household goods'; Unacast (2016), 'The Proxbook Report: The State Of The Proximity Industry, Q3 2016'; Google (2016), 'Mark up the world using beacons'.




# INTRODUCTION

Infrastructure has long been what has connected us as citizens. With urbanisation moving around 2 billion more people to cities in the coming 30 years, infrastructure must be rethought, redesigned, and redefined to accommodate for the needs of tomorrow.

While infrastructure served as a bridge to increased economic activity in the past, it is now an enabler of a higher quality of living. The urban environment is also now a key influencer of climate change, and will be a more important determinant in the future.

The following chapter describes 7 trends shaping the future of the infrastructure sector towards 2050. The 7 trends presented can be categorised into the following three areas:

2

## Transport and Mobility

- Autonomous Vehicles
- Transport beneficial to society

2

## Cities and Waste

- Smart Cities
- Circular Economy

3

## Infrastructure and economy

- New Trade Routes
- ASEAN infrastructure growth story
- Breaking the supply chain

# AUTONOMOUS VEHICLES

An autonomous vehicle is one that is capable of sensing its environment and navigating without human input. The transition from traditional cars is happening through several intermediate developments that reduce the role of the driver, for example, the blind-spot assist, automatic parking, and active lane-keeping assist. Some places even have fully autonomous buses driving fixed routes in normal traffic.

One of the biggest challenges ahead is dealing with the mix between autonomous cars and regular cars due to the unpredictable behaviour caused by human drivers. Until the shift towards a fully autonomous fleet has happened, significantly reduced congestion caused by a much smoother and coordinated traffic will not be realised. Potential economic benefits extend to greater labour mobility, increased road capacity, more optimal use of real estate, and improved safety due to fewer accidents, thus increasing productivity and savings in health care. An urban-rural divide will likely occur, with city traffic being automated much earlier, due to easier access to sharing schemes, more extensive mapping of the roads, and cities pushing the development forward to accommodate for the congestion challenges. However, the simpler highways are easily accessible for autonomous trucks, and a system of automated trucks driving between traffic centrals, where drivers will take over and drive the last miles through cities, will likely emerge along with the development in the city.

The first versions of autonomous cars will be expensive, as will retrofitting the autonomous function to old cars, hence the adoption of autonomous cars will likely occur along with the natural replacement of older cars with new models. The benefits of autonomous cars is already causing regulators to push for rapid implementation. In large cities around the world, autonomous cars will likely become commonly available through taxi float services well before 2040.

## Driving Forces

- Technological Development
- Acceleration & Complexity
- Economic Growth

## Autonomous Cars and the City

Autonomous cars have significant implications for the urban space, and how people navigate through urban life. Self-driving capabilities will most likely result in a transition into a fleet of autonomous taxis since this will enable a much more efficient use of the vehicle. The transition to a self-driving fleet will significantly decrease the need for parking spaces, freeing up the space currently used for parking along roads as well as most car parks. Increased road capacity will further happen through platooning, narrower lanes, and reduced intersection stops.

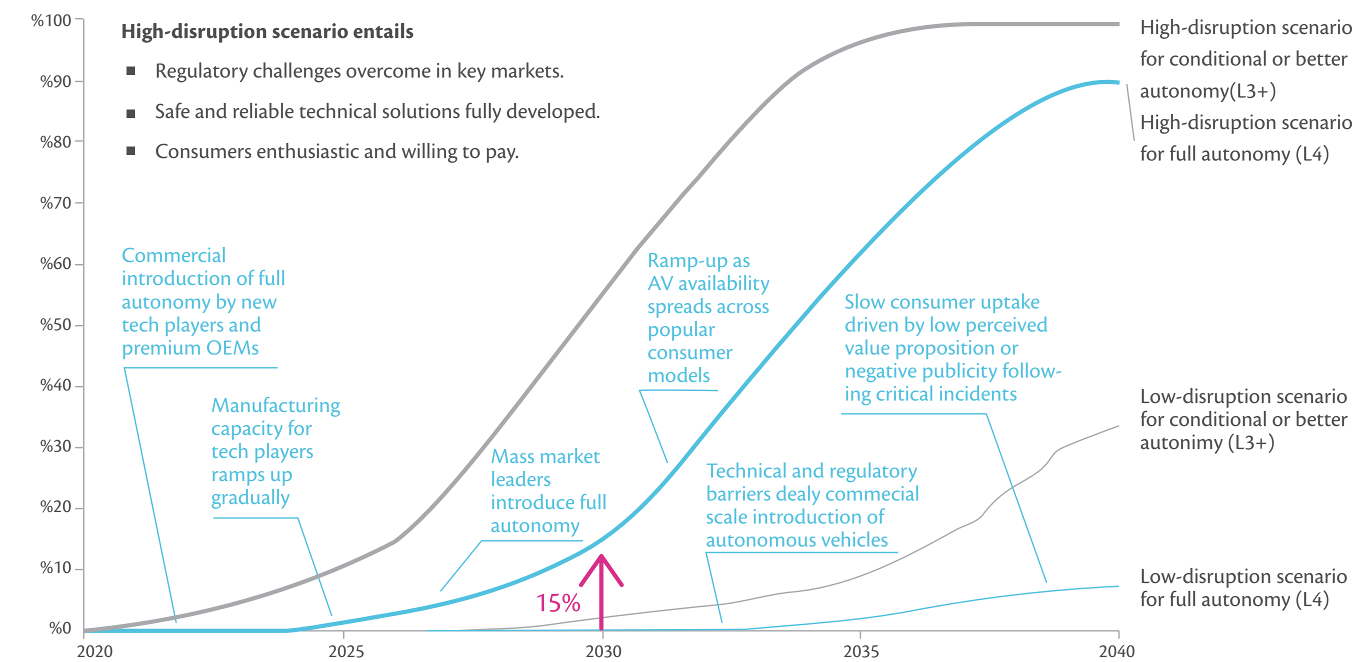
For the first time in history this will create more space in cities that could be used for recreational areas, more road space, pedestrians, or maybe for new emerging needs such as green spaces.



## Assessment

Depending on uptake, the impact could be huge by redefining work-leisure time, commuting, car ownership and sustainability. The technology is already becoming available, but needs to be refined to function commercially in practice. Transportation is a big part of the society, and the behaviour of citizens will likely reorganize around the new transport possibilities.

## Data & Facts




**New vehicle market share of fully autonomous vehicles**

Fully autonomous vehicles are unlikely to be commercially available before 2020. Factors such as regulation and consumer acceptance represent hurdles for the diffusion of autonomous vehicles. McKinsey (2016) presents a progressive scenario in which up to 15% of all new vehicles sold in 2030 could be fully autonomous, further accelerating towards 2040. In the low-disruption scenario with slow consumer uptake, only around 10% of new vehicles sold would be fully autonomous.

## Areas to Consider

Critical negatives, such as a higher risk of system failure or 'cyberterrorism', and job losses in the transport industry, needs to be taken into consideration.

Policymakers need to be aware of the implications that autonomous vehicles brings before making long-range decisions relating to e.g. transportation and infrastructure. In addition, regulatory frameworks and guidelines related to autonomous vehicles need to be contemporary.

## Did you know?

A select group of Uber users in Pittsburgh have the option to request an autonomous car. Since the autonomous cars are still being tested, the cars will come with two full-time Uber employees. One employee will loosely grasp the car›s steering wheel, ready to take over if something goes awry, while the other will monitor the computer›s software.

Sources: Litman, T. (2016), 'Autonomous Vehicle Implementation Predictions: Implications for Transport Planning'; McKinsey&Company (2016), 'Automotive Revolution – perspectives towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry'; McKinsey (2015), 'Full steam ahead: how the driverless car could transform cities'; Uber (2016), 'Fast-Forwarding to a Future of On-Demand Urban Air Transportation'.

# TRANSPORT BENEFICIAL TO SOCIETY

The transportation industry and its underlying infrastructure have historically been one of the most critical determinants of urban design, economic stimulation and, more recently health. Roads alone are an investment by countries to enable significant economic development through increased accessibility and mobility.

Infrastructural development for transportation has, however, brought with it pollution and urban sprawl, and tends to require massive utilization of high-value land.

Moving forward, with high levels of urbanization around the world, the evolution of transportation transforms from an access challenge into a design challenge. Planners are having to design sustainable and lower carbon solutions which enable an improved quality of urban living for all. This implies harnessing technology effectively, finding ecologically friendly transportation solutions and focusing on appropriate mobility options for the urban poor.

Transportation infrastructure of the future needs to incorporate these elements in an integrated manner, with a recognition that government is only one player; a new paradigm for transport, especially in developing countries with fast-growing cities, must be reliant on partnerships and novel business models.

## Driving Forces

- Technological Development
- Immaterialisation
- More efficient use of Natural Resources and Environment

## Designed for sustainability

Hammarby Lake City, a municipality in Stockholm, is a unique urban development. All aspects of transportation design have incorporated sustainability as their core feature. Also included are wide-spread public transit solutions available to all (such as trams, cycles and ferries). Moreover, water, waste and energy are designed as a closed loop with one feeding into the other. The development's publicly stated goal is that 80% of all residents' travel should be made by public transport, cycling or on foot. Finally, the city-wide car pool has 900+ members, who use 46 cars.



## Assessment

The ubiquity of convenient, affordable, sustainable transportation could be a major determinant of quality of life in the future. However, there exist opposing forces at play such as mass urbanization (specifically in developing countries) and an expanding global middle class. Redrawing this balance will be a major challenge for future transportation infrastructure developments.

## Areas to Consider

Technology redefining the need to 'be' anywhere physically: how often will we need to travel to work, the doctor or a government department in the future?

Owning a vehicle: Across generations, there are differing views in society towards owning a vehicle. While some view it as a status symbol, others perceive it as an unnecessary anchor. Demographics play a large role here; the trend is for younger urban populations in developed nations to not own a vehicle.

## Did you know?

There were 64 million kilometers of road globally in 2013.

Sources: Future Agenda: The World in 2025.

# SMART CITIES

A Smart City is an urban ecosystem that uses digital technology to drive efficiencies in existing social, economic and environmental processes, while simultaneously opening avenues for new, data-driven processes and innovations. Cities around the globe are struggling to design an infrastructure to cater to a plethora of challenges and issues – including water and energy management, urban mobility, waste (see Circular Economy), street lighting and citizen safety.

A central aspect of smart cities is the use of sensors in roads, buildings, sewers, and more, allowing for real-time analysis of bottlenecks in a given 'system' and subsequent reactionary or preventive measures to relieve the problem. The infrastructure of a smart city extends to autonomous vehicles and logistics, drone delivery, and even down to the consumer level. The integration of augmented reality is growing, causing large changes to how we interact with the city around us and far surpassing the benefits of current GPS or suggestion technology.

More than half of the global population lives in urban areas today, and this trend is expected to continue – by 2045, the number of people living in cities is expected to increase by 1.5 times to 6 billion, adding 2 billion more urban residents. The infrastructures of the largest cities will be put under serious pressure, and the development of smart cities to compensate for this would most likely reach the top of the agenda for all megacities exceeding 10 million citizens.

## Driving Forces

- Acceleration & Complexity
- Technological Development
- Economic Growth
- More efficient use of Natural Resources and Environment

## Smart City Barcelona

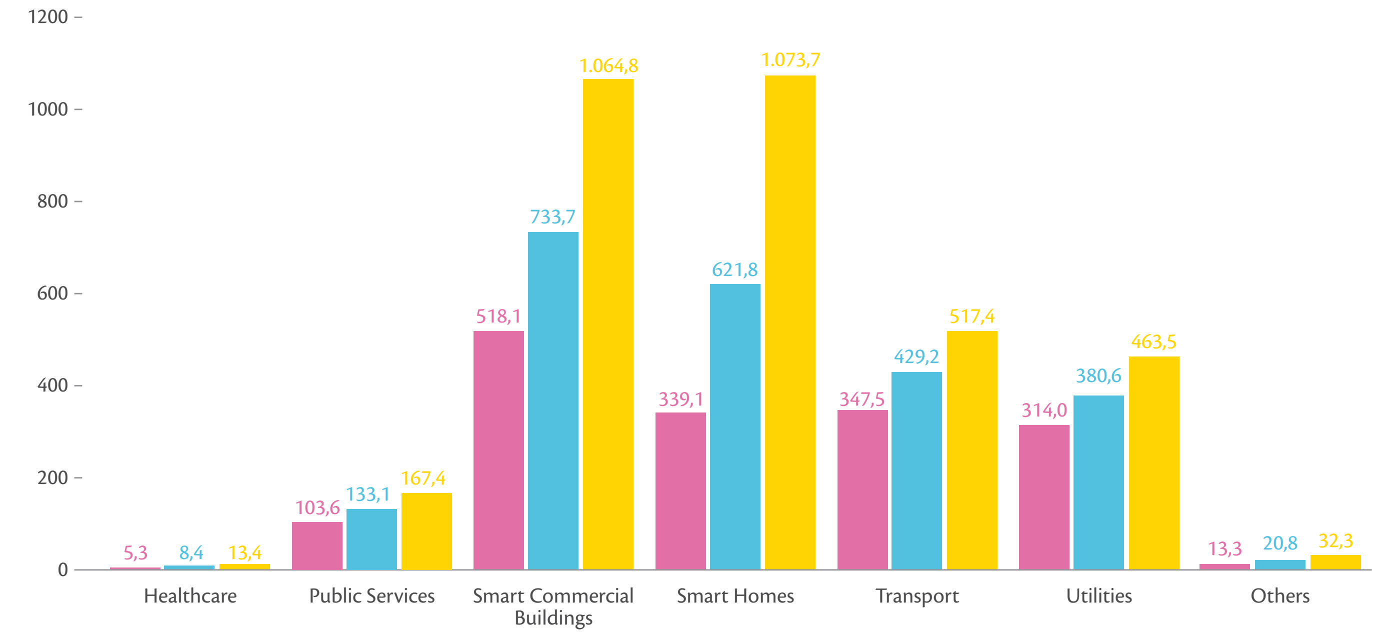
Barcelona is one of the cities rated as world class for their Smart City initiatives. The Smart City Strategy is currently formed by about 122 projects classified into 22 programs that cover all areas of the city management, from lighting, water and waste management to innovation and many others. Within Barcelona's Smart City Strategy, it is worth highlighting the importance of horizontal and open technological solutions and platforms applied in a transversal way to all city services. This helps achieve the goal of breaking away from closed silos of information, considered a main obstacle in IoT development.



## Assessment

Smart Cities will be the key to successfully meet the challenge of growing cities and achieve growth that is both sustainable and inclusive. Smart Cities are already occurring, but most initiatives are in their early phases.

## Data & Facts




**Connected Things Installed in Smart Cities (Millions)** ■ 2016 ■ 2017 ■ 2018

A Smart City is in a sense a geographic subset of the Internet of Things (see Internet of Things). Forecasts from Gartner suggest that in 2018 some 3.3 billion connected things will be in use in Smart Cities, which will rise further beyond 2020. Although all predictions are of growth, the rate of change going beyond a few years ahead is very uncertain. This is primarily due to risks stemming from yet unsolved security challenges, privacy issues and a shortage of people with the skills necessary to set up these systems. The dilemma of the Smart city is that its potential comes from integrating information from and controlling large networks of devices, but the larger such networks become, the more vulnerable they become to cyber attacks.

Despite these challenges, both public and private actors are investing heavily in Smart Cities. In the European Union, the Smart Cities and Communities European Innovation Partnership has been backed by €365 million of European Commission funding, while several nations/cities are investing heavily in Smart City initiatives.

## Areas to Consider

Challenges are centred around the questions of for whom and what purposes we are making cities smart? Authorities will have to:

- Develop policies and ethics for collecting, storing, managing, and analysing data to ensure security and protect privacy.
- Develop new methods for analysing data flows.
- Understand implications and how changes will impact our notions of ownership - the way we think about and use our assets will be different.

Much of the development will be via trial and error as we still don't truly understand the security, types of exposures and risks that the technologies expose us to.

## Did you know?

The Indian government's vision of creating 100 smart cities will require an investment of over USD 150 billion over the next few years. In the coming years, service providers and over-the-top content providers will invest heavily in citywide Wi-Fi networks, which will be the backbone for smart-city services.

Sources: Cisco (2010), 'Smart+Connected Communities: Changing a City, a Country, the World'; Gartner (2015), 'Gartner Says Smart Cities Will Use 1.6 Billion Connected Things in 2016'; C40 Cities (2014), 'Barcelona's Smart City Strategy'; IEEE Spectrum (2016), 'Wanted: Smart Public Policy for the Internet of Things Security'; Forrester (2016), 'Predictions 2017: Security And Skills Will Temper Growth Of IoT'.

# CIRCULAR ECONOMY

A circular economy is an industrial system in which the use of goods and materials is optimized and their elements returned to the system at the end of their viable life cycles. The global waste generation is expected to increase by nearly 50 % over the coming decade. Increasing urbanisation where 75 % of the global population is expected to reside in cities by 2050, together with an increasing disposal culture, resource scarcity, public health, and focus on environmental protection are driving a demand for a circular economy.

Waste is increasingly being understood as a resource instead of something which should be buried or burned, and in the future we will see an increase of circular economy approaches. Sweden recently announced tax breaks on repairs to clothes, bicycles, fridges and washing machines in order to combat its 'throwaway consumer culture'. Companies are also increasingly adopting business models that embrace circular economy. The concept of the circular economy is rapidly capturing attention as a way of decoupling growth from resource constraints. This is expected to gain traction towards 2050.

In a future environment in which everything is connected (see Internet of Things), smart waste management will have huge potential to streamline the waste collection process. Technological advances in e.g. nanotechnology, with potential to sort waste by size, shape, colour, physical, and chemical properties, will likely drive the circular economy.

## Driving Forces

- Technological Development
- Economic Growth
- More efficient use of Natural Resources and Environment

## Nanorobots Cleaning Oceans

By 2050, it is estimated that there will be more plastic than fish in the world's oceans in terms of weight.

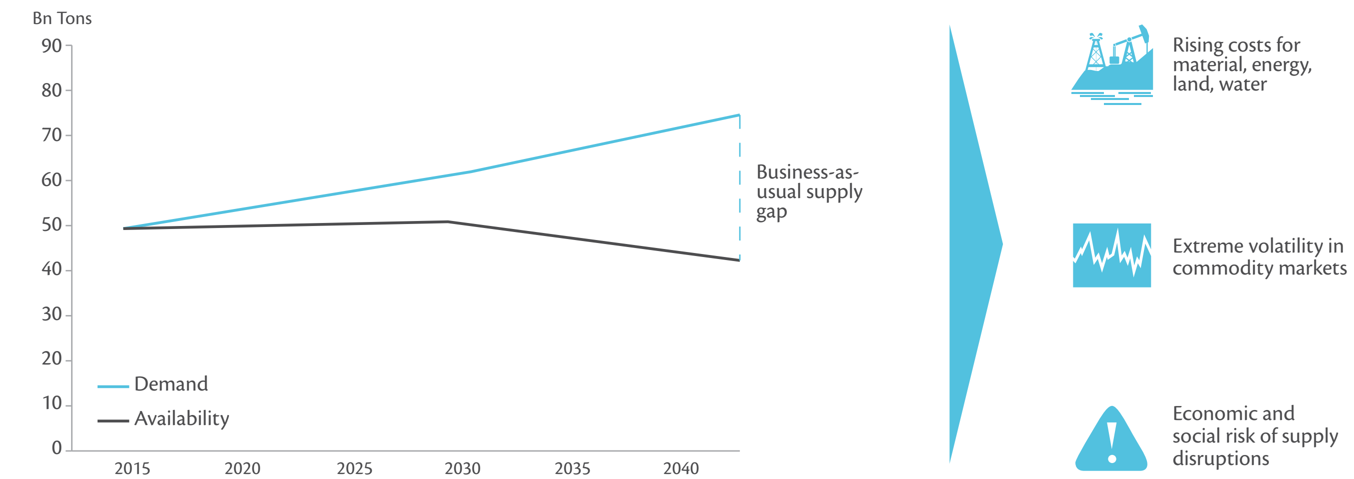
Last year, together with the Max Planck Institute for Intelligent Systems, an international team of researchers recently developed the first proof-of-concept of self-powered nanomachines that can capture heavy metals from contaminated solutions. By removing up to 95 % of lead in wastewater in just 1 hour, these swarms of graphene-coated nanorobots could become our hope for cleaning up the oceans.



## Assessment

Circular economy is already a focus area, but will increasingly affect realms like the built environment, the awareness of risks related to waste, production processes of goods as well as consumer's behavior in the mid- to long-term.

## Data & Facts




**Resource supply / demand imbalance 2015- 2040**

Given the projected growth in production, in a business-as-usual scenario, the widening gap between resource availability and demand will drive the demand for circular economy and integrated waste management in the coming years.

Issues are economic as well as environmental. According to a 2017 report by the Ellen MacArthur Foundation, each year, plastic packaging material value of USD 80 - 120 billion is lost. Concerted efforts on design, after-use systems and recycling would save society for environmental damage and bring huge economic savings.

## Areas to Consider

To move the economy in the direction of a circular economy requires strong governmental actions to decouple economic growth from environmental degradation and waste generation. Examples are support systems for renewable energy, energy efficiency standards, and targets for recycling of materials.

Efficient waste management can open up for the possibility to export expertise in waste management as well as exploiting the waste and turning it into resources.

## Did you know?

In addition to the implicit environmental benefits that a circular economy would bring, there is a compelling business case. Savings in materials alone could exceed USD 1 trillion a year by 2025 and a circular economy could become a tangible driver of global industrial innovation, job creation, and growth for the 21st century.

Sources: UNEP (2016), 'UNEP 2015 Annual Report'; UNEP (2015), 'Global Waste Management Outlook'; McKinsey&Company (2014), 'Remaking the Industrial Economy'; Ellen MacArthur Foundation (2017), 'The New Plastics Economy'; Accenture (2014), 'Circular Advantage: Innovative Business Models and technologies to Create Value without Limits to Growth'; World Economic Forum (2016), 'Sweden is paying people to fix their belongings instead of throwing them away'.

# NEW TRADE ROUTES

New trade routes are being established that many trading nations hope to rival, or at least complement conventional routes, which could drive reductions in transport costs and shorten time to market.

The melting of the Arctic Sea potentially opens up for new, shorter shipping trade routes. Opening the northern route reduces the distance to North European countries from Japan by 37 %, South Korea by 31 %, China by 23 % and Taiwan by 17 % One crucial concern however remains – that not only should the artic be penetrable by ships, but the risk of hitting the odd iceberg should also be successfully managed. China is currently constructing a new 'Silk Road' trade route that will run from China to Europe, China's largest trading partner. The high-speed railway ensures speedy delivery and positions itself between air, which is too expensive, and shipping by sea, which is too slow.

In 2050, the opening of these trade routes could have changed the face of global trade. There are strong commercial and geopolitical forces at play, as new trade routes will drive down transportation costs, open new markets and potentially reshape world trade. Some nations will lose from this trend, as their relevance in relation to world trade will diminish. For example, two-thirds of the shipped volume that goes through the Suez Canal could switch to the shorter Arctic route, which would reduce Egypt's geostrategic influence.

## Driving Forces:

- Globalization
- Acceleration & Complexity

## Expansion of the Panama Canal

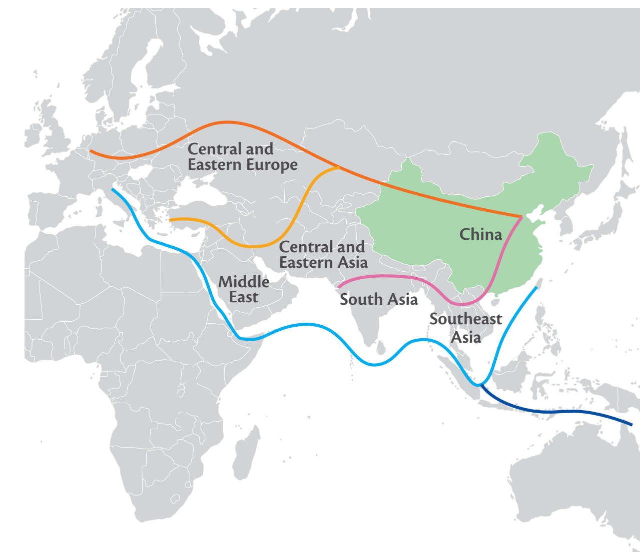
After a decade of construction, the expansion of the Panama Canal opened in the summer of 2016. The expansion allows much larger ships to transit the canal (from ships that can carry 5,000 containers to ships that can carry 14,000 containers) and is set to potentially double its current volume. It was assessed that Panama needed to expand the channel to stay competitive.



## Assessment

There is uncertainty surrounding the extent to which trade will move to these new trade routes and whether 'The Chinese Silk Road' will link to Europe. If it does, the impact on world trade will be great. Both trade routes could be fully operational before 2030.

## Data & Facts





The maps above show the planned new trade routes – the land-based high-speed railway 'Silk Road' from China to Europe, the maritime 'Silk Road', and the potential arctic shipping routes.

There are a wide array of structural developments impacting world trade and world trade patterns towards 2050 (see Breakdown of Washington Consensus and Changing Architecture of International Trade). Thus, it is difficult to asses the isolated implications from new emerging trade routes on trade volume, etc. While shorter and faster trade routes hold the promise of decreasing transportation costs and time-to-market, the global slowdown in trade and the shift in global trade patterns towards more south-south trade makes the Arctic Shipping route less economically significant.

## Areas to Consider

The strategic implications of trade routes dominated by the Chinese and Russia should be examined in term of their impact on trade of food, energy, its impact on the US dollar, and the impact on ASEAN countries and on world trade.

Arctic waters are the richest fishing grounds in the world, however the majority of ships that have transited the northern routes have been tankers. Proficient measures must be taken to safeguards the fragile polar environment in the event of an oil spill.

## Did you know?

Chinese billionaire Wang Jing has proposed the construction of a Nicaragua Canal to compete for inter-ocean traffic by servicing ships too big to pass through Panama's expanded canal. Due to financial troubles for Wang Jing, the project has been delayed, and the future of the project is highly uncertain.

A total of 18 ships transited the Northern Sea Route in 2015, that is approximately 0.1 % of what transited the Suez canal.

Sources: Wall Street Daily (2016), ‹China's New Silk Road: Railway to Europe'; McKinsey&Company (2016), 'China's One Belt, One Road: Will it reshape global trade?'; Eurasian Research Institue (2016), 'China's Belt and Road Risk Assessment Issue'; The Arctic Institute (2016), 'The Future of Arctic Shipping'.

# ASEAN INFRASTRUCTURE GROWTH STORY

The ASEAN (Association of South East Asian Nations) is a cooperative regional grouping consisting of 10 nations (Thailand, Vietnam, Indonesia, Myanmar, Laos, Brunei, Cambodia, Malaysia, Singapore, Philippines). These countries exhibit a few common traits and are mostly at similar stages in terms of socio-economic development, which makes them an interesting bloc to examine.

A recent analysis has examined the current state of infrastructure development in these countries, playing that against economic indicators in order to build an understanding of the future for these nations.

Infrastructure (power, water, roads, rail and telecom) spending in ASEAN has been low when compared to global benchmarks, and this creates challenges in an economy with quite a few competitive advantages:

- Unified production base
- Large consumer market with growing income levels
- Proximity to China

The opportunity in this, together with the opening up of economies in several countries, is the high level of growth in FDI inflows mainly focused on capital intensive infrastructure development. Since 1980 up until 2014, FDI inflows have been growing at an annual rate of 15%. This FDI growth is expected to triple from $1.8tn in 2015, to $5.2tn in 2030.

The ASEAN infrastructure growth story will largely be based upon unlocking of export potential through policy (e.g. tariffs), new trade routes (particularly to China) and critical FDI growth. Trade in particular will see significant growth: from a 6.8% global trade market share in 2014 to an 8% share in 2030 (US$4.8tn). Significantly, this is a 15 year time period during which Europe's share is expected to reduce from 25.1% to 16.7%, and NAFTA countries from 13.1% to 11.4%.

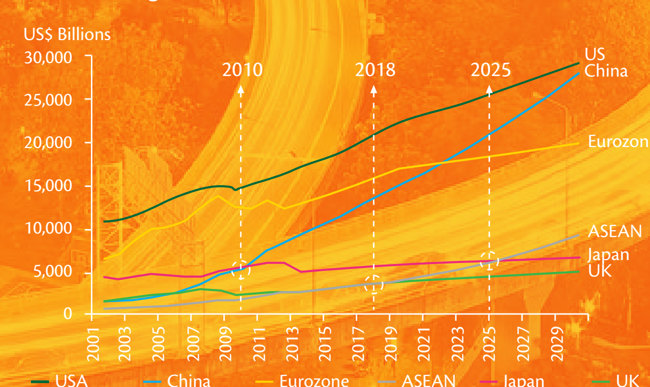
## Driving Forces:

Globalization

Economic Growth

## GDP Growth

ASEAN is set to be one of the world's top economies by 2030, fueled both by exports (particularly to China) as well as rising domestic consumerism.

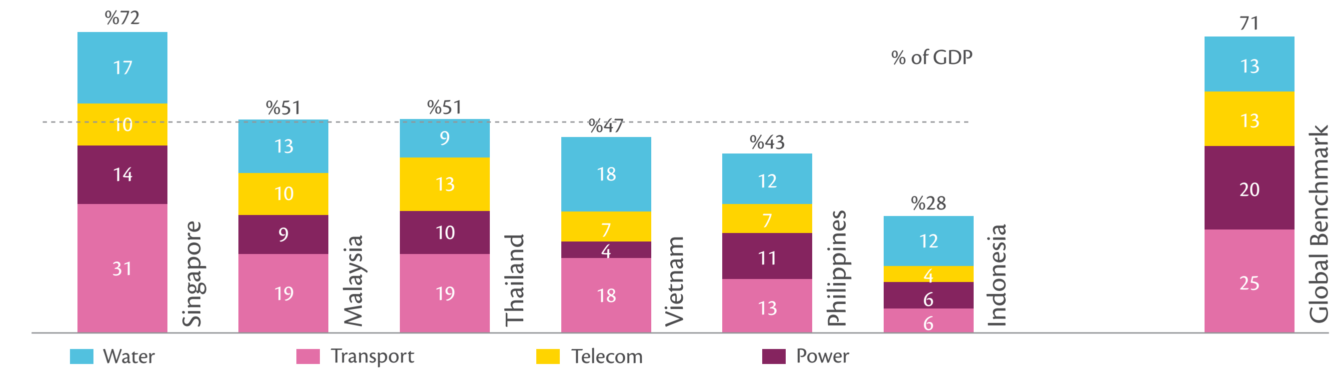




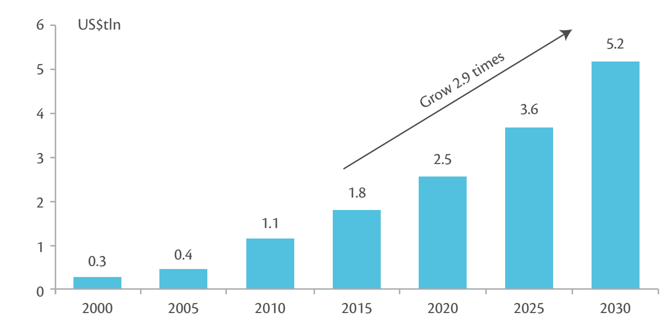

## Assessment

ASEAN countries have a high potential to significantly impact the global economy by utilizing the power of their fast-growing population. This will have to be supplemented by agile policy-making (for example on tariffs and trade negotiations with China), and sustained cooperation to operate as a unified trading bloc.

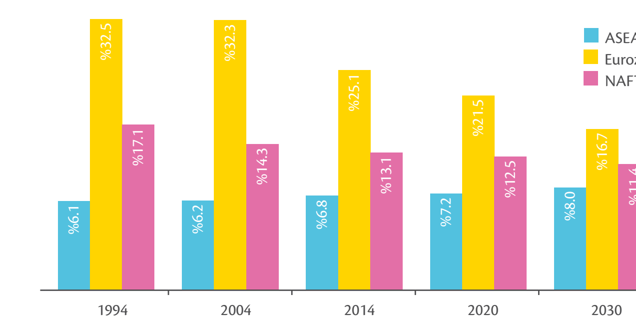
## Data and Facts




Infrastructure stock as a %'age of GDP




ASEAN FDI Stock nearly tripling from 2015 - 2030




ASEAN exhibiting sustained rise in share of global trade

- Significant scope for investment in infrastructure, fuelled by FDI.
- Expanded presence as an influencer in global trade.

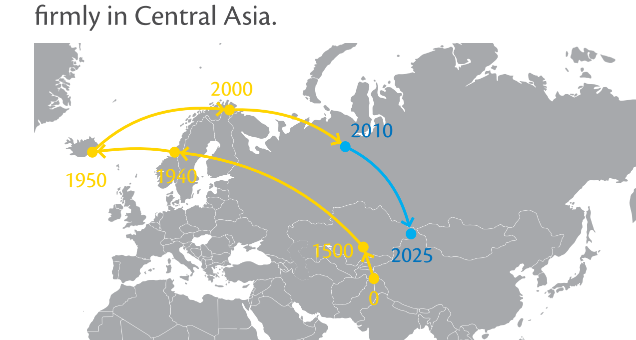
## Areas to Consider

The Asia-Pacific region's middle class population is growing at a furious rate: from 529 million people in 2009, it is projected to reach 3.23 billion people by 2030. This is a 5x increase in 21 years at an annual growth rate of 24%.

ASEAN population will only likely peak in 2064 at approximately 800 million people: excellent demographics for long-term sustained economic growth. When viewed as a bloc, ASEAN as of 2014 had a population of 622 million people, which is already the 3rd largest population in the world.

## Did you know?

The world's economic centre of gravity (calculated based on countries' economic output) has been steadily shifting East for the past 60 years, and with an accelerated pace recently, trending south-east. By 2025, the centre will be firmly in Central Asia.




The world's shifting center of gravity

Sources: Citi GPS: Future Opportunities, Future Shocks; Oxford Martin School: Now for the Long Term; UOB: Foreign Direct Investment to Provide Boost to ASEAN Economies; UOB: The Asian Miracle.

# BREAKING THE SUPPLY CHAIN

Supply chain management has always been the method by which manufacturing companies have maximized the control, efficiency and output of their production facilities. Complex supply chains have been set up around the world as a core competency, with ownership and control being one of the keys to success.

New pressures, however, are disrupting this equation. Digital marketplaces, 3D printing and mass personalized local finishing are three examples of new developments threatening to derail the existing order.

This means that new priorities are taking over, and supply chains focused on cost efficiency are giving way to more dynamic networks with the onus on eliciting faster response times. Companies are moving towards a more open, multi-dimensional web of partners. This introduces agility: a more responsive network is much more beneficial when a partner's factory shuts down and might delay delivery of a component, for example.

An additional benefit, especially if suppliers know their 'position' in the web, is that transparency becomes widespread, enabling a level playing field. Competition drives learning, innovation and can also reduce costs while increasing service levels.

In essence, companies have understood the diminishing returns from a constrained proprietary network. An open web of suppliers drives down large manufacturing/assembly/distribution investments, reduces the necessity for long-term contracts and improves operational efficiency. An analogous comparison can be seen in the dynamic pricing algorithms of Uber: transparency, reduced investment, agility and decentralization are all hallmarks of that company's competitive advantage over traditional taxis – this, in the medium term, drives down costs.

## Driving Forces:

- Globalization
- Technological Development

## Solving for inventory and instant gratification

Amazon has filed a patent for 3D printing trucks, a move which seems to indicate a desire to reduce warehousing costs while providing as immediate delivery as possible. As per the filing, there are three challenges currently being faced: maintaining inventory, finding items in warehouses and customer satisfaction dependent on how quickly an order can be fulfilled.

3D printing on demand in a mobile manufacturing apparatus attacks all of these challenges – a truck closest to the customer can receive the order, print the item and quickly deliver it to the customer.

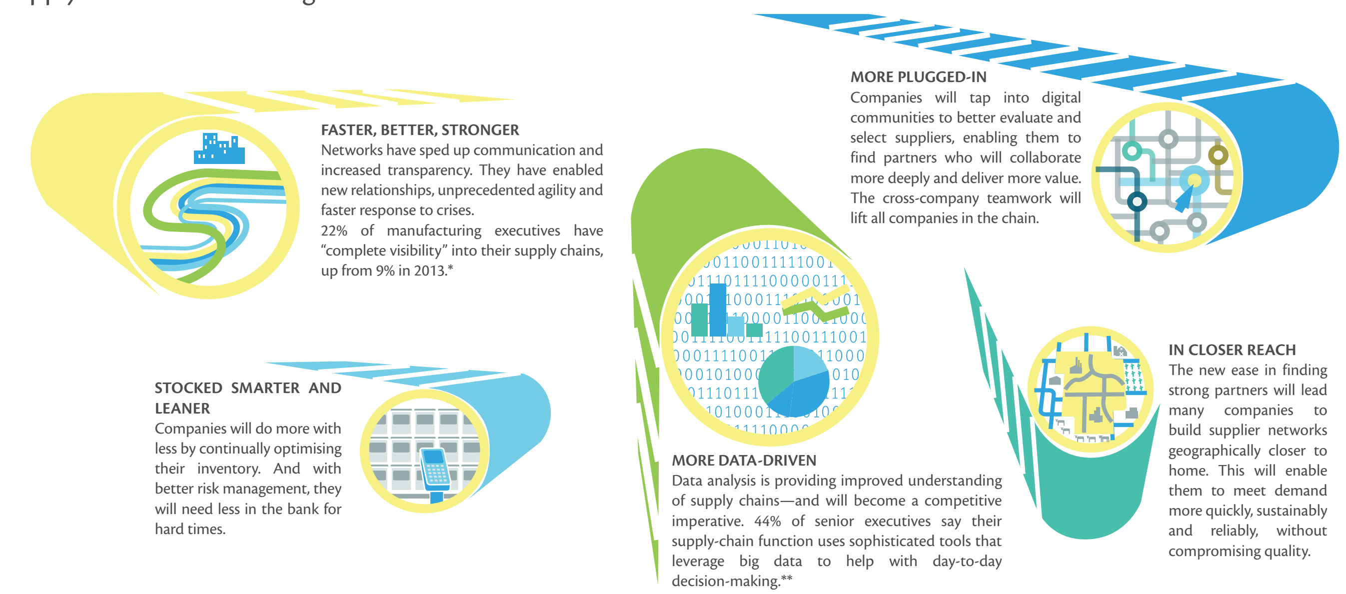


## Assessment

Companies will look to balance the benefits of open, shared supply webs with the risk of partnerships with apparent competitors and suppliers who they don't have the same traditional level of control over.

## Supply chain of the future

In the past, the supply-chain manager's key challenge was to cut costs along a single line of suppliers. But now that companies are hyperconnected by networks, mobile and social, speed is more crucial. Product cycles are shorter and more fluid, and customers are pressing for swift, exciting innovation and quicker development and delivery. As a result, supply chains are becoming:




## Areas to Consider

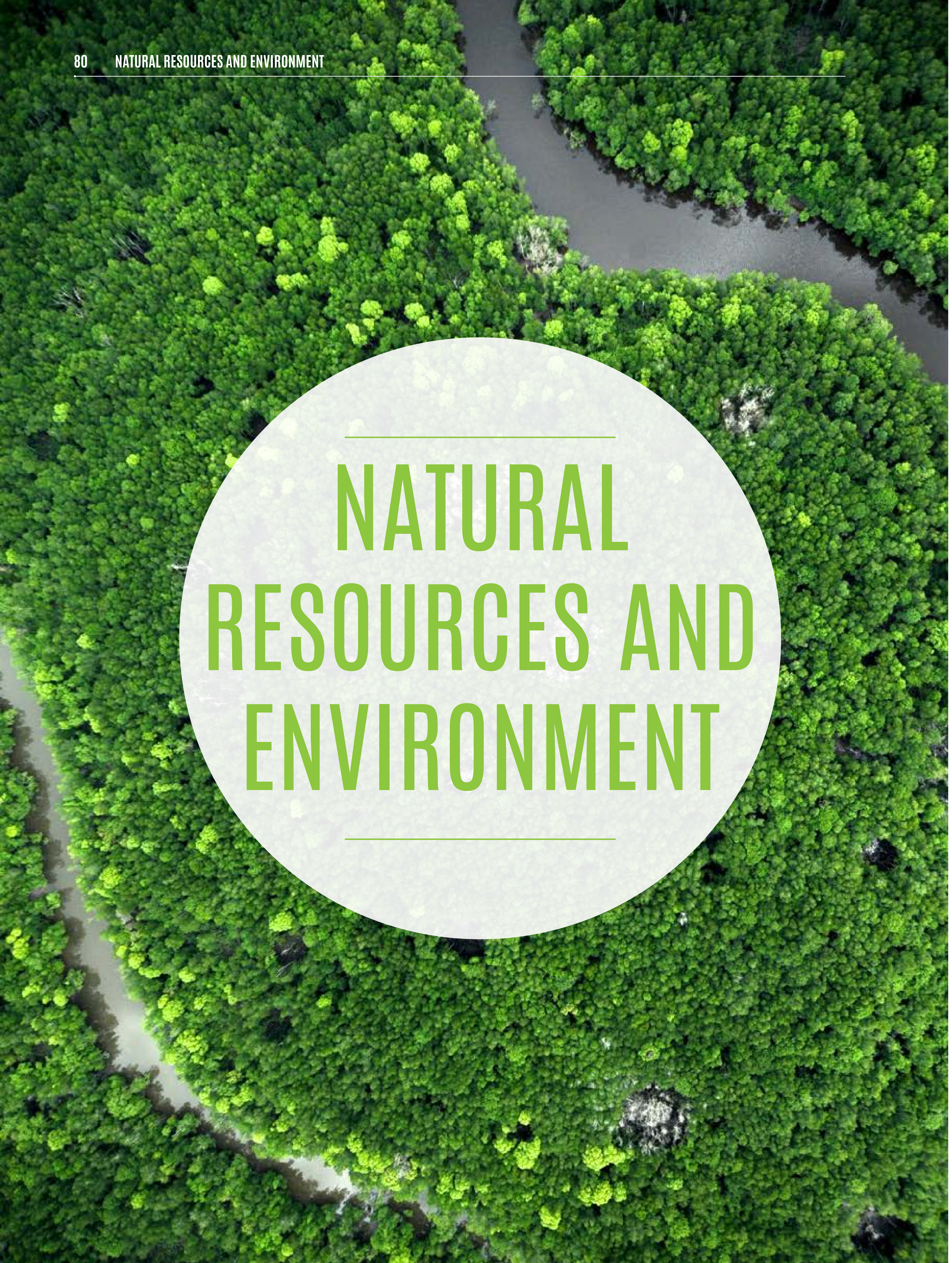
The impact of technologies such as 3D printing combined with a move towards mass personalized and local supply can change the entire concept of logistics.

There is a political angle to building supply webs (primarily driven by technological improvements) – the balancing of global and local. Trade and production on-shore can be subjects where policy can have profound effects.

## Did you know?

80% of anything we consume or use has been on a ship either as a finished product, a component or ingredient.

Sources: KPMG/forbes 2014 global manufacturing outlook; Accenture 2014 global operations mega trends study; Future Agenda: The World in 2025.



# NATURAL RESOURCES AND ENVIRONMENT



# INTRODUCTION

In August 2016, a group of experts announced that we have officially entered the Anthropocene – the geological age characterised by significant human influence on the planet. Towards 2050, we will see changes in the climate that most likely will change the public's general perception of the climate challenges we are facing. We will experience a big shift in energy consumption, in the exploitation of natural resources, and the power plays related to this.

The following chapter describes 13 trends shaping the future of natural resources and environment. The 13 trends presented can be categorised into the following three areas:


## Energy Sources:

- Rise of Renewables
- Rise of Shale
- Future of Nuclear Energy
- Energy Storage and Smart Grid
- Vehicle Fuel Substitution


## Mineral Wealth and Preservation of Resources:

- Resource Conflict Due to Scarcity
- Water is the New Gold


## Climate Change and Environment:

- Risk From Climate Change
- Environmental Degradation
- Smart Farming
- Climate Change and Food Insecurity
- Climate Refugees
- Pollution As A Mass Murderer

# RISE OF RENEWABLES

The rise of renewables refers to the growth of non-fossil fuels in the energy mix. Since the 1970s, a diversification of energy has taken place in many western countries, accelerating in recent years due to cost reductions in solar and wind energy production and a greater focus on sustainable production and energy independence. As the US National Renewable Energy Laboratory notes, today's price projections to 2020 are about half of what was being predicted a decade ago, and International Energy Agency (IEA) and British petroleum (BP) outlook for renewables has continuously been revised upwards as installation of renewables has increased.

Optimally placed onshore windfarms are now cost-competitive with combined-cycle gas turbines and hard-coal power plants. The same goes for solar power-plants, which are witnessing continued price declines as the technology matures. Efficiency gains in solar and wind will continue to outpace efficiency gains in fossil fuels.

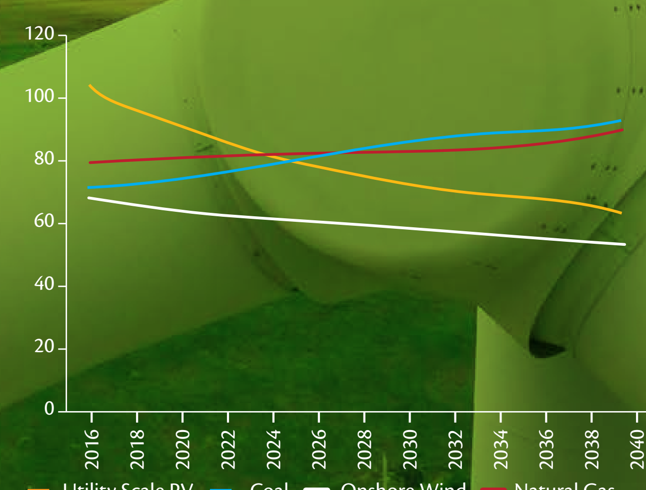
The US Energy Information Administration (EIA) in its reference case expects that by 2040, renewables will constitute more than 16 % of global energy consumption, up from 11 % today (see right hand graph next page); however The International Renewable Energy Agency (IRENA) notes that with sufficient investments, total renewables consumption could reach +30 % of total energy consumption. According to The International Energy Agency (IEA), the cost of solar in 2040 will likely have dropped by 40 %, while the cost of fossil fuels will most likely increase, accelerating the shift to renewables (see also figure below).

## Driving Forces

Technological Development

More efficient use of Natural Resources and Environment

## Future Costs of Energy Sources




Average electricity cost in Europe, USA and China ($/MWh)

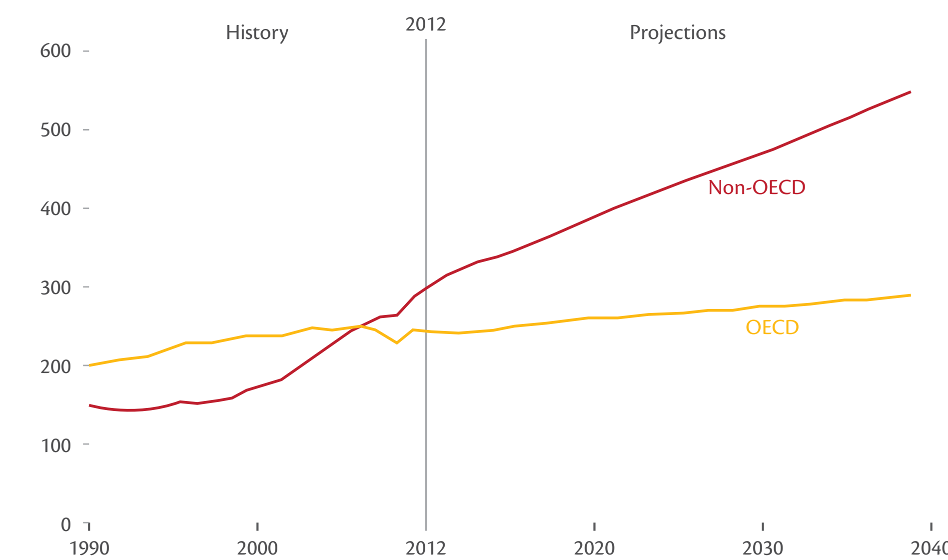


## Assessment

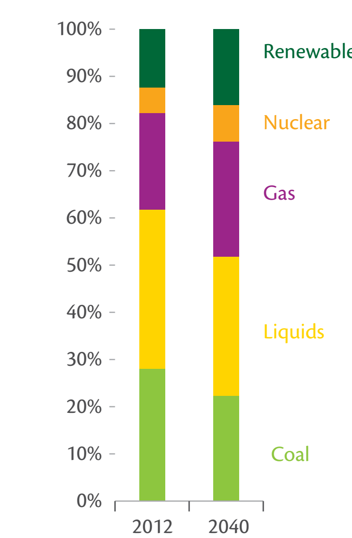
The ongoing introduction of renewables will impact global energy sectors. New technology breakthroughs, especially in storage technologies, and a global focus on energy efficiency, energy switching and CO2 reduction will determine the pace of change.

## Data & Facts

A decade ago, China built a new coal power plant every week and quickly became the world's largest emitter of CO2, ~30 % of global CO2. Today, China is set to curb emission growth and is heavily investing in renewables, setting up two wind turbines every hour. Other developing countries however, will also show an increasing demand for fossil fuels. Therefore, despite strong growth in renewables, fossil fuels will most likely comprise the majority of the energy-mix towards 2040 – see graphs below from the International Energy Association (IEA) and the US Energy Information Administration (EIA).




World Energy consumption by region 1990-2040




Global energy mix 2012/ 2040

## Areas to Consider

Policies should be designed to facilitate a transition to a complex and increasingly decentralised energy system in order to scale up renewables. This means breaking down traditional silos and cooperation across sectors. For example, electrification of the transportation sector is increasingly interwoven with residential power use.

Policymakers should assess the extent to which a shift towards renewables can create new jobs, and what such a transition means for education and new skills development.

## Did you know?

In 2015, global investment in renewables were $286 Billion. The investment in renewables made by China alone ($130 Billion) almost equalled the global investment in fossil fuels.

The global added renewable power capacity installed in 2015 was approx. 60% higher than the global added conventional installed capacity.

Since 2000, solar energy capacity has grown by almost 18,500%.

Sources: International Energy Agency (2015), 'World Energy Outlook 2015'; International Energy Agency (2016), 'World Energy Outlook 2016'; U.S. Energy Information Administration (2016), 'International Energy Outlook 2016'; BP (2016), 'BP Energy Outlook – 2016 edition'; World Energy Council (2016), 'World Energy Scenarios 2016 – The Grand Transition'; FS UNEP Collaborating Centre (2016), 'Global Trends in Renewable Energy Investment 2016'; International Renewable Energy Agency (2016), 'REmap: Roadmap for a Renewable Energy Future'; Bloomberg New Energy Finance (2015), 'New Energy Outlook 2015'.

# RISE OF SHALE

The rise of shale refers to a rise in unconventional oil and gas resources due to rapid technological progress, increasing the global energy supplies and resulting in oil prices below $50 a barrel.

The US shale revolution has been driving this production breakthrough. BP's Technology Outlook (2015) estimated that the shale revolution has increased technically-recoverable oil and gas resources by upwards of 15%. Data from 2015 also suggests that productivity gains in the US Lower-48 continued apace. The market is taking much longer to rebalance to this 'age of plenty' and has led to the phrase "lower for longer" to describe both crude and gas pricing.

Despite the "lower for longer" environment and the financial challenges facing much of the onshore industry, the marginal cost of US shale oil has consistently fallen, driven by pressure on supplier costs and through leveraging new technology, and many wells are already breaking-even below $50 a barrel. Rise of Shale is a trend likely to continue as the relatively young industry sees improvements in technology and innovation, which is likely to further reduce the cost of shale production. Towards 2050, shale prices could fall considerably, and with technological advances more reserves could open up globally. Shale's importance in the energy mix will to a large extent be determined by the move to a low-carbon economy.

## Driving Forces

- Globalization
- Economic Growth
- Technological Development
- Commercialization

## The Business Model Challenge

National and international oil producers will need to review their business models and skills in light of the different demands of producing shale oil onshore rather than developing complex 'frontier' projects that most operations and new investments are currently focused on.

Lower than expected oil prices could create long-term benefits for a wide range of businesses with products that use oil or oil-related products as inputs (e.g. petrochemicals and plastics, airlines, road haulers, automotive manufacturers, and heavy industry more generally).

Shale oil has the potential to increase energy security, independence and affordability of producing countries.

Shale's benefits need to be aligned with broader environmental concerns at both the local and global level.

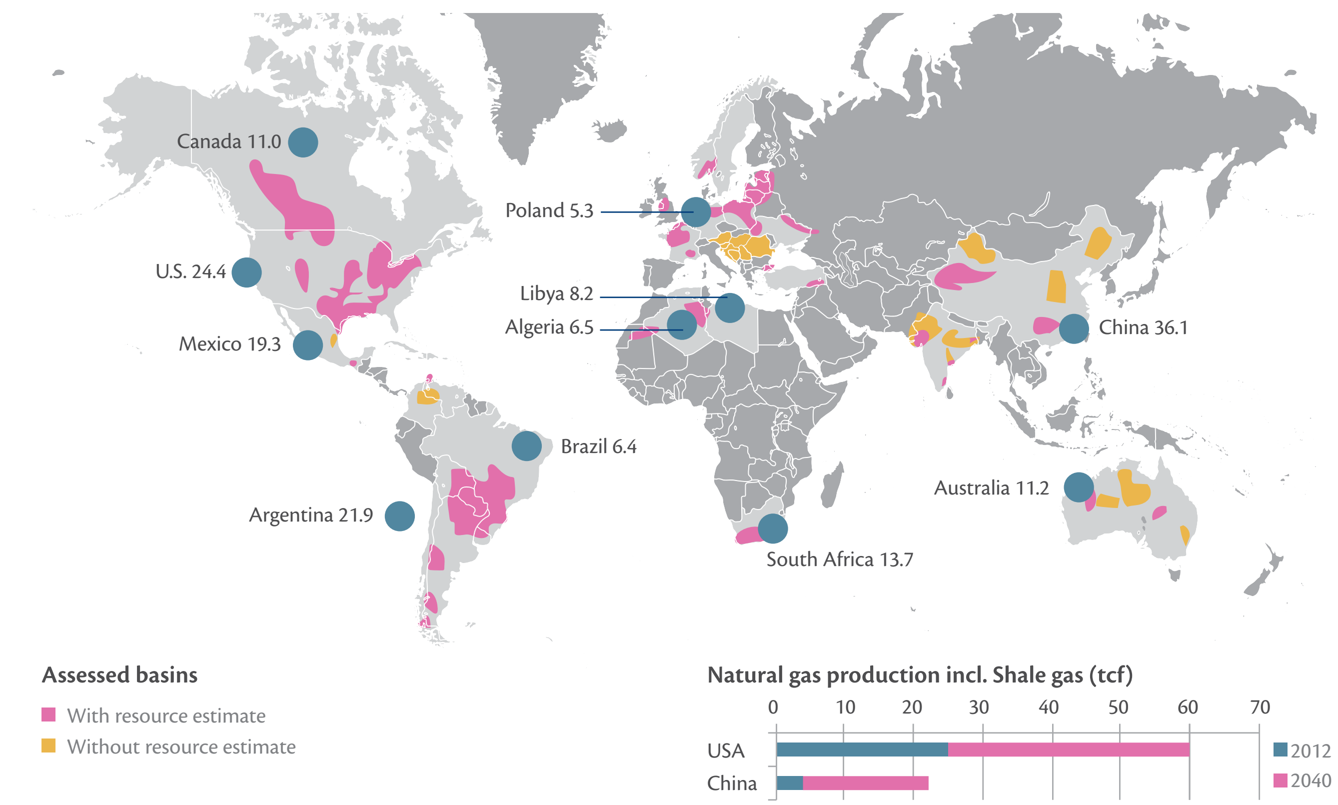


## Assessment

The 'shale revolution' is an ongoing development and could influence the dynamics of geopolitics as it increases energy independence for many countries and reduces OPEC's ability to influence prices. The biggest impact is in the medium to short term, as markets in the longer term will adapt to shale being part of the energy mix.

## Data & Facts

About 60% of the global oil production in 2025 that is economically viable at a crude price of USD 60 a barrel is in US shale, and only about 20% is in deep water. Average cost per barrel has dropped by 30 to 40% for US shale wells since 2014, but just 10 to 12% for other oil projects. In 2030, the USA will come close to the Saudi Arabian volumes of oil production, and by 2040, shale gas may have increased significantly both in the US and China. The USA may remain a net oil exporter through 2040.




Global shale gas basins (tcf)

## Areas to Consider

The rise of shale has changed geopolitics and will continue to do so as the USA becomes more energy independent.

Many uncertainties related to the emergence of new unconventional sources still exist. Technological breakthroughs could increase recoverable resources. Policymakers should have contingency plans in place if the fundamentals are changed. Volatility is likely to decrease in the long run as independence of oil increases.

## Did you know?

Presently barely 10 % of US shale projects use fully automated drilling and pressure-control systems. The opportunity to increase well performance is substantial. Between 2013 and 2015, shale gas drilling costs in the Sichuan Basin in China fell 23 %

The US has 78 billion barrels of unproven technically recoverable shale oil resources, while the world total is 418 billion barrels. The impact of the shale oil revolution is easiest understood when compared to Saudi Arabia's 266 billion barrels of proven reserves.

Sources: Accenture (2014), 'International Development of Unconventional Resources: If, where and how fast?'; PWC (2013), 'Shale oil: the next energy revolution'; Manhattan Institute (2015), 'Shale 2.0: Technology and the Coming Big-Data Revolution in America's Shale Oil Fields'; U.S. Energy Information Administration (2016), 'International Energy Outlook 2016'; BP (2016), 'BP Energy Outlook – 2016 edition'; OPEC (2015), 'World Oil Outlook 2015'; World Energy Council (2016), 'World Energy Resources: Unconventional gas, a global phenomenon'; Financial Times (2016), 'US shale is lowest-cost oil prospect'; Thomson Reuters (2011), 'China set to unearth shale power'; Reuters: Global Shale Gas Basins.

# FUTURE OF NUCLEAR ENERGY

Nuclear energy is the process of creating energy from fission or fusion of atoms. This process creates heat that is used in steam turbines to produce electricity.

Nuclear fission, despite being a low-carbon energy source, is widely unpopular in high-income countries due to issues related to the disposal of radioactive waste. Fission power currently provides approximately 11% of world electricity. Growth in fission power production will increasingly come from middle-and low-income nations. For example, China will see a doubling of its nuclear fission capacity by 2021. Therefore, fission, which offers better air quality than coal, is of particular interest to China. Towards 2050, 4th generation reactors, which promise to eliminate most radioactive waste, could enter the market.

Nuclear fusion – long hailed as the major energy disruptor – is another nuclear power option. Many consider fusion energy to be the energy source that never arrived. However, over the last decade, researchers have overcome several obstacles that have bedevilled them for decades and limited fusion's development as an energy source. Now many experts expect that fusion energy could finally become commercially available around 2050. If breakthroughs in these technologies were to happen, it would have a significant impact on the energy mix.

## Driving Forces

Economic Growth

Technological Development

## Lockheed's Compact Fusion Reactor

In October 2014, Lockheed Martin announced that over the next decade they will attempt to develop a compact fusion reactor that will fit 'on the back of a truck' and produce 100 MW output – enough to power a town of 80,000 people.

If fusion power is successful, and a reactor could fit into a airliner, it would promise unlimited airtime and eliminate the need to refuel – disrupting the aviation fuel industry.

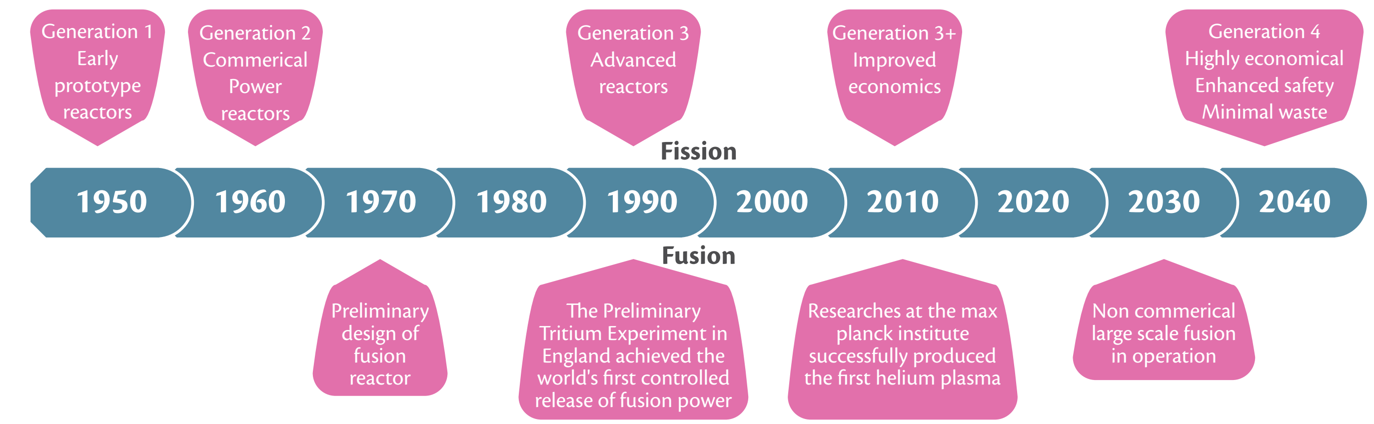


## Assessment

Fusion is still an uncertain technology. Expectations for commercialisation range from 2024 to 2070. However it is very likely that we will see a 4th generation nuclear roll out around 2030 - 2040. The impact of fusion energy on the energy mix would be profound and would create a fast transition to a low carbon economy.

## Data & Facts

Nuclear fission energy, once considered the future of energy, saw investments decline following accidents at Three Mile Island, Chernobyl, and most recently Fukushima. Though Generation IV reactors are not expected to be commercially available before 2030, they promise to increase safety and minimise waste. These reactors could make nuclear power a low-carbon, popular choice.




Nuclear energy timeline

## Areas to Consider

Low-cost desalination could be achieved through the use of fusion energy.

On-board, small nuclear reactors on aircrafts would reduce the need for refuelling, which could impact aviation hubs.

Breakthroughs that provide a realistic promise of fusion or low-cost 4th generation nuclear, could have huge consequences for the energy sector - investments in oil with long payback horizons would likely be retracted many years prior to commercial roll out of fusion energy.

## Did you know?

Fusion fuel – deuterium and tritium – can be readily extracted from ordinary water or seawater. It is environmentally friendly and can be produced with no dangerous byproducts.

Between 2011 and 2013, following the Fukushima Daiichi nuclear disaster in Japan, investments in research, development, and demonstration fell by 29% in International Energy Agency countries.

Sources: International Energy Agency (2016), 'World Energy Outlook 2016'; European Commission (2015), 'The different 'generations' of nuclear technology'; International Energy Agency (2016), 'Statistics Database'.

# ENERGY STORAGE AND SMART GRID

A 'smart grid' is an electrical grid that includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Energy storage encompasses any form of technology that is used to store energy – e.g. chemical batteries, power to gas or liquid (e.g. hydrogen or biofuels), thermal storage, and mechanical storage (pumped-storage hydroelectricity).

The introduction of energy storage in combination with the smart grid leads to smart energy. Smart energy is a prerequisite for a low-carbon economy based on weather - dependent, variable energy sources that can reduce the dependence on fossil fuels.

Towards 2050, grid systems are expected to enable smart energy capabilities. We will thus increasingly see the emergence of decentralised energy systems with micro-energy markets created by generational capability at the end-user level. The end-user energy consumer will become an energy 'prosumer', who is both producing and consuming from the grid.

This change requires an adaptation of centralised and decentralised energy storage, the advancement of a regulatory framework to support new technologies, and an increase in forecasting possibilities. The smart energy systems will become complex information systems, and methods and regulations will be required to deal with sensitive data and preserve security and privacy.

## Driving Forces

- Economic Growth
- Technological Development
- Commercialization
- More efficient use of Natural Resources and Environment

## Emergence of 'Smart'

Battery technology has historically been driven forward by the computer industry, however, the emergence of smart homes and smart transport will push further battery technology and smart grid development.

Smart homes are expected to become low carbon as the AI supported IoT (Internet of Things) networks will enhance energy efficiency.

Smart Transport is expected to become low-carbon, as automation systems in transport enable more efficient and secure driving. Smart transport encompasses micro-level (e.g. individual car efficiency) systems operation as well as macro-level systems operation (e.g. congestion reduction).

These two related areas will probably increasingly merge with smart energy.



## Assessment

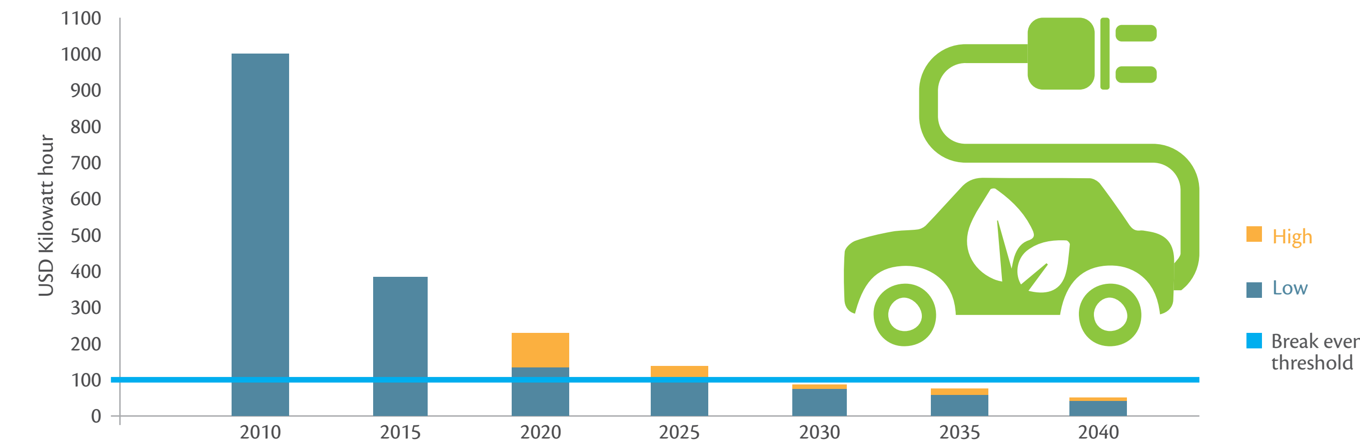
Introducing energy storage & smart grid is a prerequisite for a carbon neutral economy. Support-free, break-even battery and renewable technologies could be achieved in the near term, but their large-scale rollout will likely take time (see Fuel Substitution).

## Data & Facts

Energy storage is vital for transitioning to a low-carbon economy, but such a transition will involve transitioning to a new kind of energy system, which will take time. It has been suggested, for example, to use electrical vehicles as distributed energy storage in a future smart grid with a greater share of renewables. However, the 1 million electric cars expected to be on the roads in Germany in 2020 would only provide battery capacity corresponding to approximately 1% of what is necessary in order to shift Germany's energy mix to a stable 50% share of wind and solar energy.

Battery cost will need to continuously decrease before a greater share of renewables can be adapted.

Between 2010 and 2012, battery costs fell by 40% and are expected to continue decreasing. As depicted by the graph below: battery pack for cars are expected to break even around 2025.




## Areas to Consider

Smart grid data can be utilized to create new business models between network operators and retailers, however deploying new technologies is a risk that utilities and regulators are not willing to shoulder alone, thus the incentive structures in today's electric-power grid needs to be rewritten.

Authorities could take equity stakes through a green fund or offer banking institutions lower refinancing rates in order to provide the green sector with more attractive lending.

## Did you know?

The company Otovo in Norway is renting rooftops to find areas to place solar panels.

BioSolar and University of California have filed joined patents on a new type of battery with final cost estimates at USD 54 per kWh, nearly half of previous targets of USD 100.

Sources: Vingerhoets, P. et al. (2016), 'The Digital Energy System 4.0'; Sinn, H.W. (2016), 'Buffering Volatility: A Study on the Limits of Germany's Energy Revolution'; Bloomberg New Energy Finance (2016), 'New Energy Outlook 2016'; Clean Technica (2016), 'New 'Super Battery' Energy Storage Breakthrough Aims at 54$ per kWh'.

# VEHICLE FUEL SUBSTITUTION

The composition of world energy is changing. Coal and oil is increasingly being substituted for gas and renewables. Traditional car fuels (petrol and diesel) constitutes the majority of oil demand. Many technologies and governmental policy changes, however, promise to reduce demand for oil in vehicle transport in some regions in the future, manifested by the fact that governments around Europe are pushing to phase out fossil-fuel vehicles.

Demand for electric vehicles (EV's) – plug-in, hybrid electric vehicles and battery electric vehicles – is rapidly on the rise. Advancement in battery technology holds the promise that around 2022 - 2030, low range and battery charging time will no longer be deterring factors; and the total cost of ownership will likely be lower for EVs compared to fossil-fuel cars. From then on, the demand and supply for EVs could escalate.

Natural Gas Vehicles is another viable alternative to petrol, which is of particular interest because of the development in shale gas and second-generation biofuels. As traditional agriculture subsidies are phased out, the US and the EU could choose to strengthen domestic agriculture markets by increasing the mandatory portion of 2nd-generation biofuels in the biofuels mix, and support the introduction of Natural Gas Vehicles, which could run on gas coming from both 2nd-generation biofuels and shale gas. The impact of fuel substitution on oil demand depends heavily on the growth of EV's – not just in the EU and the US, but especially in developing countries. China has already become the third largest global market for EV's.

## Driving Forces

- Economic Growth
- Technological Development
- More efficient use of Natural Resources and Environment

## Solar Roof

In 2016, Tesla introduced the Tesla Solar Roof. The solar roof is a ground-breaking, new type of building-integrated photovoltaic shingle with the goal of making rooftop solar more affordable, better looking and longer lasting. This is a step towards integrating "green" housing and transport, with the long term objective to allow consumers to charge their electric cars from electricity produced by their own residential house. For example, an average person living in India would need approximately 20 sqm of solar panels to fuel both car and residential energy needs.

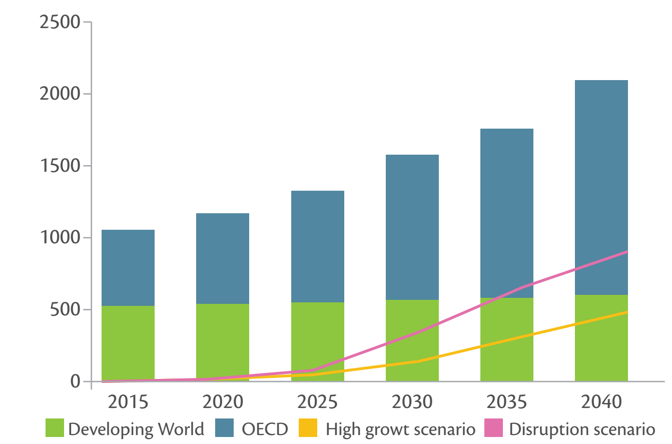


## Assessment

Fuel substitution is already happening on a minor scale. In the coming decade, growth will increase, however, the increased demand for fuel consumption is expected to more than compensate for fuel substitution. In the US and EU, oil imports are likely to decline.

## Data & Facts

EVs will probably not reduce oil demand below currents levels over the next 20 years. Even in a disruption scenario, with a widespread uptake of residential solar in developing countries to power EVs, the growth of gasoline cars will most likely outpace the uptake of EVs. If demand for oil is to fall it will require: early adoption of EVs in developing countries, strong regulatory push for phasing out the traditional combustion engine, autonomous cars, more public transportation and push for high fuels efficiency in gasoline cars.




Number of passenger cars in different regions and two scenarios for number of electric cars

## Areas to Consider

Governments can choose to implement subsidy schemes to promote fuel substitution and solar integration.

Research shows that replacing conventional vehicles with electric vehicles is possible for up to 90 % of vehicles now on the road and large-scale replacement will play a significant role in meeting climate change mitigation goals. Thus, policymakers should consider different incentive schemes to promote the replacement of conventional vehicles with electric vehicles.

## Did you know?

Today, it costs only $ 1 for all EVs to travel the same distance as a similar-sized gasoline car would on a gallon (3,8 liters) of regular fuel.

In the first 3 months of 2016, 25 % of all new cars sold in Norway were electric cars, while in US, China and Japan, the number is well below 1 %.

Sources: Accenture (2014), 'International Development of Unconventional Resources: If, where and how fast?'; PWC (2013), 'Shale oil: the next energy revolution'; U.S. Energy Information Administration (2013), 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States'; U.S. Energy Information Administration (2016), 'International Energy Outlook 2016'.

# RESOURCE CONFLICT DUE TO SCARCITY

Conflicts motivated by resource scarcity can occur at local, regional, national, transboundary, or international levels and can be the cause of civil unrest, civil war, or war between nations. Resource conflict are not necessarily armed conflict, but more often occurs between lead actors at different levels, who apply coercive economic or political pressure. Resource conflicts can occur over hydrocarbons, minerals, gemstones, land or fish and fishing rights. An example of a typical conflict is one that arises between upstream and downstream countries associated with dam building. Resources can also help sustain conflict as has been seen in Congo, where poachers shoot rhinoceros for their ivory to finance the terrorist group the Lord's Resistance Army.

Absolute resource scarcity refers to man's use of the earth's finite resources, while the distributional inequality of resources refers to geographic or economic resource scarcity. The latter is the main reason for conflict. Due to population growth, urbanisation, and environmental degradation, the demand for resources continues to grow, creating cyclical price peaks emphasising structural problems and increasing the potential for conflict. Technology development will influence dynamics, but the pace of development has to exceed the pace of demographic growth to ameliorate this situation. Resource conflict has the potential to destabilise already fragile countries, where internal power struggles can escalate resource conflicts. Technological innovation and access to capital can substantially decrease the risk of resource conflicts.

## Driving Forces

Economic Growth

Demographic Development

## Rising Food Prices

Headlines questioning whether it's possible to feed the worlds 9 bill. people in 2050 have been abundant as food prices increase, however absolute food scarcity is not the problem. There are more people suffering from obesity than starvation.

For much of the world's population, food constitutes 30 - 70 % of household budgets. Food prices are one of the most important drivers of inflation, and rising food prices can erode consumers' purchasing power.

This can create problems with political stability and national security. The revolutions in Egypt and Tunisia in 2011 and unrest in 35 other countries were partly triggered by tensions over food prices.

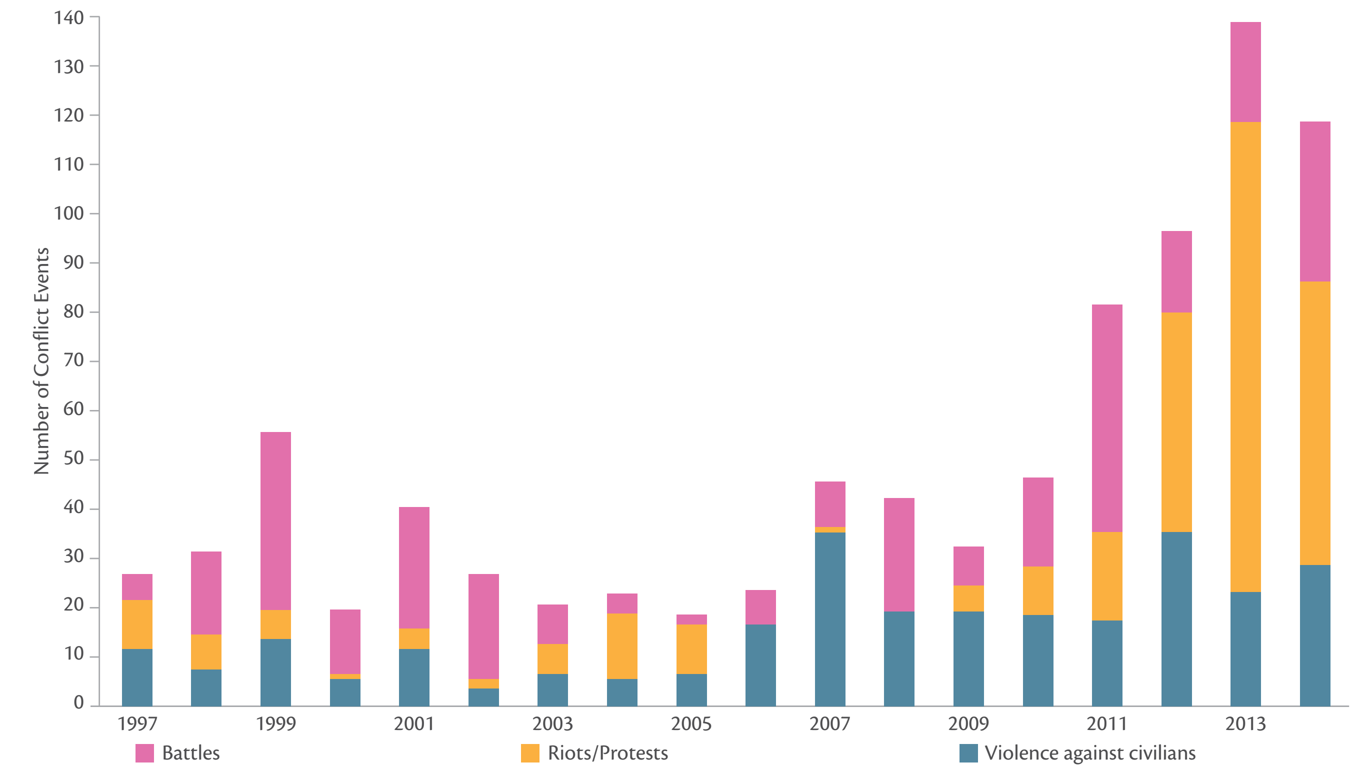


## Assessment

Resource scarcity is perceived by many as one of the greatest security risks of the 21st century. As the middle class continues to grow, the issue of resource scarcity become more pressing.

## Data & Facts

Especially African countries that are largely dependent on natural resources are more likely to experience civil war. According to the Armed Conflict Location and Event Data Project (ACLED), the number of conflict events that can be linked to resources in Africa has been increasing between 1997 and 2014. Conflict occurrence is now over 5 times the level it was about 10 years ago, however, the number of fatalities is lower. The increase in conflicts is related to larger frequency of riots and protests relating to extractive/natural resources.




**Number of resource-related conflicts in Africa, 1997 - 2014**

## Areas to Consider

The international community needs to put more effective measures in place to prevent the illegal trading of natural resources that fuel civil wars and terror.

Identify trade partners or neighbouring countries from which spill-over effects could be witnessed, be they economic or political. E.g. Nigeria an oil exporting country that imports 99 % of its wheat consumption.

## Did you know?

Slow developing, low income economies that are largely dependent on natural resources are 10 times more likely than others to experience civil war.

Over the past 60 years, 40 % of civil wars have either been fuelled or financed by natural resources.

Sources: UNEP (2015), 'Natural Resources and Conflict: A Guide for Mediation Practitioners'; Keating, M. & Brown, O. (2015), 'Addressing Natural Resource Conflicts: Working Towards More Effective Resolution of National and Sub-National Resource Disputes'; IMF (2016), 'IMF Primary Commodity Index'; World Bank (2011), 'World Development Report: Conflict, Security and Development'; Fytrou, N. (2015), 'World food crisis and the Arab Spring'; Armed Conflict Location and Event Data Project (2014), 'Resource-Related Conflict in Africa'.

# WATER IS THE NEW GOLD

"Water is the new gold" refers to the fact that water is becoming an increasingly scarce resource in many parts of the world. Water use has been growing at more than twice the rate of population increase. If current trends continue, 33 countries face severe water stress in 2040.

Most fresh water is used for food production. By 2040, demand for meat, a highly water intensive food, is expected to more than double due to population growth and the emergence of the global middle-class. At the same time, increased urbanisation means municipal and industrial water use will compete with agriculture for water access.

Water, energy and food are inextricably linked (water, food, energy nexus). The increasing demand is driving the energy intensity of water. This is happening because of the need to extract ground water from ever-deeper sources, a growing reliance on desalination, and the development of projects for water transportation. This aggravates the problem known as economic water scarcity, where water is present, but the cost of extraction is too high.

Lack of water is further aggravated by pollution and poor sanitation. A recent report from the Chinese Ministry of Water Resources, revealed that the majority of Chinese shallow, underground water sources were unfit to drink.

## Driving Forces

- Economic Growth
- Demographic Development

## Health Issues Related to Water

In some areas of the world economic water scarcity is affected by poor sanitation. At least 663 million people lack access to safe drinking water and 2.4 billion people lack access to improved sanitation, of which 1 billion practice open defecation.

The impact of diarrhoeal disease on children, often caused by poor sanitation, is greater than the combined impact of (HIV/AIDS), tuberculosis, and malaria. Improved sanitation and safeguarding drinking water could reduce diarrhoeal diseases by nearly 90%.

Poor sanitation, water, and hygiene lead to about 675,000 premature deaths annually, and estimated annual economic losses of up to 7% of GDP in some countries.

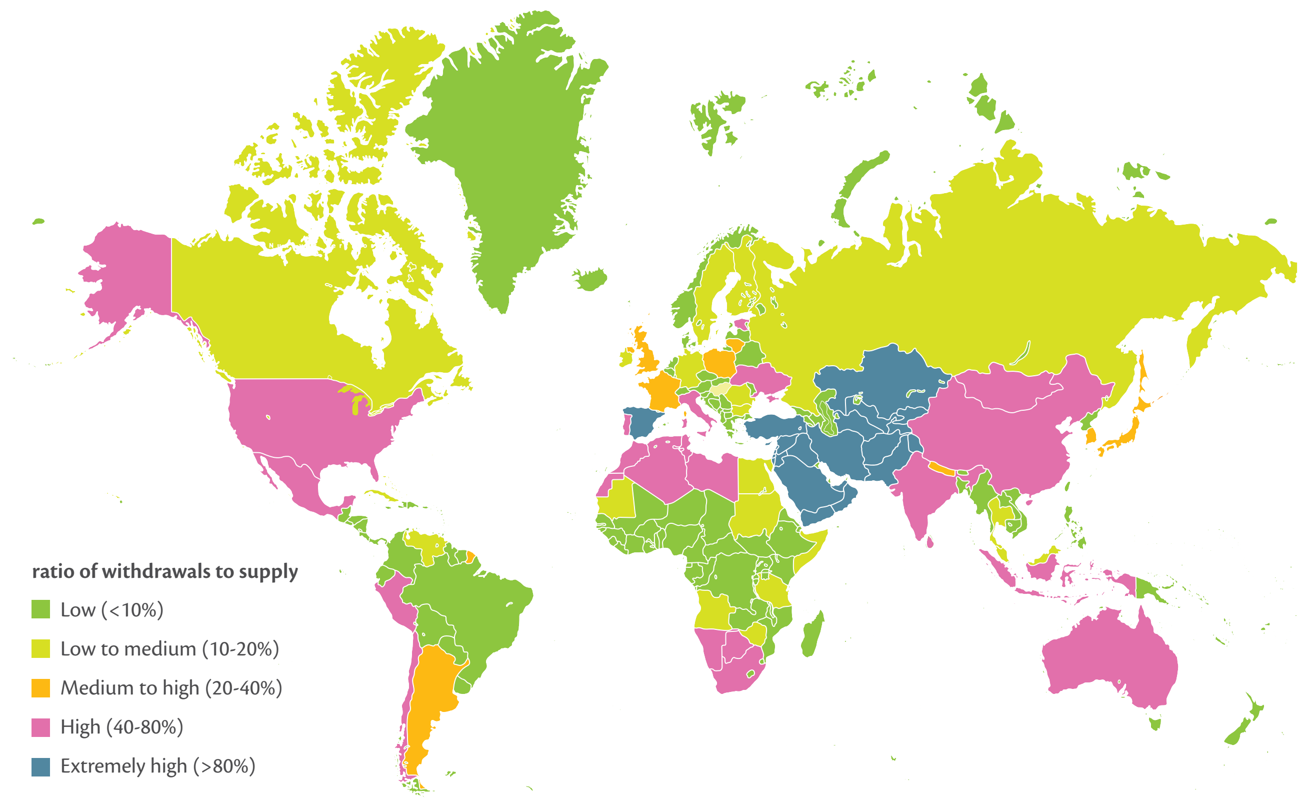


## Assessment

Water scarcity is projected to increase in many parts of the world, which could increase political risks. Over the long term, technological breakthroughs could reduce the price for desalination, lessening the challenge in some countries. Water scarcity is an ongoing challenge, but one that is likely to increase with time.

## Data & Facts

In Sub Saharan Africa, the biggest problem is not physical water scarcity, but rather economic water scarcity. In Australia, one of the world's largest wheat exporters, drought is increasingly becoming a problem. North and East China only have 20 % of the country's water resources, but account for 65 % of its cultivated land and 4 % of its GDP. At the same time, it is densely populated and includes growing cities and industrial powerhouses like Beijing and Shanghai. The result is growing competition over limited water resources.




Water stress by country 2040

## Areas to Consider

Policymakers should consider the impact on trade. High water intensity production could increasingly be moved away from countries with limited water resources; e.g. major wheat exporters like Australia cannot uphold growth in yield.

International water cooperation agreements around the world should be encouraged to avoid conflicts.

Investment in R&D of desalination should be encouraged. As solar energy matures, the price of desalinating water could decrease.

## Did you know?

Water scarcity, exacerbated by climate change, could cost some regions up to 6 % of their GDP.

80% of sewage and 70% of industrial waste in developing countries is discharged untreated directly into water bodies.

Every day, 2 million tons of human waste is disposed of in watercourses.

Today, one kilogram of rice requires 3,400 litres of water.

Sources: OECD (2012), 'OECD Environmental Outlook to 2050: The Consequences of Inaction'; China.org.cn (%80' ,(2016 underground water undrinkable in China'; World Resources Institute (2015), 'Ranking the World's Most Water-Stressed Countries in 2040'.

# RISKS FROM CLIMATE CHANGE

According to the UN International Panel on Climate Change (IPCC) there is 95 % confidence that human activity is the cause of the observed climate change. The impacts of climate change are witnessed through cases of extreme weather (hurricanes, droughts, wildfires and floods) as well as through gradual changes to the environment. These changes include invasive animal species, changes to the biosphere, changes to the tree line, coral bleaching etc.

The impact of climate change may impact peoples' livelihood, create forced migration, destroy infrastructure and cause greater global food price volatility. The impact of climate change is expected to increase with time, but by 2050 the impact relative to today will have increased significantly with loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihood, service provision, ecosystems and environmental resources.

As climate change has become more apparent the focus has shifted from prevention to adaption to climate change. According to the IPCC, however, it is not too late to prevent a 4C degree increase in global average temperature, and many of these abatement costs will pay for themselves in due time. Several reports (The Stern report, IPCC AR4 ) have found that the costs of climate change were higher than the costs of prevention. A 2016 study by the European Commission estimates that damages caused by climate extremes to critical infrastructures and key investments in the energy, transport, industrial, and social sector currently total €3.4 billion/year; but could triple by the 2020s, multiply six-fold by mid-century, and amount to more than 10 times the present damages by the end of the century.

## Driving Forces

Economic Growth

Demographic Development



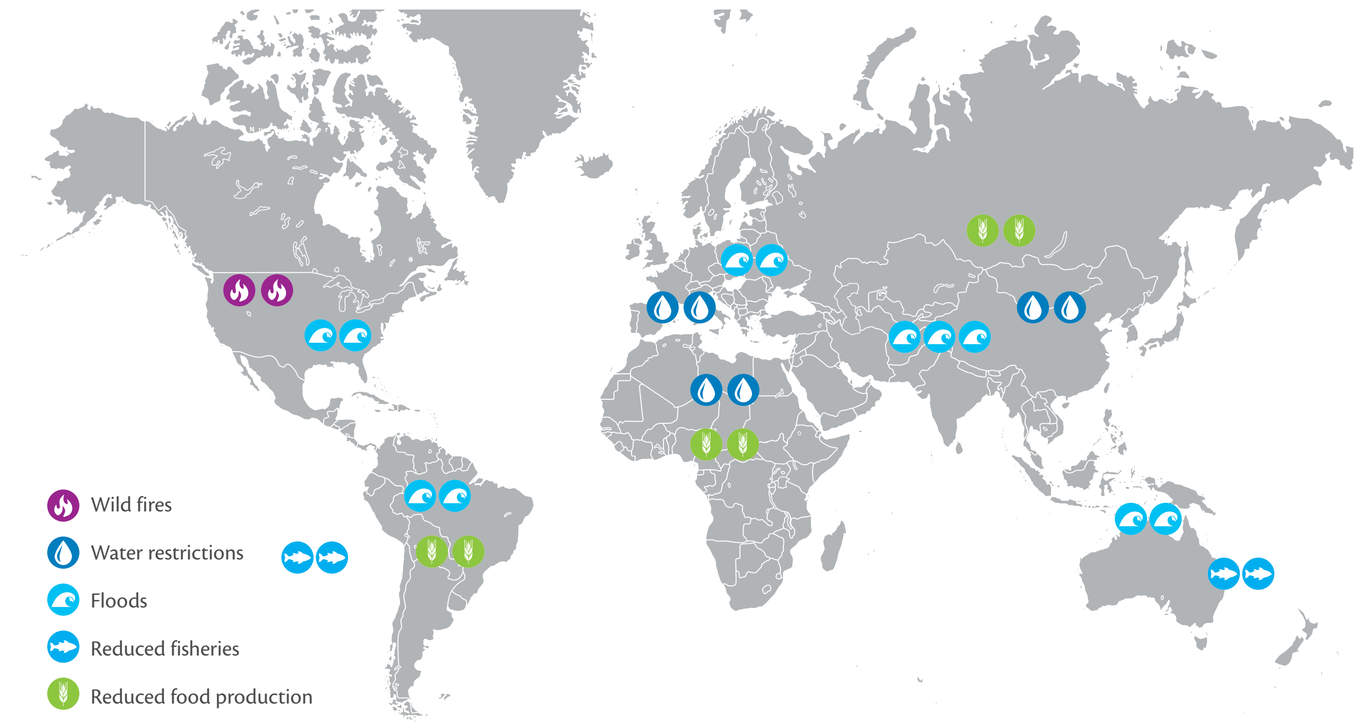
## Assessment

Climate change is considered to be one of the biggest risks to the global economy, peace and livelihood. There is wide consensus that climate change is happening and will accelerate towards 2050.

## Data & Facts

MENA countries will likely experience a decrease in soil-moisture as evaporation will increase with rising temperatures. Western Asia, Equatorial Africa and India is at risk of desertification. Increasing risk of floods is expected on almost all continents. Marine ecosystems are expected to be affected as coral reefs are destroyed.

The livelihood in low-lying coastal areas and small islands are at risk. Reduced food production and quality is expected in South America and Asia.




Risk level from climate related events 2030-2040

## Areas to Consider

Governments should consider how the geopolitical agenda and the stability of nations could be affected by climate change.

Climate adaption should be integrated into all national policies (e.g. energy, transport, food, infrastructure, health, and disaster emergency planning) to ensure their resilience.

Governments should adapt measures to prevent further greenhouse gas warming, for example by phasing out subsides for fossil fuels.

## Did you know?

At the end of the last ice age, when the Northeast United States was covered by more than 1,000 meters of ice, average temperatures were only 5 to 9 degrees cooler than today.

Lighting consumes 7% of US electricity. Solid State Lighting (LED) offer 75% reduction potential of energy consumed by lighting in the USA plus huge consumer savings and will contribute to energy security.

Since 1900 more than 11 mill. people have died as a consequence of drought.

Sources: Intergovermnmental Panel on Climate Change (2014), 'Climate Change 2014 – Synthesis Report'; Wiebe, K. et al. (2015), 'Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios'; World Bank (2013), 'Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience'.

# ENVIRONMENTAL DEGRADATION

Environmental degradation refers to manmade deterioration of the environment through pollution of water, air and soil as wells as depletion of resources such as overfishing, the destruction of ecosystems through deforestation, and the extinction of wildlife. Between 1970 and 2016, the world lost over half of its animal species population. If the current trend line is extended into the future, approximately 90% of the wildlife that existed in 1970 will be gone by 2050. All these effects and others are amplified by climate change.

Humans not only share the planet with a range of other plant and animal species, but also depend on them for our survival. Even in a world of urbanites, where more food is farmed and less comes directly from unfarmed nature, wildlife maintains a crucial role in our economy. For example, bees pollinate the plants we eat, and coral reefs provide nurseries for over the 100 million tons of fish eaten worldwide every year.

Deforestation has contributed to habitat destruction and is driven by agricultural expansion and logging industry. A majority of land animals and plants inhabit forests making deforestation a significant problem for loss of biodiversity. Luckily, the rate of deforestation has slowed down in the last 10 years.

Air and water contamination is another source of environmental degradation, which affects both ecosystems and human health.

## Driving Forces

- Economic Growth
- Globalization
- Demographic Development

## The Destruction of Coral Reefs

Over the next 20 years, the majority of the world's coral reefs could be destroyed, affecting the employment of 260 million people employed in fisheries worldwide and jeopardising food security. More importantly, fish provides 2.5 billion people with at least 20% of their animal protein intake and up to 50 % in coastal regions. In some of the most food-insecure places like Asia and Africa, fish protein is an essential part of a modest animal protein consumption.

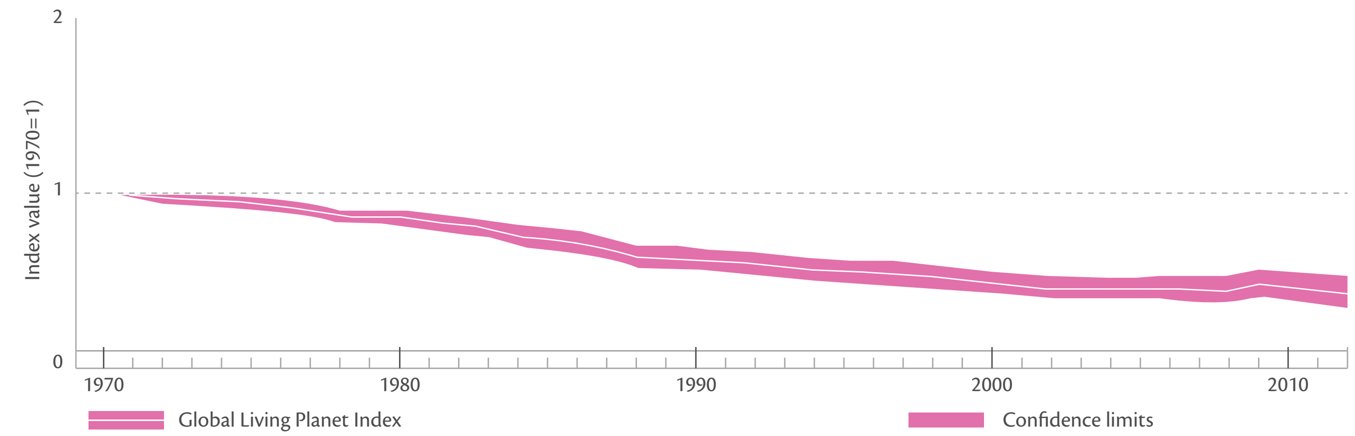
According to the Copenhagen Consensus, protecting coral reefs would yield the highest returns from all the suggested UN development goals – $24 of benefits for every $1 spent. To reduce the loss of coral reefs by half would cost about $3 billion each year, but yield at least $72 billion in benefits and secure coastal areas.



## Assessment

Continuing along the path of species destruction could jeopardise food security, lead to social unrest and have unintended negative consequences for the world economy. At current rates significant impact is expected towards 2050. However an awareness of the risk from environmental degradation is growing, which could limit the future impact.

## Data & Facts




**The global living planet index measuring the population sizes of vertebrate species**

The Global Living Planet Index shows a decline of 58% (range: -48 to -66%) between 1970 and 2012. Trends in population abundance for 14,152 populations of 3,706 species monitored across the globe between 1970 and 2012.

The white line shows the index values and the shaded areas represent the 95% confidence limits surrounding the trend. If the current trend line is extended out into the future, nearly all wildlife will be gone by 2050.

## Areas to Consider

Policymakers should consider how the tourism industry, one of the largest industries in the world, could be affected by environmental degradation.

Policymakers should consider what effect loss of marine life diversity has on food and the fishing industry.

Effective policy schemes trying to bridge ecotourism and environmental protection should be put in place.

## Did you know?

Orangutans have been reduced by 75% to 60,000. By comparison, there are about 525 million dogs globally.

An estimated 18 million acres (7.3 million hectares) of forest, which is roughly the size of the country of Panama, are lost each year.

The forest is home to 75 % of the world's terrestrial biodiversity. In the 20th century, forest area in Latin America declined by 50%, By 2050 there will be more plastic than fish in the world's oceans.

Sources: Intergovermnmental Panel on Climate Change (2014), 'Climate Change 2014 – Synthesis Report'; Wiebe, K. et al. (2015), 'Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios'; World Bank (2013), 'Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience'; World Wildlife Fund: Global Living Planet Index.

# SMART FARMING

Smart farming is about using smart technologies to improve crop yields using fewer resources. Food production needs to increase by 60 % towards 2050 if the world is to feed a growing population and a global middle-class. Smart farming could be an essential tool in that endeavour. The world is in need of a new green revolution.

The Green Revolution succeeded in turning several countries from being net food importers to net exporters by cultivating disease-resistant wheat and rice crops and using chemical fertilisers and irrigation to increase productivity. The problem now, is that productivity gains have been declining for many years. It appears as if the Green Revolution is running out of steam.

Towards 2050, with only 5 % of the global land mass available for conversion for new agriculture and wide spread farmland degradation, new production needs to come from productivity gains.

Increasing productivity is made even more difficult by climate-change induced drought and challenges of more resistant pests.

In the future, it is likely that a greater share of world agriculture will have adopted smart farming techniques. Using automation combined with sensing technology and the Internet of Things to make farms more 'intelligent' through measuring real-time soil conditions and compare them with metrological and topological data, with the aim to increase productivity. Smart farming could lead to the integration of seed and fertiliser companies with Big Data providers, leading to a greater farm consolidation.

## Driving Forces

- Economic Growth
- Technological Development
- Demographic Development

## Soil Depletion

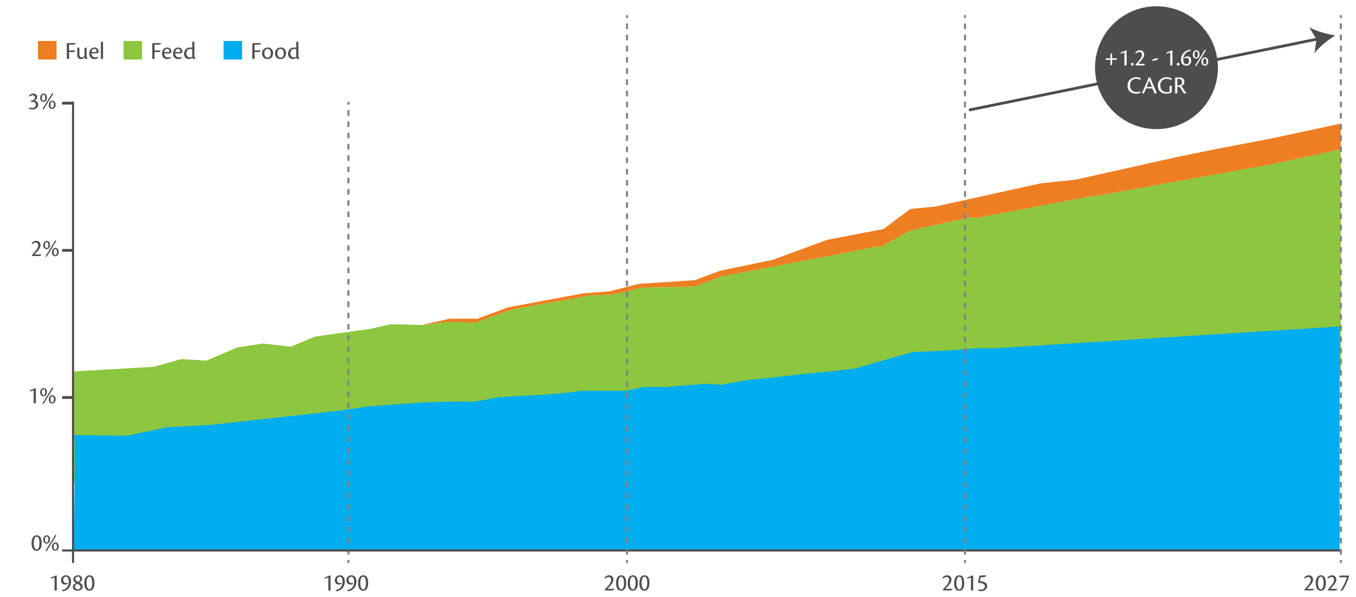
Smart farming can help secure good farm practices, through better use of resources. Approximately 40 % of global farmland is seriously degraded due to soil depletion from unsustainable farm practices. As land degradation increases, the expansion of farmland is at the expense of wilderness. In Africa the gorilla habitat has been largely destroyed due to the expansion of farmland (See Environmental degradation) and in Brazil a large part of the jungle has been cleared due to farmland expansion. Increasing farm productivity (yield) is necessary to feed the world sustainably. However growth in global yield rates have been falling since 1970, if the trend is not discontinued, neither achieving poverty reduction nor minimizing the loss of habitat will be possible.



## Assessment

Recent mergers in the agriculture sector and IBM scaling up in Big Data for agriculture show that the change to agribusiness has potential. The effects are expected to start having impact from 2020 and onwards.

## Data & Facts




**Annual increase in global demand for major grains**

- In 2050, global population will grow to over 9 billion (2 billion more than today)
- Diets are changing, especially in emerging countries, with increased demand for meats and dairy
- UN estimates that by 2050, we will need 70% more food
- Agriculture must meet this rise in demand, with significant impact necessary from productivity gains

## Areas to Consider

Agriculture sectors' potential should be examined by taking productivity gains into account.

Educating and advancing skills for data-driven farming should be promoted.

Policymakers should explore the types of agriculture best suited for smart farming.

Policymakers could explore different smart-food supplies that utilise solar energy (e.g. for hydroponics and land-based aquaculture)

## Did you know?

Private investment accounts for 50% of R&D spent in developed countries, compared to 6% in emerging markets.

It requires nature 500 years to replace 25 mm of lost soil.

There is huge potential for yield increase in Africa. The continent holds 25% of arable land, yet output is only 10% of global agricultural output.

Sources: Intergovermnmental Panel on Climate Change (2014), 'Climate Change 2014 – Synthesis Report'; Wiebe, K. et al. (2015), 'Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios'; World Bank (2013), 'Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience'; Syngenta: Our Industry 2016.

# CLIMATE CHANGE AND FOOD INSECURITY

Climate change is a key issue for global food security. To feed the world, food production needs to increase by 60 % until 2050. However, without adaptation to climate change by farmers, global crop yields in 2050 are set to decrease by approx. 7 % below estimated yields without climate change. The consequences of climate change is already impacting food production with lower yields and lower quality foods. It is estimated that higher temperatures and precipitation trends since 1980 have already lowered yields of wheat by 5.5 % and of maize by 3.8 % below what they would have been, had the climate remained stable.

There are ample historically examples of the relation between food shock and overturning of governments. The French revolution and the Arab spring was in part due to rising food prices.

Thus food insecurity poses a threat for peace and can disrupt world food trade.

According to a UK Taskforce on Extreme Weather and Global Food System Resilience, climate change has more than tripled the risk of price spikes and market volatility, which was earlier considered a once-a-century event.

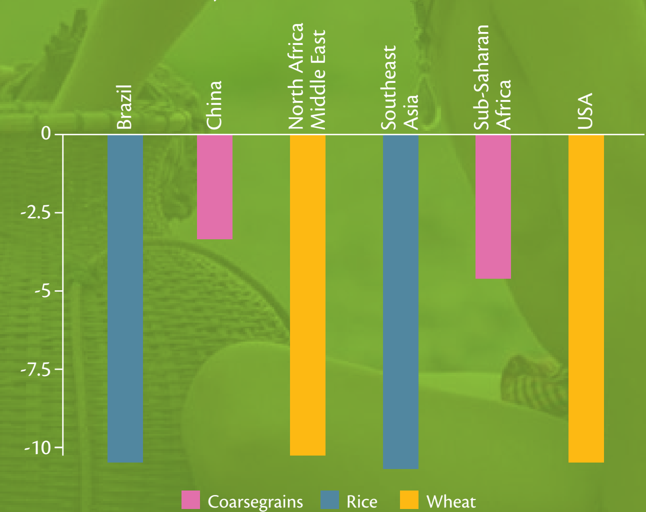
## Driving Forces

Economic Growth

Demographic Development

## Lower Yields and Higher Prices

This graph shows the impact of climate change on production of three major crops in 2050 (average result of three circulation models without adaption in % relative to baseline values)




**% Reduction in production, 2050**

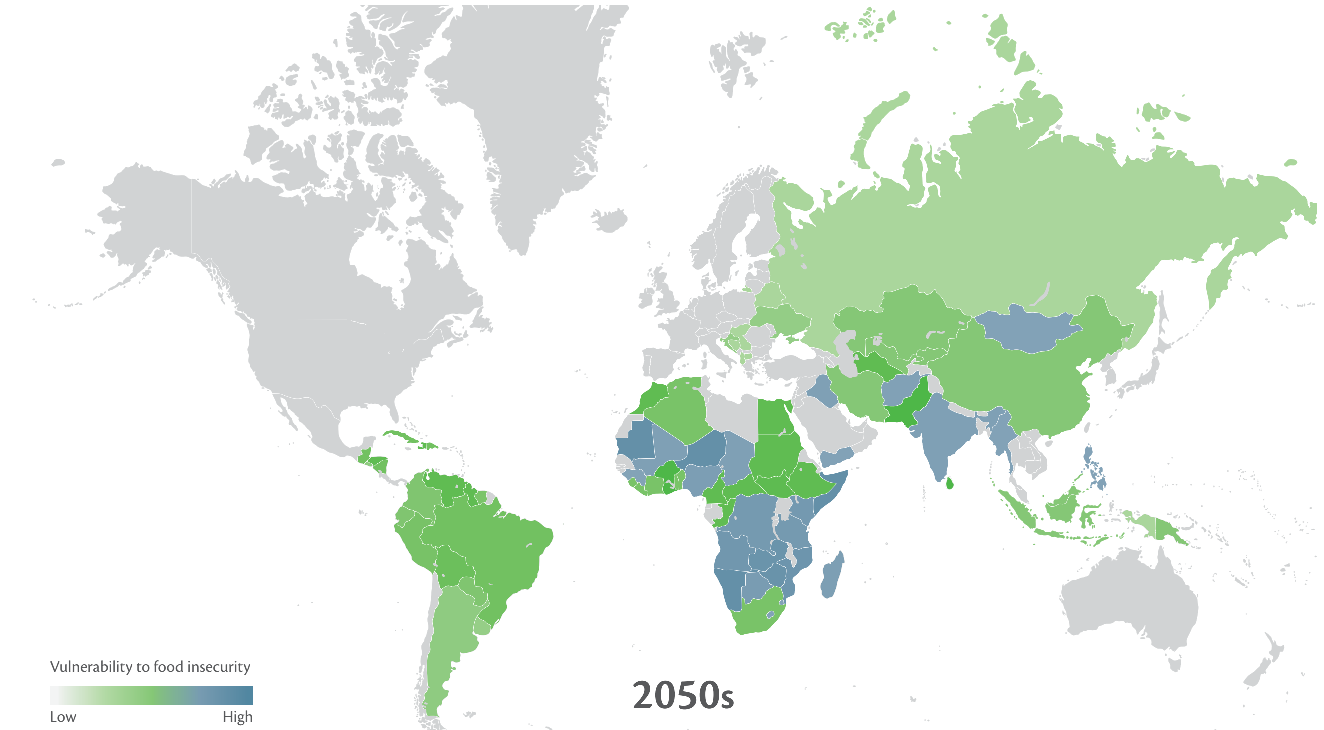


## Assessment

Climate induced food insecurity is highly likely and is set to increase with time, however, its consequences depend on the degree of climate adaption. Diffusion of existing technology could effectively mitigate the impact of supply shocks.

## Data & Facts

Climate change, population growth, and economic growth will continue to be push-factors for food price volatility. Extreme weather conditions, like drought, will exacerbate existing threats to food security through a combination of more frequent and intense climate hazards, diminishing agricultural yields and intensifying competition over scarce resources. The vulnerability to food insecurity is expected to be the highest in developing countries, emphasising the need for diffusion of advanced farming practices and new credit markets business models.




**Food insecurity and climate change for non-OECD countries, 2050s**

## Areas to Consider

Governments should consider how the geopolitical agenda and the stability of nations could change due to climate change inflicted food insecurity.

The international community needs to be ready to respond to price shocks to prevent unproductive export stop and cascading effects.

The choice between designed anthropogenic nature vs. system breakdown will increasingly confront politicians.

## Did you know?

An estimated 2.5 billion people in the developing world depend on agriculture for their livelihoods.

Even without the effect of climate change, it is projected that yields will be unable to keep up with population growth.

Fisheries are moving northwards, for example the traditional US Maine lobster will be moving out of the US and into Canadian territory.

Sources: Intergovernmnental Panel on Climate Change (2014), 'Climate Change 2014 – Synthesis Report'; Wiebe, K. et al. (2015), 'Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios'; Padgham, J. (2009), 'Agricultural development under a changing climate: opportunities and challenges for adaptation'; Fytrou, N. (2015), 'World food crisis and the Arab Spring'; Met Office (2016), 'Food Insecurity and Climate Change'.

# CLIMATE REFUGEES

Climate refugees are people who are displaced from their homes due to the effects of climate change, which compromises their wellbeing or secure livelihood. Environmental change can be caused by extreme weather, like hurricanes, floods, drought, and water scarcity, or rising sea levels causing saltwater intrusion into scarce aquifers.

Already in 1990, the Intergovernmental Panel on Climate Change (IPCC) noted that the greatest single impact of climate change could be on human migration. The IPCC and the Stern report both estimates that there could be 200 million forced climate migrants by 2050.

The international conventions on the status of refugees, which rose out of the ashes of World War II, does not recognise climate refugees. Many of the 200 million refugees would thus be defined as irregular migrants and would not be subject to protection. New multilateral agreements for resettlement are required when relocating inhabitants of climate-threatened islands. Towards 2050, there could be increasing pressure to amend the treaty to help climate migrants.

The impact on climate change is already felt. According to climatologists at NASA, the period from 1998 to 2012 in Syria was 10% to 20% drier than the worst period in the previous 900 years. Man-made climate change was at least in part to blame for the severity of the drought, according to the study. The Syrian drought was thus exacerbated by climate change.

## Driving Forces

- Focus on Health
- Economic Growth
- Demographic Development

## European Refugee Crisis

The European refugee crisis began in 2015 when more than a million migrants and refugees crossed into Europe, travelling across the Mediterranean Sea or overland through Southeast Europe. These foreign refugees encompassed not only asylum seekers with refugee status, but also encompassed economic migrants, sparking a crisis as countries struggled to cope with the influx, and created division in the EU over how best to deal with the refugees. In many European countries, it prompted the closing of national borders.

Climate change increasingly threatens the secure livelihood of people around the world, calling for political agreements for dealing with people who have been displaced, not just in Europe, but also in the rest of the world. The European refugee crisis could thus be seen as a precursor for a larger influx of climate refugees.

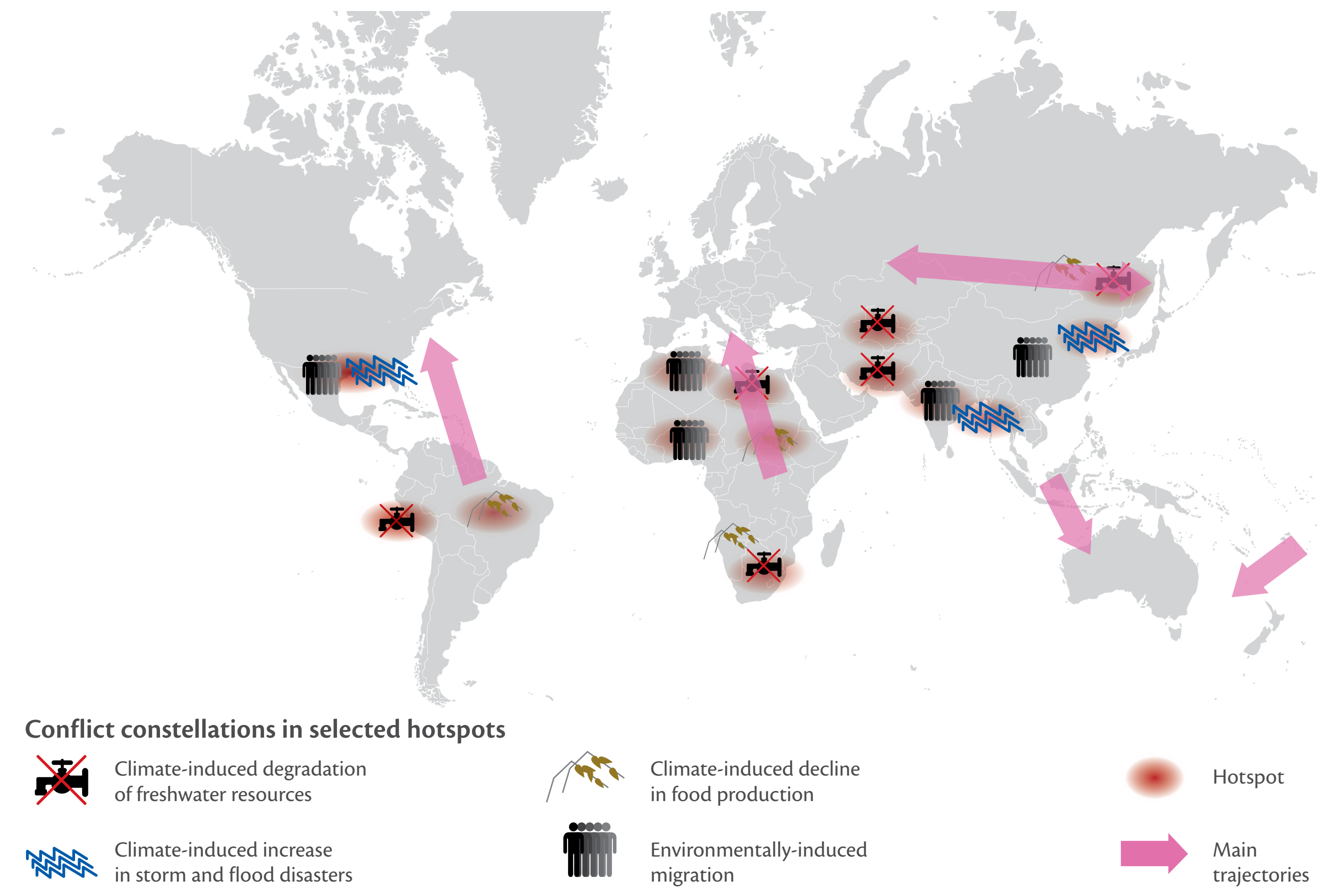


## Assessment

The greatest single impact of climate change could be on human migration. It is considered highly certain that climate migration will take place. This is an ongoing phenomena that most likely will increase towards 2050.

## Data & Facts

It is hard to project the extent of climate induced migration. The hotspots will be defined not only by the physical impact of climate change, but also by the economic ability to adapt to climate change. Migration patterns will most likely move from hotspots towards wealthier regions. The legal status of climate refugees will be a defining factor for international migration. As is the case today most climate refugees will likely be internal displaced migrants.




Climate change effects & beyond: Hotspots & Trajectories towards 2040

## Areas to Consider

Climate refugees could substantially outnumber political refugees by 2050. This would significantly increase the need for investment in border control.

Access to finance and technology that can help people in climate-sensitive areas to adapt to the changing climate is needed, e.g. improved flood defences, preparedness, and response plans, or technology to increase crop yield (See GMO).

## Did you know?

Kiribati, an island nation, a string of 33 coral atolls dotted around the international dateline in the Central Pacific Ocean, purchased land on its nearest neighbor Fiji in 2014. Kiribati is likely to become one of the first victims of climate-induced sea level rise, which will force its population away from their homes.

Sources: Stern, N. (2006), 'The Economics of Climate Change'; Intergovernmental Panel on Climate Change (2014), 'Climate Change 2014 – Synthesis Report'; National Geographic Society (2016), 'Climate Refugee'; Cook, B. et al. (2016), 'Spatiotemporal drought variability in the Mediterranean over the last 900 years'; Bogataj, L. K. (2011), 'Climate change as a problem of national and international security rather than environmental issue'.

# POLLUTION AS A MASS MURDERER

Air quality is an outcome built on a web of causal factors: industrial output and government support for it, energy policy, vehicle emissions and urban planning. Moreover, its impact is all-pervading: from health, to tourism, to demographics (parents are choosing to delay having children in China because of air quality).

Citizens therefore have a right to ask whether this issue is foremost in policy-makers› minds.

More than 5.5 million people are dying prematurely annually across the world because of the impact of poor air quality - it will soon become the biggest cause of premature death.

This is a challenge exacerbated by large-scale urbanization across the world, but especially in developing countries. The increase in population density as cities transform into mega-cities has the dual effect of exposing more people to poor air quality, and creating more pollution.

However, the most pertinent factor is economic growth. Developing nations need power to fuel their economies, and given that access to electricity is a fine and complex balance between public health and economy.

By 2060, air pollution could cost 1% of global GDP (USD $2.6 trillion) annually because of sick days and medical costs.

## Driving Forces

Focus on Health

Economic Growth

## Pollution in cities

In several Chinese cities, lifespans are 5 years shorter than the national average due to air pollution. Furthermore, 80% of the population are exposed to pollution levels higher than safe levels.

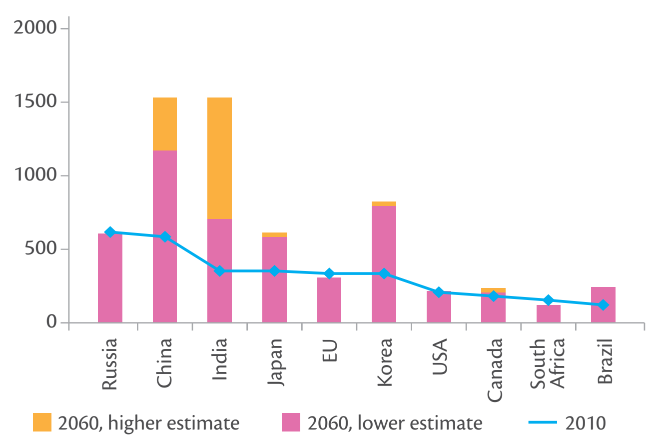
In India, 620,000 people die every year from air pollution. Delhi, in particular, has air pollution levels 15 times the World Health Organisation's safe ratings. Average regular daily exposure to these levels is equivalent to smoking 40 cigarettes per day.



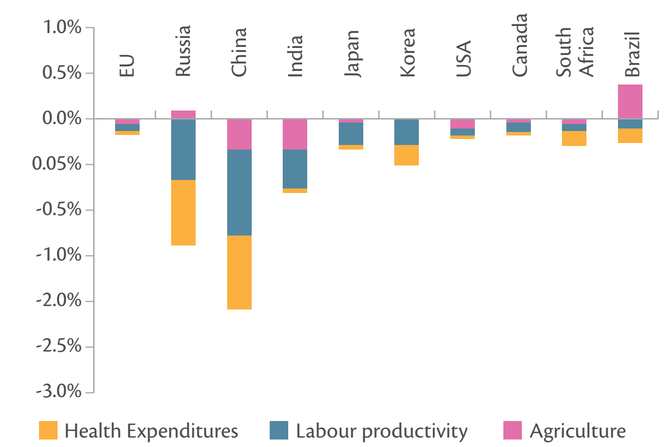
## Assessment

Declining air quality, combined with urban population increases, represents an alarming challenge to governments around the world. The impact cuts across society, economy and environment. Damaging effects are already being experienced today, and this is only projected to increase in the coming decades.

## Data & Facts




**Premature deaths from particulate matter and ozone (Deaths per million people)**




**Change in GDP from extra health costs, lower productivity and reduced farm output (Projected % change 2010 - 2060)**

The number of fatalities and economic impact is already alarming at current levels; without urgent, sustained and coordinated action, major world cities housing large populations could have untenable living conditions.

## Areas to Consider

Air quality could become the most significant indicator with regards to quality of life, happiness and other indices.

Air quality as a potential driver for mass migration: people might find themselves having to leave their homes in order to avoid pollution and respiratory diseases.

Remedial measures could include: emissions trading markets, public awareness, clean cars, retrofitted buildings and improved urban design.

## Did you know?

1.6 million people die every year in China because of air pollution

Sources: OECD: Economic Consequences of Air Pollution; Future Agenda: The World in 2025

# SECURITY AND DEFENCE



## INTRODUCTION

Towards 2050, global power relations will change from unipolar to a multipolar world, making international stability less predictable. New technologies will change warfare and security priorities significantly. It will enable single citizens and amorphous networks to potentially wreak global havoc. It could also expand conflict into outer space.

The following chapter describes 11 trends shaping the future of security and defence. The 11 trends presented can be categorised into the following three areas:

**5**

### Changing Threats Environment:

- Cybercrime and Cyberwarfare
- Engineered Pandemics
- Critical Infrastructure Fragility
- Counter-terrorism / Radicalisation
- Proliferation of Weapons of Mass Destruction

**4**

### New Security Paradigm:

- Adaptive Cyber Security Architecture
- Privatisation of Security
- Weakening and Failing States
- Evolution of Criminal Activity into the Dark Web

**2**

### Defense and Space Assets:

- Militarisation of Space
- Regulation of Space

# CYBERCRIME AND CYBERWARFARE

Cybercrime is defined as a crime in which a computer is the object of the crime (hacking, phishing, spamming) or is used as a tool to commit an offense (cyberattack, child pornography, hate crimes). Cybercriminals may use computer technology to access personal information, business trade secrets, or use the internet for exploitive or malicious purposes. Europol is the European Union's law enforcement agency headquartered in The Hague, the Netherlands. It assists the 28 EU member states in fighting international crime and terrorism. Europol is planning for a future where the criminal is an independent cybercriminal entrepreneur who sells their service to the highest bidder. These cybercriminal entrepreneurs could be experts in a niche areas, such as cyber systems. Europol notes that cybercriminals are expected to sell their services via the Darknet (networks that are not indexed by search engines and are only available to a select group of people using authorization, specific software and configurations) and Darknet websites like Silk Road (an E-Bay like exchange for illegal products and services).

Cyberwarfare is any virtual conflict initiated as a politically motivated attack on an enemy›s computer and information systems. These attacks can disable infrastructure, financial and organisational systems by stealing or altering data to undermine networks, websites and services. The distinctions between cyber crime and warfare can blur as attacks or hacks can come from a lone wolf, activist organisation, business competitor, or a state.

Towards 2050, as society becomes ever more digitised, the threat vectors that can be exploited by criminals and attackers increase exponentially, creating a more vulnerable society. Advancements in cybersecurity are necessary, otherwise it will seriously slow down the development of the Internet of Things and technological advancement in general. Currently, little thought has been given to security during the roll-out of cyber in all systems, and small players (countries and companies) often do not have the resources or awareness (financial, technical or skills) to safeguard their critical assets and infrastructures.

## Driving Forces

- Technological Development
- Technological Diffusion and Empowerment
- Network Society

## Yahoo Hack

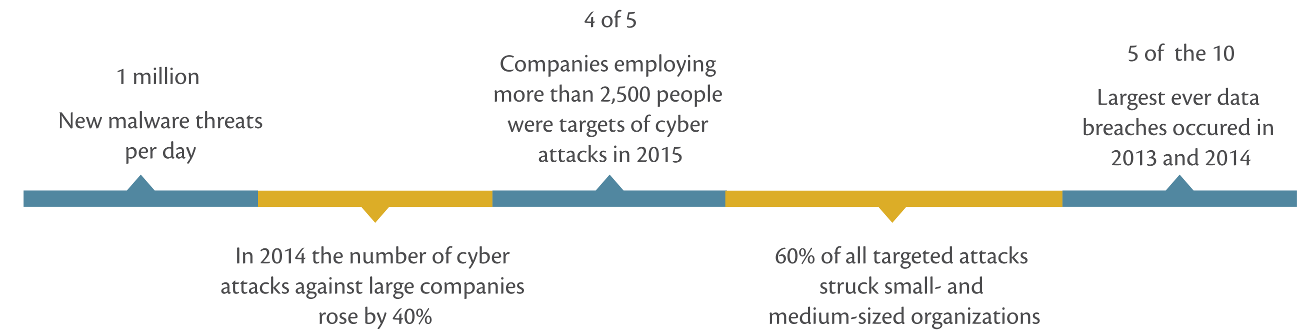
Cybercrime: In September 2016, Yahoo announced that information from at least 500 million user accounts were stolen from the company, including telephone numbers, dates of birth and passwords. In December 2016, this figure was updated to 1 billion user accounts.

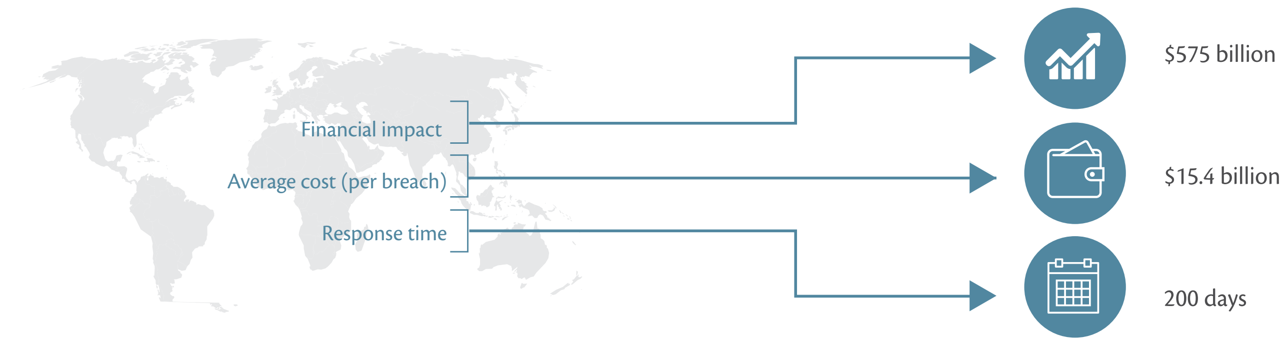


## Assessment

This trend will be an ongoing threat as new vulnerabilities are constantly emerging, intensifying the arms race between IT criminals and security developers. The impact will in a worst-case scenario cause all data communication to stop, or reveal the most confidential data.

## Data & Facts




**Impact of cyber attacks**

Due to security weaknesses in the emerging Internet of Things, cyber security experts only expect the threat to grow.

## Areas to Consider

Governments should explore not only how they can better protect themselves, but also how it can introduce better security standards and empower businesses to better protect themselves.

Governments should ensure readiness against cyber attacks in all forms including social engineering. Governments should also strengthen their cyber warfare /cyber crime contingency plans, including ensuring manual redundancies when possible.

Governments should also examine the legal consequences of cyber crime/warfare. As cyber crimes generally do not cause physical harm, they tend to be punished more leniently than traditional crime.

## Did you know?

According to Greg Shannon, current assistant director for cybersecurity strategy at the White House Office of Science and Technology Policy, it will take up to 10 years to make the most critical components of the electrical grid and large industrial systems robust against cyber attacks. The more pervasive changes will take 20 or more years.

Sources: Zurich Insurance Group & Atlantic Council (2015), 'Risk Nexus: Overcome by Cyber Risk? Economic Benefits and Costs of Alternate Cyber Futures'; MIT Technology Review (2016), 'Cyber Survival'. US National Intelligence Council (2017), 'Background to "Assessing Russian Activities and Intentions in Recent US Elections": The Analytic Process and Cyber Incident Attribution', Source: Internet Security Threat Report, Symantec, Source: The Ponemon Institute2015 Cost of Data Breach Study: Global Analysis.

# ENGINEERED PANDEMICS

Engineered pandemics and similar biological weapons are designed or enhanced by genetic modification to spread disease among people, plants, and animals through the introduction of viruses, bacteria, etc. Due to the exponential development and democratisation of genetic, medical and bio-technologies, it becomes easier for a tyrant, terrorist, lunatic, or simply a curious student to create a doomsday virus or an organism that combines long latency with high virulence and mortality. Since 2008, the costs for sequencing genomes has fallen at a rate that outpaces Moore Law, and the cost of sequencing a human-sized genome is now below USD 1,000. By 2040, many of the financial (see figure below right) and technical barriers for developing an engineered pandemic will have fallen.

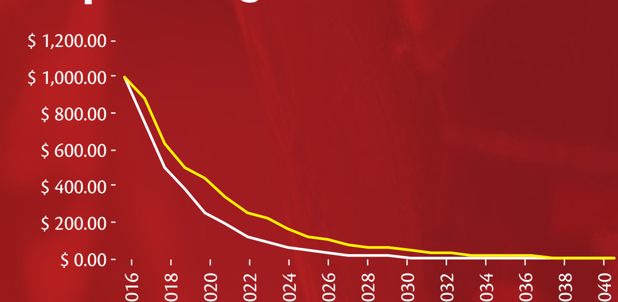
Democratisation of technology means that the methods of engineering the DNA of microorganisms are readily available. Due to the pace of technological development, these are becoming more powerful. This combined with the “Do It Yourself” movement has shifted genetic engineering out of large institutions and into DIY labs or people’s homes. As a result, in 2016 the US National Intelligence Council (US NIC) added gene editing to a list of threats posed by “weapons of mass destruction and proliferation”. In its report, the US NIC notes that research in genome editing conducted by countries with different regulatory or ethical standards than those of Western countries probably increases the risk of the creation of potentially harmful biological agents or products.

This threat will be one that needs to be continually monitored and prepared for.

## Driving Forces

- Technological Diffusion and Empowerment
- Individualisation
- Knowledge Society
- Network Society

## Moore’s Law - Genome Sequencing




**Costfrom 2016- 2040, if processing power continues to double every 2 - 3 years (Moore's Law)**

From 2001 - 2008, the price for sequencing a genome fell from 100 million to 1.3 million USD. By 2040, it could cost less than 25 cents. The yellow line represents a slowing of Moore’s law (doubling every three years) compared to every two years represented by the red line.



## Assessment

This trend will be an ongoing challenge as it is already possible to develop engineered pandemics. The challenge will be to develop responses that will either reduce the impact or mitigate their development or deployment. These range from identifying possible threats before they are deployed to limiting an engineered microbe’s or virus’ spread if it is released into a population.

## Data & Facts

Possible economic costs of a flu pandemic

| % change in GDP, first year | Mild | Moderate | Severe |
|---|---|---|---|
| World | -0.7 | -2.0 | -4.8 |
| High-income | -0.7 | -2.0 | -4.7 |
| Developing | -0.6 | -2.1 | -5.3 |
| East Asia | -0.8 | -3.5 | -8.7 |
| Europe and Central Asia | -2.1 | -4.8 | -9.9 |
| Middle-East & North Africa | -0.7 | -0.7 | -7.0 |
| South Asia | -0.6 | -2.1 | -4.9 |
| Death (millions) | 1.4 | 14.2 | 71.1 |

According to a 2008 World Bank study (table), the possible economic costs of a flu pandemic can range from mild to severe. The first (mild) scenario is modeled on the Hong Kong flu of 1968 - 1969; the moderate flu has the characteristics of the 1957 Asian flu; and the severe simulation is benchmarked on the 1918 - 1919 Spanish flu. Each of these scenarios assumes that efforts by individuals and official agencies to limit the spread of the disease are no more effectual than those observed during previous epidemics and reflects differences in population density, poverty, and the quality of healthcare available. Developing countries would likely be hardest hit, because higher population densities and poverty tends to accentuate the economic impacts.

## Areas to Consider

Engineered pandemics should be considered in policy and regulations development, national contingency plans and in national intelligence surveillance. Some solutions such as immune system enhancement require special political and ethical considerations.

Security services (law enforcement, intelligence and military) should engage with the local scientific community and do it yourself (DIY) communities to identify blind spots and to get to know the hobbyist biologist.

Governments should consider funding research into bio-agent detection and identification equipment, new vaccines, new antibiotics, and antiviral drugs.

## Did you know?

Researchers at Glasgow University and University of Lancashire Hospitals are developing 3D chemical printers that will allow technicians to assemble complex organic molecules up to fully digestible customized pills for patients.

The goal is that by 2025 this technology will allow hospitals to manufacture custom chemicals and prescription drugs in-house. Due to the diffusion of technologies, this technology will also be accessible to the enthusiast biologist in the general public. Combined with the availability of genetic sequences for viruses for download like small pox. These devices could used for good or ill.

Sources: Foley, M. (2013), ‘Genetically Engineered Bioweapons: A New Breed of Weapons for Modern Warfare’; Regalado, A. (2016), ‘On Patrol with America’s Top Bioterror Cop’; Bohannon, N. (2016), ‘The Zika Virus – A Window Into Future Security Threats’; Lentzos, F. (2014), ‘Preventing a man-made pandemic’; Miller, D. (2015), ‘Defense 2045 – Assessing the future security environment and implications for defence policymakers’; Adams, T. (2012), ‘The ‘chemputer’ that could print out any drug’; McNamee, D. (2014), ‘3D printing may make individualized medicine more affordable’; Burns, A. et al. (2008), ‘Evaluating the Economic Consequences of Avian Influenza’.

# CRITICAL INFRASTRUCTURE FRAGILITY

Critical infrastructure are sectors whose assets, systems, and networks (physical or virtual), are so vital to a country that their incapacitation or destruction would have a debilitating effect, alone or in combination, on security, economy, national public health or safety. Examples of critical infrastructure include: chemical, commercial facilities, communications, critical manufacturing, defense industrial sector, emergency services, energy, financial services, food and agriculture, etc.

Due to increasing interconnectedness, population growth, climate change, and, in many countries around the world, a lack of investment from both private and public transportation and cyber security systems, critical infrastructure could become increasingly fragile towards 2050.

For example, climate change poses a number of challenges for critical infrastructure by changing the operating parameters for which the infrastructure was designed, potentially increasing its fragility. A 2016 study by the European Commission estimates that damages caused by climate extremes to critical infrastructures and key investments in the energy, transport, industrial and social sector, which at present total to €3.4 billion/year, could triple by the 2020s, multiply six-fold by mid-century, and amount to more than 10 times the present damages by the end of the century.

A lack of investment could also increase infrastructure fragility as it often leads to shortfalls in maintenance. By 2030, globally there will be the need for between US $ 60 - 75 trillion of additional infrastructure capacity, but governments will likely to be only raise $50 trillion.

## Driving Forces

Network Society

Demographic Development

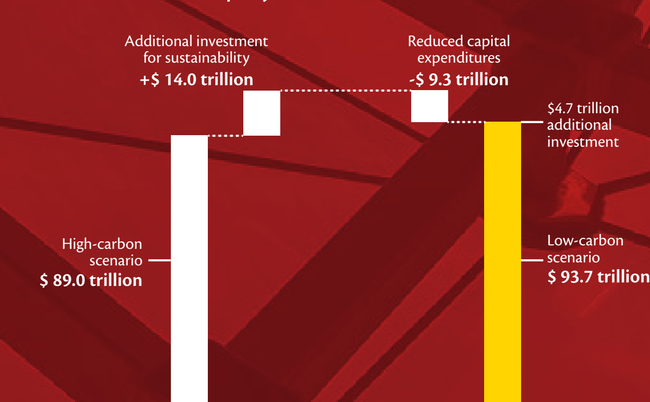
More efficient use of Natural Resources and Environment

## Assessment

The fragility of the critical infrastructure is a key challenge today, which will only grow in importance. The impact of it will be dependent on local circumstances (impact of climate change, degree of investments in cyber security and maintenance, etc).

## Global Sustainable Infrastructure Funding, 2015 - 2030

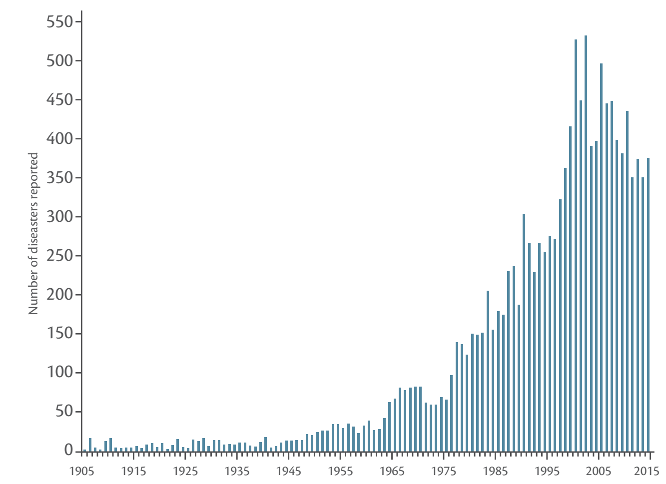
The world needs to find $7.7 trillion annually over the next 15 years to pay for required infrastructure including sustainable projects. The sustainability "premium" could add $14 trillion to overall infrastructure costs between 2015 and 2030. This is partially offset by a lower need to invest in fossil fuel projects.




Projected global demand for infrastructure services 2015-2030



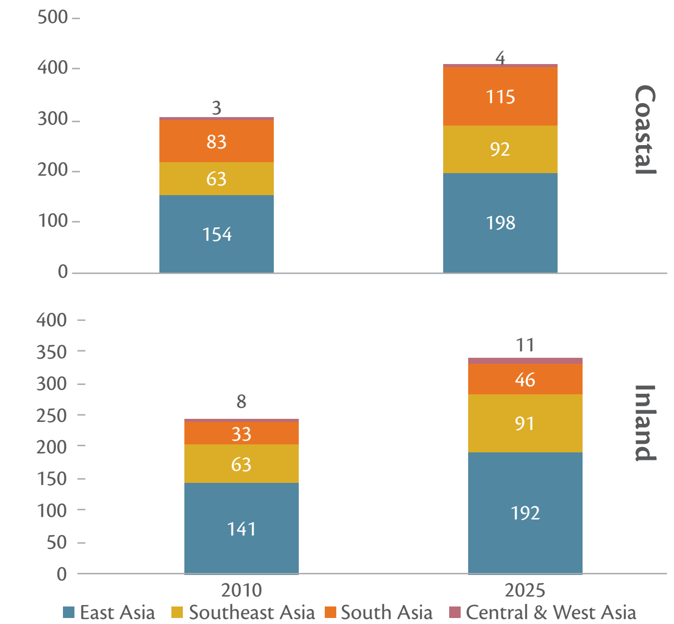
## Data & Facts




Growth in Number of Natural Disasters

Infrastructure risk and vulnerability is underpinned by the dramatic rise in natural disasters, particularly in the last 25 years.

This data points to humanity's influence on our environment, with impact manifesting through climate volatility, rising sea levels and earthquakes.




Populations in Asian cities at risk of flooding (millions)

## Areas to Consider

Governments should develop policy programmes that monitor and update national critical infrastructure contingency plans to anticipate new risks, develop new skills, and build on past experiences when it comes to the risks posed by climate change, hacking of the IoT, and potential investment gaps. Governments should ensure that local policies are developed, monitored updated to ensure emergency response, stabilisation and reconstruction expertise is available when need. Governments should also help businesses and citizens to develop the skills necessary to assist each other, as neighbours are often the first available to assist in crisis situation.

## Did you know?

On December 23, 2015, hackers attacked the Ukrainian power system, first taking 30 substations offline and then striking two other power distribution centres at the same time, leaving more than 230,000 residents in the dark. Finally, hackers disabled backup power supplies to two of the three distribution centres, leaving power plant operators themselves in the dark.

Nearly 100 out 7,600 electricity facilities in the lower 48 states United States are within four feet of high tide and are vulnerable to rising sea levels. While this number appears low, these electrical facilities serve many of the most US important cities. For example, when Hurricane Sandy in 2012 hit the US northeast, it caused record storm surges and flooding along the coasts of New York, New Jersey, and Connecticut. More than 8 million customers across 21 states lost power, and utilities reported damage to some 7,000 transformers and 15,200 masts (DOE 2013). In the aftermath of the storm, New York City found that 37 percent of the capacity of its transmission substations, and 12 percent of the capacity of its large distribution substations, are at risk of flooding during extreme weather events.

Sources: MIT Technology Review (2016), 'Cyber Survival'; Zetter, K. (2016) 'Inside the Cunning, Unprecedented Hack of Ukraine's Power Grid'; BCG (2014), 'Beyond Budgets: The Real Solution to the Global Infrastructure Gap'; Union of Concerned Scientists (2014), 'Power Failure: How Climate Change Puts Our Electricity at Risk – and What We Can Do'; Asian Development Bank (2015), 'Asia's booming cities at most risk from climate change'; McKinsey and Co: Bridging global infrastructure gaps; EM-DAT: Rise in Natural Disasters.

# COUNTER-TERRORISM / RADICALISATION

Countering radicalised terrorist groups is not a new phenomenon. Counter-terrorism consists of the practices, tactics, techniques, and strategies that governments, militaries, police departments, and corporations adopt in response to terrorist threats or acts real and imputed.

Publications by various national security agencies hope that terrorism will be marginalised by 2050, reducing the need for counter-terrorism. The future of terrorism, and the need for counter-terrorism, is difficult to predict as they are driven by geopolitics, the development and diffusion of technology, and immaterialisation trends. Geopolitics shape the motivations of potential terrorists, while the development and diffusion of technology affect the capabilities of both terrorism groups and counter-terrorism forces. Immaterialisation (the driving force shaping storytelling and the need for belonging) will define the successful terrorist group. The successful radical and terrorist organisations are those with the best stories that can recruit and inspire, and those will likely gain prominence in the future.

Counter-terrorism will be probably be more difficult to control as terrorist organizations shift from centrally controlled organisations to decentralised ones. The last 15 years have shown that centrally controlled radicalised organisations are relatively easy to counter and marginalise by aggressive military, intelligence-gathering, and law enforcement efforts. Due to the diffusion of technology, the barriers to entry to terror continue to decline. As a result, the future of radicalisation and terrorism will be centred around a virtual and global underground of individuals. Successfully countering this threat will be a critical focus for military, intelligence and law enforcement agencies, as well as private companies, as they are often the targets of terrorist and criminal networks. Private companies are preparing private cyber and other security solutions to counter the threat wherever they operate. Cyberspace will be the critical frontline to identify and counter potential threats.

## Driving Forces

- Immaterialisation
- Network Society
- Technological Diffusion and Empowerment

## Terrorism is Related With Conflict Zones

Terrorism is most related to the world's most contested zones. Since 2015, terrorist attacks have been focused largely in the Middle East (20,193 killed in 1,490 attacks) followed by Sub-Saharan Africa (3,445 killed in 187 attacks), Asia (3,279 killed in 302 attacks), and Europe and the Americas (658 killed in 46 attacks). The Middle East and Asia have experienced nearly 50 times as many deaths from terrorism than Europe and the Americas.

The counter-terrorism trend closely relates to the trends Cybercrime and Cyberwarfare, Companies v. Cities v. Nation States, and Critical Infrastructure Fragility, because cybercrime is often a resource and tool for terrorism, companies and other entities are targets of radicals and terrorists, and critical infrastructure becomes targets in need of protection.



## Assessment

Counter-terrorism and radicalisation is an ongoing challenge that is expected to continue with a high cost. Estimates suggest that the United States spends USD 125 billion annually on counter-terrorism. This cost is spread across the entirety of the government. This estimate does not include actual physical, economic consequences of terrorism.

## Data & Facts

The targets of terrorism:

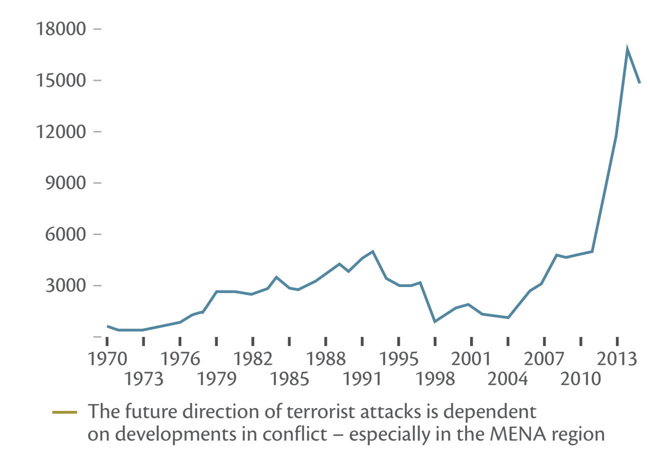
There were 62,022 terrorist attacks from 2011 - 2015. Many of the recent terrorist activities are conducted by five organisations: Taliban, ISIL, Boko Haram, Maoists in India, and Kurdistan's Worker Party. The primary targets of terrorism have historically been 1.) private property and citizens, 2.) governments, and 3.) business. In 2014, there was a six per cent increase towards private citizens and their property. The emergence of IoT could accelerate attacks against property. Terrorists most often use the following tactics: bombings (52%), armed assault (23%), hostage taking (9%), infrastructure attacks (8%), and assassination, (8%).

Transition from centralised to distributed:

Whereas centralised organisations have the best capabilities in ensuring coherent and organised communication and attacks, they are also much more vulnerable if the centralised point is harmed – as opposed to the distributed organisation, which is practically impossible to harm significantly through a single strike.

Cyber and social media are new frontlines in counter-terrorism efforts:

ISIL has been the most successful terrorist organization in using the internet and social media as both a propaganda and a recruitment tool. Cybercriminals and terrorists are now targeting financial transactions online, offering critical funding opportunities and posing significant threats to economies.




Number of terrorist targets worldwide 1970 - 2015

## Areas to Consider

Technology diffusion enables terrorists to develop their capacities, innovate, and act (recruit, secure financing, communicate self promote, attack, etc.) in an increasing number of areas. Such areas include healthcare, infrastructure, financial services, energy systems, education, internet, etc.

Governments should develop new anticipatory approaches to surveillance, policing, intelligence gathering, collaboration and other skills among its security services. Security services will have to continually research and educate staff and develop targeted partnerships with the private sector.

Security services will have to more quickly develop and disseminate best practices, training, and real-time information.

## Did you know?

From 2000 - 2014, approximately 60 per cent of all terrorist attacks were committed using explosives, 30 per cent use fire arms, 10 per cent use other weapons.

Since 2000, the top 3 business types targeted by terrorists are:

- Retail/grocery/bakery
- Bank/commerce
- Restaurant/night clubs/cafe

Sources: Miller, D. (2015), 'Defense 2045 – Assessing the future security environment and implications for defence policymakers'; Institute for Economics and Peace (2015), 'Global Terrorism Index 2015 – Measuring and understanding the impact of terrorism'; Vice (2015), 'The Future of Terrorism According to Vice'; Rand Corporation (2015), 'TACTICS: Policy and strategic impacts, implications and recommendations'; Cordesman, A. H. (2016), 'Comparing Estimates of Key Trends in the Uncertain Metrics of Terrorism'.

# PROLIFERATION OF WEAPONS OF MASS DESTRUCTION

A weapon of mass destruction (WMD) is a nuclear, radiological, chemical, biological, or other weapon that can kill or bring significant harm to a large number of humans, or cause great damage to manmade structures or the environment.

Towards 2050, technology trends will likely make WMDs cheaper and more accessible, while geopolitical developments shape motivations to acquire and use them, which are difficult to predict.

Driven by such trends as the diffusion of technology and the knowledge society, the proliferation of these weapons will be harder to prevent, and they could be more prevalent in the future. The spread of these weapons to rogue states, criminal or terrorist organizations, and even to university students or "do it yourself" enthusiasts poses significant threats to international security. Technological development could permit the development of new forms of WMD beyond those mentioned above. Chemical and biological weapons (CBW) are likely to:

- Be more accessible to state and non-state actors due to declining barriers to acquisition and further development of CBW technologies;
- Have greater capability to defeat current and emerging countermeasures
- Be more precisely targeted
- Be harder to attribute (utilising previously unknown agents and/or delivery mechanisms) than what is currently possible today

## Driving Forces

Technological Development

Knowledge Society

Technological Diffusion and Empowerment

## The Dual-use Challenge & Cheaper Technology

Countering WMD proliferation is a challenge. While much of the focus on WMD proliferation is on nuclear and chemical precursors, WMDs proliferate through dual-use technologies (conventional and WMD). Such technologies could include delivery devices, projectile weapons, launch platforms and guidance systems, which are essential components.

The UK Ministry of Defense expects that 3D printing will be a common feature in homes by 2030. This proliferation of manufacturing technology would allow non-state actors to produce advanced weapon systems, including WMDs. For example, in 2014 a 3D-printed drone was able to carry a 1.5 lbs. payload.



## Assessment

It is very likely that WMDs will continue to proliferate as technological development makes them easier and cheaper to produce. The challenge is assessing the impact and whether or not they will be used. When countries gain access to WMDs, it changes the dynamics of international relations. Non-state actors in the Middle East and Asia have already a demonstrated a willingness to use WMDs.

## Areas to Consider

Many of the activities and initiatives needed to secure critical infrastructure and to protect a country from engineered pandemics can also be applied to WMD proliferation.

WMD proliferation is an ongoing threat that requires proactive and explorative processes to understand plausible and potential threats before and as they emerge. This will help governments and companies prepare for non-state actors' acquisition of WMDs and the decentralisation of advanced manufacturing capabilities.

## Did you know?

The Islamic State (ISIL) has used its English-language online magazine Dabiq in an effort to buy usable nuclear materials.

In 2014, Iraq presented an official report to the UN General Assembly in September, 2014, notifying that ISIL seized some 40 kg of uranium isotopes from Mosul University.

Sources: Miller, D. (2015), 'Defense 2045 – Assessing the future security environment and implications for defence policymakers'; Institute for Economics and Peace (2015), 'Global Terrorism Index 2015 – Measuring and understanding the impact of terrorism'; Vice (2015), 'The Future of Terrorism According to Vice'; Rand Corporation (2015), 'TACTICS: Policy and strategic impacts, implications and recommendations'; Cordesman, A. H. (2016), 'Comparing Estimates of Key Trends in the Uncertain Metrics of Terrorism'.

# ADAPTIVE CYBER SECURITY ARCHITECTURE

The number and severity of cyber attacks are increasing due to the move to cloud-based services and open APIs, poorly secured digital infrastructure of the Internet of Things (IoT), and the increasing sophistication of threat actors. Public and private organisations can no longer rely on traditional perimeter defence and rule-based security to protect their information and systems. As a result, an alternative approach to security is emerging – adaptive security. Adaptive security consists of four main elements: Predict, Block/Prevent, Detect, and Respond to threats and attacks in real-time. These requirements are currently beyond the capability of most organisations' cybersecurity teams (see Data & Facts section).

This means that organisations and their IT departments need adaptive systems that deploy heuristic systems that share and correlate information for detecting and responding to threats in additional to more traditional blocking and other measures to prevent or block attacks. For example, adaptive security systems monitor a network for malicious traffic and behavioural anomalies, identify potential point vulnerabilities, identify real-time changes to systems, automatically enforce end-point protections and access rules, block malicious traffic, follow a compliance dashboard while providing audit data, and more.

Towards 2050, the importance of Adaptive Cyber Security will grow due to the emergence of the Internet of Things, especially in its industrial applications. In the industrial Internet of Things, industrial systems – some of which handle volatile chemicals and other dangerous materials – will be brought online. These systems need more aggressive protection to ensure their safety.

## Driving Forces

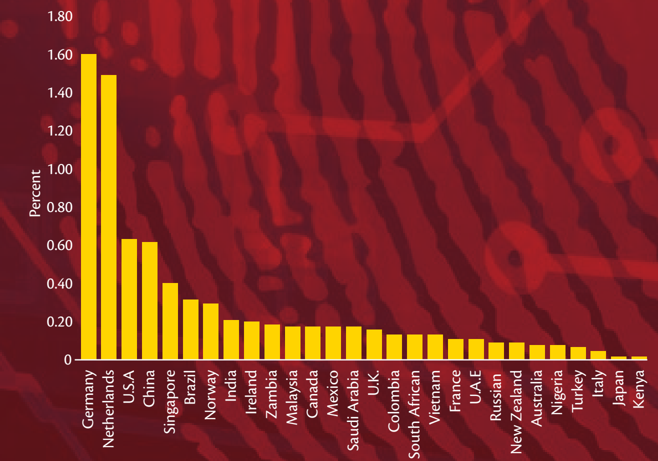
Technological Development

Network Society

Technological Diffusion and Empowerment

## The Estimated Cost of Cybercrime and Espionage

According to 2014 estimates by the Center for Strategic and International Studies (CSIS), the costs of cybercrime range from 0.02 % of GDP in Japan to 1.6 % in Germany



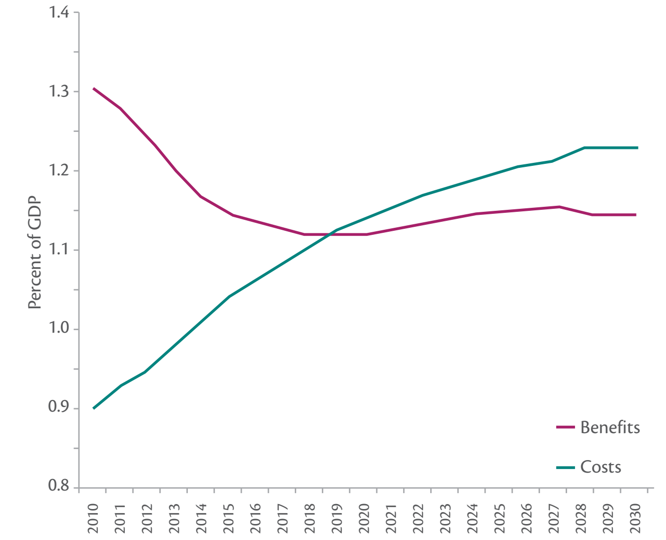



## Assessment

The development of an adaptive security architecture will be an ongoing requirement for governments and businesses in the future.

## Data & Facts

Due to the increase in cybercrime and cyberwarfare, security spending is increasing all over the world. An analysis of the benefits offered by cyber connectivity compared to the costs of cybersecurity raises a number of concerns. Due to the feebleness of current cybersecurity, the benefits offered by connectivity could be outstripped by security costs as early as 2018. By 2030, over 1% of global GDP could be spent on cybersecurity. This is half of what the NATO countries are expected to spend on defence. For the emergence of the IoT and m-society to occur as projected, cybersecurity costs need to become far more effective (or significantly less expensive), or the benefits of ICT will need to continue to multiply.




**Cyber connectivity benefits VS Cyber security costs, 2010 - 2030, % of global GDP**

## Areas to Consider

Governments should encourage next-generation security projects, build internal security and encourage private security capacity, and invest in developing national cyber resilience.

Governments should encourage a new security mindset that recognizes that there is no such thing as perfect security and that treats security as a continuous feedback loop of intelligence-gathering, learning and improving, adapting to security threats as they evolve.

Governments should prepare contingency plans and policies for situations where the costs of connectedness exceed the benefits.

## Did you know?

In a study of US and UK organisations by the Ponemon Research Institute, 70 % of security professionals said that their companies have problems taking actions based on threat intelligence because there is too much of it, or it is too complex. In particular, 69 % said that their companies lacked staff expertise. As a result, only 46 % said that incident responders used threat data when deciding how to respond to threats, and only 27 % said that they were effective in using the data.

Sources: Ponemon Research Institute (2016), 'The Value of Threat Intelligence: A Study of North American & United Kingdom Companies'; Gold, J. (2016), 'Traditional security is dead - why cognitive-based security will matter'; Korolov, M. (2016), 'Flood of threat intelligence overwhelms many firms'; Zurich Insurance Group & Atlantic Council (2015), 'Risk Nexus: Overcome by Cyber Risk? Economic Benefits and Costs of Alternate Cyber Futures'.

# PRIVATISATION OF SECURITY

The wars in Afghanistan and Iraq, as well as the fight against terrorist organisations in Africa, the Middle East and elsewhere, have led to the return of private security forces in defence and security (commonly referred to as private military and security contractors or PMSCs). Due to the emergence of opportunities in a dynamic security landscape, private actors continue to take advantage of globalisation, network societies, and the diffusion of inexpensive and increasingly powerful weapons to support a variety of interests, including nation states, private corporations, non-governmental organisations and transnational criminal and terrorist organisations. PMSCs already use drones and robots in the execution of their operations. For example, PMSCs have been used by NGOs to document abuses in Darfur. Shipping companies use private navies to protect their fleets from piracy.

According to the US think tank RAND's testimony in US Congress, security experts expect that PMSCs are going to continue to be used in large numbers alongside U.S. troops, as they provide US government the ability to 'surge' capabilities during operations. They also provide the appearance of smaller or non-existent operational footprints as they do not appear as part of official troop numbers. The US reliance on PMSC use gives other nations cover to do the same. For example, Russia has often been accused of using Chechen mercenaries in Ukraine and Syria. Putin has gone on the record supporting PMSCs as tools for implementing national interests with direct involvement of the state.

The development of PMSCs towards 2050 is dependent on three trends. Geopolitical developments will affect countries' and companies' demands for PMSC services. Technological developments (e.g. robotics) could lessen the demand for humans in the field. The diffusion of technology could empower PMSCs to such a degree that they could encroach on a nation's ability to secure itself and can even counteract national goals (e.g. by not following a country's rules for engagement or even worse switching sides or going rogue). The emergence of PMSCs create the need for new, multi-stakeholder alliances among states, industry, and civil society.

## Driving Forces

Network Society

Globalization

Technological Diffusion and Empowerment

## UK: The Largest Provider of Private Security

The United Kingdom is the world's largest provider of private security companies with approximately 200 PMSC companies in operation, including G4S the world's largest private security company. Many of these companies are based around Special Air Services headquarters. The services provided by these firms include land based and maritime security services.



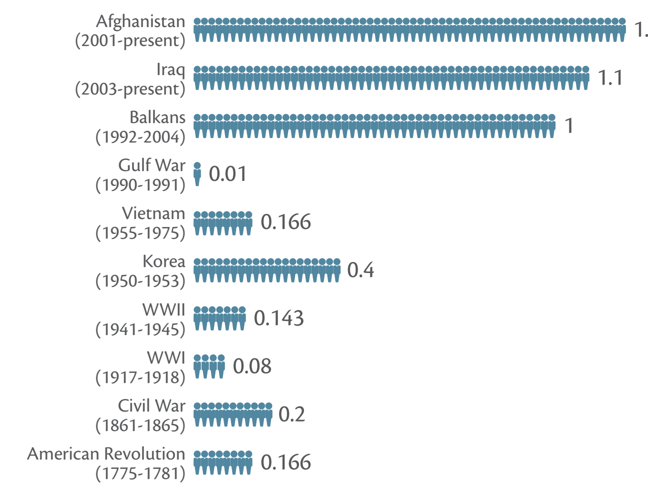
## Assessment

The impact of this trend is dependent on a country's reliance on PMSCs, and on their reliability. If PMSCs become powers in their own rights, they could become destabilising forces in regions beset with security challenges if they decide to switch sides or go rogue.

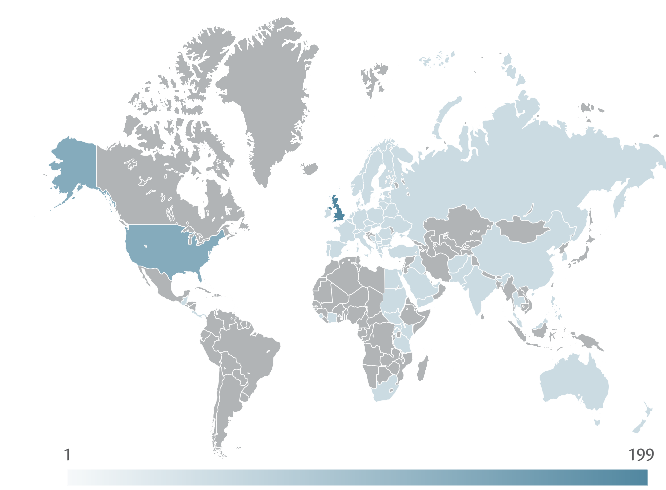
## Data & Facts

The below graph shows that the US military's reliance on PMSCs has grown significantly since the end of the Cold War. The future use of PMSCs depends on geopolitical challenges, technological developments, and changes in defence spending towards 2050. Currently, the United States, the United Kingdom, and Russia have all increased their spending on PMSCs. Increased spending comes not only from the military, but also from foreign offices, police services, and corporations. The Economist estimated that private security companies like Academi (formerly Blackwater), which used to garner the majority of its revenues from governments, will soon generate half its revenues from corporations.

The data available on PMSCs is very sparse. Much of it only covers signatories of the International Code of Conduct (ICOC) for PMSCs. The majority of signatories comes from Europe (mostly the UK), followed by Asia and North America.




PMSCs Per U.S. Uniformed Military Personnel (During Stabilisation and enabling civilian authority phases of operations)




Number of ICoC Signatory Company Headquarters per Country (2013)

## Areas to Consider

Governments should ensure oversight and enhance PMSC mechanisms as necessary to ensure that these forces do not have a detrimental impact on their military and security goals.

Governments should ensure that they possess some degree of organic capability and capacity to be able to operate and even increase operating capabilities without assistance of PMSCs.

The automation of security (drones and robots) could lessen the need for humans in the battlefield, potentially lessening the need for PMSCs.

## Did you know?

In 2014, there were three times as many private security contractors in Iraq and Afghanistan as there were US combat troops. It has now reached the point where the United States cannot deploy and operate without PMSC assistance in areas like logistics.

When government forces withdraw from post-conflict/catastrophe stabilisation operations, PMSCs often fill the security vacuum.

Sources: Zenko, M. (2015), 'The New Unknown Soldiers of Iraq and Afghanistan'; Dunigan, M. (2010), 'Considerations for the Use of Private Security Contractors in Future U.S. Military Deployments'; Gilsinan, K. (2015), 'The Return of the Mercenary'; LaPorte, M. (2014), 'Balancing Act: The U.S. Military›s Reliance on Contractors to Fulfill Operational-Level Logistical Requirements'; University of Denver (2016), 'Private Security Monitor Statistics Database'.

# WEAKENING AND FAILING STATES

Weak and failing states pose significant challenges not only to those directly affected by the internal conflicts, but to the international community as well. States can fail for a number of reasons, but mostly because of internal conflict: These include ethnic conflicts, civil wars, and revolutions. Fault lines can emerge between identity groups defined by language, religion, race, ethnicity, nationality, class, caste, clan, or area of origin. Tensions can develop into conflict over competition over resources, predatory or fractured leadership, corruption, or unresolved group grievances.

States could weaken and fail if economic dislocation, high debt rates that lead to requirements for significant cuts in government spending, growing polarisation (and the awareness of it), climate change, and population growth in Africa and Asia, are not met with policy responses that promote inclusive economic opportunity. While 43 % of the world's poor now live in countries and economies on the 2015 fragile states list, by 2030, poverty could become increasingly concentrated in fragile states. Even under the best-case scenario, 62 % of the global poor will be located in fragile states. Sub- and transnational populations and groups that are enabled by an increasingly interconnected world and the diffusion of increasingly powerful technologies will be enabled to challenge central authorities in a variety of ways.

Although the reasons for state weakness and failure are complex, they are not unpredictable. It is important that the international community understand and closely monitor the conditions that contribute to fragility — and be prepared to take the necessary actions to deal with the underlying issues or otherwise mitigate the negative effects. Effective and sustained action towards improving and fulfilling the UN' Sustainable Development Goals are some of the ways the actions that governments can make to stabilise weakening and failing states.

## Driving Forces

- Demographic Development
- Economic Growth
- Technological Diffusion and Empowerment
- More efficient use of Natural Resources and Environment

## Weak Institutions Lead to Weak and Failing States

Weak governmental and social institutions are common for all fragile states, and most are or have recently been involved in major or minor conflicts. Natural disasters also tend exacerbate challenges faced by weak states by disrupting poor infrastructure, maximizing fatalities and injuries due to urban crowding, by affecting states' ability to provide service to survivors. Disruption combined with displacement can also exacerbate existing tensions between groups and strains on supplies, which can undermine individuals' faith in public institutions. States become illegitimate in the eyes and in the hearts of a growing plurality of its citizens, which can have long-lasting consequences for fragile states. Over the past decade, ten fragile states have experienced an average of more than three natural disasters each year, with Afghanistan (105 disasters), Bangladesh (89 disasters) and Pakistan (83 disasters) especially vulnerable.

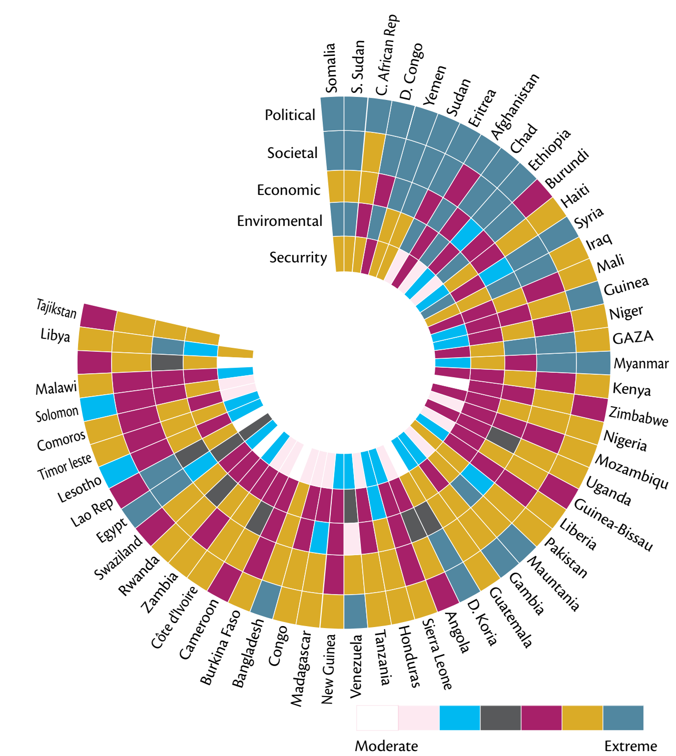


## Assessment

Weakening and failing states are ongoing phenomena that need to be monitored, as they can drive refugee flows and generate insecurity. Impact will be low unless it relates to neighbouring states, or states where countries have large financial interests or credit exposures.

## Data & Facts

According to the 2016 States of Fragility study by the OECD (figure), over the past 15 years, 3.34 billion people, or almost half of the world's population, have been affected by violence. The number of violent conflicts is decreasing, but conflicts are killing more people: conflict-related deaths have tripled since 2003. Violent extremism and terrorism are also on the rise. The economic cost of violence is rising too: the global economic impact of violence is a staggering USD 13.6 trillion, equivalent to 13.6 % of Global GDP. And civilians, especially children and women, are most at risk.




Indicators of the statesof fragility, 2016

## Areas to Consider

Internally, governments should ensure that economic development towards 2050 is inclusive and that all believe that they have an opportunity to improve their lives. This requires focusing on resident well-being.

Externally, governments should work with others to support UN's sustainable development goals and the security situation in strategically important countries.

Governments should examine their exposure and risks from emerging fragile states, including studying potential impacts of state failure in neighbouring countries. Governments should have contingency plans in place for a state failure in one its neighbouring countries ,which could engender refugee flows.

## Did you know?

Estimates project that 62 % of the global poor will be located in fragile states towards 2030. Under OECD projections, 25 % of people living in fragile states (nearly 500 million people) will remain at or below the USD 1.25/day poverty line by 2030. Under a more optimistic scenario, the share of people living in absolute poverty (USD 1.25/day) in fragile states could fall to 22 % (420 million) while the best-case scenario sees a fall to 19 % (350 million).

Sources: Fund for Peace (2016), 'Fragile State Index 2016'; OECD (2016), 'States of Fragility 2016 – Understanding Violence'. US National Intelligence Council (2012), 'Global Trends 2030: Alternative Worlds'.

# EVOLUTION OF CRIMINAL ACTIVITY INTO THE DARK WEB

The internet is divided into searchable, indexable pages (the world wide web or surface web), and a much larger, non-searchable deep web. The furthest reaches of the deep web are known as the dark web, which has content that has been purposely hidden. There are multiple legitimate uses for the dark web, but as a result of their hidden nature, there is also a proliferation of illicit uses. These illicit uses vary widely, but most commonly the dark web is used illegally as a marketplace for contraband.

The anonymous nature of the dark web assists in maintaining privacy for:

- Sensitive communications discussing private issues (e.g. mental illness or victimization)
- Anti-censorship and political activism
- Leaked information, used for example by whistle-blowers
- Criminal activity related to terrorism, spying and trading / sale of illegal goods

Anonymity is the key operating principle of the dark web. This trend projects that criminal activity will either migrate to, or evolve to new forms within, the dark web. This is because of a number of issues:

- It is difficult to be traced within the dark web
- There is no, or not enough, public information about how the dark web operates
- The magnitude of the internet means that even if criminal activity is detected and deterred in one section of the dark web, the same or new perpetrators can resurface elsewhere. Encryption, other security measures and lack of 'searchability' implies that new criminal activity could be taking place without authorities' knowledge

Criminal activity in the 21st century is becoming increasingly technology and internet enabled, and spans 'traditional' crimes as well as newer forms of illegal activity such as identity or intellectual property theft. The dark web facilitates criminal activity in distinct ways:

- Providing a secure venue for coordination
- Platforms for illicit transactions (utilizing crypto-currency). These transactions can be anything: stolen personal information, illegal substances, arms, classified documents, contract hires for assassinations etc

Going forward, policymakers, researchers and law enforcement will have to adapt in order to better understand the dark web (no established publicly available literature exists), the machinery behind it and how it may evolve.

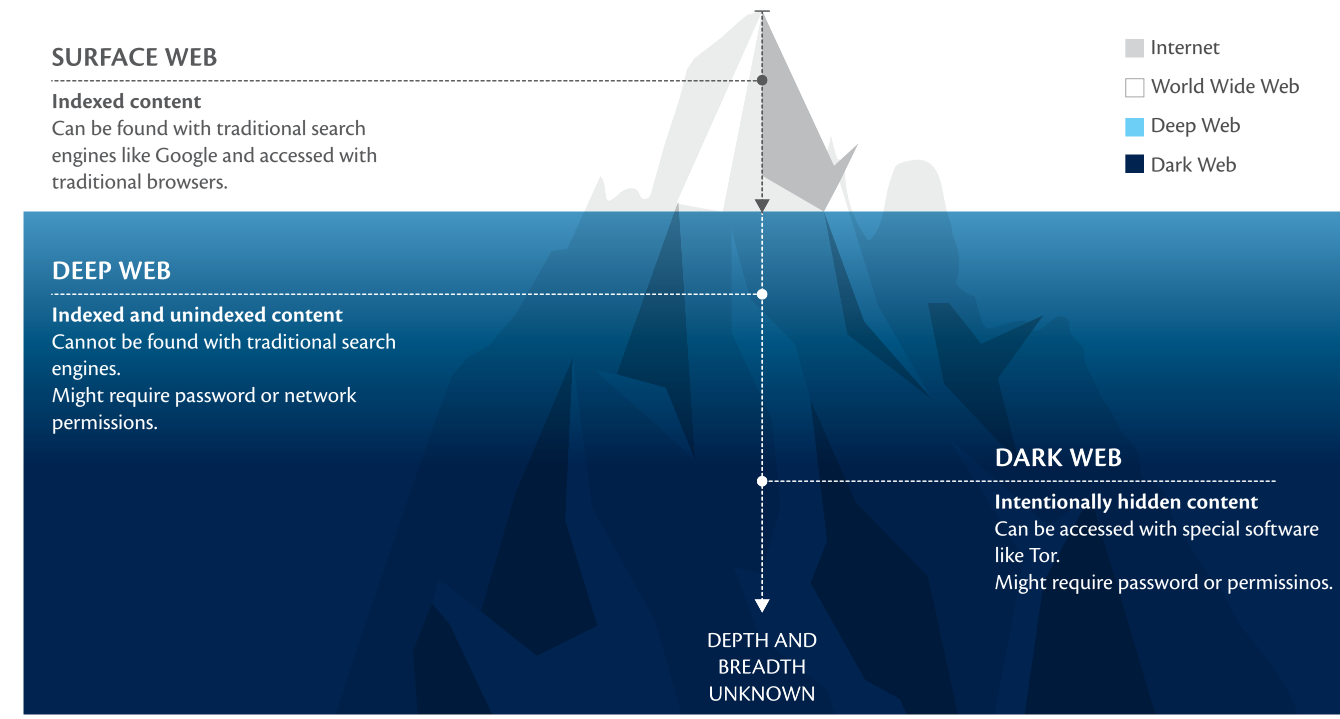
## Driving Forces

Network Society

## The Dark Web as a Tool for Terrorism

There is now an increasing body of evidence which confirms that the Islamic State is utilizing the dark web in a number of innovative manners: information sharing, recruitment, and propaganda dissemination, while using Bitcoin to raise money for their operations.






## Areas to Consider

Tor, a deep web network, generated mean daily users of 1.75 million in January and February 2017 (not clear how many of these were for legitimate applications).

'Crypto-markets' are in heavy use in the dark web. They serve as a form of escrow service, with payment in bitcoin only released upon approval of the customer. Also inherent in this system is a feedback / trust mechanism where buyers and sellers are rated, and customer forums exist for complaints (with moderators paid in bitcoin). This is reminiscent of Amazon or eBay and it is interesting to imagine how many other surface web services are mimicked in the dark web.

Advent of the Fourth Industrial Revolution has critical implications for the use of the dark web (for example, advanced or home-based manufacturing capabilities can be marketed and sold for malicious purposes). This poses security risks and requires legal frameworks to be revisited.

## Did you know?

The approximately 8 billion websites which are searchable (i.e. are on the Surface Web) using engines such as Google might only comprise 4% of the internet. The remaining 96% could comprise the Deep Web and is estimated at 7.9 zettabytes of data.

For comparison, 1 zettabyte is equal to 152 million years of video in UHD 8K format.

# MILITARISATION OF SPACE

The militarisation of space is the development, placement, and deployment of weaponry and military technology in outer space. Currently, the 1967 Outer Space Treaty forbids placing weapons of mass destruction in outer space. The Outer Space Treaty, however, does not cover conventional weapons. Although there is no expiration date for this treaty, geopolitical tensions and technological diffusion are straining countries' adherence to it.

Space represents the ultimate high ground and is a critical element of terrestrial infrastructure. Almost sixty countries have satellites or space projects. there are 3400 satellites in orbit; 1300 are operational. Satellites are also the linchpin of a military's ability to operate globally. Currently, the US is the only country with demonstrated capability to do so. Satellites are key to the US military's global reach and network-centric capabilities (comprising command, control, communications, computers, intelligence, surveillance, and reconnaissance structures, better known as C4ISR). If an opponent is able to knock these out, the United States' ability to operate, let alone respond to crises in Europe or the South China Sea, would be seriously affected.

While Cold War-based mutually assured destruction conventions once limited the militarisation of space, recent reports show that these self-imposed limitations on the militarisation of space by the world's major military powers – China, Russia, and the United States – has eroded. This is because the United States in particular possesses a strategic vulnerability, which others now can exploit.

Efforts by the European Union to establish a space code of conduct through the United Nations have not gained traction with other nations. Both China and Russia have tested anti-satellite missile systems over the past decade, while the US, China, and Russia have increased funding to improve their space-based military capabilities. Towards 2050, the militarisation of space will continue unless new frameworks for the peaceful regulation of space can be developed.

## Driving Forces

- Economic Growth
- Technological Development
- Technological Diffusion and Empowerment

## Drones Compensate for Satellites' Vulnerabilities

Satellites are particularly vulnerable to electromagnetic pulse (EMP) weapons, but detonating a satellite or ground launched-EMP at high altitude a belligerent could initiate an attack against an enemy's electrical grids, satellites, as well as the command, control communications, computers, intelligence, surveillance and reconnaissance architecture (C4ISR). Due to their lower cost, ease of replaceability, and fewer vulnerabilities, a number of companies and countries are seeking alternatives to satellites. Airbus, NASA, and Facebook are racing to build high-altitude drones that combine the advantages of a satellite and the flexibility of a plane. These drones could take on some of the roles of satellites in the near future, and the proliferation of tiny, comparatively cheap 'CubeSats' offers some means for replacing vulnerable satellites.



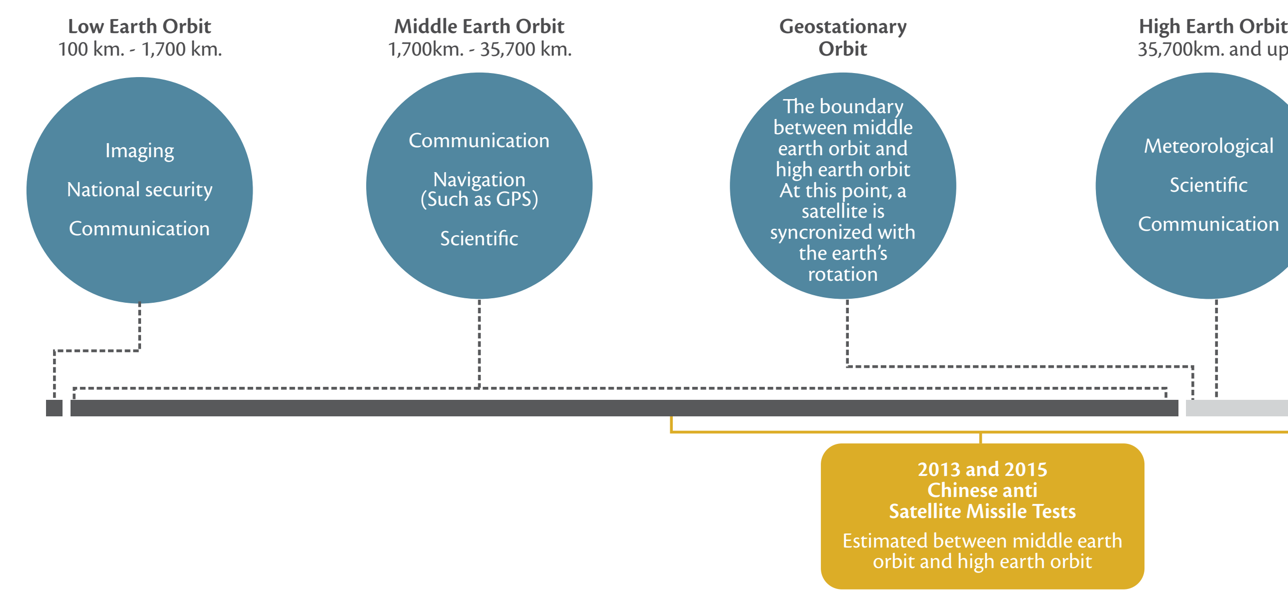
## Assessment

The militarisation of space will be an ongoing and increasingly prescient challenge towards 2050. The militarisation of space can pose a risk if geopolitical conflicts among major powers go hot and affect satellites in space. Space debris could cripple non-belligerents' satellites, affecting communication and other systems globally.

## Data & Facts

China has conducted three anti-satellite missile tests since 2007 in all four of eath`s orbit categories, which are determined by altitude. Depending on purpose, different types of satellites occupy different orbits.

This graphic shows the four orbits, some types of satellites that usually inhabit them and where China`s missile tests happened.




## Areas to Consider

6 - 7% of western countries have a GDP that is dependent on satellite timing and navigation.

The militarisation of space does face limitations. Space-based systems can be susceptible to attack and are cost-inefficient. It costs about USD 27,000 to send 1 kg into low-earth orbit. It costs double that to get into geosynchronous orbit.

Cubesats (10 $cm^3$ and less than 1 kg) are growing in popularity: 543 could be launched in 2020.

## Did you know?

The US Air Force Space Command was created in 1982 and has 38,000 employees and an annual budget of USD 8.9 billion. The US military's entire space budget is USD 22 billion.

Russia has developed several kamikaze satellites including the "Kosmos 2499", which are designed to get close to other countries satellites and disable or destroy them.

China has launched "Shiyan" satellite which can capture other countries' satellites in space.

Sources: Billings, L. (2015), 'War in Space May Be Closer Than Ever'; Stratfor (2016), 'The Real Danger from Space Weapons'; Stratfor (2015), 'The Battle to Militarize Space has Begun'; Sciutto, J. (2016), 'US military prepares for the next frontier: Space war'.

# REGULATION OF SPACE

The 1967 Outer Space Treaty represents the basic legal framework of international space law. This framework has been supplemented by other treaties like the Space Liability Convention of 1972. The regulation of space is currently state-centric and does not take space activities by private companies or persons into consideration. Towards 2050, a number of driving forces are pushing toward a modification of this framework to account for the activities of non-state entities (private persons and organisations).

Particular focus will be given to the following areas of space exploitation, including: militarisation of space, commercialisation of space resources (e.g. mining asteroids), space tourism, space colonisation (e.g. the Moon, Mars, and Venus), and space debris. The development of the regulation of space towards 2050 will depend upon the outcome of eventual negotiations among nation-states.

Space mining, space tourism, and eventually space migration, pose new challenges to the current Space Liability Convention, which posits liability on space-active states for the cost of repair and compensation for all accidents or damage caused by their objects or nationals

Space debris poses a particular challenge, as according to the Outer Space Treaty, the state that launches a space object retains jurisdiction and control over that object, including non-functioning satellites and other space debris. This means that even though a satellite or some other space object may not be functioning, it does not imply that it has been abandoned by the nation that launched it. Without consent from the nation that launched and operates or otherwise owns the satellite or space object, it cannot be disposed of or otherwise interfered with. This even extends to fragments and components from space objects, which would require identification to determine the owner and either individual or blanket consent to remove it from orbit.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

## The Space Debris Challenge

According to the European Space Agency, Scientific models estimate the total number of space debris objects in Earth orbit to be in the order of:

- 29,000 - for sizes larger than 10 cm
- 670,000 - for sizes larger than 1 cm
- More than 170 million - for sizes larger than 1 mm

According to NASA, there have been surprisingly few instances of space collisions due to space debris.



## Assessment

This trend is emerging, and its impact depends on the level of space activity of the country.

## Data & Facts

The following provides an overview of private companies involved in commercialisation of space:

### Space mining companies:

- Deep Space Industries
- Final Frontier Technologies
- Global Space Organizations
- Infinite Space Dynamics
- Kepler Energy and Space Engineering
- Moon Express
- Planetary Resources
- Shackleton Energy Company
- Stott Energy Company

### Satellite Launchers

- SpaceX

### Space tourism

- Benson Space Company
- Space Adventures
- Rocketship Tours
- Virgin Galactic

### Space settlement

- SpaceX
- Interplanetary Transport System
- Mars One

### Space debris removal

- Astroscale

### Google Lunar X

- SpaceIL
- Moon Express
- SynergyMoon
- Team Indus
- Astrobotic
- Team Italia
- Stellar International
- Independence X
- Omega envoy
- Euroluna
- Hakuto
- Part-time scientists
- Team Puli
- Spacemeta
- Plan B
- AngelicVM

## Areas to Consider

In theory, a government could be held responsible for one of its citizens' or companies' activities in space. As a result, until a modification of the Outer Space Treaty framework, some states may opt to prohibit the exploration of outer space by private bodies within their territories so as not to be liable in the event of damage caused by their actions.

There is a possibility of increased competition for water and minerals located in space.

Reduced costs can allow smaller orgnizations to acquire satellites for surveillance or vulnerability analysis, creating significant security concerns

## Did you know?

The US Airforce Command tracks over 500,000 pieces of debris. Each of these is travelling around Earth at approximately 28,000 km/hr.

In 2014, the International Space Station had to be moved thrice in order to avoid collisions with debris.

Sources: Fund for Peace (2016), 'Fragile State Index 2016'; OECD (2016), 'States of Fragility 2016 – Understanding Violence'. US National Intelligence Council (2012), 'Global Trends 2030: Alternative Worlds'.

# DEMOGRAPHICS



# INTRODUCTION

Most developed countries are facing an ageing society with little or no economic growth. Asian and African countries are experiencing much higher growth, and especially African countries have much younger populations. Together with changing lifestyles, this is changing global dynamics, in a profound manner with severe implications on production (of goods, services, energy) in particular, to match new patterns of consumption.

Countries are having to plane for long term impact of demographic developments; this is a challenge in an age of short term gratification for political expediency

The following chapter describes 6 trends shaping the future of demographics towards 2050. The 6 trends presented can be categorised into the following three areas:

3

## Population Dynamics and Age

- Ageing Society
- 21st Century Lifestyles
- Urbanization

2

## Shift in Global Dynamics

- India the Next China
- Growth of Global Middle Class

1

## Gender

- Sheconomy

# AGEING SOCIETY

The global population today is the oldest it has ever been, and it is ageing. This phenomenon is driven by increased life expectancy and/or decreasing fertility rates. Almost all – low, middle and high income – countries have, or are making, the transition from high to low child mortality and fertility rates. Current UN projections forecast that total global fertility rates will decline towards 2.25 by 2040 with high income countries having fertility rates of 1.75, middle income countries of 2.15, and low income countries 3.2.

The impact of this trend varies for governments around the world. High income countries are the first to deal with the ageing crisis as their "boom" generations transition towards retirement in 2010s-2020s. An ageing workforce increases the fiscal burden – due to reduced income tax revenues and increased welfare costs – while decreasing the capacity to respond to the ageing population's need. The decreased tax base resulting from a reduced working population makes pension funding more difficult( see the graph on the right).

In low income countries, decreasing fertility rates create an opportunity to increase the living standards of the broader population, while their boom generations are active on the labor market.

For most developed countries, rapid increases in the elderly population are predicted for the coming decades. In 2040, the majority of surviving 'baby boomers' will surpass 85 years and comprise close to 5% of the developed world's population. Low income countries that have an increasing share of people in the working age are more likely to have economic growth and increasing wealth. Unlike when high income countries "aged", population ageing is occurring at a more rapid pace than previously.

## Driving Forces

Demographic Development

Focus on Health

Economic Growth

Technological Development

## The Rapid Ageing of Europe

Europe's population is rapidly ageing, causing the working population to decline by estimated 0.4 % every year from 2015. By 2040, over 20 % of the workforce are expected to be in the age 55 - 64.

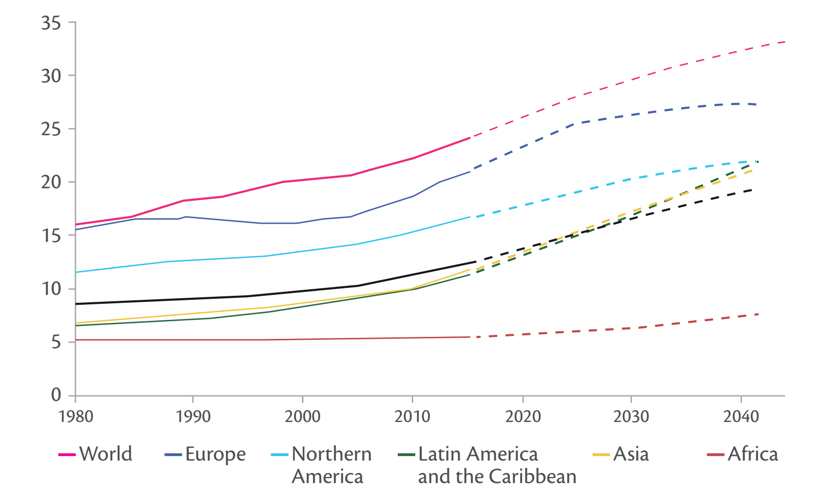
This trend exerts a macroeconomic impact in two different ways: through a higher dependency ratio (i.e. higher proportion of retirees to workers) and through workforce aging. Higher dependency could lead to fewer workers in a fixed population producing less output, so per capita GDP would fall. Aggregate saving rates could decline, as the elderly tend to save less after retirement. Public finances could be put under pressure in ageing economies as the level of age-related spending increases. Specifically there will be increased pressures on the provision of health care and long-term care. In the long term an aging population could also negatively affect technological innovation and adoption.



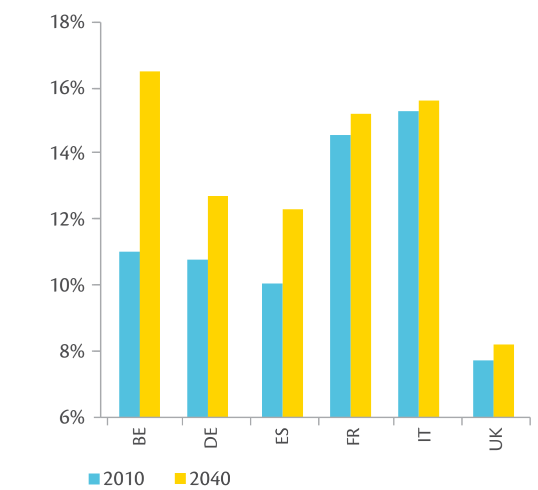
## Assessment

Population ageing is widespread across the world. It is most advanced in developed countries, while, it is growing in less developed parts of the world as well. Thus, the impact of population ageing will vary across the world. The fiscal burden will increase almost immediately in many developed countries as 'boom' generations are retiring, while less developed countries can benefit from a relatively large working age population.

## Data & Facts




Percentage of the population aged 60 years or over for the worlds and regions, 1980-2040




Change in gross public pension expenditure in GDP

By 2040, the ageing population will be much more prominent in all regions. However, even though many developing countries today have an advantage with relatively more people in the working age, many of these countries are ageing more rapidly than high income countries and often at much lower levels of national income. Simply put, high income countries became "rich" before they grew "old", while middle- and low income countries are risk growing "old" before they become "rich".

## Areas to Consider

The healthcare expenditures are expected to increase significantly due to ageing, and new ways of providing and improving healthcare should be considered.

Ageing of the global population opens up new consumption patterns, especially within products, that recognise their need for mobility, safety and medical issues.

Tourist expenditure for age + 60 for a range of European countries are expected to increase by 30- 40 % by 2030, while falling for young adults up to 29 years of age.

Pension reform will be required in many countries.

## Did you know?

In developed regions, life expectancies are increasing by about 2 months per year, which, all else equal, means that every generation can expect to live about 5 years longer than the previous generation. The UK government expects that average life expectancy of newborn girls born in 2030 could be 97 years old.

Sources: CIFS (2013), 'Members' Report – Emerging Trends'; UN (2015), 'World Population Aging'; European Commission (2014), 'Population ageing in Europe – Facts, implications and policies'; UK Government Office for Science (2016), 'Future of an Ageing Population'; Alzheimer's Association (2013), 'Fiscal Year 2014 Appropriations for Alzheimer's-related Activities'; European Commission (2012), 'The 2012 Ageing Report – Economic and budgetary projection for the 27 EU Member States (-2010 2060)'.

# 21ST CENTURY LIFESTYLES

21st century lifestyles describe large scale shifts in the composition of family structures influencing the way we live and consume due to individual empowerment, feminization of the workforce, economic growth and aging.

The changing lifestyles is being influencing various areas: 1) According to the OECD, the growth in single households as a share of all households from the years mid 2000 to the years 2025 - 2030 will reach nearly 50% across Europe as people are marrying later and the population grows older, leading to more widows and widowers. 2) The traditional family structure with mother, father, and children is becoming more complex with blended families. 3) Couples 50+ from post-war generations form an increasingly important consumer segment with greater disposable income and less saving incentive. 4) We see a greater diversity in how we choose to live with new niche groups and family structures such as DINK-couples (Dual Income, No Kids), where couples choose to focus on their careers, and so-called LAT-couples (Living Apart Together), who are in intimate relationships though who live in separate homes.

The single way of life is increasingly becoming a dominant lifestyle in the West and Asia. For some, it is a positive choice, while it can also be a consequence of structural limitations on the labour market. For others (in China and India) there are simply not enough partners to go around. The development creates a market for products and services targeted at the single segment in industries such as travel, food and restaurants and housing etc. The parenting phase of life is increasingly rejected in Europe in favour of a career. More families with only one child create a shift towards high-end consumption, since the consumption is increasingly used for one highly prioritized child and far higher disposable income on average. Towards 2050, the increasing amount of singles will be ageing, and not have the same possibilities for caregiving from relatives as couples with children. On the other hand, these generations that have lived much of their lives as singles have probably acquired better competencies for establishing social relations, that could benefit them compared with widows and widowers.

## Driving Forces

- Individualisation
- Demographic Development
- Immaterialisation
- Economic Growth

## New Phases of Life

In 1950, the western world life generally consisted of 3 simple grown up life phases: Young single, married, and widow or widower. The traditional patterns are breaking up with more and more diversified segments. In the future, life phases will be much more diversified.




## Assessment

More than ever it is possible for the individual to choose whatever lifestyle suits him or her. This has a huge influence on personal consumption, social services, housing etc. This trend looks strong on short term, yet backlashes against this more individualized lifestyles could be witnessed on medium to long term.

## Data & Facts

Projected change in number of single parents from Mid 2000 - 2025 / 30

| Germany | USA | Japan | UK | France | Norway |
|---|---|---|---|---|---|
| -16% | 8% | 22% | 22% | 23% | 27% |

Increase in childless couples from Mid 2000 - 2025 / 30

| Germany | USA | Japan | Netherlands | Austria | Korea |
|---|---|---|---|---|---|
| 14% | 37% | -16% | 10% | 28% | 72% |

Today in many countries in Western Europe and the USA, divorces are almost as common as living together. The boundaries between phases of life are far more fluent than they were before and a growing number skip the parent phase completely. Likewise the parent phase has increasingly become a serial phase with changing partners, children and stepchildren. Children play an important role in the way we live, work and consume.

Societal structures: working time, family products, housing, public services etc. are in most countries geared towards the family, however as the structure and the needs of the family change so must policies and business approach to the family.

## Areas to Consider

Fewer children will be born as a consequence of women having children later and a greater share of singles, this will possibly create an ageing problem and a workforce shortage.

Policy measures to promote fertility can be done through tax reductions, offsetting some of the direct costs of having children, better maternity or paternity leave and better availability and affordability of formal childcare.

## Did you know?

Germany is on its way to become a childless country with 45% of woman aged 25 - 49 being childless.

52% of Italian men aged 25 - 34 live with their parents

Among well educated women there is an over representation of childless women.

DINKS (Dual Income, No Kids) in Denmark consume 15% more than families with children.

Sources: CIFS (2014), 'Members' Report - 21st Century Lifestyles'; OECD (2011), 'The Future of Families to 2030'; OECD (2011), 'Doing Better for Families'.

# URBANIZATION

It is projected that 70% of the world's population will live in cities by the year 2045. Urbanization has been an ongoing concern for decades, but the cumulative effect is now being felt, as cities, with their traditional infrastructure and planning, expand and transform into mega-cities (cities with 20 million or more inhabitants), and stagger under the burden of the infrastructural demands of rapidly rising populations.

Developing countries in particular will experience the effects of urbanization, as cities represent the growth engines of their socio-economic development. Already, by 2015, most cities of 10 million or more residents are in developing countries. In China, the outlook is that 300 million rural inhabitants might move to cities between 2015 and 2030.

Apart from concerns about sanitation and public health, more people living in poor conditions can also become a security issue. A growing sense of inequality could lead to a collective rise in levels of social tensions and frustration. An additional concern is the vicious cycle of pollution, carbon emissions and climate change, especially with the rise of overpopulated cities. Cities are also traditionally vulnerable to natural disasters as urban areas are traditionally situated on coasts or rivers (climate volatility can lead to flooding and other catastrophes).

Urbanization also presents opportunities for growing and evolving societies. Significant proportions of the population are exposed to new ideas, technologies and perhaps entirely novel ways of life. In terms of infrastructure and resources, new cities can develop without the burden of legacy infrastructure.

The implications for demographics are multi-faceted. Cities will increasingly continue to become the center of activity for economies, with impact on how societies adapt to 'the city way of life', increased diversity and shifts in countries' economic output.

## Driving Forces

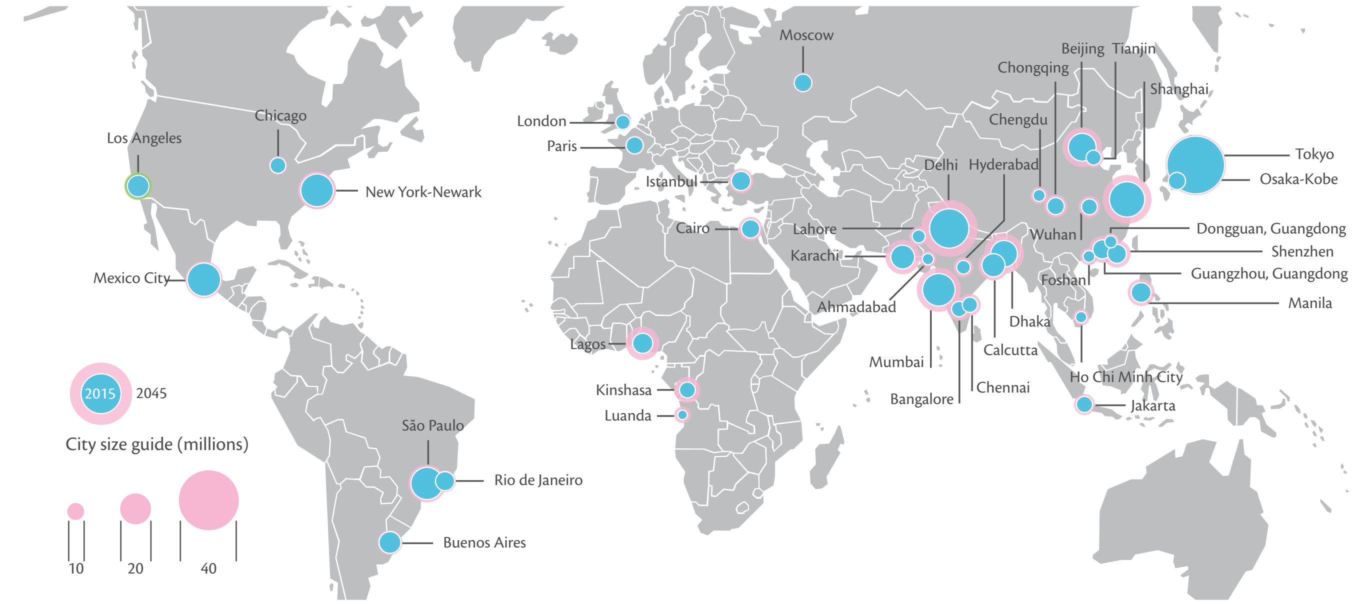
- Demographic Development
- Economic Growth
- More efficient use of Natural Resources and Environment

## Assessment

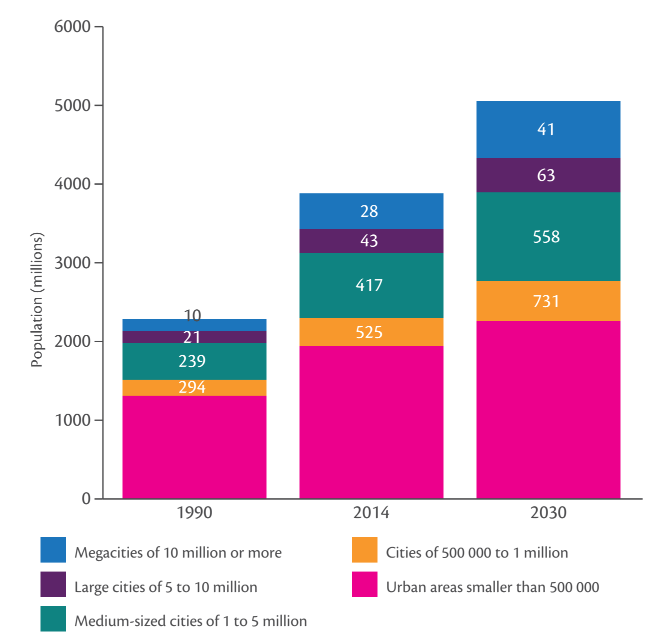
Urbanization and its consequences are certain in the long-term. This is a trend which has been developing over the last two decades and its impact is already being felt, especially in mega-cities around the world.



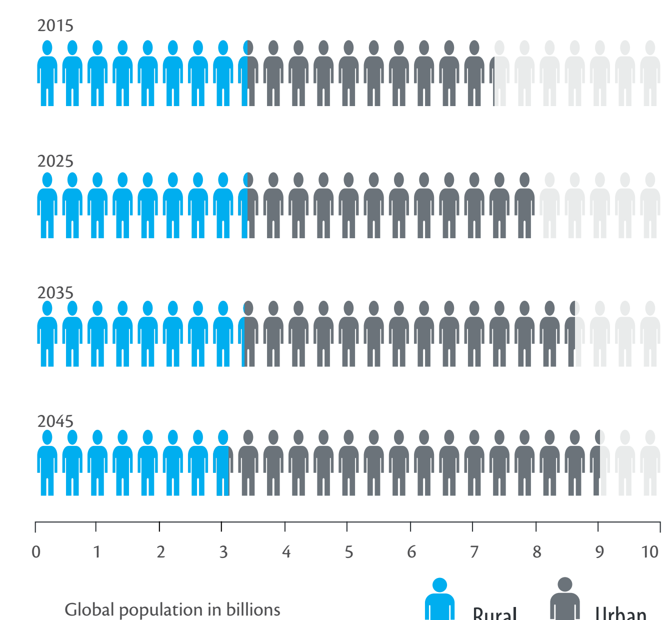
## Major Centres of Population 2015 - 2045




## Data & Facts




Projected expansion in the number of cities and megacities




A growing population living in the urban environment

## Areas to Consider

Policymakers and administrators need to consider where population growth is concentrated, and ensure that living conditions remain habitable. Infrastructure typically is not able to keep up with the pace of urbanization and as a result, population-dense slums can form. These areas are likely to have more incidences of social unrest.

## Did you know?

1 billion people live in slums (living conditions lacking basic amenities, and with constrained spaces a typical feature) around the world currently; this number could triple by 2045 without concerted efforts to re-plan for cities of the future.

Source: National Intelligence Council: Global Trends – Paradox of Progress; UN World Urbanization Prospects; UK Ministry of Defence – Global Strategic Trends: Out to 2045.

# INDIA THE NEXT CHINA

India is set to overtake China as the world's most populous nation by 2022. India's current period of rapid economic growth accompanied by large increases in per capita income, consumption, and the growing middle-class has reshaped expectations towards India's future growth prospects. Towards 2050, we can expect continued long-term growth. India's growth is often compared with China's. There are however, subtle differences between the two countries. This is predominantly in the differing industry structures, demographics, and restrictive traditional class and caste structures. Through economic liberalization in 1991, India became a global player and will continue to be a vital global trade partner, but the accumulation of wealth has not led to a radical transformation of India's caste system. India will struggle to be an independent global hub and continue to leak talent, until structural factors such as universal education and a transparent democracy are resolved. Pressure is also mounting through resource scarcity and environmental issues. This is contrasted with the potential benefits from an expanding workforce, rising incomes, and stronger governance that has been investing in public services and human capital.

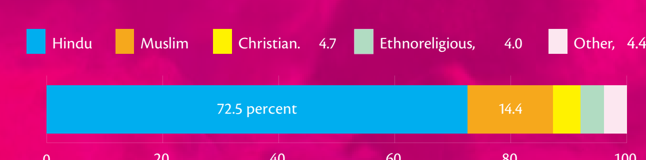
Thus, India's continuing development is shrouded by uncertainties in governance and social structure underpinning this growth. Shifts in society, such as religious revolts or citizen empowerment, as well as the risk of meeting the middle-income trap will have dramatic effects on growth.

## Driving Forces

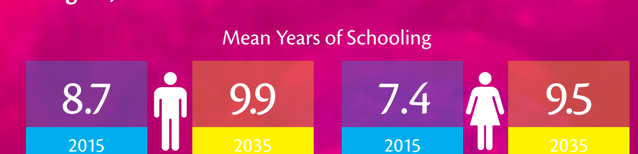
- Globalization
- Demographic Development
- Technological Development
- Economic Growth

## India in 2035

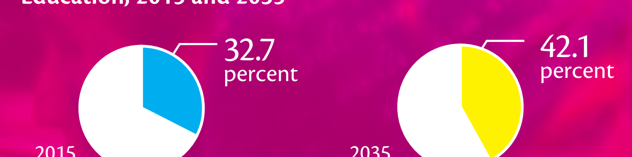
2035 Population Projection 1,585,350,000



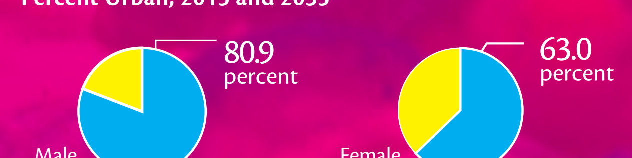

Religion, 2015




Education, 2015 and 2035




Percent Urban, 2015 and 2035



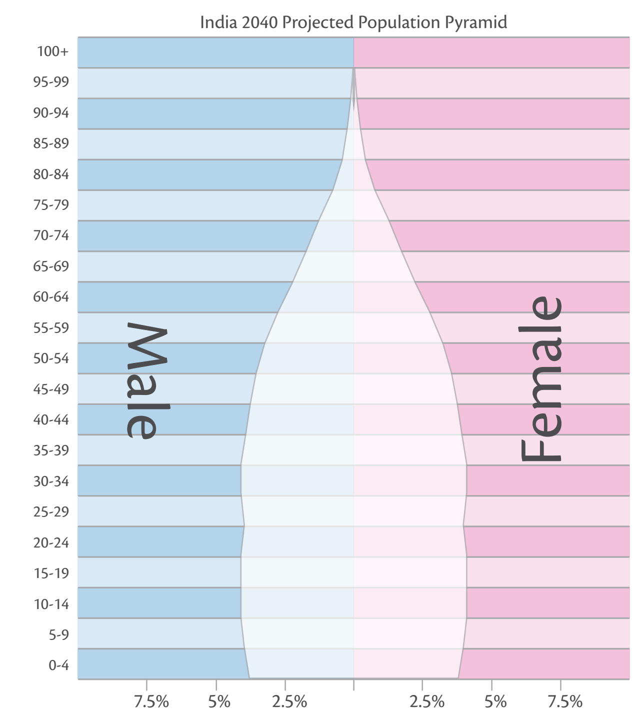

Adult Literacy, 2015

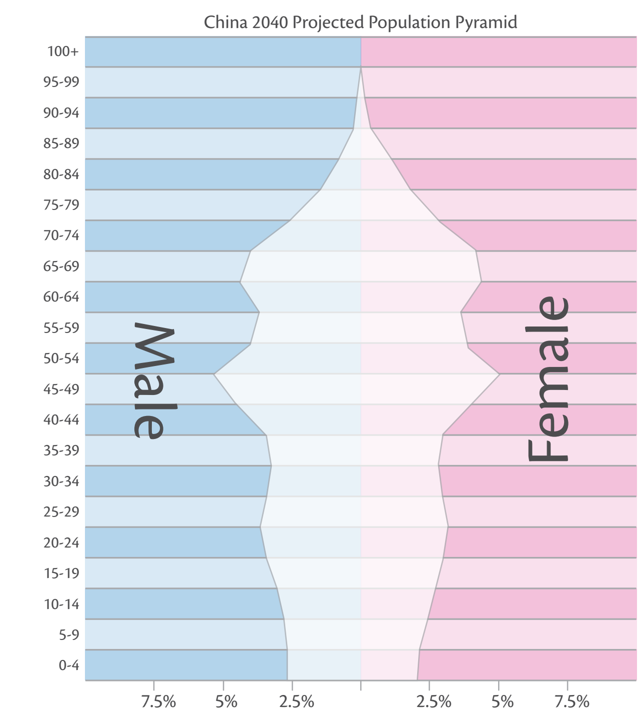


## Assessment

Rising population translates into rising GDP, yet it is still uncertain if India can emulate China's growth trajectory. India has a favorable population pyramid, but is constrained by corruption, lack of transparency, and citizen conflict. Indian consumption is booming, quality of life is improving but the middle-income trap is awaiting ahead.

## Data & Facts




Due to the higher population growth of India, the population difference between these two countries is decreasing. By 2040, India will have a population of approximately 1.64 billion people, compared to 1.40 billion in China. When looking at the projected population pyramids for India and China, it is evident that India's demographic growth is much healthier than China's. India has a comparatively well-balanced pyramid with an expanding share of the working age population, when compared to China's population pyramid, which is contracting and clearly reflects the establishment of the one child policy.

Population pyramids are powerful predictors of future development; and based on demographics, India clearly holds a comparative advantage over China in terms of future economic growth. However, as described earlier, there are many other uncertainties that come into play in relation to India's future development and economic growth.

## Areas to Consider

Demographic dividends will see the Indian labor pool expand over the next 20 years, which is projected to translate into increased economic growth and consumption, making India even more important as a trade partner and for global growth.

Of the 10 cities in the world suffering from the worst air pollution the majority are in India, which will have a major impact on health.

Climate change will reduce India's crop yields by 2050, likely resulting in a need to import food, which might push global food prices upwards

## Did you know?

India has grown at over 4% for the past 22 years, reaching a maximum of 10% growth in 2010. This means the economy has more than quadrupled in size in the last 20 years.

LinkedIn ranked India as the top source of professionals.

India has greater population than the entire Western hemisphere.

Sources: Asian Development Bank (2015), 'Asian Development Outlook 2015: Financing Asia's Future Growth'; Asian Development Bank (2016), 'Asian Development Outlook 2016: Asia's Potential Growth'; International Energy Agency (2015), 'World Energy Outlook 2015'; UN Department of Economic and Social Affairs (2015), 'Population Pyramids of the World from 1950 to 2100'; World Bank (2013), 'Turn Down The Heat: Climate Extremes, Regional Impacts, and the Case for Resilience'; National Intelligence Council: Global Trends – Paradox of Progress.

# GROWTH OF GLOBAL MIDDLE CLASS

Towards 2040, the world population is expected to increase by 1.7 billion to approx. 9.2 billion, with more people moving out of poverty and towards the expanding global urban consumer class – the global middle class. This group is expected to have limited, but growing spending power and greatly influence trade dynamics and the global economy. The increased consumption is at the centre of governmental growth strategies around the world and is increasingly creating a global economic power shift.

The global middle-class is expected to be distributed across the globe, with majority of the growth being located in Asia-Pacific. Of particular importance is the growth in India and China being further located at the top-end of the income bracket, which was previously dominated by the European middle-class.

This demographic trend is powered by globalization but influenced by commercialization and economic growth; to the extent that the definition of middle class is changing to reflect consumption habits rather than income brackets. This trend also encompasses the new expatriate middle class that is spreading across the Gulf. They are not only a source of labour but a market in their own right. Growth of higher value industries, mainly in the service sector, is drawing foreign professional talent with boosted income.

The global middle class is projected to grow from 1.85 billion in 2009 to 4.9 billion in 2030.

## Driving Forces

Globalization

Commercialization

Economic Growth

Demographic Development

## Growth 'Sweet Spot'

The idea of a growth 'sweet spot' refers to the point when people leave poverty, and enter middle-class on a large scale, resulting in rapid consumer growth. Hitting the sweet spot accelerates growth, which in turn increases the size of the middle class, leading to a virtuous circle. Economist Surjit Bhalla has claimed that every 10 % increase in a nation's middle class population produces a 0.5% rise in its growth rate. A country hits its sweet spot around $6,000 annual per capita income.

Projected year for hitting sweet spots

| Country | Year |
|---|---|
| India | 2017 |
| Philippines | 2019 |
| Vietnam | 2019 |
| Pakistan | 2024 |
| Nigeria | 2025 |
| Bangladesh | 2029 |

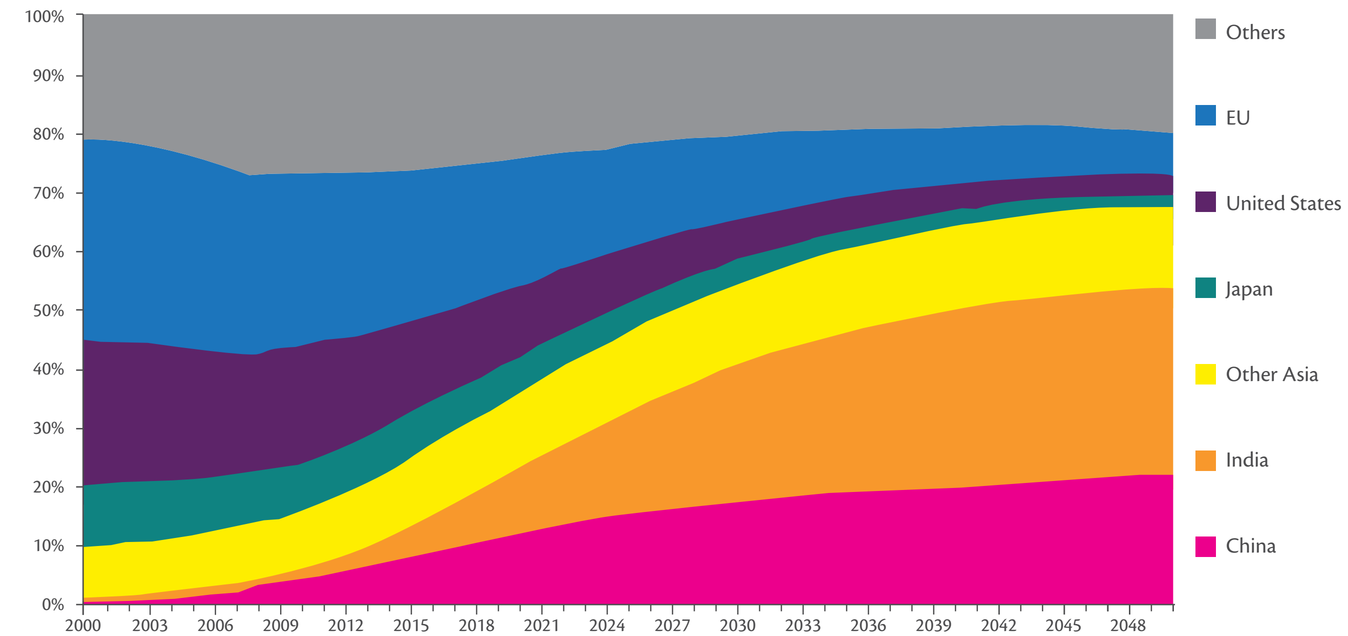


## Assessment

Rising incomes will fundamentally change the consumption landscape and size, and may also alter global labour pools and job markets. There is consensus across all forecasts, even if the exact increase is unknown. However the automation of jobs might interfere with these forecasts and adds some uncertainty to this trend.

As with most demographic trends it will take time to develop fully, but the impact will steadily rise.

## Data & Facts




Proportionate changes to the middle class is set to redefine global trade. Over half of all middle class with their superior spending power and consumption will be located in either China or India. It is forecasted that by 2030 Asia will represent 66 % of the global middle class population, and by 2040 over 60 % of middle-class consumption. As the global middle class grows the relative size of the European middle class is set to half.

## Areas to Consider

As demographic dividends will stimulate economic growth and consumer power, trade with India, China and Indonesia should continue to be a long term priority for most countries.

While there is largely a consensus on the expansion of the middle class. Productivity gains are increasingly derived from automation and could create a decoupling between economic wealth and employment, which would increase wealth, but not necessarily contribute to the growth of the middle class.

## Did you know?

The size of the "global middle class" is expected to increase to more than 3 times the combined population of Europe and the US.

Most people joining the global middle class would be defined to be below the poverty threshold by Western standards.

In 2000, 4 % of Urban Chinese had a household disposable income between ($9,000 to $34,000), in 2012 this had rose to 68%.

Sources: EY (2013), 'Hitting the sweet spot – The growth of the middle class in emerging markets'; OECD (2010), 'The Emerging Middle Class in Developing Countries'; McKinsey&Company (2013), 'Mapping China›s middle class'; Pew Research Center (2015), 'A Global Middle Class Is More Promise than Reality'; Citi GPS: Future Opportunities, Future Shocks; Oxford Martin School: Now for the Long Term.

# SHECONOMY

Sheconomy relates to women attaining higher education, greater levels of employment, more skilled jobs, higher incomes, and greater spending power. Developments in technology and access to education are the two main driving forces of this trend. Technology has relieved many women of time consuming household duties. A global focus on education for men and women through initiatives like the UN Millennium Project have increased the chances of women who have the requisite education and skills to compete with men for jobs. Furthermore, many jobs in services and manufacturing today, and in the future, do not depend on physical strength. This creates more equitable competition among women and men for the same positions.

Sheconomy creates new consumption patterns, new needs and preferences, and new dynamics, both in the workplace and in society in general. Over the next decade, the impact of women on the global economy is likely to be at least as significant as that of the Chinese and Indian economies combined (and potentially more). Additionally, the fourth industrial revolution is likely to result in more flexible and less physical working requirements. This will lead to even more parents being able to balance work and family and further close gender gaps in the workplace towards 2050. The younger generations also seem to have a slightly different perception of the traditional nuclear family and the traditional roles of men and women. For example, based on a survey of US citizens, importance of career is now valued higher by women than men. The shift in values will probably manifest itself even more in the future.

## Driving Forces

- Knowledge Society
- Technological Diffusion and Empowerment
- Economic Growth
- Demographic Development

## Women in the Workforce

According to Science Nordic, gender equality in the workforce seems to benefit both men and women. In more gender equal European countries, the chances of having a higher quality of life are about twice as much as for those living in one of the lesser gender equal counties.

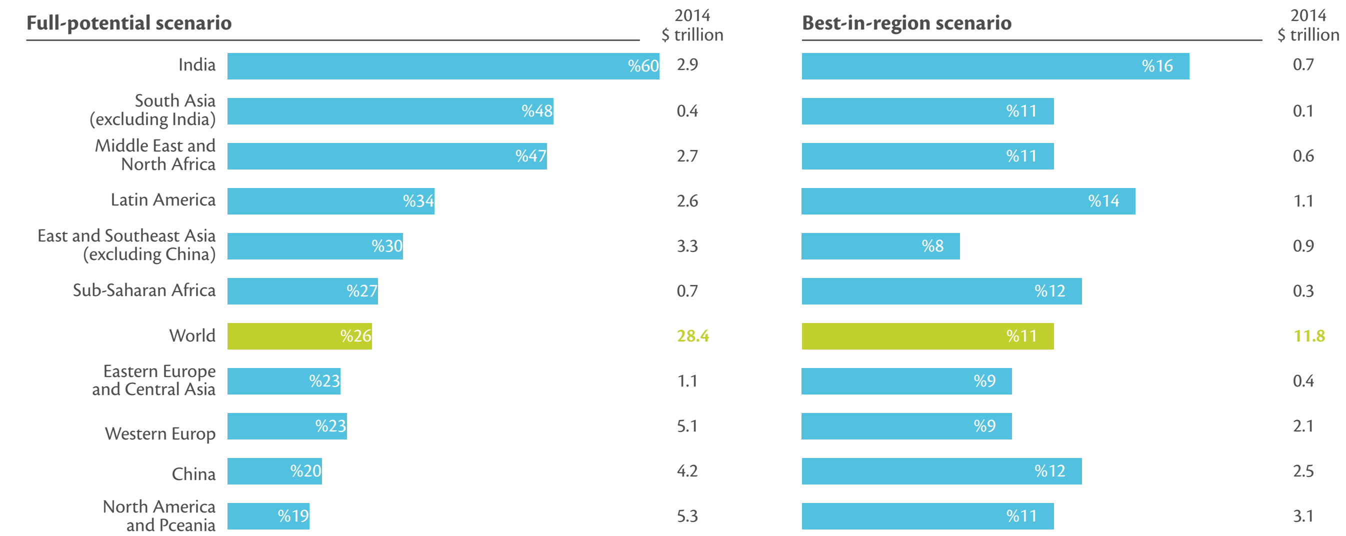
As of 2015, the share of GDP contributed by women is 37 % worldwide. India had the lowest female GDP share at 17 % This is significantly less than the 41 % female share in China.



## Assessment

Sheconomy has historically had a great impact on society. During recent years, there has been a tendency of a widening economic gender gap – especially in US, even though it is the region with the lowest economic gender gap. This could be due to the increased unemployment caused by the financial crisis. Women›s contribution to the economy, their economic independence and influence in purchase decisions vary significantly across countries.

## Data & Facts




Incremental GDP Opportunity from Bridging the Gender Gap

There are huge economic implications of lack of parity between men and women. According to a study, in a scenario in which women play an identical role in labor markets to that of men, as much as $28 trillion (26 %) could be added to global annual GDP by 2025. If every country matched the progress toward gender parity of its fastest-improving neighbour, global GDP could increase by up to USD 12 trillion (11 %) in 2025. Even though more women have entered the global workforce, there is still a long way towards closing the economic gender gap. According to the World Economic Forum Global Gender Gap Report, only 59 % of the economic participation gap has been closed in 2016.

## Areas to Consider

It is crucial to secure equal education opportunities for men and women, as a better educated population seems to be a healthier and happier population.

In addition to health benefits, there is economic potential in a more gender diverse and larger workforce consisting of everyone in a population who is able to work.

## Did you know?

According to a study, women make the purchasing decisions for 94% of home furnishings, 92% of vacations, 91% of homes, 60% of automobiles & 51% of consumer electronics. Additionally, married women increasingly control household financial planning – Up from 14 % In 2006 to 27 % in 2014.

Sources: World Economic Forum (8' ,(2016 Things Women should know about the future of work'; EY (2013), 'Women: The next emerging market'; Science Nordic (2015), 'Gender equality gives men better lives'; World Economic Forum (2016), 'The Global Gender Gap Report 2016'; Pew Research Center (2012), 'A gender reversal on career aspirations'; McKinsey&Company (2015), 'The Power of Parity: How advancing women's equality can add 12$ trillion to global growth'; Prudential (2014), 'Financial Experience & Behaviors Among Women'; Harvard Business Review (2009), 'The Female Economy'.




# INTRODUCTION

Behind all the trends described in this catalogue are human beings. As human beings are not only shaping the changes, but are also shaped by them, and in most cases human behaviour is decisive for how trends are developing. In projecting the future, this aspect is often not prioritised sufficiently, because of its complex and unpredictable dynamics. Towards 2050, citizens will develop and adjust to new technology and new societal structures, which will impact values, behaviours, preferences and needs. People are expected to change focus towards more immaterial values, live longer and healthier lives, change communication habits and continue to extend their physical lives into digital platforms, pushing the boundaries of reality.

The following chapter describes 10 trends shaping the future of citizen towards 2050. The 10 trends presented can be categorised into the following three areas:

4

## Well-being and Connectedness

- Self-actualisation and Do Good
- 21st Century Communication
- Digital Distribution
- Privacy in a data-rich future

5

## Health

- Perfect Human
- Personal Biopolitics
- Lifestyle Diseases
- Re-emergence of Diseases
- New Models of Healthcare Delivery

1

## Tolerance

- Return of Populism

# SELF-ACTUALISATION AND DO GOOD

The psychologist Abraham Maslow defined self-actualisation as the realization or fulfilment of one's talents and potentialities. Increasingly, self-actualisation – and thereby happiness – is achieved not just through one's personal life, but also at work, in your community, in social networks etc.

One of the defining traits of self-actualized people is that they are concerned for the welfare of humanity. As material needs get fulfilled people have the resource to consider other aspect of life and work for other peoples needs. While many of the actions people do indeed are utilitaristic and basically a means to gain personal reconnection, scientists have uncovered that actual altruism also do exists, and have even found a gene associated with it.

Economic growth has led to a higher level of prosperity in more and more countries and basic needs are increasingly taking for granted. As a result, values are changing, and even governments are starting to refocus. Most notably, Bhutan has supplemented GDP measures with 'Gross National Happiness'. Similarly, companies increasingly focus on Corporate Social Responsibility in part due to managements own belief in doing good, in part due to the consumer demand.

The change at the individual level combine to influence the macro level of society. Evidence show that Europeans in general have chosen to use the accumulated wealth to have longer maternity leave, longer vacations, and to work fewer hours, in comparison with the USA. How self-actualisation will play out and how the citizens in the developing world will chose to prioritize their wealth will define societies and values towards 2050.

## Driving Forces

- Immaterialisation
- Individualisation
- Economic Growth

## The Evolution of Status Symbols and the Experience Economy

As wealth increases, the approach to status symbols change to a greater focus on experiences and 'Do Good'-products, like fair trade or organic products over traditional material status symbols. Self-actualisation also gives rise to a greater focus on the experience economy. Focus on the environment, safety, simplicity, tranquillity, and time will to a greater extent be the new luxury of the self-actualized individuals.

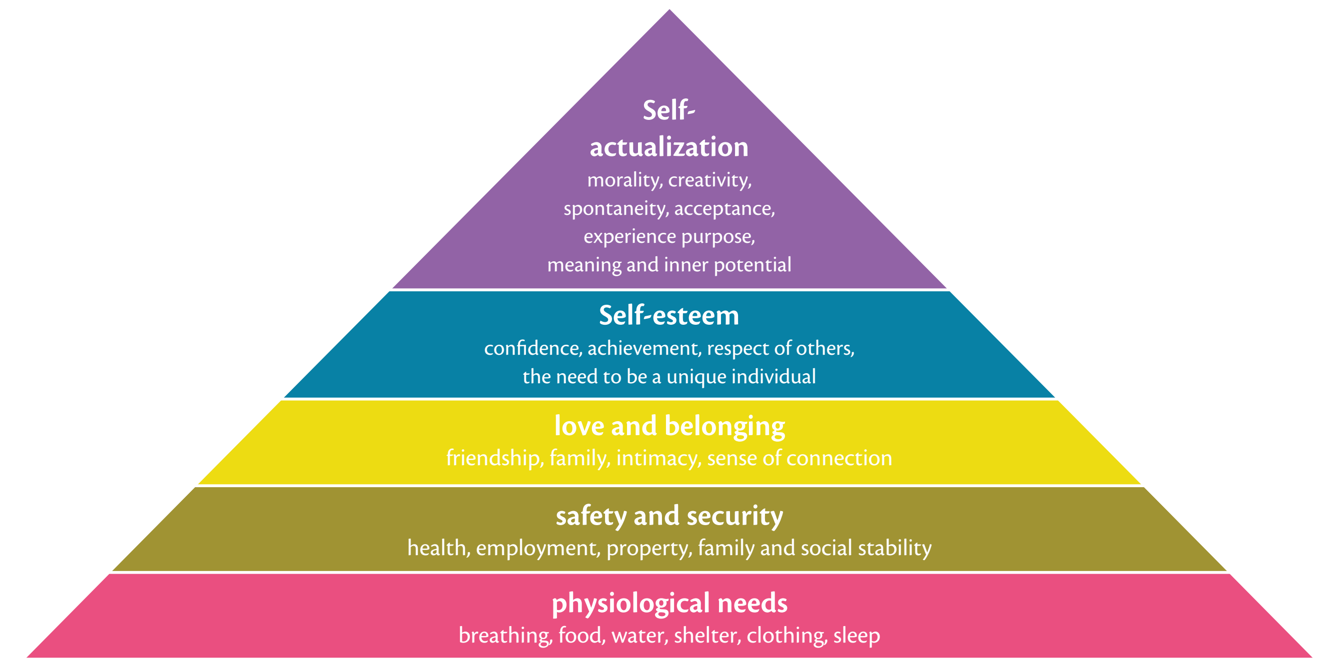
The 'new rich', particularly in the BRIC countries still value 'old-fashioned' material luxury goods, but as these consumers mature, their preferences may change towards Western patterns.



## Assessment

Self-actualization will partly drive the fight against many of the world's problems (see Environmental Degradation, Climate Change and Food Security and Climate Refugees) and will have a great impact, which will likely grow stronger towards 2050. Change in value is, however, very difficult to predict.

## Maslow's self-actualisation hierarchy




## Areas to Consider

When people strive for self-actualisation, a broad range of new, unique needs will emerge and priorities will change. Financial reward may not have the same motivational power as previously and vacations and maternity leave may be more important, for example.

## Did you know?

Wal Mart Stores Inc. has been excluded from the Government Pension Fund of Norway's investment portfolio – the largest sovereign wealth fund in the world with a market value of approx. Euro 848 billion – due to serious violations of human rights.

The Giving Pledge is a campaign to encourage the wealthy people of the world to contribute their wealth to philanthropic causes. Bill Gates and Warren Buffett who initiated the pledge have already given more than 40 billion USD.

Sources: CIFS (2008), 'Members' Report – The Future of Happiness'; The Guardian (2011), 'The Quarterlife Crisis: Young, Insecure and Depressed'; Pew Research Center (2013), 'Public's Policy Priorities: 1994-2013'.

# 21ST CENTURY COMMUNICATION

Technology has always shaped the way we communicate and will continue to do so in the future. The future of communication is likely to be characterised by constant connectedness and is fuelled by an abundance of devices and the Internet of Things. Technology improvements and the increased velocity of data has made communication more free-flowing and complex than ever. Smartphones allow people to communicate and connect from anywhere, and the increased use of social media has led to a change in communication with increased use of shortened words, hashtags, slang, emoticons, symbols and pictures.

Especially younger generations are constantly connected by informal, instant and short communication forms and a lot of communication has become visual (photos and videos). This has already lead to the development of a near-universal language based on symbols. Together with increased availability of automated translation systems, this has the potential to overcome language barriers and bring people closer across borders.

The opportunity for 24/7 communication has changed the way humans interact today, and is likely to evolve further along with adoption of new technologies and diffusion of existing technologies like augmented reality. Further, advancements in AI over the next decade or two could allow much of our daily communications to happen without personal touch, with automated responses based on past behaviour and individual preferences.

## Driving Forces

- Technological Development
- Network Society
- Globalization
- Technological Diffusion and Empowerment

## Future of Media

In the recent years we have seen a "Great Unbundling" of media and a decline in printed news media, as people have moved towards on-demand consumption and use of social media platforms for receiving news. This has lead to a de-centralisation of the distribution of media and news.

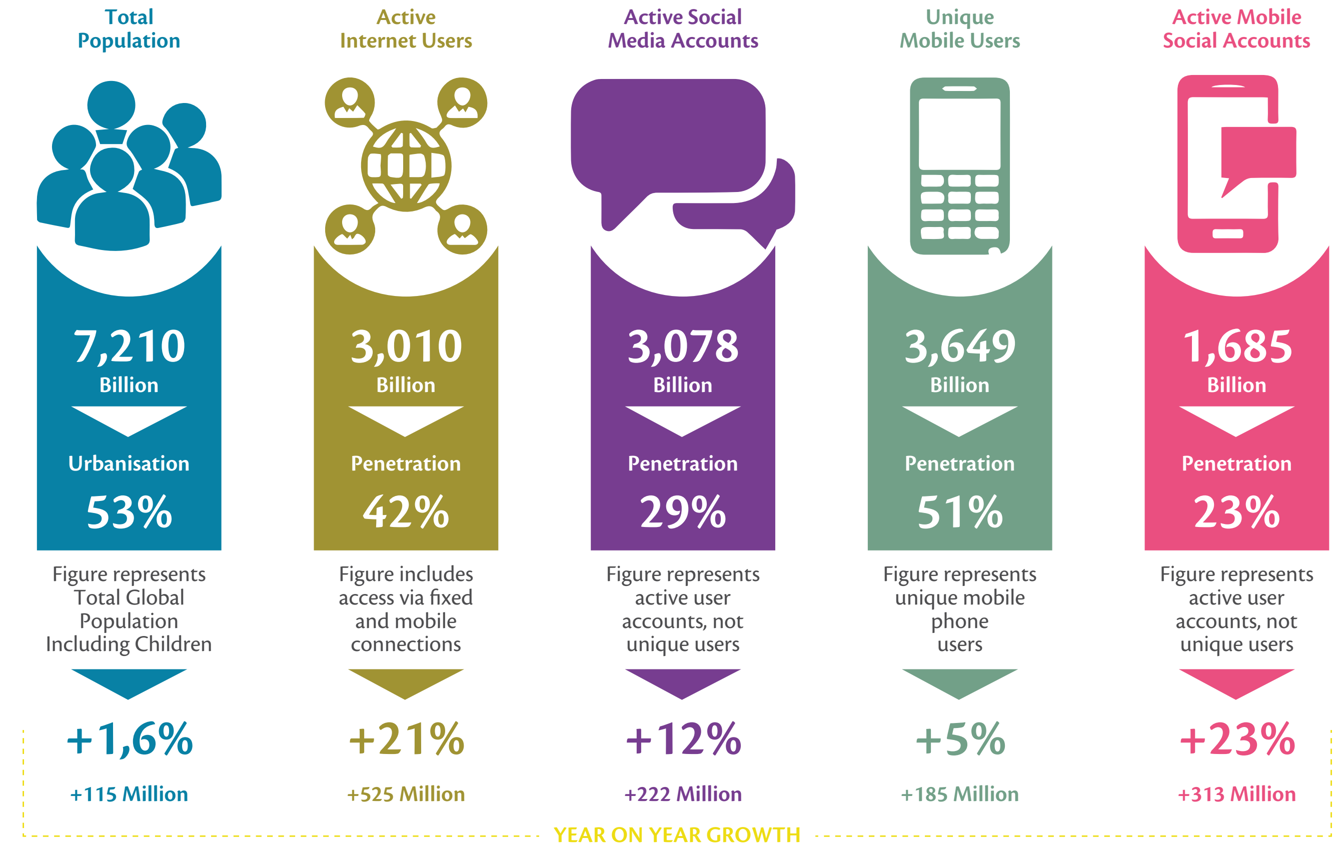
While these trends are expected to continue, it is further predicted that the future of media and communications are likely to be transcended by new technologies such as virtual reality, wearables, and live streaming, which are expected to dominate 21st century communication.



## Assessment

Changes in communication have for many years changed the way we interact, and this can be expected to continue in 5 - 10 years with the development of technologies such as virtual- and augmented reality. However, these changes happen at a steady pace, and the impact is estimated to be low for the coming wave. However, the changes in the wake of AI could be more severe and very unpredictable.

## Data & Facts




**Global Digital Landscape and Year-on-Year Growth**

The above graph depicts major current increases in the use of technology and social media for communication. The rapid pace of adoption and technological changes makes further projections difficult and unreliable. Platforms such as Facebook and Twitter are not only leading to an increase in communication and access to the world, but shaping how we communicate and consume information. Social media channels are likely to shape inter-personal communication and communication with governments in the future.

## Areas to Consider

Governments should continuously embrace and adapt to new ways of communicating, to reach citizens and organisations on an individual-level based on their preferred platforms. This will not only allow for cost savings (communication through physical letters greatly exceed digital messages), but also much faster, tailored and dialogue based communication.

## Did you know?

In terms of usage, emojis far outstrip English as a system of communication. There are estimated to be around 2 billion smartphone users who send over 41 billion text messages including over 6 billion emojis on a daily basis.

Sources: Huffington Post (2016), 'How social media has changed the way that we engage consumers'; SCENARIO Magazine (2016), 'Language and Communication in the 21st Century'; Techcrunch (2016), 'How The Growth Of Mixed Reality Will Change Communication, Collaboration And The Future Of The Workplace'; Statista (2016), 'Number of global social network users 2010 to 2020', World Economic Forum – Digital Media and Society; We Are Social: Global Digital Landscape.

# DIGITAL DISTRIBUTION

Digital distribution describes the development of, and access to, digital content. Digital distribution makes global content available locally and enable people to connect in borderless digital societies. Messages with political, social and personal statements are spread instantly through social medias and the like. Digital distribution is essentially free, allowing the sale of digital products at very low costs or even giving them away for free, as in open source software and through open content media.

The number of individuals who leverage telecommunications technologies to perform their work duties, and more generally conduct their lifestyles, is growing. Many individuals are now "mobile in the moment" – each with their own computer in their pocket. Digital distribution is a catalyst and accelerator of total customer centricity, especially among a millennial population yielding greater consumer influence. On the societal level, increased access to information and content has an empowering effect.

Towards 2050, content development will continue to increase, created by an increasing number of people accessing the internet and engaging in content development. Communication channels will most likely develop within new spheres as well as continue to spread within the known social platforms in new shapes, e.g. by leveraging the virtual reality technology (see Immersive Technologies). Encrypted channels and channels like the dark web (see box below), challenging centralised control and surveillance of communication, will most likely become more popular.

## Driving Forces

Network Society

Technological Development

Technological Diffusion and Empowerment

## The Dark Web

The "Dark Web" is a hidden version of the internet requiring specific software, configurations or authorization to access. Once inside, web sites and other services can be accessed through a browser in much the same way as the normal web.

However, some sites are effectively 'hidden', in that they have not been indexed by a search engine and can only be accessed if you know the address of the site. Special markets also operate within the dark web, called "darknet markets", which mainly sell illegal products like drugs and firearms, paid for in the cryptocurrency Bitcoin.

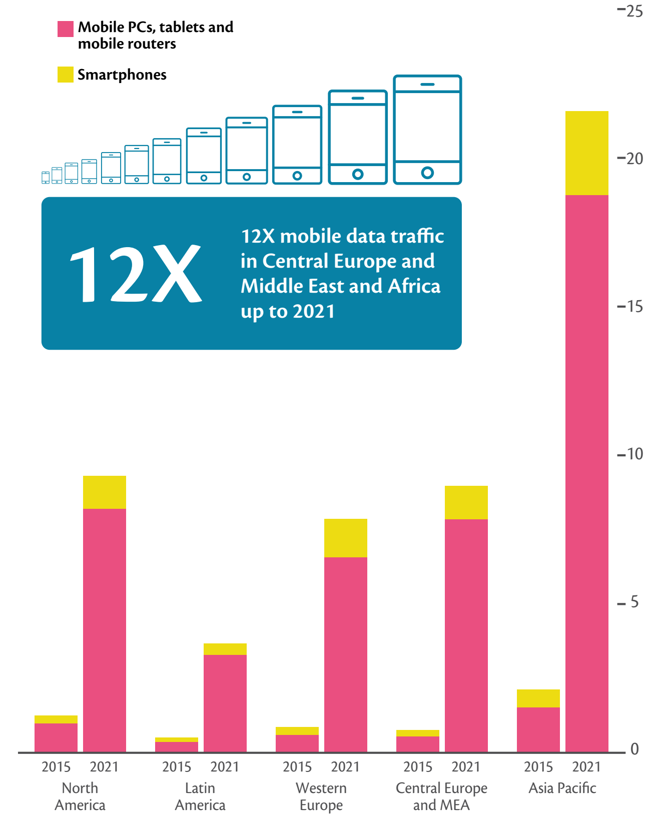
Because of the dark web's almost total anonymity, it has been the place of choice for groups wanting to stay hidden online from governments and law enforcement agencies.



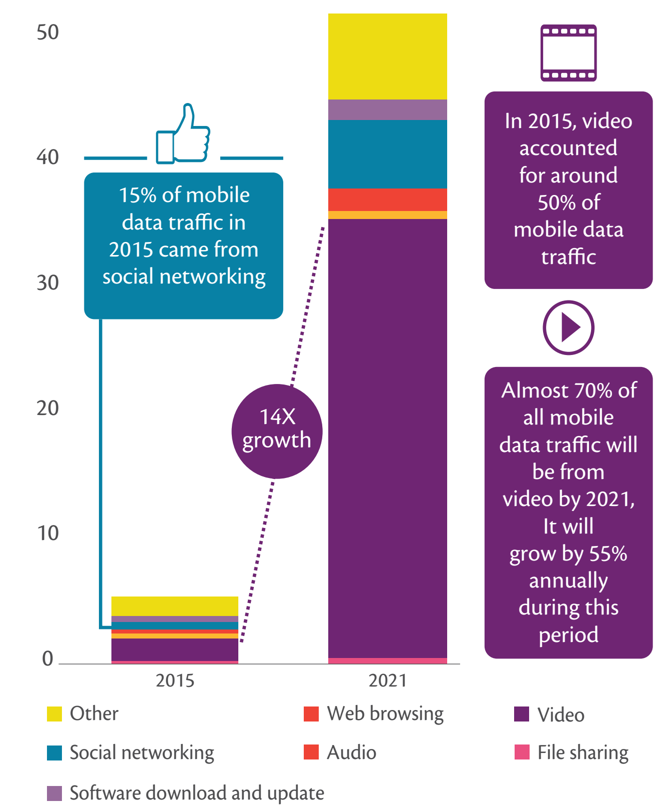
## Assessment

Digital distribution is already high and is expected to develop into new areas in the future. As more content goes digital, more people will have access to digital devices and the digital experience will merge with the physical world.

## Data & Facts




**Global mobile data traffic projections (monthly ExaBytes)**




**Mobile data traffic by application type (monthly ExaBytes)**

Digital Distribution is enabled by high-speed internet: The digital distribution is being enabled by the transition from cable network to wireless communication. The future of digital distribution depends on 1) the number of people, and things, with access, and 2) the speed of the connection. The development of the 5G network is expected to arrive around 2020 and will change the speed in a way that much more extensive data could be transferred by an expanding number of devices (see Internet of Things).

## Areas to Consider

Availability of digital communication and distribution infrastructure is essential for innovation and for empowering citizens to utilize global markets for products and services. The societies first to implement the new 5G might also be the societies that are first to develop new solutions and usage suited for 5G.

Digital distribution is enabling trade and payment solutions to emerge as an integrated seamless experience in the physical and digital world – and in an integration of these. Global digital players mastering this experience will transform current trade patterns.

## Did you know?

With more than one billion users, YouTube is the world's most used channel for digital distribution of video content. An estimated 500 hours of new content is uploaded to YouTube every minute, and about a year's worth of content is viewed every minute.

Sources: CNET (2015), 'How 5G will push a supercharged network to your phone, home, car'; World Economic Forum (2016), 'The dark web: What is it and how it works'; www.techdirt.com; www.zmescience.com; Ericsson Network Traffic Measurements 2015.

# PRIVACY IN A DATA-RICH FUTURE

The explosion of data in a new, digital world, has led to new layers of information built on top of, and embedded in, everything that we do. This has had tremendous ramifications – the potential to vastly improve lives while making it increasingly complex.

Personal privacy is now closely intertwined with the emergence of data as a powerful economic force. Behaviors, preferences, decisions, politics, locations, health: the power of data is supreme. Privacy is an even more complicated concept in today's world due to national security concerns. Companies and governments are discovering new uses for personal data, and the over-riding question for a citizen is: Do they have the right to know that about me? If so, who defines how and when they can use it?

This is unprecedented as a technological advancement and so it is important to understand who has the ability to maintain control, protect rights but still ensure that we continue to discover innovative ways of value creation from data. The complexity is of gargantuan proportions because the nature, uses and availability of data varies across sectors and countries. A report produced by UNCTAD indicates that while 107 countries had developed regulations concerning privacy by 2013, some of these were piece-meal and in many cases rendered obsolete due to rapid technological progress.

Corporations tend to lead the charge in exploiting economic benefit from data, often leaving behind in their wake the deliberative processes that politicians and law-makers follow. This means that nations have distinct approaches, perspectives and challenges when dealing with privacy.

Moving forward, it is uncertain whether personal data breach 'events' will define policy, or if there can be a unified global paradigm for managing privacy.

## Driving Forces

Network Society

Knowledge Society

Technological Development

## Cases and Examples

Facebook released a new feature in March 2017 entitled Town Hall. This effectively enables internet activism by creating a direct connection between citizens and their elected representatives. The feature allows, currently, users to understand who their representatives are, to contact them and to be reminded of the next election. However, the potential of such a tool and the network effect, is easy to comprehend. Behind the potential of billions of users stating their political preferences and influencing policy, a vast swathe of data can be collected, crunched, packaged and sold. This is, once again, unprecedented.



## Assessment

The rapidly changing nature of privacy – new types of data, obtained in novel ways, with distinct meaning and value to each party – could give rise to a host of opportunities and challenges. Citizens might cede control, go 'dark', or completely embrace the economic benefit of data.

## Areas to Consider

Quantum computing could make genuine encryption impossible. If this is the case, armed and security forces may have to physically separate their computer systems from the Internet, posing huge problems for networking and efficiency. Alternatively this technology could guarantee security of a message.

Data for social good: data can be purposed to better understand our environment. Crime hotspots can result in targeted deployment of police. Data from social networks could provide a deeper understanding of the local population and its culture.

## Did you know?

86% of internet users have taken steps online to remove or mask their digital footprints—ranging from clearing cookies to encrypting their email, from avoiding using their name to using virtual networks that mask their internet protocol (IP) address.

55% of internet users have taken steps to avoid observation by specific people, organizations, or the government.

Sources: Future Agenda: The World in 2025.

# PERFECT HUMAN

Perfect human is a drive for advancement of our bodies and minds through the use of technology eg. cognitive enhancements, genome editing technology and cosmetic surgery.

The quest for eternal youth, eternal life, wisdom and beauty have been part of human mythology for centuries. What was once considered magical or divine is increasingly becoming in the reach of humans. Current examples are cognitive enhancement drugs, which can improve or optimise the individual's ability in the short-term, or cosmetic surgery, which can restore people to youthful looks or improve the appearance of individuals. The definition and boundaries for human advancement are growing, however. A growth of the 'quantified self' trend, where individuals collect and analyse their personal health data with electronic wearables is giving people the opportunity to monitor and optimise behaviours. Several start-ups focus on extension of life as well.

Towards 2050, an interdisciplinary approach across all biological science disciplines will give a much better understanding of the biological mechanisms of life. However along with technological advances a host of complicated ethical issues will appear, pushing the limits and social norms for curing diseases, treating defects, and enhancing looks, cognitive and physical competencies. Some worry that this could create even further polarization as the rich will be "young", smart and beautiful while the poor, who can't afford it must stay plain, consequently decreasing social mobility.

## Driving Forces

Focus on Health

Technological Development

Individualisation

## Designing Your Own Offspring

With the recent development of CRISPR/Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) genome editing technology, the possibility to genetically manipulate the human germline (gametes and embryos) has become a distinct technical possibility. Although many technical challenges still need to be overcome in order to achieve adequate efficiency and precision of the technology in human embryos, the path leading to genome editing has never been simpler, more affordable, and more widespread.

Thus, in the future, you may very well be able to choose your child's genetic makeup using genome editing. This would create a clash between technological advances, religions, ethics and state finances and redefine humanism.



## Assessment

The quest for perfection, longevity and superiority will always stimulate a drive to develop the perfect human. Secure use of genetic editing in complex areas is at least a decade away from being a reality, however in other areas the trend is strong already today.

## Areas to Consider

In nature, similarity is a weakness; hence a process where the human diversity becomes smaller as people strive to become 'genetically perfect' could increase the danger for human near-extinction in case of severe pandemic outbreak.

Biological and behavioural data gathered through electronic wearables could be a prerequisite for entitlement for public health care.

Genetic profiling could e.g. be used to find the people who are genetically best suited for different tasks. However is also increase the change of discrimination.

## Did you know?

There are two types of cognitive enhancement solutions currently:

- Nootropics: Natural, no side effects (supplements, nutraceuticals, functional foods).
- Smart drugs: Medications sometimes used for treatments but have found themselves as cognitive enhancers in a (perhaps) modified form.

Sources: OECD (2016), 'Health at a Glance: Europe 2016'; National Human Genome Research Institute (2015), 'A Brief Guide to Genomics'; American Society of Plastic Surgeons (2016), '2015 Plastic Surgery Statistics Report'; Nature Review Genetics (2010), 'Annotating non-coding regions of the genome'.

# PERSONAL BIOPOLITICS

Biopolitics is the governance of populations' health and life expectancies to create a healthy, productive, and content society. Personal biopolitics means focusing healthcare on helping individuals in a population stay self-reliant and healthy by promoting physical and mental wellbeing. This entails a focus on prevention and early detection as well as empowering personal responsibility and incentivising individuals to govern their own health. The biopolitics of the future will work on two levels: The aggregated societal level and the stratified/individual level.

Biopolitics represents a transition from focusing on the health outcomes of a perceived homogenic population towards a heterogenic view. This transition is being driven by skyrocketing costs associated with healthcare due to massive increase in life expectancy and the 'elderly burden' – which will increase towards 2050 in most societies.

The transition also covers a shift from treatment of symptoms towards more focus on the cause of diseases and disorders. In the future, a focused effort in personal biopolitics will be a necessity to keep healthcare costs at a sustainable level.

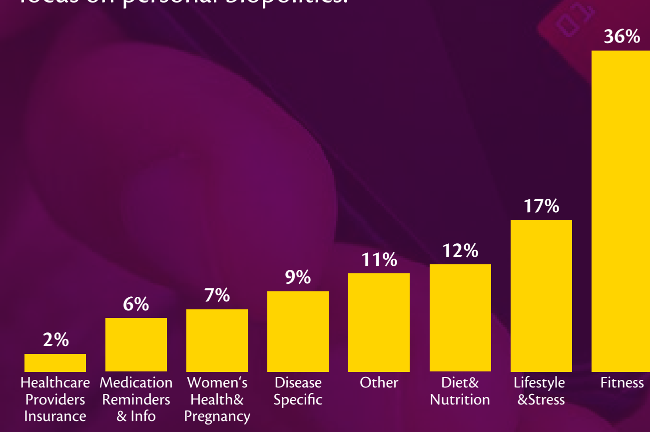
For personal biopolitics to become the dominant health paradigm, a number of challenges need to be solved, especially related to the access, sharing, and security of personal health data. Towards 2050, public systems are expected to increasingly acquire, sell, and share health data in order to develop actionable and clinically usable health knowledge. This will especially be prevalent in order to focus on prevention and early detection recommendations, enabling citizens to live a healthy self-reliant life.

## Driving Forces

- Focus on Health
- Technological Development
- Demographic Development
- Technological Diffusion and Empowerment

## Health- and Wellness Apps

The market is flooded with health apps, but we are still waiting for good, holistic usable apps. The diagram shows the breakdown of the 150,000+ health and wellness apps for iOS and Android, as an example of the widespread focus on personal biopolitics.

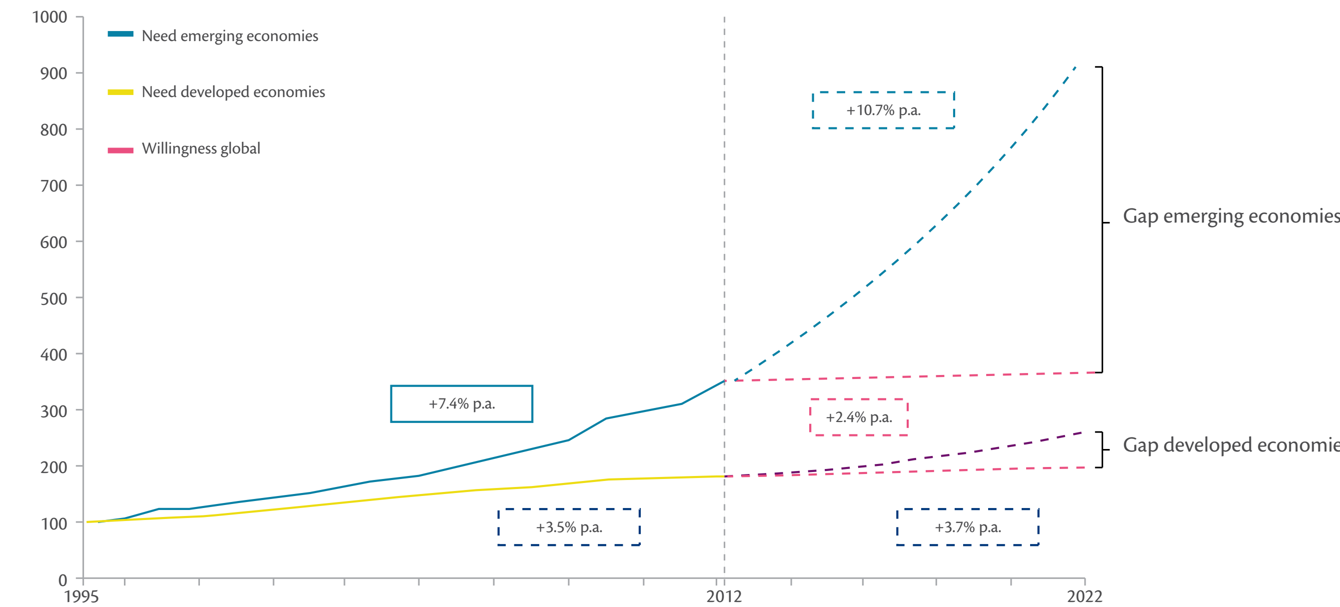





## Assessment

There are high expectations to more precise customised health advisory services supported by monitoring and data solutions. However, it will take some years for the health sector to embrace the opportunities.

## Data & Facts




**Gap between the need and willingness for healthcare spending**

In the graph above, we illustrate the the gap between need for healthcare spending in emerging and developed economies, and contrast it with the willingness for global spending in healthcare, based on extrapolation of historical spending on healthcare compared to GDP development. The gap will reach unsustainable levels towards 2050, unless new and more efficient healthcare models like personal biopolitics are adopted.

The emerging personal biopolitics has the potential to change the future healthcare cost significantly, by focus on prevention as well as tailored and hence more efficient healthcare.

## Areas to Consider

Health will rapidly become much more data driven and focused on accessing the best expertise available. This will likely lead to internationalisation of health solutions, where big pharma, ICT and insurance/pension companies will begin offering global health solutions.

It will be necessary to harvest and analyse life style data from citizens in order to optimise the delivery of preventive health solutions. Security solutions enabling the individual citizen to manage personal and health relevant data will be necessary.

## Did you know?

Nutrigenetics aims to identify how genetic variation affects response to nutrients. Online nutrigenetics services such as NutriFit and DNAFit perform testing to see if a persona has lactose intolerance, sensitivity to alcohol, coffee, carbohydrates or saturated fats, and identify any supplement needs.

This research can be extended into understanding the main genetic variants that might affect cancer risk, heart disease risk, and how genetic variants in combination with particular diets could optimize health and wellbeing.

Sources: The Guardian (2016), 'Could a diet tailored to your DNA save your life'; World Economic Forum (2015), 'Five global health trends you just can't ignore'; IMS Institute for Healthcare Informatics (2015), 'Patient Adoption of mHealth: Use, Evidence and Remaining Barriers to Mainstream Acceptance'; OECD (2016), 'Health at a Glance: Europe 2016'; UN (2015), 'World Population Prospects – 2015 Revision'; The Lancet (2016), 'National spending on health by source for 184 countries between 2013 and 2040'.

# LIFESTYLE DISEASES

Lifestyle diseases describe the increasing threat arising from our lifestyles rather than infection- or genetic related disorders. The burden of chronic lifestyle-inflicted (non-communicable) diseases is rapidly increasing worldwide, and more and more young people (below age 30) fall victim to such. Lifestyle diseases and disorders will become extremely costly for societies due to a huge burden on health budgets and loss of productivity. Lifestyle diseases are by far the leading cause of death in the world, representing 63% of all annual deaths in 2013.

Some of the main factors contributing to lifestyle diseases include bad food habits, smoking, alcohol consumption, physical inactivity, wrong body posture, and a perturbed biological clock. The obesity pandemic – and the ills it inflicts – has intensified globally, as incomes rise and the consumption of processed and semi-prepared food products increases. At the same time, increasing urbanisation and 'urban stress' has a general negative impact on long-term health, with less physical activity on the job combined with long hours and poor work/life balance.

Without any significant changes, we will towards 2050 see populations with declining health levels within many societies. Advances in health knowledge and technologies can, however, lessen the impact on individuals and society of non-communicable diseases. It is likely that the current polarisation, where the more well-off and better educated people focus far more on health, will be even more pronounced and that we will see the elite being the primary consumers of preventative health care means. Going forward, a more cross-sectoral holistic approach has the potential to create better means to prevent and control lifestyle diseases.

## Driving Forces

Focus on Health

Demographic Development

Economic Growth

## Global Action Plan for Lifestyle Diseases

WHO has developed a global action plan to enable global tracking of progress in preventing and controlling major lifestyle diseases. The framework lists 9 voluntary global targets, with an overall goal to reduce the number of global deaths from lifestyle diseases by 25% by 2025.

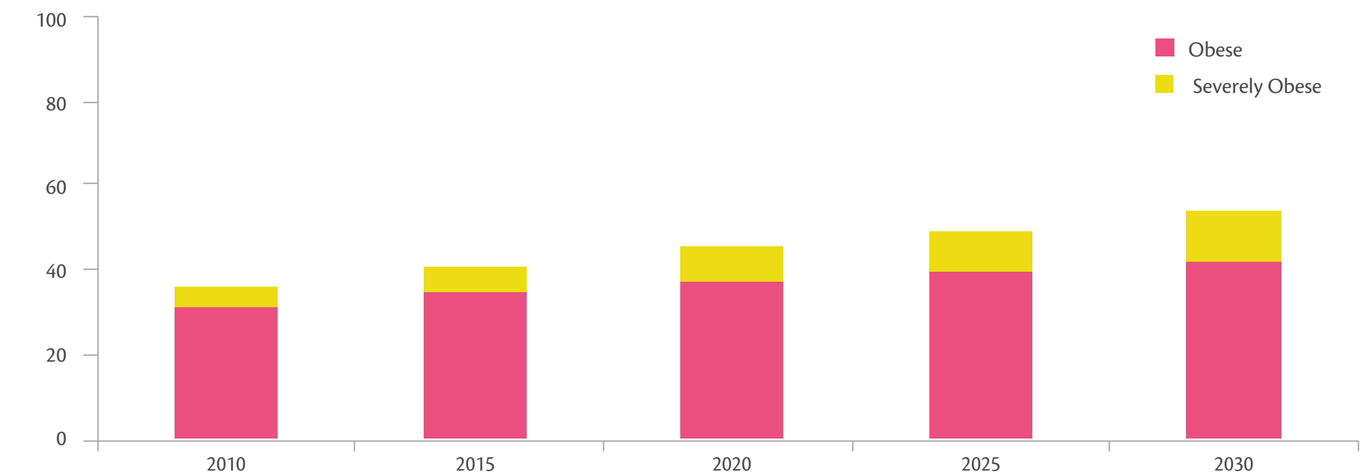
In 2015, India became the first country to develop specific national targets and indicators by adopting a national multi-sectoral action plan that outlines actions by various sectors in addition to the health sector.



## Assessment

Non-communicable diseases represent a huge burden to the global society. It is possible to address these diseases with early detection and prevention, which in turn require a targeted societal effort. If this is not done the impact on health expenditure will certainly be high.

## Data & Facts




**Prevalence of obesity and severe obesity in the USA 2010 - 2040**

Obesity levels in the USA has almost tripled since 1960, yet obesity – for years known to be a problem afflicting developed countries – is increasingly becoming a problem for developing countries. Worldwide obesity has more than doubled since 1980. Today most of the world›s population live in countries where overweight and obesity kills more people than underweight.

Significant increases in total global expenditure on health should be expected in the future, driven largely by lifestyle-inflicted diseases. Global health care spending is expected to increase from $7.83 trillion in 2013 to $18.28 trillion in 2040. Managing the development of lifestyle diseases is crucial for not only the wealth of the citizens, but also for the public budget (or private, depending on the funding model).

## Areas to Consider

In the future, a part of public healthcare could be to map the genetic health profile of the citizens at birth in order to give them a tool to customise their health behaviour.

Desirable incentive structures for the general public to exercise, diet and stay healthy should be considered. Some countries have put regulations and taxation in place – e.g. a tax on fat – in an attempt to influence social conditions and life style changes.

Promoting the emerging healthcare concept where payment for health services will be based on outcome rather than expenses would likely be beneficial.

## Did you know?

Lifestyle diseases have a large negative impact on productivity. More than 80 % of deaths caused by lifestyle diseases occur in low- and middle-income countries.

In the USA, chronic diseases mainly caused by lifestyle choices affect approximately half of all adults, accounting for at least seven of the ten leading causes of death and 86% of all healthcare spending.

Sources: The Lancet (2016), 'Trends in adult body-mass index in 200 countries from 1975 to 2014'; Finkelstein, E. et al. (2012), 'Obesity and Severe Obesity Forecast Through 2030'; World Health Organization (2015), 'Noncommunicable diseases'; World Health Organization (2013), 'Global Action Plan for the Prevention and Control of Noncommunicable Diseases'; European Environment Agency (2015), 'The shift in global disease burden, and share of non-communicable diseases by world regions'.

# RE-EMERGENCE OF DISEASES

Re-emerging diseases are those diseases that were previously eradicated in a locality or those that medical professionals thought they had under control, but have come back in new forms or in different locations. Examples are resistant infections (see figure below), the West Nile virus in the Western hemisphere, monkey pox in the United States, and dengue fever rebounding in Brazil and other parts of South America and working its way into the Caribbean.

There has been a widespread belief that epidemiological transition would emerge as we left the 20th century, with many diseases consigned to a pre-modern past. Yet, in the 21st century there have already been close to 200 new or re-emergent human diseases. Eradication of disease has long been a major political goal for both international organisations and countries, but many new diseases have emerged despite the rise in living standards and better understanding of disease. The emergence of the Zika virus is an example of how new diseases keep emerging, but also of how we more rapidly gain a deeper understanding of a disease that challenges.

Furthermore, there is a real risk that the current development in antibiotics will compromise our health resistance. Towards 2050, despite advancements in healthcare and standards of living, we will inevitably experience the re-emergence of diseases as well as emergence of new communicable diseases.

## Driving Forces

- Focus on Health
- Demographic Development
- Globalization

## Assessment

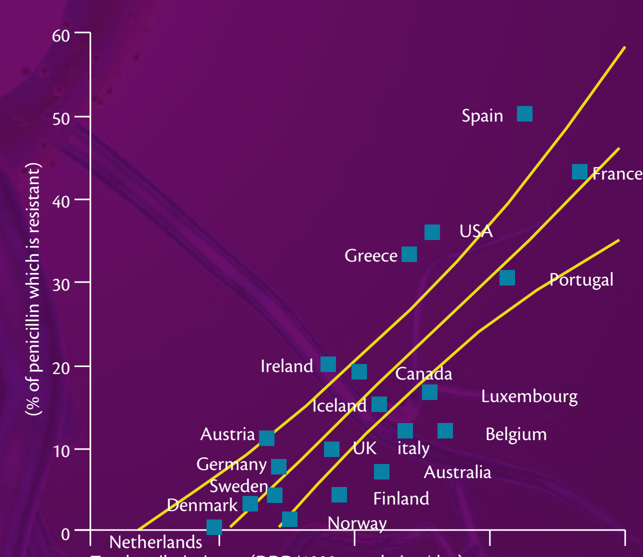
Migration, global trade, and increased global travel make it difficult to contain disease outbreaks and will result in new communicable diseases.

Diseases are already reemerging today, and this is expected to continue. Medical innovation and deeper understanding of diseases however, will have an increasing mitigating effect on the impact of many of the re-emerging diseases.

## Resistance to Antibiotics

WHO describes a 'post-antibiotic' era – in which common infections and minor injuries can kill – as a real possibility at some point in the 21st century.

The graph shows a clear correlation between the use of antibiotics and antibiotics resistance, which threatens the effective prevention and treatment of a range of bacteria and viruses.

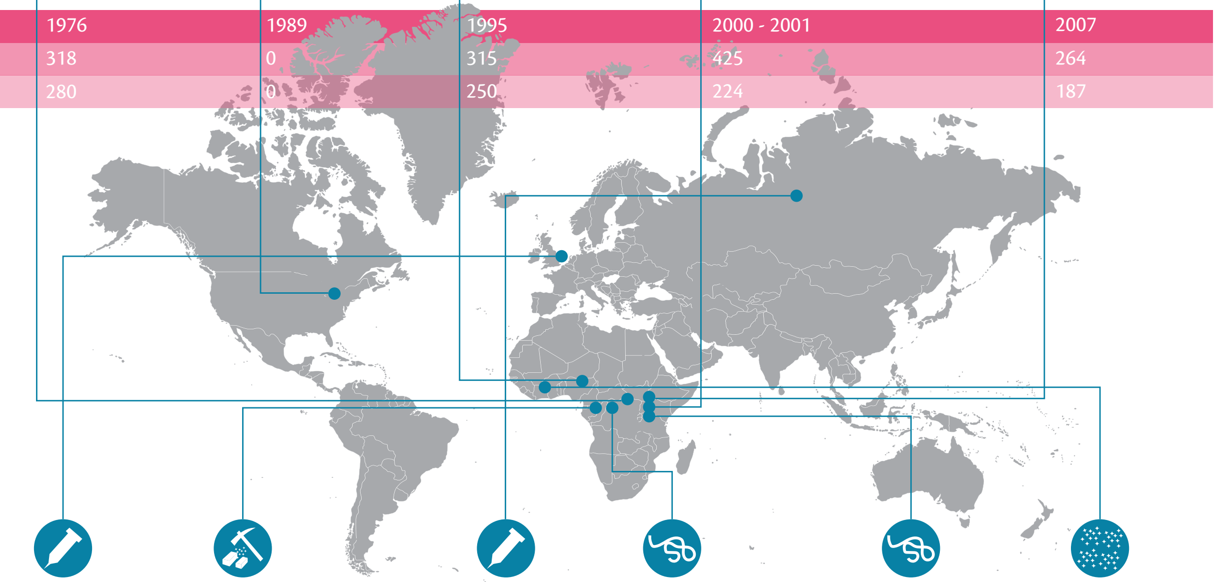



**Antibiotic use and resistance in selected countries**



## Data & Facts

| | First oubreak of Ebola in Zaire | Ebola Reston introduced into US quarantine facilties by monkey from the Philippines | Outbreak in DRC Index patient worked in the forest adjoining the city | Outbreak in Uganda associated with funeral attendance and caring for patients with Ebola\ without proper PPE | Outbreak in DRC Last confirmed case on 10 /4 and last death 10 / 10 |
|---|---|---|---|---|---|
| Year | 1976 | 1989 | 1995 | 2000 - 2001 | 2007 |
| Cases | 318 | 0 | 315 | 425 | 264 |
| Deaths | 280 | 0 | 250 | 224 | 187 |



| | Lab infection by accidental stick of contaminated needle | Outbreak in Gabon in gold-mining camps in the rainforest | Lab contamination in Russia | First oubreak reported in the Republic of Congo | outbreak of a new strain of Ebola in wetern Uganda | Ebola outbreak in West Africa; largest in history |
|---|---|---|---|---|---|---|
| Year | 1976 | 1976 | 1996 | 2001 - 2002 | 2007 | 2014 |
| Cases | 1 | 1 | 1 | 57 | 149 | *27,000+ |
| Deaths | 0 | 0 | 1 | 43 | 37 | *11,000+ |

An example of a re-emerging disease is Ebola. The Ebola case shows the dynamics of re-emerging diseases that often flourish from on a combination of conditions. The devastating Ebola epidemic in West Africa 2014 - 2015 was the result of a perfect storm: dysfunctional health services after decades of war, low public trust in government and Western medicine, traditional beliefs, and even denials about the cause or existence of the virus. In January 2016, WHO declared Ebola officially eradicated in West Africa.

## Areas to Consider

Contingency plans ensuring rapid and effective response to epidemics that hit suddenly, like Zika and Ebola did in other parts of the world, is important.

Controlling diseases will become much more important with the increasing globalisation and migration.

A situation with general antibiotic resistance might give uncontrollable outbreaks of diseases.

## Did you know?

WHO has identified the top 8 emerging diseases that are likely to cause severe outbreaks in the near future: Crimean-Congo haemorrhagic fever, Ebola, Marburg, Lassa fever, MERS, SARS, Nipah and Rift Valley fever.

The list provides a basis for working on research and development preparedness to try and control potential future outbreaks.

Sources: World Health Organization (2012), 'The evolving threat of antimicrobial resistance: Options for action'; Centers for Disease Control and Prevention (2016), 'Outbreaks Chronology: Ebola Virus Disease'; World Health Organization (2016), 'Latest Ebola outbreak over in Liberia; West Africa is at zero, but new flare-ups are likely to occur'; World Economic Forum (2016), 'Top 8 emerging diseases likely to cause major epidemics'.

# NEW MODELS OF HEALTHCARE DELIVERY

Due to technological advancements and the possibility to gain access to almost unlimited data, new and more dynamic models of healthcare delivery are emerging. The overarching goal for these new delivery models is to drive increased savings and better services for the sponsors and receivers of healthcare.

More data-driven healthcare allows an increased focus on precision and personalised health. A more individually focused healthcare is driving a shift towards value-based patient-centric business models, where patients will be charged depending on actual (positive) health outcomes. These approaches include telemedicine and mobile on demand healthcare. Telemedicine provides healthcare from a distance, enabled by devices at home or at local clinics and various kinds of wearables that allow real-time information sharing between the individual and healthcare provider. Mobile on-demand healthcare follows the Uber model. One example is 'Kalldoc', where doctors come to the home or the office on-demand.

Towards 2050, new and much more effective and efficient models of healthcare will gain ground, based on data-driven holistic models. Private providers will likely enter markets with innovative large scale solutions – based on technology-enabled business models – that increases quality, reach and access. Whether public providers will be the front runners or follow in footsteps of commercial providers is uncertain, but one important aspect that needs to be taken into consideration is society's need for long-term resilient healthcare models with focus on continuity.

## Driving Forces

- Focus on Health
- Technological Development
- Technological Diffusion and Empowerment
- Individualisation

## Robot Doctors and VR Training

U.S. surgeons expect about 35 % of operations will involve robots in five years, an increase from 15 % today. Developers of the next wave of robots aim to make them less expensive, more nimble and capable of performing more types of surgeries. Surgical robots are already used in hernia repair, bariatric surgery, hysterectomies and prostate removals. Robots assisting during surgeries reduce fatigue and increase precision.

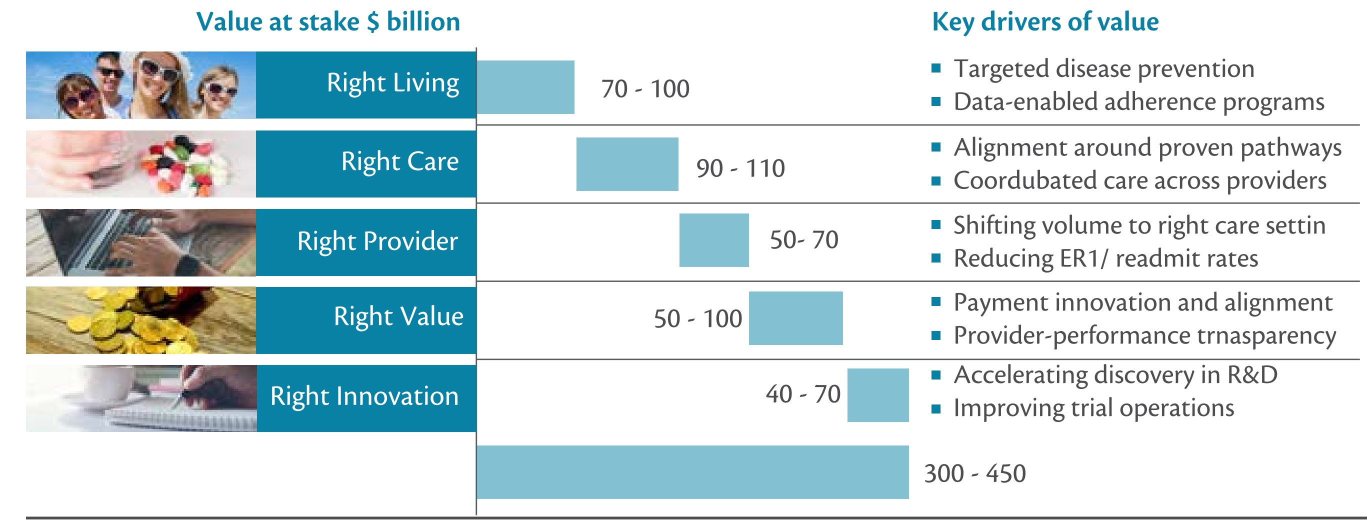
To meet global demands for medical procedures, 2.2 million extra surgeons need to be trained. Virtual reality (VR) can revolutionize the way surgeons are trained, especially in the developing world. In 2016, the first surgical procedure was live streamed in VR.



## Assessment

There is a strong push for development of new healthcare delivery models. However, it will likely take at least five years before we see the first wave of the new models in full scale, while in ten years such models can be expected to be a general standard for the sector.

## Data & Facts




**Cost reduction potential using data driven health care, USA**

The use of big data to deliver data-driven healthcare holds enormous potential for value creation. A study estimates that applying early data-driven successes at scale could reduce the US healthcare cost by USD 300-450 billion dollars annually. It is expected that by 2020, 70 - 90 % of healthcare providers will be equipped to participate in data analytics.

Data can help capture value in healthcare in several ways:

Right living: Data can help patients take an active role in their own health, such as diet, exercise, and medication adherence, to take control of their health.

Right care: Data can improve outcomes and reduce medical errors. Application of big data tools will facilitate evidence-based care that is personalised to the specific patient.

Right provider: Proven outcomes for patients to receive the best medical care based on data that better match the provider's skill set with the needs of the patient, etc.

Right value: Cost-effective healthcare through different methods, such as value/outcome based models.

Right innovation: Innovators will be able to utilise data from past trials as well as analysing trends from current data. Healthcare providers can analyse patient history data, real-time data from monitors, clinical factors, lifestyle choices and social determinants to provide a holistic view of the patient and develop the most effective care plans.

## Areas to Consider

The fact that leading experts can 'treat' the patient at a distance presents some interesting business opportunities. It opens up for countries to position themselves as leading destinations within specific healthcare fields, without the patient having to travel to the country.

## Did you know?

A systematic review study conducted by NIH (USA) in 2012 disproves the claim that the private healthcare sector is generally more efficient, accountable, and medically effective than the public sector.

Sources: Fortune (2016), 'Rise of the surgical robot and what doctors want'; McKinsey&Company (2013), 'The big-data revolution in US health care: Accelerating value and innovation'; Basu, S. et al. (2012), 'Comparative Performance of Private and Public Healthcare Systems in Low- and Middle-Income Countries: A Systematic Review'; Wired (2016), 'Robot doctors will 'absolutely' replace surgeons'.

# RETURN OF POPULISM

Return of populism is a growing sense that the elites in one's country does not represent or reflect your interests and that the system no longer serves your benefit, but benefits another group. It currently manifests as strains of anti-capitalism, anti-elitism, and the resurgence of nationalism. This trend is spreading across Europe, the Americas, and Asia. In representative democracy, it is correlated with demagogic political movements. In non-democratic societies, it can fuel subnational conflicts.

While subnational rivalries, tensions and conflicts have always existed, tensions are being exacerbated by the ongoing consequences of globalisation, polarisation, job dislocation, the financial crisis and the emergence of 'filter bubbles' and fake news on social media. This trend is leading to a return of both religious and ethnic clustering, increased migration flows, conflicts over refugees, terrorism, and reactions against neoliberalism. This trend has serious ramifications throughout society.

Instead of bringing people together and exposing people to other they would not normally see, social media tends to enable people to share information and engage in networks only with people similar to themselves (shared values and backgrounds). Personalised newsfeeds ensure that people only receive the information and news they like – creating so-called 'filter bubbles'. This polarises people into groups that do not engage with each other, creating intolerance between them and a lack of understanding of other people's perspectives.

The duration and strength of this trend beyond 10 years is uncertain. The return of populism will, however, shape global relations and trade for the next decade.

## Driving Forces

Network Society

Globalization

Acceleration & Complexity

## Fake News - Difficult to Assess

A recent survey among US adults show that it is very difficult for the average person to discern between real and fake news. According to this survey, fake news headlines related to the elections deceive respondents approximately 75% of the time. Respondents believed that the fake headlines were "somewhat or very accurate." In comparison, respondents believed that real headlines were "somewhat or very accurate" 83% of the time.

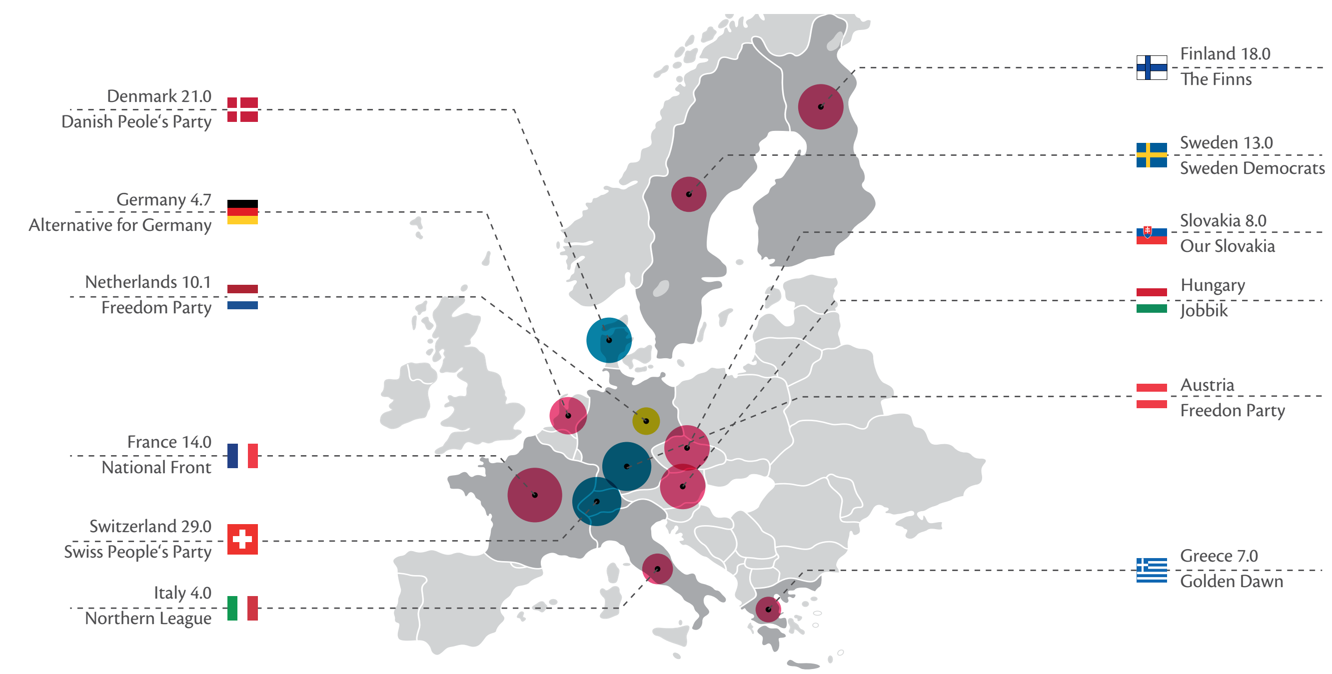
The study further found that people who said they relied on Facebook as a major source of news appeared to be disproportionately susceptible to fake news headlines.



## Assessment

This trend has global effects and concerns the safety of the population as well as the disruption of trade and international relations. The return of populism is steadily increasing, and major events could easily happen within the next 5 years

## Data & Facts




**The rise of nationalism across Europe (% votes of nationalist parties in the most recent elections)**

As this figure from May 2016 shows, nationalistic and populistic movements are on the rise in many European countries, particularly Austria, Denmark, Finland, Hungary, and Switzerland.

There are similar trends in countries such as China, India and Turkey. In India the ruling party is the Hindu nationalist party, propagating traditional values. Soon after the Chinese elections, the president launched the 'Chinese Dream' slogan to promote the country's great revival. While in Turkey, the president vowed to build a 'New Turkey' to stand up to dissenting factions.

## Areas to Consider

At a global level, increasing international conflict can break down important trade or migration routes and partners, especially with regionwide instability and negative safety ratings.

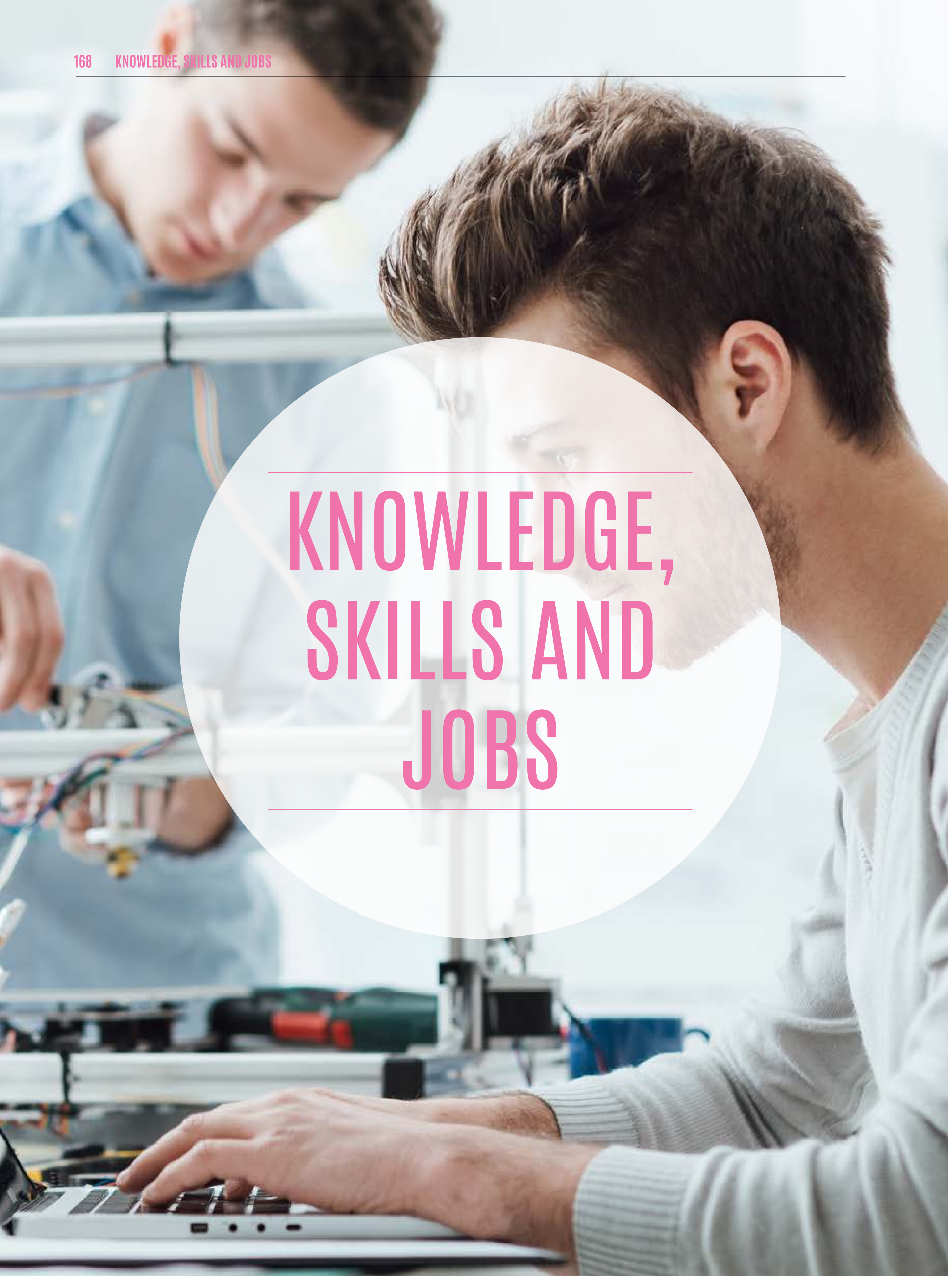
Decreasing globalisation will have severe impact on trade-dependent economies as well as creating a larger dependence on home-grown skills and talents.

Countries could capitalise on the opportunity to showcase tolerance as a way to attract foreign talent.

## Did you know?

"Individual users choosing news they agree with and Facebook's algorithm providing what those individuals already agree with is not either-or but additive. That people seek that which they agree with is a pretty well-established social-psychological trend ... what's important is the finding that [the newsfeed] algorithm exacerbates and furthers this filter bubble." - Fortune, 2015.

Sources: Statista (2016), 'The rise of nationalism across Europe'; The Globalist (2016), 'Managing the Forces of European Populism'; Project Syndicate (2016), 'The Geopolitics of Populism'; Ipsos Public Affairs (2016), 'Ipsos/BuzzFeed Pool – Fake News'; Fortune (2015), 'Facebook 'filter bubble' study raises more questions than it answers'.



# KNOWLEDGE, SKILLS AND JOBS



## INTRODUCTION

The skills needed to thrive in the job markets and in society in general are constantly evolving and will continue to do so with increasing speed in the coming decades. Along with technology development, an increasing number of tasks are getting more complicated, requiring extensive knowledge and experience to master. This is creating a need for updating the current structures in most societies, based on a linear development through the education system to the job market. The focus is shifting from acquiring knowledge, to learning how to learn.

The following chapter describes 9 trends shaping the future of knowledge, skills and jobs towards 2050. The 9 trends presented can be categorised into the following three areas:

3

### Jobs

- Next Wave of Automation and Employment
- Polarisation of the Labour Market
- War for Talent 2.0

3

### Skills

- 21st Century Skills
- Emergence of the Neo-Generalist
- Googlisation

3

### Education

- Digitisation of Education
- Lifelong Learning
- Gamification in Education

# NEXT WAVE OF AUTOMATION AND EMPLOYMENT

Automation or technological unemployment is driven by labour saving machines (mechanical muscle) or more efficient processes (mechanical mind). Since the introduction of the steam engine, human occupations and tasks have been affected by automation. The current wave of automation that will impact the labour market towards 2050 is being driven by robotics and artificial intelligence (AI) among other technologies. As they become more capable, automation will affect occupations that we once thought required uniquely human abilities (e.g. cognitive automation), affecting the way we work, do business, and organize our society. Experts, however, are uncertain about the general pace and intensity of the development of this trend and its impacts on employment. The challenge will be to help the labour force adapt by developing new skills and competencies.

The current wave of automation differs from previous ones in three crucial ways: 1) It will likely impact all industries and sectors, 2) it will impact occupations at all skill levels from high to unskilled, and 3) it will penetrate markets more rapidly and deeply than previously.

Examples of some of the occupations at greatest risk of automation are the routine ones in knowledge industries – e.g. bookkeeping, accounting, financial trade, and legal professions.

Some, like Stephen Hawking and Bill Gates, point out that increased automation will decimate the middle class jobs, create greater inequality and increase the risk of major political change. Others, like IBM CEO Ginny Rometty, argue that while automation will make some jobs redundant in the short run these will be replaced by others in the longer term.

Broader society will have to develop solutions to ensure that workers can adapt to the new reality and remain relevant in the labor market throughout their lives through short and intense learning programs that focus on just-in-time learning instead of just in case learning. The ability to quickly acquire new skills will be crucial and should be acquired in early education, and personal and physical resilience will be important to be able to handle a more dynamic working life.

## Driving Forces

Technological Development

Knowledge Society

Economic Growth

## White-Collar Jobs Being Automated

AI and robotics have already matured to the point where they are taking over routine job tasks in knowledge industries. Examples include:

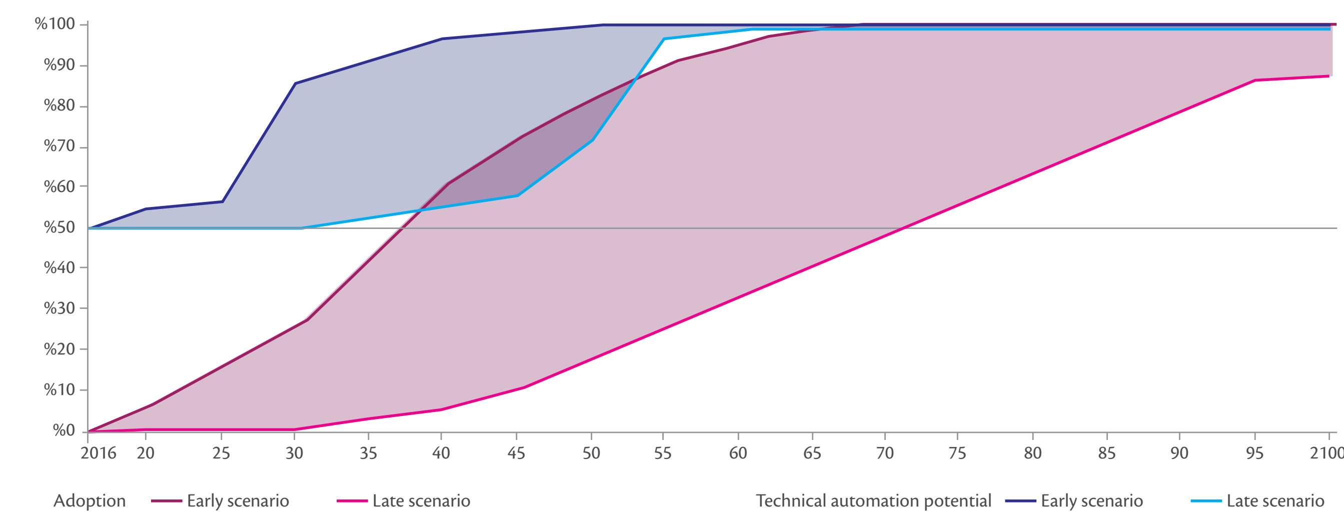
- Robot pharmacists are used to fill prescriptions with zero mistakes. This has improved efficiency and at the same time enhanced patient-centred consultations, as it has freed up human resources that can be dedicated to customer interaction.
- In the US, there has been a major decline in accounting jobs after intelligent software (like Turbotax) have replaced many traditional accounting tasks.
- In journalism, AI can now publish publish financial reports, sports commentaries, clickbait and myriad other articles formerly done by trained journalists.



## Assessment

Automation technologies are already capable of taking over many jobs, and the development will continue, despite uncertainties about the pace and intensity. The development will have different consequences for different industries and regions.

## Data & Facts




**Time to be spent on current work activities in six countries up to 2100 (80% of global labor force).**

A recent report investigates the potential that a given work activity could be automated by adopting currently demonstrated technologies. The report concludes that 50% of all work activities globally (based on 46 countries) can be automated with already demonstrated technology (blue area). However, adoption will take decades and there is significant uncertainty on timing. In an early adoption scenario, up to 80% of all work activities could be automated by 2050, assuming all the factors are in place for successful adoption by then (purple area).

The new technologies that are introduced now – dubbed exponential technologies – that have the potential to take over even more work activities, will most likely be affordable to most businesses by 2050. However, the rollout of technological solutions has been hampered by technological and economic barriers, social restrictions, and basic inefficiencies that influence the pace and intensity of the development.

## Areas to Consider

Policy makers need to adapt the needed structural changes to ensure a well-balanced automation adoption trajectory. This includes regulatory issues and labour market protections.

It will become critical to prepare both the current and coming labour force for the next wave of automation. Policy makers need to address the skills and knowledge needed for the future through efficient lifelong learning – technical as well interpersonal skills. This demands a shift in the focus of education from 'just-in-case learning', where people are taught all sorts of things that they might need later in life, to 'just-in-time learning', where people teach themselves skills they need when the need arises.

## Did you know?

According to the World Bank, 77% of all existing jobs in China are at risk of being automated over the next 20 years. If this is adjusted for delayed technology adoption, the number is closer to 55% or 425 million jobs – mainly blue-collar jobs, but also white-collar jobs.

Sources: CIFS (2016), 'Members' Report - Automation'; McKinsey&Company (2016), 'Where machines could replace humans – and where they can't (yet)'; McKinsey&Company (2017), 'A Future That Works: Automation, Employment, and Productivity'; Deloitte (2015), 'The Robots Are Coming'; Accenture (2016), 'Why Artificial Intelligence is the Future of Growth'; World Bank (2016), 'World Development Report 2016 - Digital Dividends'; Forbes (2016), 'What Will Happen When AI Starts Replacing White-collar Jobs?'.

# POLARISATION OF THE LABOUR MARKET

Polarisation of the labour market has been an ongoing trend over the last 25 years in high-income countries, and has led to the highest levels of income inequality measured in OECD countries. Driven by automation (see Next Wave of Automation and Employment), regulatory reform, and, to a lesser extent, globalisation, the number of jobs requiring medium levels of skill has decreased, while the demand for high-skilled and low-skilled labour has increased. Automation replaces the need for labour, while globalisation impacts employment conditions through off-shoring of manufacturing and some service sector jobs (e.g. call centres). Many of those displaced fall out of the middle class, finding employment in low-skilled jobs in the service sector.

Polarization is detrimental to society. It raises social, political and economic concerns, as income inequality leads to lower levels of growth in countries, frays social institutions and erodes trust in public institutions.

Combatting it will be difficult as it is deeply embedded in current economic structures and require changing institutions, policies, and relationships between economic actors. An important issue is taxation and redistribution of wealth. For example, Bill Gates has recently suggested that we should tax the robots income on equal terms with labor, while others have proposed basic income financed by the increase in prosperity that the next wave of automation will create.

## Driving Forces

- Technological Development
- Knowledge Society
- Economic Growth
- Globalization

## Middle-Class Jobs at Zalando Disappearing

Due to the rise of e-commerce, traditional brick- and mortar stores are increasingly competing with fast-growing online shops. This is causing classical middle-class jobs to disappear, such as sales assistant positions.

However, the example of Zalando, Europe's fastest growing fashion online shop, shows that the digitised economy also creates new sectors and new jobs. Within only 7 years, Zalando created 10,000 new jobs in Germany, e.g in big data analysis and other tech professions.

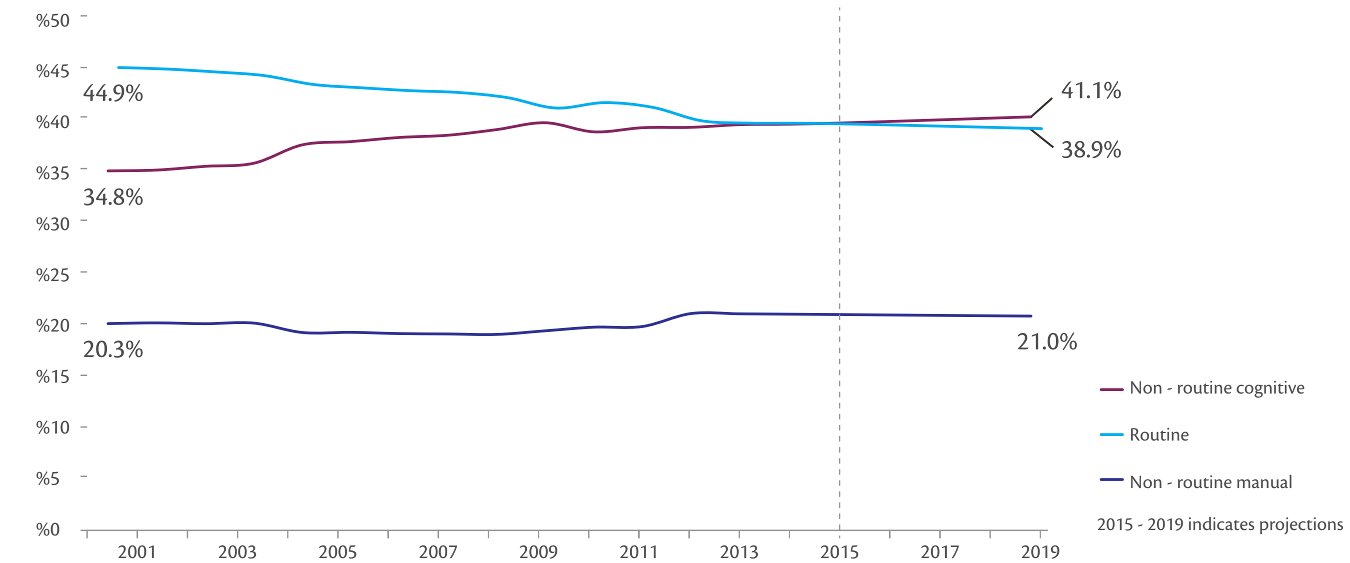


## Assessment

It is not clear to what extent automation will create increased polarisation and structural unemployment or more jobs.

Individuals are already experiencing the effects of labour market polarisation, losing jobs caused by efficiency gains, however the effect will increase in speed and magnitude in the long run.

## Data & Facts




**Occupational employment shares, Developed Economies and European Union, projections until 2019.**

In developed economies, high-skilled non-routine cognitive jobs have been increasing steadily while medium-skilled routine jobs are declining. Low-skilled non-routine manual jobs are more or less stable. While outsourcing of routine jobs was a main source of labour market polarization from 2000 to around 2010, the polarizing effect decreased somewhat in recent years, as companies outsourced less and even started re-shoring to some degree.

However, the polarization of the labour market is expected to pick up speed again towards 2050, as the new wave of automation intensifies and technology eliminates more and more routine jobs. There, however, will be significant regional variations according to the pace of change.

## Areas to Consider

In order to assist in creating a skilled competitive workforce, policy makers will need to ensure that they are helping the population continually adjust to the labour market's needs through, e.g., lifelong learning.

Employers should be encouraged to take ownership by developing training solutions, supporting upskilling and reskilling of employees with lower-level skills, and mitigate local, regional and demographic disparities in access to jobs and skills.

## Did you know?

In addition to technological change, other factors drive labor market polarization in a complex combination. Given the weight of China in manufacturing supply chains, the decline in routine labour in the rest of the world in recent decades are to some degree the result of a shift of routine labour to China's manufacturing sector.

Sources: CIFS (2016), 'Members' Report - Individual Resilience'; World Economic Forum (2016), 'The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution'; International Labour Organization (2015), 'World Employment Social Outlook'; Cheremukhin, A. A. (2014), 'Middle-Skill Jobs Lost in U.S. Labor Market Polarization'; OECD (2015), 'In it together: Why less inequality benefits all'.

# WAR FOR TALENT 2.0

The war for talent is driven by demography and automation. Demographic change is affecting the war for talent because a large age cohort, baby-boomers in OECD countries and China, are heading towards retirement, which are replaced by smaller age cohorts that follow. The global distribution of talent is also changing towards 2050 and talents from emerging economies are increasingly in demand at home and abroad.

Automation affects the war for talent because the new jobs created in place of those disrupted will require greater technical, social or creative skills than the jobs that disappear due to automation. Currently, most societies are not structured institutionally nor financially to train and re-train the labor force on an ongoing basis to fulfill new jobs. Talent is therefore a resource that organizations, public and private, will compete over. The most successful organisations are those who succeed in attracting, integrating and retaining talent globally.

Individual, sought-after talents have become consumers of the workplace. They desire the jobs best aligned with their lives, leading to job hopping, freelancing opportunities and multiple careers. It has become the new norm for companies to 'steal talent' by providing the best, most individualized packages – especially in more innovative industries. This is expected to continue and accelerate due to the demographics of the future workforce and technology development.

## Driving Forces

- Technological Development
- Globalization
- Knowledge Society
- Demographic Development

## Data-driven Talent Management

Businesses are starting to recognize that they need a data-driven approach (people analytics) to figure out what makes talent join, thrive, and become high-performers, and stay with an organization.

The Global Human Capital Trends survey by Deloitte shows that companies who build capabilities in people analytics outperform their peers in quality of hire, retention, and leadership capabilities. According to the survey, 77 % of all organizations rate people analytics as important, 32 % are 'somewhat ready' or 'ready' for people analytics, while only 8 % are fully capable of developing predictive people analytics models. These numbers suggest that people analytics is gaining speed, compared to previous years surveys.



## Assessment

The ability to develop, attract and maintain a talented labour pool will determine the winning societies and companies. This war for talent is already impacting, and will continue to grow in importance.

## Data & Facts


**Mismatch between supply and demand for talent in 2021 (Average annual % change of deficit/surplus).**

The war for talent will intensify globally. As shown in the figure above, most developed countries will experience increased talent shortages - especially distinct for economies with advanced industries – and by contrast many emerging countries will have a talent surplus. On a global level, the war for talent towards 2050 will manifest itself predominantly in the need of developing countries to develop and retain talent, while developed regions have to attract talent from outside their borders, find ways to automate tasks, our offshore functions.

## Areas to Consider

The overall regulatory framework play an important role in attracting and retaining global talent. To help their companies attract talent, governments will have to provide frameworks for easily attracting, integrating and retaining talent.

In order to attract the best talents from a global talent pool, businesses have to become more agile and flexible in their employment options and provide benefit packages to create excellent and fulfilling job experiences.

## Did you know?

In a recent study, it was found that 21% of Millennial workers had left their job in the last year for another job opportunity. This is more than three times higher compared to non-Millennials in the same period of time.

Sources: Fortune (2016), 'Why Tech is Winning the War for Talent'; Harvard Business Review (2016), 'What millennials want from a new job'; Deloitte University Press (2016), 'Global Human Capital Trends 2016 – The new organization: Different by design'; PWC (2012), 'Talent mobility – 2020 and beyond'; Oxford Economics (2012), 'Global Talent 2021 – How the new geography of talent will transform human resource strategies'; Oxford Economics: Global Talent 2021.

# 21ST CENTURY SKILLS

The automation of work and the accelerating pace of change in the global economy and society require individuals to not only cope and adjust, but to also find new opportunities, occupations and ways to contribute on an ongoing basis. This requires Individual Resilience (see section below). To be a resilient individual that thrives in the 21st century, traditional foundational skills (for example, language and mathematic skills) have to be complemented with new, so-called horizontal skills. These include collaborative skills, critical thinking, creativity, and problem-solving, as well as to 'learn how to learn' for 'just in time learning' (See Lifelong Learning). The need for horizontal skills is already manifesting itself today and will likely increase towards 2050.

As most national education systems were designed for the Industrial Age, not for the knowledge society we live in today, the gap between the skills people learn and the skills people need is becoming more obvious. The notion of 21st century skills has been on many countries' political agenda for more than a decade, and their importance continues to grow. According to the World Economic Forum, by 2020 more than a third of the desired core skill sets of most occupations will be comprised of skills that are not yet considered crucial in today's labour market. For students and workers to be prepared for challenges and seize opportunities, a more proactive approach to education needs to be adopted by preparing students for jobs and technologies that do not yet exist.

## Driving Forces

- Globalization
- Acceleration & Complexity
- Technological Development
- Knowledge Society

## Individual Resilience

Resilience refers to the ability to respond and adapt effectively to changing circumstances, recover rapidly, and find innovative strategies on how to cope with stress and change. Resilient individuals possess a series of traits that allows them to thrive in a more rapidly changing world. Overall, resilient traits can be divided into four categories:

- Resilient body: Being physically fit and of good health to better handle physical stress and hardship
- Resilient mind: Having a mindset that is prepared for change and able to cope with mental stress and hardship
- Resilient behaviour: Cultivating social behaviour that helps us during crises and changes in a globalised and urbanised world
- Resilient competencies: Learned skills and tools that help you thrive in the 21st century characterised by automation and constant change



## Assessment

Skill requirements have already changed, but skills disruption is expected to accelerate over the medium to long term.

Where a specialist skill in the past could be useful for a person an entire lifetime; today, a skill is perhaps useful for half a lifetime, and in the future, less than that.

## Data & Facts

| Abilities | Basic Skills | Cross-functional Skills | |
|---|---|---|---|
| Cognitive Abilities<br>• Cognitive Flexibility<br>• Creativity<br>• Logical Reasoning<br>• Problem Sensitivity<br>• Mathematical Reasoning<br>• Visualization | Content Skills<br>• Active Learning<br>• Oral Expression<br>• Reading Comprehenssion<br>• Written Expression<br>• ICT Literacy | Social Skills<br>• Coordinating with Others<br>• Emotional Inteligence<br>• Negotiation<br>• Persuasion<br>• Service Orientation<br>• Trading and Teaching other | Resource Management Skills<br>• Management of Financial<br>• Resources<br>• Management of Material<br>• Resources<br>• People Management<br>• Time Management |
| Physical Abilities<br>• Physical Strength<br>• Manual Dexterity and Precision | Physical Abilities<br>• Physical Strength<br>• Manual Dexterity and Precision | Process Skills<br>• Active Listening<br>• Critical Thinking<br>• Monitoring Self and Other<br><br>Complex Problem Solving Skills<br>• Complex Problem Solving | Technical Skills<br>• Equipment Maintenance and Repair<br>• Equipment Operation and control<br>• Programming<br>• Quality Control<br>• Technology and User Experience Design<br>• Troubleshooting |

In 2015, the World Economic Forum compiled a new set of skills that will be necessary in order to cope with jobs of the future. Employers are already looking beyond the hard skills and formal qualifications, and many practical skills will likely be disrupted by 2050. The World Economic Forum assessed that in 2020, 36% of all jobs across all industries require complex problem-solving as one of their core skills. Social skills (e.g. coordination, emotional intelligence and training, and teaching others) and cognitive / process abilities will also be a growing part of the core skills requirements for many industries.

## Areas to Consider

For a society to be more resilient, it needs resilient individuals with resilient competencies. Hence, it is important that the educational system is designed to provide these, to prepare its citizens for an age of automation and constant change. It is essential that the educational system actively embrace Lifelong Learning, to support continuous learning throughout life in the best way possible.

## Did you know?

The US founded Partnership for 21st Century Learning – a coalition between the business community, education leaders and policymakers – has developed a skill framework encompassing a comprehensive set of skills that all sectors can agree are essential for in the 21st century. The partnership represents global as well as US businesses and actors.

Sources: CIFS (2016), 'Members' Report - Individual Resilience'; World Economic Forum (2016), 'The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution'; World Economic Forum (2016), 'What are the 21st century skills every student needs?'; www.p21.com.

# EMERGENCE OF THE NEO-GENERALIST

As business and work becomes more interdependent, complex, and knowledge-based, specialization within the labour market will increase, where complex tasks are broken down into more specialised tasks. Hence, in recent years, the need for specialists who can perform a set role in their business ecosystems has increased. While they are skilled at identifying and executing ever discrete findings, they are vulnerable to disruption.

At the same time, the need for generalists is evolving and increasing, leading the emergence of the neo-generalist. The competencies needed for neo-generalists becomes increasingly demanding and complex, thus needing specialisation to assume the role. The need for the neo-generalists is increasing because they are able to apply a holistic view and to understand the interconnectedness of society, technology, economy and politics and how it affects/disrupts business. Neo-generalists are needed to work alongside hyper-specialists to serve as connectors between disciplines, to help create the bigger picture and to bring metaskills like combinatorial creativity, systems thinking and pattern recognition into play. Towards 2050, the neo-generalist will be a specialisation in its own right.

## Driving Forces

- Acceleration & Complexity
- Technological Development
- Knowledge Society

## Increasing Value of Generalists

A recent study found that in the age of specialisation, employers (in this case, investment banks) actually value generalists higher than specialists. One reason is that specialisation in more and more industries are becoming commodified and thus relatively easy to substitute. In a complex world where solving complex problems and develop new innovative solutions is priority, the majority of leaders tend to be generalists.



## Assessment

As technology and society continue to grow ever more complex, the 'specialisation' of generalists will certainly also grow in the years to come.

## Areas to Consider

At the company level, it becomes increasingly important to have organizational structures in place that allows for specialists and neo-generalists to complement each other and create synergies.

## Did you know?

Global Vice President of Customer Strategy at SAP, Reuven Gorsht, described the emergence of a new type of generalist in the following way:

'The new Generalist is in fact a master of their trade. They bring expertise and experience in several areas, fuelled by insatiable curiosity and the ability to 'hyper-learn' new concepts and ideas'.

Sources: World Economic Forum (2016), 'The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution'; Harvard Business Review (2016), 'Generalists Get Better Job Offers Than Specialists'; World Economic Forum (2016), 'Generalists or specialists: who do employers value more?'; Forbes (2013), 'New Problems, New Approaches: The Rise of The Generalist'.

# GOOGLISATION

'Googlisation' covers the general trend of instantly finding information. Since Google revolutionised the way we search for information online, it has become increasingly easy to find the product, service, and information you need almost instantly. As we experience a move to an environment of instant and infinite information, it becomes less important in the future to know and memorise information and instead more important to be able to search for and find information. This is phrased as a shift 'from being knowledgeable to being knowledge-"able"'.

As the internet continues to grow at an unprecedented rate and search habits are changing, the challenge of providing users with appropriate and personalised answers has become more complex. Thus, search engines are evolving to accommodate future needs, making use of technological breakthroughs in machine learning and artificial intelligence. Newer configurations of search engines have already begun to imitate personal assistants, thus becoming more proactive with predictive power rather than reactive. In the near future, our AI personal assistant might know us so well, that they are able to give us specific information, even before we are aware that we need it.

While googlisation makes it easier and more time-efficient to find and access information in general, it also offers powerful empowerment to people in less developed countries with increasing access to the internet. In countries where traditional sources of information like libraries, news media and educational institutions are in relative short supply, increased access to information strengthens transparency and democratises knowledge.

## Driving Forces

- Technological Development
- Knowledge Society
- Globalization
- Technological Diffusion and Empowerment

## Intelligent PA Search Engines

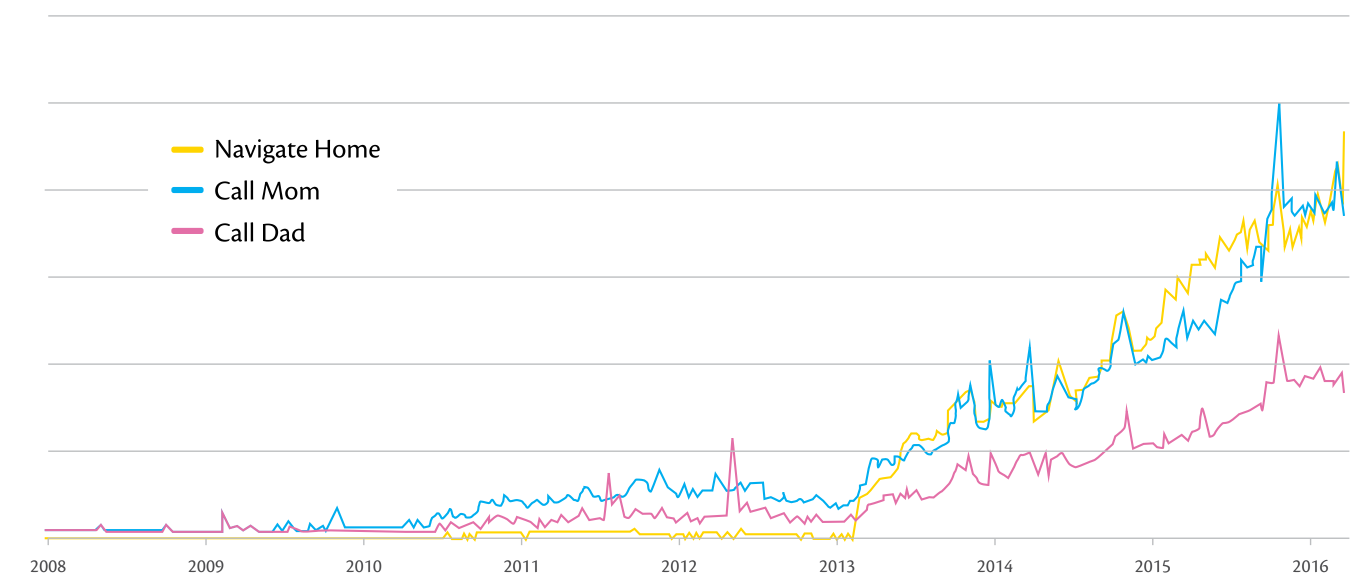
Google, Apple Amazon, and Microsoft all have intelligent personal assistant search engines that are developed to provide you with information even before you realise that you need the information. These predictive search tools tap into user behavioural patterns and various sources of information, such as location and location history, search history, calendar entries, emails with flight and hotel reservations, and many more. With the rise of mobile devices, wearables, and the growth of the Internet of Things, search engines are bound to become more and more accurate.



## Assessment

Googlisation is already very advanced due to technological development. Technological breakthroughs in machine learning and artificial intelligence will further advance this trend in the medium to long term.

## Data & Facts




**The rise of voice-specific search queries, from Google Trends, 2016-2008**

In the Internet Trends Report from 2016, the rise in voice searches are proxied by tracking the rise in voice-specific queries such as 'navigate home', 'call mom' and 'call dad'. According to the report, it is a surprisingly accurate way to map the growth of voice search and voice commands.

Voice search is a fast-rising trend in search, as the proliferation of mobile devices with digital assistants and the advances in AI applications within conversational language recognition make voice searching easier and more accurate. In recent years, voice search has been growing exponentially. It is predicted that in 2020, 50 percent of all searches will be voice searches and 30 percent of all web browsing sessions will be done without a screen. People are turning to voice search to save time and to instantly access information, wherever they are and whenever they need it. It is difficult to make predictions beyond 2020 as this is an area with rapid technological advances. However, towards 2050 it is certain that we are quickly moving towards an environment with instant and infinite information.

## Areas to Consider

Search engines are collecting unimaginable amounts of personal data about user behaviour, which raises important questions on data privacy and protection.

'Filter bubbles' is a real risk when search engine algorithms personalise search results. Users may become separated from information that goes against their viewpoints.

## Did you know?

Google's PathNet project is an attempt to create self-learning AI by allowing a neural network to reuse what it already knows in new contexts.

Sources: Quartz (2015), 'The search engines of the future will be able to see and hear like humans'; KPCB (2016), 'Internet Trends Report 2016'; Forbes (2016), 'Gartner's Top 10 Strategic Predictions For 2017 And Beyond'; Pariser, E. (2011), 'TED Talk - Beware online filter bubbles'; Wesch, M. (2010), 'TED Talk - From Knowledgeable to Knowledge-able'.

# DIGITISATION OF EDUCATION

Learning environments are transforming due to the integration of technology into the educational setting. This is changing how learning and teaching will develop and the requirements for future learning environments – physical as well as virtual. The digital transformation is occurring at all levels of education, but differs greatly in scope and form.

Technology will need to deliver improved quality and personalisation as well as be cost-effective and widen access to education. Developments in such areas as online education and data analytics, virtual and augmented reality, and AI and machine learning have already started to change the educational landscape.

This opens for a wide range of new technology-enabled education strategies in physical and virtual learning environments. Examples of such strategies include blended learning, flipped classroom, makerspaces, or more advanced approaches such as learning analytics and adaptive learning.

The pace of digitisation in education is generally slower than in other more profit-driven sectors. As a central policy area, there are many stake holders and potential 'gate keepers' (e.g. governing bodies and teachers) involved in digital transition decisions. The role of these gate keepers is being challenged via the democratisation of education and the need for lifelong learning. These two forces are leading driving an increased demand for education on a global scale, permitting the emergence of the EdTech industry (through e.g., MOOCs, see below).

## Driving Forces

- Technological Development
- Knowledge Society
- Technological Diffusion and Empowerment
- Demographic Development

## The Rise of MOOCs

The emergence of Massive Open Online Courses (MOOCs) has been described as one of the most disruptive innovations to impact education. MOOCs offer opportunities for flexible learning and opens up education to a vast audience, thereby empowering people from different places and social backgrounds to access education. It is a democratisation of education.

Led by Coursera (a private EdTech company), more than 35 million learners have enrolled in more than 4,200 courses offered by around 570 universities in 2015 – compared to roughly 160,000 at one university in 2011.



## Assessment

Virtual and digital classrooms are probably the most important drivers for an effective future education system. The emergence of technology enabled learning environments has already left its mark to a certain degree, and will be even more transformative over a longer time horizon.

## Data & Facts

Projected attainment rates in 2030 and year of achieving universal attainment, by educational level

| | Primary attainment rate(%) (2030) | Projected year of universal primary attainment | Lower secondary attainment rate (%) (2030) | Projected year of universal lower secondary attainment | Upper secondary attainment rate (%) (2030) | Projected year of universal upper secondary attainment |
|---|---|---|---|---|---|---|
| World | 91.5 | 2042 | 84.4 | 2059 | 68.6 | 2084 |
| Low income | 69.6 | 2088 | 50.0 | 2096 | 29.0 | After 2100 |
| Lower middle income | 93.2 | 2054 | 86.8 | 2066 | 71.8 | 2088 |
| Upper middle income | 99.1 | 2020 | 96.1 | 2045 | 75.2 | 2084 |
| High income | 99.6 | Achieved | 98.7 | 2017 | 94.9 | 2048 |

Technology is set to play a major role in increasing both reach and quality in education across the globe, as technology can fundamentally transform education delivery. Arguably, the most important aspect of technology in education is the promise of greater democratisation (access to) knowledge.

Access to both basic and higher education remains a pronounced challenge in many low and middle income countries, as evident in the above figure. Education is essential for sustainable development, as acknowledged by the UN Sustainable Development Goals that aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Even so, many people – children and adults – in developing countries lack access to quality education and knowledge, but this can be mitigated by innovative solutions with technology-enabled education.

## Areas to Consider

To reap the full potential of technology integration in education, it is paramount that focus is not only on technology itself. There has to be a strong focus on teachers' ability to navigate and deliver learning in an increasingly digitised learning environment. Innovation in pedagogy and professional training of teachers should therefore be a priority.

## Did you know?

Globally, education is a US $ 7 trillion market. The scope of opportunity for digital education as disruptor is larger than entire industries, or in some cases, GDP of entire countries.

Sources: New Media Consortium (2016), 'Horizon Report – K12- Education'; New Media Consortium (2016), 'Horizon Report – Higher Education'; UNESCO (2016), 'Global Education Monitoring Report – Education for people and planet: Creating sustainable futures for all'; Class Central (2015), 'Less Experimentation, More Iteration: A Review of MOOC Stats and Trends in 2015'.

# LIFELONG LEARNING

Lifelong Learning (LLL) is the continuous building of skills and knowledge throughout the life of an individual in order to fulfil a broad range of purposes, from direct economic objectives through social inclusion and active citizenship, to personal fulfilment and life quality. The world is changing at record pace, transforming the way we live and work, and LLL acknowledges the emergence of new skills and competencies deemed critical for individuals going forward (see Next wave of automation and 21st Century Skills).

An increasingly knowledge-based economy has profound implications on LLL's role towards 2050, as labour markets increasingly demand new and higher-order skills and competencies. This essentially means that the workforce has to continually and proactively adapt and learn new skills that are needed in the 21st century through LLL to maintain their relevance for the labour market, as people will live and work longer. At the same time, LLL is also very important at the personal level as an enabler for the individual to take active part in society through active citizenship.

Learning is no longer confined to a classroom or a formal setting as digitisation transforms education and drives new approaches to learning (see Digitisation of Education). Knowledge has become much more accessible as it is possible to constantly access information and share ideas. Thus, non-formal- and informal learning plays and important role in LLL.

## Driving Forces

- Knowledge Society
- Technological Development
- Acceleration & Complexity
- Demographic Development

## LLL a priority in Singapore

Singapore has transformed itself from a developing country to a moderneconomy in one generation – thanksin part to a strong focus on educationand Lifelong Learning.

The Government of Singapore continues to invest in Lifelong Learning with the aim to boost economic growth and increase the country's competitiveness. The Government has committed to increase the funding for continuing education and training from S$600 million in 2015 to S$1 billion in 2020. An additional S$20 million has been devoted to research on Lifelong Learning between 2016 and 2020.

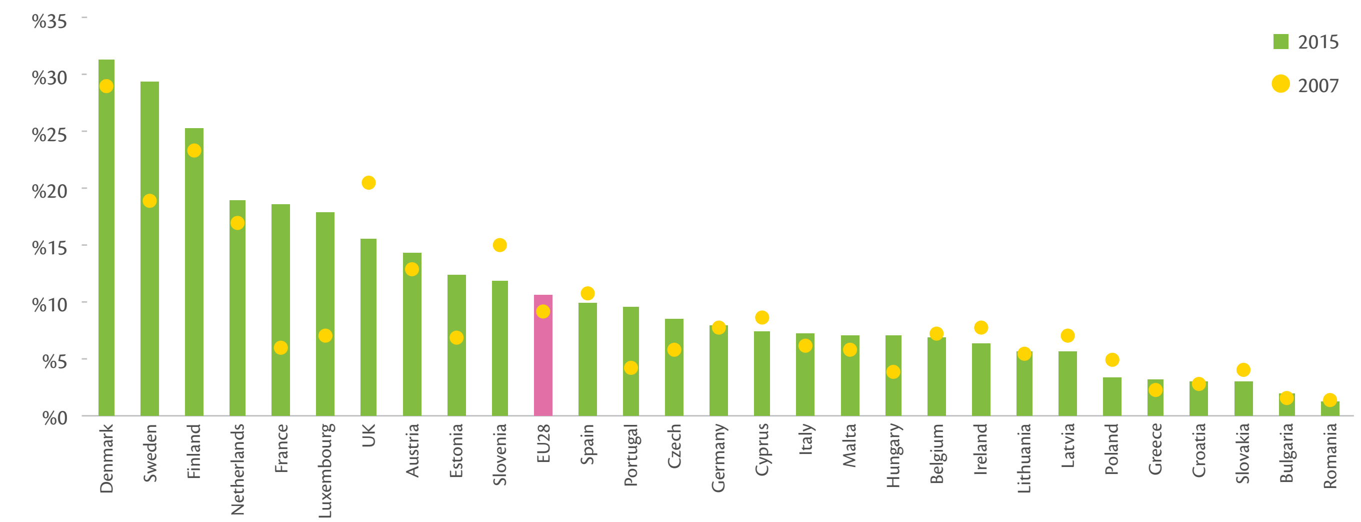


## Assessment

Lifelong Learning has gained traction and political focus in both developed- and developing countries, but it remains important to have a proactive approach to constantly be on par with the development.

even more transformative on longer time horizon.

## Data & Facts




**% of population aged 25 to 64 participating in education and training, EU28**

LLL continues to be a top priority for national and international policymakers around the world as an overarching policy response to cope with the rapid technological and societal change. LLL is a central element of the EU strategic framework on education and training (ET 2020), and the EU Commission adopted as a benchmark for LLL that an average of at least 15 % of adults aged 25 to 64 should participate in formal LLL activities in 2020. The Scandinavian countries stand out from the other EU Member States. See the figure above.

LLL is also a centrepiece in the UNESCO Education 2030 agenda (The Incheon Declaration), which is also adopted as part of the Sustainable Development Goals. The UNESCO Education 2030 agenda state: "We commit to promoting quality lifelong learning opportunities for all, in all settings and at all levels of education."

## Areas to Consider

At a policy level, there is a need to formulate and invest in lifelong learning strategies that opens up a full range of learning opportunities, as well as a qualifications framework that acknowledges the outcomes of non-formal and informal learning.

It is particularly important to retain people whose jobs may be lost to automation (see 21st Century Skills).

## Did you know?

By 2020, over one-third of skills (35 %) that are considered important in today's workforce will have changed, according to World Economic Forum. Horizontal skills such as problem solving, critical thinking, creativity and learning agility – the ability to quickly learn new things – will be among the most important skills.

Sources: World Economic Forum (2016), 'The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution'; UNESCO (2016), 'Education 2030: Incheon Declaration and Framework for Action'; Laal, M. & Salamati, P. (2012), 'Lifelong learning: Why do we need it?'; www.uil.unesco.org; www.eurostat.com.

# GAMIFICATION IN EDUCATION

The basic thinking behind the process of gamification is to encourage participation of people in certain events, whether it be in education and training, marketing or other applications. Gamification focuses on the use of mental rewards e.g. through points and badges to incentivise the behaviour of the participants. Gamification is widely used in different business-related applications. It is slowly gaining ground in educational contexts – in formal education as well as corporate training – as a natural consequence of the digitisation of education and the fact that younger generations play games on a variety of devices from an early age. Gamification is a way to promote learning outcomes and influence student behaviour, while allowing for greater learner personalisation.

In the short term, gamification will continue to gain ground without really revolutionising education. The development towards 2050 remains more uncertain. The future development and penetration into educational contexts relies heavily on the overall pace of technology integration in education.

## Driving Forces

- Knowledge Society
- Technological Development

## Virtual Reality Laboratories

Danish tech start-up Labster provides interactive advanced lab simulations using virtual reality technology. This enables science students to carry out open-ended scientific experimentations. The Labster virtual reality platform simulates fully equipped laboratories that students rarely have access to in real life due to financial-, safety-, and time constraints.

Labsters virtual laboratories utilize gamification elements, such as an immersive 3D universe, storytelling, and a scoring system, in order to stimulate students' natural curiosity to experiment.



## Assessment

The impact of gamification in education remains rather limited, and future development relies heavily on the overall digitisation of education. However, the coming years might show that gamification is a much more efficient way of learning, in which case quick adaptation becomes crucial.

## History of gamification

2000 – 2010 – 2020

**Everquest released**

1999
Everquest, the first successful massively multiplayer online role-playing game (MMORPG), is released, bringing social online gaming into the public consciousness. Everquest would pave the way for World of Warcraft, a 2004 release, for which more than 100 million accounts were created in the game's first decade.

**'Gamification' coined**

2002
British computer programmer and entrepreneur Nick Pelling coins the term gamification, defining it as "applying game-like accelerated user interface design to make electronic transactions both enjoyable and fast"

2005
Scratch, a visual programming language designed to teach the concepts behind computer programming, is released.

2007
The Institute of Play is founded in New York City.

2007
James Paul Gee publishes his book "What video games have to teach us about learning and literacy"

2009
Quest to Learn (Q2L), a project initiated by the Institute of Play, opens. Q2L has gamified nearly all of its courses and classes.

2010
Gamification gains traction within academic literature and becomes a popular term in internet searches.

2011
The first gamification conference is held in San Francisco.

2011
The Oxford English Dictionary adds gamification to its word of the year shortlist. It defines it as 'the application of concepts and techniques from games to other areas of activity'.

2012
The Deloitte Leadership Academy is revamped with gamified content, implemented by a specialised gamification consultancy.

2015
Fantasy Geopolitics, a gamified website designed to encourage students to learn about the world's news, is released through Kickstarter.

2016
Oculus Rift, the first commercial PC-based virtual reality head-mounted display, is set to be released.

## Areas to Consider

For gamification to become an integral part of educational systems, teachers needs to embrace and understand how to best employ new technology in education and to learn how to teach in new ways – gamification as part of teachers training could be applied. On the other hand, gamification poorly implemented can lead to negative impacts

## Did you know?

MIT professor Scot Osterweil has defined the concept of 'the four freedoms of play', which explains the learning and motivational value of gamification:

- The freedom to fail
- The freedom to experiment
- The freedom to assume different identities
- The freedom of effort

Sources: Pew Research Center (2012), 'The future of gamification'; Elm Magazine (2015), 'From social to engaging? – Learning groups and gamification'; Oxford Analytica (2016), 'Gamification and the future of education'.

# GOVERNMENT



## INTRODUCTION

As a society changes, so do its citizens' expectations towards governmental institutions. Most governments are adapting to changes slower than the surrounding society because of their size and bureaucratic governance structures, and we will likely see private organisations and networks facilitating new solutions that will cover needs which were earlier seen as public responsibilities. Increasing globalisation will continuously intensify the competition among states, in their pursuit to ensure the best possible conditions for their citizens through economic growth and thriving societies. The countries most successful in this competition will be governed by institutions (private and public) that are managing to anticipate and react faster than institutions in other countries and servicing their citizens from a citizen-centric perspective.

The following chapter describes 9 trends shaping the future of government towards 2050. The 9 trends presented can be categorised into the following three areas:

4

### Citizen Expectations Towards Service Delivery

- Focus on Outcome Rather than Output
- Citizen Centric Service Delivery
- Increased Transparency
- Artificial Intelligence in Government

3

### Government Funding

- The Weight of Ageing on Healthcare Cost
- Affordable Governance
- Privatisation of Infrastructure

2

### International Relations

- Companies vs. Cities vs. Sovereign States
- Power Shift in Global Security

# FOCUS ON OUTCOME RATHER THAN OUTPUT

The focus on outcome rather than output trend is defined by, the impact of outcomes on services such as, citizen wellbeing being the final arbiter of successful government service delivery. Organizations today are beginning to look beyond the limited notions of input, output, and profit towards growth that is much more performance-driven, outcome-based, and socially-centred. Towards 2050, developing new outcome-based metrics that demonstrate how government services are driving betterments in society, will become more common. This will require that governments transition from being a provider of services to an entity that predominately commissions, facilitates, or brokers services. To drive the transition, new skills are needed in governments – such as agility, innovation, transparency and connectedness – and new capabilities for facilitating relationships with external partners – such as flexibility, co-venturing, co-creation. The transition will further require governments to focus on defining new public-private partnership business models that involve the public sector, the private sector, the third sector and the citizen in service delivery as well as metrics.

## Driving Forces

- Network Society
- Individualisation
- Acceleration & Complexity

## Data-Driven Decision-Making in Government

The table below is an example of an outcome focused framework for evaluating government investments into data

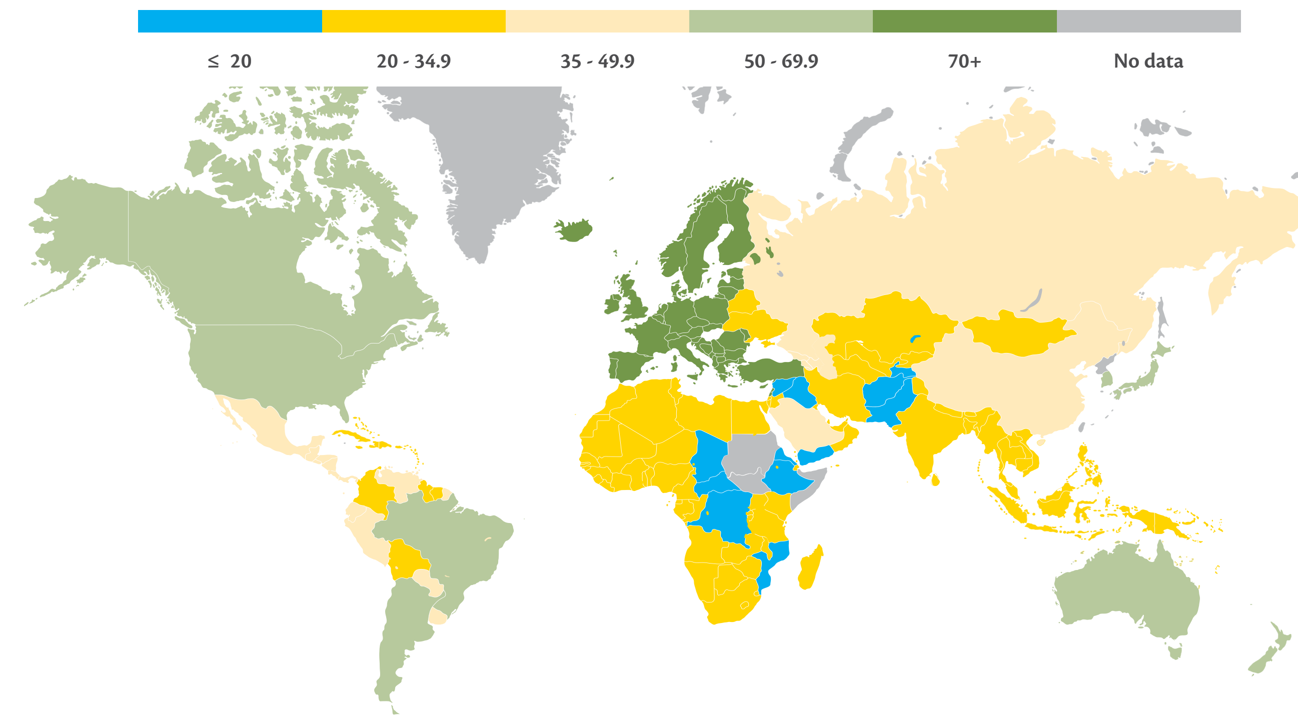
| Citizen Experience | Data-Driven Decision Making | Operational Efficiency | Economic Impact |
|---|---|---|---|
| Citizen participation in government decisions | Systematic approach to defining and tracking goals | Consolidation and re-use of apps, data, and services | Ability to deliver reduced data transaction costs for businesses |
| User-friendly digital services on web, mobile, and machine-to-machine interfaces | Interactive public dashboard to show performance data | Retirement of aging systems, and the ability to scale programs more easily | Embrace 'catalyst' role in the emerging data economy; help in incubating civic startups |
| Government services via location-aware mobile apps | Data visualization and employee-facing analytics apps to extract insights | Reduction of labor-intensive information requests through self-service tools | Access to data that supports academic research, driving new discoveries |
| Integration with consumer web services like Google Maps, Yelp, and Zillow | Sophisticated data collection capabilities, including crowdsourcing and sensor networks | Economies of scale through outsourced data storage | Public-private data exchanges |
| Active promotion of data transparency efforts | De-siloed systems and centralized, web-based access to data | Shift from custom- built systems and databases to service-oriented architecture (SOA) | Cross-departmental and inter-government data federation |



## Assessment

The impact of this trend is dependent upon the speed of its application. This trend is global and transitions are ongoing in a number of countries.

## Data & Facts




Quality of Nationality Index best=100 ,2015

The Quality of Nationality Index, depicted in the map above, aims to look at the value of citizenship based on economic output, human development, peacefulness and stability. In addition, the index measures the number of other countries that a citizen might want to travel to and settle in (based on economic strength and stability).

In 2015, all the top countries were European.

## Areas to Consider

The key challenge with developing a focus on outcomes is metrics. This is because appropriate measurement systems are not yet in place to assess whether progress is being made towards a milestone or an outcome. Developing these monitoring and assessment tools are also difficult as they are highly qualitative in nature. More citizen centric and outcome based metrics that put greater focus on citizen's overall wellbeing, which requires more citizen involvement, will have to be developed.

## Did you know?

In the UK, government training sessions and evaluations are carried out by the private sector, with PWC being the main provider and charging up to £100,000 per assessment. They also implemented a model that charges a percentage of costs saved (outcomes) known as win-return.

Sources: CIFS and ISS (2016), 'ISS 2020 Vision: Future of Service Management'; Quality of Nationality Index: Henley and Partners.

# CITIZEN CENTRIC SERVICE DELIVERY

Citizens increasingly see themselves as consumers of public services. As a group, they are a complex, individualized and diverse population, with growing, shifting, and at times contradicting expectations. Citizen Centric Service Delivery (CCSD) builds upon user-centricity and citizens' ever-increasing demands. Using more granular data on citizen requirements combined with emerging communication channels and new welfare technologies, CCSD seeks to continuously understand the needs of citizens and their communities, to tailor services in order to exceed user-defined outcomes through user-friendly services provided by the government. The public sector is likely to undergo an ongoing effort to optimize and transform public sector to deliver on CCSD. Due to the large size of the public sector, as well as the inertia of most bureaucracies, long term planning and reliable partners are increasingly important considerations when focusing on CCSD.

## Driving Forces

- Network Society
- Individualisation
- Acceleration & Complexity

## Paris's Budget Participatif

Governments are adopting technological solutions towards developing citizen-centric services. For example, the municipality of Paris launched the budget participative or "participatory budget", where citizens can directly influence how 5% of the city's investment budget or EUR426 million should be spent from 2014-2020. The projects cover several thematic areas and include quality of life, smart city, health, education, among others.

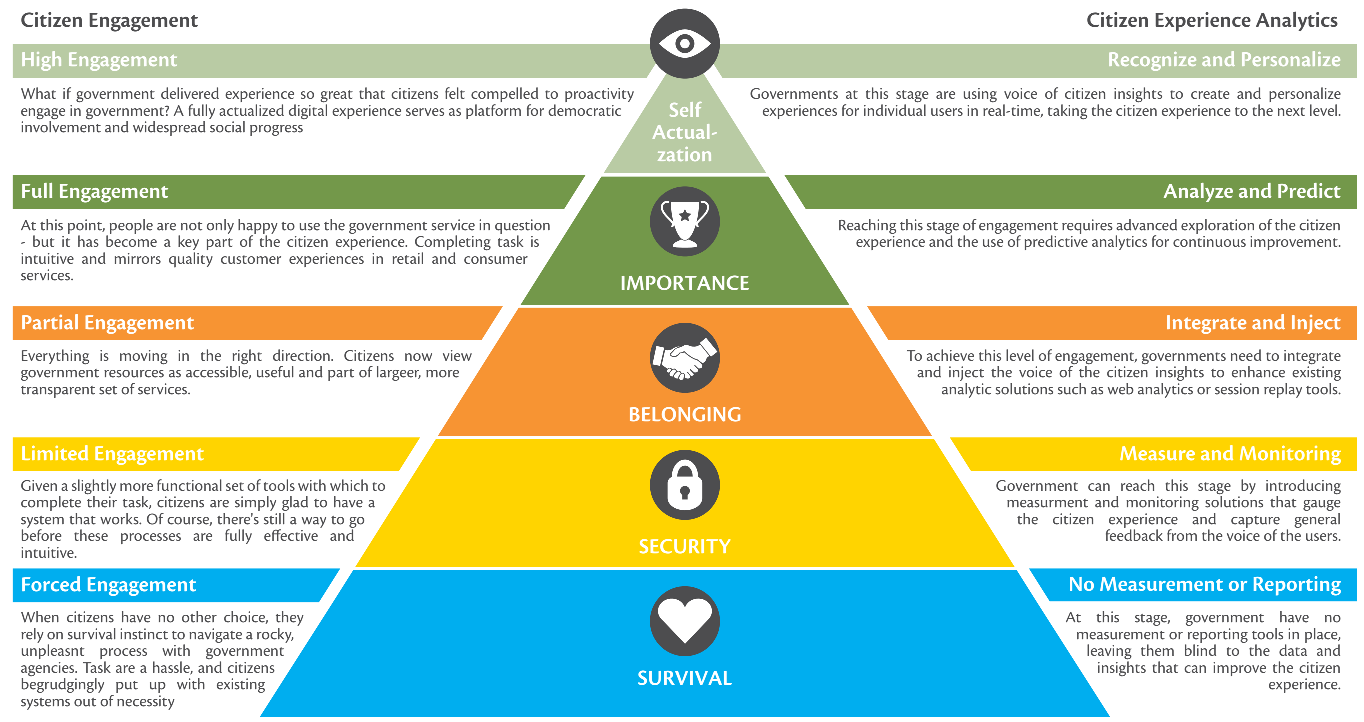


## Assessment

Governmental administrations will experience large impacts from reorientation of governance towards citizen-centricity. The development is already taking place, and is expected to increase significantly in the coming decade.

## Data & Facts

The graphic outlines a framework for evaluating government engagement with citizen needs, based on Maslow's self actualisation pyramid




## Areas to Consider

Applying CCSD requires implementing across a wide range of areas. Many governments have made efforts to improve service delivery through online portals or "one-stop shops", but find they are still unable to meet the public's expectations. Many governments, despite their best intentions, continue to design and deliver services based on their own requirements and processes instead of the needs of the people they serve. As a result, governments face declining citizen satisfaction and increasing costs associated with delivering services across multiple channels.

## Did you know?

According to a survey, American citizens generally consider their customer service experience to be much better than their citizen service experience. By calculating a Citizen Satisfaction Score, the survey found that the score for service experience for private sector services were 2.5 times higher than the score for government services.

Sources: McKinsey&Company (2014), 'Putting Citizens First – How to improve citizens' experience and satisfaction with government services'; McKinsey&Company (2015), 'Implementing a citizen-centric approach to delivering government services'; www.smartnation.sg ; Iperceptions citizen experience.

# INCREASED TRANSPARENCY

Many public sector organizations are facing increased scrutiny and calls for further accountability, monitoring and control. Increased transparency is seen to be a guard against vested interests, abuse of power and a safeguard against corruption. This involved e.g. campaign finance disclosure policies and facilitating watchdog journalism (like Watergate). As technology becomes an integral part of our daily lives, citizens are looking towards their governments to utilize technological innovations to increase transparency of decision making.

However, how increased transparency will be achieved will undergo a change in the future. Specifically, there is a growing movement towards new metrics that include integrated, holistic reporting as opposed to individual audits and accountability. This is especially the case with public-private partnerships, which are a critical means of gaining insights and responding to growing citizen demands. The pervasiveness of technology and use of social media to disseminate opinions is increasing citizens' role in shaping policy. The Italian Government has partnered with the private sector to implement an initiative called 'Digital4Democracy', which incorporates innovative Automatic Speech Recognition technologies into government meetings. This allows citizens free and immediate access, and increases citizens participation in the democracy. For example, when votes are being cast, or legislation is being debated users can see how one or more public officials voted or the comments they made.

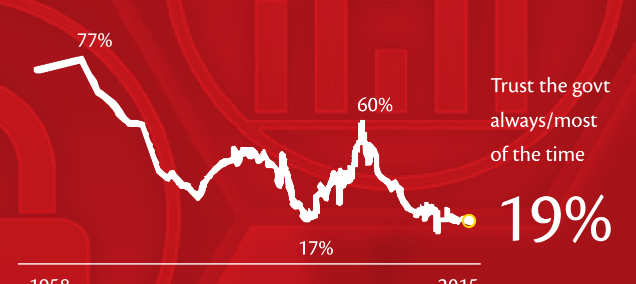
## Driving Forces

- Network Society
- Technological Development
- Knowledge Society
- Technological Diffusion and Empowerment

## Trust in Government

Trust in government is a growing problem in most high income countries. An issue that is being exacerbated by the emergence of fake news.

In 2016, Americans reported an all-time low trust in their government's ability to handle post-recession policies and threats to security.




Americans overall views of the federal government are very negative .....

74% Most elected officaials put own interests ahead of country s

55% Ordinary Americans would do better job solving problems

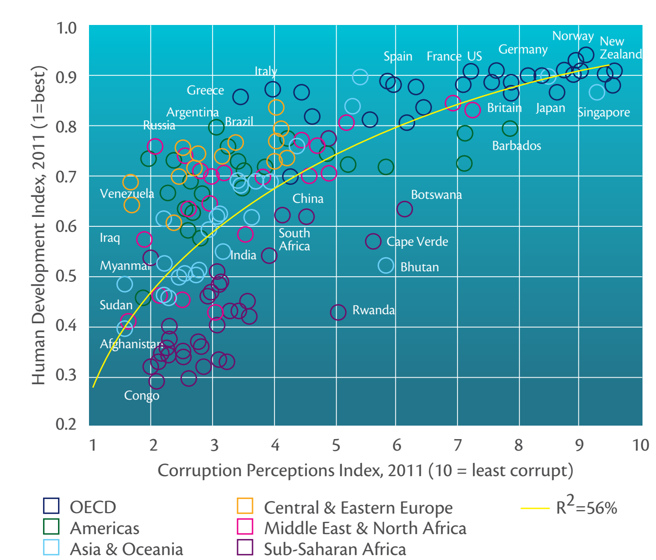
... but views of governments role and performance are more mixed



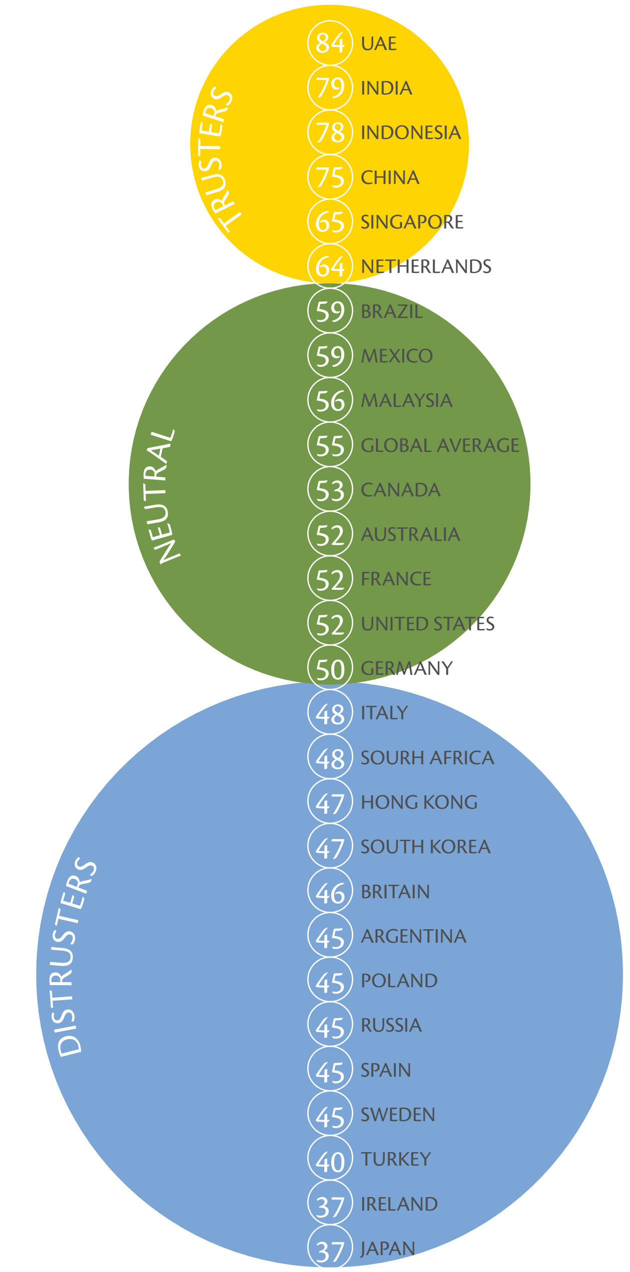
## Data & Facts

The infographic details the varying levels of trust across a selection of more developed countries. The most apparent conclusion from the trust barometer is the relatively large number of countries where citizens 'distrust' their institutions. One of the interesting conclusions from this study is that newly developed countries, such as India and Singapore, have populations that show greater trust in their institutions, while developed economies, like Japan and Britain, struggle. The business sector saw the largest increase in trust in 2016, with 80% agreeing it is up to businesses to now solve societal issues. Towards 2050, the key issue is whether trust in institutions in countries like India, will follow the trajectories seen in high income countries.

## Did you know?




Correlation between human development and the perception of government corruption levels




Average of trust in government, business, media, and NGOs, 2015 (%)

## Areas to Consider

The use of social media for active citizenry and increased transparency can be applied with little additional costs. Challenges, however, include developing policies and employee intransigence.

There may be additional costs in offering transparency, either through IT costs for new websites, auditing methods, new agencies or new processes.

Ensuring security is essential, since increased transparency could come at the cost of increased vulnerability towards threat vectors such as cyberattacks or physical attacks.

## Assessment

The impact of this trend depends on the government and parallels participative government, and citizen centricity trends.

Calls for transparency will vary based on culture and society, and economic conjuncture, since citizen likely will be more critical in low growth or recession periods.

Sources: CIFS and ISS (2014), 'ISS 2020 Vision: Future of Public Sector Outsourcing'; Edelman (2016' ,(2016 Edelman Trust Barometer'; Pew Research Center (2016), 'Beyond Distrust: How Americans View Their Government'; Fyfe, T. & Crookall, P. (2010), 'Social Media and Public Sector Policy Dilemmas'; UN Human Development Report.

# ARTIFICIAL INTELLIGENCE IN GOVERNMENT

Humans have long held a fascination with developing machines and software that mimic our intelligence. As we inch towards this milestone, with several notable achievements behind us, the mystique is evaporating. We have begun to comprehend the applications and benefits of intelligent machines; concurrently, a deeper examination of the risks and unintended consequences is also taking place.

Scientists have developed intelligent machines that can replicate human reasoning, amass knowledge, and utilize computing power to define and work towards goals. This improves humanity's collective predictive powers, problem solving abilities and productivity (through automation). As we move towards 2050, the challenge for governments is to embrace these rapid advances, harnessing benefit for their citizens.

Governments have two major roles in the context of AI:

- Develop the frameworks which will govern intelligent machine technologies, creating guidance, regulations and controls for its applications
- Drive forward government objectives of transparency, citizen-centricity and efficiency by utilizing AI

Governments should be tasked with looking beyond short-term benefits of cognitive technologies to pursue long-term capabilities and transformational socio-economic projects, in order to generate game-changing effects on society and the world.

Some of the applications for AI in government, envisaged for the near future are:

- Enhancing efficiency by predicting demand, to improve data-driven decision-making and the creation of responsive services
- Automating interactions
- Autonomous offence and defence (drones, weapons and collation / processing of real-time data for security)
- Law enforcement (analysis and recognition of faces / facial expressions, tracking number plates)
- Social well-being (medical applications, virtual tutors)

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Knowledge Society

## AI in Food Inspection

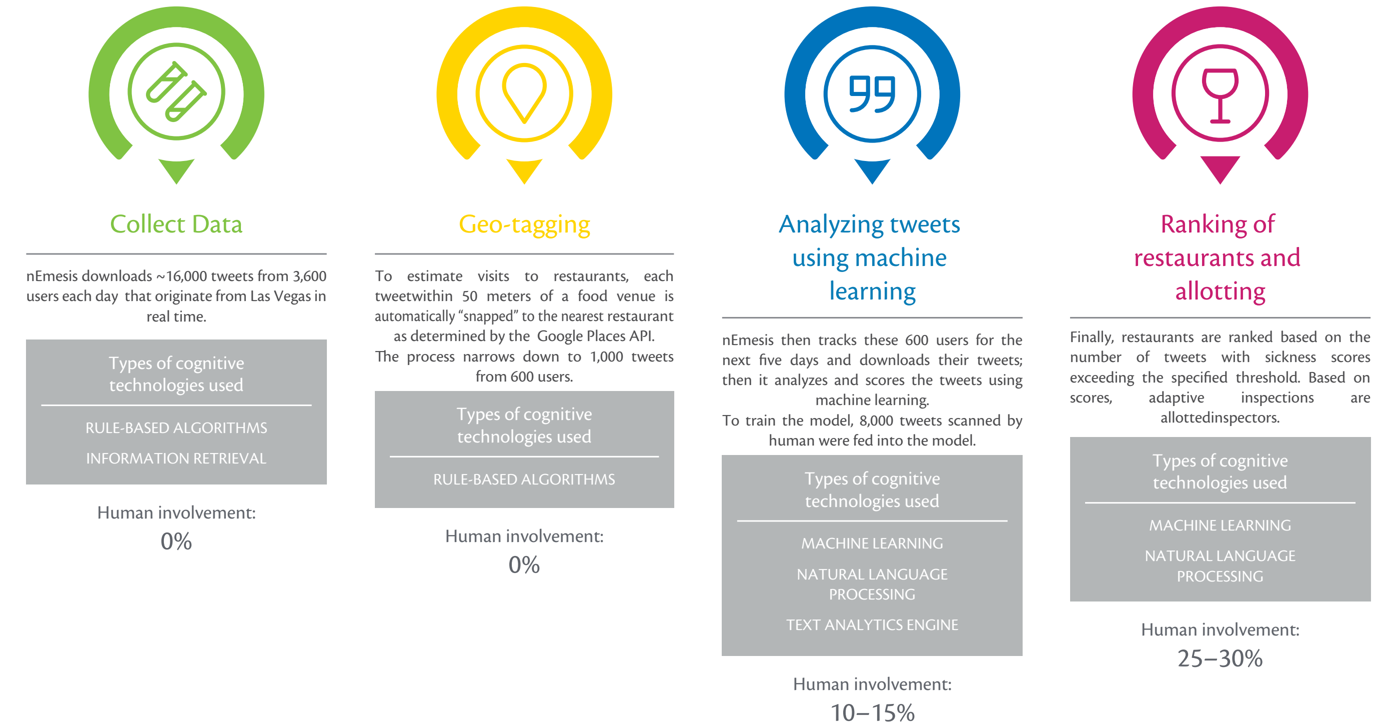
A health department in Las Vegas has been utilizing AI to facilitate more efficient inspection of restaurants. This government agency analyzes a vast number of tweets (tens of thousands daily) using geo-tagging and natural language processing, in order to identify instances of food poisoning and flag the concerned restaurant. Health inspectors are then dispatched to check for health. Adaptive inspections outperform random inspections: there was a marked increase in citations (violations) from 9% of inspections to 15% of inspections. It is estimated that this application could result in 9,000 fewer food poisoning incidents and 557 fewer hospitalizations per year (please refer to figure on next page).



## Assessment

The business case for each application of AI in government should be assessed individually; technology cannot solve every problem. However, the onset of AI is likely to fundamentally alter the way government works. A large set of government activities naturally lend themselves to automation (data collection, citizen communications, financial analysis and transactions); meanwhile AI will continue to advance in power and capabilities.

## Data & Facts




**Deploying nEmesis: Preventing foodborne illness in Las Vegas by using AI**

## Areas to Consider

The regulation of AI-enabled products (for safety of use or consumption) should be concerned with an assessment of level of risk reduced (e.g. data-driven increased speed of safety response) vs aspects of risk increased (e.g. privacy of data).

Advancement in the space of AI is dependent on the development of relevant skillsets, such as data literacy and computer science (with AI components).

Governments need to assess in a detailed manner the impact of intelligent automation on its workforce (e.g. redundancies, re-skilling requirements).

Communities of practice for AI in government could serve as a vital pathway towards developing a common set of open standards, and sharing best practices.

## Did you know?

The US Government spent a total of $1.2 billion on unclassified R&D into AI in 2016. The White House, in October 2016, issued a strategic plan for government-sponsored AI R&D, in order to identify scientific / technological needs, track progress and maximize impact of investments.

A global study of jobs, covering 54 countries and 78% of the total global workforce, found that automation potential (jobs where machines could replace humans) of the Administration and Government sector stands at 41%. That amounts to 63 million jobs out of a sample set of 155.6 million employees.

Sources: Deloitte University Press: Gov2020; McKinsey Global Institute: Where Machines Could Replace Humans; Deloitte University Press: AI-augmented Government.

# THE WEIGHT OF AGEING ON HEALTHCARE COSTS

Managing the impact of ageing on healthcare costs will become an increasing challenge towards 2050. The government's ability to proactively develop policies and strategies as well as repurpose funding, services and infrastructure to meet demographic shifts in a population caused by aging, will in all likelihood become a priority for governments in the future, requiring governments to reduce cost not only in healthcare, but across the board.

One consequence of demographic bulges is that it will push government demand patterns at different paces and times across the globe. Just as in high income countries, almost all middle- and low-income countries have, or are making the transition from, high to low mortality and fertility rates. Globally, the average number of children per woman has declined from 5 to 2.5 over the last fifty years. In high-income economies, the average number of children per woman has declined to less than 2. This transition creates a "boom" generation that works its way through a country's age structure, affecting the demand for government services from birth through to death, predominantly in the direction of greater numbers of elderly relative to working age citizens.

The result is a number of challenges for governments around the world. High-income countries are dealing with the ageing crisis as their "boom" generations transition towards retirement and old age. In high-income countries, an ageing workforce increases the fiscal burden while decreasing the immediate capacity to respond to the general challenges of the ageing population. The combination of these two factors will stress public services' capacity for service delivery. Managing demographic bulges requires the continuous shifting of investments and flexibility in approaches to governance, as current infrastructure and policy will not meet the increasing needs of a growing older population.

## Driving Forces

- Demographic Development
- Economic Growth

## The Rise of Alzheimers

Just 20 years ago, Alzheimer's was a relatively limited disease. In the US, for instance, only about 0.5 million Americans were diagnosed with the disease, but today the number has increased ten-fold. The enormous funds, used directly or indirectly on Alzheimers pale in comparison to the expenses lurking ahead. By 2050, the US expenses on Alzheimers alone are expected to be 1.2 trillion US dollars. Measured in relation to the US GDP now and in 2050, it is an increase of about 220 %

Studies of next of kin show that their private economies also suffer. The cost runs up to between 10 - 25 % of their annual income during the time of sickness, depending on country. They often stop working and become full-time caretakers, something that naturally carries a high society cost. American studies show that 33 % of the next of kin who care for Alzheimers patients are under 55 year old, typically women, with 22 % being employed full time, which could impact the rise of women in the workforce.



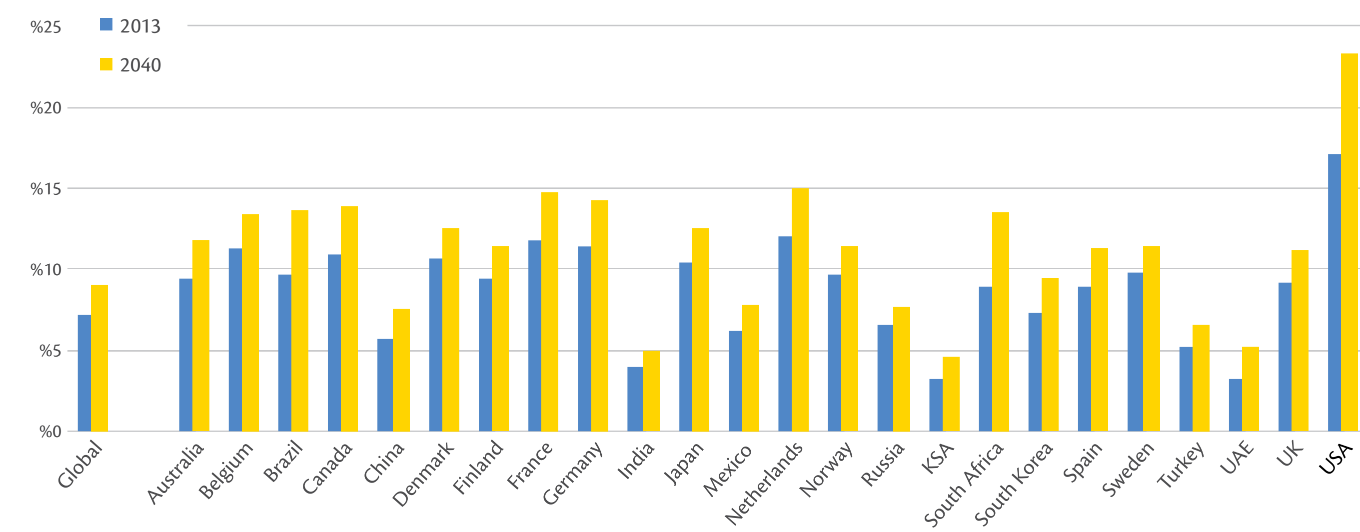
## Assessment

Demographic bulges can cause sudden budget deficits and dissatisfaction unless anticipated and responded to with flexibility.

Demographic development and aging populations are certain, yet the contribution of migration and retirement is uncertain.

This is an ongoing trend that will amplify over time unless service provision adapts.

## Data & Facts




**Projected total health care expenses (2040) as % of GDP for selected countries**

Significant increases in total global expenditure on health should be expected in the future. Global healthcare spending is expected to increase from $7.83 trillion in 2013 to $18.28 trillion in 2040. It is expected that healthcare spending per capita will increase annually by 2.7 % in high-income countries, 3.4 % in upper-middle-income countries, 3.0 % in lower-middle-income countries and 2.4 % in low-income countries.

## Areas to Consider

Governments need to review their infrastructure portfolio (hospitals, elderly homes, etc.) and corresponding services, to meet the demands of changing demographics.

To control costs and meet individualized demands, governments are developing new operating models and engaging with increasingly complex eco-systems of partners to deliver government services.

## Did you know?

According to the credit rating firm Standard & Poor's, the ageing of the world's population is the greatest threat to national debt on a global level.

According to the US Alzheimer's association, in 2012 the direct costs associated with the disease, was estimated at 203 billion dollars. In comparison, the 2008 US stimulus package to prevent the nation from falling into a recession was 152 billion US dollars.

Sources: CIFS (2014), 'Members' Report – 21st Century Lifestyles'; CIFS and ISS (2014), 'ISS 2020 Vision: Future of Public Sector Outsourcing'; Pollitt, C. (2014), 'Future Trends in European Public Administration and Management: An Outside-in Perspective'; Wheatley, J. (2013), 'EM Youth Bulge: A Demographic Dividend or Time Bomb?'; UN (2015), 'World Population Prospects – 2015 Revision'; UN Department of Economic and Social Affairs (2015), 'Population Pyramids of the World from 1950 to 2100'; Alzheimer's Association (2013), 'Fiscal Year 2014 Appropriations for Alzheimer's-related Activities'.

# AFFORDABLE GOVERNANCE

Making government affordable is the new reality for current and future public sector organizations. Driven by demographic aging, increasing customer demands, growing sustainability challenges, and high debt burdens (see Global Debt Overhang), governments will likely need to meet expenditure gaps or shortfalls of billions of dollars to be able to continue to deliver public services at current levels to future populations.

Governments could respond to this challenge by cutting spending, raising additional revenue, developing innovative solutions, or by applying a combination of all three strategies. The application of these three different solutions would be context-dependent and contingent upon the fiscal state of the country under examination.

Towards 2050, the key challenge will be in defining the 'core' services, where the market of stakeholders deem it too valuable to fail or to be compromised, particularly for the poor or disadvantaged sectors of society.

## Driving Forces

- Focus on Health
- Demographic Development
- Commercialization
- Individualisation

## Cost Savings in the Public Sector

The most affordable cuts are often the smallest. One of the best cases being Sharp Texas Performance Review, saving the state USD 10 billion from minor changes, such as turning the backlight of soda machines saving USD 200,000. Alternatively they saved USD 3 million by adjusting the settings on the public salt sprayers.

A new study by CISCO has determined a value estimate on the opportunity and concludes that the public sector could see as much as USD 4.6 trillion in IoT-related savings and revenues worldwide over the next decade.



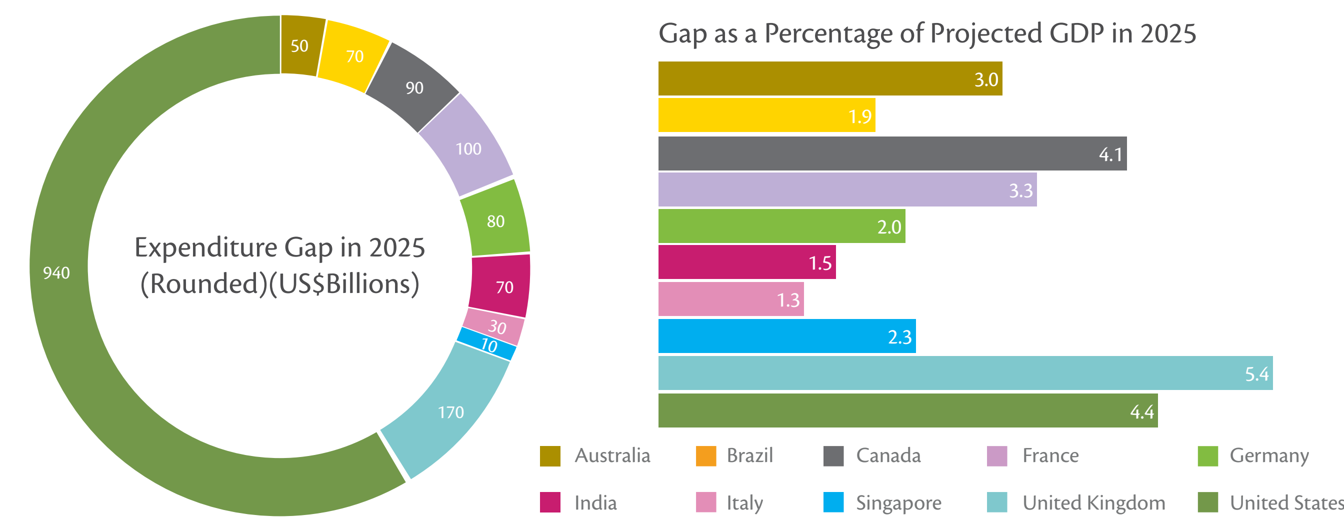
## Assessment

Affordable governance is critical with growing living standards, ageing, and declining natural resources.

As costs of governance increase, so do the importance of focusing on efficiency savings.

## Data & Facts

Most countries are confronting shortfalls of billions of dollars over the next decade just to be able to deliver public services at current levels to future populations. In countries such as the United Kingdom and United States, new financial realities and aging populations will escalate demand. In countries like Brazil and India, burgeoning economies and rapidly rising citizen expectations will massively stretch government capacity. Despite the different challenges, however, all the countries in the illustration below share a similarly stark expenditure gap if they do not change how public services are delivered




## Areas to Consider

Affordable governance is increasingly relying on finding the best level of taxation that creates the most revenue without disincentivising business and citizens.

Governments will have to identify new ways of engaging local SMEs, non-governmental organizations, and citizens to provide services themselves. This involves more DIY solutions and automation through welfare technologies.

For public services, the decision to automate requires a careful consideration of all stakeholders needs, or even some kind of consideration of ethics which is invariably sector- and context specific. Striking the appropriate balance requires evaluating the internal and external value for a given service.

## Did you know?

Hospitals in Singapore have developed the Antimicrobial Resistance and Utilization Surveillance and Control (ARUS-C), to provide electronic decision support for the prescription of antibiotics in order to track antibiotic use and reduce unnecessary antibiotic use. This improves efficiency and streamlines labor-intensive administrative duties, thus reducing the operational costs of public hospitals.

Sources: CIFS and ISS (2014), 'ISS 2020 Vision: Future of Public Sector Outsourcing'; PWC (2013), 'Future of Government'; Accenture (2012), 'Delivering Public Service for the Future: Navigating the Shifts'; Cisco (2013), 'Internet of Everything: A 4.6$ Trillion Public-Sector Opportunity'; Deloitte (2009), 'The Public Innovator's Playbook: Nurturing Bold Ideas in Government'.

# PRIVATISATION OF INFRASTRUCTURE

Privatisation of infrastructure refers to three types of private-public financial relationships: Outsourcing of public infrastructure assets and services; Privatization through sale or lease of infrastructure assets; and Public-Private Partnerships (PPPs). Privatisation is typically motivated by the need for cost saving and enhanced quality by opening up for competition (see Affordable Governance), ideology, or reducing government deficits. In recent years, the universe of infrastructure has expanded beyond real assets such as toll roads to include services like prison markets.

Large, predominantly private companies that control markets for public services are referred to as shadow state. In instances where the shadow state becomes strong – such as in infrastructure and prison markets – governments are often left with a difficult choice. Do they continue to source services from 'bureaucrats with limited incentive to deliver and sclerotic ability to reform on the one side', or do they select from 'weakly regulated private companies that know more about winning a contract than delivering services' at the other end of the spectrum. Towards 2050, the challenges for the public sector are developing risk and control as provisions and go beyond internally oriented command and control processes to include external partners in their development and execution. All the while maintaining affordability, excellent service delivery, and adequate investments in maintenance. As the private sector is required to 'do more with less', new collaboration models enabled by technology will be needed.

## Driving Forces

- Economic Growth
- Globalization
- Acceleration & Complexity

## Remunicipalisation

Remunicipalisation is a related trend that has emerged in relation to the privatisation of water management. Due to a variety of problems, many communities have 'insourced' previously outsourced/privatised services. Examples of problems include:

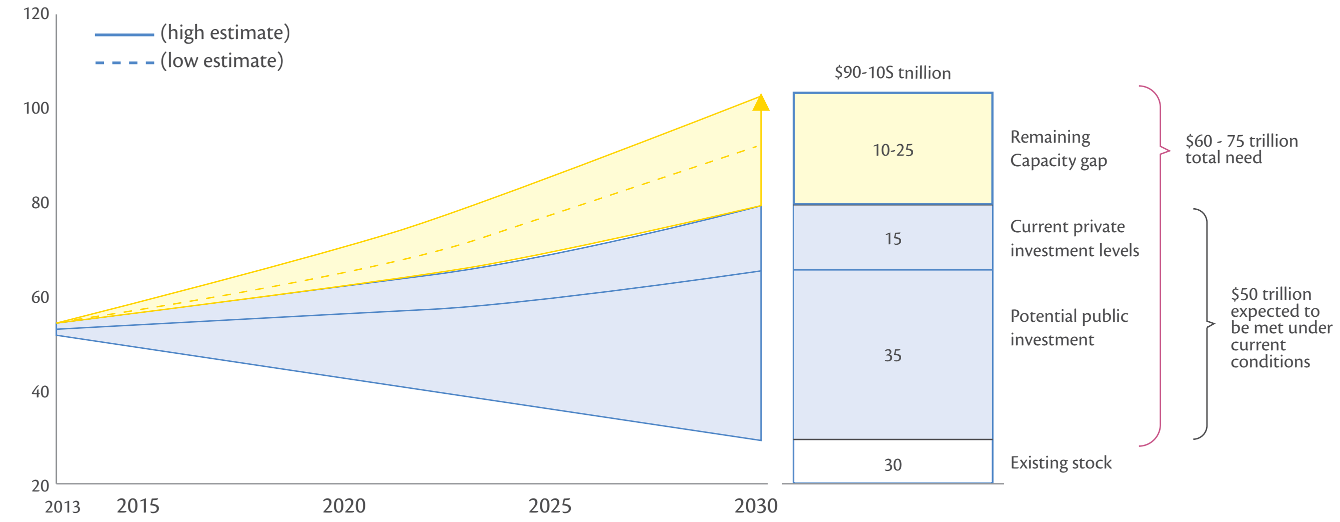
- Poor performance of private companies
- Under-investment
- Disputes over operational costs and price increases
- Excessive price increases
- Difficulties in monitoring private operators
- Lack of financial transparency
- Workforce cuts and poor service quality



## Assessment

In the future, privatization could pose a growing challenge to governance and critical infrastructure in many countries around the world, where governments continue to bring in external skills and resources to deal with increasingly challenging societal problems.

## Data & Facts




**Global infrastructure investment gap, 2030**

By 2030, an estimated $60 trillion to $75 trillion in additional infrastructure capacity will be needed globally. But with the balance sheets of most governments already stretched to the limit, only about $50 trillion in spending is likely to materialize, leaving a gap of up to $25 trillion. This opens possibilities for further privatization, but also reinforces the need of creating mutually beneficial outcomes.

## Areas to Consider

As governments integrate private sector service delivery into its infrastructure, communication and citizen engagement becomes a more critical challenge to engage participatory citizens in processes to become flatter, agile, streamlined and accountable.

To ensure effective service delivery new metrics for success will be needed that use outcomes as final arbiter.

## Did you know?

Hospitals in Singapore have published a report that suggests 180 cities in 35 countries, including Paris, Berlin, La Paz, Accra, Maputo, Buenos Aires, Johannesburg, and Kuala Lumpur, have all actually 're-municipalised their critical infrastructure and water systems within the past decade. More than 100 of the 'returnees' were in the US and France, 14 in Africa and 12 in Latin America.

Sources: Pigeon, M. et al. (2013), 'Remunicipalisation: Putting Water Back into Public Hands'; BCG (2014), 'Beyond Budgets: The Real Solution to the Global Infrastructure Gap'; CIFS and ISS (2014), 'ISS 2020 Vision: Future of Public Sector Outsourcing'.

# COMPANIES VS. CITIES VS. SOVEREIGN STATES

Alongside the power transition among states, there is also a power transition away from states towards non-state actors. This transition towards a 'G-Zero' world, where nation-states are no longer the sole arbiter of global security, comes with a series of opportunities and challenges.

Since the 1990s, nation states have devolved authorities to or had their sovereignty challenged by a number of other non-state entities. These include companies, NGOs, regions and cities, and supranational organizations. Due to relative economic power, increasing interconnectedness and access to increasingly advanced technologies, non-state entities and actors play increasingly important roles in the future governance towards 2050. For example, many of the top 100 global economic entities (measured in terms of GDP or revenue) are not nation states. If this list was expanded to subnational groupings, the list would become increasingly eclectic.

Urban areas in many countries are becoming more powerful and are dealing with many challenges more effectively than their national governments can. This could lead them to seek greater autonomy from their central governments – even leading to the re-emergence of city-states. Cities are also re-emerging as political forces due to technology developments that enable strong and vibrant local networks and societies.

All across the world, it is increasingly the case that 'supercities' and 'megaregions', that are made up of large networks with strong economic linkages, have begun to collaborate to share environmental systems, infrastructure, and settlement and use patterns across national borders.

## Driving Forces

- Technological Development
- Technological Diffusion and Empowerment
- Economic Growth
- Network Society

## Return of the City State

At a time when it has proven difficult for nation states to agree on common environmental standards, the C40 initiative brings together over 80 cities and mayors to exchange best practices, transfer technologies, and promote public-private partnerships that reduce the urban carbon footprint. Today, the standards set by the C40 Cities in clean-energy buildings, waste management, and sustainable transport systems, often exceed standards set by national governments. In early 2017, the C40 permanent office was opened in Copenhagen.

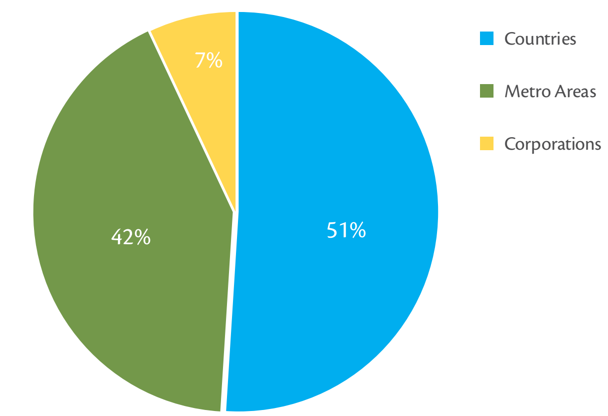


## Assessment

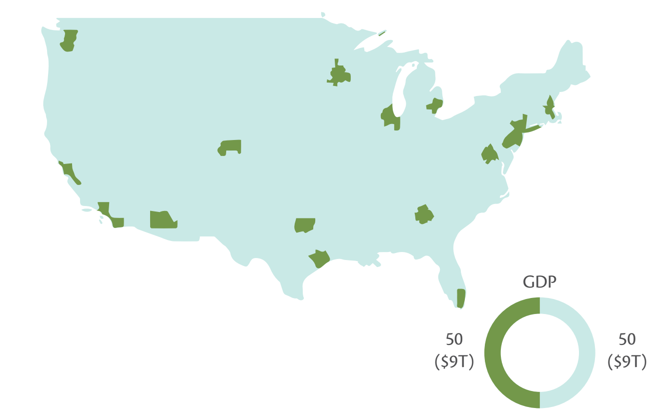
There is a great deal of uncertainty surrounding this trend. The development of this trend is dependent upon governments' willingness and smooth acceptance of devolving powers to non-state actors, cities and supranational organizations.

In some instances, devolution to a city or region works well. In other instances, non-state actors, like transnational terror and criminal groups, pose existential threats to societies that governments should combat.

## Data & Facts




World Top 100 Economic Entities




USA's $18 Trillion Economy (2015) – The 50/50 split

Even though countries still represent the majority on the 'World Top 100 Economic Entities' list with 51%, metro areas and corporations will become more powerful towards 2050, thus represent a larger portion of the Top 100. Most growth within countries is generated from a few urban areas within an economy. Cities are at the center of global growth and human capital. For example, half of the USA's economic growth is generated by relatively few urban areas (see figure upper right).

## Areas to Consider

Navigating the future balance of power will require increasing partnerships between cities, to increase city competitiveness. Potential alliances and competitors will emerge from complex ecosystems of states and various non-state entities.

In many environments, especially in failed or failing states, the true power brokers will not be state entities.

National security strategies towards 2050 will have to constantly monitor, develop and adjust policies to best secure national interests.

## Did you know?

In 2015, the Bill and Melinda Gates foundation gave $4.2 billion in direct grant support, while the World health organization's operating budget was $4.0 billion.

Not only is Apple bigger than Finnish Nokia, Apple revenue is more than the entire Finnish GDP. WalMart's revenue is bigger than the combined GDP of Portugal and Greece.

Tokyo accounts for approx. 30% of Japanese GDP.

Sources: US National Intelligence Council (2012), 'Global Trends 2030 - Alternative Worlds'; The Chicago Council on Global Affairs (100' ,(2016 Top Economies: Urban Influence and the Position of Cities in an Evolving World Order'; US Association of Mayors (2013), 'US Metro Economics: Outlook – Gross Metropolitan Product, with Metro Employment Projections'; Perry, M. (2016), 'Understanding America's ridiculously large 18$T economy by comparing the GDP of US metro areas to entire countries'; Brookings (2015), 'Global Metro Monitor 2014: An Uncertain Recovery'.

# POWER SHIFT IN GLOBAL SECURITY

Towards 2050, the power transition among major national economies is shifting national power away from the G-8 countries towards the G-20. As the US Quadrennial Defense Review has noted, economic power, while not a guarantee, is the foundation upon which military strength is based. A country or a non-state actor cannot field world class security forces without sufficient capital. Currently, most countries spend 2 percent of the GDP on defense – excepting the United States, which spends more, and China, which spends less. If China increased its spending to US levels, it would represent a 68 % growth in their defense expenditures. Russia increased its military spending by 7.5 % in 2015 (to 4.5 % of their GDP), however, as of 2016 Russia was no longer one of the top 3 military spenders, and will have trouble keeping level towards 2050 due to a relative decline in their GDP compared to the other major military powers.

The global security balance will likely shift towards Asia, with both China and India becoming leading global security powers. The US National Intelligence Council concludes that India could surpass the United States in its four component power index – GDP, population size, military spending and technology by 2045.

## Driving Forces

Economic Growth

Technological Development

## Demographics and Global Security

Economic factors and demography could pose limits on countries' security ambitions. Much of government expenditures in high income economies goes towards social benefits – retirement and health benefits, costs that increase in ageing societies.

Europe and the North America are ageing and relatively rich, while China and Russia are relatively poor and ageing. On the other hand, many countries in Asia, the Middle East, and Latin America have relatively young populations. This could limit China's ability to project power as compared to India, as its population is relatively older and has to deal with the consequences of China's one child policy.

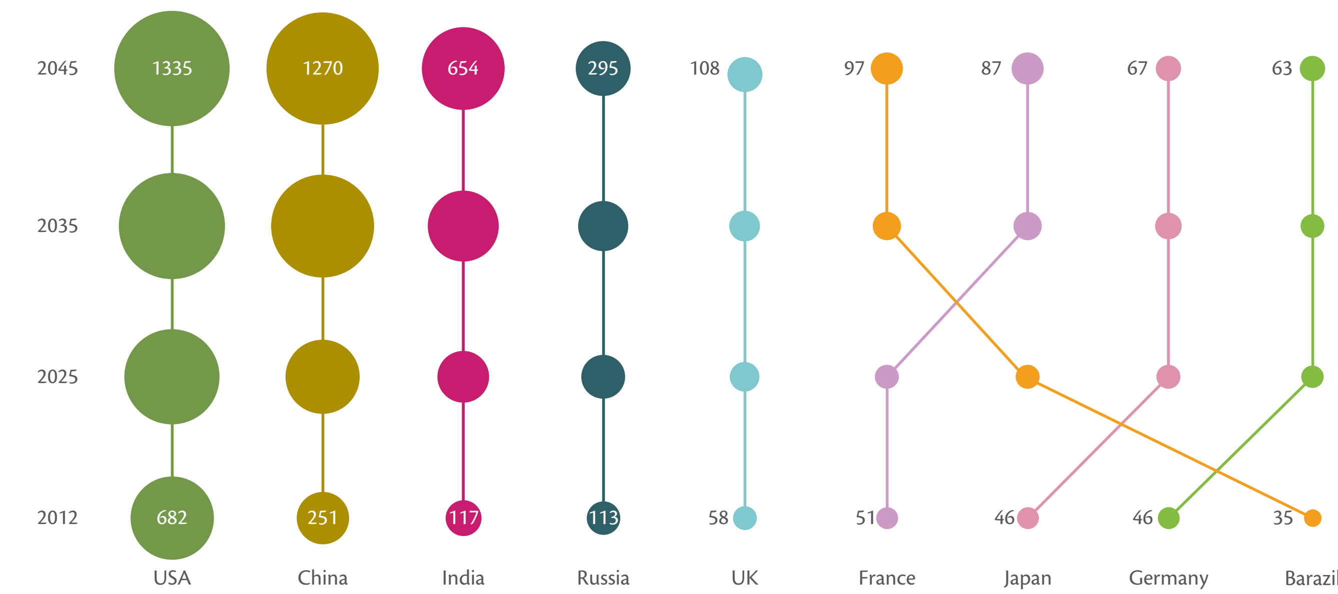


## Assessment

The dynamics driving towards a global power shift from the North Atlantic towards Asia is a highly impactful and certain trend. It is one that will occur more gradually. One uncertainty, however, relates to the speed by which India will rise in economic prominence.

## Data & Facts

China is currently the second largest military spender and is increasingly investing in new systems. Towards 2050, China is expected to overtake the US as the world's largest military spender. China's military build-up will inevitably influence America's defense policy as well as other countries, especially with interests in the Asia-Pacific region.




**Projected military expenditure, US $ billions**

## Areas to Consider

Navigating the future balance of power will become increasingly challenging for most countries as the competition is more intense among global powers as compared to a unipolar world.

Countries will have to balance a transition of global power interests from the United States and Europe towards Asia. National security strategies towards 2050 will have to constantly monitor, develop and adjust policies to best secure domestic interests. Choosing the right alliances will be very crucial for each country's future.

## Did you know?

China's first home built aircraft carrier CV-17 is nearing completion and is expected to become operational by 2020. It will operate along side China's first aircraft Liaoning, which was acquired from Russia in the late 1990's.

CV-17 is thought to displace 60,000 to 70,000 tons, which is 40 % smaller than the US Ford class of carriers that displace 100,000 tons. Experts estimate that the CV-17 will carry 48 aircraft, including 36 J-15 multi-role carrier-based fighters and 12 Z-18 or Z-9 helicopters.

Sources: US National Intelligence Council: Global Trends – Paradox of Progress; Stockholm International Peace Research Institute (2016), 'SIPRI Military Expenditure Database'; CIFS and ISS (2014), 'Future of Public Sector Outsourcing'; OECD Database (2016), 'GDP long-term forecast'.


# ADVANCED TECHNOLOGIES AND SCIENCES



# INTRODUCTION

The previous industrial revolutions caused by technological developments have automated physical tasks and changed the boundaries for transportation and manufacturing. The current revolution is challenging the human brain. The development is reaching a maturity state where even quite advanced tasks can be carried out by computers and robots, and many technologies are reaching a maturity state where they will start to merge together and create new society structures, communication forms and even challenge the current perception of reality. It will remove the boundaries for decision making and it will allow us to live longer, better and more convenient lives. The technologically savvy will benefit greatly from this development, but risks are that some population segments will be isolated and have difficulties in adapting.

This section will focus on explaining the overall development and impact of the technology. Most trends are to some degree affected by technology, and reading through this section will contribute to a better understanding of these trends.

The following chapter describes 13 trends shaping the future of advanced technologies and sciences towards 2050. The 13 trends presented can be categorised into the following three areas:

4

## AI and Robotics

- Artificial Intelligence
- Robotics
- The ethics of AI
- 4IR determining our future

2

## Genomics

- Decoding the Body
- Genetically modified organisms

7

## Other Technologies

- Commercialisation of Space
- Nanotechnology
- Immersive Technology
- Blockchain
- Big Data
- Internet of Things
- 3D printing

# ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) is a term for machine decision-making at a near human level of competence. AI implies a level of analysis beyond simple response systems working from a fixed list of situations and responses. An example is the AI in self-driving cars, which analyses a large amount of input to generate suitable responses in real time. The most advanced current AI uses self-learning routines, allowing the system to learn from experience. Current uses of AI can be seen in Tesla's 'autopilot' system and IBM›s self-learning Watson system and is influential in the design of 3D motion-capture interfaces such as Xbox Kinect.

Long before AI is able to outperform the best human specialists in a specific field, it will be able to handle routine tasks rapidly with few errors. Hence, AI will more be seen as a support to existing jobs than a replacement. Examples of this include medical practitioners, who will increasingly rely on image processing algorithms for diagnosing patients, and lawyers, who will rely on language processing algorithms to pick out relevant paragraphs from law texts (see New Wave of Automation and Employment).

With advances in computer capacity and self-learning systems over the coming years, there may be few cognitive tasks that AI by 2050 cannot handle as well as or better than humans, possibly apart from tasks requiring empathy, creativity, or aesthetics. Many experts have assessed that AI will impact society more than any other technology e.g. through a loss of most current 'white collar' jobs, and through improved services, enabling people to act like "executive directors" in their own life, only taking most important decisions and delegating administrative assignments and routine decisions to AI-programs.

## Driving Forces

- Technological Development
- Technological Diffusion and Empowerment
- Knowledge Society

## Robots Speak Your Language

Though we are still not particularly wowed by our conversations with the iPhone's voice-controlled virtual assistant, Siri – or her slightly more intelligent rivals, the Android platform's Google Now, and Amazon Echo's Alexa – year-on-year improvements are staggering, and it won't be long before we will all be speaking to our devices. AI, however, does much more than just translate our texts and answer our questions. AI keeps us up to speed, with leading media companies such as the Associated Press, Forbes, The New York Times, Los Angeles Times, and ProPublica already employing computer 'journalists' to write informative articles about finance, sports, crime, and earthquakes. Kristian Hammond, cofounder of Narrative Science (a leading provider of such services), believes that 90 % of the news could be written by computers by 2030.

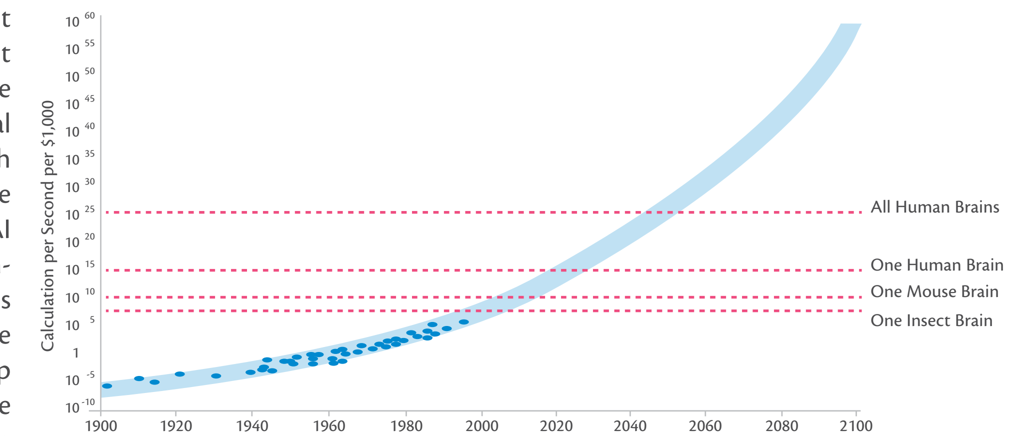


## Assessment

AI looks to be a major growth industry. Many AI services for various purposes are already available as apps working through 'the cloud' and outperform human intelligence in a number of fields, but the impact will increase intensively as algorithms get more and more sophisticated. AI will be responsible for major changes over the next many decades, and will likely be omnipresent in digital products in the future.

## Data & Facts

Moore's Law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years. This prediction has been driving the projections in the past decades, and is also the fundament for the prediction made by the infamous futurist Ray Kurzweil, predicting that AI will reach the level of human intelligence before 2040 – see the figure below.




**Exponential Growth of Computing Twentieth through twenty first century**

Moore's Law, however, is not a natural law and will not necessarily continue in the coming decades, as a physical limit exists as to how much smaller transistors can be made. The development of AI also depends on non-exponential factors, and it is not certain that software development can keep up with the development. We still need people to program the computers, even though machines to some extent have become able to learn to solve tasks on their own, e.g. through so-called deep learning that simulates how human brains learn. This, however, still happens within frameworks created by people, so people could easily be the limiting factor in computer development.

## Areas to Consider

Mastering AI will be a decisive factor for nations' competitiveness and power and the service levels available for its citizens. Developing communities with scientists, practitioners and the experts of tomorrow cannot be underestimated.

The 'automation wave' that AI is causing poses risk to certain working groups in a transition period, and it is vital for governments to ease this transition without hindering development (see Polarisation of the Labour Market). AI will affect many areas that requires long-term planning like infrastructure, mobility patterns, healthcare, etc., and governments need to apply foresight techniques that not only extrapolate the past developments, but take completely new structures into consideration.

## Did you know?

Nick Bostrom is one of the world's leading researchers on AI. In a survey with the world's top 100 AI researchers as respondents, he asked them to predict – with 10%, 50% and 90% probability, respectively - the year when a Human Level Artificial Intelligence will be created.

The results were:

| 10% | 50% | 90% |
|---|---|---|
| 2024 | 2050 | 2070 |

Sources: Tractica (2016), 'Artificial Intelligence for Enterprise Applications'; TechEmergence (2016), 'Valuing the Artificial Intelligence Market, Graphs and Predictions for 2016 and Beyond'; Tow Center for Digital Journalism (2016), 'Guide to Automated Journalism'; Kurzweil, R. (2005), 'The Singularity is Near'; The Guardian (2017), 'Vanishing point: the rise of the invisible computer'; Müller, V. & Bostrom, N. (2014), 'Future Progress in Artificial Intelligence: A Survey of Expert Opinion'; CIFS (2016), 'Members' Report - Automation'; www.ibm.com/Watson.

# ROBOTICS

We have had industrial robots for half a century, but today we see rapid development in advanced robotics, where robots combine artificial intelligence, sensors and actuators (tools with which a robot can influence or move in its environment). This heralds the dawn of a 'robotic age' where more and more physical work is taken over by robots – not just in manufacturing, but also in services.

Sometimes, AI systems performing purely digital tasks are referred to as 'robots', e.g. robot lawyers, robot traders and robot journalists, but true robots are able to physically interact with their environment.

Robots are moving into the facilities management industry, handling tasks in cleaning, into the restaurant industry, making fast food, and into health services, handling tasks like carrying patients, emotional assistance, and remote surgery. In transportation, we have autonomous cars (see Autonomous Vehicles), trucks, container ships and flying drones. Robots are also finding uses in security and the military.

Robots are not just becoming more advanced; they also become less expensive and will diffuse from factories to almost all thinkable areas as replacement for, or assistants to, existing labour force. Towards 2050, further advancements in robotics and production efficiencies will make advanced robots available for the mass markets and probably be just as natural a part of the every day life in offices and households as smart phones and tablets are today.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Economic Growth

## Robots With Real Brain Tissue

When we typically first think of a robot, we regard it simply as a machine. We tend to think that it might be operated remotely by a human, or that it may be controlled by a simple computer program.

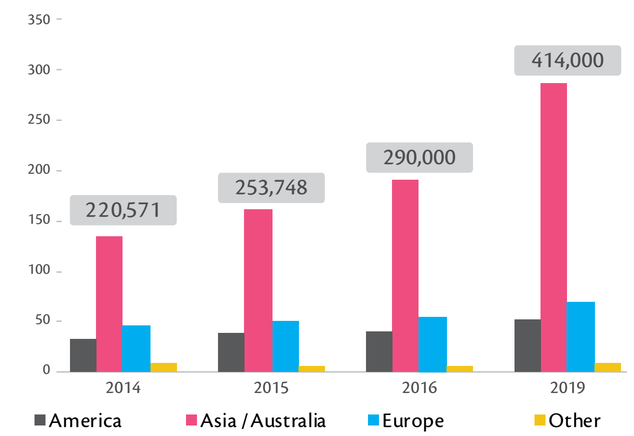
However, what if the robot has a biological brain made up of brain cells, possibly even human neurons? Neurons grown under laboratory conditions on an array of non-invasive electrodes provide an attractive alternative with which to realize a new form of robot controller. In the near future, we will likely see thinking robots with brains not very dissimilar to those of humans.



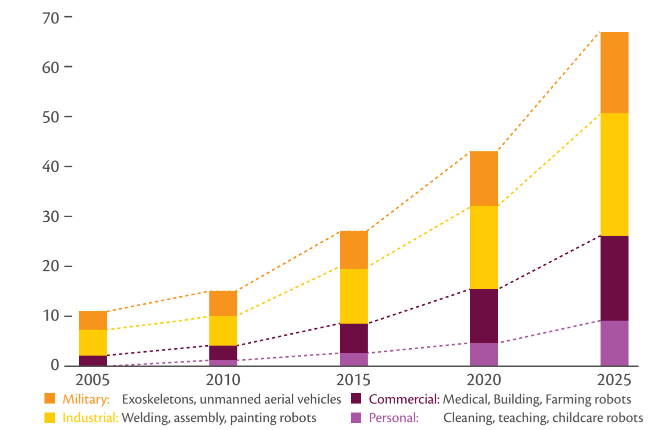
## Assessment

Robots are expected to take over millions of jobs in the US alone. Robot labour will increasingly become cheaper and more efficient than human labour within many areas, creating major changes in the current trade patterns shaped by significant differences in cost of labour among nations.

## Data & Facts




Worldwide annual supply of industrial robots, 2014 – 2019




Global robotics market ( US $ billions)

Since 2010, the demand for industrial robots has accelerated considerably due to the ongoing trend toward automation and the continued innovative technical improvements in industrial robots. Asia (Australia and New Zealand included in the category) has manifested itself as the world's strongest growth market and the region saw a total 160,600 units sold in 2015 – a rise of 19%. From 2016 to 2019, industrial robot installations are estimated to increase by around 14% on average per year.

There are five major markets representing 75% of the total sales volume in 2015: China, the Republic of Korea, Japan, the United States, and Germany.

## Areas to Consider

When robotics become increasingly autonomous, regulation on responsibility in case of casualties and preventative measures regarding security precautions becomes necessary. A general stance in terms of setting a proactive or reactive regulatory line should be decided.

Robotics will create economic opportunities, e.g. in reducing the labour cost. It should be noted that past periods of mass unemployment have not coincided with advances in automation, but rather with economic crises.

To enhance the development government should not only focus on the development of engineers with the needed specialities, but also on educating people in working alongside robots.

## Did you know?

US-based company Rethink Robotics offers two types of versatile robots; Baxter, which has two human-like arms, and Sawyer, which has a single arm with more joints. Both have sensors and software that enable them to work safely alongside people, and they don't need to be programmed; instead, you simply show them what they have to do. According to the company website, they can handle tasks like packaging, sorting, material handling, machine tending, loading and unloading, and assembling electronic circuits. The robots cost USD 25,000 and USD 29,000, respectively, and are thus within the economic range of even small companies.

Sources: CIFS (2016), 'Members' Report – Automation'; Rethink Robotics (2016), 'Worldwide annual supply of industrial robots by International Federation of Robotics via Market Realist'; McKinsey&Company (2016), 'Where machines could replace humans - and where they can't (yet)'; International Federation of Robotics (2016), 'IFR World Robotic Report 2016'; MIT Technology Review (2016), 'The Future of Artificial Intelligence and Cybernetics'; nature.com: a world where everyone has a robot.

# THE ETHICS OF AI

Rapid advances in computing have heralded improvements in perception tasks. This is evidenced by new applications for machine learning, voice recognition, and neural network processing. The common thread is artificial intelligence.

AI's influence can span from the mundane to the exceptional and, as technology advances, there is now a definitive timeframe whereby machine intelligence exceeds that of humans. This has already happened in specific applications (e.g. beating a grandmaster at chess or a champion at Jeopardy – this is known as Artificial Narrow Intelligence). In the near future, AI will reach Artificial General Intelligence, where a machine can perform any intelligent task that a human can.

Beyond this, the explosion of data available around us gives machines knowledge, which can feed an exponential learning curve, giving rise to machine self-improvement.

The ethics behind AI is quite complex: the first layer of complexity separates when intelligent machines malfunction, and when they function but make decisions that impact humans. These are two discrete sets of ethics:

- If an intelligent machine malfunctions, who is at fault? The designer, the programmer, the manufacturer or the operator? This area is in dire need of regulation as it could have wide-ranging impact on supplementary industries (e.g. financing, insurance)
- If an intelligent machine performs its function but has to take a decision which has impact on human life, such as a robot soldier deciding who to kill. Regulatory bodies are not equipped to deal with this issue with current frameworks

Ethics in technology had historically always been about how humans utilize machines – this might now be a less relevant concept. Intelligent machines will be considered as 'behaving' in particular ways towards humans. What is acceptable (e.g. Amazon's Alexa making fun of you) and what is not (e.g. a robot misleading you on purpose)? Further, ethics might have to govern how intelligent machines behave with each other.

AI surpassing human intelligence opens up new dynamics in ethics. In particular, the development of AI weapons poses a significant threat and begs the question – why teach a machine to kill? These – and other – considerations need to be taken into account before pushing forward in the field of AI.

## Driving Forces

- Technological Development
- Commercialization

## Cases and Examples

Robots reflecting human biases: The first international beauty contest judged by intelligent machines was held in 2016. Beauty.AI received 6,000 submissions from over 100 countries. The concept behind this contest was that AI would determine which faces resembled 'human beauty'.

The results were interesting – the machines did not like or select people with colored skin. Almost all of the 44 winners were white.

The construction of the algorithms behind the beauty contest reflected some human biases, perhaps in the same way that 'beauty' is perpetuated through media and television.



## Assessment

The advent of AI surpassing human intelligence, with the potential to progress by several orders of magnitude, shines a light on the applications that intelligent machines are being considered for. It is difficult to obtain consensus globally on new creations, and even with that, corporations and governments may forge ahead regardless.

## Areas to Consider

Intelligent machines learn from data created out of human behavior, and by definition are non-empathetic. This means that the root of intelligent machine behavior is good or bad human intent. Creating a policy framework to tackle AI will be a long-term challenge for governments.

The ethics of AI built to damage / destroy other machines (i.e. property damage), or any other malicious behavior, would perhaps require a separate branch of study and amendments to legal frameworks.

## Did you know?

Chatbot Tay, Microsoft's AI chatbot, was meant to be friendly, however, within 24 hours it was withdrawn because of racist, sexist and anti-religious comments.

Source: Future agenda: the world in 2025.

# 4TH INDUSTRIAL REVOLUTION (4IR) DETERMINING OUR FUTURE

4IR is an increasingly popular term used to characterize the new age we inhabit, massively influenced by exponential advances in technology. The 4IR is defined by breakthrough achievements in artificial intelligence, computing, automated manufacturing, everything digital and connected, 3D printing, data analytics, advanced biosciences, advanced materials and energy. These advances will alter pathways for almost every industry globally. Technology-driven change of this scale can have ground-breaking socio-economic and political consequences, which necessitates that governments prepare meticulously for the opportunities and challenges that abound.

Governments face a truly significant challenge to cope with rapid change and evolution. 4IR represents a new wave of technologies that requires expertise to be understood, and to create applicable frameworks of governance for.

At the moment, the 4IR has had impact for those with higher incomes, who can access the digital world. New technologies have improved convenience – buying goods is a one-click exercise, as is ordering a cab. More significantly, 4IR could elevate global income levels and change the concept of quality of life for billions of people.

Moving towards the future, the new age of technological advances will impact supply and result in long-term efficiency and productivity growth globally. Whether it is logistics, trade or communication, improving costs and innovative products will open up new markets and drive economic growth.

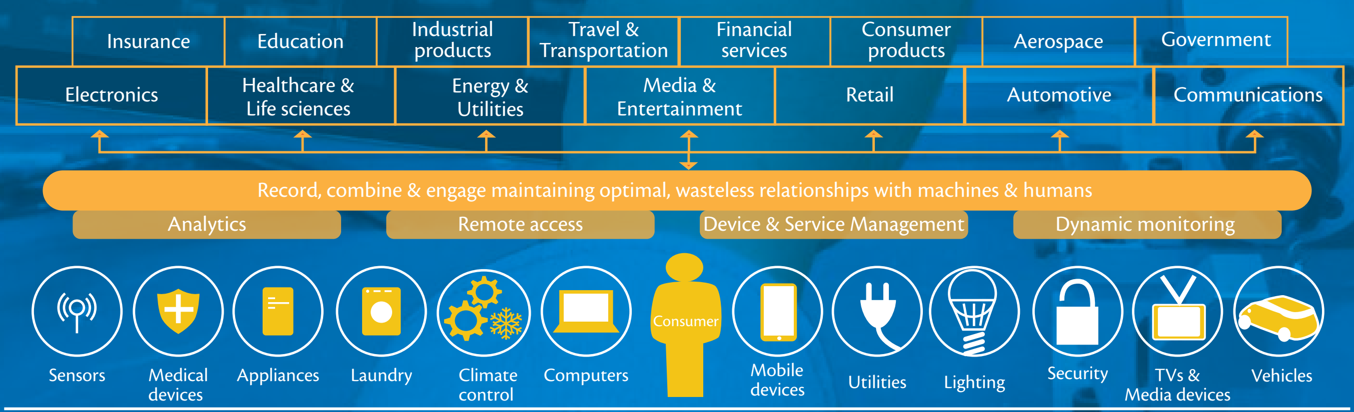
## Driving Forces

Technological Development

Acceleration & Complexity

## 4IR's Digital Backbone

Digital infrastructure in many ways will form the backbone of 4IR. With approximately 5 billion 'things' connected today, that number could explode to 25 billion by 2025. Digital infrastructure will also evolve in other dimensions: cost, data and advances in electronics. (see figure below)




**Merging the cyber and the physical: 4IR will be based on the digital relationship between humans and machines.**



## Assessment

The implications are profound across entire industry value chains: 4IR can change the nature of business by disrupting R&D, marketing, sales and distribution, and creating competition for incumbents by lowering the barriers to entry and the costs of innovation. Furthermore, patterns of consumption are evolving alongside new technologies, with customers requiring more transparency, individualization and engagement.

## Data & Facts

### PRE-INDUSTRIAL — HAND CRAFTED

**Summary**
The pre-industrial age revolved around subsistence agriculture and production

**Products and production techniques**
Society being primarily agricultural, products were crafted by hand, focussing on agricultural toolds and household products.

**Change In Porduction Sector Example: Textiles**
Hand woven.

**Sharing of information**
Domesticated animals were used for any major transportation. Information was shared within communities.

### 1 — TOWARDS THE END OF 18TH CENTURY

**Summary**
Mechaninal production equipment powered by water and steam provided the energy needed to power this revolution. This change also brought about the concept of the 'factory System'

**Products and production techniques**
Through the use of power, production was mechanised significantly increasing productivity.

**Change In Porduction Sector Example: Textiles**
Spinning jenny and power loom.

**Sharing of information**
The invention of the steam locomotive and steam ships significantly reduced the time of trasport and communication.

### 2 — TOWARDS THE END OF 19TH CENTURY

**Summary**
Production equipment moved to electrical power. This change, along with standardised replacement parts and automated factory line. provided the productivity galins to usher in'mass production'

**Products and production techniques**
The factory system built around mechanical power, namely line shafts and belts, could be replaced by centralised electric power supply improving efficiency.

**Change In Porduction Sector Example: Textiles**
Industrial sewing machines.

**Sharing of information**
The rise of motoring and increased use of the railway led to faster transportation and sharing of ideas. With the birth of electrical power came the telegraph.

### 3 — 1970s ONWARDS

**Summary**
Sometimes known as the digital revolution, the third industrial revolution saw high levels of automation through the increased proliferation of digital logic circuits and microprocessors.

**Products and production techniques**
Examples of new production technologies included automated robots, control systems, computer aided design and a range of digitaly based techniques.

**Change In Porduction Sector Example: Textiles**
Digital screen printing on fabrics

**Sharing of information**
Computer networking. the internet, mobile phones and other forms of digital communication significantly reduced the time needed to share large volume of information.

### 4 — TOMORROW

**Summary**
The 4th industrial revolution is the coming together of cyber networks, with physical networks, to create new autonomous systems.

**Products and production techniques**
Through the use of sensors, mare and more data will be collected allowing new products, processes and integration to be conceived.

**Change In Porduction Sector Example: Textiles**
Personalised design and 3D printed clothing.

**Sharing of information**
The autonomous nature of communication system allows grater coordination with supply chains, tracking of assets and integrated business planning and production.

Progress at a global scale for humanity has tended to occur in waves. The 4IR has the potential to be the most powerful of those waves, with scope of impact boosted because the technologies themselves are evolving exponentially. While previous industrial ages brought about new goods, lower costs and smarter products, the 4IR could create completely new systems.

## Areas to Consider

Automation will replace labor, with global impact. Disruption of labor markets at this scale brings a risk of yielding greater labor market inequality. The question of "what will we in a world where machines do all the work for us?" becomes more and more relevant, and will be a topic that governments shall have to seek answers to.

Governments will face renewed and sustained pressure to adapt as technology redefines their role by creating competition for services and creating a new paradigm in terms of standards for fiscal responsibility and transparency.

Government must also place new emphasis on surveillance and security with technology giving rise to new threats (i.e. cyber-terrorism, biological warfare).

## Did you know?

A survey of technology executives and experts (2015) on tipping points in technology revealed the following insights, when asked about their expectations for 2025:

- 84% believe that the first entirely 3D-printed car will be in production
- 76% believe that the first 3D-printed liver transplant will have taken place
- 45% believe that the first AI machine will be on a corporate Board of Directors by 2025

Source: VINT research: the fourth industrial revolution; world economic forum; EEF - fourth industrial revolution.

# DECODING THE BODY

Decoding the body illustrates the ability to not only mapping the human genome, but also extract information about how the human genome is connected with diseases and capabilities. The Human Genome Project, that managed to identify and map all of the genes of the human genome, was the first step of many in understanding human biology. In 2000, there was belief in a simple correlation between each gene and a specific disease in a traditional scientific reductionist approach. With the exception of some severe single-gene diseases, we do now know that diseases generally have a multigenetic component that is influenced by both lifestyle and the surrounding environment. It will be necessary to look at several other molecular expressions, e.g. real-time cellular expression, in order to better understand the biological mechanisms of the body, and enable a personal medicine approach that is expected to be the pillar for preventive health and medical treatments in the coming decades.

The falling cost of genetic sequencing has enabled sequencing of everything both in the body as well as in the environment. It has become apparent that it is important to understand the biology of the environment around people – but also the so-called microbiome, which are the living colonies we have on and in us, where in particular the gut microbiome will be of great influence concerning medication, diets, and the treatment of patients.

The decoding of the body will go on for many years, and by 2050 we will most likely see a holistic biological system approach combined with personal lifestyle information gained from wearables and more general environmental information collected e.g. via smart-city concepts. By 2050, we might have reached a high level of system understanding and begun to decode the brain as well.

## Driving Forces

Focus on Health

Technological Development

Acceleration & Complexity

Knowledge Society

## All of Us Research Program

Many diseases do not have proven preventions or treatments. We need to gain better insights into the biological, environmental, and behavioral factors that drive these diseases. Precision medicine, that is enabled by the ability to decode the body, is an emerging approach for disease treatment and prevention that takes into account individual variability in environment, lifestyle and genes for each person.

The All of Us Research Program is a landmark longitudinal research effort that aims to engage 1 million or more U.S. participants in 2017 to improve our ability to prevent and treat disease based on individual differences in lifestyle, environment and genetics.

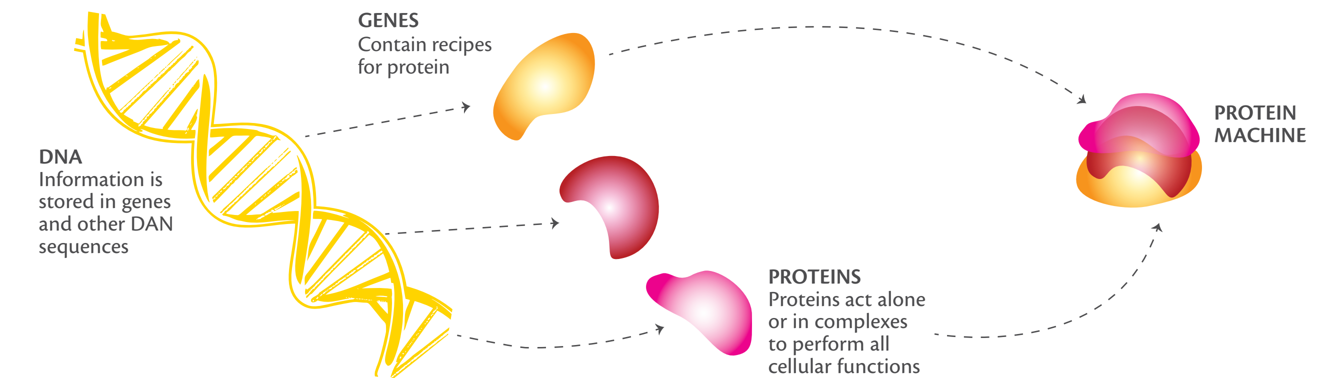


## Assessment

Better insight into the molecular and cellular level of biology will give us a new understanding of life.

We will be decoding the body for at least the coming 100 years, gaining increasingly complete knowledge.

## Coding for Protein




**Converting DNA into protein**

The genomes can be seen as our backbone of information that give the orders (recipes) to the proteins that perform the cellular actions. Today, we have knowledge about this protein-coding part, which constitutes 2 % of the genome, but very limited knowledge about the role of the remaining 98 % of the genome.

## Areas to Consider

International cooperation is necessary to develop the area of human biological knowledge. One of those is the Global Alliance 4 Genomics and Health (GA4GH), which has both public and private partners. GA4GH has undertaken the task of enabling data sharing and standardization.

There are genetic differences between all populations, and a focus from health authorities should be to produce a reference genome in order to develop exact health knowledge and health services to their population.

## Did you know?

In connection with the Summer Olympic Games in Rio in 2016, the so-called Olympiome Project was launched with the quest to collect and sequence everything that could be swept off surfaces before, during, and after the games, in order to see if the influx of many people from many places at the same time led to environmental changes and if this could provide health-relevant information.

The project will be repeated during the 2020 Summer Olympic Games in Tokyo, and it could potentially be used as a model for the surveillance of large cities and during other large-scale human events.

Sources: International Service for the Acquisition of Agri-biotech Applications (2006), 'Omics Sciences: Genomics, Proteomics, and Metabolomics'; Deloitte (2014), 'Healthcare and Life Sciences Predictions 2020: A bold future?'; US department of Health & Human Services (2017), 'All of Us Research program'.

# GENETICALLY MODIFIED ORGANISMS

Genetically modified organisms (GMO) are organisms whose genetic material has been altered using modern biotechnology, typically giving the organism enhanced properties like herbicide tolerance and insect resistance. GMO are used to produce many medications and food products and are widely used in scientific research.

A fast-growing global population with improved living standards creates a demand for more and better food. Food security, defined as avoiding food shortages, as well as the provision of safe food with beneficial health properties, is a crucial role of government. According to the UN, the world need to produce 60 % more food in 2050. Utilising GMO is a controversial way of increasing yield and creating higher-nutrient food. Especially in Europe, there has been much reluctance towards GMO crops.

GMO will most likely be a fundamental part of food production towards 2050, especially in areas prone to drought or with drug-resistant weeds. It is likely that GMO will give plants other abilities, like warning of pollution, and will be used in medication to create specific ingredients that are difficult to develop today. In certain areas, environmental movements will likely slow down the adoption of GMO, and clear standards will be needed of GMO crops. It will likely take a decade before both legal and scientific issues are harmonised in such a way that the application of GMO reaches low transaction costs.

## Driving Forces

- Technological Diffusion and Empowerment
- Commercialization
- More efficient use of Natural Resources and Environment

## Data & Facts

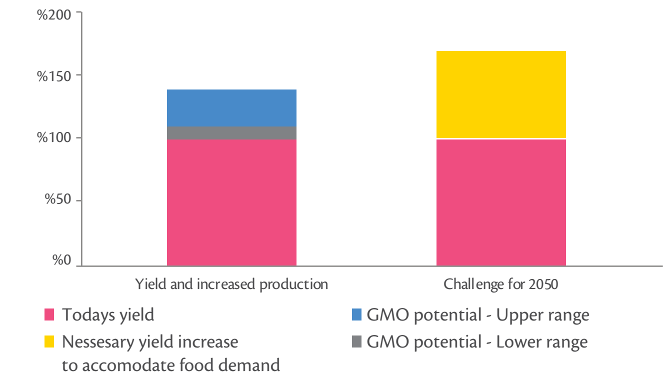
Despite popular beliefs, there seems to be no evidence to support the claim that GMO foods are harmful to humans. However, concern remains that the spreading of GMO seeds, which normally are stronger than wild variations, would outcompete these and effectively create an unsustainable ecosystem. This risk needs to be weighed against the possible upsides – by some accounts, using modern breeding practises and technologies to modify organism genetically could increase yield by 40 % (see GMO potential yield increase figure on next page).

It is important to note that there are disagreements as to the added production potential. In 2016, the US National Academies of Sciences published a comprehensive study on GMO finding little evidence for greatly boosting yields under ideal conditions. In fact, conventional plant-breeding techniques appear to be more successful, however most crops are not gown under ideal conditions and the study also finds that some insect-resistant GM traits do appear to have increased actual yield for certain crops.

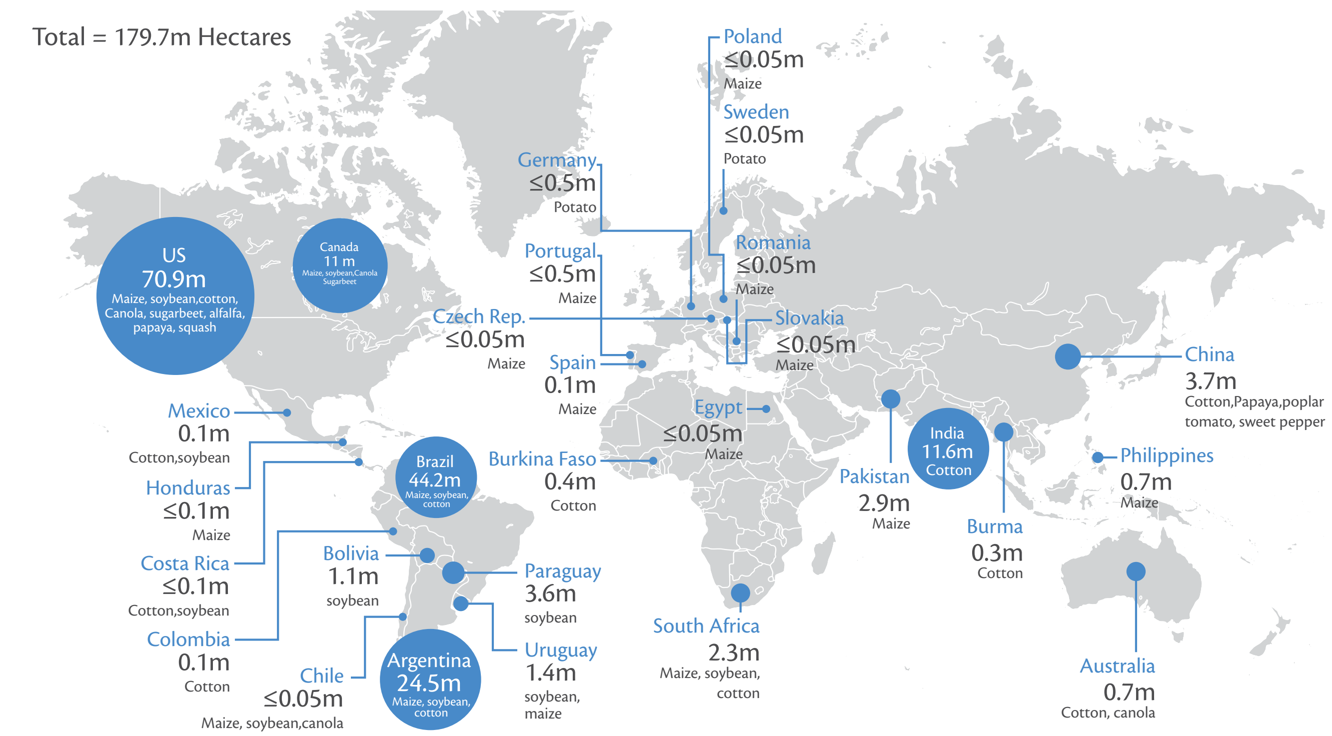


## Assessment

GMO could provide more food, which would be a global stabilising factor. The needs in emerging economies are huge and could be seen as a necessary part of economic development. It will probably take a decade before both legal and scientific issues are harmonised.




**GMO potential yield increase**




**Global Status of GM Crops, 2015 (Hectares of land)**

## Areas to Consider

There is a concern that a few companies will have commercial ownership of vital aspects of food production, which might not be in the best interests of populations and governments.

GMO poses a risk to natural habitats, and policymakers are advised to make contingency plans, producing efficient plans for monitoring and precise and urgent response if risk are evident.

## Did you know?

Unsafe food containing harmful bacteria, viruses, parasites or chemical substances causes more than 200 diseases – ranging from diarrhoea to cancers. An estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food, and 420,000 die every year, resulting in the loss of 33 million healthy life years (DALYs), GMO can be designed to signal or be more resistant to contamination.

The North America region represents 50 % of the global GM planted area.

Sources: Syngenta (2016), 'Our Industry 2016'; US National Academies of Science (2016), 'Genetically Engineered Crops: Experiences and Prospects'; World Health Organization (2015), 'Food Safety'; Pew Research Center (2016), 'Many Americans are skeptical about scientific research on climate and GM foods', the guardian.

# COMMERCIALISATION OF SPACE

During the first age of space travel, only the largest nations on Earth – USA and USSR – could afford to send people and satellites into space. Today, the cost has declined to a degree that dozens of private spaceflight companies can afford to develop their own space programs, complete with rockets, to lift materials – and soon people – into space.

Space business is still very expensive, and very often the private spaceflight companies are mainly subcontractors to NASA, European Space Agency (ESA) and similar government-funded institutions. The cost, however, is declining, particularly with the introduction of reusable rockets that can land on platforms at sea or on land after use. This creates opportunities for even more commercial satellites and space tourism.

So far, all the major commercial space companies are American, but nations like China, India and Japan are developing space programs, which may eventually give rise to local private spaceflight companies and global competition. For example, in February 2017, the Indian Space Research Organization (ISRO) broke the record for launching the most satellites from a single rocket by placing 104 in orbit. This effort is part of ISRO's goal of establishing itself as a reliable and cost-effective option for launching other countries and companies' satellites.

A promising future possibility is asteroid mining, where automated rockets mine near-Earth asteroids for rare materials, mainly for use in space, as an alternative to the very expensive launching of materials from Earth.

## Driving Forces

- Technological Development
- Globalization
- Commercialization
- Technological Diffusion and Empowerment

## SpaceX

The most successful private spaceflight company to date is SpaceX, founded by PayPal billionaire Elon Musk. The company's Falcon 9 rocket has made many deliveries to the International Space Station (ISS) and has landed several rockets safely after use. Future plans include manned flights, eventually to the planet Mars.



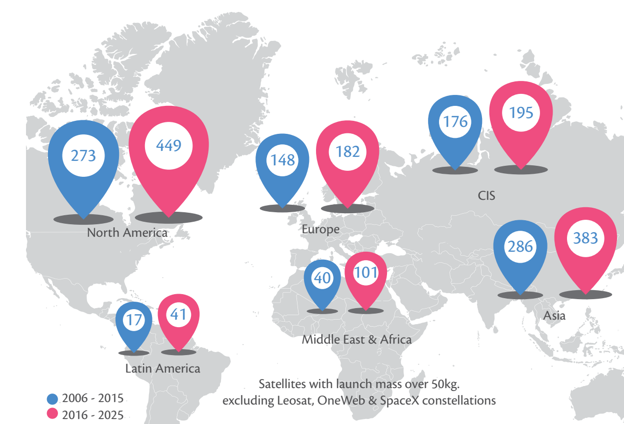
## Assessment

Private spaceflight will remain a niche industry for decades, albeit a very high-end niche.

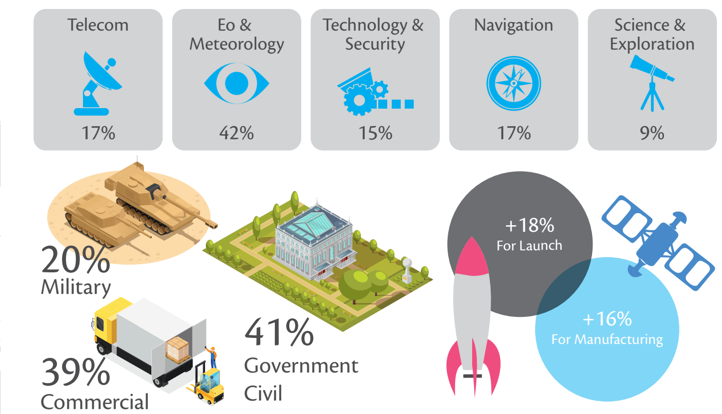
Private spaceflight is still very dependent on public funds. A change in policy could adversely affect the industry.

Private spaceflight should be seen as a long-term investment with high potential.

## Data & Facts




Two Decades Of Satellites, 2006 - 2025




Future Satellite and Space Market Growth, 2025

A study anticipates that 145 satellites with launch mass over 50kg will be launched on average each year by 2025. This represents a market of approximately $250bn for the space industry.

When including satellites smaller than 50kg, the total for 2016-2025 would grow precipitously to 9,000 units (vs. 1,480 launched in the past ten years).

## Areas to Consider

The commercialisation of space will make it easier and cheaper for nations to get their own satellites into orbit for a variety of purposes, including monitoring weather and ground conditions, providing satellite-based internet and telephony, and for research purposes.At the moment, access to space is strictly regulated, but with more international companies and national space programs, it may prove difficult to enforce regulations.

## Did you know?

An increasing problem for satellites is the growing amount of space debris deriving from broken satellites, parts of launch rockets, etc. It's estimated that there are more than 500,000 pieces 1 cm across or larger in orbit, travelling at speeds of up to 28,000 km/h. Of these, about 20,000 that are larger than a fist are tracked by NASA.

Sources: Ars Technica (2016), 'NASA signals commitment to private space with 14$ billion investment'; Washington Post (2016), 'The inside story of how billionaires are racing to take you to outer space'; Satellite Industry Association (2016), 'State of the satellite industry report'; Wall Street Journal (2017), 'India Breaks Record for Launching Most Satellites from Single Rocket'; www.lunar.xprice.com; www.nasa.gov; www.spacex.com; Euro Consult: Satellite Manufacturing and Launch.

# NANOTECHNOLOGY

The term nanotechnology comes from nanometre, a measure of length representing one billionth of a metre. Any use of materials which are less than 100 nanometers is defined as nanotechnology. Using nanotechnology, materials can be made stronger, lighter, more durable, more reactive, and many other possibilities. There already exist over 800 everyday commercial products that rely on nanoscale materials and processes.

A field that holds much promise is nanoelectronics, where electronics are based on carbon nanotubes and graphene sheets. Nanoelectronics can in theory be made with finer details and less power use than traditional silicon circuits, which are approaching the limits for further development, and could hence be a replacement technology.

Another emerging field is nanorobots (often called 'nanobots' or simply 'nanites'); nanometre-scale machines that e.g. can be injected in the human body by the million to combat diseases.

Over the medium term, nanotechnology will be of high interest and will continue to attract R&D investment. As the utilization of advanced nanomaterials expands, consumers will enjoy tremendous value and benefit, through a new generation of products.

## Driving Forces

- Technological Development
- Focus on Health
- More efficient use of Natural Resources and Environment

## Medical Nanobots

In recent years, scientists have experimented with nanorobots made from folded DNA strings. In tests on animals, such nanobots float in the bloodstream carrying minute amounts of cancer drugs, which they automatically release when encountering cancer cells. Human trials are expected soon.

Scientists have demonstrated that they can control their nanobots' release of drugs through 'mind control': The brain waves of a controller are read with an EEG cap, and certain patterns trigger an electromagnetic field that releases the drug. This could feasibly be used for real-time treatment of mental disorders.

They have recently been able to add a rotor and a gripper to similar nanobots, allowing for controlled navigation towards a target.



## Assessment

Given the wide range of applications, nanotechnology is expected with a high degree of certainty to impact almost all industries. The time frame varies for different aspects of nanotechnology: nanomaterials have already had a big impact, while it may be decades before nanoelectronics and nanorobots become mainstream.

## Future Uses of Nanotechnology

### Medicine

Devices the size of blood cells will target pathogens in the human body. These techniques will also make full-immersion virual reality possuble. Surgery will be completed on a cellular base. Doctors will identify and remove cancer cells and surgically implant healthy cells in their place.

### Nanofabrication and molecular manufacturing

Macro-scale objects, each with their own algorithm, will be built atom-by-atom. The process will be simple using biotechnological techniques to make appliances function like 3-D printers.

### Application to Social Issues

Nanotechnology presently has the most potential to solve problems of water remediation, pollution, and hunger.

### Nanorobotics

Nanorobots will complete both ordinary human tasks and tasks too complicated for humans to achieve. They will fight disease in the body by Killing parasites and destory blood clots and kidney stones. They may also seek out and destroy single molecules of contaminants in water and air.

## Areas to Consider

The natural support base for nanotechnology because of potential benefits in areas such as medicine should not stop policymakers from undergoing rigorous risk analysis of new advanced materials becoming part of future products. Regulation of nanotechnology engineering, manufacturing and its end products must be looked at as a specialized priority focus.

Policymakers should consider the social implications of nanotechnology, which encompassses many areas, such as: privacy, security, environment, and ethical questions.

## Did you know?

Chinese scientists have doubled the strength of silk by feeding silkworms the nanomaterials graphene and carbon nanotubes. The enhanced silk is also electrically conductive, making it possible to weave electronic devices into silk textiles.

Sources: Global Futurist (2016), 'Scientists use brain controlled DNA nanobots to release drugs inside roaches'; EurekAlert (2016), 'Nanoscale rotor and gripper push DNA origami to new limits'; The Guardian (2016), 'Nanotechnology: striking a balance between glorification and 'grey goo''; The National Nanotechnology Initiative (2015), 'Supplement to the President's 2016 Budget'; Nanoglobal: Future Uses of Nanotechnology.

# IMMERSIVE TECHNOLOGY

Immersive technologies are technologies that create a full or partial illusion of being in another place. This includes virtual reality (VR), which transports the user's senses to a completely different setting (real or fictional), augmented reality (AR), which adds unreal elements to the user's actual environment, and augmented virtuality (AV), which adds elements of reality to a virtual environment, e.g. through motion capture. The latter two are often referred to together as mixed reality (MR). The more immersive an experience is and the more interaction is added (level of sensory impressions), the higher is the level of presence (feeling of actually being in the VR).

Immersive technologies have been around for a long time, but only recently the quality has become good enough for general use, with VR headsets (head mounted displays), like Oculus Rift and AR headsets like Microsoft HoloLens. So far, immersive technologies mainly create visual and auditory input, but in the future, we may see other senses added, like smell, taste and touch; all of which are being tested today.

Towards 2050, along with the progress of the technology, immersive technologies will pervade most industries and significantly change current times dependency on physical presence and interaction. According to revenue forecasts done by Techcrunch in 2015, AR/VR is expected to hit USD 150 billion revenue by 2020, with AR taking the lion's share around USD 120 billion and with VR at expected USD 30 billion.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Network Society

## Different Uses Cases for IVEs

A recent study on short and long-term effects of immersive virtual environments tested the power of embodied experiences within Immersive Virtual Environments (IVEs) by comparing the effects of cutting a virtual tree against reading a print description or watching a video depiction of the tree-cutting process to encourage paper conservation. The experiment showed, that in long term, participants in the IVE consume 20 % less paper than participants who read a print description of tree cutting.

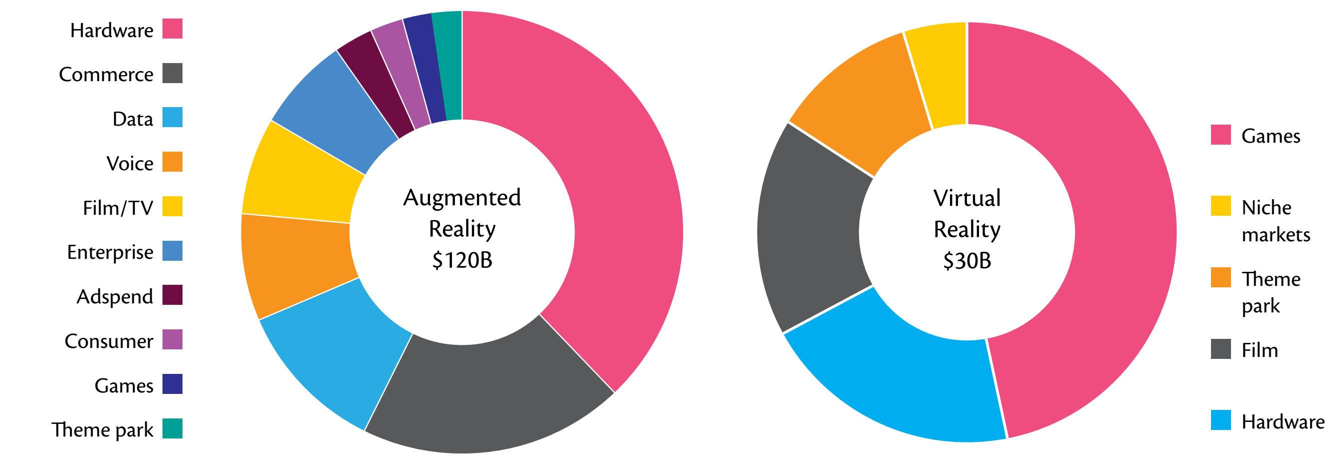
Experiments in Denmark show that if people suffering from Alzheimer's experience events related to their past lives in VR (e.g., singing in a choir), they get a temporary boost in mental abilities.



## Assessment

Immersive technologies are likely to have a high impact in entertainment and low or medium impact in other industries.

## Data and Facts




Augmented / Virtual Reality Revenue Share 2020

Future Uses of VR/AR:

- To better model designs – VR will benefit key players in the construction space such as architects and designers. The tool allows a user to virtually inhabit spaces in three dimension.
- To test car safety and drive sales: VR gives cars engineers the ability to test the safety of vehicles in a virtual setting before actually manufac-turing them.
- Businesses are beginning to employ VR in a number of ways: to reduce costs, lessen business travel, conduct interviews, give tours, forecast trends and hold meetings.
- To help paraplegics regain body functions – patients are able to regain some brain functions associated with moving their legs.
- To train medical students – VR provides medical and dental students a safe and controlled environment to practice surgeries.
- In retail, augmented and virtual reality can be used in ways that help businesses move customers through the purchase funnel.
- Smart glasses are seeing adoption on factory floors and in fields like construction and oil and gas, where hands need to be free.

## Areas to Consider

VR could be used to safely remote-control robots to perform dangerous tasks like rescuing people from collapsed or burning buildings.

Virtual Reality can also be interesting for Future Studies itself, since research shows that virtually experiencing situations create a greater awareness for the topic afterwards.

This might be especially relevant for education, where learning through immersive technologies would be much more efficient for some people.

## Did you know?

VR and AR generally produces stereoscopic images where the viewer must focus on screens close to the eyes no matter how distant the projected scene seems to be. A new technology called virtual retinal display (VDR) gets around this by painting images directly on the retina with coloured lasers. This requires more precise technology, but allows the simulation of focus depth for more realistic viewing, as well as more vibrant colours. In 2016, the first commercial VDR headset, the Avegant Glyph, was released.

Sources: Techcrunch (2015), 'Augmented And Virtual Reality To Hit 150$ Billion, Disrupting Mobile By 2020'; Techrepublic (2016), 'Infographic: VR and AR are gaining traction for use in the enterprise'; Ahn, S. J. et.al. (2014), 'Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior'.

# BLOCKCHAIN

A blockchain is a distributed ledger database that maintains a continuously-growing list of records, called blocks, secured from tampering and revision. Each block contains a timestamp and a link to a previous block. Blockchain technology can be used to create a permanent, public, transparent ledger system for compiling data. That could be information on sales, taxes, rights, votes, which could be combined with algorithms, making e.g. contracts being executed based on objective conditions like financial contracts. The blockchain technology can securely move and store digital money, titles, deeds, music, art, scientific discoveries, intellectual property, and even votes. The blockchain is the technology that underlies Bitcoin (see Digital Currencies), where it serves as the public ledger for all transactions.

With a blockchain, trust is not established by powerful intermediaries like banks, governments and technology companies, but through mass collaboration and clever code. In Honduras and Greece, projects are underway to base land registry on blockchains, ensuring that no-one can claim ownership of land they do not own.

The blockchain is part of a larger trend of decentralized infrastructure based on code and protocols, like the internet, which is based on HTML code and protocols like IP, TCP, and HTTP, and wireless mesh networks, which connect smart devices in extensive decentralized networks through Wi-Fi or Bluetooth.

In the future, we are likely to see blockchain technology crop up in more and more arenas, both by authorities and commercial companies to reduce the workload of keeping secure ledgers, and by grassroots organizations to provide free and open alternatives to commercial or governmental solutions, similar to how open source software is used today.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Network Society

## Slock.it

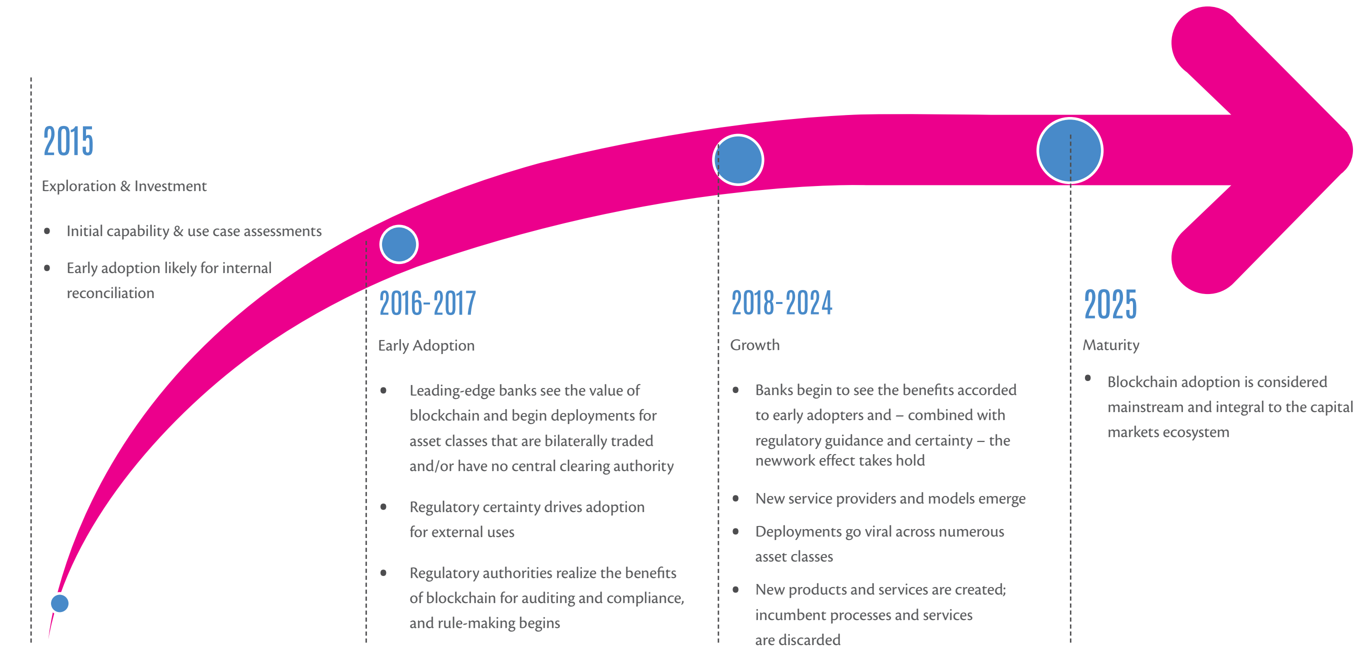
Slock.it is a company that combines digital locks with blockchains to e.g. allow renting apartments, cars, bicycles, lockers and more without any middlemen. Once a transaction has been validated by adding a block to a blockchain, the renter receives an encrypted code to their smart device, which can be used to unlock digital locks on the rented items, with locks provided by Slock.it. Unlike Airbnb, Uber and similar services, the system requires no middleman once the lock is in place.



## Assessment

The blockchain is a very new technology, being first applied in 2009 with the introduction of Bitcoin. As for most new technologies, while some implementations already exist, we are many years from seeing the full potential of the technology.

## Data & Facts




**Potential maturity path for blockchain**

## Areas to Consider

Blockchain will be able to deliver more reliable, more secure, and more transparent governmental services such as property ownership, digital identities, digital surveys and other sorts of transactions internal in the government as well as with citizens.

Benefits could also include reduced cost of operations (including fraud and error in payments) and better services.

The flip side of the coin is that transactions based on blockchains could be difficult to control or regulate by central authorities if they are made as decentralized as it is the case with Bitcoin.

## Did you know?

Blockchain is subject to substantial evolution within the financial industry, and blockchain will likely lead to significant cost savings as well as faster, more secure, reliable and transparent services within the coming few years.

One of the most prominent initiatives driving these changes is the R3 Consortium. R3 is a financial innovation firm that leads a consortium partnership with over 50 of the world›s leading financial institutions, with the purpose of designing and delivering advanced distributed ledger technologies (such as blockchain) to the global financial markets.

Sources: Harvard Business Review (2016), 'The Impact of the Blockchain Goes Beyond Financial Services'; Reuters (2016), 'Banks adopting blockchain ‹dramatically faster› than expected: IBM'; The Economist (2015), 'The great chain of being sure about things'; PhysOrg (2015), 'Finally, interesting uses for the blockchain that go beyond bitcoin'.

# BIG DATA

Big Data is the term used for all the data being generated and collected by everything around us at all times. Every day, 2.5 exabytes of data is generated, which is equivalent to the memory of 150 million iPhones, 5 million laptops or 90 years of HD video. Big Data gives unprecedented power to understand, analyze, and ultimately change the world we live in, and has already heavily contributed to progress within healthcare, self-driving cars, insights into consumer patterns, and much more.

Big Data can be applied to discover patterns that are not immediately recognisable by human intelligence. It can be applied in early warning systems for crime, terrorism, epidemics, extreme weather events, financial crises, and more – though past patterns cannot always be used to predict future events, particularly when it involves people, since fashions and behaviour patterns change over time, often as a reaction to past behaviour.

Towards 2050, Big Data is expected to increase exponentially, driven by an increased number of devices, increased processing power, increased transmission capabilities, and more and more clients analysing data and generating new data. The means to gather data will become increasingly automated and sophisticated, and the methods of analysing large amounts data will be improved with more powerful computers and better algorithms for analysis. Forecasts of all things based on Big Data will likely be as common as weather forecasts are today – and probably about as reliable.

## Driving Forces

Technological Development

Knowledge Society

Acceleration & Complexity

## Predictive Policing

Predictive Policing, or 'PredPol' for short, is about collecting data about crimes and arrests in order to predict where and when to focus efforts in crime prevention. PredPol is used by 60 US police districts.

In the US, PredPol has been criticized for replicating the bias of police officers. Police are more likely to search citizens in poor, black neighbourhoods and hence more likely to make arrests for illegal possession of drugs there – though studies show that illegal drug possession is equally prevalent in wealthy white neighbourhoods.

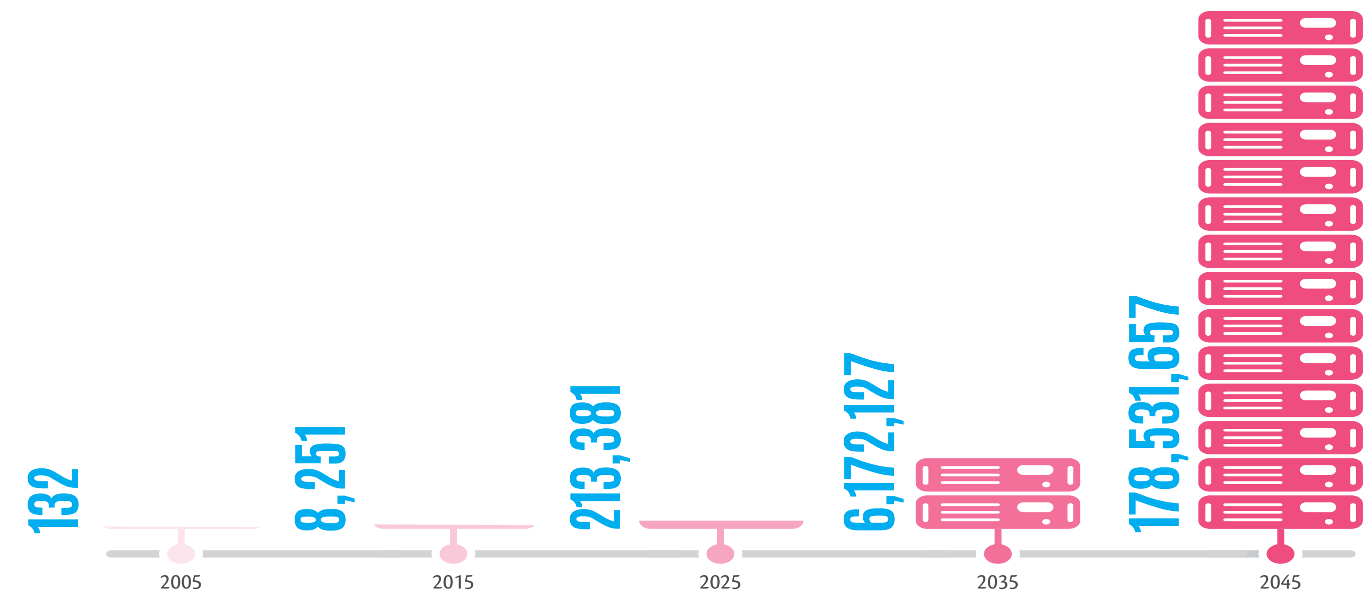
This shows the importance of avoiding sampling bias in Big Data – and how difficult this may be.

## Assessment

Big Data is the fuel needed to develop AI (See Artificial Intelligence), and Big Data will become even more useful along with the advancement of AI. Big Data is also closely related to IoT (See Internet of Things) and will serve as input to digital agents ensuring that people can interact seamlessly with their surroundings.



## Data & Facts




Growth in volume of digitally stored information

Volume: Every decade, the amount of data we can store in a given space and at a given cost has increased a thousand fold. By 2040, it will likely be about 25 million times as much as today.

Velocity: Today's mobile communication network (4G) is capable of transferring about 100 MB per second. In the 2020s, 5G will be capable of transferring up to 10 GB per second (see Digital Distribution). A proposed 6G network could use satellites to provide up to 11 GB per second to even remote areas by 2040.

Variety: Computers become better at comparing and interpreting unstructured data. In the future, computers will most likely not need people to feed them data.

Veracity: A major issue today is making sure that data fed to computers is truthful, unbiased and complete. In the future, computers are expected to be able to criticise the data they are fed and seek alternative sources on their own.

## Areas to Consider

In a strategy on tackling the Big Data challenges, the EU Commission proposes the following actions to the member states:

- Develop Big Data public-private partnership that funds 'game-changing' Big Data ideas in areas such as personalised medicine and food logistics.
- Create an open data incubator, to help SMEs set up supply chains based on data and use cloud computing more.
- Propose new rules on data ownership and liability of data provision for data gathered via IoT.
- Mapping of data standards, identifying potential gaps
- Establish a series of Supercomputing Centres of Excellence to increase number of skilled data workers
- Create network of data processing facilities

## Did you know?

According to Bernard Marr, author of the books Big Data and Big Data in Practice, we now produce more data every two years than was created from the dawn of time until 2003, and the amount of data we capture and store doubles every 1.2 years.

In July 2014, the EU Commission outlined a new strategy on Big Data, supporting and accelerating the transition towards a data-driven economy in Europe. The main problems identified in public consultations on Big Data were: Lack of cross-border coordination; insufficient infrastructure and funding opportunities; shortage of data experts and related skills; fragmented and overly complex legal environment.

Sources: SAS (2016), 'Big Data -What it is and why it matters'; IBM (2016), 'What is BigData'; Turk, M. (2016), 'Is Big Data Still a Big Thing'; Sciencemag (2016), 'Can 'predictive policing' prevent crime before it happens?'; Northeastern University (2016), 'How much data produced every day?'; UK Ministry of Defence – Global Strategic Trends: Out to 2045.

# INTERNET OF THINGS

The Internet of Things(IoT) is a term reflecting the movements towards more and more physical objects being connected to, and communicating over, the internet. IoT is closely connected to Big Data and Artificial Intelligence (AI), as internet-connected devices will contribute to the exponential increase data, which will feed and drive forward AI. IoT is made possible because of the small size and price of microprocessors and sensors that can be attached to almost any product, enabling new ways of tracking, coordinating, and controlling everything from industry processes to people's every day lives.

IoT allows for better management of e.g. urban infrastructure systems like traffic, waste, water systems, and public safety (see Smart Cities). IoT will enhance productivity and create new products and services by capturing data, aggregating the information, and allowing for real-time reaction. Some of the initial application areas are within automobiles, medical devices, industrial systems, and a growing number of consumer electronics devices. Research and consulting firm Gartner predicts these networks will grow to encompass 50 billion devices worldwide by 2020.

IoT will alter the basis of competition to be about harvesting and reacting on knowledge about how products are actually being used, when they are used, by whom, and with which other devices they are connected to. Towards 2050, IoT will probably be one of the most significant vectors for change, and new ways of delivering services and interacting with other people and companies will emerge along with the technology being integrated in society.

## Driving Forces

Technological Development

Technological Diffusion and Empowerment

Network Society

## GE's Brilliant Factory

In the manufacturing industry, closed-loop setups based on IoT, that react to incoming signals and adjust process flows accordingly, can significantly improve the operational efficiency.

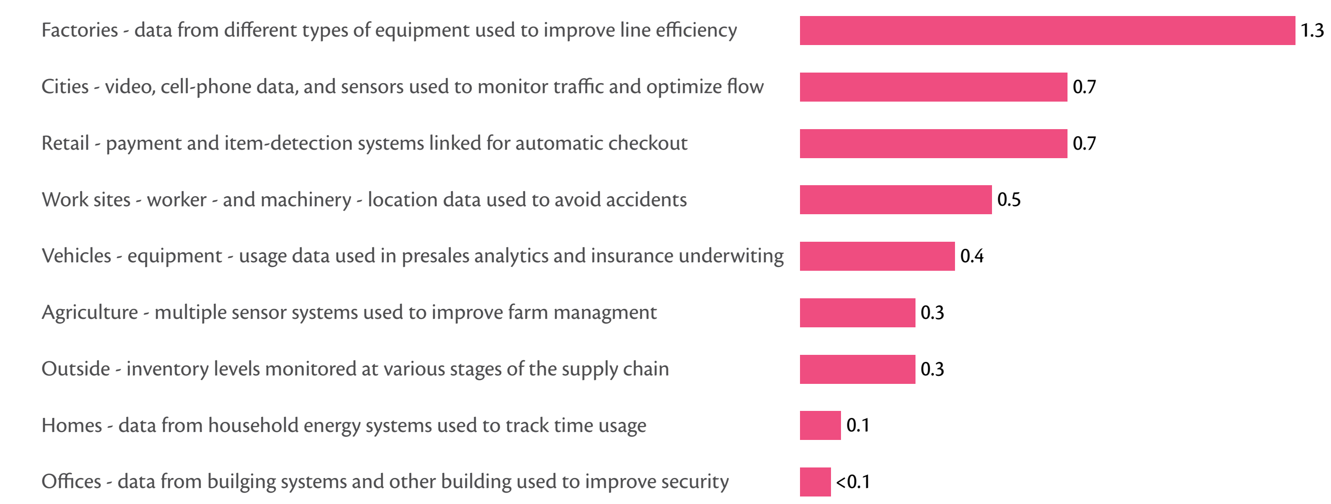
A current example is GE's Brilliant Factory, which implements sensors and uses the GE's Predix software platform to stream data in all GE plants. By linking design, engineering, manufacturing, supply chain, distribution and services into one globally scalable intelligent system, they could reduce unplanned downtime by 10-20 %



## Assessment

IoT has a wide range of uses and will most likely remain a growth industry over the next decades. However, the persistent security and privacy issues connected to IoT could cause the development to slow down and prevent an omnipresence for the technology. The effect of IoT is expected to have significant impact 5-10 years from now. However, a widespread use of sensors can already be observed, and the cost of sensors have declined by 70 % since 2010.

## Data & Facts




**Potential economic impact by 2025 of IoT (US $ trillions)**

While the consumer's adoption of fitness bands and connected household appliances might generate more media buzz, the potential for business usage is much greater. Research suggests that the operational efficiencies and greater market reach in B2B IoT will account for nearly 70 % of the value expected to flow from IoT in the next ten years, corresponding to USD 11 trillion a year globally by 2025.

## Areas to Consider

The continued growth of IoT is expected to revolutionize every sector of the economy, creating new business models for every industry and significantly altering how society and government function. It is paramount to consider policy areas of i.e. cybersecurity, since hacking is one of the main challenges to IoT. Also privacy concerns, e.g. in balancing privacy rights with data security requirements, will determine if people will embrace the technology.

Establishing technological standards would help build, maintain and implement integrated systems, and investments in infrastructure as well as considering employment and training would contribute to further the Internet of Things.

## Did you know?

In the fall of 2016, several massive cyberattacks were undertaken against websites, exploiting tens of millions of malware-infected IoT devices to overwhelm websites with traffic.

Hackers at the Def Con security conference (one of the worlds largest hacker conventions), which was held in Las Vegas August 2016, found nearly 50 critical issues in internet-connected door locks and solar panels, among other devices. This illustrates the vulnerability of the IoT and the need for immense cyber security measures for ensuring safety.

Sources: McKinsey&Company (2014), 'The Internet of Things: Sizing up the opportunity'; McKinsey&Company (2015) 'An executive's guide to the Internet of Things'; European Commission (2016), 'The Internet of Things'; RT (2016), 'Internet of Things believed to be targeted in massive DDoS attacks'; Scientific American (2016), 'IoT Growing Faster Than the Ability to Defend It'; Busines Insider (2015), 'Google has gotten incredibly good at predicting traffic - here›s how'.

# 3D PRINTING

3D printing is a layer-by-layer approach to creating an object using a digital drawing, or model. 3D printers are able to incorporate materials such as plastic, aluminium, steel, ceramic and alloys. This portends massive change in the world of manufacturing because of the potential to replace assembly lines and even entire factories.

This technology is already in use across sectors for prototyping purposes or even for creating customized products. Currently, 3D printing is predominantly used in automotive and aerospace industries, and there is significant progress in using 3D printing in the healthcare sector (for organs and prosthetics).

The impact of 3D printing will be felt in the consumer experience. If a 3D printer is available at hand, shopping could almost become an experience resembling Amazon, except with the purchase being code for a customized object. This creates a deeper connection between the customer and the product, and democratization in this case means access / ability to make purchases to unprecedented exacting specifications.

3D printing, significantly, poses impact for manufacturing, because this is a sea change to manufacturing economics. 3D printing will be less labor intensive, use less material, produce less waste, and can use new materials not traditionally utilized. Supply chain and logistics economics will also have to be revisited by companies and possibly entire industries.

One major impact area is the reduction of barriers to creating a complex prototype or product, as this creates vast opportunities for innovations in product design and utility. Additionally, 3D printing allows a much closer relationship between producer and customer, primarily because of proximity. Removing several steps of the manufacturing process reduces reliance on the supply chain and allows renewed focus on what the customer wants.

## Driving Forces

- Technological Development
- Technological Diffusion and Empowerment
- Individualisation

## 3D Bio-Printing

3D bio-printing is being applied to the field of regenerative medicine in order to create 'synthetic' versions of tissues and organs for transplantation. This is a complex field of study and involves intricacies such as the choice of materials, cell types, growth and differentiation factors, and technical challenges related to the sensitivities of living cells and the construction of tissues.

Addressing these challenges needs expertise from many domains: engineering, biomaterials science, cell biology, physics and medicine. 3D bio-printing has already created prototypes of tissues, including multilayered skin, bone, vascular grafts, tracheal splints, heart tissue and cartilaginous structures. Further uses for 3D printing in medicine could include the creation 3D-bioprinted tissue models for research, drug discovery and toxicology.



## Assessment

Looking forward over the next 10 years, there is scope for high potential:

- Home consumer market, where the major form of trade is in designs / code and raw materials. This poses questions to traditional retail and wholesale models (if consumers print their products at home).
- While traditional high-volume manufacturing would retain a cost advantage over the medium term, 3D printing could take over the market for low-volume, customizable complex parts.

## Data & Facts

CURRENT APPLICATIONS → LIKELY NEAR-TERM DEVELOPMENTS → FUTURE OF 3D PRINTING

| | | | | |
|---|---|---|---|---|
| COMMERCIAL ACTIVITY | • Intellectual property regulations<br>• Capability building | • Crowd-funding of design<br>• 3D printing startups | • Markets for 3D printing raw materials | • Impact on new industries (e.g. construction) and capital reallocation |
| SUPPLY CHAIN | • 3D printing offices for niche markets | • Recycled materials for 3D printing | • Challenges to off-shore production | • Customer proximity<br>• Shipping, re-export challenges |
| MANUFACTURING | • Rapid prototyping and design | • Low volume, specialist manufacturing | • Printed electronics<br>• Innovative 3D printed components | • Factory floors lined with 3D printers |
| AEROSPACE AND DEFENSE | • Weight reduction<br>• Niche spare parts | • Aircraft wings | • Space exploration<br>• Battlefield printing | • Entire aircraft printed<br>• Self-healing vehicles |
| AUTOMOTIVE | • Design and prototypes | • Customization and restoration | • Niche spare parts<br>• Manufacturing | • Printing entire cars with innovative materials |
| HEALTHCARE | • Prosthetics<br>• Dental and bone implants | • Medical instruments<br>• Pharma products | • Printed simple tissue and organs | • Nano-medicine<br>• Complex organ printing |
| CONSUMER AND RETAIL | • Novelty items | • Custom products<br>• 'Maker' communities | • Home 3D printer for regular retail purchases | • Consumer 'experience' built around 3D printing |

Future pathways for 3D printing are challenging to fully define. It is certain, however, that the onset and mainstreaming of 3D printing will disrupt industries and create new economic opportunities, while redefining products and experiences.

It is projected that the global 3D printing market could grow to US $12.5 billion by 2021, from approximately $4 billion in 2014. This is due to possible growth in three spaces: 3D printed consumer products, 3D printed design and prototyping, and 3D printed manufacturing.

## Areas to Consider

Lower barriers to entry: the barriers to creating a prototype have always been high, with expensive machinery and sophisticated software usually required. 3D printing has peeled away these barriers, opening new possibilities that allow almost anyone to be a manufacturer. This also encourages innovation.

3D printing piracy: the ability to take the design of a traditionally manufactured good and recreate it cheaply and quickly with 3D printing, bypassing the manufacturing process. This could pose challenges to definitions of intellectual property.

Disruption of logistics and supply chain economics: companies and indeed entire industries would need to reconsider how to align their business models, as 3D printing offers tremendous opportunities through customer proximity, immediate (and cheap) customizations and economies of scale.

## Did you know?

FoodInk is the world's first 3D-printed restaurant (in London, UK). Everything from the furniture to the cutlery to the food itself is 3D-printed. Patrons are provided a 9-course 3D-printed meal prepared live.

Sources: Citi GPS: Future Opportunities, Future Shocks; Oxford Martin School: Now for the Long Term.

# ACKNOWLEDGEMENTS AND REFERENCES



# ACKNOWLEDGEMENTS

The United Arab Emirates Ministry of Cabinet Affairs and the Future, Prime Minister's Office would like to acknowledge the time, efforts and expertise of the Copenhagen Institute for Future Studies in assisting with the research, structuring and compilation of 'Future Outlook: 100 Global Trends for 2050'.

# ECONOMY


- Abbate, J. (1999). Inventing the Internet. MIT Press.
- ATKearney. (-2020 .(2015Seven Growth Economies.
- Bain & Company. (2013). Making it personal: Rules for success in product customization.
- BBC. (2016). The economic outlook for 2016. Retrieved from www.bbc.com: http://www.bbc.com/news/business35191325-
- Bersin, J. (2016). The New Organization: Different by Design. Retrieved from www.joshbersin.com: http://joshbersin.com/03/2016/the-new-organization-different-by-design/
- Bisgaard, T., Henriksen, K., & Bjerre, M. (2012). Green Business Model Innovation - Conceptualisation, Next Practice and Policy. Nordic Innovation Publication.
- Bloomberg. (2012). Rise of the Barter Economy. Retrieved from www.bloomberg.com: https://www.bloomberg.com/news/articles/26-04-2012/rise-of-the-barter-economy
- Botsman, R. (2012). TED Talk - The Currency of the New Economy is Trust. Retrieved from https://www.ted.com/talks/rachel_botsman_the_currency_of_the_new_economy_is_trust
- Business Insider. (2013). Mauldin: Economists Are Totally Clueless About The Economy. Retrieved from www.businessinsider.com: http://www.businessinsider.com/mauldin-economists-are-still-clueless6-2013-?r=US&IR=T&IR=T
- Business.com. (2015). Is Wholesale over? Death of the Middle Man. Retrieved from www.business.com: http://www.business.com/ecommerce/is-wholesale-over-the-death-of-the-middleman/
- CIFS. (2009). Members' Report - Anarconomy.
- CIFS. (2013). Members' Report - Freedom From Ownership.
- CIFS. (2014). Members' Report - Future Luxury.
- CIFS. (2014). Members' Report - Trends for Tomorrow.
- CIFS. (2016). Members' Report - Automation.
- CIFS. (2016). Members' Report - How to be Resilient in the 21st Century.
- CIFS and ISS. (2016). ISS 2020 Vision: Future of Service Management.
- CoinDesk. (2016). State of Bitcoin and Blockchain 2016: Blockchain Hits Critical Mass. Retrieved fromwww.coindesk.com: http://www.coindesk.com/state-of-bitcoin-blockchain2016-/
- CoinMarketCap. (2016). Crypto-Currency Market Capitalizations. Retrieved from www.coinmarketcap.com.
- Confederation of Danish Industry. (2007). Working with the Bottom of the Pyramid.
- Council of Foreign Relations. (2016). Global Order and the New Regionalism.
- Deloitte University Press. (2015). Patterns of Disruption - Anticipating disruptive strategies in a world of unicorns, black swans, and exponentials.
- Deloitte University Press. (2015). The Deloitte Consumer Review - Made-to-order: The rise of mass personalisation›.
- Deloitte University Press. (2016). Global Human Capital Trends 2016 - The new organization: Different by design.





# ECONOMY



- European Parliament. (2016). Virtual currencies: what are the risks and benefits? Retrieved from www.europarl.europa.eu: http://www.europarl.europa.eu/news/en/news-room/20160126STO11514/virtual-currencies-what-are-the-risks-and-benefits
- Express. (2016). China BUBBLE BURST is just ‹months away›, warns expert and BRITAIN will feel it FIRST. Retrieved from www.express.co.uk: http://www.express.co.uk/finance/city/641398/Britain-is-world-s-most-exposed-country-to-China-huge-debt-bubble
- FastCompany. (2014). What A Coffee Shop Can Teach You About Finding Loyal Customers. Retrieved from www.fastcompany.com: https://www.fastcompany.com/-3/3030929lessons-coffee-shops-can-teach-you-about-finding-loyal-customers
- Financial Times. (2013). Incubators: Start-ups enjoy benefit of proximity. Retrieved from www.ft.com: https://www.ft.com/content/2c3b17b2-8c11-26e-3acf00144-4feab7de
- Financial Times. (2016). Global trade: structural shifts. Retrieved from www.ft.com: https://www.ft.com/content/0e0e-6960da-17 11e98-5fd06-d75973fe09
- Financial Times. (2016). WTO warns on rise of protectionist measures by G20 economies. Retrieved from www.ft.com: https://www.ft.com/content/2dd0ecc11-3768-4e-6a-780b48ed7b6126f
- Forbes. (2013). Having It Their Way: The Big Opportunity In Personalized Products. Retrieved from www.forbes.com: http://www.forbes.com/sites/baininsights/05/11/2013/having-it-their-way-the-big-opportunity-in-personalized-products/6#ba8b0fe7036
- Fortune. (2015). Why every aspect of your business is about to change. Retrieved from www.fortune.com: http://fortune.com/22/10/2015/the21-st-century-corporation-new-business-models/
- Glassdoor. (2016). Top 20 Employee Benefits & Perks. Retrieved from www.glassdoor.com: https://www.glassdoor.com/blog/top-20-employee-benefits-perks/
- Google. (2016). Mark up the world using beacons. Retrieved from developers.google.com: https://developers.google.com/beacons/
- Harvard Business Review. (2012). The Economics of Well-Being. Retrieved from www.hbr.org: https://hbr.org/01/2012/the-economics-of-well-being
- Harvard Business Review. (2015). Beyond Automation. Retrieved from www.hbr.org: https://hbr.org/06/2015/beyond-automation
- Iafrikan. (2016). Senegal To Introduce A New Blockchain-Based National Digital Currency, The Second Such Currency in The World. Retrieved from www.iafrikan.com: http://www.iafrikan.com/24/11/2016/senegal-to-introduce-a-new-blockchain-based-national-digital-currency-making-it-only-the-second-country-to-have-a-national-digital-currency/
- IBM Analytics. (2016). The Employee Experience Index - A new global measure of a human workplace and its impact.
- IMF. (2016). World Economic Outlook Database. Retrieved from https://www.imf.org/external/pubs/ft/weo/02/2016/weodata/index.aspx
- Innosight. (2016). Corporate Longevity: Turbulence Ahead for Large Organizations.
- Institute of International Finance. (2017). Emerging Markets Bank Lending Conditions Survey – 2016 Q4.
- Intergovermnmental Panel on Climate Change. (2014). Climate Change 2014 – Synthesis Report.
- International Financing Review. (2000 .(2013th issue: 40 years in review. Thomson Reuters.
- Knight Frank. (2016). Global Cities Trend 2016 Report - The Future of Real Estate in the World›s Leading Cities.
- Kristjan, V. (2015). Estonian e-Government Ecosystem: Foundation, Applications, Outcomes.
- Legatum Institute. (2016). The Legatum Prosperity Index . Retrieved from www.prosperity.com: http://www.prosperity.com/rankings?pinned=&rankOrScore=1&filter=&v=gap
- McKinsey&Company. (2014). Same-day delivery: The next evolutionary step in parcel logistics. Retrieved from www.mckinsey.com: http://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/same-day-delivery-the-next-evolutionary-step-in-parcel-logistics

# ECONOMY


- McKinsey&Company. (2014). Sustainability's strategic worth: McKinsey Global Survey results. Retrieved from www.mckinsey.com: http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/sustainabilitys-strategic-worth-mckinsey-global-survey-results
- McKinsey&Company. (2015). Debt and (not much) deleveraging. McKinsey Global Institute.
- Miller, D. T. (2015). Defense 2045 - Assessing the future security environment and implications for defence policymakers. CSIS International Security Program.
- Nesta. (2016). Pushing Boundaries - The 2015 UK Alternative Finance Industry Report.
- OECD. (2012). The Future of Eco-Innovation: The Role of Business Models in Green Transformation. OECD background Paper, OECD/European Commission/Nordic Innovation Joint Workshop.
- OECD. (2016). An OECD Horizon Scan of Megatrends and Technology Trends in the Context of Future Research Policy. Danish Agency for Science, Technology and Innovation.
- Pine, J., & Gilmore, J. H. (2011). The Experience Economy. Harvard Business School Press.
- PWC. (2011). Future of World Trade - Top 25 sea and air freight routes in 2030.
- PWC. (2015). The World in 2050 - Will the shift in global economic power continue?
- PWC. (2016). Assessing the size and presence of the collaborative economy in Europe.
- Sandler Research. (2016). Global Digital Coin Market 2020-2016.
- Strategy&. (2016 .(2016 Manufacturing Trends.
- Tech City News. (2016). Number of new UK startups increased %4.6 in 2015. Retrieved from www.techcitynews.com: http://techcitynews.com/13/01/2016/number-of-new-uk-startups-increased-6-4-in2015-/
- Techcrunch. (2015). The battle is for the customer interface. Retrieved from www.techcrunch.com: https://techcrunch.com/03/03/2015/in-the-age-of-disintermediation-the-battle-is-all-for-the-customer-interface/
- Techcrunch. (2016). Facebook launches Marketplace, a friendlier Craigslist. Retrieved from www.techcrunch.com: https://techcrunch.com/03/10/2016/facebook-marketplace2-/
- Techcrunch. (2016). The future is the trust economy. Retrieved from www.techcrunch.com: https://techcrunch.com/24/04/2016/the-future-is-the-trust-economy/
- TechHive. (2015). Amazon Dash Button lets you insta-buy household goods. Retrieved from www.techhive.com: http://www.techhive.com/article/2904393/amazon-dash-button-lets-you-insta-buy-household-goods.html
- The Economist. (2015). Deleveraging delayed. Retrieved from www.economist.com: http://www.economist.com/news/finance-and-economics/-21676837credit-growth-still-outstripping-economic-growth-deleveraging-delayed
- The Economist. (2015). Why everyone is so keen to agree new trade deals. Retrieved from www.economist.com: http://www.economist.com/blogs/graphicdetail/10/2015/global-trade-graphics
- The Economist. (2016). Red ink rising. Retrieved from www.economist.com: http://www.economist.com/news/finance-and-economics/-21693963china-cannot-escape-economic-reckoning-debt-binge-brings-red-ink-rising
- The Economist. (2016). The trouble with GDP. Retrieved from www.economist.com: http://www.economist.com/news/briefing/-21697845gross-domestic-product-gdp-increasingly-poor-measure-prosperity-it-not-even
- The Economist Intelligence Unit. (2016). The Chinese consumer in 2030.
- The Guardian. (2016). Land that debt forgot: tiny Pacific country of Niue has no interest in loans. Retrieved from www.theguardian.com: https://www.theguardian.com/world/2016/oct/27/land-that-debt-forgot-tiny-pacific-country-of-niue-has-no-interest-in-loans




# ECONOMY


- The Market Mogul. (2015). Starbucks' New Business Model. Retrieved from www.themarketmogul.com: https://themarketmogul.com/starbucks-new-business-model/
- The Rockefeller Foundation. (2016). Resilience – the big picture: Top themes and trends.
- Unacast. (2016). The Proxbook Report: The State of the Proximity Industry, Q2016 3.
- UNCTAD. (2015). Key statistics and trends in international trade.
- UNDP. (2015). Human Development Report 2015 - Work for Human Development.
- United States Department of Agriculture. (2016). International Macroeconomic Dataset.
- US National Intelligence Council. (2012). Global Trends 2030 - Alternative Worlds.
- Value Walk. (2016). No Boom Without A Bust. Retrieved from www.valuewalk.com: http://www.valuewalk.com/03/2016/no-boom-without-bust/2/
- Wallman, J. (2013). Stuffocation: Living More with Less. Penguin Books.
- World Business Council for Sustainable Development. (2016). Unlocking More value with Fewer Resources.
- World Economic Forum. (2016). The Global Competitiveness Report 2017-2016.
- World Trade Organization. (2013). World Trade Report 2013 - Factors shaping the future of world trade.
- World Trade Organization. (2016). Regional trade agreements and the multilateral trading system. Cambridge University Press.
- World Travel & Tourism Council. (2016). Travel & Tourism: Economic Impact 2016.
- www.alexa.com
- www.symbiosis.dk
- Users of Mobile Money in Africa: World Bank / GSMA
- CoinDesk: State of BitCoin and BlockChain 2016

# NATURAL RESOURCES AND ENVIRONMENT


- Accenture. (2014). International Development of Unconventional Resources: If, where and how fast?
- Armed Conflict Location & Event Data Project. (2014). Resource-Related Conflict in Africa. Retrieved from www.crisis.acleddata.com: http://www.crisis.acleddata.com/resource-related-conflict-in-africa/
- Bloomberg New Energy Finance. (2015). New Energy Outlook 2015.
- Bloomberg New Energy Finance. (2016). New Energy Outlook 2016.
- Bogataj, L. K. (2011). Climate change as problem of national and international security rather than environmental issue.
- BP. (2016). BP Energy Outlook - 2016 edition.
- China.org.cn. (%80 .(2016 underground water undrinkable in China. Retrieved from www.china.org.cn: http://www.china.org.cn/environment/11/04-2016/content_38218704.htm
- Clean Technica. (2016). New 'Super Battery' Energy Storage Breakthrough Aims at 54$ per kWh. Retrieved from www.cleantechnica.com: https://cleantechnica.com/26/02/2016/new-energy-storage-solution-could-hit-magic-54-mark/
- Cook, B., Anchukaitis, K. J., Touchan, R., Meko, D. M., & Cook, E. R. (2016). Spatiotemporal drought variability in the Mediterranean over the last 900 years.
- Danish Energy Agency. (2016). Danish Climate Policies. Retrieved from www.ens.dk/en: https://ens.dk/en/our-responsibilities/energy-climate-politics/danish-climate-policies
- European Commission - DG Research. (2015). The different 'generations' of nuclear technology. Retrieved from www.ec.europa.eu/research: http://ec.europa.eu/research/energy/euratom/index_en.cfm?pg=fission&section=generation
- European Parliament. (2014). Precision agriculture: An opportunity for EU farmers – potential support with the CAP 2020-2014.
- FAO. (2014). The State of World Fisheries and Aquaculture.
- FAO. (2014). World Agriculture Towards 2050/2030.
- Financial Times. (2016). US shale is the lowest-cost oil prospect. Retrieved from www.ft.com: https://www.ft.com/content/0a7a817a-11-4863e8-6d72-68e9211e86ab
- Forbes. (2016). Permian Basin Break-Even Price Is 61$: The Best of a Bad Lot. Retrieved from www.forbes.com: http://www.forbes.com/sites/arthurberman/19/06/2016/permian-basin-break-even-price-is-61-the-best-of-a-bad-lot/5#de5ad5b6af1
- FS UNEP Collaborating Centre. (2016). Global Trends in Renewable Energy Investment 2016.
- Future Agenda. (2016). The World in 2025.
- Fytrou, N. (2015). World food crisis and the Arab Spring.
- IMF. (2016). IMF Primary Commodity Index. Retrieved from http://www.imf.org/external/np/res/commod/index.aspx
- Intergovernmental Panel on Climate Change. (2014). Climate Change 2014 – Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
- International Energy Agency. (2015). World Energy Outlook 2015.
- International Energy Agency. (2016). Statistics Database. Retrieved from http://www.iea.org/statistics
- International Energy Agency. (2016). World Energy Outlook 2016.




# NATURAL RESOURCES AND ENVIRONMENT


- International Renewable Energy Agency. (2016). REmap: Roadmap for a Renewable Energy Future.
- Keating, M., & Brown, O. (2015). Addressing Natural Resource Conflicts: Working Towards More Effective Resolution of National and Sub-National Resource Disputes. Chatham House.
- Manhattan Institute. (2015). Shale 2.0: Technology and the Coming Big-Data Revolution in America's Shale Oil Fields.
- Markandya, A. (2014). Benefits and Costs of the Biodiversity Targets for the Post2015- Development Agenda. Copenhagen Consensus Center.
- McKinsey&Company. (2010). Africa's path to growth: Sector by sector. Retrieved from www.mckinsey.com: http://www.mckinsey.com/global-themes/middle-east-and-africa/africas-path-to-growth-sector-by-sector
- Met Office. (2016). Food Insecurity and Climate Change. Retrieved from www.metoffice.gov.uk: http://www.metoffice.gov.uk/food-insecurity-index/
- National Geographic Society. (2016). Climate Refugee. Retrieved from www.nationalgeographic.org: http://nationalgeographic.org/encyclopedia/climate-refugee/
- OECD. (2012). OECD Environmental Outlook to 2050: The Consequences of Inaction.
- OPEC. (2015). World Oil Outlook 2015.
- Padgham, J. (2009). Agricultural Development Under a Changing Climate: Opportunities, and Challenges for Adaption.
- PWC. (2013). Shale oil: the next energy revolution.
- Secretariat of the Convention on Biological Diversity. (2010). Global Biodiversity Outlook 3.
- Sinn, H.-W. (2016). Buffering Volatility: A Study on the Limits of Germany's Energy Revolution. CESifo Working Paper No. 5950.
- Smil, V. (2002). The Earth's Biosphere. The MIT Press.
- Stern, N. (2006). The Economics of Climate Change. Cambridge University Press.
- Syngenta. (2016). Our Industry 2016.
- Thomson Reuters. (2011). China set to unearth shale power.
- U.S. Energy Information Administration. (2013). Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States.
- U.S. Energy Information Administration. (2016). International Energy Outlook 2016.
- UNEP. (2015). Natural Resources and Conflict: A Guide for Mediation Practitioners.
- Vingerhoets, P., Chebbo, M., & Hatziargyriou, N. (2016). The Digital Energy System 4.0. European Technology Platform for Smartgrids.
- Wiebe, K. et al. (2015). Climate change impacts on agriculture in 2050 under a range of plausible socioeconomic and emissions scenarios. IOP Science Environmental Research Letters.
- World Bank. (2011). World Development Report 2011: Conflict, Security and Development.
- World Bank. (2013). Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience.

# NATURAL RESOURCES AND ENVIRONMENT


- World Energy Council. (2016). World Energy Resources: Unconventional gas, a global phenomenon.
- World Energy Council. (2016). World Energy Scenarios 2016 – The Grand Transition.
- World Resources Institute. (2015). Ranking the World's Most Water-Stressed Countries in 2040. Retrieved from www.wri.org: http://www.wri.org/blog/08/2015/ranking-world%E99%80%2s-most-water-stressed-countries2040-
- World Travel & Tourism Council. (2015). Travel & Tourism: Economic Impact 2015 Tanzania.
- WWF. (2016). Living Planet Report 2016: Risk and Resilience in a New Era.
- http://time.com/4219575/air-pollution-deaths/
- http://www.oecd.org/env/air-pollution-to-cause-9-6-million-premature-deaths-and-cost-1-gdp-by2060-.htm
- https://thinkprogress.org/an-illustrated-guide-to-the-science-of-global-warming-impacts-how-we-know-inaction-is-the-gravest-f04743c28ab5
- Future Agenda: The World in 2025




# SECURITY AND DEFENCE


- Adams, T. (2012). The 'chemputer' that could print out any drug. Retrieved from www.theguardian.com: https://www.theguardian.com/science/2012/jul/21/chemputer-that-prints-out-drugs
- Asian Development Bank. (2015). Asia's Booming Cities Most At Risk from Climate Change. Retrieved from www.adb.org: https://www.adb.org/news/features/asias-booming-cities-most-risk-climate-change
- BCG. (2014). Beyond Budgets: The Real Solution to the Global Infrastructure Gap. Retrieved from www.bcgperspectives.com: https://www.bcgperspectives.com/content/articles/public_sector_transportation_travel_tourism_beyond_budgets/
- Billings, L. (2015). War in Space May Be Closer Than Ever. Retrieved from www.scientificamerican.com: https://www.scientificamerican.com/article/war-in-space-may-be-closer-than-ever/
- Bohannon, N. (2016). The Zika Virus – A Window Into Future Security Threats. Retrieved from www.americansecurityproject.org: http://www.americansecurityproject.org/zika-epidemics-future-security-threat/
- Burns, A., van der Mensbrugghe, D., & Timmer, H. (2008). Evaluating the Economic Consequences of Avian Influenza.
- Caves, J. P., & Carus, S. (2014). The Future of Weapons of Mass Destruction: Their Nature and Role in 2030. Center for the Study of Weapons of Mass Destruction, National Defence University.
- Cole, S. (2015). Space Tourism: Prospects, positioning and planning. Journal of Tourism Futures.
- Cordesman, A. H. (2016). Comparing Estimates of Key Trends in the Uncertain Metrics of Terrorism. Center for Strategic and International Studies.
- Dunigan, M. (2010). Considerations for the Use of Private Security Contractors in Future U.S. Military Deployments. RAND Corporation.
- Foley, M. (2013). Genetically Engineered Bioweapons: A New Breed of Weapons for Modern Warfare. Retrieved from www.dujs.dartmouth.edu: http://dujs.dartmouth.edu/03/2013/genetically-engineered-bioweapons-a-new-breed-of-weapons-for-modern-warfare/#.WFfw71XhCpr
- Fund for Peace. (2016). Fragile State Index 2016.
- Gilsinan, K. (2015). The Return of the Mercenary. Retrieved from www.theatlantic.com: http://www.theatlantic.com/international/archive/03/2015/return-of-the-mercenary/388616/
- Gold, J. (2016). Traditional security is dead - why cognitive-based security will matter. Retrieved from www.computerworld.com: http://www.computerworld.com/article/3068185/personal-technology/traditional-security-is-dead-why-cognitive-based-security-will-matter.html
- Institute for Economics and Peace. (2015). Global Terrorism Index 2015 - Measuring and understanding the impact of terrorism.
- Korolov, M. (2016). Flood of threat intelligence overwhelms many firms. Retrieved from www.csoonline.com: http://www.csoonline.com/article/3138003/security/flood-of-threat-intelligence-overwhelming-for-many-firms.html
- LaPorte, M. A. (2014). Balancing Act: The U.S. Military's Reliance on Contractors to Fulfill Operational-Level Logistical Requirements. Naval War College.
- Lentzos, F. (2014). Preventing a man-made pandemic. Retrieved from www.thebulletin.org: http://thebulletin.org/preventing-man-made-pandemic7856
- McNamee, D. (3 .(2014D printing may make individualized medicine more affordable. Retrieved from www.medicalnewstoday.com: http://www.medicalnewstoday.com/articles/284381.php
- Miller, D. T. (2015). Defense 2045 - Assessing the future security environment and implications for defence policymakers. CSIS International Security Program.
- MIT Technology Review. (2016). Cyber Survival.
- NASA. (2013). Space Debris and Human Spacecraft. Retrieved from www.nasa.gov: https://www.nasa.gov/mission_pages/station/news/orbital_debris.html
- OECD. (2016). States of Fragility 2016 - Understanding Violence.

# SECURITY AND DEFENCE


- Ponemon Research Institute. (2016). The Value of Threat Intelligence: A Study of North American & United Kingdom Companies.
- RAND Corporation. (2015). TACTICS: Policy and strategic impacts, implications and recommendations.
- Regalado, A. (2016). On Patrol with America's Top Bioterror Cop. Retrieved from www.technologyreview.com: https://www.technologyreview.com/s/602643/on-patrol-with-americas-top-bioterror-cop/?utm_campaign=internal&utm_medium=readnext&utm_source=item_1
- Sciutto, J. (2016). US military prepares for the next frontier: Space war. Retrieved from www.cnn.com: http://edition.cnn.com/28/11/2016/politics/space-war-us-military-preparations/
- Shakouri, B. (2013). Space settlement and future of space law. Retrieved from www.thespacereview.com: http://www.thespacereview.com/article/1/2269
- Stratfor. (2015). The Battle to Militarize Space has Begun. Retrieved from www.stratfor.com: https://www.stratfor.com/analysis/battle-militarize-space-has-begun
- Stratfor. (2016). The Real Danger from Space Weapons. Retrieved from www.stratfor.com: https://www.stratfor.com/analysis/real-danger-space-weapons
- Union of Concerned Scientists. (2014). Power Failure: How Climate Change Puts Our Electricity at Risk - and What We Can Do.
- University of Denver. (2016). Private Security Monitor Statistics Database. Retrieved from http://psm.du.edu/articles_reports_statistics/data_and_statistics.html
- US National Intelligence Council. (2012). Global Trends 2030 - Alternative Worlds.
- US National Intelligence Council. (2017). Background to "Assessing Russian Activities and Intentions in Recent US Elections": The Analytic Process and Cyber Incident Attribution.
- Vice. (2015). The Future of Terrorism According to Vice. Retrieved from www.vice.com: http://www.vice.com/read/the-future-of-terrorism114-
- Yale Global. (2013). WMD Proliferation Threatens the World. Retrieved from www.yaleglobal.yale.edu: http://yaleglobal.yale.edu/content/wmd-proliferation-threatens-world
- Zenko, M. (2015). The New Unknown Soldiers of Iraq and Afghanistan. Retrieved from www.foreignpolicy.com: http://foreignpolicy.com/29/05/2015/the-new-unknown-soldiers-of-afghanistan-and-iraq/
- Zetter, K. (2016). Inside the Cunning, Unprecedented Hack of Ukraine's Power Grid. Retrieved from www.wired.com: https://www.wired.com/03/2016/inside-cunning-unprecedented-hack-ukraines-power-grid/
- Zurich Insurance Group & Atlantic Council. (2015). Risk Nexus: Overcome by Cyber Risk? Economic Benefits and Costs of Alternate Cyber Futures.
- McKinsey and Co: Bridging global infrastructure gaps
- EM-DAT: Rise in Natural Disasters




# DEMOGRAPHICS


- Alzherimer's Association. (2013). Fiscal Year 2014 Appropriations for Alzheimer's-related Activities.
- Asian Development Bank. (2015). Asian Development Outlook 2015: Financing Asia's Future growth.
- Asian Development Bank. (2016). Asian Development Outlook 2016: Asia's Potential Growth.
- CIFS. (2013). Members' Report - Emerging Trends.
- CIFS. (2014). Members' Report - 21st Century Lifestyles.
- European Commission. (2012). The 2012 Ageing Report - Economic and budgetary projections for the 27 EU Member States (-2010 2060).
- European Commission. (2014). Population ageing in Europe – Facts, implications and policies. Directorate-General for Research and Innovation.
- EY. (2013). Hitting the sweet spot – The growth of the middle class in emerging markets.
- EY. (2013). Women: The next emerging market.
- Harvard Business Review. (2009). The Female Economy. Retrieved from www.hbr.org: https://hbr.org/09/2009/the-female-economy
- International Energy Agency. (2015). World Energy Outlook 2015.
- International Energy Agency. (2016). Global EV Outlook 2016: Beyond one million electric cars. Electric Vehicle Initiative.
- McKinsey&Company. (2013). Mapping China's middle class. Retrieved from www.mckinsey.com: http://www.mckinsey.com/industries/retail/our-insights/mapping-chinas-middle-class
- McKinsey&Company. (2015). The Power of Parity: How advancing women's equality can add 12$ trillion to global growth.
- OECD. (2010). The Emerging Middle Class in Developing Countries. OECD Development Center, Working Paper No. 285.
- OECD. (2011). Doing Better for Families.
- OECD. (2011). The Future of Families to 2030. International Futures Programme.
- Pew Research Center. (2012). A gender reversal on career aspirations.
- Pew Research Center. (2015). A Global Middle Class Is More Promise than Reality.
- Pew Research Center. (2015). The Future of World Religions: Population Growth Projections, 2050-2010.
- Prudential. (2014). Financial Experience & Behaviors Among Women.
- Science Nordic. (2015). Gender equality gives men better lives. Retrieved from www.sciencenordic.com: http://sciencenordic.com/gender-equality-gives-men-better-lives
- UK Government Office for Science. (2016). Future of an Ageing Population.
- UN. (2015). World Population Aging. Department of Economic and Social Affairs.

# DEMOGRAPHICS


- UN Department of Economic and Social Affairs. (2015). Population Pyramids of the World from 1950 to 2100. Retrieved from www.populationpyramid.net.
- World Bank. (2013). Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience.
- World Economic Forum. (2015). How religious will the world be in 2050? Retrieved from www.weforum.org: https://www.weforum.org/agenda/10/2015/how-religious-will-the-world-be-in2050-/
- World Economic Forum. (8 .(2016 things women should know about the future of work. Retrieved from www.weforum.org: https://www.weforum.org/agenda/01/2016/what-should-women-expect-from-the-fourth-industrial-revolution
- World Economic Forum. (2016). The Global Gender Gap Report 2016.
- National Intelligence Council: Global Trends – Paradox of Progress
- UN World Urbanization Prospects
- UK Ministry of Defence – Global Strategic Trends: Out to 2045
- Citi GPS: Future Opportunities, Future Shocks
- Oxford Martin School: Now for the Long Term




# INFRASTRUCTURE


- Accenture. (2014). Circular Advantage: Innovative Business Models and technologies to Create Value without Limits to Growth.
- C40 Cities. (2014). Barcelona's Smart City Strategy. Retrieved from www.c40.org: http://www.c40.org/case_studies/barcelona-s-smart-city-strategy
- Cisco. (2010). Smart+Connected Communities: Changing a City, a Country, the World.
- Ellen MacArthur Foundation. (2017). The New Plastics Economy.
- Eurasian Research Institute. (2016). China's the Belt and Road Risk Assessment Issue. Retrieved from www.eurasian-research.org: http://eurasian-research.org/en/research/comments/international-relations/china%E99%80%2s-belt-and-road-risk-assessment-issue
- Forrester. (2016). Predictions 2017: Security And Skills Will Temper Growth Of IoT.
- Gartner. (2015). Gartner Says Smart Cities Will Use 1.6 Billion Connected Things in 2016. Retrieved from www.gartner.com: http://www.gartner.com/newsroom/id/3175418
- IEEE Spectrum. (2016). Wanted: Smart Public Policy for the Internet of Things Security. Retrieved from www.spectrum.ieee.org: http://spectrum.ieee.org/tech-talk/telecom/security/wanted-smart-public-policy-for-internet-of-things-security
- Litman, T. (2016). Autonomous Vehicle Implementation Predictions: Implications for Transport Planning. Victoria Transport Policy Institute.
- McKinsey&Company. (2014). Remaking the Industrial Economy. Retrieved from www.mckinsey.com: http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/remaking-the-industrial-economy
- McKinsey&Company. (2016). Automotive Revolution – perspectives towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry.
- McKinsey&Company. (2016). China's One Belt, One Road: Will it reshape global trade? Retrieved from www.mckinsey.com: http://www.mckinsey.com/global-themes/china/chinas-one-belt-one-road-will-it-reshape-global-trade
- The Arctic Institute. (2012). The Future of Arctic Shipping. Retrieved from www.thearcticinstitute.org: http://www.thearcticinstitute.org/the-future-of-arctic-shipping/
- Uber. (2016). Fast-Forwarding to a Future of On-Demand Urban Air Transportation.
- UNEP. (2015). Global Waste Management Outlook.
- UNEP. (2016). UNEP 2015 Annual Report.
- Wall Street Daily. (2016). China's New Silk Road: Railway to Europe. Retrieved from www.wallstreetdaily.com: http://www.wallstreetdaily.com/21/04/2016/china-europe-silk-road-railway/
- World Economic Forum. (2016). Sweden is paying people to fix their belongings instead of throwing them away. Retrieved from www.weforum.org: https://www.weforum.org/agenda/10/2016/sweden-is-tackling-its-throwaway-culture-with-tax-breaks-on-repairs-will-it-work/
- Future Agenda: The World in 2025
- Citi GPS: Future Opportunities, Future Shocks
- Oxford Martin School: Now for the Long Term
- UOB: Foreign Direct Investment to Provide Boost to ASEAN Economies
- UOB: The Asian Miracle
- KPMG/forbes 2014 global manufacturing outlook
- Accenture 2014 global operations mega trends study

# KNOWLEDGE, SKILLS AND JOBS


- Accenture. (2016). Why Artificial Intelligence is the Future of Growth.
- Cheremukhin, A. A. (2014). Middle-Skill Jobs Lost in U.S. Labor Market Polarization. Federal Reserve Bank of Dallas.
- CIFS. (2016). Members' Report - Automation.
- CIFS. (2016). Members' Report - Individual Resilience.
- Class Central. (2015). Less Experimentation, More Iteration: A Review of MOOC Stats and Trends in 2015. Retrieved from www.class-central.com: https://www.class-central.com/report/moocs-stats-and-trends2015-/
- Deloitte. (2015). The Robots Are Coming.
- Deloitte University Press. (2016). Global Human Capital Trends 2016 - The new organization: Different by design.
- Elm Magazine. (2015). From social to engaging? – Learning groups and gamification. Retrieved from www.elmmagazine.eu: http://www.elmmagazine.eu/articles/from-social-to-engaging-learning-groups-and-gamification
- Forbes. (2013). New Problems, New Approaches: The Rise of The Generalist. Retrieved from www.forbes.com: http://www.forbes.com/sites/sap/28/12/2013/new-problems-new-approaches-the-rise-of-the-generalist/6#f97b6dd1abb
- Forbes. (2016). Gartner's Top 10 Strategic Predictions For 2017 And Beyond. Retrieved from www.forbes.com: http://www.forbes.com/sites/gartnergroup/15/11/2016/gartners-top-10-strategic-predictions-for-2017-and-beyond/3#ede3aa830d0
- Forbes. (2016). What Will Happen When AI Starts Replacing White-collar Jobs? Retrieved from www.forbes.com: http://www.forbes.com/sites/larryalton/25/05/2016/what-will-happen-when-ai-starts-replacing-white-collar-jobs/41#eff31b3663
- Fortune. (2016). Why Tech is Winning the War for Talent. Retrieved from www.fortune.com: http://new.fortune.com/26/01/2016/tech-is-winning-the-war-for-talent/
- Harvard Business Review. (2016). Generalists Get Better Job Offers Than Specialists. Retrieved from www.hbr.org: https://hbr.org/06/2016/generalists-get-better-job-offers-than-specialists
- Harvard Business Review. (2016). What millennials want from a new job. Retrieved from www.hbr.org: https://hbr.org/05/2016/what-millennials-want-from-a-new-job
- International Labour Organisation. (2015). World Employment Social Outlook.
- KPCB. (2016). Internet Trends Report 2016.
- Laal, M., & Salamati, P. (2012). Lifelong learning: Why do we need it? Procedia - Social and Behavioral Sciences.
- McKinsey&Company. (2016). Where machines could replace humans – and where they can't (yet). Retrieved from www.mckinsey.com: http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet
- McKinsey&Company. (2017). A Future That Works: Automation, Employment, and Productivity.
- New Media Consortium. (2016). Horizon Report – Higher Education.
- New Media Consortium. (2016). Horizon Report – K12- Education.
- OECD. (2015). In it together: Why less inequality benefits all.
- Oxford Analytica. (2016). Gamification and the future of education.




# KNOWLEDGE, SKILLS AND JOBS


- Oxford Economics. (2012). Global Talent 2021 – How the new geography of talent will transform human resource strategies.
- Pariser, E. (2011). TED Talk - Beware online filter bubbles. Retrieved from https://www.ted.com/talks/eli_pariser_beware_online_filter_bubbles?language=da
-
- Pew Research Center. (2012). The future of gamification. Retrieved from www.pewinternet.org: http://www.pewinternet.org/18/05/2012/the-future-of-gamification/
- PWC. (2012). Talent mobility - 2020 and beyond.
- Quartz. (2015). The search engines of the future will be able to see and hear like humans. Retrieved from www.qz.com: http://qz.com/329739/the-search-engines-of-the-future-will-be-able-to-see-and-hear-like-humans/
- UNESCO. (2016). Education 2030: Incheon Declaration and Framework for Action.
- UNESCO. (2016). Global Education Monitoring Report - Education for people and planet: Creating sustainable futures for all.
- Wesch, M. (2010). TED Talk - From Knowledgeable to Knowledge-able. Retrieved from http://tedxtalks.ted.com/video/TEDxKC-Michael-Wesch-From-Knowl
- World Bank. (2016). World Development Report 2016 - Digital Dividends.
- World Economic Forum. (2016). Generalists or specialists: who do employers value more? Retrieved from www.weforum.org: https://www.weforum.org/agenda/06/2016/generalists-or-specialists-who-gets-hired/
- World Economic Forum. (2016). The Future of Jobs - Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution.
- World Economic Forum. (2016). What are the 21st century skills every student needs? Retrieved from www.weforum.org: https://www.weforum.org/agenda/21/03/2016st-century-skills-future-jobs-students/
- Oxford Economics: Global Talent 2021

# CITIZEN

- American Society of Plastic Surgeons. (2015 .(2016 Plastic Surgery Statistics Report.
- Bain & Company. (2015). Luxury Goods Worldwide Market Study.
- Basu, S., Andrews, J., Kishore, S., Panjabi, R., & Stuckler, D. (2012). Comparative Performance of Private and Public Healthcare Systems in Low- and Middle-Income Countries: A Systematic Review. PLoS Medicine.
- Centers for Disease Control and Prevention. (2016). Outbreaks Chronology: Ebola Virus Disease. Retrived from www.cdc.gov: https://www.cdc.gov/vhf/ebola/outbreaks/history/chronology.html
- CIFS. (2008). Members' Report - The Future of Happiness.
- CIFS. (2013). Members' Report - Emerging Trends.
- CNET. (2015). How 5G will push a supercharged network to your phone, home, car. Retrived from www.cnet.com: https://www.cnet.com/news/how5-g-will-push-a-supercharged-network-to-your-phone-home-and-car/
- European Environmental Agency. (2015). The shift in global disease burden, and share of non-communicable diseases by world regions. Retrived from www.eea.europa.eu: http://www.eea.europa.eu/data-and-maps/figures/the-shift-in-global-disease
- Finkelstein, E., Khavjou, O., Thompson, H., Trogdon, J., Pan, L., Sherry, B., & Dietz, W. (2012). Obesity and Severe Obesity Through 2030.
- Fortune. (2015). Facebook 'filter bubble' study raises more questions than it answers. Retrived from www.fortune.com: http://fortune.com/07/05/2015/facebook-filter-bubble-doubts/
- Fortune. (2016). Rise of the surgical robot and what doctors want. Retrived from www.fortune.com: http://fortune.com/28/07/2016/surgical-robot-development-intuitive-surgical-medtronic-google/
- Huffington Post. (2016). How Social Media Has Changed The Way That We Engage Consumers. Retrived from www.huffingtonpost.com: http://www.huffingtonpost.com/anna-johansson/how-social-media-has-changed-the-way-that-we-engage-consumers_b_9874242.html
- IMS Institute for Healthcare Informatics. (2015). Patient Adoption of mHealth: Use, Evidence and Remaining Barriers to Mainstream Acceptance.
- Ipsos Public Affairs. (2016). Ipsos/BuzzFeed Pool – Fake News.
- McKinsey&Company. (2013). The big-data revolution in US health care: Accelerating value and innovation.
- McKinsey&Company. (2015). Get wired for the ultimate luxury experience.
- National Human Genome Research Institute. (2015). A Brief Guide to Genomics. Retrived from www.genome.gov: https://www.genome.gov/18016863/a-brief-guide-to-genomics/
- Nature Review Genetics. (2010). Annotating non-coding regions of the genome. Retrived from www.nature.com: http://www.nature.com/nrg/journal/v11/n8/full/nrg2814.html
- OECD. (2016). Health at a Glance: Europe 2016.
- Pew Research Center. (2013). Public's Policy Priorities: 2013-1994.
- PR Daily. (2016). How much data is shared online every minute? Retrived from www.prdaily.com: http://www.prdaily.com/Main/Articles/How_much_data_is_shared_online_every_minute_21121.aspx
- Project Syndicate. (2016). The Geopolitics of Populism. Retrived from www.project-syndicate.org: https://www.project-syndicate.org/commentary/populism-driven-by-geopolitical-change-by-danny-quah-and-kishore-mahbubani12-2016-
- SCENARIO Magazine. (2016). Language and Communication in the 21st Century. Retrived from www.scenariomagazine.com: http://www.scenariomagazine.com/language-and-communication-in-the21-st-century/



# CITIZEN

- Statista. (2016). Number of global social network users 2010 to 2020. Retrived from www.statista.com: https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/
- Statista. (2016). The rise of nationalism across Europe. Retrived from www.statista.com: https://www.statista.com/chart/4901/the-rise-of-nationalism-across-europe/
- Techcrunch. (2016). How The Growth Of Mixed Reality Will Change Communication, Collaboration And The Future Of The Workplace. Retrived from www.techcrunch.com: https://techcrunch.com/30/01/2016/how-the-growth-of-mixed-reality-will-change-communication-collaboration-and-the-future-of-the-workplace/
- The Globalist. (2016). Managing the Forces of European Populism. Retrived from www.theglobalist.com: http://www.theglobalist.com/managing-the-forces-of-european-populism/
- The Guardian. (2011). The Quarterlife Crisis: Young, Insecure and Depressed. Retrived from www.theguardian.com: https://www.theguardian.com/society/2011/may/05/quarterlife-crisis-young-insecure-depressed
- The Guardian. (2016). Could a diet tailored to your DNA save your life. Retrived from www.theguardian.com: https://www.theguardian.com/lifeandstyle/2016/feb/29/die-now-diet-later-could-nutrigenetics-save-your-life
- The Lancet. (2016). National spending on health by source for 184 countries between 2013 and 2040.
- The Lancet. (2016). Trends in adult body-mass index in 200 countries from 1975 to 2014.
- UN. (2015). World Population Prospects – 2015 Revision.
- WIRED. (2016). Robot doctors will 'absolutely' replace surgeons. Retrived from www.wired.co.uk: http://www.wired.co.uk/article/shafi-ahmed-medical-realities-vr-surgery
- World Economic Forum. (2015). Five global health trends you just can't ignore. Retrived from www.weforum.org: https://www.weforum.org/agenda/04/2015/five-global-health-trends-you-just-cant-ignore/
- World Economic Forum. (2016). The dark web: What is it and how it works. Retrived from www.weforum.org: https://www.weforum.org/agenda/10/2016/the-dark-web-what-it-is-and-how-it-works
- World Economic Forum. (2016). Top 8 emerging diseases likely to cause major epidemics. Retrived from www.weforum.org: https://www.weforum.org/agenda/04/2016/top-8-emerging-diseases-likely-to-cause-major-epidemics/
- World Health Organization. (2012). The evolving threat of antimicrobial resistance: Options for action.
- World Health Organization. (2013). Global Action Plan for the Prevention and Control of Noncumminicable Diseases.
- World Health Organization. (2015). Noncommunicable diseases. Retrived from www.who.int: http://www.who.int/mediacentre/factsheets/fs355/en/
- World Health Organization. (2016). Latest Ebola outbreak over in Liberia; West Africa is at zero, but new flare-ups are likely to occur. Retrived from www.who.int: http://www.who.int/mediacentre/news/releases/2016/ebola-zero-liberia/en/
- We Are Social: Global Digital Landscape
- Ericsson Network Traffic Measurements 2015
- Future Agenda: The World in 2025

# GOVERNMENT


- Accenture. (2012). Delivering Public Service for the Future: Navigating the Shifts.
- Alzherimer's Association. (2013). Fiscal Year 2014 Appropriations for Alzheimer's-related Activities.
- BCG. (2014). Beyond Budgets: The Real Solution to the Global Infrastructure Gap. Retrived from www.bcgperspectives.com: https://www.bcgperspectives.com/content/articles/public_sector_transportation_travel_tourism_beyond_budgets/
- Brookings. (2015). Global Metro Monitor 2014: An Uncertain Recovery.
- CIFS. (2014). Members' Report - 21st Century Lifestyles.
- CIFS and ISS. (2014). ISS 2020 Vision: Future of Public Sector Outsourcing.
- CIFS and ISS. (2016). ISS 2020 Vision: Future of Service Management.
- Cisco. (2013). Internet of Everything: A 4.6$ Trillion Public-Sector Opportunity.
- Deloitte. (2009). The Public Innovator's Playbook: Nurturing Bold Ideas in Government.
- Edelman. (2016 .(2016 Edelman Trust Barometer.
- Fuerth, L. S. (2012). Anticipatory Governance: Practical Upgrades. Project on Forward Engagement.
- Fyfe, T., & Crookall, P. (2010). Social Media and Public Sector Policy Dilemmas. Institute of Public Administration of Canada.
- Guston, D. H. (2014). Understanding 'anticipatory governance'. Social Studies of Science.
- ISS. (2015). Linking Customer Experience with Service Employee Engagement.
- McKinsey&Company. (2014). Putting Citizens First: How to improve citizens' experience and satisfaction with government services. McKinsey Center for Government.
- McKinsey&Company. (2015). Implementing a citizen-centric approach to delivering government services. Retrived from www.mckinsey.com: http://www.mckinsey.com/industries/public-sector/our-insights/implementing-a-citizen-centric-approach-to-delivering-government-services
- OECD Database. (2016). GDP Long-term forecast. Retrived from https://data.oecd.org/gdp/gdp-long-term-forecast.htm
- Perry, M. J. (2016). Understanding America's ridiculously large 18$T economy by comparing the GDP of US metro areas to entire countries. Retrived from www.aei.org: https://www.aei.org/publication/understanding-americas-ridiculously-large18-t-economy-by-comparing-the-gdp-of-us-metro-areas-to-entire-countries/
- Pew Research Center. (2015). Beyond Distrust: How Americans View Their Government.
- Pigeon, M., McDonald, D. A., Hoedeman, O., & Kishimoto, S. (2013). Remunicipalisation: Putting Water Back into Public Hands. Transnational Institute.
- Pollitt, C. (2014). Future Trends in European Public Administration and Management: An Outside-in Perspective. Coordinating for Cohesion in the Public Sector of the Future.
- PWC. (2013). Future of Government.
- PWC. (2015). Participative Governance: Serving the right dish to the citizen. Retrived from www.pwc.com: http://pwc.blogs.com/psm_globally/01/2015/participative-governance-serving-the-right-dish-to-the-citizen.html




# GOVERNMENT


- Stockholm International Peace Reserach Institute. (2016). SIPRI Military Expenditure Database. Retrived from https://www.sipri.org/databases/milex
- The Chicago Council on Global Affairs. (100 .(2016 Top Economies: Urban Influence and the Position of Cities in an Evolving World Order.
- UN. (2015). World Population Prospects – 2015 Revision.
- UN Department of Economic and Social Affairs. (2015). Population Pyramids of the World from 1950 to 2100. Retrived from www.populationpyramid.net.
- US Association of Mayors. (2013). US Metro Economics: Outlook - Gross Metropolitan Product, with Metro Employment Projections.
- US National Intelligence Council: Global Trends – Paradox of Progress
- Wheatley, J. (2013). EM Youth Bulge: A Demographic Dividend or Time Bomb? Retrived from www.ft.com: http://on.ft.com/2hD0v3z
- Smart Nation Singapore
- Quality of Nationality Index: Henley and Partners
- UN Human Development Report
- Deloitte University Press: Gov2020
- McKinsey Global Institute: Where Machines Could Replace Humans
- Deloitte University Press: AI-augmented Government

# ADVANCED TECHNOLOGIES AND SCIENCES


- Ahn, S. J., Bailenson, J. N., & Park, D. (2014). Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior. Computers in Human Behavior.
- Ars Technica. (2016). NASA signals commitment to private space with 14$ billion investment. Retrieved from www.arstechnica.com: http://arstechnica.com/science/01/2016/nasa-signals-commitment-to-private-space-with-14-billion-investment/
- Business Insider. (2015). Google has gotten incredibly good at predicting traffic - here's how. Retrieved from www.businessinsider.com: http://www.businessinsider.com/how-google-maps-knows-about-traffic11-2015-?r=US&IR=T&IR=T
- CIFS. (2016). Members' Report - Automation.
- Deloitte. (2014). Healthcare and Life Sciences Predictions 2020: A bold future? Deloitte Centre for Health Solutions.
- EurekAlert. (2016). Nanoscale rotor and gripper push DNA origami to new limits. Retrieved from www.eurekalert.org: https://www.eurekalert.org/pub_releases/03-2016/tuom-nra030416.php
- European Commission. (2016). The Internet of Things. Retrieved from www.ec.europa.eu: https://ec.europa.eu/digital-single-market/en/internet-things
- Global Futurist. (2016). Scientists use brain controlled DNA nanobots to release drugs inside roaches. Retrieved from www.globalfuturist.org: http://www.globalfuturist.org/10/2016/brain-controlled-dna-nanobots-deliver-medicine-that-makes-cockroaches-glow/
- Harvard Business Review. (2016). The Impact of the Blockchain Goes Beyond Financial Services. Retrieved from www.hbr.org: https://hbr.org/05/2016/the-impact-of-the-blockchain-goes-beyond-financial-services
- IBM. (2016). What is Big Data? Retrieved from www.ibm.com: http://www.ibm.com/big-data/us/en/
- International Federation of Robotics. (2016). IFR World Robotic Report 2016.
- International Service for the Acquisition of Agri-biotech Applications. (2006). Omics Sciences: Genomics, Proteomics, and Metabolomics. Retrieved from www.isaaa.org: http://www.isaaa.org/resources/publications/pocketk/15/default.asp
- Kurzweil, R. (2005). The Singularity is Near. Penguin Group.
- McKinsey&Company. (2014). The Internet of Things: Sizing up the opportunity. Retrieved from www.mckinsey.com: http://www.mckinsey.com/industries/high-tech/our-insights/the-internet-of-things-sizing-up-the-opportunity
- McKinsey&Company. (2015). An executive's guide to the Internet of Things. Retrieved from www.mckinsey.com: http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/an-executives-guide-to-the-internet-of-things
- McKinsey&Company. (2016). Where machines could replace humans – and where they can't (yet). Retrieved from www.mckinsey.com: http://www.mckinsey.com/business-
- functions/digital-mckinsey/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet
- MIT Technology Review. (2016). The Future of Artificial Intelligence and Cybernetics. Retrieved from www.technologyreview.com: https://www.technologyreview.com/s/602830/the-future-of-artificial-intelligence-and-cybernetics/
- Müller, V. C., & Bostrom, N. (2014). Future Progress in Artificial Intelligence: A Survey of Expert Opinion.
- Northeastern University. (2016). How Much Data is Produced Every Day? Retrieved from www.northeastern.edu: http://www.northeastern.edu/levelblog/13/05/2016/how-much-data-produced-every-day/
- Pew Research Center. (2016). Many Americans are skeptical about scientific research on climate and GM foods. Retrieved from www.pewresearch.org: http://www.pewresearch.org/fact-tank/05/12/2016/many-americans-are-skeptical-about-scientific-research-on-climate-and-gm-foods/
- Phys.org. (2015). Finally, interesting uses for the blockchain that go beyond bitcoin. Retrieved from www.phys.org: http://phys.org/news/-12-2015blockchain-bitcoin.html




# ADVANCED TECHNOLOGIES AND SCIENCES


- Rethink Robotics. (2015). Worldwide annual supply of industrial robots by International Federation of Robotocs via Market Realist. Retrieved from www.rethinkrobotics.com: http://www.rethinkrobotics.com/blog/robot-recap-collaborative-robots-automation-and-a-splash-of-william-shakespeare/market-realist-chart-worldwide-annual-supply-of-industrial-robots/
- Reuters. (2016). Banks adopting blockchain 'dramatically faster' than expected: IBM. Retrieved from www.reuters.com: http://www.reuters.com/article/us-tech-blockchain-ibm-idUSKCN11Y28D
- RT. (2016). Internet of Things believed to be targeted in massive DDoS attacks. Retrieved from www.rt.com: https://www.rt.com/viral/-363778internet-things-ddos-attack/
- SAS. (2016). Big Data: What it is and why it matters. Retrieved from www.sas.com: http://www.sas.com/en_us/insights/big-data/what-is-big-data.html
- Satellite Industry Association. (2016). State of the satellite industry report.
- Sciencemag. (2016). Can 'predictive policing' prevent crime before it happens? Retrieved from www.sciencemag.org: http://www.sciencemag.org/news/09/2016/can-predictive-policing-prevent-crime-it-happens
- Scientific American. (2016). IoT Growing Faster Than the Ability to Defend It. Retrieved from www.scientificamerican.com: https://www.scientificamerican.com/article/iot-growing-faster-than-the-ability-to-defend-it/
- Syngenta. (2016). Our Industry 2016.
- Techcrunch. (2015). Augmented And Virtual Reality To Hit 150$ Billion, Disrupting Mobile By 2020. Retrieved from www.techcrunch.com: https://techcrunch.com/06/04/2015/augmented-and-virtual-reality-to-hit-150-billion-by2020-/
- TechEmergence. (2016). Valuing the Artificial Intelligence Market, Graphs and Predictions for 2016 and Beyond. Retrieved from www.techemergence.com: http://techemergence.com/valuing-the-artificial-intelligence-market-2016-and-beyond/
- TechRepublic. (2016). Infographic: VR and AR are gaining traction for use in the enterprise. Retrieved from www.techrepublic.com: http://www.techrepublic.com/article/infographic-vr-and-ar-are-gaining-traction-for-use-in-the-enterprise/
- The Economist. (2015). The great chain of being sure about things. Retrieved from www.economist.com: http://www.economist.com/news/briefing/-21677228technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable
- The Guardian. (2016). Nanotechnology: striking a balance between glorification and 'grey goo'. Retrieved from www.theguardian.com: https://www.theguardian.com/science/small-world/2013/apr/23/nanotechnology-striking-balance-grey-goo
- The Guardian. (2017). Vanishing point: the rise of the invisible computer. Retrieved from www.theguardian.com: https://www.theguardian.com/technology/2017/jan/26/vanishing-point-rise-invisible-computer
- The National Nanotechnology Initiative. (2015). Supplement to the President's 2016 Budget. National Science and Technology Council.
- Tow Center for Digital Journalism. (2016). Guide to Automated Journalism. Retrieved from www.towcenter.org: http://towcenter.org/research/guide-to-automated-journalism/
- Tractica. (2016). Artificial Intelligence for Enterprise Applications.
- Turck, M. (2016). Is Big Data Still a Thing? (The 2016 Big Data Landscape). Retrieved from www.mattturck.com: http://mattturck.com/01/02/2016/big-data-landscape/
- US department of Health & Human Services. (2017). All of Us Research program. Retrieved from www.nih.gov: https://www.nih.gov/research-training/allofus-research-program
- US National Academies of Sciences. (2016). Genetically Engineered Crops: Experiences and Prospects.
- Wall Street Journal. (2017). India Breaks Record for Launching Most Satellites From Single Rocket. Retrieved from www.wsj.com: http://blogs.wsj.com/indiarealtime/15/02/2017/india-breaks-record-for-launching-most-satellites-from-single-rocket/
- Washington Post. (2016). The inside story of how billionaires are racing to take you to outer space. Retrieved from www.washingtonpost.com: https://www.washingtonpost.com/business/economy/the-billionaire-space-barons-and-the-next-giant-leap/795/19/08/2016a11-6307-4012e8-6b-27bb8ba39497a2_story.html?utm_term=.ac412257fb9c
- World Health Organization. (2015). Food safety. Retrieved from www.who.int: http://www.who.int/mediacentre/factsheets/fs399/en/

# ADVANCED TECHNOLOGIES AND SCIENCES


- https://fas.org/sgp/crs/misc/R44101.pdf
- http://www.futureagenda.org/news/the-world-in2025-
- http://www.economist.com/news/international/-21702176drug-trade-moving-street-online-cryptomarkets-forced-compete
- http://www.csc.com/innovation/insights/3-92142d_printing_and_the_future_of_manufacturing
- https://www.forbes.com/sites/louiscolumbus/-2015/31/03/2015roundup-of3-d-printing-market-forecasts-and-estimates/4753#a361b30f
- https://www.eef.org.uk/campaigning/campaigns-and-issues/current-campaigns/industry-four/4th-industrial-revolution-facts-and-figures
- http://www3.weforum.org/docs/GAC16_The_Future_of_Manufacturing_report.pdf
- https://www.theguardian.com/technology/2016/sep/08/artificial-intelligence-beauty-contest-doesnt-like-black-people
- https://www.weforum.org/agenda/01/2016/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
- http://www.livescience.com/-5729robots-ethical-decisions.html
- https://3dprint.com/46934/amazon3-d-printing-patent/
- http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf
- http://www.iotone.com/guide/why-blockchain-amp-iot-is-the-future/g439
- http://www.meti.go.jp/english/press/01_0531/2016.html
- www.lunar.xprice.com
- www.nasa.gov
- www.spacex.com
- www.ibm.com/watson
- Nanoglobal: Future Uses of Nanotechnology
- Euro Consult: Satellite Manufacturing and Launch
- UK Ministry of Defence – Global Strategic Trends: Out to 2045
- Citi GPS: Future Opportunities, Future Shocks
- Oxford Martin School: Now for the Long Term