

California Energy Commission

DOCKETED

14-IEP-1B

TN 72527

AUG 04 2014



A BROADER VIEW

A SAFE AND SUSTAINABLE FUTURE: ENABLING THE TRANSITION

ACKNOWLEDGEMENTS

Programme director

Sven Molleklev

Lead authors

Cecilie A. Hultmann
Anne Louise Koefoed

Project team

Jonathan Sykes
Bettina Reinboth
Dave Knight

Sector Working Groups

Shipping

Tore Longva (lead)
Magnus Strandmyr Eide
Per Holmvang
Kjersti Aalbu

Electricity

Christian Hewicker (lead)
Holger Ziegler
Tim Mennel

Oil & Gas

Etienne Romsom (lead)
Lars Petter Blikom

Healthcare

Stephen Leyshon (lead)
Eva Turk
Morten Pytte
Stephen McAdam

Food & Beverages

Stefano Crea (lead)
Louise Ayling
Tracy Oates
Juan Andres Salido
Tonje Folkestad

Lead authors - DNV GL enabling the transition

Mette Vågnes Eriksen
Henning Kristoffersen

Project support

Morten Jastrup (*Sustainia*)
Corey Glick (*Xyntéo*)
Åsgeir Helland (*Xyntéo*)

Writing and editing support

Elliot Frankal
ESG Communications

We would like to thank the following people for taking the time to review and comment on draft versions of this report:

Kevin Noone

Director of the Swedish Secretariat for Environmental Earth System Sciences

L. Hunter Lovins

President and Founder Natural Capitalism Solutions

Robert Engelman

Former President of the Worldwatch Institute

Tørris Jæger

International Director at the Norwegian Red Cross and his team in the international department

Svein-Erik Figved

*Nina Jensen
WWF Norway*

DNV GL and the authors take full and sole responsibility for the topicality, accuracy, completeness and quality of the information provided in this report.

April 2014

A BROADER VIEW

A SAFE AND SUSTAINABLE FUTURE: ENABLING THE TRANSITION

CONTENTS



GENERAL: INTRODUCTION



04

Foreword.....	06
Taking a broader view	08
Executive summary.....	10
Introduction.....	14

3

BARRIERS PREVENTING THE TRANSITION TO A SUSTAINABLE FUTURE



48

Introduction.....	48
Barrier overview: 36 barriers identified	50
Cognitive and behavioural barriers.....	52
Policy and governance barriers.....	54
Economic and market barriers.....	56
Technology and innovation barriers.....	60
Societal barriers.....	62

1

BUSINESS AS USUAL OUTLOOK: WHERE ARE WE HEADED?



18

Introduction.....	18
Planetary boundaries.....	20
Trends.....	22
Implications.....	30
The world in 2050: A planet under pressure	36

4

CHANGING COURSE: PATHWAYS TO A SUSTAINABLE FUTURE



64

Introduction.....	66
Overview: 3 pathways identified	68
A green and inclusive economy: Reorienting the economy and the functioning of markets	70
Good governance and decision-making: Governing for a sustainable future	80
Stable and prosperous societies: Ensuring resilience, equity and well-being....	88

2

OUR VISION FOR A SAFE AND SUSTAINABLE FUTURE



38

Introduction.....	38
An environment in balance.....	42
A stable and prosperous society.....	44
A green, inclusive and regenerative economy	46

5

SPOTLIGHTS ON SUSTAINABILITY IN KEY SECTORS



96

Safe and Sustainable shipping.....	100
Safe and Sustainable electricity.....	108
Safe and Sustainable oil & gas.....	116
Safe and Sustainable food & beverage	124
Safe and Sustainable healthcare.....	132
Conclusion.....	140
End-notes and comments.....	142
Reference list.....	144
Interview list.....	146



MANAGING RISK, BUILDING TRUST

DNV GL'S PAST, PRESENT AND FUTURE

One hundred and fifty years ago, the world was in the midst of a profound transition. New technologies such as steam power, electricity and the telegraph led to an explosion in productivity and connectivity, reshaping the global economy in just a few short decades. Yet these shifts also introduced new risks to life, property and the environment and transformed the relationship between technology, business and society.

It was this context into which Det Norske Veritas and Germanischer Lloyd were born. These companies, which have now merged into DNV GL, took on the role of verifying that vessels were seaworthy during a time when the convergence of new technology and business models caused an unacceptable number of ship accidents. By managing the increasingly complex risks associated with the rapidly evolving maritime sector, classification societies built trust among shipping stakeholders, contributing to the birth of a new era in international trade.

Today, as DNV GL celebrates our 150th anniversary and our first year as a united company, the world is at another inflection point. The technologies, systems and institutions that have driven the most prolonged period of growth in our civilisation's history are being tested by the new demands of the 21st century. And once again, our ability to manage risk and build trust will help us enable the changes the world needs.

In order to rise to this challenge, we have been exploring six themes of strategic relevance to our new organisation. Some of the themes, such as climate change adaptation, have taken us into newer territory; others, such as the future of shipping, have seen us re-evaluate more familiar ground. I believe that all of them, however, are absolutely central to our efforts to empower our customers and society to become safer, smarter and greener.

I hope that we can use the themes' findings, as well as the momentum of 2014, to engage a wide range of stakeholders in a forward-leaning discussion about how to achieve our vision - global impact for a safe and sustainable future.

I look forward to the journey ahead.

Henrik O. Madsen

Henrik O. Madsen
President and CEO, DNV GL Group



A BROADER VIEW

THEMES FOR THE FUTURE

As DNV GL turns 150, we are exploring six 'themes for the future' - areas where we can leverage our history and expertise to translate our vision into impact. We selected these themes as part of our efforts to take a broader view of the relationship between technology, business and society. On these pages you will find short introductions to each theme. To find out more, join us at: dnvgl.com/vision-to-impact

A SAFE AND SUSTAINABLE FUTURE



The future is not what it used to be. Rising global temperatures, diminishing natural resources and deepening inequality threaten everyone's prospects, including those yet to be born. Yet alongside these new global challenges are new innovations, solutions and opportunities that make a safe and sustainable future possible: a world where nine billion people can thrive while living within the environmental limits of the planet. In this theme, we set a vision towards this future. We analyse the barriers to change and detail the concrete actions that governments, business and civil society must take together if the obstacles are to be overcome and the opportunities for safer, smarter and greener growth are to be seized.

FROM TECHNOLOGY TO TRANSFORMATION



Technology has always been an enabler of societal change and we can expect that it will play a pivotal role in our transition to a safe and sustainable future. Indeed, existing technology is already unlocking safer, smarter, greener solutions for powering our economy, transporting our goods, caring for our sick and feeding our growing population. But history shows that transformative technologies - from the automobile to the internet - can take decades to reach scale. And time is one resource we do not have. How can we accelerate the deployment and commercialisation of sustainable technologies while ensuring that they are introduced safely into society? In this theme, we investigate this question, analysing the barriers to technological uptake and providing insights from past and present technologies.

THE FUTURE OF SHIPPING



Shipping is the lifeblood of our economy and the lowest-carbon mode of transport available to a world with ever-rising consumption. It therefore has a crucial part to play in a safe and sustainable future. But the industry faces a challenging climate: more intense public scrutiny of safety and security, tightening restrictions on environmental impacts and a revolution in digital technology. To meet these challenges, we have analysed six technology pathways that can help us achieve three ambitions for 2050: reduce the sector's fatality rates 90 per cent and reduce fleet-wide CO₂ emissions 60 per cent, all without increasing the costs of shipping.

ELECTRIFYING THE FUTURE



Electricity is already revolutionising the way we power our operations, fuel vehicles, and light and heat our buildings - and it will have an even bigger role to play in the decades to come. Many emerging technologies can provide cleaner, smarter, affordable and reliable energy. Floating offshore wind can provide emissions-free power at scale by 2050. And a suite of smart grid technologies will enable households and communities to participate in leaner, more local power systems. In this theme, we take a closer look at these technologies, and examine the contributions they can make to providing low-carbon power to future generations.

ARCTIC: THE NEXT RISK FRONTIER



The Arctic offers a preview of a new paradigm for business: harsher environments, higher public scrutiny and a greater need to engage with stakeholders. As industries enter the Arctic, understanding, communicating and managing risks will be essential both to earning social licence to operate and minimising the impacts of their activities. With such high stakes, the Arctic will be a defining frontier - not just of operations, but of safer, smarter, greener technologies and standards. The Arctic is rich with resources and dilemmas. And while there are no easy answers to these dilemmas, we must tackle questions about its development step by step, based on a common understanding of the risks. In this theme, we examine the complex Arctic risk picture and explore its implications for shipping, oil and gas, and oil spill response.

ADAPTATION TO A CHANGING CLIMATE



Climate change mitigation remains essential for our work to build a safe and sustainable future. But the greenhouse gases that have accumulated in the atmosphere over the past century and a half have already set changes in motion. Infrastructure and communities around the world urgently need to adapt to a climate characterised by more frequent and more severe storms, droughts and floods. And given the interdependence between business and society, business has a strong interest and critical role to play in these efforts. In this theme we have been developing tools to help both businesses and communities adapt to this new risk reality: a web-based platform for sharing information and best practices; a risk-based framework to help decision-makers prioritise their adaptation investments; and a new protocol to equip leaders to measure and manage community resilience to climate change.

EXECUTIVE SUMMARY

From rising levels of obesity in the OECD countries to chronic hunger in the developing world, from short-term thinking to long-term debts, from pollution to poverty - there are an abundance of issues that threaten human well-being.

Critical resources are nearing exhaustion, the earth is growing steadily less inhabitable, disparities are widening, social instability is on the rise and a growing population is adding to these pressures. The challenges facing humanity are serious and becoming progressively more complex and interlinked.

The tremendous achievements in human progress and prosperity experienced since the beginning of the 20th century have come at the expense of the planet. We are at a historic turning point where human activity is not only undermining our future prospects, but also the possibility that future generations can enjoy the same levels of well-being and prosperity that we experience today. This century may well be the one where we see a peak in some key aspects of human development, and possibly a reversal of its progress. Society is taking substantial risks by delaying urgent and large-scale action. Unless we act now and change course, we may be headed towards disaster.

Whereas industrialisation was the great project of the last 150 years, sustainability has become the greatest project of our time. The question is: will mankind step up, take responsibility and meet this challenge in time to avert major crises?

At the same time, the transition towards sustainability offers amazing opportunities. We are at a moment in time where we can create the society of tomorrow we would like to see and pass on to the next generations. If we put sustainability at the core of the change, building it into the DNA of our business enterprises and the economy, it creates a space for innovation that will create a better future for our children. We have this opportunity now. Let's take it!

THIS IS OUR VISION

DNV GL's vision is to have 'global impact for a safe and sustainable future'. To mark our 150 years' anniversary in 2014, DNV GL decided not to simply celebrate past achievements, but to look to the future and explore what needs to happen to achieve our vision. In this report, we describe where the world is headed if we continue on the same path as today, and clarify what we mean by our vision of a safe and sustainable future. We assess the main barriers preventing our vision from becoming a reality, and outline the broad changes needed to overcome these barriers. We also explore what this means for five industry sectors where we, as an organisation, have particular competence, and present what we will do ourselves to enable the transition.

OUR APPROACH

The topic of sustainability has generated tremendous amounts of research and writing. Our approach for this report has been to identify, review and synthesise the most recognised and credible sources of research and analysis produced by leading organisations and experts worldwide. We have also added to this knowledge base through 30 interviews with leading sustainability experts. As such, we do not lay claim to having produced our own scenarios or projections. Instead, we have taken a bottom up approach, and through systematic review tried to reveal the areas where there is consensus across the board; whether related to the root causes of today's challenges, projections for the future, barriers preventing progress or actions needed to generate change. Inevitably, we have made a selection and narrowed down the focus to what we believe to be important issues in need of urgent attention.



WHAT WE HAVE FOUND

In **CHAPTER ONE**, we look at the implications of **BUSINESS AS USUAL**. It maps current environmental, social and economic trends and analyses how they are likely to impact the world by 2050. As this chapter shows, the world is in serious trouble and the environmental, social and economic effects of a business as usual trajectory are unsustainable, uneconomic and dangerous. The Planetary Boundaries framework provides an unambiguous picture. Telling us which boundaries have been overstepped and where efforts need to be focused. If we do nothing to change course, we will arrive at a world in 2050 in which:

» **The environment is warmer, more intense and less diverse.** Mean temperatures will be 3-6° higher, sea levels 1-2 metres higher and intense weather events more frequent – with frequent flooding in some regions and extreme drought and heat waves in others. There will have been a massive loss of plant and animal biodiversity and our natural capital assets will have been severely eroded – 60 per cent of major ecosystems will have been extensively or irreversibly damaged and most ‘planetary boundaries’ crossed.

» **Society is crowded, unequal and unstable.** Society is feeling the pressure from a global population of nine billion and gradually deteriorating environmental conditions. Progress – particularly in the area of education and health – have lifted millions out of poverty. However, rising pollution levels, severe resource shortages (water in particular), wide economic disparities, the forced migration of millions and a lack of trust in governance institutions threaten to lead to instability, insecurity and deepened suffering at a global scale.

» **The economy is struggling and creating deepening disparities.** Our consumer-led, resource-intensive and linear economy has exceeded the total carrying capacity of the planet, and growth is stagnating. Severe natural resource shortages threaten supply and lead to higher production costs across many industries. Stricter regulation – in particular on emissions and waste – has also forced many companies out of business. Widening income gaps and growing disparity between rich and poor have fuelled social tension and unrest, leading to severely reduced safety and security levels across the globe. A delayed response to climatic changes has resulted in high adaptation costs, diverting funds away from productive investment, toward repair and damage control.

In **CHAPTER TWO**, by contrast, we describe our **VISION** for a safe and sustainable future where nine billion people thrive within the environmental limits of the planet. It is a world where a booming economy is decoupled from environmental destruction and material consumption; a future where all people live well and enjoy universal access to the basics needed to live a healthy, safe and flourishing life.

In spite of growing consensus about where we are headed, it's clear that we are not doing the right things at the right scale and with the right speed, in order to change course. Therefore, in **CHAPTER THREE** we map out 36 **BARRIERS** preventing the transition towards a safe and sustainable world. We look at the barriers across five categories:

- » **Economy and market barriers:** those where financial priorities undermine efforts to achieve social and environmental goals.
- » **Policy and governance barriers:** those related to the structures and processes of public policy and decision-making.
- » **Technology and innovation barriers:** those that prevent the talent capable of creating breakthrough products and services from realising its potential.
- » **Societal barriers:** societal structure, systems and conditions that prevent communities from achieving sustainable development.
- » **Cognitive and behavioural barriers:** those related to people's mindsets, principles and behaviour.

Despite daunting challenges ahead, a safe and sustainable future is within reach. If humanity chooses to act, we can create the future we want. But radical change is needed in several domains. In **CHAPTER FOUR**, we describe three broad pathways that are central to **CHANGING COURSE**, overcoming barriers and accelerating progress to enable the shift towards a sustainable future. The three broad paths are:

- 1. A GREEN, INCLUSIVE AND REGENERATIVE ECONOMY:**
Reorienting the economy and the functioning of the markets.
- 2. GOOD GOVERNANCE AND DECISION-MAKING:**
Governing for a sustainable future.
- 3. STABLE AND PROSPEROUS SOCIETIES:**
Building resilience, equity and well-being.

For each pathway, we identify 20 essential building blocks – enablers – that will contribute to changing course. The changes we need to generate over the coming decades depend on the contribution from all societal actors, but we have different roles to play. We highlight some of the actions that governments, business and civil society can take for each enabler to work.

CHAPTER FIVE provides a deep dive into five business areas where DNV GL has particular competence, and hence we outline what the implications of our vision are for these areas. These **SECTOR SPOTLIGHTS** look at the shipping, electricity, oil & gas, food & beverage and healthcare sectors and explore what sustainability means for each industry, what the major sustainability-related challenges are, and what are the most important actions that need to be taken within these sectors.

THE JOURNEY OF CHANGE

This report confirms that we are left with little uncertainty with regards to the consequences of our current ways. Business as usual is risky, costly and unsustainable, and will increasingly constrain the ability of business to operate and societies to thrive. But despite the abundance of evidence indicating where we are headed and the changes needed, the current level of action is insufficient to take us to the safe and sustainable future.

We conclude the report by reflecting on the journey of change. Moving beyond old thinking and business as usual practices is essential to ensuring the transition to a safe and sustainable future, and fundamental resources, the public and private sectors, as well as civil society all shape the journey.

The world we live in is not simple, and simple solutions aimed at solving one problem at a time is unlikely to bring us to a society that can flourish sustainably. Embracing this complexity

involves seeking and welcoming collaboration across many sectors and areas of expertise. It requires us to humbly recognise that no single one of us possesses all the knowledge needed to solve the complex, connected problems we now face. We need to work together and relish the challenge of dealing with complexity.

Concrete action must be stepped up with scientific understanding of global challenges informing priorities and goal setting. And then we must focus on achievement, measure and monitor progress and performance against boundaries and goals. Business must contribute to the well-being of the planet and society, which implies redefining the nature of value and to value nature.

Government, business and civil society – that means all of us – must lead and do the right thing. And the right thing here is to act as if our future matters.



A SAFE AND SUSTAINABLE FUTURE: ENABLING THE TRANSITION



THE FUTURE LOOKS COOL

These are truly exciting times. We have a unique opportunity to shape a future where the planet thrives, where human creativity and collaboration can flourish and where society is equal, stable and prosperous. We can create a path for humanity to follow in the coming decades that is full of hope and possibility and which makes the planet a better place for our children and grandchildren.

We can already see change happening around the globe. We see creative individuals thinking outside the box to develop innovative solutions; business leaders and investors challenging the status quo to focus on creating long-term value; politicians willing to make brave but unpopular choices and citizens helping transform their communities. These individuals realise that it is possible to create shared value that contributes to well-being for all.

We have the capital, knowledge and technology to create change - if we make the right choices, and if we make them now. We are more connected than at any point in human history, allowing innovative ideas and solutions to spread quickly to all corners of the globe. These are exciting times, exciting for our future and for humanity.

MAKE OR BREAK

At the same time, we need to recognise that the future is not what it used to be. Many of the assumptions that we have come to rely on in the past, no longer hold true. Infinite growth is not possible on a finite planet, and past abundance cannot continue. On our current trajectory, the coming decades will present humanity with potentially graver and bigger challenges than anything previously encountered.

The global population - which is already putting our resources under huge strain - will escalate to approximately nine billion by 2050. By then, more than half of the world population will be living in water scarce regions. We have exceeded our planetary limits for biodiversity loss, climate change and nitrogen flows and are likely to cross more such environmental thresholds. We are on track for global warming of between 3-6°C by the end of this century - well above the 1.5°C threshold considered safe by scientists.

These trends are creating a new and risky reality, and the economic, environmental and human cost to society - and business - should we fail to manage those risks, will be enormous.

CHANGING OUR TRAJECTORY

We can and we must change our trajectory. Changing trajectory will depend on our ability to understand and identify risks, manage the uncertainties and, most importantly, take actions to counter those risks. Indeed, we may be the first generation that is able to identify and understand these systemic and complex issues on a worldwide scale - a generation that could live the Chinese saying: 'If you do not change direction, you may end up where you are heading'.

We can choose an alternative path; a path where we create the future we want to live in. For those who act now, the path to a safe and sustainable future is paved with opportunity.

STEPPING STONES

This report hopes to pass on a sense of urgency when it comes to both meeting the challenges and grasping the opportunities, ahead. It seeks to offer a vision for a safe and sustainable future and to describe on a high level how it can be achieved.

Our analysis relies on several sources. We have conducted an extensive review of literature and documentary evidence from a wide range of internationally recognised sources including international organisations, research institutes, universities, think-tanks and publications by leading experts. We have been privileged to speak with and learn from thought leaders from around the world. Our intention has been to synthesise the best available knowledge, facts, trends and projections that the global community has to offer on sustainability challenges and solutions.

Looking towards 2050 - a date widely used as a temporal measure point or target in many studies - there are inevitably ranges in projections. For example, population growth estimates for 2050 vary from 8.3 to 10.9 billion people. The challenges that follow tend to be graver and more difficult to manage if the upper ranges turn out to be accurate.

We have also used 2050 to denote our vision for a safe and sustainable future. This future year is intended to provide direction by setting a course of action and defining our ambitions. Realising that many targets are ambitious and perhaps unrealistic to achieve by the year 2050, the idea has been to describe the desired end-goal (rather than the precise timeline for reaching this goal). The purpose is to outline actions we must take today, tomorrow and in the years towards 2050 if we are to make the future we desire a reality.

DNV GL's 150 year history of managing risk to safeguard life, property and the environment has in itself been a source of information and experience providing us with a framework for understanding complex issues and sustainability-related challenges.

THIS REPORT

- » Reviews the broad, current trends shaping the world's future and the likely impacts of these forces;
- » Provides a vision of, 'The Society of Tomorrow', exploring what a safe and sustainable future may look like;
- » Provides a comprehensive analysis of the social, economic, technological, political and behavioural barriers blocking or delaying the transition to this brighter future;
- » Identifies pathways and actions which can break through these barriers;
- » Looks in depth at how the shipping, electricity, oil & gas, food & beverage and healthcare sectors could evolve to push sustainability priorities. It provides practical examples of how DNV GL is enabling the transition towards safer, smarter, and greener business.

TIME FOR ACTION

By working together we achieve more. With this report we hope to help inform, inspire and empower the leaders of tomorrow.

We know that change begins at home and requires open dialogue about the issues we face. We in DNV GL want to actively participate in those dialogues and look forward to hearing your voice. Our ambition is to provide the vision, facts and insights that can fuel the transition towards a safe and sustainable future.

Success requires good forces to play together. It requires action today, not tomorrow - because time is rapidly becoming our most finite resource of all. We hope you will join us on this journey.

BUSINESS AS USUAL OUTLOOK: WHERE ARE WE HEADED?



“ It is business as usual that is the utopian fantasy. Humanity will have to create something different and better – or risk collapse into something far worse.

State of the World 2013, Worldwatch Institute



Growing evidence suggests that the world is in serious trouble. Science has confirmed threats of climatic change and loss of ecosystem services and that these have complex impacts on societal and economic well-being. Critical resources are nearing exhaustion, the earth grows steadily less habitable, an expanding population puts an ever-larger strain on nature and billions of people lack access to basic amenities.

Environmental damage is reaching a scale that is beginning to threaten both future prosperity and the progress achieved in human development to date¹. Without ambitious action, human activities will continue to degrade the environment and deplete resources critical to development and the welfare of current and future generations.

IN THIS CHAPTER, we first describe some of today's most significant environmental, social and economic trends and how they might impact the world by 2050. Then we describe the future we are heading towards if we do nothing to change our current ways.

Our analysis shows growing consensus on the main trends that are shaping future challenges. However, when it comes to predicting the likely implications of these trends, different forecasts inevitably exist. This chapter provides an overview of projections by credible international sources. Where there are major discrepancies between estimates, we highlight this in notes.

It is important to keep in mind that projections are just that: projections, not facts or 'sure things'. Although we are locked in to some level of change, the outcome is not inevitable and there is the potential to change course. Our actions today, and changes in economic, social and technological conditions coupled with innovation, may rapidly change the outlook. The one thing that seems to be clear is that a business as usual trajectory places us on a costly and dangerous path.

Before we dive into the trends, we introduce the Planetary Boundary framework which outlines a safe operating space for humanity by defining the limits of the planet.

“ The challenges of the 21st century – resource constraints, financial instability, widening income gaps, environmental degradation, unemployment and social unrest – are clear signals that 'business-as-usual' cannot continue.

THE PLANETARY BOUNDARIES²: DEFINING A SAFE OPERATING SPACE FOR HUMANITY

The condition of the natural environment that surrounds us sets limits on human activity. The stable functioning of the earth's systems - such as the atmosphere, oceans, forests, waterways, biodiversity and biogeochemical cycles - are prerequisites for a thriving global society. However, at present, scientists observe unsafe levels of pollution, ecological change and resource demand. Environmental stress is evident in many ways from species loss, ecosystem degradation, ocean acidification, water scarcity, carbon build-up, fisheries depletion and deforestation.

For the first time in history, humans have become the dominant force transforming the planet and driving global environmental change. We are entering into a new geological epoch - the Anthropocene (the "era of man") - where humans have become a planetary force. Our activities are driving environmental changes in a negative direction, which may undermine long-term development opportunities and trigger abrupt changes (like heat waves, droughts, floods, rapid sea level rise, pandemics and ecosystem collapse).

The earth is made up of complex adaptive systems that are self-organising and resilient to degradation - but *within* limits. To continue to live and operate safely, humanity has to stay away from critical 'hard-wired' thresholds in the earth's environment. If thresholds are crossed, the earth can experience irreversible damage with potentially catastrophic consequences for human civilisation.

Building on decades of research, the *Planetary Boundaries Science Collaboratory presented the Planetary Boundaries framework in 2009 - a framework defining a safe operating space for humanity within which humanity can continue to develop and thrive for generations to come.* The framework identifies nine earth-systems or planetary processes that govern the safe operating space for life as we know it. For each of these processes, boundaries or thresholds have been identified, which would be unsafe to cross.

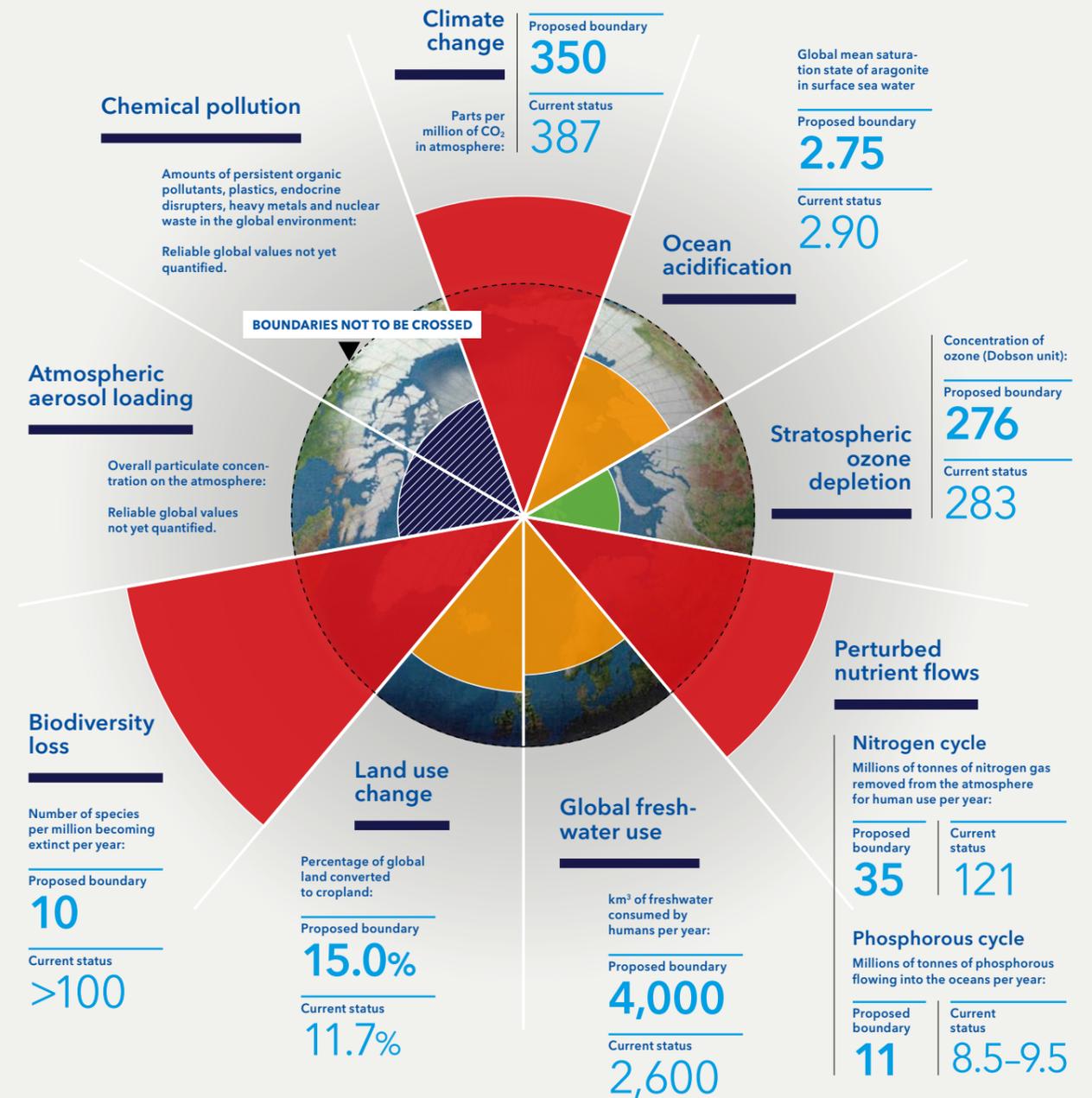
» **Staying within** the boundaries will safeguard the desired stability of the Earth's systems; and within the boundaries, humans can choose pathways for future development and well-being that can lead to an increasingly prosperous world on a crowded planet. The area within the circle defines a safe operating space for humanity.

» **Crossing** the boundaries increases the risk and possibility of irreversible changes to planetary processes, and could lead to a state less conducive to human development³.

The figure indicates that, at present, all nine planetary processes are being disturbed on a global scale. Three boundaries - for climate change, biodiversity loss and nitrogen cycle - have already been transgressed. The world is on track to cross the boundaries for use of freshwater, change in land use and the acidity of oceans.

FIGURE 01 | THE NINE PLANETARY BOUNDARIES
DEFINING A SAFE OPERATING SPACE FOR HUMANITY

Source: Rockström et al. (2009)



- Areas where we have exceeded the boundaries and are continuing to move further beyond them.
- Areas where we are still below the boundary values, but are moving towards them.
- Area where international political agreements have allowed us to start moving away from a boundary - in the correct direction.
- Areas where no boundary values were established.

TRENDS

■ ENVIRONMENTAL

■ SOCIETAL

■ ECONOMIC

ENVIRONMENTAL TRENDS

ACCELERATING GREENHOUSE GAS EMISSIONS

From 1850 to today, emissions have grown more than 100-fold – from 200 million tonnes a year to 36 billion tonnes in 2013⁴. CO₂ concentrations in the atmosphere reached 400 parts per million (ppm) in 2013⁵. This means we have already crossed the 350 ppm level defined as the safe upper limit for CO₂ concentration⁶. This would have prevented a more than a 2°C rise above pre-industrial levels, keeping the atmosphere roughly the same it has been for most of human history. Without more ambitious policies, emissions will double by 2050⁷. Figure 2 describes different projections for emission rates towards 2100, and the expected implications on temperature rise. Historically, there has been a fairly linear relationship between accumulated CO₂ emissions and global temperature rise and this is projected to continue.

NATURAL RESOURCES: RAVENOUS HUNGER, LIMITED SUPPLY

Important metals and materials are fundamental to running our societies. Global consumption of almost every commodity has increased dramatically over the past century, and this trend looks to continue aggressively into the foreseeable future⁸. From infrastructure to iPads, food to football stadiums, the demands of a growing and richer global population, especially in emerging economies, results in depletion of increasingly scarce natural resources. Yet resource-backed economic growth cannot be sustained because of physical limits of the world⁹. The metals, minerals and commodities we rely on are getting more expensive and increasingly difficult to extract and produce. With anticipated supply-side challenges, the general contention is that the world is entering a period of intensified resource stress.

ESCALATING FRESHWATER STRESS

Current rates of freshwater consumption mean we are headed for an increasingly water-stressed world in 2050. The demand for water has quadrupled in the second half of the 20th century, and will increase by approximately 55 per cent before 2050¹⁰. Whereas the agricultural sector is responsible for about 70 per cent of current water consumption, industry use is driving future shortages. Water availability is also severely affected by climate change, where higher temperatures and changing weather patterns cause dry areas to become dryer and wet areas wetter¹¹. Today, 36 per cent of the world population currently lives in water scarce regions. This is expected to rise to 52 per cent by 2050¹². With current water management practices, we will only have enough water to satisfy 60 per cent of water demand in 2030¹³.

A BROWN HAZE DESCENDING OVER US

Urban air quality is deteriorating¹⁴, and concentrations in some cities, particularly in Asia, are already far above acceptable health standards (see figure 3)¹⁵. Air pollution is already reducing quality of life and impacting life expectancy. In China, air pollution is estimated to kill up to 500,000 people a year¹⁶. Air pollution, such as particulate matter, carbon monoxide and ozone, is largely caused by a growing urban population, unsustainable use of energy and the burning of fossil fuels, and burning of forests and waste products. Towards 2050, East and South Asia and India will continue to be affected the most, but if no new legislation is implemented, world average air quality will worsen, severely affecting human health¹⁷.

EXCESSIVE NUTRIENT RELEASE - A LITTLE KNOWN KILLER

Chemical fertiliser underpins modern-day agriculture. However, excessive release of nitrogen and phosphorous leads to 'nutrient pollution' of the atmosphere, land and water systems. High concentrations have caused vast marine dead zones in world oceans, where oxygen levels are too low to support aquatic life¹⁸. More intense agricultural practices to meet increasing food demand will have devastating consequences for biodiversity. Emissions of nutrients are also a major source of air pollution. The burning of fossil fuels, particularly from transportation, electric power generation and heavy industry, is causing the release of pollutants including nitrogen oxides and soot, causing smog, acid rain, and brown haze¹⁹.

SOARING GLOBAL GARBAGE

The unwanted by-product of modern economic activity is the increasing volume and complexity of waste flowing back into the environment. Our linear 'take-make-dispose' model for resource consumption and poor management of waste products leads to contamination of water and soil, and poses serious risks to ecosystems and human health. Waste is today generated faster than any other environmental pollutant, including GHG emissions²⁰. Rapid technological change has led to the increasing generation of large quantities of unwanted and near end-of-life items. Just in the past century, global waste production has risen tenfold, and by 2025 it will double again. The world is projected to generate 13.2 billion tonnes of global waste in 2050²¹ – equivalent to the weight of 1.3 million Eiffel Towers.

FERTILE SOIL OUT OF STOCK

Land degradation significantly reduces the quality and productive capacity of fertile land, and is caused by population growth, migratory patterns, unsustainable agricultural land use, poor soil and water management practices, deforestation and overgrazing among others. Natural disasters, including drought, floods and landslides also contribute. Presently, one quarter of the world's land surface is degraded, threatening biodiversity, reducing the capacity of ecosystems to deliver goods and services and putting food production systems at risk. Close to 1.5 billion people are negatively affected by land degradation²².

FIGURE 02 GLOBAL CARBON EMISSIONS LEADS TO A 3-6°C TEMPERATURE INCREASE
PROJECTIONS FOR EMISSION RATES TOWARDS 2100 AND IMPLICATIONS ON TEMPERATURE RISE

Source: Global Carbon Project (2013)

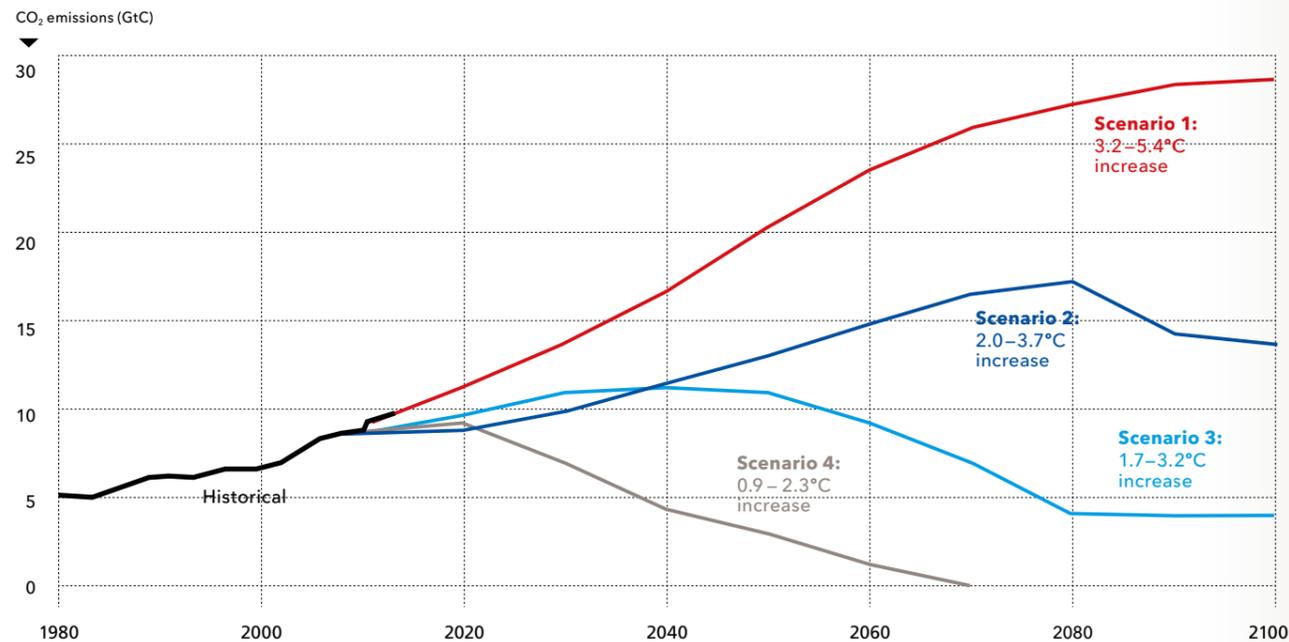
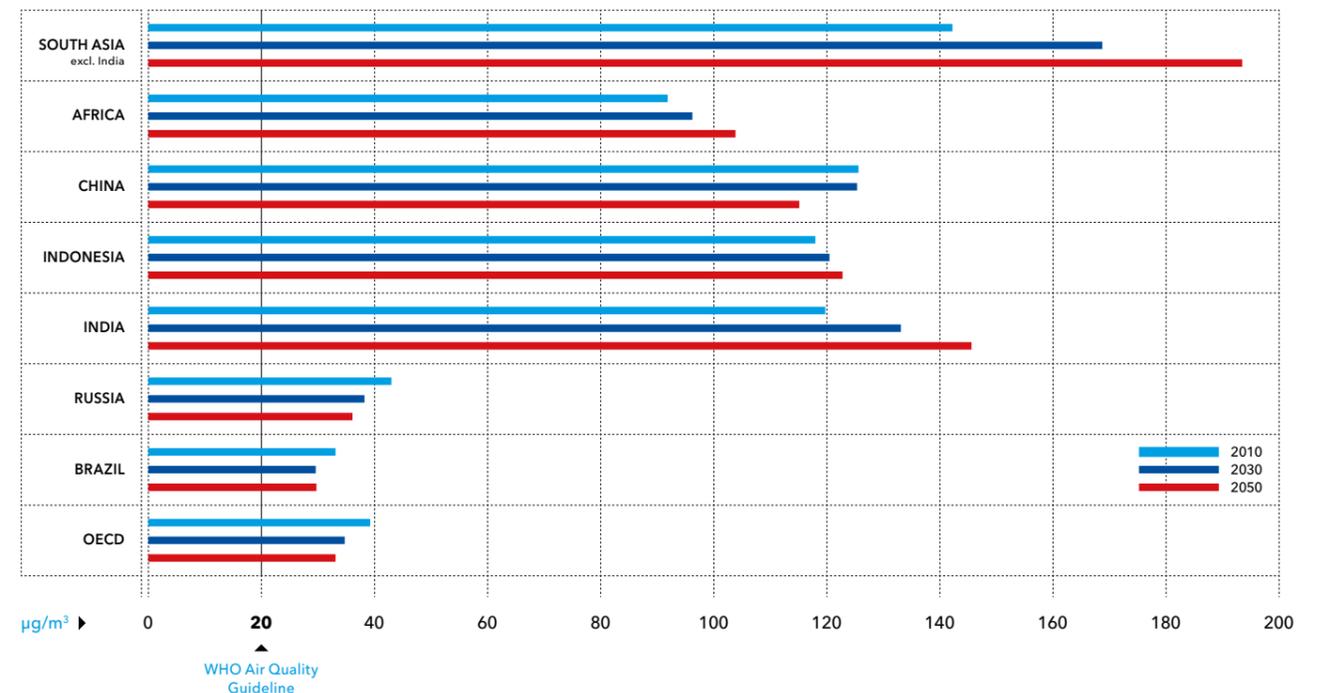


FIGURE 03 RISING LEVELS OF AIR POLLUTION
EAST AND SOUTH ASIA AND INDIA WILL BE AFFECTED THE MOST

Source: OECD (2012a)



SOCIETAL TRENDS

THE WORLD IS GETTING CROWDED...

The world's population is projected to grow from 7 billion people today to 9.6 billion people in 2050²³. However, there are significant regional differences. A remarkable 98 per cent of future population growth is expected to occur in the emerging and developing world²⁴. The largest population growth will occur in Africa (see figure 4) The population in richer, industrialised countries will first peak and then decline. China will follow suit, with the population expected to peak around 2020 as a result of the one-child policy²⁵.

... AND WE ARE GETTING OLDER

We are on average living longer. For the first time, the world will soon have more elderly people than children²⁶ and global average life expectancy is projected to exceed 75 years in 2050²⁷, compared to 70 today²⁸. Rich countries and China will

shrink and age, resulting in high dependency ratios between the productive working-age population and those outside the labour force²⁹.

WE ARE MOVING TO BIG CITIES...

In the future, more of us are likely to live in cities – and some in very big cities. In 2008, the world became predominantly urban for the first time in human history, and this trend is set to continue. By 2050, 70 per cent of the global population is expected to live in urban areas³⁰, with the fastest urbanisation rate occurring in Africa. Rapid urbanisation means cities are getting bigger. From 20 mega-cities with more than 10 million inhabitants today, we will see anywhere from 60–100 in 2050³¹. Many of the world's mega-cities face great social and economic risk from climate change as they are located in environmentally fragile locations, vulnerable to flooding, typhoons and earthquakes.

... BUT FUELLING 'URBAN TIME BOMBS' AS WE GO ALONG

Poverty, conflict and natural disasters in rural areas drives urbanisation, as people move in search of jobs and hopes for a better future. But rapid, unmanaged urbanisation has resulted in the emergence of vast overcrowded slums with poor sanitation, polluted air, poverty, unemployment, high levels of crime and social tension. In 2012, around 33 per cent of the urban population in the developing world lived in slums³². The number of slum dwellers may hit 3 billion in 2050, according to the UN³³.

HUNGER EXISTS AMIDST ADEQUATE SUPPLY

A total of 12 per cent of the global population – 868 million people – are chronically hungry³⁴, with the vast majority residing in developing countries³⁵. Poverty is the main cause, preventing the poor from purchasing the quantity needed even amidst sufficient supply. Recent price volatility has aggravated the situation, and has, according to the World Bank, driven an additional 44 million people into poverty³⁶. At the same time, waste plagues global food production. Due to poor practices in harvesting, storage and transportation, it is estimated that 30–50 per cent of all food produced never reaches a human stomach³⁷. Against this backdrop, we face the tremendous challenge of feeding the world's larger and richer population in the coming decades, with an estimated 70 per cent increase in food production needed to meet demands³⁸.

NEW HEALTH RISKS ON THE HORIZON

Despite remarkable advances in health in the last century, there is growing evidence of widening health and healthcare gaps worldwide³⁹. In global terms, we are witnessing a shift towards non-communicable diseases (NCD) relating to ageing and unhealthy lifestyles (heart disease, obesity, diabetes and cancer), and a general decrease in infectious diseases (diarrhoea, malaria or HIV/AIDS)⁴⁰. Low-income countries face a double burden of disease, with rapidly rising NCDs combined with still high prevalence of infectious disease straining already strained and inadequate healthcare systems. New risks are looming on the horizon. A warming climate spreads water, and food borne diseases (malaria and yellow fever) to new regions, and changing weather poses both direct and indirect health risks. There is also a growing risk of antibiotic-resistant bacteria as due to overuse, with potentially disastrous consequences for developed and developing countries alike.

continue to be wide gaps in terms of distribution of rights, resources and opportunities in many regions. Achievements in education have not translated into greater labour market opportunities, which remain divided along gender lines⁴⁸. Women hold less secure jobs, with fewer social benefits and lower wages (on average 16 per cent lower than men in OECD countries⁴⁹), and are under-represented in managerial jobs and on boards. Politically, deep disparities prevail. Whereas women are assuming more power in the world's parliaments, the average share remains low at 20 per cent⁵⁰.

NEW CHALLENGES, OLD STRUCTURES

The emergence of new complex, cross-border challenges (e.g. climate change, resource shortages, terrorism and pollution), have shown that many governance structures do not have the needed mechanisms for collective action, nor are they adapting quickly enough to new circumstances. Global governance failure is the single greatest geopolitical risk of the next decade according to the World Economic Forum⁵¹. This is mirrored at the national level where slow decision-making processes and short-term election cycles undermine effective responses. Policies and incentives are geared towards protecting the status quo, and political processes are insufficiently transparent and inclusive, while also heavily influenced by vested interests.

PERSISTENT HIGH-LEVELS OF CORRUPTION

High-levels of corruption prevail in many countries and continue to distort markets, undermine democratic institutions, slow economic development, widen inequality gaps and contribute to government instability. Corruption, according to the World Bank, is the single greatest obstacle to economic and social development⁵². Countries with high levels of corruption show low levels of human development (see figure 5). Estimates show that the cost of corruption equals more than 5 per cent of global GDP (USD 2.6 trillion)⁵³ with over USD 1 trillion paid in bribes each year. Research shows that countries that tackle corruption and improve their rule of law can increase their national incomes as much as four-fold in the long term⁵⁴.

BOURGEONING SOCIAL TENSION AND UNREST

In recent years, protests, social tension and unrest have erupted in a variety of locations around the world, including Greece, UK, Ukraine, Thailand and several Arab nations. Although causes vary, protests have been spurred by a combination of factors, such as declining trust in government, declining income levels and high unemployment rates, densely populated and poorly managed urban areas, combined with wide income-inequality and low levels of social provision. After a period of steady decline in the number of armed conflicts in the world since World War II, the downward trend has ended and the number has remained fairly stable at around 30 conflicts in the past few years⁵⁵.

FIGURE 04 AFRICA RISING - REGIONAL DIFFERENCES IN POPULATION GROWTH. NUMBERS IN BILLIONS

Source: UNDESA (2013b)

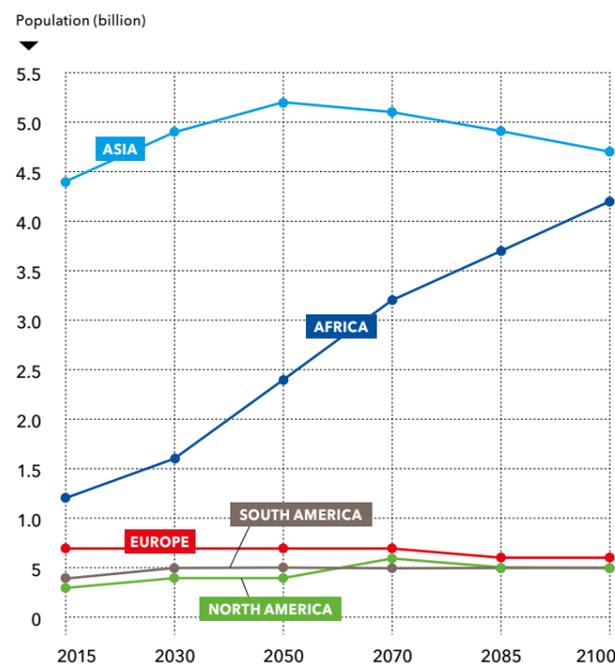
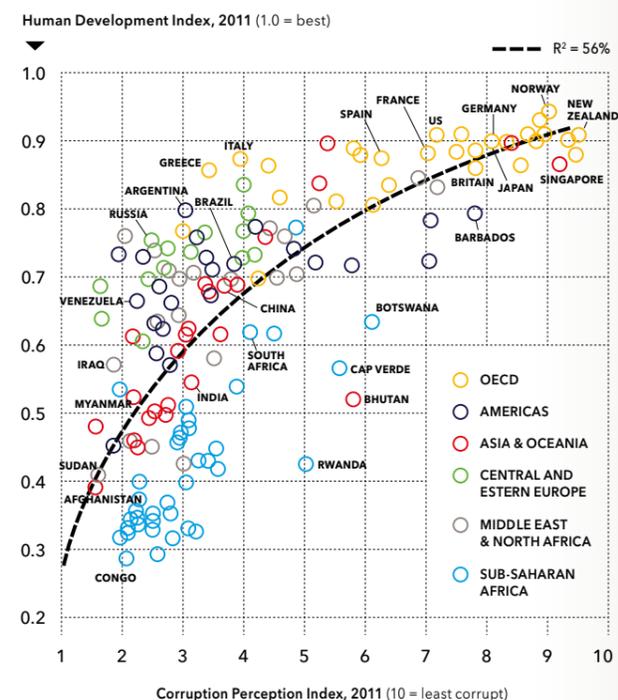


FIGURE 05 HUMAN DEVELOPMENT AND CORRUPTION HIGH LEVELS OF CORRUPTION SHOW LOW LEVELS OF DEVELOPMENT

Source: Oxford Martin School (2013)



ECONOMIC TRENDS

SLOWING GROWTH AND GROWING PAINS

The global financial crisis revealed long-term structural weaknesses in the global economy. Macroeconomic imbalances, fiscal crises in developed economies, massive unfunded social liabilities and weak financial markets are all present in a complex nexus of economic risk. Global economic growth is, according to the International Monetary Fund, expected to remain sluggish at around 3 per cent per year⁵⁶ for several decades. According to PWC, the global economy is set to double in size by 2032, and nearly double again by 2050⁵⁷.

However, these projections are likely to be overly optimistic as they are not taking into account particularly the consequences of deteriorating environmental conditions⁵⁸. A major concern is that weak global economic recovery is failing to create jobs. Global unemployment rates are continuing to rise, particularly with young people being victims.

ECONOMIC GRAVITY SHIFTS EAST AND SOUTH

The bulk of future economic growth will occur in emerging economies, with China and India leading the way (see figure 6). Growth in advanced economies will be slow in the next decade⁵⁹. As a result, the world is seeing a shift in the balance of economic power⁶⁰, driven by population growth, a better-educated and more productive workforce in emerging economies. An ageing population will drag down growth in many regions, including Europe. The global middle class will grow from 2 billion people today, to nearly 5 billion in 2050, with the vast bulk of new entrants coming from China, India and other Asian countries⁶¹.

WIDENING GAPS AND GROWING CONCENTRATIONS

Income inequality has been widening both between and within countries in recent decades. Whereas the rise of emerging economies will do much to reduce global income disparities in the coming years, by 2060, the OECD says, living standards will still only be 25-60 per cent of the level enjoyed by those in the US⁶². Disparities are also widening within countries, and wealth is increasingly concentrating in the hands of the few (see figure 7⁶³). This, according to the World Economic Forum, is the second greatest risk facing the world, threatening political and economic systems, social stability and security on a global scale⁶⁴. The numbers are stark⁶⁵:

- » Almost half of the world's wealth is owned by just one percent of the population.
- » The wealth of the one percent richest people in the world amounts to USD 110 trillion. That's 65 times the total wealth of the bottom half of the world's population.
- » The bottom half of the world's population owns the same as the richest 85 people in the world.
- » Seven out of ten people live in countries where economic inequality has increased in the last 30 years.

CONSUMPTION BEYOND LIMITS

Worldwide consumption of goods and services has risen steadily for decades by virtually any measure⁶⁶. A growing share of the consumer class now resides in emerging economies, and India and China alone account for 20 per cent of the global total consumption⁶⁷. However, inequalities in consumption remain stark. Globally, the 20 per cent of the world's people in the highest-income countries account for 86 per cent of consumption - the poorest 20 per cent a minuscule 1.3 per cent. Over the coming decades, some projections indicate that global consumption growth will slow as a greater share of GDP must be allocated to solve the problems created by resource depletion, pollution, climate change, biodiversity loss and inequality⁶⁸.

EXTERNALITIES ARE STILL EXTERNAL

We are entering an era where the concept of uneconomic growth - meaning growth that costs more than it is worth⁶⁹ - is gaining relevance. Costs associated with damages to the environment and society from externalities of economic activity (emissions, pollution, waste) are not carried by the entities causing them⁷⁰. The cost of global environmental externalities is high and increasing. Research shows that the externalities of the top 3,000 stock-exchange listed companies are close to USD 2.15 trillion⁷¹ and it is estimated that economic activity overall has undisclosed costs to society of USD 6.6 trillion. In other words, 'business as usual' already costs human society an estimated 11 per cent of global GDP every year, and projected external cost relative to global GDP is expected to reach USD 28.6 trillion, equivalent to 18 per cent of GDP in 2050⁷².

BROWN AND LINEAR DOMINATES

A world economy four times larger than today, is projected to use 80 per cent more energy in 2050. Primary energy demand is expected to grow by over 57 per cent, and if following a business as usual path, production of fossil fuels will continue to increase - comprising 81 per cent of total energy supply⁷³ - to meet demand. The main challenge is to meet future energy demand while at the same time reduce the brown share of the growth. At present, enabling conditions, such as public incentive systems, are heavily weighted towards the prevailing brown economy.

According to the International Energy Agency, fossil fuel subsidies amounted to USD 523 billion in 2011⁷⁴, up almost 30 per cent from 2010, six times higher than subsidies to renewables⁷⁵. An International Monetary Fund report from 2013 found that total fossil fuel subsidies added up to an eye-popping USD 1.9 trillion / year. Removing these subsidies could lead to a 13 per cent decline in CO₂ emissions and generate positive spill over effects by reducing global energy demand⁷⁶.

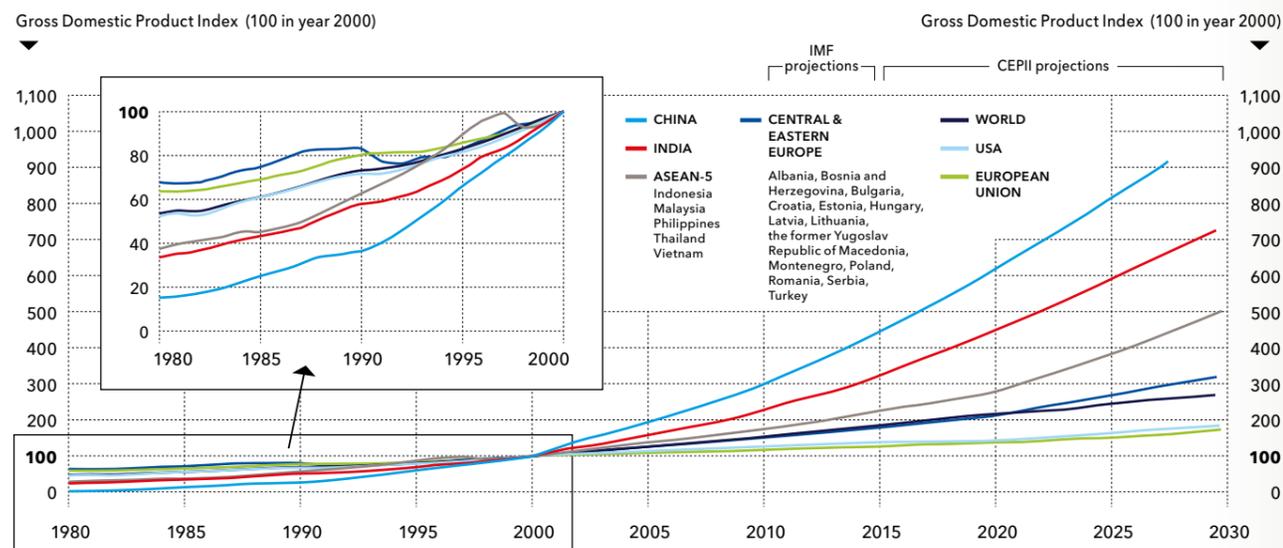
In a linear economic model (cradle-to-grave), wealth creation is based on conversion, use and disposal of resources with recycling rates currently far too low. As a result, current manufacturing, production and consumption patterns generate enormous amounts of waste and limit the availability of resources for future economic activities.

STUCK WITH THE WRONG KIND OF GROWTH

Current capital investment practices reinforce status quo and contribute to decades-long lock-in to the current economic system. Large scale capital expenditures, whether private or public, are guided by short-term investment horizons and narrow focus on financial parameters lacking consideration for long-term sustainability and well-being⁷⁷.

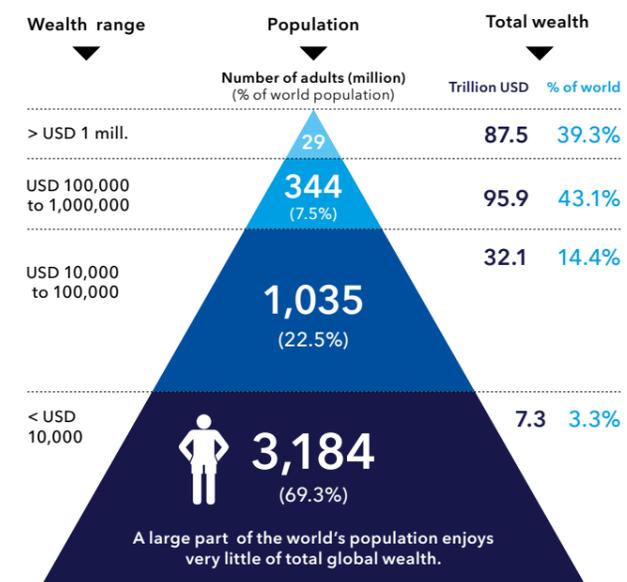
06 ECONOMIC GROWTH TOWARDS 2030 - FASTER IN EMERGING ECONOMIES

Source: EEA (2010)



07 GLOBAL WEALTH PYRAMID WIDENING DISPARITIES

Source: Credit Suisse (2012)



08 THE COST OF EXTERNALITIES OF DAMAGES TO THE ENVIRONMENT AND SOCIETY

Environmental impact	2008		2050	
	External cost (USD bill.)	External cost relative to global GDP	Projected external cost (USD bill.)	Projected external cost relative to global GDP
Greenhouse gas (GHG) emissions	4,530	7.54%	20,809	12.93%
Water abstraction	1,226	2.04%	4,702	2.92%
Pollution (SO _x /NO _x /PM/VOCs/mercury)	546	0.91%	1,926	1.20%
General waste	197	0.33%	635	0.39%
Natural resources: fish	54	0.09%	287	0.18%
Natural resources: timber	42	0.07%	256	0.16%
Other ecosystem services, pollutant and waste	NA	NA	NA	NA
Total	6,596	10.97%	28,615	17.78%

IMPLICATIONS

– A PLANET UNDER PRESSURE

If we continue along a 'business as usual' trajectory, and take no steps to curb emerging challenges, we are heading into a dangerous future: a volatile and strained economy where a much larger share of resources will be locked into coping with disruption and destruction, a world increasingly uninhabitable where life will be difficult and human suffering widespread, where deep inequalities will fuel violence and conflict, and where irreversible changes to planetary processes will result in systemic environmental breakdown. Life on Earth will be threatened.

THE ENVIRONMENT IN 2050 WARMER, MORE INTENSE AND LESS DIVERSE

The environment surrounding humans in 2050 will be marked by high-carbon, energy-intensive industry, and high levels of pollution. Coupled with a growing and richer population with increasingly material-intensive consumption patterns, and unsustainable use and management of natural resources, we are headed towards a world that is warmer, with more extreme weather, less diverse plant and species life and resource constraints. We will have crossed most of the planetary boundaries. Our natural capital assets will be eroded, with 60 per cent of major ecosystems being extensively and irreversibly damaged. We have started experiencing disruptive changes to our Earth systems.

CLIMATE CHANGE – A STORM BREWING

In 2050, emissions of greenhouse gases will have increased by about 50 per cent, and changes to the climate will be even more widely observable⁷⁸. By 2050, global annual surface temperatures could rise 1.5-2.5°C and by the end of the century to 3-5.5°C higher than present.

The following effects are likely⁷⁹:

- » More intense coastal storm surges, tropical cyclones, hurricanes and typhoons will erupt with more frequency along coast lines, particularly in tropical areas.
- » Sea levels will rise one metre on average towards the end of the century, with higher levels in warmer climates close to the Equator. Sea level could increase by several metres if Greenland and West Antarctica ice sheet melt accelerates⁸⁰.
- » There will be longer, more intense and frequent heat waves and long periods of drought in some regions, and heavy rainfall in others.
- » The world's oceans will become acidic at an unprecedented rate seriously harming marine biodiversity.
- » With temperatures increasing, the possibilities for adaptation of society and ecosystems rapidly decline with an increasing risk of social disruption through health impacts, water shortages and food insecurity⁸¹.

POLLUTION RISING TO DANGEROUS LEVELS

Unrestricted release of nutrients, emissions from increasing transportation and industrial production, emissions and release of hazardous chemicals and toxins from burning and improper disposal of waste, will severely deteriorate air quality, and contaminate surface ground water and soil. High concentrations of pollutants will permanently damage ecosystems, further deteriorating the productive capacity of land, and severely impacting human health and the economy⁸².

While pollution levels will be worse in low and middleincome countries, affecting the poor and vulnerable in urban areas the most, effects will be felt globally.

DRAMATIC BIODIVERSITY LOSS

Currently, the rate of species extinction is running at between 1,000-10,000 times higher than the natural extinction rate (the baseline rates seen over Earth's history). With current rates, we will be witnessing the greatest extinction crisis since dinosaurs disappeared from our planet 65 million years ago. Climate change, conversion of natural habitat to human use and pollution will severely damage ecosystems and result in widespread biodiversity loss⁸³, with 5 out of 10 million animal and plant species threatened by extinction⁸⁴.

Pollution of waterways and ocean acidification will result in coral reefs entirely disappearing by 2050⁸⁵. Overfishing and expansion of marine dead zones will result in oceans being largely fish free, worsening food insecurity⁸⁶.

NATURAL RESOURCES: FROM ABUNDANCE TO LIMITS

Pressures from a growing and richer population will lead to the severe erosion of natural resources. Land degradation will intensify and the productive capacity of the Earth will be severely diminished, heavily impacting food production. Freshwater sources will be increasingly drained, with great regional differences, as a result of unsustainable consumption and intensifying climate change.

The metals and minerals needed for production of goods will be increasingly difficult and expensive to extract. Energy and water intensive extraction methods will contribute to a 30 per cent increase in water use on today's levels and result in higher carbon emissions. Supplying the anticipated demand for natural resources is likely to require up to 175 million hectares of added deforestation⁸⁷. A number of critical metal and rare earth elements may be 'running out' by mid-century, and we will exhaust supplies of silver, indium, terbium and other elements commonly used in modern industries⁸⁸.

SOCIETY IN 2050 CROWDED, UNEQUAL AND UNSTABLE

Changes to the physical environment will make life increasingly difficult for people, and threaten the possibility, not only for us to thrive, but for our children to maintain the level of well-being we enjoy today. Whereas the global population is projected to stabilise at around 9 billion⁸⁹, in part as a result of broader access to education and female empowerment, environmental pressures coupled with economic stress and income disparities will cause billions of people around the world to suffer, threatening stability and security at a global scale.

FAILING YIELDS AND DEEPENING FOOD INSECURITY

The challenge of increasing food production by 70 per cent to meet future demand, and in a sustainable manner, will be enormous. To meet this demand, a sizeable increase in yields, better technology, fertilizers and irrigation systems and an expansion of arable land is needed. However, a desire to increase production will be severely hindered by environmental limits.

Higher temperatures, shifting seasons, more frequent and extreme weather events, flooding, drought and severe soil degradation will cause crop yields to fall in many regions. Towards 2050, this will be observed mostly in developing regions (in areas experiencing the highest population growth), but it will spread to developed regions before 2080⁹⁰.

Freshwater available for agricultural use will diminish, and the scope for expanding agricultural land will be limited. Total arable land is projected to increase by less than 5 per cent⁹¹, most of which is located in countries with poor infrastructure or issues of political instability. As a result, an initial increase in crop production levels towards 2030 will be followed by negative effects in the long run and food insecurity is expected to intensify⁹².

Adverse environmental factors are also expected to boost world food prices 30-50 per cent in real terms in the coming decades and will increase price volatility, with hard repercussions for poor households⁹³.

As global fish stocks are exploited, health risks associated with protein deficiency will affect millions as fish is unlikely to remain the poor man's protein⁹⁴.

BILLIONS AT RISK FROM WATER SHORTAGES

In 2050, water demand will exceed supply by 3,300 km³⁹⁵. More than half of the world's population will live in water scarce areas⁹⁶, and severe water shortages will threaten up to a billion people⁹⁷. Reduced freshwater availability will increase risks, consequences and costs for industry, and energy and food production. 49 per cent of global grain production will be at risk due to water stress. Limited availability of water will also severely impact human health.

With more than half of the world population living in water scarce areas, competition for this scarce resource is likely to become fierce, and water access will fuel geopolitical tension and inter- and intra-state conflict across the globe.

SICK PLANET, SICK PEOPLE

New technologies and greater awareness of health risks can be expected to relieve the pressures from communicable and non-communicable diseases. As new diseases emerge and spread, so does new medicine and technology. However, as the environmental conditions surrounding us deteriorate and climate changes intensify, this will pose direct and indirect threats on human health, and the loss of biodiversity will impact our ability to research and develop new treatment. OECD projects that by 2050, air pollution will become the top cause of environmentally-related deaths worldwide causing nearly 6 million deaths annually⁹⁸.

The impacts of other forms of pollution are presently poorly understood, however, toxic chemicals' effect on health and long-term low-dose exposure are suspected to have subtle but serious effects (such as causing developmental disorders in children). The burden will fall more heavily on non-OECD countries, where people will be at greater risk of exposure to hazardous chemicals and waste, and where a six fold increase in chemical production is projected by 2050⁹⁹.

The impacts of climate change on food production and water scarcity will have major health impacts. Hunger is already causing more deaths than AIDS, malaria and tuberculosis combined¹⁰⁰. As changes accelerate, the number of undernourished will rise, large-scale famines are likely to erupt, which will lead to an increase in the number of hunger-related premature deaths.

Finally, widening income gaps and increasingly strained public budgets may mean that the progress achieved to date in expanding access to quality healthcare may be reversed or at best remain highly unequal.

URBAN TIME BOMBS

With continued unmanaged urbanisation, and the emergence of vast slum areas around major cities, life for the urban poor will remain tough. A third of the global population will subsist with limited access to public services, electricity, sewerage systems, waste management or access to health care and education¹⁰¹. High levels of air pollution will cause respiratory disease and high mortality rates among children.

Widening income gaps and growing social disparity between rich and poor is likely to fuel social tension and unrest, with high levels of crime and violence as a result. The ability of government to safely manage and control urban slum areas is likely to be diminished because of extreme danger, as seen today in the favelas in Brazil and the slums in Guatemala. Society will be more divided, as the richer part of the population will seek to live in segregated, gated communities.

MASS-MIGRATION: THE GREAT REVERSAL

We may be on the brink of a momentous reversal in migratory trends. Many densely populated urban areas are located in low-lying coastal zones - home to around 10 per cent of the world's population and 65 per cent of megacities¹⁰² - and will be at risk from sea level rise, flooding and extreme weather¹⁰³. In some places, engineering solutions will not suffice and the retreat from the coast will need to begin. In some regions, there will be no higher ground to retreat to. By the next century, if not sooner, large numbers of people will have to abandon coastal areas in Florida and other parts of the world. It is expected that a sea level rise of 0.5 metres will expose 170 million people to these risks¹⁰⁴. As many cities will not have built sufficient resilience against extreme weather and flooding, millions of people will be forced to abandon these increasingly uninhabitable areas.

Migration is also expected to increase as a result of other direct and indirect climate impacts, such as drought, food and water scarcity, and eruption of conflict over scarce resources. Estimates show that 1.6 billion people will be at risk from natural hazards by 2050¹⁰⁵, and the UN has estimated that there may be 200 million 'climate refugees'. According to the World Economic Forum, the number of displaced people may reach a total of 1 billion people in 2080¹⁰⁶ largely as a result of environmental factors.

HEIGHTENED RISK OF CONFLICT

Greater competition for natural resources, crowded urban centres and a wide gap between the rich and the poor, will increase social pressures that can lead to conflict. High levels of unemployment, particularly among youth, will provide breeding grounds for criminal and terrorist organisations, which may impact security at a global scale.

Water shortages in areas where there are intense demands from agriculture (e.g. Sub-Saharan Africa), or where aquifer systems cross national boundaries (e.g. the Middle East) there will be high potential for inter-regional conflicts.

Mass migration from increasingly uninhabitable areas will force people to move, many at the same time. Social tension is likely to rise, as diverse cultural and ethnic groups will be mixed. This prospect will be exacerbated by a lack of international governance arrangements to deal with such transnational crises. The big question for the future is - how will civilisation cope with this?



65%

of megacities, home to around 10 per cent of the world's population, at risk from sea level rise.



49%

of global grain production at risk due to water stress.



6 mill.

deaths annually as a result of air pollution.

THE ECONOMY IN 2050 DEEPENING DISPARITIES AND GROWING PAINS

If we do not change course, our linear- and consumption driven economic growth model will clash with the limits and the total carrying capacity of the planet. Resource-backed economic growth – based on growth in materials and energy consumption – cannot be sustained because of the physical limits of the world, and wealth creation will therefore be constrained¹⁰⁷. Following a business-as-usual path it will simply be impossible to achieve the development goals of lifting all nations to the material standards of today's developed world, while also living within the environmental capacity of the planet¹⁰⁸.

STAGNATING GROWTH AND REVERSAL OF PROGRESS

Economic trends are likely to be unfavourable to developed nations in the next four decades. Stagnating growth, chronic fiscal imbalances, continued deep levels of indebtedness¹⁰⁹ and high dependency-ratios will put a strain on government budgets and reduce the capacity to handle further shocks to critically low levels. With poverty and inequality on the rise, this will fuel social tensions.

However, in emerging economies there will be less poverty and the growing global middle class – with China, India and other Asian countries expected to provide the bulk of new consumer entrants – is projected to grow from two billion today to five billion in 2050¹¹⁰.

Rich and poor worlds alike, however, will suffer the consequences of deteriorating environmental conditions. This in turn will affect growth as a greater share of GDP will have to be allocated to solving the problems created by resource depletion, pollution, climate change, biodiversity loss and inequity.

Climate change impacts and increasing environmental stress will impact and possibly reverse the achievements seen in human development over the past few decades¹¹¹. A worst case scenario where environmental disaster strikes, the UN projects that a worst case environmental disaster scenario could put an additional 3.1 billion into extreme poverty, if no significant steps are taken (see figure 9)¹¹².

RISING TEMPERATURES, RISING COSTS

Changes to the environment have economic implications, ranging from damage to physical infrastructure and degradation of ecosystem services, to costs associated with human health. Both the Stern Review and the EU Climate Change Expert Group have estimated that the long-term costs associated with climate change will range between 5 to 20 per cent of global GDP each year¹¹³. According to the OECD, by 2070, USD 35 trillion worth of property is at risk due to coastal flooding. See figure 11 for cities most at risk from rising seas by 2070.

Even if massive mitigation efforts to reduce emissions were to be initiated at the time and scale recommended, adaptation efforts will be necessary to cope with climatic changes. By 2030, it is estimated that the cumulative economic cost of adapting to changes to the physical environment could be in the range of USD 2 trillion to USD 4 trillion (see figure 10).

With delays in mitigation efforts and a poorly coordinated policy response, the risks and costs will be greater¹¹⁴. Adaptation and disaster costs will explode as reactive investments will be needed to repair damage to infrastructure, and to protect coastal zones and industrial and municipal water supply¹¹⁵.

HIGHER PRICES AND A STRAINED PUBLIC PURSE

Significant costs will be associated with growing health, water and resource risks. For business, issues of water stress may be a potential economic game-changer. Restrictions on water supply will create financial, reputational, regulatory and operational risks in many key sectors. By some estimates the expected 40 per cent gap between water supply and demand has the potential to put 45 per cent, or USD 63 trillion, of global GDP at risk by 2050¹¹⁶ – that's the size of today's entire global economy.

The effects of an ageing population and the increase in non-communicable diseases such as obesity are also likely to put an enormous strain on public resources. For example, a World Economic Forum analysis estimates that by 2030 non-communicable diseases will cost more than USD 30 trillion to treat¹¹⁷.

Enormous demand and limited supply of natural resources means that there will be increases in prices with the potential for price shocks. Price hikes will reduce demand and will incentivise recycling after natural resources have become scarce or depleted – and with delays in conservation and recycling efforts, the outlook is one of supply disruptions with resulting consequences for production¹¹⁸. As the impacts from extreme weather are expected to intensify, commodity prices are expected to become increasingly volatile.

FIGURE 09 ENVIRONMENTAL SCENARIOS' IMPACTS ON EXTREME POVERTY. POPULATION IN EXTREME POVERTY (MILLION)

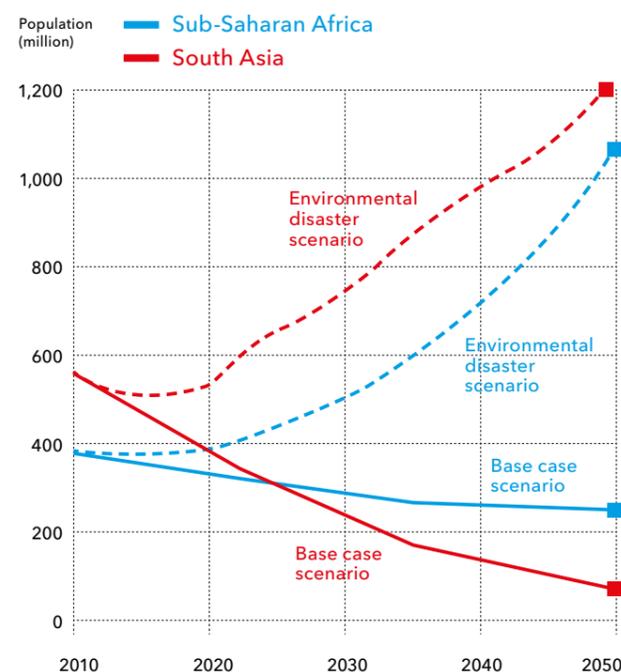


FIGURE 10 ADAPTATION COSTS IN 2030 CLIMATE BREAKDOWN SCENARIO (USD BILLION) Source: Mercer (2011)

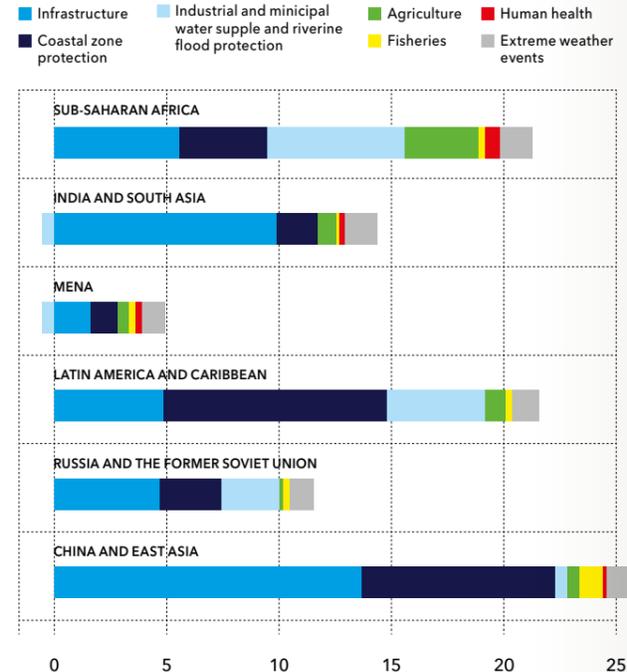
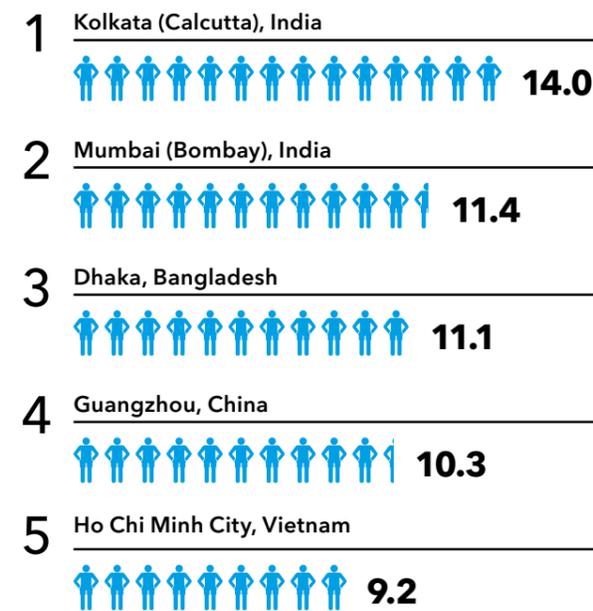
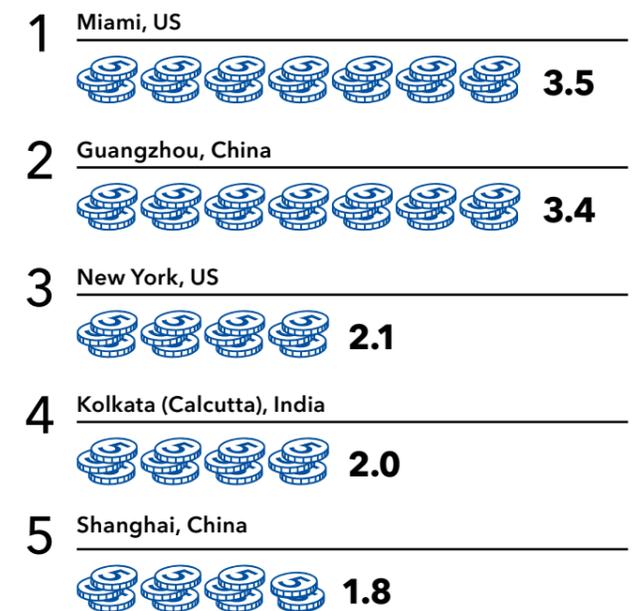


FIGURE 11 CITIES AND ASSETS AT RISK FROM RISING SEAS BY 2070 National Geographic (September 2013)

By exposed population (million)



By exposed assets (trillion USD)

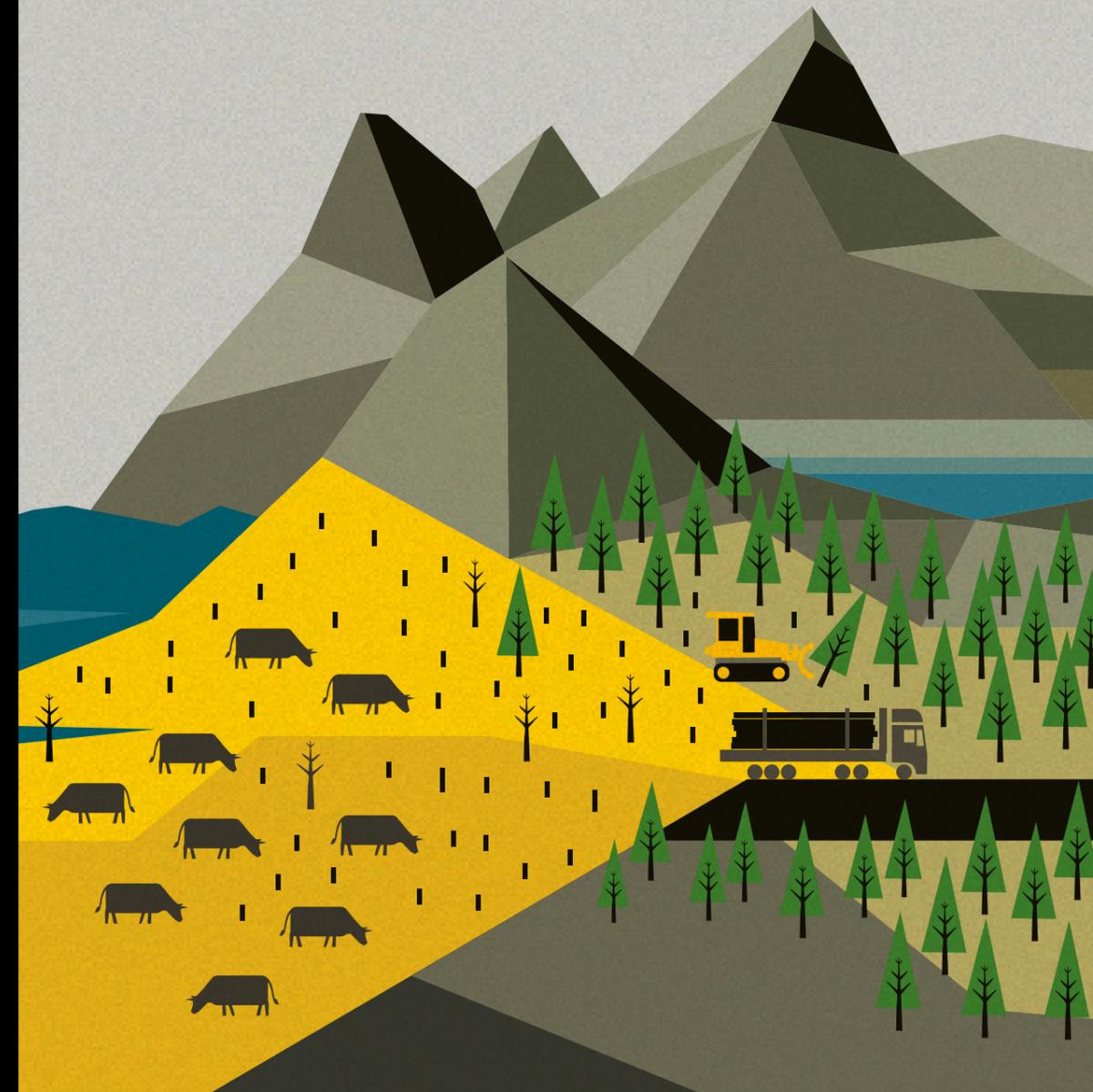


BUSINESS AS USUAL OUTLOOK:
WHERE ARE WE HEADED?



“ Absolutely no one gains anything from climate change. If we end up with hundreds of millions of climate refugees, it will soon become apparent that we are all very much in the same boat.

EVA JOLY, MEP, THE EUROPEAN GREEN PARTY



28.6

COST OF EXTERNALITIES
ARE USD 28.6 TRILLION
18% OF GLOBAL GDP

RICE TEMPERATURE
3-6°C
by 2100
safe level

led to
from
ation

THE WORLD IN 2050 A PLANET UNDER PRESSURE

90% HIGHER SULPHUR DIOXIDE LEVELS
50% HIGHER NITRIC OXIDE LEVELS

IN EMERGING ECONOMIES CAUSES SMOG, ACID RAIN, BROWN HAZE AND SOOT

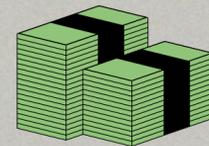
x 3
3 planets needed to meet demands from human consumption

RICE IN TEMPERATURE

3-6° C temperature rise by 2100 (the defined safe level is 2°C)



9 billion people
2 billion more than today
3 billion more middle class consumers



70-100 BILLION USD A YEAR
THE COST OF ADAPTING TO A 2°C WARMER WORLD

60% of major ecosystems are under strain

IN AN ENVIRONMENTAL DISASTER SCENARIO,

3 BILLION PEOPLE ARE PUSHED INTO POVERTY

3 BILLION SLUM DWELLERS

70% LIVE IN URBAN AREAS

MORE FREQUENT AND INTENSE EXTREME WEATHER PUT 1.6 BILLION PEOPLE AT RISK

ENERGY DEMAND UP
57% OF WHICH
81% IS FOSSIL

THE AMOUNT OF LAND NOT USED BY HUMANS DROPS TO LESS THAN **20%**

MOST PRIMARY FORESTS ARE DESTROYED

15-40% OF SPECIES FACE EXTINCTION

WATER SCARCITY THREATENS

52% OF PEOPLE AND AFFECTS 45% OF GLOBAL GDP

200 MILLION CLIMATE REFUGEES

13.2 BILLION TONNES OF WASTE

20% MORE THAN TODAY

= THE EQUIVALENT OF 1.3 MILLION EIFFEL TOWERS OF GLOBAL GARBAGE

AIR POLLUTION IS THE LEADING ENVIRONMENTAL CAUSE OF PREMATURE DEATH, KILLING

3.5 MILLION PEOPLE

28.6

COST OF EXTERNALITIES ARE USD 28.6 TRILLION, 18% OF GLOBAL GDP

1-2 METRE SEA LEVEL RISE FORCING MILLIONS TO MIGRATE FROM LOW LYING COASTAL AREAS



FOOD PRODUCTION MUST INCREASE WITH 70%, BUT WITH ONLY 5% MORE ARABLE LAND

1.5 BILLION PEOPLE ARE NEGATIVELY AFFECTED BY DEGRADED LAND

OCEANS ARE LARGELY FISH FREE AND ALL CORAL REEFS ARE LOST

OUR VISION FOR A SAFE AND SUSTAINABLE FUTURE

2



DNV GL believes it is possible to create a **thriving economy** where growth is decoupled from environmental destruction and material consumption. We believe it is possible to **stay within the limits of the planet** while still enjoying a decent quality of life. And we believe it is possible for a society of nine billion **people to live well**, enjoy universal access to the basics needed to live a healthy, safe and flourishing life.



The future is in large part the outcome of the millions of choices we as individual make every day. Fortunately, the outlooks described in the previous chapter remain projections, not facts: probable, but not inevitable effects of the actions we take today¹.

There are many alternative paths to take, leading to different outlooks. We believe mankind is capable of making the right choices, and with the right focus and determination, can create a more desirable future for the generations to come. In many ways, this is already happening.

IN THIS CHAPTER, we describe our vision for a safe and sustainable future:

- An environment in balance
- A stable and prosperous society
- A green, inclusive and regenerative economy

The transition to a safer and more sustainable future is not primarily driven by the need to avoid disaster or achieve incremental progress. It is a matter of realising opportunities emerging from the pursuit of a new model for society and the economy – one which brings about a more prosperous and fulfilling future.

Undoubtedly, the challenges we face are great, having to balance the need to solve the troubles facing the world today, whilst at the same time taking preventive measures to avoid future risks. Should we choose not to act, we are heading towards a world of far greater uncertainty, complexity and risk.

DNV GL comes from a long tradition of managing risk to safeguard life, property and the environment. Being true to that heritage means doing what we can to bring societies back on the right side of the boundaries for safe human activity.

That is why we are committed to our vision of global impact for a safe and sustainable future.

Achieving this vision requires deep changes in the way we do things – as societies, as businesses and as individuals. But while the challenge is immense, there is no doubt that we have the capacity to meet it. Our limitations lie not in our technology or resources. If we choose to work together, we have the capital, capacity, knowledge and technology to overcome the obstacles ahead and create a world that is thriving, equitable, green, connected and collaborative.

SETTING A COURSE

A century old proverb in the shipping industry goes: “If one does not know to which port one is sailing, no wind is favourable”. This is why we set out to describe DNV GL’s vision for a safe and sustainable future. It is to this port we wish to plot our course.

OUR VISION 2050: AN ENVIRONMENT IN BALANCE

In a safe and sustainable 2050, international policy-makers, business and society have made it a priority to live within the safe boundaries for human activity set by the planet's natural systems. We have recognised that resilient ecosystems are one of the key requirements for human prosperity, and have implemented strategies worldwide for increasing the socio-ecological health of the planet. While we might not have solved all issues, we have curbed the emissions of greenhouse gases and are hopeful that we will keep global warming below 2°C.

However, our aim is to reduce it to 1.5°C, and 350 ppm with active policies to sequester carbon in forest, soils and special storage facilities. Although the world is experiencing effects from climate change, we have avoided the worst scenarios and we have adapted our infrastructure and communities to become more resilient to natural hazards and to withstand new extremes.

For most people this is not something they think about in everyday life, but the older generation will tell you that the energy efficient buildings most of us live and work in are more comfortable than what we used to have. Abundant access to daylight and integration of roof and terrace gardens creates living and working spaces that we thrive in.

In many of the new megacities around the globe people enjoy air quality much above what we used to see, as use of fossil fuels has plummeted. Many cities have become carbon neutral and energy efficiency technologies such as smart grids are standard. With an increased focus on pricing pollution – including greenhouse gas emissions – renewables are consistently and significantly cheaper than fossil fuels.

IMPROVED FARMING PRACTICES have curbed the use of nitrogen and phosphorous fertilizers and limited the use of water for irrigation, making more water accessible for drinking. We consume less meat and entrepreneurial chefs are developing new cuisine styles that are making healthy, sustainable choices fashionable.

RESPONSIBLE STEWARDSHIP to safeguard the world's freshwater resources – from the individual to the international level – has helped maintain the integrity of freshwater ecosystems and ensure that all people have access to enough safe water to meet their needs.

PROTECTING ECOSYSTEMS from the combined pressure of climate change and the growing world population has been a great challenge. However, our increasing understanding of the value of healthy ecosystems has resulted in smarter policies that protect ecosystems and provide greater long-term benefits for human society.

Similarly, our production economy, which is low-carbon, resource efficient and socially inclusive, values natural capital and has moved away from the linear 'take, make, dispose' regime towards a more circular production model working within natural systems and cycles. This shift has slowed, and will in some cases halt, the exploitation of resources that characterized the beginning of the 21st century leaving future generations less exposed to ecological and resource scarcities.

OUR VISION FOR THE ENVIRONMENT

01 The world has avoided run-away climate change and restricted global temperature rises to below 2°C. Atmospheric CO₂ concentration has fallen to around 350 parts per million through global emissions reductions of 50-80 per cent.

02 We have reversed current rates of ecosystem degradation. There is no net loss of biodiversity, and species extinction rates have dropped ten-fold. We are carefully managing biodiversity, safeguarding aquatic ecosystems from overfishing and acidification. Sustainable forestry and land management practices have been realized, and zero net deforestation is helping to abate carbon emissions and encourage biodiversity.

03 Widespread deployment of clean energy and energy efficiency measures provide for a low-carbon society. Renewables make a major contribution to global energy supply and enhance energy security.

04 Natural capital is appropriately valued and costs are internalised in markets, helping to maintain human well-being, biodiversity and the integrity of ecosystems.

05 The value of water is recognised and paid for. Global freshwater use is prudently managed and does not exceed 4,000 km³ per year, while withdrawal from river basins does not exceed 80 per cent of mean flows.

06 An evolved agriculture sector feeds an additional 3 billion people while using less energy and water and avoiding land degradation. Nutrients such as nitrogen and phosphorous are used in a sustainable way – ensuring that no more than 35 million tonnes per year of nitrogen are extracted from the atmosphere, and no more than 10 million tonnes per year of phosphorous flow into the oceans.

07 We have reduced levels of resource extraction, consumption and waste as part of a move towards a circular economy. Products are produced as part of closed loop systems, based on the principles of high longevity, low embodied energy and water, and low material content.

OUR VISION 2050: A STABLE AND PROSPEROUS SOCIETY

In a safe and sustainable society of 2050, 9 billion people have to share the limited resources of the planet. While this may have sounded like a recipe for disaster, the opposite has turned out to be true.

OVER THE PAST FEW DECADES, billions of families have been lifted out of poverty and now enjoy a decent quality of life with access to essential health services and opportunities for development. Income and prosperity has risen, especially in what used to be called the developing world, while richer nations have moved to reduce income disparities within their own countries. Broader and more equitable distribution of opportunity has in part been achieved by meeting basic needs, including universal access to energy. Energy poverty is a thing of the past.

ALL CHILDREN HAVE ACCESS to primary and secondary education. This has improved overall health, boosted equitable economic growth and encouraged transparency, good governance and stability. In addition, wider levels of female education and empowerment in low-income countries have stabilized fertility rates at sustainable levels. The world population is now poised for a steady decline to more sustainable numbers. Universal access to good family planning services has been essential to this transition.

We live in societies where all people enjoy the same rights and are treated equally in all arenas – whether economic, political, civic or cultural. Diversity is valued and accommodated. Society is free from discrimination and oppression. Empowerment, collaboration and creative entrepreneurship drive prosperity.

IN A WORLD WHERE PRESSURES are commonplace, people have increased understanding, compassion and collaboration. Our mindsets have changed, and we see ourselves in relation to a larger purpose, and as embedded in the social fabric and in nature. New kinds of collaboration between public and private sectors, civil society, business and government are commonplace and help to solve problems and forge forward-looking policies and actions. Technology and education has opened borders, enabling global thinking and driving innovation.

THE TOUGHEST CHALLENGE has been to create safe, healthy and prosperous living conditions for the billions of people living in the world's cities. It is no mean feat to develop a social fabric that supports both greater numbers of people and greater diversity. Interaction between young and old has been a cornerstone in achieving this goal.

Accessible social services have been important and business and industry have also played an integral part not just as a generator of jobs and prosperity, but as a provider of social cohesion. As a result of increased welfare, more equitable distribution of opportunity and sustainable management of resources, societies are more stable. Increased well-being has countered the escalation of social tension and conflict seen at the beginning of the century.

COMPARED TO THE EARLY PART of the 21st century, our society is resilient, well prepared to respond to both the social pressures of a large population as well as more frequent natural disasters and the effects of climate change.

We live in a transparent world with greatly reduced levels of corruption, where the public is active in governance process, and take greater responsibility for collective actions. It is a world where leaders fulfil their roles and govern for better futures.

OUR VISION FOR THE SOCIETY

01 The world population has stabilized at sustainable numbers as a result of access to family planning and healthcare, empowerment of women, and wider access to education and opportunity.

02 Extreme poverty has been eliminated and there is opportunity for all communities to access the essential goods, services and information they need to survive and thrive. This includes wide access to affordable and clean energy.

03 We have achieved long-term food security globally. No one is suffering from under-nourishment. Food production has increased by 70 per cent and is based on sustainable systems of production, distribution and consumption.

04 All people have access to safe drinking water and adequate sanitation. No one has to be excluded from work or education in order to source water each day.

05 There is universal access to good quality healthcare services. The spread of preventable diseases such as malaria has been reversed. No child or mother is dying from unnecessary or preventable causes. Healthier lifestyles and new treatments have led to declining rates of non-communicable diseases.

06 There is universal access to primary and secondary education. Every child is enrolled in primary school. Gender disparity has been eliminated in all levels of education.

07 A thriving and inclusive economy provides all people with the chance for work, helping to reduce income and gender inequality. Focused efforts on creating sustainable and resilient livelihoods in low-income countries, particularly in urban areas and for younger generations, have paid off and reduced poverty rates as well as crime rates, and social tension.

08 There is no tolerance for child or forced labour and human rights risks are regularly assessed and reduced throughout business operations.

09 Cultural diversity is fostered and encouraged, with innovation, art and entrepreneurship valued. Collaboration and debate proves more effective than violence and conflict in settling disputes and creating vibrant societies.

10 The United Nations' Sustainable Development Goals, agreed on in 2015, have all been met.

OUR VISION 2050: A GREEN, INCLUSIVE AND REGENERATIVE ECONOMY

In our safe and sustainable future, life in business has taken a dramatic turn from the time when maximising financial returns for shareholders was the main concern for management.

BUSINESS IS STILL THE ENGINE of economic growth, and entrepreneurship and ingenuity is valued just as much as before, but companies are now valued not just for their capacity to generate revenue. Their impact on societies and the environment is just as important, and more, is recognised as critical to their ability to create profit. Companies no longer view value creation through the narrow lens of financial performance over short time scales, but look to create long-term shared value for both business and society.

This shift has been achieved in part by clear evidence that taking a long-term and holistic perspective on value creation and a collaborative approach outperforms the hunt for short-term benefits². As a society, we now view and measure growth and value differently.

AT FIRST, THIS SHIFT WAS DRIVEN by pioneering companies, but as society's awareness of challenges facing the world grew, so did the incentive for businesses to address them. Sustainability went from being nice to have to being commonplace. In 2050, business accounts for natural, human and

social capital alongside financial capital, and a culture of full disclosure of impacts by companies provide investors and consumers with comprehensive information upon which to base decisions.

MANY PEOPLE HAVE MOVED UP the economic ladder toward a better standard of living, and income disparities at both local and international levels are levelling out thanks to a global trade system that is open and fair. High-income countries act with responsibility and work to alleviate global poverty and climate change impacts. There is inequality, but trends are reversed and it is not as stark as at the beginning of the 21st century.

THE NOTION OF REGENERATIVE and collaborative capitalism has emerged, where economic activity is sustainable because it is regenerative. Companies strive to rebuild rather than break down the ecological and social support systems we depend on. Prosperity is still the goal, but our understanding of prosperity has changed from a 'supply-side' prosperity measuring a product value by the amount of resources needed to build it, to a 'demand-side' prosperity valuing products and services by the needs they meet.

We spend more of our income on our health, education and cultural services, and less on buying more stuff. Private ownership has been largely replaced by leasing

or sharing models. By decoupling the economy from adverse environmental impacts and resource use, society has in turn moved away from unsustainable levels of consumption.

INVESTMENT FLOWS HAVE SHIFTED from unsustainable and speculative investment to regenerative companies and projects. Investment in green business and new technology has become a foundation of the new economy. Innovative and alternative modes of transport - such as public transport driven by clean technology - help cater for the needs of both urban and rural populations. Applications of technology offer possibilities for building infrastructures for smarter grids and smarter cities, and services tailored to consumer tastes and needs. Commitment to building green infrastructure that society needs to live more sustainably is also resulting in new job creation.

WE ARE ON OUR WAY to creating a more circular economy, with the infrastructure, incentives, business models and knowledge to reuse materials and minimise resource extraction. Subsidies supporting unsustainable resource use have been abolished and we have entered a new era of stewardship where the goal is to stop and quickly reverse the environmental degradation of the planet to ensure that future generations have access to sufficient natural capital and a clean environment. For the first time, we can truly say that each generation is leaving a better world to their children.

OUR VISION FOR THE ECONOMY

01 Wealth and progress are no longer measured by GDP alone. Human well-being and development are taken into account and business is seen as part of the solution to tackling the big issues faced by society.

02 Financial markets intentionally seek to create social, environmental and economic value along with financial returns and actively measure and account for all these parameters when valuing assets. Company valuation is no longer based on short-term financial performance. Investors and business alike are taking a longer term horizon.

03 Businesses factor in all their outputs including negative social and environmental impacts, which are no longer seen as 'external' to the balance sheet. Integrated reporting is the common practice.

04 A circular economy has been established with materials used efficiently so that embedded resources are not lost. Products are designed and optimised for longer life cycles of disassembly and reuse. The energy needed to drive the circular economy comes from renewable sources. Durable products are leased, rented or shared whenever possible.

05 Labour practices are sound with industries striving to provide healthy, safe, secure and fulfilling working conditions. Flexible working practices help enable fuller employment.

06 Economies are more decentralised, operating with greater focus on local production, local ownership and local markets - and therefore providing greater job and community stability. Competition has been joined by collaboration as the engine of innovation and growth.

07 Climate-smart policies are in place to stabilise global emissions, enhance development, reduce vulnerabilities and finance low-carbon growth. These are based on an equitable and effective global climate deal.

08 Sustainable performance is incentivised and perverse subsidies that led to environmental and social damage have been eliminated. Instead, companies and organisations that minimise pollution, maximise land use efficiency and promote more equitable resource distribution are rewarded.

BARRIERS PREVENTING THE TRANSITION TO A SUSTAINABLE FUTURE

3



At present, there are many barriers at play inhibiting our ability to change and constraining investments in sustainable solutions. To overcome these barriers, a first step is to define and understand them.





COGNITIVE & BEHAVIOURAL BARRIERS

Cognitive and behavioural barriers are those related to people's mindsets, principles and behaviour.

Our values and viewpoints can be both an enormous catalyst and a significant barrier for progress. They influence the choices we make as individuals and consumers, and they affect whether there is inertia or momentum for change. Our collective future will be the outcome of the millions of choices we as individuals make every day. But despite increasing awareness of the problems of business as usual, and a growing consensus around what must change, too many of us choose not to alter course. A safe and sustainable future starts in the battle for hearts and minds.

6

COGNITIVE & BEHAVIOURAL BARRIERS HAVE BEEN IDENTIFIED

01 INSUFFICIENT AWARENESS

There remains an overall lack of public knowledge about the risks of business as usual and the rate at which damage is being done. This is driven by a combination of a dearth of information, a lack of transparency and misperceptions created by vested interests.

The internet and social media are providing new, open platforms for communication and knowledge sharing but can also be a channel for misinformation.

02 HUMAN-CENTRIC VIEW OF NATURE

We have a tendency to view ourselves as 'separate' to nature and this contributes to a failure to value natural resources and ecosystems in a way that adequately reflects our reliance on them.

“ IT IS BASICALLY THIS WAY OF THINKING THAT VALUES SHORT-TERM INTERESTS LIKE MONEY, POWER AND CONVENIENCE MORE THAN THE SURVIVAL OF FUTURE GENERATIONS AND THE WELL-BEING OF THE NATURAL WORLD. THAT IS WHAT IT COMES DOWN TO.

ALEC LOORZ
FOUNDER OF IMATTER,
KIDS VS. GLOBAL WARMING

03 REACTIVE AND SHORT-TERM THINKING

We struggle to grasp (or consider) long-term consequences of decisions or activities or adequately appreciate the potential for future crisis. Our actions are rarely guided by the precautionary principle. We tend to be passive observers of the future, not agents of change.

04 MATERIALISTIC VALUES

The pre-dominant culture in the world is one that increasingly defines success through material well-being. This promotes a mind-set of accumulation and the need for ownership over access, contributing to overconsumption.

05 COGNITIVE BIAS

Human nature has a habit of forming opinions based on past experience, inhibiting our ability to adopt new practices, innovations and understandings. In a rapidly changing world, however, we cannot rely on a mirror to carve out the best strategies for the future.



“ POLICIES ARE DEVELOPED IN A LANGUAGE THAT COMMON PEOPLE CAN'T UNDERSTAND.

BAWA JAIN
THE WORLD COUNCIL
OF RELIGIOUS LEADERS

06 DENIALISM AND LACK OF URGENCY

Sustainability remains a contested concept with skeptical voices attacking consensus positions such as those on climate science. A transition to a safe and sustainable future requires a shared, widespread belief that a change of course is both feasible and desirable,

and a sense of urgency. However, contesting the premise for action undermines opportunities to build that shared vision, thwarting urgent action.



POLICY & GOVERNANCE BARRIERS

Policy and governance barriers are those related to the structures and processes of public policy and decision-making.

Moving beyond business as usual requires good policy and strong governance. But short-termism and lack of visionary and decisive leadership slow and block the needed change. The failure of political leaders to make decisions that favour long-term well-being over short-term gain is often cited as the most important barrier to sustainability. Policy-makers need to address market failures, facilitate technological development, overcome behavioural biases and address social inequality. This requires leadership that can inspire change.

10

POLICY & GOVERNANCE BARRIERS HAVE BEEN IDENTIFIED

07 INSUFFICIENT AWARENESS

There is a lack of effective apparatus to make the global policies which can drive and enforce the transformations required. The global-scale challenges that we face require new forms of international cooperation, governance and enforcement but we are currently inadequately organised and focused.

08 OPAQUE AND EXCLUSIONARY DECISION-MAKING

Decision making, at all levels, is neither transparent nor inclusive enough. Decisions are often influenced by vested interests or lobbying and can be affected by corruption. Stakeholder engagement whether by public or private sector decision-makers is rarely systematic, and tends not to take account of all necessary sustainability issues and interests. As a result, decisions are rarely based on scientific evidence or motivated to benefit society and the environment.

09 SHORT-TERM FOCUS OF POLITICS

Political cycles are short-term, which restricts planning horizons and means uncomfortable choices to address 'big issues' (such as environmental damage) for future generations are ignored for policy options and solutions that provide more immediate political and economic gain.

10 PROBLEMS OF DEMOCRACY

Consensus and agreement in a vital part of the democratic system, but it also tends to slow decision-making. This delay can in turn make the challenge of facing sustainability problems more difficult and expensive, creating a vicious circle of inaction.

11 ECONOMIC BIAS

Economics often takes precedence over environmental and social concerns in policy and decision-making forums. Too often, governments and leaders tend to measure progress on purely economic indicators, such as GDP, rather than reflecting environmental considerations or human well-being in their calculations.

12 PUBLIC FUNDING CRISIS

Public funding continues to be stretched following the global financial crisis and slow growth rates. This creates reduced budgets and competition for funding which frequently put sustainability issues lower down the agenda.

“ IN TRUTH, MOST PEOPLE ARE NOT WILLING TO MAKE A SACRIFICE TODAY TO GET AN UNCERTAIN BENEFIT FOR THEIR CHILDREN OR GRANDCHILDREN 30-60 YEARS IN THE FUTURE. THAT UNDERLIES INACTION IN PARLIAMENTS, THE MARKET AND AT THE INDIVIDUAL LEVEL.

JØRGEN RANDERS
NORWEGIAN BUSINESS SCHOOL

13 LACK OF VISIONARY LEADERSHIP

Throughout history, visionary leadership has proved critical to large-scale societal change. Today however, few political leaders stand out as truly visionary, courageous enough to make the sacrifices needed to challenge business as usual.

14 LACK OF DIRECTION AND COORDINATION

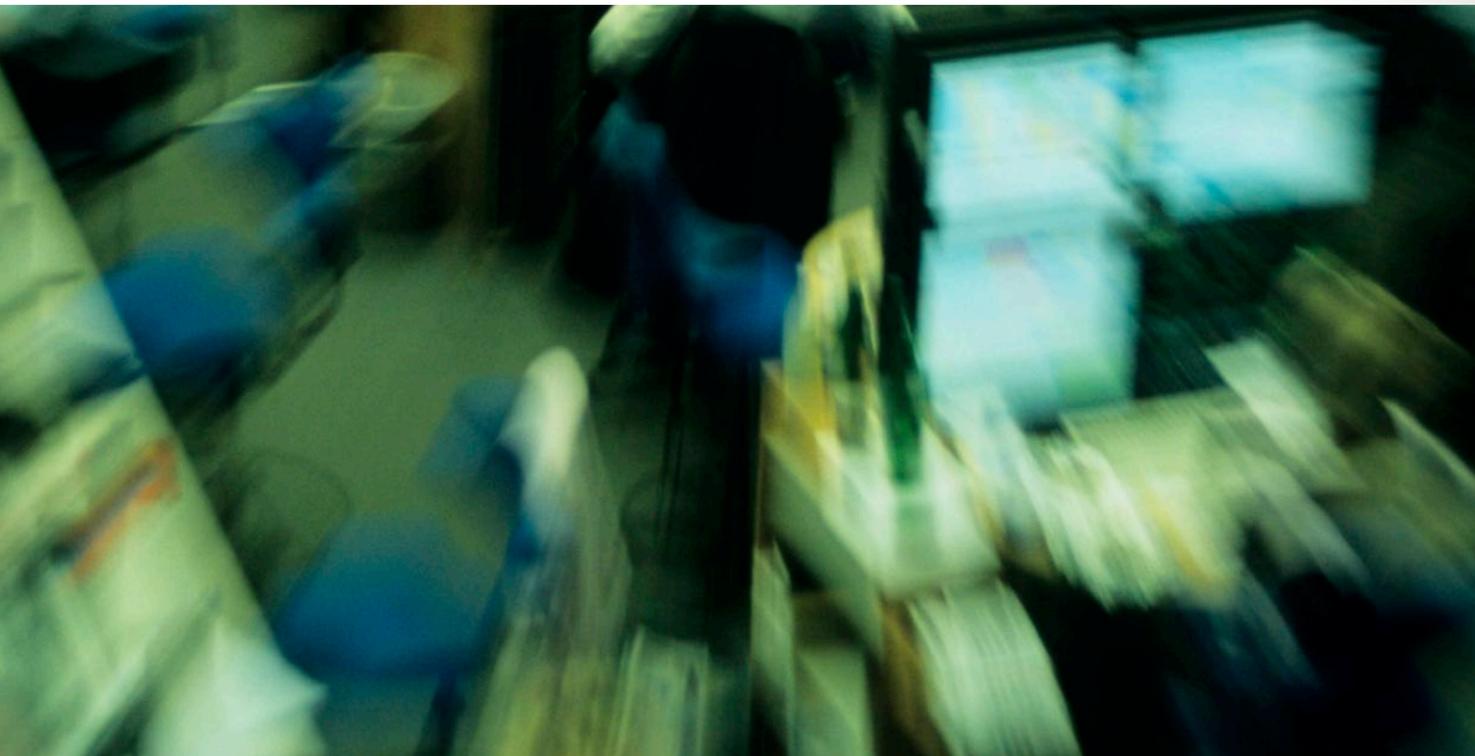
The complex, long-term and international nature of sustainability solutions require clear direction, detailed planning and comprehensive systems of implementation. However there is insufficient multi-level cross-cutting policy coordination between national, regional and sectoral bodies to ensure that these actions are taken.

15 WEAK INSTITUTIONAL FRAMEWORKS

Legal and regulatory frameworks need to be robust enough to guard against sustainability issues such as corruption and to enforce basic rights such as property rights. Institutional frameworks, particularly in developing countries, are however sometimes too weak to effectively enforce regulation and investment and growth is reduced as a result.

16 LACK OF COLLABORATIVE ARRANGEMENTS

Collaboration within and between governments, business and civil society is insufficient to solve the complex sustainability challenges we face. Although there is increasing collaboration, it tends to be neither broad enough nor of an adequate scale to be measurably effective.



ECONOMIC & MARKET BARRIERS

Economic and market barriers are those where financial priorities undermine efforts to achieve environmental and social goals.

The way the economy and markets function globally does not bring about the environmental and social outcomes needed for a safe and sustainable future. The misalignment with sustainability priorities springs from several economic and market barriers such as our failure to adequately value environmental and social assets, short-term profit-seeking, perverse incentives, and the use of narrow financial indicators as the dominant measure of progress. Inadequate valuation and measurement perpetuates business as usual.

9

ECONOMIC AND MARKET BARRIERS HAVE BEEN IDENTIFIED

17 LACK OF TRUE COSTING AND VALUATION

Companies are set up to focus on short-term financial performance and do not adequately account for the true cost of their negative impacts on society and the environment. This deters companies from making sustainability a core part of business strategy, and deters investors from valuing a company's sustainability performance.

18 SKEWED AND PERVERSE INCENTIVES

There are currently too many perverse and harmful subsidies that support environmental damage, and too few positive market incentives to drive the required change in behaviour.

19 LINEAR ECONOMIC MODELS

Our linear cradle-to-grave, rather than cradle-to-cradle economic model makes it convenient and economic to throw resources away, rather than influencing a more circular approach which makes re-use and recycling central to production and design.

20 FINANCIAL SHORT- SIGHTEDNESS

Investment in clean technologies and sustainability innovations tend to have long payback periods, high initial costs and higher risk ratings. Therefore, although many are sound investments over the life of project, the short-term financial disincentives deter investment.

**“ WHEN WE MEASURE
CORPORATE PERFOR-
MANCE WE DON'T INCLUDE
OUR IMPACTS ON NATURE
AND WHAT OUR BUSINESS
COSTS SOCIETY. THAT HAS
TO STOP.**

**PAVAN SUKHDEV
FOUNDER-CEO,
GIST ADVISORY**

21 LACK OF DISCLOSURE ABOUT RISKS AND EFFECTS

There tends to be a lack of corporate disclosure about the sustainability risks of business operations. On a market scale, there is no clear picture of how businesses are affecting society and the environment, either positively or negatively, resulting in a lack of accountability and a lack of trust from consumers.

22 LACK OF VALUE CHAIN OVERSIGHT

The value chain behind many of today's products is highly globalised, complex and interconnected. This makes their sustainability risks difficult to understand and manage.

23 UNFAIR DISTRIBUTION OF OPPORTUNITY AND WEALTH

Our economic model tends to reinforce high levels of inequality. Those who most need economic opportunities, get a disproportionately small share and this only reinforces global inequalities in wealth and well-being.

24 SKILLS SHORTAGE

Existing skills and competences are locked into unsustainable sectors, which inhibit our ability to operate and engage in new, greener technical systems or industries. Educational systems reinforce this shortage, by focusing on existing industries rather than the new skills and competencies required for a green economy.



25 EMPLOYEE APATHY

If employees are not encouraged to 'care' about the sustainability practices of their companies, then the firm is deprived of a fountain of ground-level ideas which can benefit the firm and improve sustainability performance.

BARRIERS TO LNG AS FUEL IN SHIPPING

WHY LNG MAKES SENSE. Over the next decades, we expect to see a more diverse fuel mix in shipping, for example using biofuels or batteries. The transition is driven by new regulations on air emissions and increased cost of oil based fuels. The most mature of alternative fuels is Liquefied Natural Gas (LNG).

Deployment and use of LNG by the shipping industry has enormous potential to reduce harmful emissions. It is estimated that use of LNG as ship fuel could reduce CO₂ emissions by 20–25 per cent, sulphur oxide emissions by 90–95 per cent and help reduce nitrogen oxide

emissions. LNG powered ships would also make financial savings on fuel costs over the longer term when compared with traditional fuels.

Although LNG makes sense from both an economic and environmental point of view, multiple barriers are at play in preventing LNG's growth. The majority of the barriers are likely to be overcome. DNV GL expects rapid LNG uptake in the next five to 10 years, first on short sea ships operating in areas with developed bunkering infrastructure, followed by larger oceangoing vessels when bunkering infrastructure becomes available around the world.



POLICY & GOVERNANCE BARRIERS

Wide adoption of LNG requires major changes to transportation, storage and bunkering right through the supply chain, requiring large investment by many stakeholders in the industry and on a global scale. This presents a classic 'chicken and egg' barrier. Many ship owners and other shipping players are unwilling to invest in LNG if **infrastructure remains poor**; and energy providers do not want to finance expensive infrastructure without securing customers first.

The development of global LNG infrastructure has so far suffered from a **lack of direction and coordination** and **lack of collaborative structures**, on a national, regional and global scale.



ECONOMIC & MARKET BARRIERS

A major barrier to the uptake of LNG is **skewed and perverse incentives**, known as split incentives. This phenomenon occurs when the incentive to reduce emissions and fuel costs rests with the charterer paying the fuel bill, while the ship owner, who pays for the investment in new ships, has no incentive for paying the price premium of the new technology.

Another barrier is **financial short-sightedness** in the market. Ship owners often operate with a short payback time on investments, and mistake opportunities related to LNG for risk. For example, while LNG can be far more financially attractive than the other fuel alternatives in the long-run, many ship owners are reluctant to commit to the initial capital investment.

Market uncertainty and unpredictability in the LNG as fuel market, particularly uncertainty regarding the price of LNG fuel, deter some actors from switching to LNG.



TECHNOLOGY & INNOVATION BARRIERS

There are no significant technical barriers for using LNG as fuel. In January 2014, there were 47 LNG fuelled ships in operation worldwide and 48 confirmed LNG fuelled new-builds. However, there is a **technical, structural and skills lock-in** in the industry.

The majority of existing vessels now operate on heavy fuel oil, and using LNG requires new types of engines (pure gas or dual fuel engines) and training of crew. However, this will only be a short-term barrier for the uptake of LNG as fuel.



SOCIETAL BARRIERS

There has been a **low emphasis in the media** regarding the benefit of shifting to LNG.





TECHNOLOGY & INNOVATION BARRIERS

Technology and innovation barriers are those that prevent sustainable solutions and technologies from being realised at a speed and scale necessary to achieve our vision.

The uptake of sustainable products and services will require continued innovation and investment in effective design, and development and use of better technologies at scale. Access to financing must be improved and trust must be built in the performance and the reliability of solutions. We must understand barriers, so as to help entrepreneurs and businesses bring their ideas and solutions to market, most efficiently and economically. Barriers range from a lack of predictability in enabling conditions – such as targets, policies and incentives – to subsidies supporting older, existing and unsustainable technologies.

6

TECHNOLOGY & INNOVATION BARRIERS HAVE BEEN IDENTIFIED



26 MARKET UNCERTAINTY AND UNPREDICTABILITY

Investing in innovative new technology is, by its nature, full of uncertainty. This is exacerbated by changeable public policies, unclear priorities and a lack of long-term planning. Lack of predictability undermines investor confidence.

There is also uncertainty in the consumer market with customer demand for new, cleaner or more effective technology often limited by an information gap or local resistance to infrastructure, such as wind turbines.

There is also a lack of funding to help commercialise and deploy known solutions and a failure to adequately direct technology to address the big issues.

27 MATURE MARKETS VERSUS IMMATURE SOLUTIONS

New technologies must compete in large and mature markets such as energy, transportation and construction.

Mature markets tend to include deep-rooted incumbent industries supported by government regulation and subsidies.

It can be difficult for new solutions to gain a foothold. Customers also tend to be wary of products or services that have a limited track record. Innovations bring uncertainty in terms of financial outcomes for investors, which makes it difficult for technology developers to source capital for capacity building and scale-up.

28 INSUFFICIENT COORDINATION

Promising new technologies often fail to leap the divide between scientific breakthrough and commercial success because it requires co-ordination across a range of networks including suppliers, partners, customers and regulators. Products can fail if they are not carefully piloted from research and development phase through to commercialisation and deployment.

29 DESIGNS ARE NOT 'CIRCULAR' BY DEFAULT

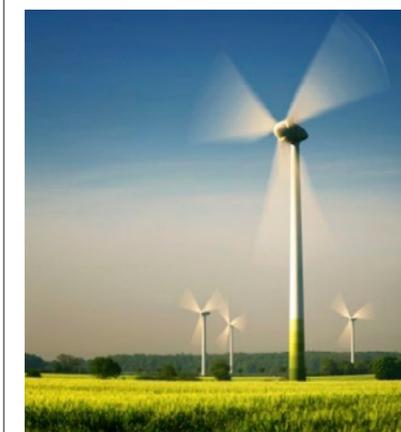
The predominance of a linear 'take, make and dispose' economic model provides little incentive to build in circular use and resource-efficiency as standard at the design stage.

“ THE REAL ELEMENT THAT NEEDS TO BE PUT IN PLACE IS THAT IN EACH COUNTRY, THE REGULATORY FRAMEWORKS ARE PUT IN PLACE SO THAT RENEWABLES ARE GIVEN A FAIR CHANCE.

ACHIM STEINER
EXECUTIVE DIRECTOR
OF UNEP

30 DEPENDENCE ON NON-RENEWABLE ENERGY SOURCES

The world economy is hugely dependent on fossil fuel based energy sources and a substantial shift away from these reserves could threaten social stability by affecting employment levels, energy security and corporate value. This has the effect of 'locking-in' the use of these older, trusted technologies and making support for new technologies more difficult.



31 BARRIERS TO ENTRY

New entrants are dependent on incumbents for the scaling up, commercialisation and diffusion of radical innovations, allowing the latter to negotiate favourable positions in strategic alliances.



SOCIETAL BARRIERS

Societal barriers are systems, structures and patterns of activity in society which prevent communities from effectively tackling problems and unlocking potential so as to achieve desired levels of sustainable development. Social systems and ways of organising may fortify deep rooted challenges, reinforce an unbalanced and unequal society, and can prevent investment and resources from being used to create a better future.

5

SOCIETAL BARRIERS HAVE BEEN IDENTIFIED

“CORRUPTION IS THE SINGLE BIGGEST ROADBLOCK TO UNLOCKING DEVELOPMENT.”

GEORG KELL
EXECUTIVE DIRECTOR,
UN GLOBAL COMPACT

32 INSUFFICIENT PROVISION OF BASIC SERVICES

Millions of people around the world do not have the basic services that they require. Access to energy, water, education and healthcare is limited, which restricts the ability of the poor to realize their potential.

33 HIGH LEVELS OF INEQUALITY

High levels of inequality exist in both the developed and developing world and contribute to create reinforcing cycles and conditions that have a detrimental effect on health, well-being and quality of life.



“TO EAT UNTIL YOU’RE FULL AND THEN ASK THE HUNGRY PERSON TO THINK ABOUT OUR COMMON FUTURE IS NOT JUST UNFAIR, IT’S UNREALISTIC.”

FENGSHU LIU
ASSOCIATE PROFESSOR,
UNIVERSITY OF OSLO

34 POOR INFRASTRUCTURE

Infrastructure for energy, transport, health and sanitation may not be available or is not up to the required standard or capacity. This limits the development of communities, and leaves some locked into poverty.

35 SOCIAL UNREST AND CONFLICT

War and conflict destroys societies and diverts attention from long-term sustainability priorities.

People living in fragile and conflict-affected areas must prioritise survival over other societal needs or environmental concerns.

Conflict can - and often does - undermine public institutions, destroy essential infrastructure (e.g., schools, hospitals, and power systems), create social unrest and facilitate corruption, and force people to become displaced.

Worsening environmental conditions also contribute to conflict and jeopardise development. The negative impacts from conflict prevent and block the transition to a sustainable future.

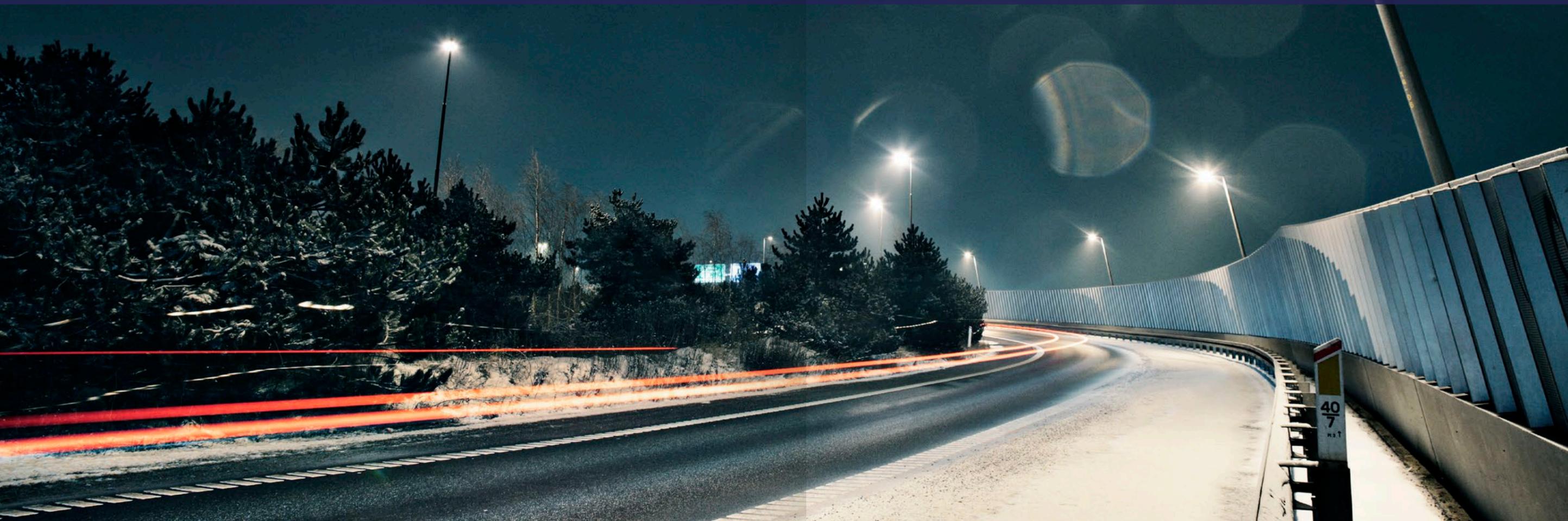
36 LOW EMPHASIS IN THE MEDIA

Mainstream media tends to live in the here and now, focus on short-term issues and reinforce a culture of materialism. This creates an 'attention deficit' in the public thought-process, which then leads to lack of awareness of the importance of longer-term issues affecting society.



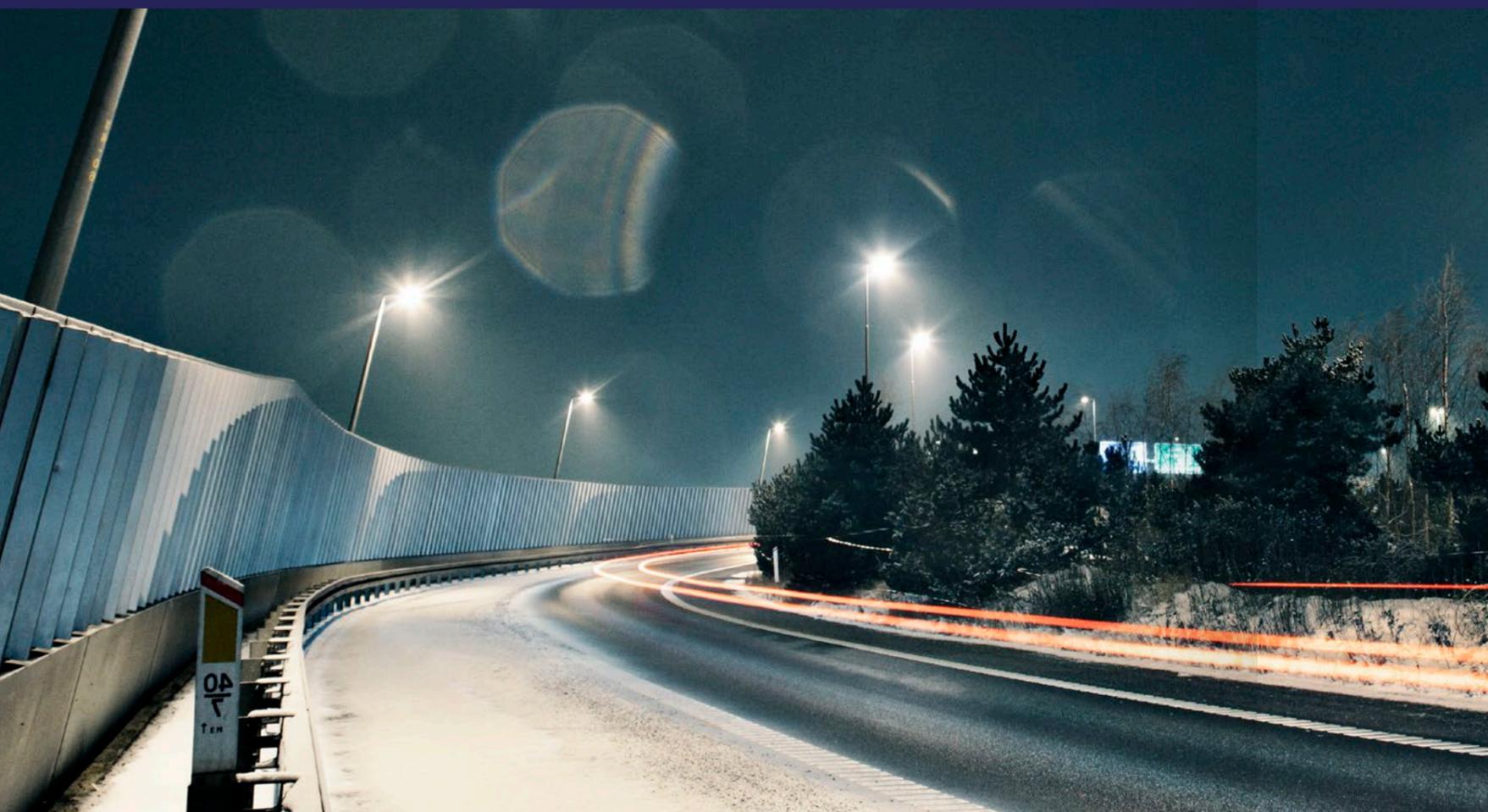
CHANGING COURSE: PATHWAYS TO A SUSTAINABLE FUTURE

4



“ The thing about change is that it’s made up of millions of different actions. Change happens when enough things come together for that to manifest. So the important thing is not to focus on one thing but rather on the multitude, which makes everyone important in creating a transformation.

Jo Confino, Executive Editor of the Guardian and Editorial Director of Guardian Sustainable Business



Our vision for a safe and sustainable future is within reach. Humanity has faced, and overcome, grand challenges in the past. Undoubtedly, we can surmount our present challenges too - if we choose to. Changing course will depend on our ability to work together, to act quickly and to harvest opportunities both today and tomorrow.

We can develop an economy that is sustainable and regenerative, we can rejuvenate our ecosystems, and we can build the stable, equitable and thriving societies that we desire for the future. We are at a moment in time where there is a unique opportunity to shape the future we want.

IN THIS CHAPTER, we connect the dots between the economy, the well-being of society and good governance through the lens of sustainability.

We ask the fundamental question: What changes need to happen to achieve our vision for a safe and sustainable future?

To answer this, we have synthesised arguments from literature and outline three broad pathways for change which we believe are crucial to accelerating progress and facilitating the shift towards greater sustainability. Each pathway begins with a description of the overarching ambition towards which the transition must be oriented:

- 1** **A green, inclusive and regenerative economy:**
Reorienting the economy and the functioning of markets
- 2** **Good governance and decision-making:**
Governing for a sustainable future
- 3** **Stable and prosperous societies:**
Ensuring resilience, equity and well-being

The pathways should not be seen as separate paths, but as intertwined aspects of what it will take to reach the future we want. For each pathway, we outline essential building blocks - enablers - that will contribute to changing course. The enablers are supplemented with specific actions to be taken by business, government and civil society - the three most important catalysts for change.

With the nested concept of sustainability in mind, the three pathways are developed with the ultimate objective of helping to safeguard the global environ-

ment. Environmental sustainability is a prerequisite for maintaining the conditions in which social and economic systems can develop and flourish.

As we are seeing evidence of human activity changing the natural environment - so too must we rely on human activity to revert to the 'safe operating space for humanity' - as defined by the Planetary Boundaries framework - within which human development and prosperity can continue for generations to come.

THREE PATHWAYS IDENTIFIED

1

ECONOMY

**A GREEN, INCLUSIVE AND
REGENERATIVE ECONOMY:
REORIENTING THE ECONOMY
AND THE FUNCTIONING
OF MARKETS**

- 01 Define a new measure of growth and prosperity
- 02 Transform incentive systems
- 03 Implement full cost accounting and valuation
- 04 Design and develop a circular economy
- 05 Embed sustainability in corporate systems
- 06 Embed ESG into mainstream finance and capital markets
- 07 Unlock the potential of technology
- 08 Drive sustainable consumption

2

GOVERNANCE

**GOOD GOVERNANCE
AND DECISION-MAKING:
GOVERNING FOR A
SUSTAINABLE FUTURE**

- 01 Align regulation with sustainability priorities
- 02 Strengthen the effectiveness of governance institutions
- 03 Build transparent and inclusive decision making
- 04 Make informed, long-term decisions
- 05 Encourage visionary leadership and long-term thinking
- 06 Harness the power of collaboration

3

SOCIETY

**STABLE AND
PROSPEROUS SOCIETIES:
ENSURING RESILIENCE,
EQUITY AND WELL-BEING**

- 01 Ensure basic needs and rights are met
- 02 Advance social equity and justice
- 03 Foster skills and employment
- 04 Change mindsets and values
- 05 Strengthen resilience and adaptive capacity
- 06 Manage urbanisation sustainably

A GREEN, INCLUSIVE AND REGENERATIVE ECONOMY: REORIENTING THE ECONOMY AND THE FUNCTIONING OF MARKETS

A profound reorientation of how markets function is needed if we are to achieve not only long-term economic prosperity, but also the environmental and social outcomes that a sustainable future demands. It is well recognised that to deliver lasting prosperity, the kind of growth needed in the future must be different from that of the past.

Economic growth must be decoupled from environmental impacts and resource use, so historical patterns cannot be replicated. We must bring economic activities in line with the limits of the planet and provide more effective, equitable and durable solutions for the well-being and security of society. The economy that we aspire to create is low carbon, resource efficient and socially inclusive and its creation promises great potential for job creation.



THE TRUE COST OF ECONOMIC ACTIVITIES IS BORNE BY THE PUBLIC. COMPANIES ARE MAKING PRIVATE PROFITS, THE PUBLIC IS MAKING LOSSES. WE HAVE TO FIX THAT PROBLEM BY ACCOUNTING FOR EXTERNALITIES WHICH MEANS MAKING COMPANIES DISCLOSE THEIR EXTERNALITIES, MEASURE THEM, MANAGE THEM AND REPORT THEM TO THE PUBLIC.

PAVAN SUKHDEV

FOUNDER AND
CEO GIST ADVISORY

HERE WE OUTLINE
EIGHT ENABLERS
TO CHANGING THE
ECONOMY





WE ALWAYS WANT TO KEEP IN MIND WHAT THE FUNCTION, THE PURPOSE OF THE ECONOMY IS. THE PURPOSE OF AN ECONOMY IS NOT PRODUCING GDP. IT IS INCREASING THE WELFARE OF CITIZENS, AND IT IS INCREASING THE WELFARE OF MOST CITIZENS.

JOSEPH STIGLITZ

ECONOMIST
& PROFESSOR
COLOMBIA
UNIVERSITY

ECONOMY

01

DEFINE A NEW MEASURE OF GROWTH AND PROSPERITY

"The metrics we use to measure our goals affect the path we take to reach our goals". Measuring affects what we do, and if our measurements are flawed, decisions may be distorted. The current practice of measuring growth and progress using GDP means we do not capture many vital aspects of national wealth and well-being (e.g. changes in the quality of natural resources and health). As a result, choices between promoting GDP growth and safeguarding the environment may be false as environmental degradation impact economic conditions.

It is increasingly recognised that GDP is an inadequate measure of economic wealth and well-being. A sustainable economy demands that the measurements used also take account of national well-being factors (e.g. education and poverty levels) and environmental factors (e.g. natural resource use and ecosystem degradation). New metrics of progress and prosperity that incorporate sustainability will enable us to better navigate through the challenges ahead and redirect the economy and society towards sustainability.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Lead by example by measuring impact and implement integrated bottom line accounting
- » Support government efforts to develop new measures of growth
- » Provide more and better data to assess whether GDP growth is being decoupled from natural resource use

GOVERNMENT

- » Engage with stakeholders to develop and agree on a new measure of growth and prosperity that includes social and environmental factors
- » Enable the shift towards more holistic thinking about prosperity
- » Enable sustainable economies by re-adjusting to longer term focused policies and international collaboration
- » Create Integrated Well-being Index and hold all agencies accountable for measuring progress against it

CIVIL SOCIETY

- » Foster academic research around happiness - how to measure and how to achieve
- » Encourage more holistic thinking about prosperity
- » Rate and report: empower people around the world to hold policymakers accountable
- » Encourage media coverage about increased well-being, not just GDP

CHECK OUT



The **Genuine Progress Indicator (GPI)** is a new metric to replace or supplement GDP and examines economic, environmental and social factors to form a measure of growth that goes beyond consumption and investment.



WE NEED TO PRICE NEGATIVE EXTERNALITIES, BECAUSE IT'S THE ONLY WAY TO TRANSFORM MARKET INCENTIVE STRUCTURE SO THAT GREEN INVESTMENT IS MOTIVATED AND CROWDS OUT DIRTY BROWN INVESTMENT. ULTIMATELY, WE NEED TO ACHIEVE A BINDING COMMITMENT FOR A CARBON PRICE BY 2015.

GEORG KELL

EXECUTIVE
DIRECTOR,
UN GLOBAL
COMPACT

02

TRANSFORM INCENTIVE SYSTEMS

Subsidies and economic incentives must be re-directed to reflect long-term priorities and reward investment in a sustainable economy. This includes removing subsidies (direct support, feed-in tariffs, tax breaks and tax expenditures) to the fossil fuel economy which keep the price of fossil fuels artificially low, and prevents cleaner and renewable energy to enter the market at scale. It also includes eliminating harmful subsidies supporting unsustainable resource extraction (e.g. contributing to the collapse of world fish stocks).

Rather, incentives should promote a greening of the energy mix, widespread corporate adoption of socially and environmentally sound practices, and policy mechanisms must be applied in a way that is both equitable to stakeholders and effective in achieving sustainability objectives. The two steps are linked: as more capital flows into low carbon investments, emissions reductions and investment in climate resilience, it becomes increasingly counter-productive to subsidise 'climate-incompatible' activities.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Advocate governments to ensure the right incentive structures are in place
- » Adopt fair practices in regard to tax payments linked to where activities are performed and value created
- » Tie personal bonuses to achievement of sustainability goals
- » Implement internal carbon taxes

GOVERNMENT

- » Urgently halt subsidies for unsustainable resource use and allow subsidies for renewable technology
- » Tax pollution and depletion
- » Subsidise and incentivise efficiency and sustainable behaviour
- » Offer "golden carrots" - programmes to give prizes for technology development and its deployment

CIVIL SOCIETY

- » Mobilise against harmful subsidies
- » Take advantage of incentive systems to drive efficiency, uptake of technology and sustainable solutions
- » Crowd fund local energy solutions
- » Offer prizes for more sustainable innovation

CHECK OUT



Economic incentives and public support for charging infrastructure have resulted in **Norway** being home to the largest per capita electric vehicle market in the world.

China's use of development targets and nationwide incentive schemes for renewable energy growth. China is the number-one global solar market and number-one wind power producer in the world.

ECONOMY

03 IMPLEMENT FULL COST ACCOUNTING AND VALUATION

To understand the true value of activities in the economy, a complete picture of the costs and benefits is required. As such, full cost accounting is needed to steer the economy towards sustainability. This means that the environmental and societal impacts of business, which are currently external² to corporate balance sheets, will have to be considered as a cost of doing business. This entails accounting for the use of natural capital and environmental services (such as clean

air, water, land and biodiversity) as well as social capital (e.g. equality, labour practice or local community). As a result, companies will be incentivised to manage impacts and focus on capital and resource productivity. The most sustainable companies will gain a competitive advantage and seize new opportunities, especially in resource-scarce and rapidly developing markets.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Identify material social and environmental impacts (across the value chain) and factor them in when measuring and accounting for company performance and product cost
- » Ensure public policy (lobbying), marketing and communications aligned to sustainability principles
- » Implement environmental profit and loss statements
- » Label products to tell their full story at point of sale

GOVERNMENT

- » Finance initiatives to gain clarity on how to implement environmental and social capital valuations
- » Implement regulation that requires business to account for negative externalities
- » Implement criteria for full cost valuation in public procurement

CIVIL SOCIETY

- » Lobby governments for stricter regulation to ensure full cost accounting
- » Educate consumers on sustainable choices
- » Create alternative accounting systems, e.g. the Genuine Progress Indicator (GPI)
- » Third party verification of claims

CHECK OUT



The pioneering work of **Puma** in their Environmental Profit & Loss Account to put a cost on the impact a business has on the environment, across its entire supply chain.

The Natural Capital Leaders index by **Trucost** recognizes companies demonstrating natural capital leadership - and that are truly 'moving the needle' by decoupling growth from natural capital impact.



IN BRAZIL, 98 PER CENT OF ALL ALUMINIUM CANS ARE RECYCLED. IN OTHER COUNTRIES, IT'S 98 PER CENT NOT RECYCLED. WHY IS THAT? BECAUSE IN BRAZIL, THE INCENTIVE WAS PUT IN PLACE BY THE GOVERNMENT TO PROMOTE THE COLLECTION. IT HAS CREATED JOBS, AND IT HAS CREATED A MATERIAL RECYCLING ECONOMY.

ACHIM STEINER

EXECUTIVE
DIRECTOR
UNEP

04 DESIGN AND DEVELOP A CIRCULAR ECONOMY

The economy must find a better way to minimise resource usage by decoupling resource consumption from wealth creation. The development of a circular economy³ will enable us to capture materials so that today's goods are remanufactured or reused and become tomorrow's goods, rather than waste.

Creating the circular economy is an innovation issue and products need to be designed based on 'cradle to cradle' principles. Designing products and materials for de-con-

structability and reuse should encourage and incentivise product return and recycling. Infrastructure and 'closed loop systems' should be organised for a range of consumer products in order to maximise efficiency, reduce raw material extraction and reduce waste generation.

Reuse, repair, remanufacturing and technological upgrading of goods and components are often best done in the regional economy and will therefore also create jobs and employment.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Incorporate environmental considerations into product design phase
- » Adopt closed loop manufacturing processes
- » Set up reverse supply chains to manage product end of life
- » Develop new business models for lease and access

GOVERNMENT

- » Design investment support / tax breaks / incentive schemes to foster private sector investment in infrastructure that enhances material recycle and reuse
- » Reward businesses and institutions for measurable impacts and realization of circularity potential
- » Require extended producer responsibility

CIVIL SOCIETY

- » Consumer responsibility to recycle and return products (not waste)
- » Consumer choice for circular products (lease and subscription rather than consuming)
- » Educate consumers and workers on 'cradle-to-cradle' principles

CHECK OUT



Subaru's factory in Indiana - the world's first car manufacturing plant to recycle and reuse 100 per cent of its manufacturing waste, achieving zero landfill status.

Timberland's Design for Disassembly boots are designed to pursue a cradle-to-cradle goal.



SUSTAINABILITY IS THE TOUCHSTONE OF ALL INNOVATION AND IN THE FUTURE, ONLY COMPANIES THAT HAVE SUSTAINABILITY AS A GOAL WILL ACHIEVE COMPETITIVE ADVANTAGE. IT'S BETTER BUSINESS.

L. HUNTER LOVINS
PRESIDENT NATURAL
CAPITALISM SOLUTIONS



WHAT ECONOMY IS IT WE WOULD LIKE TO SEE? WE NEED TO SHIFT FINANCIAL CAPITALISM TO A MORE HOLISTIC CAPITALISM DEFINED BY ENVIRONMENTAL AND SOCIAL CAPITAL AS WELL AS ECONOMIC CAPITAL.

JOHN FULLERTON
FOUNDER & PRESIDENT
CAPITAL INSTITUTE

ECONOMY

05 EMBED SUSTAINABILITY INTO CORPORATE SYSTEMS

For the transition to take hold, all companies must fully embed sustainability into their corporate DNA through strategy, management systems, day-to-day operations and by disclosing sustainability performance in a transparent manner. As such, companies should develop metrics (e.g. key performance indicators) to benchmark company footprint and manage their risks and impacts on issues

ranging from material and energy use to corruption and working conditions along the value chain. The development of integrated reporting, which puts sustainability reporting on a par with traditional financial reporting, will be key to this. This change implies a new understanding of the purpose of business – beyond maximising profit for shareholders – to also serve societies' needs and contribute to the common good.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Commit to the principles of the United Nations Global Compact
- » Set a corporate sustainability vision and strategy, and ensure sufficient staffing to carry it out
- » Assess and manage sustainability impacts across the entire value chain
- » Produce integrated reporting to stakeholders
- » Align with others around responsible lobbying to advance positive change

GOVERNMENT

- » Develop mandatory corporate governance requirements that encompass sustainability
- » Make integrated reporting mandatory for all organisations
- » Ensure that state-owned enterprises become leaders in sustainability
- » Offer incentives to meet sustainability targets
- » Implement sustainability criteria for all public procurement

CIVIL SOCIETY

- » Support the development of standards for measurement, reporting and certification of sustainable practices
- » Exercise watchdog function
- » Collaborate with business to identify risks and find solutions
- » Embed environmental education at all levels
- » Ensure citizens have sufficient information to know which products are more sustainable

CHECK OUT



Marks and Spencer's Plan A with 180 commitments to become the world's most sustainable retailer by 2015. Why Plan A? Because there is no Plan B for the one planet we have.

Business wants change. **BICEP** businesses work with policy makers to pass meaningful and innovative energy and climate legislation to enable a rapid transition to a low-carbon, 21st century economy.

06 EMBED ESG INTO MAINSTREAM FINANCE AND CAPITAL MARKETS

Alongside efforts to encourage companies to embrace transparent sustainable practices, investors should factor environmental, social and governance (ESG) issues into their investment processes. Merely optimising single variables such as financial return will no longer be seen as sufficient to investment decision making. Expanding the meaning and measures of wealth to take account of the different forms of capital – natural, social and financial – is key⁴.

Incorporating ESG issues into financial analysis is likely to result in more capital flowing into those technologies, products, companies and sectors that have a superior sustainability performance. Unfettered markets in their current form are not designed in a way to solve societal problems⁵ – rather the market is designed to maximise profit to shareholders on a short-term basis. Leadership will need to set targets and a clear long-term direction for aligning societal interest with the private sector.

WHAT CAN INVESTORS, GOVERNMENT AND CIVIL SOCIETY DO?

INVESTORS

- » Incorporate ESG into investment criteria, due diligence processes and financial valuation metrics
- » Shift and scale-up capital investment into regenerative options
- » Create 100-year investment plans

GOVERNMENT

- » Make it mandatory for financial markets to integrate ESG into financial analysis and valuation
- » Strengthen regulation and oversight of financial markets
- » Apply responsible investment principles to sovereign wealth funds and other pools of public funds
- » Create financial mechanism for future generation bonds that accounts for costs of environmental harm to future generations

CIVIL SOCIETY

- » Raise awareness of bad and good corporate performance
- » Choose pensions and financial products with credible ESG policies in place
- » Encourage media coverage of the business case for sustainable investing
- » Encourage education to foster financial literacy

CHECK OUT



More than 1000 asset owners and managers, with more than 34 trillion dollars in assets under management, currently back the **Principles for Responsible Investment (PRI)**.

The new approach by the **Norwegian Church Endowment**, in collaboration with DNVGL, to systematically assess the ESG performance of asset managers



NEW TRANSPORT, ENERGY AND FOOD SUPPLY SYSTEMS WILL REQUIRE FUNDAMENTAL INVESTMENT IN TECHNOLOGICAL SOLUTIONS. IF WE CANNOT GET CAPITAL MARKETS AND ENTREPRENEURS TO CROWD INTO THE NEW SPACE OF GREEN INVESTMENT, WE WILL HAVE NO CHANCE.

ACHIM STEINER
EXECUTIVE DIRECTOR
UNEP



THERE IS TOO MUCH DEMAND FOR MORE STUFF, AND WHAT IS DRIVING THAT DEMAND IS ADVERTISING AND MARKETING. IN ORDER TO FIX DEMAND, WE NEED TO MAKE ADVERTISING HONEST AND INFORMATIVE, RATHER THAN PERSUASIVE.

PAVAN SUKHDEV
FOUNDER & CEO,
GIST ADVISORY

ECONOMY

07 UNLOCK THE POTENTIAL OF TECHNOLOGY

Deployment of technology is vital to decoupling environmental degradation from economic growth. Environmentally friendly technology (e.g. in renewable energy and energy efficiency) is available today, and offers alternatives to being locked into fossil fuel-based growth and material-intensive resource consumption.

To accelerate the transition to a green economy, long-term policies and investment support are required to back the full innovation cycle of green technology from research and development (R&D), to demonstration and large scale market deployment.

Technology (software and information networks) also holds enormous potential to transform societies by facilitating communication and mobility, and unleashing collective efforts to solve societal challenges (e.g. access to financial services and mobile banking, identifying counterfeit medicine, free online education, crowdfunding or sharing models).

Technology holds the potential to bring about the radical transition needed to build not only a more sustainable future, but at the same time a more desirable, convenient, cool and efficient world for human kind. For this to happen, resources and capital should be directed at innovative developments that maximise technology's benefits and contribute to this goal.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Adopt longer-term technology payback periods
- » Develop and deploy low-carbon technologies
- » Collaborate on innovation strategies with research institutions, government and technology hubs
- » Stimulate eco-preneuring inside companies

GOVERNMENT

- » Plan, establish targets for and incentivise clean energy development
- » Ensure compatibility between research, development and deployment initiatives with sustainability priorities
- » Ensure predictability and stability in policy frameworks and regulatory instruments, in order to de-risk deployment of new technologies

CIVIL SOCIETY

- » Raise awareness of available technology solutions
- » Crowd source technological innovations
- » Promote competition that rewards efficiency innovation (e.g. 1 litre car races)
- » Convene sustainability 'hackatons'
- » Promote creativity in education and teach systems thinking

CHECK OUT



Plastic is taking over our oceans. With Spindrift, **DNV GL** and **WWF** have proposed a research vessel employing the latest technology to understand marine pollution and to develop collection methods.

Water utilities lose an estimated \$14 billion due to inefficiencies in the water supply networks. **TaKaDu** reduces water distribution losses with their novel software technology.

08 DRIVE SUSTAINABLE CONSUMPTION

Consumers can drive sustainable business practices by voting with their wallets. Product disclosure, labelling schemes and improvements in the coverage and sophistication of mobile apps will raise consumer awareness of the environmental and social costs of individual products.

Introducing new norms and standards to encourage responsible advertising will also push reliable and actionable information into the market. However, driving sustainable consumption in the market isn't just about information; it is also about re-

designing business models and entire systems of commerce. The redesign which is unfolding has been dubbed the 'sharing economy' and the 'access economy' where ownership models are replaced by access to goods and services.

Innovative business models are emerging in sectors as diverse as transportation and travel, buildings, tools, entertainment, farming, fashion, resource use and recycling (e.g. airbnb, zipcar, leasing models).

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Tell compelling sustainability narratives about activities, products and services
- » Communicate reliable and actionable information about the performance of products and services
- » Uphold new advertising norms and standards (empowerment marketing)
- » Evolve business models to embrace decentralised solutions

GOVERNMENT

- » Introduce norms and standards to ensure advertising is more responsible and accountable
- » Review and reform legal frameworks to allow access and sharing models
- » Provide 'hard' and 'soft' incentives to change consumer behaviours and shift material consumption to services (e.g. tax credits for collaborative consumption)

CIVIL SOCIETY

- » Drive end-user campaigns to increase awareness of smarter consumer choices
- » Provide knowledge and new narratives to influence values and mindsets towards more sustainable ways of living
- » Consumers to adopt eco-efficient solutions, lifestyles and consumption behavior
- » Promote the sharing economy

CHECK OUT



The 'Buy less' campaign by **Patagonia** - encouraging people to consider the effect of consumerism on the environment and purchase only what they need.

GOOD GOVERNANCE AND DECISION-MAKING: GOVERNING FOR A SUSTAINABLE FUTURE

Decisive governance and decision-making – at all levels and in all sectors – is crucial to effectively respond to emerging challenges and realise our vision for a safe and sustainable future. This requires a strengthening of the governance architecture at the international, regional, national and local levels. It also requires intelligent, bold and visionary leadership by those in a position to act to correct and reset the ‘rules of the game’ and to step up and take the lead for the long-term.

Governing requires a ‘*dual vision*’: a commitment to address current needs and to build the foundations for vibrant generations in the decades ahead⁶. Leaders urgently need to look beyond the needs of the present and provide appropriate long-term direction, to enable and catalyse action towards a more sustainable trajectory. It will require willingness on behalf of decision-makers to make unpopular and perhaps in the short-term more costly decisions, to ensure a better long-term outcome.

HERE WE OUTLINE
SIX ENABLERS,
APPLICABLE ACROSS ALL
LEVELS, TO CREATE BETTER,
MORE RESPONSIBLE GOVER-
NANCE AND TO STRENGTHEN
DECISION-MAKING FOR
THE LONG TERM



IF YOU GO BACK TO THE ORIGINS OF THE ENGLISH LANGUAGE, THE WORD ‘LEADERSHIP’ MEANS ‘PATH-FINDER’. THAT MEANING IS INTERESTING BECAUSE WE HAVE IMAGES OF WHAT A SUSTAINABLE WORLD LOOKS LIKE, BUT NOBODY KNOWS ABOUT THE HOLISTIC REDESIGN OF THE SYSTEM WE NEED. TO GET THERE, WE NEED LEADERS TO GO FIRST.

PETTER BAKKER

PRESIDENT, WORLD
BUSINESS COUNCIL
FOR SUSTAINABLE
DEVELOPMENT



WE HAVE TO MOVE BEYOND TALKING - AND ACTION OUR SUSTAINABLE STRATEGIES AND BEHAVIOR. GOVERNMENTS ARE LOOKING AT REGULATION AND RED TAPE. BUT IN MY CONVERSATIONS WITH OTHER BUSINESS LEADERS IT'S CLEAR THERE IS AN APPETITE AMONGST MANY TO HOLD THEMSELVES TO A HIGHER STANDARD.

PAUL POLMAN
CEO, UNILEVER

GOVERNANCE

01 ALIGN REGULATION² WITH SUSTAINABILITY PRIORITIES

The transition towards a sustainable future must be adopted as a priority across all levels of governance, and any policy, framework, agreement, mandate, law, regulation or incentive that counterbalances this priority needs to be amended. Intelligent and well-designed regulatory frameworks must be developed that balance the needs of today and tomorrow, respond to immediate societal and planetary needs whilst at the same time lays the ground for long-term prosperity. Mandates of international and national economic institutions (and economic/trade/fiscal policy) should be aligned with sustainability objectives to ensure efforts from all actors pull in the same direction. All regulatory initiatives should put the long-term well-being of social and environmental systems

at their core. Legal recognition of equal rights to a healthy, well-functioning environment.

Regulatory responses must not view economic growth, poverty reduction, social development and environmental sustainability as competing goals to be traded off each other, but as interconnected objectives which are most effectively pursued together. New binding global agreements are urgently needed in the areas of climate change (COP 21 talks in Paris 2015), new post-2015 UN Sustainable Development Goals, governance of global water, food and energy supplies and regulation to protect the global commons such as our oceans and fish stocks.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Support and align with sustainability priorities and frameworks (e.g. UN Global Compact/WBCSD/UN Sustainable Development Goals)
- » Commit to avoid more than 2°C of warming by 2050 and responsibly manage impact on the global commons
- » Withdraw from lobbying against binding agreements / initiatives e.g. climate change

GOVERNMENT

- » Commit to the post-2015 Sustainable Development Goal agenda and international agreements to manage global commons sustainably
- » Establish national sustainability vision and targets
- » Align economic, trade and fiscal policy with sustainability goals
- » Develop innovative tax structures to encourage competition and equality (e.g. negative income tax for poor, small businesses tax free first year)

CIVIL SOCIETY

- » Work with political leaders to develop and implement a sustainable development agenda with concrete targets
- » Demand a goal setting approach with corresponding reporting on progress
- » Map and flag regulations that inhibit sustainability (e.g. building codes and land use requirements)

CHECK OUT



A pioneer in environmental protection, **Costa Rica** has adopted a human rights approach to environmental protection and has included the right to a healthy environment in its constitution.

02 STRENGTHEN THE EFFECTIVENESS OF GOVERNANCE INSTITUTIONS

Governance institutions at all levels need to be more coordinated, representative, effective and flexible, to ensure they are capable of effectively following-up on, monitoring and executing policy.

At the global level, governance is needed to address complex challenges and seize opportunities that transcend national borders. However, global governance today is a patchwork of formal and informal institutions that lack real power to enforce collective decisions. To improve institutional effectiveness and legitimacy, reform is needed so influence more adequately reflects shifts in global power, as well as to avoid silos and duplication of efforts. This will save cost, realise synergies and ensure a more harmonised and coordinated approach.

At the national level, institutional structures must be representative and decision-making processes inclusive and avoid undue influence by vested interests. Many developing countries suffer from low institutional capacity to enforce and execute regulation, and institutional capacity and competence development building is needed.

Where decision-making processes are slow or lead to decisions based on the lowest common denominator (such the deadlock in climate negotiations), structural reform should be urgently considered temporary regional and sub-regional arrangements explored.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Engage with national authorities and other stakeholders to improve effectiveness of governance institutions
- » Partner with public sector organisations to advance sustainable development objectives
- » Align social investment with national priorities

GOVERNMENT

- » Push for urgent reform of global governance structures and treaties to improve operational efficiency
- » Establish a Sustainable Development Council to review performance of countries
- » Support institutional capacity building in low-income countries
- » Explore alternative coalitions in areas where global agreements are difficult to reach or where challenges are regional in nature

CIVIL SOCIETY

- » Participate in dialogue with governments and other stakeholders to identify opportunities to strengthen governance institutions
- » Support local capacity building efforts
- » Align objectives with national sustainable development priorities
- » Raise awareness of how citizens and businesses can support good governance initiatives

“ WITH THE RIGHT TECHNOLOGY, THE REAL TIME EVOLUTION OF A PROBLEM CAN BE ON DISPLAY. THESE ARE NEW WAYS OF NOT ONLY SPEAKING TRUTH TO POWER, BUT ALSO MEASURING PERFORMANCE AND ENGAGEMENT.

BRIGHT SIMONS
FOUNDER
MPEDIGREE

GOVERNANCE

03 BUILD TRANSPARENT AND INCLUSIVE DECISION MAKING

Governance institutions and decision-making processes need to be representative and transparent to avoid undue influence by vested interests and corruption. Fair, reliable, and accountable governing institutions open to public scrutiny, are essential for sustainable development.

In all countries, the public should have a legal right to access government information. This creates visibility and enables civil society to ensure that public officials are making decision in the best interest of society. Similarly, the existence of independent media, and the use of social media technology to investigate and report misuse of power is critical. An effective and independent

judiciary is important to ensure misconduct is investigated and regulation enforced.

Inclusiveness in policy decisions is vital, as it is ensuring that marginalized groups are equally represented. Peripheral and new ideas should be encouraged to flow to the centres of power. At most levels, this will require a more consultative approach to decision-making that encourages the involvement of community-organisations, youth and others to shape their own future.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Adopt a zero-tolerance policy against corruption and implement measures for monitoring and reporting » Support and engage with local collective action initiatives » Publish what you pay » Regularly and actively engage with stakeholders 	<ul style="list-style-type: none"> » Formalize mechanisms for involving stakeholders in decision-making processes » Strengthen capacity of independent media and judiciary » Empower and involve marginalised groups in decision-making » Establish a legal right to access government information 	<ul style="list-style-type: none"> » Monitor and report on government » Support and advance free, independent media » Strengthen inter-generational dialogue » Mobilize religious leaders around sustainable development » Educate to ensure that people have adequate information

CHECK OUT

» In India, ipaidabribe.com is a site allowing ordinary citizens to report on bribes paid to government officials to get work they are legally entitled to do. All reports are publicly available.

Natural resource extraction can lead to corruption and conflict. See how much governments are receiving from extraction of resources in [Extractive Industry Transparency Initiative](#) reports.

“ SOCIETY HAS TO TAKE DECISIONS. IF THEY ARE INFORMED BY SCIENCE, WE MIGHT TAKE THE RIGHT DECISIONS. IF THEY'RE NOT INFORMED BY SCIENCE, WE WILL CERTAINLY TAKE THE WRONG DECISIONS.

JOHN ASHTON
INDEPENDENT
COMMENTATOR
AND ADVISOR
ON THE POLITICS
OF CLIMATE
CHANGE

04 MAKE INFORMED AND LONG-TERM DECISIONS

Decision-making at all levels and in all sectors should be based on and aligned with best available scientific knowledge on global challenges. The scientific community should take a stronger stance to actively influence strategy development and decision-making in both the public and private sphere. Science can and should provide guidance to help steer decisions towards long-term societal priorities.

For humanity to deal with climate change and other global environmental threats that lie ahead in the 21st century, political discussions and regulation on environmental issues must be grounded on accurate understandings of the underlying Earth system science. The Planetary Boundary framework

is valuable for policy. It establishes a set of boundaries or safety margins around complex thresholds that are intertwined at regional and global scales, and these can be used directly in decision-making processes.

Post-2015 UN Sustainable Development Goals (SDGs) to align international effort in addressing risks are in the making. Goals for global sustainability are needed to provide essential targets for societies and must be based on scientific evidence.

The targets for the SDGs must be measurable, based on the latest research and should apply to developed and developing countries.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Align corporate strategy and decision-making with scientific evidence to ensure business becomes a force for long-term good » Large companies should create a Chief Science function or invite scientists onto strategic advisory boards » Invest in long-lasting green infrastructure 	<ul style="list-style-type: none"> » Benchmark national performance against Planetary Boundaries and set targets » Improve collection of data on society and environment » Finance effective national statistical offices in developing / emerging economies » Increase funding for science education 	<ul style="list-style-type: none"> » Strengthen the role and influence of research and science » Raise awareness among the general public to understand issues » Citizens, coordinated by civil society organisations (CSOs) need to hold their governments accountable » Publicize examples of long-term thinking

CHECK OUT

» The [European Climate Foundation's Roadmap 2050](#) project analyses pathways to reduce energy consumption and climate impacts, providing policymakers with tools to make informed decisions about the region's energy future.

Germany's [Energiewende](#) sets policy targets to gradually phase out nuclear power by 2022 and increase the renewables' share in national electricity production to 80 per cent in 2050.



LEADERSHIP IS ABOUT ACTING WITH RESPONSIBILITY. IT HAS TO BE BALANCED WITH SOMETHING GREATER. NOW LEADERSHIP DOES NOT HAVE THIS DEPTH OF MEANING.

ALEC LOORZ
FOUNDER,
IMATTER AND
KIDS VS. GLOBAL
WARMING



SOME OF THE MOST EXCITING INNOVATIONS WE HAVE DOCUMENTED HAVE IN COMMON THAT THEY ARE COLLABORATIVE.

GEORG KELL
EXECUTIVE
DIRECTOR,
UN GLOBAL
COMPACT

GOVERNANCE

05 ENCOURAGE VISIONARY LEADERSHIP AND LONG-TERM THINKING

A fundamental shift in the quality of leadership is needed, across all domains, if we are to bring about positive change. Short-termism fostered by political election cycles, quarterly performance reporting and immediate rewards are prohibitive of decisions for the long-term. Existing structures must be reoriented towards long-term policies and longer-term returns on investments.

To restore trust, business leadership must be invigorated and reconnected with societal progress. The attention of the boardroom to foster big and bold leadership is needed

to ensure we are actively managing risks, identifying opportunities and catalysing innovation. Leaders losing this sense of unity risk being harshly scrutinized and lose legitimacy and reputation in the market place.

Frontrunners have long been knocking on the door of transformation, but issues and challenges must also be understood by all citizens. Politicians, business leaders, civic and religious leaders - must collectively make the case for sustainability and ensure everyone knows what to do in their personal and professional lives to advance that goal.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Develop business vision and goals aligned with long-term sustainability objectives » Stand-up and actively advocate to peers and stakeholders a long-term perspective » Set ambitious zero-impact targets 	<ul style="list-style-type: none"> » Develop collective vision for - and pathway towards a sustainable future » Develop and adapt effective responses to long-term sustainability challenges » End political backroom deals by ensuring the process is transparent and open to the public 	<ul style="list-style-type: none"> » Strengthen accountability at all levels » Support visionary thinkers and leaders » Celebrate leadership examples » Ensure open and transparent communication platforms

CHECK OUT



The **Ibrahim Prize for Achievement in African Leadership** awards outstanding leaders who have developed their countries, lifted people out of poverty and paved the way for sustainable and equitable prosperity

Under **Paul Polman's** leadership, Unilever - one of the world's largest companies - has set out an ambitious vision to double its size while reducing its overall environmental footprint and increasing its positive social impact.

06 HARNESS THE POWER OF COLLABORATION

We live in an era of 'wicked' interconnected trans-border problems too large and too complex for any one actor or sector to solve alone. Embracing complexity means recognizing the need for cross-sector collaboration. Simple solutions from operating in silos have proven costly and have failed to adequately address challenges. By pooling resources, knowledge, competence and insights from a range of actors, new solutions, approaches and opportunities can be brought to light and efforts to transform existing structures and practices scaled. However, realising synergies from collaboration has proved difficult.

For collaboration to work, more effective models are needed, and there is a need to ensure clarity and alignment on objectives, roles and responsibility and reporting lines as well as clarity on the circumstances under which collaboration can work and similarly when it is not a good strategy. Collaboration is clearly more desirable if there is a demonstrated win-win situation e.g. if the size of the pie is increased for all. By working more effectively together we can more quickly advance our common goals.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Implement a company policy to engage in partnerships locally to address complex challenges and nurture local initiatives and solutions » Align initiatives with local priorities » Engage in collective action efforts with peers to move the sustainability agenda and create a level playing field 	<ul style="list-style-type: none"> » Identify effective collaboration models to overcome complex sustainability challenges » Establish collaborative platforms for ideas and solutions » Incentivise volunteerism e.g. allow tax deductions for it 	<ul style="list-style-type: none"> » Identify effective collaboration models to overcome complex sustainability challenges » Citizens, coordinated by civil society organizations (CSOs) need to hold their governments to account » Teach collaborative leadership in schools

CHECK OUT



The ground-breaking energy efficiency retrofit of the **Empire State Building** realized by a team of leading organizations - such as the Rocky Mountain Institute - to not only maximize energy savings, but also build a strong economic case.

STABLE AND PROSPEROUS SOCIETIES: ENSURING RESILIENCE, EQUITY AND WELL-BEING

The actions we take today will define our opportunities for generations to come. To build a stable and prosperous future for all, we must tackle the problems of poverty, inequality and socio-political discontent alongside global environmental and economic challenges. Where there are scarce resources and a lack of access to opportunity, there are foundations for conflict and unrest. Social priorities and development goals must underpin efforts to tackle sustainability challenges so as to allow a larger share of the global population to thrive – yet without compromising the planet that sustains us.

To protect and advance the diversity and richness of human society, urgent change is needed.

HERE WE OUTLINE
SIX ENABLERS
TO CREATE GREATER
EQUITY, RESILIENCE
AND WELL-BEING



A SUSTAINABLE SOCIETY IS ONE IN WHICH WE CAN FLOURISH WITHIN OUR PLANETARY LIMITS. WHERE EVERYBODY – US, AND FUTURE GENERATIONS HAVE THE ABILITY TO MAKE OUR DREAMS COME TRUE, BUT WE DO IT IN A WAY THAT DOESN'T COMPROMISE ANYBODY ELSE'S ABILITY TO MAKE THEIR DREAMS COME TRUE.

KEVIN NOONE

DIRECTOR OF SWEDISH
SECRETARIAT FOR
ENVIRONMENTAL
EARTH SYSTEM
SCIENCES



“ AID PLAYS A VITAL ROLE IN TIMES OF EMERGENCIES, BUT DOES NOT EMPOWER A GENERATION TO ALLEVIATE ITSELF OUT OF POVERTY. EMPOWERMENT IS WHAT THE WORLD NEEDS. ”

SARAH COLLINS
FOUNDER AND CEO
NATURAL BALANCE,
WONDERBAG

“ I THINK IT'S EASY TO IMAGINE HOW THE POPULATION CAN BE SUSTAINABLE. IT RELATES TO THE WELL-BEING OF WOMEN. ”

ROBERT ENGELMAN
PRESIDENT
OF WORLDWATCH
INSTITUTE

SOCIETIES

01 ENSURE BASIC NEEDS AND RIGHTS ARE MET

To foster a decent quality of life for the growing global population, we must ensure that - at a minimum - basic needs such as access to food, safe drinking water, education, healthcare, shelter and energy are met. When more people are healthy, feel safe and have livelihoods to support their families, communities can thrive.

Although the main responsibility for ensuring basic needs are met rests with governments, all societal actors have a responsibility to support. Meeting the basic needs of vulnerable populations avoids a host of humanitarian, socio-economic,

environmental, political and security-related challenges - favourable for business and communities alike. A key priority is to ensure more equitable distribution of wealth and income opportunities, strengthen (rural) infrastructure and markets, education and health.

A focus should also be to develop energy supply systems providing accessible and affordable energy services without compromising environmental objectives.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Operate responsibly and fairly to improve impact of business » Develop inclusive business models and pro-poor product lines » Recruit and source locally, and transfer knowledge and competence to local businesses » Partner with international organisations, governments and civil society on development projects 	<ul style="list-style-type: none"> » Address trade, taxation and other policy distortions which reinforce wealth concentration, inequality and exclusion » Invest in green efficiency in the agricultural sector in low-income countries » Provide assistance to low-income countries to strengthen resilience against climate changes » Establish social safety nets to protect the most vulnerable 	<ul style="list-style-type: none"> » Be transparent about funding and impacts of projects and align efforts with national priorities » Ensure the voice of the most vulnerable is heard to ensure efforts respond to needs » Support female and young entrepreneurs » Ensure that women have information on - and access to - family planning

CHECK OUT

» Liter of Light takes green technology to the grassroots, redesigning solar lighting for the developing world using plastic bottles. The simple design creates local jobs, teaches green skills, and empowers communities.

Khan Academy - an educational website provides free world-class education for anyone, anywhere.

02 ADVANCE SOCIAL EQUITY AND JUSTICE

Equitable societies are characterised by higher levels of trust, better educational performance and health, lower levels of crime and greater stability⁷. High levels of inequality in a society - manifested through unequal access to education, employment opportunities, healthcare provisions, decision-making and political participation, on the basis of ethnicity, social class, gender, ability and sexual orientation - are found to cause greater levels of social dysfunction.

Reducing inequality and discrimination not only contributes to realising the human potential and more equitable distribution of resources, opportunities and obligations, it also

enables social mobility, provides social stability and allows all people to become active contributors to society.

Advancing equity is key to ensure a more equitable distribution of well-being and shared prosperity. Higher levels of equality also has an impact on the quality of decision-making, and lead to more sound policy-making, more in line with sustainability priorities, as decisions are representative and not based on vested interests. Embracing diversity is not only vital for advancing social well-being and stability and safeguarding the environment, it also makes business sense.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS	GOVERNMENT	CIVIL SOCIETY
<ul style="list-style-type: none"> » Embrace and harness diversity, and uphold principles for fair labour practices, including equal remuneration, in own operations and throughout the supply chain » Ensure female representation in board rooms and top management » Advance economic opportunity and entrepreneurship 	<ul style="list-style-type: none"> » Ensure regulation and policy do not reinforce discrimination but takes into account principles of equity » Advance female representation in political and government positions at all levels » Ensure high-quality universal education focused on empowerment, leadership collaboration and entrepreneurship » Ensure access to family planning services for all women 	<ul style="list-style-type: none"> » Raise awareness of and challenge systemic inequalities » Partner with business and government to develop inclusive strategies embracing diversity » Avoid stereotypical presentations in the media and challenge cultural norms that contribute to inequality

CHECK OUT

» Joint Forest Management guidelines in India emphasize the involvement of local communities in the protection, afforestation and development of degraded areas with participation of women and vulnerable groups in society.

SOCIETIES

03 FOSTER SKILLS
AND EMPLOYMENT

Improved education and skills open up opportunities for employment. Employed individuals are better equipped to be self-sufficient and become active and productive members of society. High levels of unemployment reinforce social divides and deepen poverty. High dependency ratios are also detrimental to sustainable economic growth, as it increases the burden on the active workforce.

To address the problems of long-term unemployment and foster sustainable job creation, a key focus should be to

promote entrepreneurship, business creation and innovation. The transition to a new economy offers great potential for creating new jobs and developing new markets that better align market forces with societal needs.

To improve employability of youth, vocational skills training and apprenticeships should be offered by all sectors. Also, exploring more flexible employment arrangements will allow people to remain in the workforce throughout different phases of their lives.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Public-private partnerships that promote technological and vocational training, lifelong learning and entrepreneurship
- » Offer flexible contractual agreements
- » Focus on skills to develop, adopt, implement or adapt new technologies

GOVERNMENT

- » Forecast skill needs and invest in education and training to respond to future needs
- » Provide targeted incentives (grants / funds) to promote sustainable business creation and innovation
- » Predictable regulation to enable businesses to make long-term investment and allow entrepreneurs to succeed
- » Redirect subsidies from big, global companies to local businesses

CIVIL SOCIETY

- » Direct efforts towards fostering vocational and entrepreneurial training in local communities
- » Engage with business and government to identify local business opportunities aligned with local sustainability priorities and resources
- » Create platforms in every community to train and mentor entrepreneurs

CHECK OUT



'A new chance': 25 per cent of **Stormberg's** employees, a Norwegian clothing company, are former criminals and drug addicts, offering them a way back to society through work.



LET US SPREAD MORE
POSITIVE MESSAGES ABOUT
WHAT A CLEANER, GREENER
ECONOMY CAN ACHIEVE.

JESSICA CHEAM
EDITOR,
ECO-BUSINESS.COM

04 CHANGE MINDSETS
AND BEHAVIOUR

The future is the outcome of the millions of choices individuals make every day. Engaging and mobilizing people is key to moving beyond our current patterns of thinking and adopting more sustainable lifestyles.

For people to consider sustainability in their personal lives, a shared sense of urgency must be created by connecting to people at a personal level, through their hearts and minds. Engagement can be accelerated by relating change to personal concerns and positive benefits such as community development,

local environment, cleaner air and better health, stability, and the creation of jobs. A wider, shared understanding of our current 'business as usual' trajectory may also drive change. We need a shared vision on the desired future and the actions and solutions needed to make this a reality.

As people become more aware of their role in the creation of a safe and sustainable future, it can help build positive confirmation for leaders in business and policy to promote long-term sustainability interests and objectives.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Empower and motivate consumers through reliable and actionable information about products and services
- » Create space for ideas to flourish and encourage and promote positive change
- » Visionary leadership to point out a new direction and advocate for change
- » Communicate in a new language of opportunity

GOVERNMENT

- » Incentivise sustainable choices
- » Work with stakeholders to create and communicate a compelling sustainability vision that provides direction and ambition
- » Agree to binding targets and timetables on carbon reduction
- » Require decisions to be made with an advocate for future generations
- » Fund the arts

CIVIL SOCIETY

- » Business, governments and society (community, citizens, customers) must work together to define sustainable products and lifestyles
- » Media should take responsibility for communicating findings of the scientific community
- » Teach systems thinking in all schools

CHECK OUT



The **Land Art Generator Initiative (LAGI)** - bringing together artists, architects, scientists and engineers to increase popular acceptance of clean energy infrastructure through art and design.

Sustainia aims to make sustainability more tangible and easier to grasp by sharing inspirational examples of sustainable practices that can be used today.



SUSTAINABILITY IS ABOUT CONTINUED THRIVING. ANOTHER ELEMENT IS THE CONCEPT OF RESILIENCE - KNOWING THERE ARE PRESSURES AND SHOCKS SET TO HIT US, SOME OF WHICH WE CAN'T EVEN THINK OF NOW, BUT HAVING THE CAPACITY TO CONTINUE TO THRIVE.

JEREMY BENTHAM
VICE-PRESIDENT,
ROYAL DUTCH SHELL

SOCIETIES

05 STRENGTHEN RESILIENCE AND ADAPTIVE CAPACITY TO CLIMATE CHANGE

To reduce vulnerability to climate change and extreme weather events, business and society must assess risks and invest to build resilience. If hazards are unaddressed it can create cascading effects, including severe human impacts, social instability, economic turmoil and business discontinuity.

Building resilience can be understood as a systems ability to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.

Therefore, countries must invest today to safeguard critical infrastructures, populous areas, and centres of economic activity against future climate-related losses. In particular, developing countries that are most vulnerable to climate risks need better support in developing and financing their adaptation strategies.

Resilience thinking is relevant to countries, companies, cities, and communities alike. Institutions must be prepared to operate with far greater flexibility than at present, and must improve their ability to operate during and after disruption.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Build more resilient assets
- » Build resilience in supply chains to avoid discontinuity
- » Create a platform for sharing information on adaptation between industrial sectors
- » Develop more dynamic and resilient business models and decision-making processes

GOVERNMENT

- » Identify vulnerable parts in infrastructure and communities
- » Invest and manage the resilience of systems and infrastructure
- » Coordinate preparation, response and recovery between businesses and society at large
- » Invest in distributed, anti-fragile infrastructure

CIVIL SOCIETY

- » Evaluate the resilience of communities
- » Collaborate among stakeholders on preparedness measures
- » Develop and share information on how to adapt to climate change
- » Teach resilience and sustainable design in engineering schools

CHECK OUT



NY City (Bloomberg) Adaptation Plan: Under the administration of Mayor Michael Bloomberg, New York City's PlaNYC initiative analysed climate risks and developed a USD 20 billion plan for adaptation measures for critical infrastructure and vulnerable neighbourhoods.



CITIES AND BIG COMPANIES ARE THE TWO MAIN DRIVERS OF SUSTAINABILITY, AND THEY HAVE TO COMBINE THEIR EFFORTS.

MARINA GROSSI
PRESIDENT
OF BRAZILIAN
BUSINESS COUNCIL
FOR SUSTAINABLE
DEVELOPMENT

06 MANAGE URBANISATION SUSTAINABLY

The growth of cities is driven by the prospects of jobs and a higher standard of living. Actions across the urban space in the areas of land use planning and hazard risk, housing, infrastructure, and urban transport need to be coordinated to build sustainable cities⁸.

While city development, job creation and competitiveness are in the interest of city leaders and citizens alike so too is there a common interest in improving quality of life. For city development to be sustainable, focus and investments

must be stepped up on environmental consequences such as habitat destruction, poor air quality, sewage and waste. Low-pollution cities are essential to a high quality of urban life. Urban problems such as traffic congestion, housing and crime must be dealt with to ensure the quality of life for citizens.

Planning and investment decisions must be made to improve living conditions - especially in slums - and to manage development in hazard-prone areas. The carbon footprint of cities must be reduced and energy shifted to low carbon trajectories.

WHAT CAN BUSINESS, GOVERNMENT AND CIVIL SOCIETY DO?

BUSINESS

- » Provide capital outlays to develop smarter and greener infrastructure and services
- » Leverage competitive markets alongside regulation to expand basic infrastructure
- » Partner with local organisations and authorities to expand urban green infrastructure to low-income communities

GOVERNMENT

- » Chart a course for cities by setting the terms of urbanisation e.g. policies for expanding basic infrastructure and public services
- » Value the cities land by establishing systematic and transparent assessment
- » Develop next-generation building codes and appliance standards with improved enforcement

CIVIL SOCIETY

- » Create platforms for stakeholder interaction between innovative entrepreneurs and investors
- » Encourage 'gamification' of resource use (e.g. neighbours competing on reducing energy consumption, water use, waste, improve recycling rates)
- » Support urban gardens/ agriculture and green spaces
- » Support local initiatives to improve slums (e.g. Slum Dwellers International)

CHECK OUT

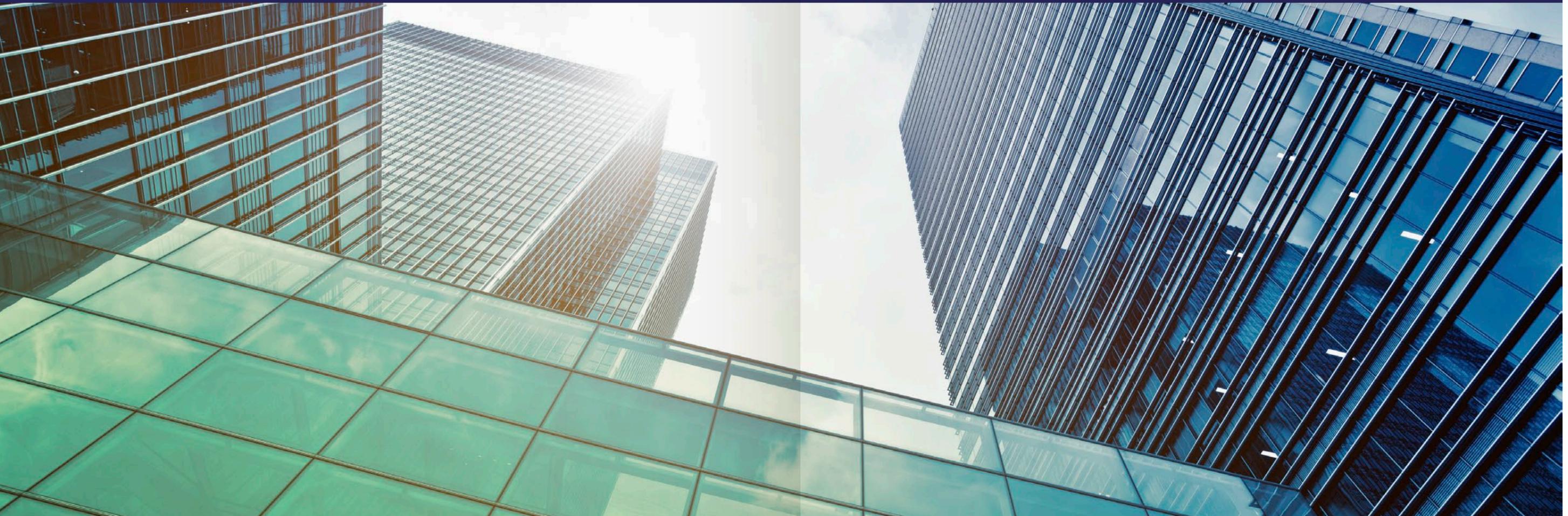


WBI Urban programme equipping city leaders and practitioners in city management with innovative strategies and tools to maximize the benefits of urbanization.

The Colombian city of **Monteria** shows how cities can grow their economies while focusing on clean urban mobility, waste management, protecting the city's natural heritage with biodiversity and reforestation.

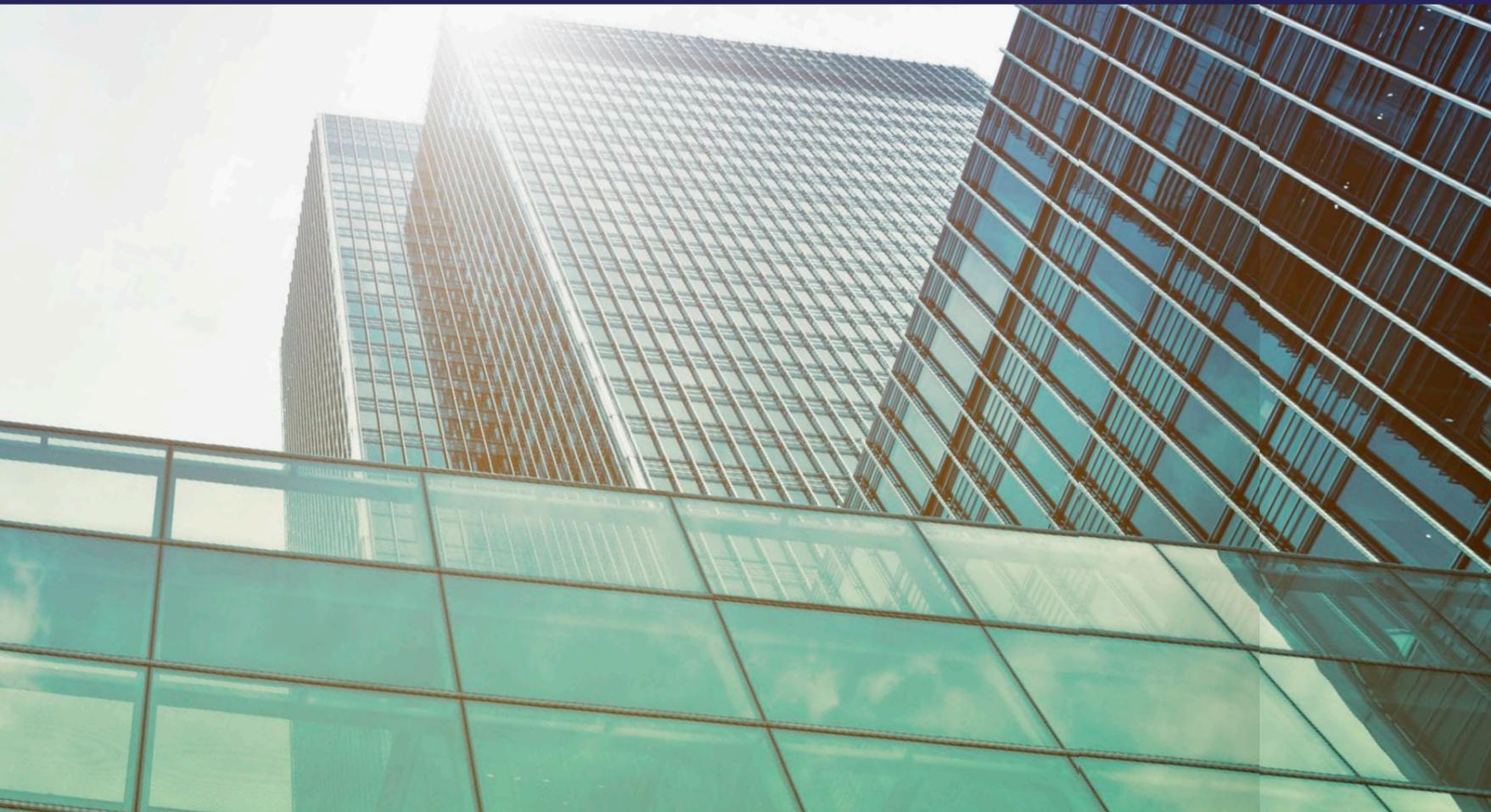
CHANGING COURSE: SECTOR SPOTLIGHTS ON SUSTAINABILITY

5



“ For-profit corporations must be better aligned with public policy and societal priorities. That’s clearly the vision for the future. In practical terms, it means individual corporations must fully master the integration of environmental, social and governance issues, and have a long-term vision that articulates what sustainability means for their business model.

Georg Kell, Executive Director, UN Global Compact



The world is changing and tension is growing between balancing economic, societal and environmental needs. Companies are coming under increased pressure to rethink how they conduct business. Radical change is needed – from how businesses organise and operate, to the materials, processes, products and technologies they make and sell.

Dynamic companies need to rethink their purpose and stimulate innovation to effectively meet sustainability challenges and solve the problems that we face today. They will accelerate sustainable innovations by working more closely with government and civil society.

IN THIS CHAPTER, we look at the implications of our vision for a safe and sustainable future on five key sectors that we have particular expertise and knowledge in. The spotlights include:

- » Shipping
- » Electricity
- » Oil & Gas
- » Food & Beverage
- » Healthcare

The spotlights build on elements presented in the previous chapters of the report and highlight the challenges, barriers and pathways DNV GL believes are the most important.

We also include a brief description of the role DNV GL will play in enabling the transition to a safe and sustainable future and present practical examples

of how we work with business to enable safer, smarter and greener solutions.

Our intention is to highlight the most pressing risks we see facing each respective sector so that we can collectively make informed decisions and seize opportunities going forward.

The structure of the sector spotlights mimics the rest of the report. We outline:

- » Our vision for a safe and sustainable sector
- » Key challenges and barriers to overcome
- » The action pathways towards greater sustainability
- » The role of DNV GL in enabling the transition

SAFE AND SUSTAINABLE SHIPPING

Almost every product we own and use, at some point, probably travelled to us by container ship; and it's likely that the world's waterways, ocean routes and ports will still be crucial to world trade in 2050. Therefore improving the shipping industry's energy use, pollution control, impact on marine life and health and safety standards would make a major contribution to creating a safe and sustainable future. The sector's global reach can also help spread sustainability best practice to some of the least developed parts of the world.

MAJESTY OF THE SEA

WHERE WE WANT TO GO: SHIPPING VISION 2050

Our vision for a safe and sustainable shipping sector is based on a triple ambition of improving safety, efficiency and the environment.

Our vision for shipping in 2050 is of a safer and cleaner sector, able to service the needs of a greater world population without growing costs. It not only helps food and other goods to travel the seas, but it maintains jobs and livelihoods.

THE VISION'S KEY CHARACTERISTICS INCLUDE:

NO ENVIRONMENTAL AND PUBLIC HEALTH IMPACT

The industry has phased out sulphur-rich, high carbon fuels and replaced them with a mix of energy sources including electricity, biofuels and LNG. This has curbed emissions of greenhouse gasses, particulate matter (PM), sulphur and nitrogen oxides (SO_x, NO_x), with direct CO₂ emissions reduced 60 per cent from present levels.

Similar improvements have been made to local air quality in coastal cities, reducing the incidence of respiratory diseases and premature deaths. The problem of commercial ships bringing invasive species with them and threatening marine habitats has been controlled and eliminated. On shore, the recycling of ships has been transformed, and is now only conducted in specialised facilities with high standards of safety, labour rights and recycling practices.

SAFETY AS STANDARD

The industry has tackled its high fatality rates, reducing them by 90 per cent from present levels to meet OECD best practice for industry workers. By 2050, it is just as safe to work on a ship as ashore, and passengers rely on ships as a thoroughly safe means of transport. The digital age has been harnessed with new technologies helping to prepare crews for extreme events at sea and avoid risks, wherever possible.

A VITAL AND COST-COMPETITIVE SECTOR

Shipping has remained a vital part of the world economy, and has benefited from significant cost-efficiency improvements, including energy efficiency. Some cleaner fuels and other technologies may have initially increased costs, however competition and profitability were able to act as powerful drivers that reduced costs across the sector. The freight cost as a percentage of the value of goods has not risen at all between 2010 and 2050.



90%

reduction in fatality rates
from present levels.



60%

reduction in fleet CO₂ emissions
from present levels.



zero

increase in freight costs
from present levels (relative
to cargo value).

SHIPPING

KEY CHALLENGES
TO OVERCOME

To achieve our 2050 vision, the sector must take action on a diverse range of issues, many of which are on a global, sector-wide scale.

REDUCING EMISSIONS

The sector must find a way to meet growing demand for seaborne trade while also reducing CO₂, SO_x and NO_x emissions. For shipping to play its part in restricting global temperature rises to below 2°C, the industry will need to reduce CO₂ emissions by 60 per cent on current levels. Taking growth trends into account means that shipping must cut CO₂ emissions per transported unit by 80 per cent in 2050.

REDUCING ENVIRONMENTAL DAMAGE

Currently merchant shipping too often damages marine ecosystems through accidental oil spills or by introducing invasive species through ballast water and on the hull.

PROTECTING LIVES AT SEA

On average there are around 900 crew and passenger fatalities per year due to ship accidents with similar numbers related to individual accidents. There is therefore some way to go before OECD levels of best practice can be met.

IMPROVING AFFORDABILITY

Shipping freight cost has steadily declined over the past decades, and is down to 6 to 11 per cent relative to the value of goods according to UNCTAD. However economies of scale cannot be fully exploited in all regions due to the lack of land-to-shore infrastructure and low trade volumes. Costs can also vary widely depending on transport distance, volume and the value of goods.

ACCESSING CAPITAL FOR NEW TECHNOLOGY

Investment in new technology is needed but payback periods for cleaner technologies can be long, suffer from insufficient capital and require the training of crew in new competences or use of new equipment. There is also the inherent potential for unforeseen technical issues adding further to the cost.

SPLIT INCENTIVES

In the shipping sector it is often charterers of ships who pay for the fuel, removing any financial motivation for ship owners to explore alternative fuels and energy efficiency measures.

LACK OF INFRASTRUCTURE

New fuels, such as LNG, tend to require new infrastructure with both ship owners and energy providers reluctant to finance it.

LIMITED STANDARDISATION AND REGULATION

The mix of different governmental bodies involved in global shipping has limited the standardisation of data and formats. This holds back data sharing, limits the integration of systems and locks-in use of old technologies. It has also created a complex patchwork of regulations that discourages investment in research and development due to proprietary issues.



900

crew and passenger fatalities
in ship-related accidents per year.

20,000

marine organisms introduced
in non-native habitats every day.

900 mill.

tonnes of CO₂ emitted
each year.

SHIPPING

HOW TO GET THERE: PATHWAYS FOR CHANGE

In order to overcome the challenges and reach our safe and sustainable vision for the sector, we believe that the shipping industry must prioritise the following actions in the coming years:

GREEN SHIP FUELS AND VESSEL DESIGN

To reduce its environmental and health impacts, the sector needs to make significant improvements to energy efficiency and undergo a major shift in its fuel mix. Liquefied natural gas fuel (LNG) should be embraced in the short-term with an increase in biofuels, electric batteries and renewable energy harnessed over time.

More radical solutions such as nuclear power or ships fitted with their own carbon capture and storage systems should be considered but are probably best left on land to produce carbon-neutral electricity for the sector to use. A massive scaling up of global infrastructure will be required to deliver new technology fuels such as LNG.

A new focus on ship design is also required. Traditional ship design practices, including the shape of the hull and the location of machinery, will need to change in order to assimilate new technologies. Emerging energy efficiency technologies in the areas of vessel hull and hydrodynamics, bio-inspired processes and components, energy storage, recovery, harvesting and electrification must all be given the opportunity they need to realise their potential.

MAKE IT SAFE TO GET BACK ON THE WATER

The current crew fatality rate in shipping is 10 times higher than the OECD best practice for industry workers, with ship workers too exposed to risks such as major accidents, grounding, collisions and fire.

To vastly improve and create a culture of safety, five key challenges in maritime safety have been identified that must be met. These are: i) putting more focus on large-scale accident risk; ii) not solely relying on technology and procedures as a panacea; iii) avoiding an autocratic work environment; iv) addressing human error; and v) taking a more pro-active attitude towards a learning and safety culture.

These are complex challenges for owners and ship managers, with many variables to consider given the potential range of behaviours, how personnel interact with heavy machinery and the potential for severe weather and harsh conditions far from land-based resources. However, digital technology, computer modelling and improved design can help improve ship stability, and better prepare ships for fire, extreme weather and evacuation at sea. New technologies should also be focused on improved human to machine interactions and on automating routine tasks so the crew can stay fresh and make better decisions.

As is already a reality in subsea operations, merchant shipping may increasingly turn to remote-controlled or even fully autonomous ships to limit risk to humans – although many concerns remain with this approach.

INVEST IN A SMARTER, MORE COMPETITIVE SECTOR

To improve competitiveness and efficiency the sector must get smarter, by harnessing ICT and big data analytics. The focus should be on creating ultra-efficient supply chain coordination to reduce empty space on ships; creating virtual design laboratories to produce vessels with radically lower cost and energy profiles and improving communications to improve logistics and maintenance operations.

Competition and transparency should be welcomed in order to drive ship and freight owners towards more cost efficient operations; although stringent, minimum safety and environmental performance levels also need to be enforced.

To catalyse investment in energy efficiency, the sector must find new finance models that share the benefit of fuel savings between ship owner and charterers. Collaboration with regulators should also be welcomed, with policy makers asked to take a lead on finding the balance between the ambitions for the sector of creating value, improving efficiency, ensuring safety and protecting the environment.

SNAPSHOT OF OPPORTUNITIES

- » Provide effective tools and processes to take shipping to the next level.
- » Change financial and business models so that ship owners, investors and charterers are incentivised to invest in energy efficiency.
- » Invest in new technologies, particularly for governments as buyers of transportation services.
- » Capitalise on new, shorter trade passages through the arctic which are likely to become accessible due to global warming, but only if new rules for safe transport in the arctic can be agreed.
- » Invest in renewable energy installations at sea, with specialised ships to service them, including wind mills, tidal power and ocean thermal energy conversion (OTEC).

SHIPPING

THE ROLE OF DNV GL IN ENABLING THE TRANSITION

The impact of technological advances, increasing public engagement and changing industry mindsets will create new opportunities for the industry to become safer, smarter and greener in the years and decades to come.

As the world's leading classification society, and a recognised advisor for the maritime industry, we will continue to work to enhance safety, quality, energy efficiency and environmental performance of the global shipping industry - across all vessel types and offshore structures.

As maritime experts we will use our independence to mobilise the full potential of the industry - with collaborative innovation and by addressing strategic, operational and regulatory challenges preventing our transition to a safe and sustainable future. By working through inter-governmental agencies, such as the International Maritime Organisation, we will ensure that regulations are global, achievable, measurable, and verifiable - and create wider value for society.

DNV GL STRATEGIC PROJECT:

THE FUTURE OF SHIPPING



The drive for sustainability is rewriting the rules for all industries - and shipping will be no exception.

New market drivers and new technologies will enable a safer, smarter, greener fleet of the future to transport goods and people safely and sustainably. Our shipping work highlights the key trends and game changers that we believe will play the biggest role in the future of shipping. We also identify indicators that can be used to measure the sustainability of shipping and six technology pathways that we believe hold the greatest potential to make shipping safer and more sustainable.



Want to know more?
[www.dnvgl.com/
future-shipping](http://www.dnvgl.com/future-shipping)

CASE



CORVUS ENERGY: SHIP-SHAPE TECHNOLOGY

When a ship sets sail across hazardous seas or oceans, the reliability of its power supply can be a matter of life and death. So before industrial sectors such as shipping can switch to cleaner fuels, they need absolute confidence that the new products will work.

That is why, when Corvus Energy designed their new Lithium-ion-battery system for use in offshore oil and gas and commercial shipping, they approached DNV GL for type-approval of their battery modules - i.e. to test that it meets or exceeds the regulatory, technical and safety requirements for industrial use.

The new technology passed, and became the world's first battery pack to be validated in this way, therefore giving industry new potential to improve fuel efficiency and reduce emissions.

A VOYAGE TO THE FUTURE

The battery pack has already proved popular and has, for example, been used as a source of power for the Folgefonn ferry in Norway and Eidesvik's 6,000 ton offshore supply vessel Viking Lady (pictured). New applications for the energy storage system, beyond marine and offshore applications, are also being explored.

The battery is a valuable contribution to creating a safer, smarter and greener shipping fleet of the future.

 For more cases, please visit DNV GL Vision Stories:
dnvgl.com/vision-stories

SAFE AND SUSTAINABLE ELECTRICITY

Since we first plugged into electricity around four centuries ago mankind has used electricity to make life better, primarily by using it to control the adverse environmental factors which can harm us. In the years to come however, the evolution of the electrification sector will be pivotal to defining how much we harm the environment. It will also be key to unlocking the economic growth which can provide stability and prosperity for a global population of nine billion.

WHERE WE WANT TO GO: ELECTRICITY VISION 2050

Our vision for a safe and sustainable electricity sector is one that is efficient and affordable, and powered by cleaner and more decentralised sources.

Our vision for 2050 is an electricity sector that caters for both environmental and social concerns. It will deliver universal access to safe and affordable energy services. Energy use will be far more efficient than today, energy supply will be dominated by low carbon technologies and, in the case of electricity generation, will be mostly decentralised.

THE VISION'S KEY CHARACTERISTICS INCLUDE:

EFFICIENCY

Widespread adoption of modern technologies such as smart grids, CHP plants and energy storage solutions have created a much more efficient and effective electricity supply infrastructure, that is capable of dealing flexibly with inputs from variable sources. More energy-efficient appliances and new materials, e.g. for insulation, have reduced the energy needed for specific energy services such as cooling or heating.

CLEAN ENERGY DOMINANCE

Emissions in the power sector will be a quarter of today's levels by 2050. The energy mix is characterised by dominating renewable energy sources and a remaining base of low-carbon fossil-fuel technologies. Clean energy use

will be backed by universal regulation to penalise carbon emissions; the deployment of hydro, wind or solar power will tend to be determined by geography. i.e. socio-economic structure, climate and the networks. The shift to new energy sources has also reduced local air pollution, boosting public health.

DECENTRALISATION AND DEMOCRATISATION

Electricity has become the essential energy source for transportation and, residential energy needs, including heating, and much more of this energy comes from decentralised generation such as micro wind turbines, solar panels on residential roofs or stand-alone combined heat and power stations. These are often owned and operated by local consumers and businesses spurring local and regional development without environmental degradation, whilst ensuring security of supply.

ENERGY FOR ALL

Everybody has access to affordable basic energy services such as heating, lighting and electricity-based household appliances, ending the scourge of fuel poverty. Much of the low-cost energy, especially in the developing world, comes from clean technology sources such as solar.



50-80%
share of electricity from renewable energy sources by 2050.



100 kWh
per person annually needed to provide basic energy to those who now have none. (Average US household uses 11,040 kWh per year).



\$400 bill.
is the amount of money the world needs to spend per year to meet UN's goal of bringing clean and modern electricity to all people by 2030.

ELECTRICITY

KEY CHALLENGES
TO OVERCOME

The obstacles to creating a safe and sustainable electricity sector cut across a variety of social, environmental and economic areas.

INCREASING DEMAND

Ever increasing energy demand, driven by economic and population growth and growing mobility, makes the transition harder as our fossil fuel dominated energy sector is stretched just to meet demand. At the same time an enormous amount of energy is wasted by the use of obsolete technologies and negligent consumer behavior. New energy-efficient technologies often face too many barriers for deployment.

ENERGY POVERTY

Access to energy is uneven and energy poverty remains a serious issue in developing as well as developed countries. Innovative technologies in energy supply and in energy-efficiency need to be adopted and/or transferred to developing countries, possibly complemented by redistributive schemes and local innovations, to ensure that all have access to basic energy services.

COST CONCERNS

Over many decades, fossil fuels have provided cheap and reliable energy supply: Petroleum products dominate mass transportation, while coal and gas are the cornerstone of heating and electricity generation. At the same time fossil fuels continue to be subsidized in many countries. Most renewable energy sources find it difficult to compete so far: they still require financial support mechanisms in or outside the electricity market and are thus equated by most consumers with increased cost.

TECHNICAL ISSUES

More work needs to be done to build the capacity of renewable energy to meet the massive and rising global energy demand. In particular, the variability of wind and solar energy continues to cause concerns about system stability.

ENVIRONMENTAL AND SOCIAL DAMAGE

Although renewable sources are arguably the most climate-friendly energy source, they can still negatively affect the environment. For example, large monocultures created by biofuel providers can permanently damage existing ecosystems. Renewables, such as biofuels or large-scale solar farms can also compete with other forms of land use, most notably agriculture, and cause social and political tensions.

LACK OF INVESTMENT

Creating a low-carbon energy sector is highly capital intensive and requires large upfront investments, putting a high burden on limited public and private budgets. On top of this, the power stations and power generation assets that currently provide our energy tend to have a lifetime of several decades, and decommissioning them before the end of their lifetime may cause major economic losses for their owners. Investors also tend to be reluctant to finance new energy infrastructure projects given the risk of policy changes and a lack of credible long-term commitments to a low carbon global economy.

LACK OF GLOBAL COORDINATION
ON CLIMATE POLICY

Although many countries now have policies to limit emissions, improve energy efficiency and increase the use of renewables, no binding Post-Kyoto agreement on climate policy and environmental protection could be reached to create a level-playing field in national energy markets and for international trade. A lack of global governance means each nation is likely to continue to trade off its own short-term interests against a global public good; and that unilateral efforts of emission abatement are distorted by carbon leakage problems.



1.3 bill.

people are without access to electricity.



19.4%

will be the renewable energy share in 2030, at current pace of growth. Far below the required trajectory.



3.5 mill.

people, mainly women and children, die each year from respiratory illness due to harmful indoor air pollution from wood and biomass cookstoves.

ELECTRICITY

HOW TO GET THERE: PATHWAYS FOR CHANGE

To get past the challenges and set a course for our 2050 vision, we believe that the most important actions needed in the next few years will be:

CLARITY AND COMMITMENT FROM POLICY-MAKERS

A strong, long-term political commitment is necessary to overcome fossil-fuel dominance and make renewable energies the new backbone of the energy system. On an international level, governments will have to co-operate on carbon abatement efforts and measures to end fuel poverty.

First and foremost, developed countries will need to provide the regulatory certainty that will allow the necessary capital to flow into creating new energy infrastructure. This should include a commitment to a stable and harmonised legal framework supporting renewable energies, grid expansion and emission abatement - while maintaining security of supply. Policy should also consider the issue of partial compensation for those negatively affected by such policy-driven changes.

There must also be a commitment to technology transfers to developing countries, possibly under the UNFCCC framework, enabling them to benefit from potential 'leapfrog' technologies such as smart grids and decentralised renewable energy generation.

INCREASED INVESTMENT AND NEW BUSINESS MODELS

Large investments into new infrastructure, including storage, smart grids and smart appliance technologies will be required to cope with the variability of renewable energies. Major investment will also be required in the transport sector.

Also, new business models will be needed to make the transition happen. For example, we expect to see the growth of energy service contracting, which involves the outsourcing of energy services such as hot water or street lighting to a third party. At a local level, the energy needs of small communities and small businesses could be met by small businesses running decentralised energy systems based on renewables. In developing countries where many regions today have insufficient grid infrastructure, entrepreneurs can thus seize the opportunity to electrify poor regions.

A CLEAN TECH REVOLUTION

A sustainable energy sector will require major technological challenges to be met in several areas. First low-carbon technology needs to be advanced so its costs can come down - this likewise applies to renewable energies, carbon capture and storage (CCS) and efficient gas-fired plants.

There also needs to be more progress in technologies that enable the integration of different energy sources so that we can build smart, green and reliable power systems. In parallel, energy efficiency has to be improved not just within the electricity sector but also for industry, residential use and transport.

Meeting these technological challenges will require major investments in research and development, and a transformation of education and the labour market. New energy

technologies should become part of the curriculum at universities and engineering schools, and there needs to be a focus on transforming skills in an energy sector formerly dominated by fossil fuels.

WINNING HEARTS AND MINDS

If politicians, investors and private sector operators are to commit to some of the pathways above, then they will need to know that consumers and the public at large support this action.

In practice, this means that consumers throughout the world are likely to have to adapt to rising energy costs and a more variable energy supply. For example, a long-distance journey may involve a combination of train and rented electric cars rather than simply driving their petrol-powered car from A to B.

Similarly, operating an integrated micro-energy supply system based on solar panels, electricity and heat storage demands more technical versatility and commitment from prosumers (energy consumers producing energy for self-consumption or to supply others) than a centralised electricity and gas supply system.

Moreover, infrastructure projects are often subject to public opposition, especially if they are perceived to degrade landscape or health. Education and awareness will be needed to help overcome these issues in the public domain.

In the developing world too, wider acceptance of low-carbon and renewable technologies will need to be encouraged, with the benefits of clearing the local pollution often caused by fossil fuels forming a key part of the argument.

SNAPSHOT OF OPPORTUNITIES

- » Invest in energy efficiency, in particular new insulation materials, energy-efficient products for manufacturing, construction and planning and energy service provision.
- » Create new low carbon technologies for industry including energy storage, batteries and energy-efficient appliances.
- » Create local decentralised micro energy systems to power small communities or even individual households, especially in developing countries where there is currently insufficient grid infrastructure.
- » Invest in smart energy technologies that help network operators to manage variable generation from a wider range of energy sources.

ELECTRICITY

THE ROLE OF DNV GL IN ENABLING THE TRANSITION

Electricity has already revolutionised the way we power our operations, fuel our vehicles, and light and heat our buildings - and it will have an even bigger role to play in the decades to come.

At DNV GL, we will work to continue to deliver world-renowned testing and advisory services and will continue to take the broader view by bringing together knowledge

that extends across the value chain: from policy and regulation to power generation (conventional and renewable), through transmission and distribution, and efficient use of energy. Together, we can successfully transform our power systems and integrate technology that provide cleaner, smarter, more affordable and more reliable energy.

DNV GL STRATEGIC PROJECT:

ELECTRIFICATION - POWERING THE FUTURE

Electrification holds the potential to decouple society's energy use from its greenhouse gas emissions.

Technologies such as offshore wind and smart grid are technically and economically feasible, and can enable a transition away from fossil- and nuclear-based energy systems. Our Electrification work takes a closer look at two particular solutions that can revolutionise the energy landscape over the coming decades: floating offshore renewable power and smart energy systems. We also examine the contributions these technologies can make to the energy systems in two geographies: Europe and Japan.



Want to know more?
[www.dnvgl.com/
electrifying-the-future](http://www.dnvgl.com/electrifying-the-future)



THE POWERMATCHING CITY PROJECT AND SMART GRIDS: INTEGRATION OF RENEWABLES AND SECURING RELIABLE ENERGY SUPPLY

In PowerMatching City in Groningen, the Netherlands, 40 households have been part of a laboratory for sustainable living, since 2007. In this project, the participating households have managed to find a balance between energy conservation and home comfort. They are also to a certain extent becoming self-supporting.

CREATING A SMARTER AND GREENER WAY OF LIVING

The smartness of the system is behind the scenes. Various technologies offer sufficient flexibility, and thereby enable consumers to retain their freedom of choice without sacrificing comfort or reliability. What the households have to give in return is space for a heat storage tank and/or a battery. Furthermore, they are given detailed insight into their energy consumption, enabling them to make decisions on the effective and efficient use of energy. In the PowerMatching City project, the inter-connected households are equipped with micro co-generation units, hybrid heat pumps, PV-solar panels, smart appliances, home energy storage and electric vehicles.

THE SMART GRID SOLUTION

A smart grid enables the needed flexibility and creates systems efficiency by storing heat in a buffer tank or electricity in the battery of an electric car. By charging the battery at a time when electricity is cheap, you can drive the car at the lowest possible cost. The energy trading on the local

market is fully automated through a system - the Powermatcher - that optimises, independently and objectively, the interests of all participants.

DNV GL SECURING QUALITY AND ROBUSTNESS

As member of the project team, DNV GL brought all stakeholders together. The team worked on the inter-operability of micro combined heat and power systems, hybrid heat pumps, and smart appliances in one system. Now in the second phase DNV GL will work on the end-user billing and monitor and evaluate the consequences for energy market processes. DNV GL also developed an energy monitor, giving the participants online insight in their energy consumption and production. The billing touches the electricity and gas markets, as well as the heat and cold storage processes.

In the PowerMatching City project we see how smart grids have the ability to inter-connect different types and scales of energy flows, as well as implement new services and technologies - something which again will create opportunities for new business models. This is unique in the world, and sets the standard for the future development of sustainable living.

 For more cases, please visit DNV GL Vision Stories:
dnvgl.com/vision-stories

SAFE AND SUSTAINABLE OIL & GAS

By providing a reliable source of energy, the oil and gas industry has enabled economic activity while enhancing human development. A growing world population needs over 50 per cent more energy by 2050 to meet demand, but must also act to avoid the damaging impact of emissions on the environment and society. At the heart of this 21st century dilemma is the oil and gas industry.

We need hydrocarbons to meet energy demand but, as the IEA points out, continuing on the current path of consuming fossil fuels will cause global warming to exceed 2°C. The answer to the dilemma is likely to lie in accepting hydrocarbon use as part of a transition to a low-carbon energy mix, while ensuring that the oil and gas sector harnesses the very highest standards of environmental efficiency and social impact.

WHERE WE WANT TO GO: OIL & GAS VISION 2050

Our vision for a safe and sustainable oil and gas sector is one that is transparent and efficient, and which takes account of the full cost of its environmental and social impacts while reducing its impact on climate change.

Our vision for oil and gas in 2050 is a collaborative and open sector that strives for the highest possible efficiency in its operations. More than this, it is a sector that helps meet large global energy demand while acknowledging and measuring its environmental and social impacts, building these costs into pricing and decision-making and is committed to reducing its impact on climate change by supporting a wider energy mix.

THE VISION'S KEY CHARACTERISTICS INCLUDE:

A COLLABORATIVE SECTOR OPEN TO PUBLIC SCRUTINY

The sector engages openly with society, including NGOs, not to convince but to jointly develop better solutions. A culture of collaboration and shared innovation helps develop new technologies, spread stringent safety standards and encourage sustainability. There is zero tolerance for major accidents, regardless of where these occur. Local emissions causing pollution and health risks are minimised. The industry contributes to social and economic development across the globe and the sustainability performance of all oil and gas companies is clear and transparent, monitored closely by the public.

TRUE COST ACCOUNTING

Oil and gas companies incorporate the 'true cost' of their activities in their pricing and decision-making in a full life-cycle perspective. Furthermore, opportunity costs are included in the baseline. Environmental and social impacts - from oil spill clean-ups to

community issues - appear in corporate reports and on corporate balance sheets. This plays an integral part of oil and gas companies' investment decisions, stock market evaluations, corporate ratings and project financing. This 'footprint economics' approach ensures that the higher environmental cost burden of extracting oil and gas from pristine natural resources is fully accounted for before any work can commence.

SUPPORTING THE MOVE TO A LOW CARBON WORLD

The burning of oil and gas will always release carbon emissions, but by 2050 the industry is part of a wider plan to avoid dangerous levels of global climate change while meeting global energy demand. Renewables will make up the largest share of the energy mix, but there is also likely to be much greater use of natural gas, some use of oil alongside advanced carbon capture and storage (CCS) technology and potentially 'clean' coal. Gas prices will be competitive with oil in the market and liquid hydrocarbons (including Gas-To-Liquids fuels) are restricted to air travel and back-up power where there are no alternatives.

TOTAL EFFICIENCY

The sector is committed to, and is implementing, impressive efficiency measures across all oil and gas operations. This includes enhanced recovery efficiency and reserves replacement of hydrocarbon resources, lifetime extensions of existing infrastructures and massively improved safety, including zero tolerance of oil spills. It has the effect of reducing the environmental and social footprint of global oil and gas operations.



40%
reduction target in Germany's greenhouse gas emissions to be achieved by 2020 and 80 per cent by 2050.



€118
per tonne CO₂ tax in Sweden has contributed to reduce the use of fossil fuels to less than 15 per cent in district heating.



50%
of Denmark's electricity consumption to be generated from wind power by 2020.

OIL & GAS

KEY CHALLENGES
TO OVERCOME

Re-creating the hydrocarbon sector for a safe and sustainable future presents enormous hurdles for the sector and all its stakeholders.

LACK OF TRUST WITH CIVIL SOCIETY

There is insufficient constructive dialogue between oil & gas companies and NGOs and this prevents the building of relationships based on trust. Similarly, a lack of openness by oil & gas companies on their projects and operations and insufficient external assessment reduce the wider public's trust of the sector.

COMPETITION OVER COLLABORATION

Technological innovations that could improve sustainability standards are often proprietary and used by companies for short term competitive gains rather than being used in the open collaborative way that is required to meet the future challenges.

TRUE COSTS NOT INCLUDED

Company performance in the sector is judged on direct financial measures and not on 'footprint economics', which would include environmental and social considerations as part of an overall valuation. Such factors will need to be built in to achieve our vision. Oil & gas companies also need to win public acceptance by showing they can grow without increasing their harmful environmental and societal footprints.

FAILURE TO COMMIT

There remains a lack of commitment from the sector to agree on a global plan that would minimise its impact on climate change and move towards a global energy mix that balances economic, environmental and societal costs.

NO LABELS

Consumers are not able to decide between oil and gas products based on the companies' relative environmental performances. There is still no environmental differentiation in the consumer market.

FAILURE TO DEVELOP A GLOBAL, EFFICIENT GAS MARKET

The growth of the gas market is hampered by political distrust which leads to inefficient gas development decisions and by subsidies that make gas less competitive to develop. LNG gas contracts are currently inflexible and cause gas market inefficiencies in regions such as Asia Pacific.

**2020**

is the deadline for peaking of global greenhouse gases, if temperature rise is to be limited below 2°C.

**2x**

emission intensity of coal over gas.

**2/3**

of the total global CO₂ emissions in 2011 were caused by only 10 countries.

OIL & GAS

HOW TO GET THERE: PATHWAYS FOR CHANGE

To break through the barriers and achieve our 2050 vision, we believe that the oil and gas sector must work towards taking the following steps as a priority in the coming years:

LET THE SUNLIGHT IN

A new culture of transparency, accountability, collaboration and openness to public scrutiny will be required for the sector to achieve our vision. For example, best practices in areas such as safety or energy efficiency should be widely distributed and not maintained for competitive advantage. An 'industry campus' approach should be developed to lift the performance of the industry as a whole, encouraging wide collaboration with the public, government institutions, universities and with other companies and creating high-quality sustainability standards and practices. Those who consistently fail to meet the required standards should exit the business.

As part of this new approach, oil and gas companies must professionalise relationships with leading NGOs, inviting them to evaluate social and environmental impact assessments for proposed developments alongside regulators and independent external verifiers. The industry will need to ensure that its value creation benefits the local communities in which it operates. Public scrutiny should be encouraged, using online networks of engaged global citizens to judge operators' and contractors' performances.

Benefits of such an approach are reflected in companies' abilities to attract the best talent and obtain the trust of the public for their activities. This is also the area of focus for competing in the market place; it is a competition for access to human capital and public trust.

ADOPT 'FOOTPRINT ECONOMICS'

In addition to capital and operational expenditure, oil and gas companies should begin to add environmental and social costs into their accounting, with the relevant impacts being independently verified. Standards must be developed to quantify and account for these costs in a consistent manner across projects and companies. For example, if a company aims to develop a hydrocarbon resource that requires the venting or flaring of gas, compensation for the loss of the gas resource to communities and mitigation of the environmental impact of the gas disposal should be considered in total project costs. This would favour alternative solutions that are optimum on a true cost basis, such as gas re-injection or gas-fired local power.

Including this full 'footprint economics' within oil and gas activities would affect expenditure for producers and prices for consumers, with the effect of making renewable energy sources more competitive against oil and gas options. Stock exchanges should be encouraged to make the disclosure of these 'true costs' mandatory for all listed companies, so that investors and analysts can get a full picture of companies' liabilities. Public focus should also be directed towards large institutional investors such as pension funds to encourage them to only invest in entities that meet minimum footprint economics ratings. Such Triple Bottom Line accounting is already facilitated by several UN and global investors' initiatives, like the Principles for Responsible Investment and Equator principles¹.

Oil and gas companies also face the challenge of extracting hydrocarbon resources from increasingly remote, harsher, deeper and more pristine and environmentally vulnerable locations. Wider use of footprint economics will ensure that the effects of the increased energy intensity of the extraction process are accounted for before these resources are developed.

COMMIT TO CLIMATE CHANGE ACTIONS

Providing a decent quality of life for the growing global population while staying within the planet's environmental boundaries will require actions to rebalance the energy mix over time from coal and oil towards gas and renewables. Hydrocarbons will be an energy resource also in the future, but the industry will need to improve the way it manages environmental and social impacts.

To support this process, oil & gas companies must adopt measures to improve sustainability performance. In addition, enhanced performance must be coded into regulatory standards and for example by incorporating such performance measures in license agreements and regulatory standards. Alongside this, the industry should work with regulators to adopt a global carbon tax that is fair, workable and effective in reducing hydrocarbon's contribution to climate change. Effective carbon taxes and/or 'cap and trade' systems would stimulate a shift to renewables and would enable carbon sequestration – such as CCS or CO₂ Enhanced Oil Recovery – to be introduced on a large scale.

By using CO₂ as a reservoir flooding agent, oil recovery efficiency is increased, while simultaneously storing CO₂ in the oil reservoir results in a net reduction of CO₂ compared to alternative oil recovery options. CO₂ tax proceeds are utilised to further stimulate consumer choices that enhance the transition towards a low carbon economy.

As part of an overall action plan, governments should remove hydrocarbon fuels subsidies to consumers and should encourage greater consumer awareness, for example by introducing an environmental rating label for oil & gas products and services that measure the life cycle environmental impact.

COMMIT TO 'TOTAL EFFICIENCY'

In order to maintain a moral right to exploit the world's hydrocarbon resources the sector must adopt the very highest levels of care in exploring, developing, producing and abandoning oil & gas fields. This should include the adoption of a 'total efficiency' approach when it comes to standards of safety, energy efficiency, climate change mitigation and other environmental and social impacts.

Part of this will need to include commitments by oil and gas companies not to flare or vent hydrocarbons, to shift their portfolios from oil to gas and renewables, to develop appropriate CCS technology and to measure and reduce their energy intensity and CO₂ footprint. For example, the average recovery factor for conventional proved reserves of crude oil is estimated at 22 per cent², implying that 78 per cent of the oil in place is left in the ground at the time of field abandonment.

The sector should strive to use new secondary and tertiary recovery schemes to aim for a significant increase in recovery efficiency in existing fields and extending the lifetime of

existing infrastructures. Improving recovery rates in existing fields reduces the requirement to develop new green field locations and thereby could reduce the incremental Footprint by the oil & gas industry. Other efficiency measures include the prevention of oil theft and pipeline vandalism and the rejuvenation of oil and gas infrastructure.

Regarding safety, greater emphasis needs to be placed on avoiding accidents through asset integrity and barrier management, external verification of asset safety, further development of fail-safe systems and adoption of risk based performance standards that are consistent with industry best practice. The sector should also be willing to pool resources to help mitigate oil spills and to help avoid personal accidents and fatalities.

GAS AS A BRIDGING FUEL TOWARDS A LOW CARBON WORLD

As the world struggles to meet high-energy demand while still developing scalable renewables and low carbon infrastructure, gas is the best bridging fuel towards a low carbon world.

To fulfil this role, the gas market needs to be made much more efficient. For example, there are currently numerous examples of countries importing liquid natural gas (LNG) from long distances overseas (often for political reasons) whereas neighbouring countries have an abundance of gas, sometimes flared due to lack of domestic demand. Other inefficiencies are caused by commercial considerations, such as fixed destination clauses prohibit LNG purchasing parties to redirect or trade cargoes, limiting supply chain optimisation. It is not uncommon for LNG ships to cross each other on voyages from Australia to India and from Qatar to Japan.

Furthermore, gas market inefficiencies occur due to gas price subsidies to consumers that limit development of domestic gas resources as well as restrict import of international gas. These inefficiencies cause avoidable energy losses and CO₂ emissions and further impede opportunities to switch coal and oil fuels to gas.

The extent of inefficiency in LNG shipping has been estimated³ by comparing actual versus optimized shipping routes to supply the LNG demand centers in 2012. The result is a 45 per cent reduction in the number of LNG carriers and a 29 per cent reduction in sailed distance, implying a reduction of 7 million tons of CO₂ emissions per annum. A much larger reduction in CO₂ could be achieved by also incorporating opportunities to optimize gas infrastructure such as pipelines and re-gas terminals.

A powerful catalyst for establishing a global and efficient gas market could be the adoption of LNG as a shipping fuel. This will not only promote additional gas demand, but also create new gas infrastructure for bunkering and promoting spot pricing for gas trading.

OIL & GAS

THE ROLE OF DNV GL IN ENABLING THE TRANSITION

The oil and gas industry is venturing into uncharted territory. Increasing energy demand and the decline of easy oil and gas will take operations into harsher environments and require solutions with greater technical complexity. At the same time, there is a growing need to transition to a low-carbon future that provides cheap energy to a growing population.

We recognise the dilemma in driving a safer and more efficient oil and gas industry, and the need to speed up the transition towards a low-carbon future. We also recognise the need to find a balance between the two.

The road towards the future requires all global citizens to walk a tight-rope together by carefully balancing economic, environmental and societal needs. The bottom line of our actions affects the balance of us all to stay on track.

DNV GL's key contribution towards a safe and sustainable future for the oil and gas industry is three-fold:

- » First, it is our purpose to safeguard life, property and the environment and this includes the oil and gas sector as an area of focus. We develop best practices and standards that manage risk to increase safety and reduce negative environmental impact.
- » Secondly, we enable the global transition to a low-carbon future through urging environmental efficiency. We develop solutions to displace coal and oil by enabling gas as a bridging fuel towards a low carbon world and we urge total efficiency and transparency in oil and gas development and operations.
- » And finally, DNV GL can help to unlock and drive technology transfer of superior oil and gas industry technologies and competencies to be used for alternative energy production.

DNV GL STRATEGIC PROJECT:

ARCTIC - THE FRONTIER OF RISK MANAGEMENT

The melting of sea ice means that the Arctic is more accessible than ever before, and growing population and consumption are pushing many industries into remoter places in search of energy, minerals and shorter transportation routes. From its considerable oil and gas resources, shorter shipping routes, rich fisheries to the unique species, ecosystems and communities it supports, the Arctic is a prize valued far beyond its own borders. Discussions about investments in the Arctic - and their impact on the environment and climate - are vibrant around the world.

Our work examines and frames the complex Arctic risk picture, the implications of these risks for the maritime and oil & gas sectors and identifies solutions for mitigating risks for the growing number of ships in the Arctic.



Want to know more?
www.dnvgl.com/arctic



CASE

USING OIL AND GAS EXPERIENCE FOR INNO- VATIVE RENEWABLE ENERGY PLATFORMS OFFSHORE

TenneT is the national electricity transmission system operator of the Netherlands, operating in Northwest Europe supplying electricity to 36 million end users.

TOWARDS RENEWABLE ENERGY

Germany has ambitious goals to transition to renewable energy. A key contribution is the converter platforms currently being installed by TenneT as part of a large grid offshore wind park. The three converter platforms are being installed 160 km off the German coast at water depths up to 30-40 metres. The converter platforms, Dolwin Alpha, Dolwin Beta and Sylwin Alpha, will be connected to an ever expanding wind turbine farm producing green energy.

DEMONSTRATING VALUE AND HIGH STANDARD

DNV GL has been involved in the project in three ways:

- » During different stages of the project to perform surveys of design, manufacturing, construction and installation of the converter platforms.
- » Verifying the environmental design including leakage containment, waste management and water and air emissions. The platforms are verified to the highest standard to uphold the safest possible working environment offshore.

- » Providing resources and coordinating the design review of the safety critical systems, including electrical, fire fighting, evacuation and escape as well as structural verification.

TRANSFER OF TECHNOLOGY AND COMPETENCIES FROM OIL AND GAS TO RENEWABLES

With the DNV GL wind turbine transformer platform certification the client will be able to receive a German regulatory body approval and a permit to install the platform offshore and start the operation. This significantly improves the safety and operation of the installation.

This project illustrates how DNV GL's extensive offshore oil and gas safety experience proves to be transferable into these new and innovative platforms to make them safer and more robust - such technology transfers will help to accelerate the transition to a low-carbon future.

For more cases, please visit DNV GL Vision Stories:
dnvgl.com/vision-stories

SAFE AND SUSTAINABLE

FOOD &
BEVERAGE

The challenge for the food and beverage sector seems overwhelming: to increase access to water and produce more food to sustain a growing population, with a smaller agricultural labour force and less land to cultivate, whilst adapting to increasingly dynamic climate patterns. Food, water and energy shortages in the future, exacerbated by climate change, may lead to rising food prices, migration and conflict. But although the risks associated with this business-as-usual scenario seem challenging to overcome, they are by no means insurmountable. There is a growing appetite for change and the drivers to achieving the vision for a safe and sustainable future are convincing.

WHERE WE WANT TO GO: FOOD & BEVERAGE VISION 2050

Our vision for a safe and sustainable food and beverage sector is one that produces food for 9 billion people, supports social equality for both large and small scale farmers, and operates within the carrying capacity of the environment.

Our vision for the food and beverage sector in 2050 is one that provides for an increased global population, while maximising land use and minimising environmental impact. It is dynamic enough to adapt to changing climate patterns, water scarcity, and competition for land-use and labour force. This is extremely challenging and will require significant change from business-as-usual – not only for the industry but for policy makers and everyone across the value chain – including farmers, producers, manufacturers, retailers and consumers.

THE VISION'S KEY CHARACTERISTICS INCLUDE:

MEETING DEMANDS FOR INCREASED PRODUCTION

Market demand for food is projected to reach 3 billion tonnes by 2050. To meet this requirement, overall food production must increase by 70 per cent from 2007 levels, and production in developing countries must double. This will need to be produced by a combination of small and large-scale farmers, who will have access to capital, better knowledge of intensive agriculture and the ability to adhere to more stringent sustainability standards. The production chain will also need to minimise food waste. Currently one third of food produced (around 1.3 billion tonnes) never reaches our plate, and it is estimated that this could feed an extra two billion people annually.

OPERATING RESPONSIBLY UPSTREAM AND DOWNSTREAM

Responsible sourcing will be the norm for the industry where accounting for both the value chain and the individual company's total sustainability impacts will be backed up by regulations that support supply chain transparency and the need for assurance. There will be increased interaction and collaboration with farmers and other stakeholders for mutually beneficial identification of solutions and outcomes. Sustainable practices will include areas like: price guarantees for farmers, protection of human rights and health & safety, a greater role for female farmers in the developing world, and commitment to ensure a product's end-of-life is sustainable via product innovation, packaging reduction and greater sustainable choice.

RESPONDING TO CLIMATE CHANGE

The sector will be more adaptable and resilient to climate change. Areas that previously benefitted from steady climatic conditions will now be exposed to fluctuations, and new growing zones and markets will need to open up. Crops will be adapted to withstand more extreme conditions, and farmers will be forced to diversify to reduce vulnerability and to capitalise on opportunities arising from new weather patterns. Water management systems must be drastically improved to cope with the increase in both droughts and flooding, while also guaranteeing the provision of safe, clean water to surrounding communities.

OPERATING WITHIN ENVIRONMENTAL LIMITS

Agriculture currently accounts for 70 per cent of fresh water use, globally. The sector will need to transform the way it is responding to water scarcity by transitioning to smarter agricultural practices such as drip irrigation, reducing sources of pollution, such as agricultural run-off, and innovating its water management approaches. The transition to smarter agricultural practices should also reduce the sector's dependence on non-renewable or damaging pesticides, fertilisers and other chemicals. Use of nitrogen, phosphorus and freshwater will need to be reduced to operate within planetary boundaries through more efficient fertiliser use and irrigation systems, closed loop fertiliser cycles and other innovations. In the future, pricing mechanisms for environmental commodities will need to be considered.

WELL BALANCED LAND USE

The debate about whether to use land for food or fuel will have eased, in part thanks to the evolution of second and third generation biofuels produced from non-food crops and waste materials, and due to adjustments in market mechanisms. Governments will have a duty to ensure that the amount of natural habitats converted to farmland is sustainable and does not cause desertification or excessive deforestation. There will be less tolerance for large-scale land acquisitions by major corporations at the expense of small-scale producers and their families.

FOOD & BEVERAGE

KEY CHALLENGES
TO OVERCOME

The food and beverage sector is at the core of both climate change causes and impacts. Being able to produce more with less seems to be the guiding principle for future food and water production. Looking towards 2050, the conditions for production are increasingly strained, whilst the demand for food and water increases.

COMPLEXITY IN VALUE CHAINS

The food and beverage sector has highly globalised, complex and interconnected value chains. This makes it difficult to control and understand sustainability risks and effects and limits the ability to take action and manage them.

UNFORESEEABLE NATURE

Dynamic climate patterns are hard to predict, making it difficult to adapt to more appropriate forms of agriculture or to invest in the right technological advancements.

AMBIGUOUS COST OF NATURE

The true cost of environmental commodities is not clear, and this lack of an internationally applicable pricing mechanism prevents a move towards a more sustainable land and water management.

LACK OF INVESTMENT

Capital investment to develop the new agricultural practices, technology and machinery will be needed to enable the transition to a more sustainable sector. Investments will also be needed in human knowledge, skills and capabilities.

VESTED CAPITAL AND INTERESTS

Civil unrest or stakeholder pressure can prevent the necessary cross-sector collaboration required to change existing, unsustainable agricultural methods and systems.

CONSUMER DEMAND

There is consumer trepidation as well as a global lack of education and awareness to drive consumer demand for more nutritious foods and responsible sourcing, or innovations in food production technology.

INSUFFICIENT INFRASTRUCTURE

Poor connections between producers, transporters and end consumers creates large amounts of waste along the food supply chain. Long distribution times are a significant contributing factor to food spoilage and thus, waste.

**70%**

of global freshwater is consumed by the agricultural sector.

**>30%**

of food produced never reaches a human stomach.

**15-18%**

of global GHG emissions are produced by land-use change and deforestation for agriculture.

FOOD & BEVERAGE

HOW TO GET THERE: PATHWAYS FOR CHANGE

To meet the demands of a growing world population in the coming years, and to achieve a safer, smarter and greener food and beverage sector, we must consider the following scenarios:

SHIFT POLICY TO INCENTIVISE SUSTAINABILITY

A more sustainable sector will need more effective, inclusive and co-ordinated public policy frameworks. For example, at an international level agriculture should be placed at the heart of global climate change negotiations, while local level governance will be important in protecting land rights. Small scale farmers, in particular female farmers who made up 43 per cent of developing world farmers in 2012, could support increased productivity if granted equal rights to land, water, finance and education. Three distinct priorities for policy-makers should therefore be to:

- 1) Adopt a holistic approach to climate change - incentivising farmers to work for global food security, involving local communities, and providing capital and support to carry out local community projects.
- 2) Connect small scale farmers with global or national capital that gives them better access to market and enables them to compete on pricing.
- 3) Replace our current, industrial model with a market-based system that captures the value of supplies from nature, pricing in externalities into corporate balance sheets.

For such ambitious policies to work, the sector itself also needs to improve its governance at all levels.

A HIGH-TECH HARVEST

The food and beverage sector will need to utilise a range of technologies to boost productivity, efficiency and rural development for both small and large-scale farming. These range from: farming production technologies like sensing devices that monitor plant growth and detect disease, locally adaptable and climate resilient crops that utilise genetically modified organisms, selective breeding, and organic production. Value chain innovations will also be needed to increase shelf life and safety of food products.

A key development will be m-agriculture, using mobile services and applications to help rural farmers access information, collaborate, and compete against large-scale producers. Current examples include farmers securing group discounts on fertilisers or seeds, facilitating financial transactions, and providing tailored crop advice and information on the latest farming practices.

AN AGE OF COLLABORATION

A more sustainable sector will require improved governance and more extensive collaboration both within the industry - between farmers, producers, manufacturers, retailers and consumers - and outside, with different industries governments, NGOs, trade unions and other stakeholders. One likely mechanism is a rise in agricultural cooperatives, which share costs and pool resources. This would improve access to markets and security of supply for the industry. In 2012, an estimated 250 million small-scale farmers in developing countries belonged to farmers' associations.

SUSTAINABILITY ALL ALONG THE SUPPLY CHAIN

Responsible sourcing will be fundamental to achieving a sustainable food and beverage industry. Companies will favour suppliers who maximise resource efficiency, minimise their environmental impacts, guarantee the welfare

of workers throughout the value chain and drive improved quality. For example, large companies will be expected to provide training and technical assistance to smaller farmers in their supply chain.

Over the long-term, such direct engagement will reduce volatility and ensure the security of future supply, whilst helping mitigate potential price shocks. Responsible sourcing will also produce more transparent and accountable companies, enforced through a robust auditing process, and supported by supplier information platforms (such as SEDEX) that can handle multiple customer requests simultaneously.

CHANGING THE MENU

By 2050 there's every likelihood that our diets and our perception of food will have altered. Fighting the double burden of obesity and malnutrition around the world will require improvements in education about nutrition and responsible marketing by the sector, as well as improvements to the nutritional composition of products and their availability in the developing world.

The developed world is likely to have reduced its meat consumption and adjusted to alternative sources of protein, with radical alternatives including laboratory-grown meat or the large-scale consumption of insects. Fish is likely to continue to provide a substantial proportion of our protein intake but more of it will come from aquaculture and fish farms instead of the oceans.

WASTE NOT, WANT NOT

Between now and 2050, steps should be taken to drastically reduce food waste. Raising awareness about the impact of food waste and changing the behaviour of retailers and consumers will comprise part of the solution, alongside innovation in food preservation, storage and packaging,

to improve the longevity of food. Upstream, collaboration and coordination to maximise efficiency of resources and knowledge sharing will be paramount, in conjunction with infrastructure improvements and faster transport times at the production stage to help reduce spoilage.

SNAPSHOT OF OPPORTUNITIES

- » Collaborate to drive innovation, new products and new ways of doing business that are mutually beneficial to the industry and wider society.
- » Expand growing zones as global climatic conditions change.
- » Develop crops that are more resilient to likely climate fluctuations and extreme weather.
- » Invest in second and third generation biofuels.
- » Capitalise on growing need for assessment, verification and certification of products' origins.
- » Use increasing agricultural demand to aid economic development in developing and emerging markets.
- » Benefit from cost savings as more efficient ways to manage energy, water and food waste emerge and are incentivised.
- » Enhance brand reputation and consumer trust - and potentially greater access to infrastructure and raw materials - by demonstrating a social license to operate.
- » Invest in clean technologies and innovations that create sustainable solutions for the sector.

FOOD & BEVERAGE

THE ROLE OF DNV GL IN ENABLING THE TRANSITION

The issues that companies face today are extremely complex - it's not simply a question of managing the bottom line any more. The food and beverage sector will come under increasing pressure in the years and decades to come as global food production will need to increase to meet the demands of a growing population and, at the same time, a growing number of people will live in increasingly water stressed regions.

DNV GL will continue to work with businesses to assure the performance of their organizations products, people, facilities and supply chains through certification, verification, assessment, advisory and training services. At DNV GL, we will continue to partner with our customers to take a broader view in order to help them manage their operational challenges today while building sustainable business performance over time; thus creating sustainable value and stakeholder trust.

Going forward, we have the ambition to provide a number of new approaches with the purpose to go beyond business as usual:

» Next Generation Risk Based Certification™ is a step towards sustainable business performance. We will enable customers to integrate environmental, social and economic risks into their management systems and thereby meet stakeholder's expectations today and tomorrow.

» Sustainable project management allows for all project managers to integrate a broader view on environmental and social aspects into the way small and big projects are run around the world. We will enable customers to use a 'Safer, Smarter, Greener' measurement methodology and thereby achieving more sustainable solutions.

» Calculating the return on sustainable investment helps companies create financial, social and environmental value and to measure the return on capital and operational expenditures. We will enable customers to evaluate sustainability impacts and link these to financial metrics and integrated reporting.

We are certain that by working together we can enable the leaders of tomorrow to create new, wider value by meeting the world's economic, social and environmental needs today.

CASE

ILLYCAFFÉ TAKING RESPONSIBILITY WAKE UP AND SMELL THE COFFEE

Italian coffee giant illycaffé - whose famous brand of coffee is sold in over 140 countries - has recognised the critical importance of responsible sourcing for its business and the wider coffee industry. In 2011, it became the first ever company to receive DNV's Responsible Supply Chain Process Certification - recognising sustainability in every aspect of its coffee sourcing from the coffee estate to the café espresso.

illycaffé wanted to be certified by a third party as a recognition for its efforts in developing a sustainable model all along the production chain. Andrea Illy, Chairman and CEO of illycaffé explains, "A product cannot be sustainable if the company itself is not sustainable. What we're witnessing is a global trend where more and more people care about what goes on behind the product. So we wanted a certificate because we needed a third-party witness to document what we do."

A COMPLEX GLOBAL VALUE CHAIN

illycaffé is based in Italy but buys green coffee directly from growers in Brazil, Central America, India and Africa and has a worldwide chain of coffee bars and distributors. As part of managing this diverse supply chain the company has

committed to creating shared value for all its stakeholders, including paying its growers higher than market prices in recognition of the quality of the product.

The holistic certification process of illycaffé's complex global supply chain saw DNV GL analyse their long-term sustainability strategies, the organisation's roles and responsibilities, business conduct, stakeholder engagement activities and communication practices. The organisation had to demonstrate a robust approach to managing risks such as environmental management, product safety and the human rights management of its suppliers.

BREWING SUCCESS

Since achieving the certification, illycaffé has continued to grow. They now generate a gross revenue of over €360 million (2012) and promote new technology such as coffee machines which consume less than half a liter of water per kg of parchment coffee produced.

For more cases, please visit DNV GL Vision Stories: dnvgl.com/vision-stories

SAFE AND SUSTAINABLE

HEALTHCARE

As we move towards 2050, healthcare faces a series of challenges. Growing and ageing populations, the persistence of infectious diseases, the rise of chronic diseases and widening disparities in quality and access between rich and poor all present significant hazards. Evolution of the healthcare sector so that it can respond to these will be a fundamental part of whether we can create a world that provides a decent quality of life for all.



WHERE WE WANT TO GO: HEALTHCARE VISION 2050

Our vision for a sustainable healthcare sector is one that ensures universal coverage to quality health services, and that is personalised, safer, smarter and more equitable.

Our vision for healthcare in 2050 is a sector that endeavours to level out the inequalities in access to healthcare that currently exist, has individual needs at the heart of everything it does and which is free from preventable harm. It will use delivery mechanisms that are seamless and smart wherever possible.

THE VISION'S KEY CHARACTERISTICS INCLUDE:

UNIVERSAL ACCESS TO QUALITY SERVICES

The ability to receive high-quality, affordable healthcare will no longer be a privilege of the rich world. Currently, the 34 OECD countries encompass 18 per cent of the world's population but account for 84 per cent of world spending on health⁴. This chasm of inequality will have been significantly closed by 2050, thanks in part to low and middle-income countries getting access to 'leapfrog' technologies and health systems for chronic diseases such as diabetes, heart disease and cancer.

Improvements in education, income and access to healthcare for women and girls in the developing world will significantly help to tackle access inequality. Moreover, efforts to spread effective, affordable interventions (such as widespread immunisation), and access to clean water, have successfully reversed the spread of infectious disease such as malaria and diarrhoea. No child under five is dying from preventable diseases.

PERSON-CENTRED CARE

In higher-income countries, people have their genome sequenced at birth, forming the basis of a personalised health plan that will emphasize prevention. The plan will be guided by individual health coaches and mobile technology which help each individual to take healthy choices throughout life. For example, each of us could choose to have a transcutaneous monitor implanted that relays real-time data on our health status and triggers an intervention from our health coach when readings deviate from expected ranges. We can even choose to link such smart devices to our consumer choices so it prompts us to select healthier food and products.

HARM-FREE HEALTHCARE

Currently, around 10 per cent of the hospitalisations in the world are associated with some degree of adverse event - making unsafe care a significant cause of morbidity and mortality⁵. By 2050, there will be sustained improvements in healthcare safety levels. In part this will be driven by our ability to target treatments and to intervene at genetic and cellular levels. Where people are living with chronic conditions much of the care will be delivered in the home or other location of choice through telemedicine with support from local health centres.

SEAMLESS AND SMART DELIVERY

As we age, a combination of personalised prevention plans, rapid interventions to stop or slow deterioration, integrated services and support from health coaches and telemedicine will enable us to live longer in our own homes. When it does become necessary to move to supported care, it will be to facilities within our local community, ensuring that we maintain the connections that are important to us across our lifespan.



100%

of the world's population has access to primary care by 2050.



75%

reduction in global burden of non-communicable diseases.

HEALTHCARE

KEY CHALLENGES
TO OVERCOME

Existing healthcare systems around the world are no longer sustainable. There is inequitable access. Pressure is increasing due to demographic change, new disease patterns, changing and deteriorating environmental conditions, technological advances and retrained public spending. To succeed in establishing our vision for the sector by 2050, the challenges that must be overcome are medical, systemic and psychological. They include:

INEQUALITY OF ACCESS

Universal access to healthcare is recognised as an essential human right⁶. Unfortunately, large sections of the world do not yet have affordable, effective and safe basic healthcare⁷.

GROWING RISK FROM ENVIRONMENTAL FACTORS

The impact of environmental risk factors on human health are extremely varied and complex. However, gradually worsening environmental conditions, in particular rising levels of air pollution, chemical pollution, climatic changes and water stress, is putting increasing pressure on human health, most severely impacting the world's poor. In fact, climate change is considered the greatest threat to the global public health outlook⁸.

Extreme weather is on the rise, changing weather patterns impact food and water security, and warming exacerbates the spread of some water, vector and food borne pathogens (e.g. malaria and yellow fever). Another serious risk comes in the form of antibiotic resistant bacteria, where overuse has led to genetic mutations which are resistant to antibiotics. All this will put additional pressure on already strained healthcare systems.

INCREASING BURDEN OF CHRONIC DISEASES

The overall trend is that people dying from infectious diseases will decrease. However, chronic diseases such as obesity, asthma, diabetes or dementia (often associated with lifestyle, consumption and aging), are a worldwide problem and it is estimated that by 2020, 57 per cent of the burden of death and disease will be due to these conditions⁹. The rise of chronic diseases poses a double burden on low income countries which still experience high prevalence of infectious disease.

CHANGING NEEDS OF AN AGEING POPULATION

Between 1950 and 2000, the number of people over the age of 60 years old tripled worldwide. By 2050, it will have tripled again¹⁰. This will have major financial impacts with proportionally fewer economically active people to pay for healthcare combined with a greater burden from more people living with chronic conditions.

UNSUSTAINABLE COSTS

In the last 30 years, global healthcare expenditure has increased massively, and it is projected that public spending on health and long-term care in OECD countries could rise to as much as 14 per cent of GDP by 2060; and up to 9.8 per cent of GDP for some of the BRICS countries¹¹. Thus healthcare faces a formidable challenge to control spending while meeting growing needs.

Globally, 20–40 per cent of resources spent on health are wasted. Inappropriate or overuse of medicines and technologies contributes to rising health expenditure. In 2008 for example, France saved almost USD 2 billion by use of generic medicines wherever possible¹².

UNSAFE CARE: HEALTHCARE IS DANGEROUS

This is a global problem affecting low, middle and high income countries. Of the 421 million hospitalisations in the world annually, 42.7 million are estimated to be associated with some degree of patient safety incident – this makes unsafe care the '14th leading cause of morbidity and mortality, comparable to the burden from tuberculosis or malaria'¹³.

Although the majority of studies of patient safety have focused on the developed world, recent evidence suggests unsafe care is a significant burden in developing countries too, with between 2.5 per cent and 18.4 per cent of patients admitted to hospital experiencing at least one adverse event¹⁴. Despite the efforts of professionals, managers, policy makers and researchers, healthcare has yet to achieve sustained improvements in safety.

SILO-STYLE ORGANISATION

The organisation of healthcare – including funding, staffing and service delivery – is fragmented into 'silos'. Different disciplines and professions each have their own logic, routines and incentives and do not integrate. A more holistic approach is needed to achieve the cohesion, coordination and communication between systems required.

INSUFFICIENT FOCUS ON PREVENTION

Moreover, in practically all healthcare funding models, acute care (short-term treatment for a severe injury, illness, or condition) accounts for the greatest single spend. This skews the funding available away from investment in preventative services.

SHORTAGE OF HEALTHCARE WORKERS

There is a serious challenge in attracting, training, retaining and distributing an adequate number of healthcare workers for the global healthcare system to be effective. For example, in the EU currently there is an estimated shortage of around 1,000,000 health workers, meaning almost 15 per cent of the care for the EU population will not be covered¹⁵. In low and middle income countries the shortage is even more acute. Africa, for example, has 25 per cent of the world's disease burden, but only 3 per cent of the world's health workers¹⁶.



84%

of world spending on health-care serves only 18 per cent of the global population.



23%

of the global disease burden is attributable to the environment.

HEALTHCARE

HOW TO GET THERE: PATHWAYS FOR CHANGE

Health is an essential element of a sustainable future. Although the journey to a safe and sustainable healthcare sector will be difficult, it is not a hopeless one. To achieve our vision, we believe that the priority actions for the sector in the coming years should be:

GLOBAL SOLIDARITY

If high income countries were to immediately honour their international commitments for official development assistance, the estimated short-fall in funds to reach the health related Millennium Development Goals would be virtually eliminated¹⁷.

NO ONE SIZE SOLUTION

There is no single solution to the challenges the world faces in relation to health and healthcare. Rather countries must look to understand their local risks and obstacles in order to understand how they can improve.

BUILD A STRONG FOUNDATION THROUGH PRIMARY HEALTHCARE SERVICES

Effective primary healthcare is basic to preventing disease, promoting healthy lives and managing long-term conditions. Rwanda, for example has, in recent years, increased funding to community and primary care initiatives. In doing so it has increased life expectancy by 10 years, halved child mortality and extended health coverage to 97 per cent of the population¹⁸.

PUT THE INDIVIDUAL FIRST

Organise care around the individual's health needs rather than diseases and physicians' specialties. A dedicated team of both clinical and non-clinical personnel should support each individual by coaching and active partnerships: providing counselling, education, encouraging adherence and supporting healthy behaviours.

INCENTIVISE OUTCOMES NOT ACTIVITY

Financial incentives should be focused on achieving outcomes, rather than just funding the performance of tasks by providers. Focus payments on the results of the full cycle of care and on the achievement of sustained happiness and independence.

INTEGRATE CARE ACROSS SECTORS AND SERVICES

Healthcare is not the sole determinant of health. Care should be built around pathways that reflect the reality of life for service users, not just their episodes in hospital. Health, social care and civil society organisations should be rewarded by how well they work together to support individuals and communities in gaining and retaining happiness and independence.

INVEST IN NEW TECHNOLOGY

Advancing technology will be key to personalising healthcare while achieving manageable costs across populations provided that we use it to change the way care is delivered. We need to invest in, and capitalize on, new technology opportunities such as the chance to use increasingly large and complex data sets through cloud networks, and the decreasing costs of genome mapping. In low and middle income countries, open source technology, such as mHealth, can be used to improve the spread of best practice¹⁹.

STANDARDISE SAFETY AND QUALITY

We need a common set of principles for healthcare provision if we are to achieve equitable and high-quality standards of service. Risk-based standards should be used to redesign systems and deliver services. This will enable hazards to be identified and managed before they become harms: reducing variability, improving the service user experience and lowering costs

SNAPSHOT OF OPPORTUNITIES

- » Improve safety and quality by using risk-based approaches to create sustainable improvements in healthcare that engage with local hazards.
- » Build strong primary care sectors to ensure equitable access, promote health and manage long-term conditions.
- » Organise care around the individual's health needs rather than diseases and physicians' specialties.
- » Integrate care across specialties and providers. Healthcare is not the sole determinant of health. Care should be built around pathways that reflect the reality of service users with multiple needs rather than episodes in hospital. Health, social care and civil society organizations should be rewarded by how well they work together in supporting individuals and communities in gaining and retaining happiness and independence.

» Empower individuals to make choices about their healthcare providers by sharing up-to-date information on quality in easy to understand formats.

» Invest in, and capitalise on, the growth of technology so long as it is supported by systems approaches to risk and change management. Using systems approaches will ensure sustainable change and enable technology to be a key element to personalising healthcare while achieving manageable costs across populations.

» Incentivise what matters. Focus payments on the results of the full cycle of care rather than on separate treatments. Use finances to drive improvements in quality and public health by moving from an emphasis on the tasks performed by providers to an emphasis on achieving outcomes in terms of sustained well-being.

» Invest in climate change adaptation to ensure healthcare is prepared to cope with the impact of changing weather patterns.

HEALTHCARE

THE ROLE OF DNV GL IN ENABLING THE TRANSITION

Reflecting on the challenges and obstacles facing healthcare between now and 2050, it would be easy to feel that change is impossible. But together we can make a difference.

Other safety critical sectors, such as oil and gas, have used risk based approaches to achieve significant and lasting improvements: mapping and monitoring hazards, setting goals, and creating proportional cultural, structural and process controls. In DNV GL's experience, using risk based approaches can be a powerful way to drive improvements.

To that end, from our analysis of the challenges, obstacles and strategic agenda, we have identified the following priorities for DNV GL's Strategic Healthcare Research and Improvement:

- » Using accreditation and standards to promote person-centered care, reduce variability and improve quality.
- » Creating cultures and mindsets that embrace continuous quality improvement.
- » Improving quality assurance and risk prediction with smarter data analysis.
- » Developing safety case methodologies to manage risk locally.

These build on proven services that manage safety by combining cutting edge research in the dimensions that offer potentially the biggest impact for quality improvement. We welcome the opportunity to work with others.



The US healthcare system like many throughout the world is under increasing pressure from an aging population, high levels of chronic disease, a shortage in primary care givers and limited funding.

To help US hospitals and clinics to meet these long-term challenges, DNV GL Healthcare in the US is providing a unique accreditation program approved by the US government that helps improve standards and inspire staff so they can cope with the demands put upon them.

All other accreditation programmes in the US occur once every three years. However, DNV GL surveyors collaborate with their client hospitals with annual surveys to implement sustained quality improvements. We take an educational, cooperative approach and this is resulting in a culture change that can create real solutions - such as more preventative care.

The DNV GL hospital accreditation programme is the only program of its kind in the US that incorporates compliance with the internationally recognised ISO 9001 quality system.

DNV GL-accredited hospitals are discovering that accreditation does not have to be a fear-inducing inspection, it can be an engine for the continuous quality improvement required to meet the challenges they face.

LIFE SUPPORT SYSTEMS

Today, nearly 10 per cent of the eligible hospitals in the US have opted to join DNV GL's accreditation, and we have client hospitals in nearly every state in the US, large and small. We are helping make healthcare safer and smarter and initiatives such as the Healthy Hospitals Initiative are also helping make them greener.

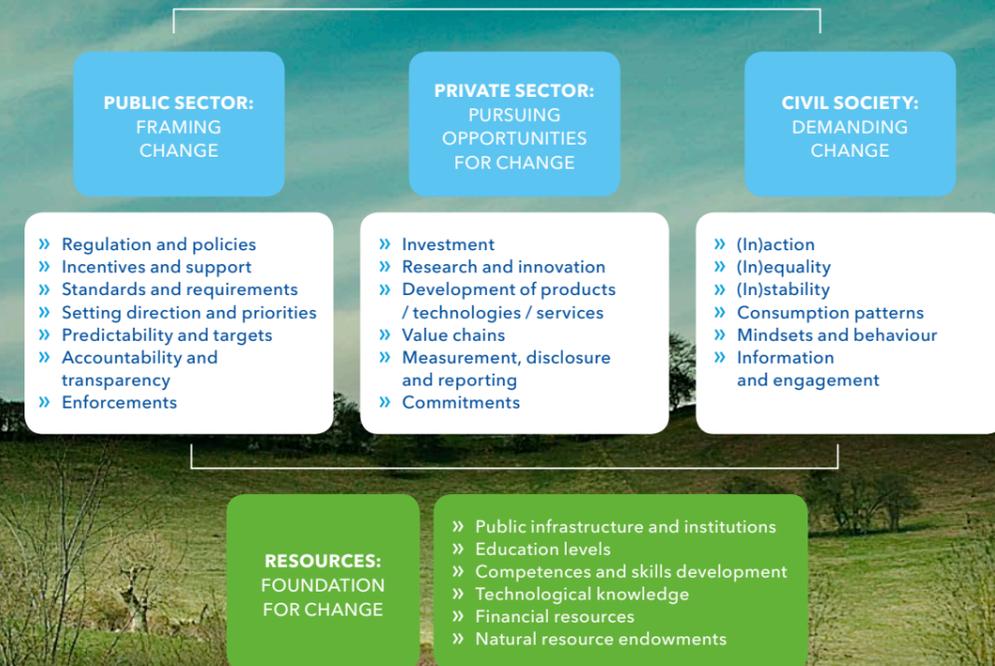
Although the challenges facing the US healthcare system, like many across the world, are enormous, we are confident that the expertise and innovation in the system can cure the problems.

 For more cases, please visit DNV GL Vision Stories: dnvgl.com/vision-stories

CONCLUSION

THE JOURNEY OF CHANGE: A GOLDEN OPPORTUNITY

SUSTAINABILITY JOURNEYS



In a rapidly changing world, with rising populations, a changing climate and a volatile economy, society cannot rely on a rear-view mirror to ensure future success. Prosperity and development for the future must be created differently to how it was achieved in the past. As such, the transition towards a safe and sustainable future is comparable to a journey into uncharted territory. It is an innovation journey where opportunities emerge as new paths are built. We know the destination we desire to arrive at - a safe and sustainable future - however, as with all such journeys, it involves unknowns.

- » Unknowns created by the 'moving targets' that we must develop solutions for - we live in a complex and dynamic world with changing consumer trends, advances in technologies, diverse ideologies, societal movements and shifting leadership.
- » Unknowns created by competition - the journey of change resembles a tug of war between what has been and what is to come, and therefore opportunity for some means demise for others.
- » Unknowns created by a lack of a 'guiding hand' - the course and pace of the journey are hard to predict as no one party is in ultimate control.

What we do know, is that the journey's momentum and direction will be a result of efforts emerging from many different parts of society: consumers, communities, entrepreneurs, managers, investors and policy makers. The journey will involve innovation and constant communication between these groups and there will be the need to mobilise support for novel ideas, activities, projects, solutions, and technologies. The journey's momentum

will also depend on the capacity of all stakeholders to collaborate by aligning decisions, efforts, collective resources and competencies.

In this report, we have highlighted the sustainability outcomes we desire to create. They are at once social, economic, and environmental, and business, government and civil society are the main change agents who can bring about these outcomes.

We have highlighted broad pathways and actions to be taken by these three important catalysers for change. Our illustration seeks to bring together these domains and aspires to present a broad view on the elements that facilitate or constrain the journey or transition to a safe and sustainable future.

- » **THE PUBLIC SECTOR** shapes the journey by setting a direction through regulation, planning and requirements. It supports the journey through investment, procurement, incentives and funding in alignment with sustainability and tomorrow's priorities.
- » **CIVIL SOCIETY** shapes the journey by driving change. Social movements, education, mindsets, consumption, responsibility and preferences can influence the legitimacy of actions, technologies, solutions and demand change.
- » **THE PRIVATE SECTOR** shapes the journey by either perpetuating business as usual or by pursuing opportunities to advance the transition. Vested interests may seek to uphold their positions and lobby against change. Other organisations will spot opportunities in the creation of a safe and sustainable future. Activities in research, development and the introduction of solutions, services and technologies can transform resource use, and can lead to the establishment of new industrial ecosystems to sustain long term shifts in the economy.

» **RESOURCES** create the capacity for change. Depending on location, there are diverse natural, social, human and financial capital - such as natural resource endowments, education levels, technological knowledge, financial resource bases, competences and skill sets that, in combination, create the starting point and capacity for undertaking the journey.

A GOLDEN OPPORTUNITY

DNV GL sees the transition towards a safe and sustainable future through the lens of risk and opportunity. Necessity is the mother of invention. As the world re-shapes itself to handle sustainability challenges, opportunities for value creation are there to be seized for those who act early. Businesses that connect to society's needs and challenges will be well positioned to create economic value in tomorrow's economy - as well as adding value to society. It is an exciting road ahead, a road paved with opportunities, and leaders in business and politics must take the lead in realising the transition.

The actions we take today will define our opportunities for generations to come. A low-carbon, resource-efficient and socially inclusive economy is within our reach. But progress towards that future has been slow and pressures for change have intensified. We need to reboot society's efforts. We need collective action between government, business and civil society to devote sustained attention to the challenges. Most of all, we need innovation and ingenuity to develop and implement solutions at the appropriate scale to change course.

Let's work together to overcome the barriers that are blocking the transition to a safe and sustainable future. Let's take action to recalibrate markets and business models and repair

governance and institutions to ensure we stay within the limits of the planet and safeguard long-term well-being for all.

For the past 150 years, DNV GL's purpose has been to safeguard life, property and the environment. As we go forward, fulfilling this role takes on new urgency. DNV GL will continue to collaborate with stakeholders to demonstrate, implement and build trust in solutions that enables the transition to a safer and more sustainable world. We are at a moment in time where there is a great opportunity to create the future we want. We have the resources, the knowledge, the technology and solutions - if we make the right choices, and if we make them now.

SUSTAINABILITY JUST MEANS LIVING AS IF OUR FUTURE MATTERS.

ALEC LOORZ, FOUNDER IMATTER AND KIDS VS. GLOBAL WARMING

1 BUSINESS AS USUAL OUTLOOK: WHERE ARE WE HEADED?

1. UNDP (2011)
2. Rockström et al. (2009). The figure includes 2009 numbers and some have changed significantly since 2009 (e.g. we passed 400 ppm CO₂ concentration in the atmosphere in May 2013 (NASA 2013)). The research team behind the Planetary Boundary framework is currently updating all figures. However, as these are not available yet, the numbers from the original article are included for the sake of consistency.
3. Griggs et al. (2013)
4. Global Carbon Project (2013)
5. NASA (2013)
6. Rockström et al. (2009)
7. OECD (2012a) Climate Change Chapter
8. Ellen MacArthur Foundation (2012)
9. Sverdrup et al (2013)
10. OECD (2012a)
11. IPCC (2009)
12. IFPRI (2011). Chatham House (2012) indicates that this number may be higher, and that by 2050 three-quarters of the world's population could face acute freshwater scarcity.
13. McKinsey Quarterly (2009)
14. OECD (2012a)
15. WHO (2005)
16. The Telegraph (2014)
17. Pozzer, A. et al. (2012)
18. The Economist (2008), Stockholm Resilience Centre (2009)
19. OECD (2012a)
20. Hoorweg, Daniel et al. (2013)
21. UNEP (2011a)
22. UNCCD (2012)
23. Statistics from the United Nations World Population Prospects 2012 Revision (UN DESA (2013b)); however, some scientists argue that the global population will peak before 2050, and only reach 8.4 billion in 2040 (Randers 2012).
24. WBCSD (2009)
25. Randers (2012)
26. WHO (2011a)
27. Randers (2012)
28. World Health Organisation
29. A measure showing the number of dependents (aged below 14 and above 65) to the working age population (age 15-65)
30. UN DESA (2012a)
31. These numbers are highly contested and vary significantly (WEC 2011)
32. UN Habitat (2007)
33. Lee-Brago (2013)
34. FAO (2012)
35. FAO (2012)
36. World Bank (2011a)
37. According to FAO 15-30% is lost in storage or transportation (FAO 2011b)
38. FAO (2009b)
39. Oxford Martin School (2013)
40. The Lancet (2010)
41. 2011 numbers from United Nations (2013)
42. UNESCO (2005)
43. In developing countries
44. Redden (2012)
45. Gates Foundation (2014)
46. IMF (2013b)
47. UNDP (2011)
48. IMF (2013b)
49. OECD (2012c)
50. UNDP (2011), OECD (2012c)
51. World Economic Forum (2013a)
52. World Bank (2011b)
53. Organisation for Economic Co-operation and Development CleanGovBiz (2014)
54. World Bank (2004)
55. PRIO (2008)
56. Growth continues to be weighed down by slowing credit, capacity constraints in key emerging market economies and possibly tighter financial conditions (IMF 2013a)
57. PWC (2013)
58. Randers (2012)
59. IMF (2014)
60. McKinsey Global Institute (2011)
61. HSBC Global Research (2012)
62. OECD (2012b)
63. Credit Suisse (2012)
64. Oxfam (2014)
65. Oxfam (2014)
66. Worldwatch Institute (2013b)
67. Worldwatch Institute (2013b)
68. Randers, J. (2012)
69. Herman Daly in Randers (2012)
70. Sukhdev (2012)
71. Trucost (2010)

72. Actual externalities are likely to be higher than the US\$ 2.15 trillion, since the analysis excludes external costs caused by product use and disposal, as well as companies' use of other natural resources and release of further pollutants through their operations and suppliers (Trucost 2010)
73. IEA (2012b)
74. IEA (2012b)
75. Love (2013)
76. IMF (2013c)
77. Fullerton (2014)
78. IPCC (2013)
79. Although there is no firm scientific evidence on the exact extent or timing of impacts of climate change, there is a growing literature that describes the prospective risks and adverse effects (IPCC 2013)
80. In 2012, an expert panel convened by the National Oceanic and Atmospheric Administration adopted 6.6 feet (2 meters) as its highest of four scenarios for 2100. The US Army Corps of Engineers recommends that planners consider a high scenario of five feet (National Geographics 2013), Strategic Environmental Research and Development Program (SERDP 2013).
81. IPCC (2009)
82. UN (2013)
83. IUCN (2014)
84. Nature (2011)
85. World Resources Institute (2011)
86. Vince (2012)
87. McKinsey & Company (2011)
88. Randers (2012)
89. Some argue this number is too high, as a result of declining fertility rates (Randers 2012), others argue this number may rise to 10 billion later in the century (UN DESA 2013b)
90. WEF (2013a)
91. FAO (2011a)
92. USDA (2013)
93. UNDP (2011)
94. IFPRI (2010)
95. UN DESA (2012a)
96. IFPRI (2010)
97. WEF (2013a)
98. OECD (2012a)
99. As developing countries and those in economic transition increase their economic production, related chemical releases have raised concerns over adverse human and environmental effects. Chemical contamination and waste associated with industrial sectors of importance in developing countries include pesticides from agricultural runoff; heavy metals associated with cement production; dioxin associated with electronics recycling; mercury and other heavy metals associated with mining and coal combustion; butyl tins, heavy metals, and asbestos released during ship breaking; heavy metals associated with tanneries; mutagenic dyes, heavy metals and other pollutant associated with textile production; and toxic metals, solvents, polymers, and flame retardants used in electronics manufacturing. (UNEP 2013)
100. UN World Food Programme
101. UN-Habitat (2007)
102. National Geographic (2013)
103. National Geographic (2013)
104. UNDP (2011) 0.5 m being a conservative estimate
105. UN DESA (2012a)
106. WEF (2013a)
107. Sverdrup et al (2013)
108. Randers (2012)
109. WEF (2012)
110. Ellen MacArthur Foundation (2012), McKinsey&Company (2011)
111. Lowrey (2013)
112. Lowrey (2013)
113. WEF (2013a), Stern (2006)
114. Mercer (2011)
115. Randers (2012)
116. IFPRI (2011)
117. WEF (2013)
118. Chatham House (2012)

2 OUR VISION FOR A SAFE AND SUSTAINABLE FUTURE

1. UNSG (2012)
2. See for example: Eccles et al. (2013)

4 CHANGING COURSE: PATHWAYS TO A SUSTAINABLE FUTURE

1. Edwards (2011) referencing statement by Kenneth Henry
2. Externalities are costs that occur as a consequence of one actor's behaviour, but affect the welfare of another party or parties.
3. The Circular Economy and the concept of Cradle-to-Cradle were first set forth by Walter Stahel in the mid-1970s (see <http://www.product-life.org/>). More recently (2012), the Ellen MacArthur Foundation (2013) has described it as: A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end of life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and within this, business models.
4. Capital Institute (2013)
5. Yunus (2007)
6. Oxford Martin School (2013)
7. Regulation in this context is defined as a rule, principle, procedure or condition that controls and governs behaviour by setting requirements, and is taken to denote: international agreements, treaties, national legislation, policies as well as voluntary standards and principles.
8. UN-HABITAT (2010)
9. Wilkinson et al. (2010)
10. World Bank (2013)
1. IHIS (2012) Based on statistics from IHS Fairplay for the period 2003-2012
2. EIA (2013)
3. Sandrea et al. (2007)
4. Det Norske Veritas (2013)
5. FAO (2009a)
6. FAO (2011b)
7. FAO Aquastat (2013)
8. WHO (2011b)
9. Jha et al. (2013)
10. United Nations General Assembly (2012)
11. WHO (2010)
12. The Lancet (2012)
13. WHO (2002)
14. UN (2002)
15. OECD (2013)
16. WHO (2012)
17. Jha et al. (2013)
18. Wilson RM et al (2012)
19. Sermeus et al. (2010)
20. O'Brien P & Gostin L (2011)
21. WHO (2012)
22. WHO (2013)
23. WHO Global Observatory for eHealth (2011)

5 SPOTLIGHTS ON SUSTAINABILITY IN KEY SECTORS

REFERENCE LIST

ACCA, Fauna & Flora International, KPMG (2012): Is natural capital a material issue? An evaluation of the relevance of biodiversity and ecosystem services to accountancy professionals and the private sector

AccountAbility (2013): Redefining Materiality II: Why it Matters, Who's Involved, and What It Means for Corporate Leaders and Board

Asian Development Bank (2011): Asia 2050 Realizing the Asian Century

Capital Institute (2013): Regenerative Capitalism, draft June

Ceres (2013): Investors ask fossil fuel companies to assess how business plans fare in low-carbon future, Boston, MA Oct 24, 2013. Available at <http://www.ceres.org/press/press-releases/investors-ask-fossil-fuel-companies-to-assess-how-business-plans-fare-in-low-carbon-future>

Ceres (2010): The 21st Century Corporation: The Ceres Roadmap for Sustainability

Credit Suisse (2012): Global Wealth Report

Chatham House (2012): Resources Futures

CRS Report for Congress (2010): Managing Electronic Waste - Issues with Exporting E-Waste

Det Norske Veritas (2013): Aqua Recovery - Offshore recycling of wastewater

Det Norske Veritas (2012): Technology Outlook 2020 Healthcare

Det Norske Veritas (2013): The LNG shipping fleet could have been halved. Available at <http://blogs.dnv.com/ing/2013/10/the-ling-shipping-fleet-could-have-been-halved/>

Eccles, Robert G. et al (2013): "The Impact of Corporate Sustainability on Organizational Processes and Performance", Working Paper 12-035, Harvard Business School, July 2013

Edwards, Mark G. (2011): "Redefining GDP and what we mean by growth", The Conversation, 28 April 2011. Available at <http://theconversation.com/redefining-gdp-and-what-we-mean-by-growth-708>

Ellen MacArthur Foundation (2012): Towards The Circular Economy; Economic and business rationale for an accelerated transition

Ellen MacArthur Foundation (2013): Towards The Circular Economy Vol.2 : Opportunities for the consumer goods sector

European Communities (2008): The Economics of Ecosystems & Biodiversity: An interim report

European Environmental Agency (EEA) (2010): State and Outlook

Financial Times (2012): Future of the Food Industry, Available at <http://www.ft.com/reports/future-food-industry>

Food and Agriculture Organization of the United Nations & Aquastat (FAO) (2013): Water uses, Available at http://www.fao.org/nr/water/aquastat/water_use/index.stm

Food and Agriculture Organization of the United Nations (FAO) (2012): The State of Food Insecurity in the World

Food and Agriculture Organization of the United Nations (FAO) (2011a): State of the World's Land and Water Resources for Food and Agriculture (SOLAW)

Food and Agriculture Organization of the United Nations (FAO) (2011b): Global Food Losses and Food Waste, Available at www.fao.org/docrep/014/mb060e00.pdf

Food and Agriculture Organization of the United Nations (FAO) (2009a): Climate change and bioenergy challenges for food and agriculture, Available at http://www.fao.org/fileadmin/templates/wfs/docs/Issues_papers/HLEF2050_Climate.pdf

Food and Agriculture Organization of the United Nations (FAO) (2009b): How To Feed The World In 2050

Food and Agriculture Organization of the United Nations (FAO): Hunger Portal / Hunger Statistics, Available at <http://www.fao.org/hunger/en/>

Fullerton, John (2014): Limits to investment

G. Wilkinson, Richard et al. (2010, November 27): "Equality, sustainability, and quality of life", (BMJ Vol. 341), Available: <http://www.bmj.com>

Gansky, Lisa (2013): Mesh - The pulse of the sharing economy, Available at <http://meshing.it/>

Gansky, Lisa (2010): "The Mesh - Why the future of business is sharing", Portfolio/Penguin, New York

Gates Foundation (2014): Bill and Melinda Gates Annual Letter 2014, Available: <http://annualletter.gatesfoundation.org/#section=myth-three>

Global Carbon Project (2013): Global Carbon Budget; An annual update of the global carbon budget and trends) published on 19 November 2013. Available at http://www.globalcarbonproject.org/carbon-budget/13/files/GCP_budget_2013.pdf

Global Footprint Network (2013): World Footprint: Do we fit on the planet?, Available at http://www.footprintnetwork.org/en/index.php/gfn/page/world_footprint/

Goldman Sachs (2007): GS Sustain GreenBiz Business 2013

Greenpeace International (2012): Getting Rid of Harmful Subsidies

Griggs, David et al. (2013): "Sustainable development goals for people and planet", Nature Vol. 495, Macmillian Publishers Limited, London

Hoornweg, Daniel et al. (2013): "Waste production must peak this century", Nature, Vol. 502, 31. October, 2013, Macmillan Publishers Limited. All rights reserved

HSBC Global Research (2012): Consumers in 2050, October

Howstuffworks (2013): Rise of Megacities: The Future Illustrated, Available at <http://science.howstuffworks.com/environmental/energy/rise-of-megacities.htm>

IHS (2012): IHS Fairplay World Fleet Statistics, Available at <http://www.ihs.com/products/maritime-information/statistics-forecasts/world-fleet.aspx>

Ingram, John et al. (2010): Food security and global environmental change, Earthscan

Institution of Mechanical Engineers (IMechE) (2013): Global Food, Waste Not, Want Not

International Food Policy Research Institute (IFPRI) (2011): Finding the Blue Path for a Sustainable Economy, White Paper

International Food Policy Research Institute (IFPRI) (2010): Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options

International Energy Agency (IEA) (2012a): CO₂ Emissions From Fuel Combustion 2012 edition

International Energy Agency (IEA) (2012b): World Energy Outlook

International Monetary Fund (IMF) (2014, November 27): "World Economic Outlook (WEO) Update Is the Tide Rising?"

International Monetary Fund (IMF) (2013a): World Economic Outlook

International Monetary Fund (IMF) (2013b): Women, Work and the Economy: Macroeconomic Gains from Gender Equity

International Monetary Fund (IMF) (2013c): Energy subsidy reform. Available at <https://www.imf.org/external/np/pp/eng/2013/012813.pdf>

International Monetary Fund (IMF) (2010)

IPCC (2013): Fifth Assessment Report Climate Change 2013: The Physical Science Basis

IPCC (2009): Climate Change 2009: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change

IPCC (2007): Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change

ISSC (2013): World Social Science Report; Changing Global Environments, UNESCO Publishing

IUCN (2014): About the biodiversity crisis. Available at <https://www.iucn.org/what/biodiversity/>

Jha, Ashish. K. et al. (2013): "The global burden of unsafe medical care: analytic modelling of observational studies", BMJ Quality & Safety, 2013;22:809-815

Lee-Brago, Pia (2013): "Number of slum dwellers may hit 3 billion by 2050 - UN report", The Philippine Star, July 7. Available at <http://www.philstar.com/headlines/2013/07/07/962526/number-slum-dwellers-may-hit-3-billion-2050-un-report>

LG (2013): LG Washing machine first in home appliance industry to receive water footprint verification, Available at <http://lgnewsroom.com/newsroom/contents/63802>

Love, Patrick (2013): "Fossil fuel subsidies: billions up in smoke?", OECD Insights, Available at <http://oecdinsights.org/2013/02/11/fossil-fuel-subsidies-billions-up-in-smoke/>

Lowrey, Annie (2013): "The Inequality of Climate Change", Economix, New York Times. Available at http://economix.blogs.nytimes.com/2013/11/12/the-inequality-of-climate-change/?_r=0

M. Hsiang, Solomon et al. (2013, August 1): "Quantifying the Influence of Climate on Human Conflict", (Science Express), Available: <http://www.sciencemag.org> (Accessed: 2013, August 28)

McKinsey Global Institute (2011): Urban World: Mapping the economic power of cities. Available at http://www.mckinsey.com/insights/urbanization/urban_world

McKinsey&Company (2011): Resource Revolution: Meeting the world's energy, materials, food, and water needs, McKinsey Global Institute

McKinsey&Company (2009): "The business opportunity in water conservation", McKinsey Quarterly, December

Mercer (2011): Climate change scenarios: Implications for strategic asset allocation

Myers, Norman (2005): "Environmental Refugees: An Emergent Security Issue, Paper presented at 13th Economic Forum, Prague, 23-27 May 2005

NASA (2013): NASA scientists react to 400 ppm carbon milestone. Available at <http://climate.nasa.gov/400ppmquotes/>

NASA (2007): The current and future consequences of global change. Available at <http://climate.nasa.gov/effects>

National Geographic (2013): Rising Seas, September

Natural Capitalism Solutions (2012): Sustainability Pays Studies That Prove the Business Case for Sustainability

Nature (2011): Number of species on Earth tagged at 8.7 million, published by Lee Sweetlove, August 2011 Corrected online: 24 August 2011. Available at <http://www.nature.com/news/2011/110823/full/news.2011.498.html>

Nidumolu, R., Prahalad, C.K., Rangaswami, M.R. (2009): "Why sustainability is now the key driver of innovation", Harvard Business Review, September 2009

O'Brien P & Gostin L (2011): Health Worker Shortages and Global Justice, New York: Milbank Memorial Fund

Oliver-Smith, Anthony (2009): "Sea Level Rise and the Vulnerability of Coastal Peoples", InterSecTions Vol. 7, UNU-EHS

Organisation for Economic Co-operation and Development (OECD) (2011): Towards Green Growth

Organisation for Economic Co-operation and Development (OECD) (2012a):

Environmental Outlook To 2050: The consequences of Inaction. Available at <http://www.oecd.org/env/indicators-modelling-outlooks/oecdenvironmentaloutlookto2050theconsequencesofinaction-keyfactsandfigures.htm>

Organisation for Economic Co-operation and Development (OECD) (2012b): Looking to 2060: A Global Vision of Long-Term Growth

Organisation for Economic Co-operation and Development (OECD) (2012c): Gender Equality, Available at: <http://www.youtube.com/watch?v=j85fGU3PeeY>

Organisation for Economic Co-operation and Development (OECD) (2012): Public Health Spending on Long-Term Care: a new set of projections, Available at www.oecd.org/eeco/growth/Health%20FINAL.pdf

Organisation for Economic Co-operation and Development CleanGovBiz (2014): The rationale for fighting corruption. Available at <http://www.oecd.org/cleangovbiz/49693613.pdf>

Organisation for Economic Co-operation and Development/ International Energy Agency (2003): Creating Markets for Energy Technologies, IEA

Oxfam (2014): Working for the Few

Oxford Martin School (2013): Now for the Long Term, University of Oxford

PERL: Sustainable Lifestyles <http://www.perlprojects.org/Project-sites/PERL/Responsible-living/Sustainable-lifestyles>

PEW Center for Climate and Energy Solutions (2011): The Business of Innovating: Bringing Low-Carbon Solutions to Market

Pozzer, A. et al. (2012): "Effects of business-as-usual anthropogenic emissions on air quality", Atmospheric Chemistry and Physics, 12, 6915-6937. Available at <http://www.atmos-chem-phys.net/12/6915/2012/acp-12-6915-2012.html>

PRI0 (2008): Data on Armed Conflict. Available at <http://www.prio.no/Data/Armed-Conflict/>

PWC (2013): World in 2050 - The BRICs and beyond: prospects, challenges and opportunities

Randers, Jørgen (2012): "2052- A Global Forecast for the Next Forty Years", Chelsea Green Publishing, USA

Redden, Elizabeth (2012): "Global Education Trends", Inside Higher Ed, September 11, 2012. Available at <http://www.insidehighered.com/news/2012/09/11/oecd-releases-report-global-education-trends>

Rockström, Sachs, Öhman, Schmidt-Traub (2013): Sustainable Development and Planetary Boundaries, Background Research Paper, Submitted to the High Level Panel on the Post-2015 Development Agenda, 15 March 2013

Rockström, Johan et al. (2009): "A safe operating space for humanity", Nature Vol. 461, Macmillian Publishers Limited

Sandrea, Ivan & Sandrea, Rafael (2007): "Global Oil Reserves-1: Recovery factors leave vast target for EOR technologies", Oil and Gas Journal, May 11 2007

Sermes W. & Bruyneel L. (2010): Investing in Europe's health workforce of tomorrow:

Scope for innovation and collaboration, Available at www.healthworkforce4europe.eu/downloads/Report_PD_Leuven_FINAL.pdf

Science Daily (2010): Hazardous E-Waste Surging in Developing Countries. Available at <http://www.sciencedaily.com/releases/2010/02/100222081911.htm>

Scientific Organizing Committee Planet Under Pressure conference (2012): The State of the Planet Declaration, The global change research programmes of the International Council for Science

Stahel, Walter (1981): The Product-Life Factor. Available at <http://www.product-life.org/en/cradle-to-cradle>

Stern, Lord Nicolas (2006): Review on the Economics of Climate Change. Commissioned July 2005, published October 2006. Available at http://www.hm-treasury.gov.uk/stern_review_report.htm

Strategic Environmental Research and Development Program (SERDP) (2013): Climate Change and Impacts of Sea Level Rise, Available at <http://www.serdp.org/Featured-Initiatives/Climate-Change-and-Impacts-of-Sea-Level-Rise>

Stiglitz Commission (2009): Report on the Measurement of Economic Performance and Social Progress

Stiglitz Commission (2008): Report on the Measurement of Economic Performance and Social Progress, commissioned by the French Republic

Stockholm Resilience Centre (2011): What is resilience? An introduction to social-ecological research

Stockholm Resilience Centre (2009): Planetary Boundaries: Exploring the Safe Operating Space for Humanity

Sverdrup, Harald Ulrik et al. (2013): "Peak Metals, Minerals, Energy, Wealth, Food, and Population; Urgent Policy Considerations for a Sustainable Society", Journal of Environmental Science and Engineering, ISSN 1934-8932

Sukhdev, Pavan (2012): Corporation 2020 - Transforming Business for Tomorrow's World, Island Press

Sustainable Brands (2013): Redefining Value: The New Metrics of Sustainable Business

The Economist (2008): Dead Water, March 15, Available <http://www.economist.com/node/11367884>

The International Bank for Reconstruction and Development / The World Bank (2010): World Development Report 2010

The Telegraph (2014): China's 'airpocalypse' kills 350,000 to 500,000 each year. Available at <http://www.telegraph.co.uk/news/worldnews/asia/china/10555816/Chinas-airpocalypse-kills-350000-to-500000-each-year.html>

The Lancet (2010): Global Burden of Disease Study 2010

The World Bank (2010): World Development Report 2010; Development and Climate Change

The World Bank (2012): Inclusive Green Growth - The Pathway to Sustainable Development

Transparency International (2013): It Belongs To You: Public Information In The Middle East And North Africa, Transparency International the global coalition against corruption

Trucost (2012): Trucost launches True Cost blog, August 14. Available at <http://trucost.com/news-2012/154/trucost-launches-true-cost-blog>

Trucost (2010): Universal Ownership: Why Environmental Externalities Matter to Institutional Investors. Available at http://www.unpri.org/viewer?file=files/6728_ES_report_environmental_externalities.pdf

United Nations Secretary-General's High-Level Panel on Global Sustainability (UNSG) (2012): Resilient people, resilient planet: A future worth choosing, Overview. New York: United Nations.

United Nations (2013): United Nations Millennium Development Goal Report 2013, printed by United Nations, New York

United Nations (2012): The Millennium Development Goals Report 2012, compiled by an Inter-Agency and Expert Group on MDG, printed by United Nations, New York

United Nations (2011): The Need for a New Global Agreement on Climate Change, Available at <http://www.un.org/wcm/content/site/climatechange/pages/gateway/the-negotiations/the-need-for-a-new-global-agreement>

United Nations (2005): Millennium Ecosystem Assessment

United Nations (2002): World Population Ageing, New York, United Nation

United Nations Department of Economic and Social Affairs (UN DESA), Division for Sustainable Development (2013a): Global Sustainable Development Report - Executive Summary: Building the Common Future We Want, New York

United Nations Department of Economic and Social Affairs (UN DESA), Population Division (2013b): World Population Prospects: The 2012 Revision

United Nations Department of Economic and Social Affairs (UN DESA) (2012a): Back to Our Common Future; Sustainable Development in the 21st century project

United Nations Department of Economic and Social Affairs (UN DESA) (2012b): Back to our Common Future - SD21 summary for policy makers

United Nations Environmental Programme (UNEP) (2011a): Green Economy Modelling Global Green Investment Scenarios

United Nations Environment Programme (UNEP) (2011b): Decoupling - Natural resource use and environmental impacts from economic growth

United Nations Environment Programme (UNEP) (2011c): Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication

United Nations Environment Programme (UNEP) (2013): Global Chemicals Outlook - Towards Sound Management of Chemicals

United Nations Environment Programme (UNEP) (2012): Nature and its role in the transition to a green economy

United Nations Environment Programme (UNEP) (1972): Declaration of the United Nations Conference on the Human Environment, Stockholm, June

United Nations General Assembly (2012): Adopting Consensus Text, General Assembly Encourages Member States to Plan, Pursue Transition of National Health Care Systems towards Universal Coverage, General Assembly GA/11326 New York: UN Department of Public Information, News and Media Division, 12th December 2012

UN Global Compact / Accenture (2010a): UN Global Compact - Accenture CEO study; A New Era of Sustainability

UN Global Compact / Accenture (2010b): UN Global Compact - Accenture CEO study; Towards a New Era of Sustainability in the Energy Industry

UN-HABITAT (2010): Sick Water? The central role of wastewater management in sustainable development, Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). ISBN: 978-82-7701-075-5

UN-HABITAT (2008): State of the World's Cities 2008/2009; Harmonious Cities

UN-HABITAT (2007): The Challenge of Slums: Global Report on Human Settlements 2003, Twenty First Session of the Governing Council. Available at <http://www.unhabitat.org/content.asp?catid=9&typeid=24&cid=11712>

United Nations World Food Programme: Available at <http://www.wfp.org/hunger>

United Nations Convention to Combat Desertification (UNCCD) (2012): Zero Net Land Degradation, UNCCD Secretariat policy brief, May

United Nations Development Programme (UNDP) (2013): Human Development Report 2013: The Rise of the South

United Nations Development Programme (UNDP) (2012): Human Development Report 2012: The Real Wealth of Nations

United Nations Development Programme (UNDP) (2011): Human Development Report 2011, Sustainability and Equity: A Better Future for All

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2005): EFA Global Monitoring Report - Chapter 1 Understanding education quality. Available at http://www.unesco.org/education/gmr_download/chapter1.pdf

United States Department of Agriculture (USDA) (2013): International Food Security Assessment 2013-2023

REFERENCE LIST

US Energy Information Administration (EIA) (2013): International Energy Outlook 2013

University of Cambridge (2006): The Sustainable Economy Dialogue, The Prince of Wales Business and the Environment Programme

Vince, Gaia (2012): How the world's oceans could be running out of fish. BBC Available at <http://www.bbc.com/future/story/20120920-are-we-running-out-of-fish>

Virginia Institute of Marine Science (2013): Dead Zones - Lack of oxygen a key stressor on marine ecosystems. Available at http://www.vims.edu/research/topics/dead_zones/

Volans (2013): Breakthrough Business Leaders, Market Revolutions, Volans Ventures Ltd., London

Waste Management World (2012): Global municipal solid waste continues to grow, July-August.

Waste Management World (2010): Waste management 2030+, Vol. 11, Issue 2, 03/03/2010

Wilkinson, R., Pickett, K. (2010): The Spirit Level, Penguin Books, London

Wilson RM et al (2012): "Patient safety in developing countries: retrospective estimation of scale and nature of harm to patients in hospital", *BMJ Quality & Safety* 344:e832 doi: 10.1136/bmj.e832

World Bank (2013): Planning, Connecting, and Financing Cities—Now, Washington, DC

World Bank (2011a): Food Price Watch, February Issue. Available at http://www.worldbank.org/foodcrisis/food_price_watch_report_feb2011.html

World Bank (2011b): Capacity Development for Anti-Corruption and Transparency. Available at <http://go.worldbank.org/Q88TTGHYN0>

World Bank (2010): Economics of Adaptation to Climate Change Synthesis Report. Available at <http://documents.worldbank.org/curated/en/2010/01/16436675/economics-adaptation-climate-change-synthesis-report>

World Bank (2004): The Cost of Corruption. Available at <http://go.worldbank.org/LJA29GHA80>

World Business Council for Sustainable Development (WBCSD) (2009): Vision 2050

World Business Council for Sustainable Development (WBCSD) (2013): Action 2020

World Economic Forum (WEF) (2013a): Global Risks 2013 Eight Edition

World Economic Forum (WEF) (2013b): The Green Investment Report; The ways and means to unlock private finance for green growth

World Energy Council (2011): Global Transport Scenarios 2050

World Health Organization (WHO) (2013): The many paths to universal health coverage. Available at: <http://www.youtube.com/watch?v=VQ3sHfYzcv8&feature=youtu.be>

World Health Organization (WHO) (2012): The World Health Report 2012: reducing risks, promoting healthy life, Geneva

WHO Global Observatory for eHealth (2011): mHealth: new horizons for health through mobile technologies, Geneva

World Health Organization (WHO) (2011a): Global Health and Ageing

World Health Organization (WHO) (2011b): Global Health Expenditure Atlas, Available at <http://www.who.int/nha/atlas.pdf>

World Health Organization (WHO) (2010): World Health Report - Health Systems Financing - The Path to Universal Coverage, Geneva

World Health Organization (WHO) (2009): Global Health Risks; Mortality and burden of disease attributable to selected major risks

World Health Organization (WHO) (2005): Air quality guidelines

World Health Organization (WHO) (2002): The world health report 2002: reducing risks, promoting healthy life, Geneva: World Health Organization

World Resources Institute (2011): Reefs at Risk

Worldwatch Institute (2013a): State of the World 2013: Is Sustainability Still Possible?

Worldwatch Institute (2013b): The State of Consumption Today. Available at <http://www.worldwatch.org/node/810>

Worldwatch Institute (2012a): State of the World 2012: Moving Toward Sustainable Prosperity

Worldwatch Institute (2012b): Global Municipal Solid Waste Continues to Grow

Yunus, Muhammad (2007): "Creating a World Without Poverty; Social Business and the Future of Capitalism", Public Affairs, New York

Zelman, Joanna (2011, February 2): "Coral Reefs May Be Gone By 2050: Study", (The Huffington Post), Available: http://www.huffingtonpost.com/2011/02/25/coral-reefs-may-be-gone-b_n_827709.html

INTERVIEW LIST LIST OF SUSTAINABILITY EXPERTS INTERVIEWED FOR THE REPORT

Mr. Ashton, John, Independent commentator and adviser on the politics of climate change, *interviewed 13.09.13*

Mr. Bakker, Peter, President & CEO World Business Council for Sustainable Development, *interviewed 29.10.13*

Mr. Bentham Jeremy, "Vice-President Global Business Environment & Head of Scenarios", Royal Dutch Shell, *interviewed 03.10.13*

Mr. Cameron, Rob, Executive Director SustainAbility, *interviewed 10.09.13*

Ms. Cheam, Jessica, Editor-in Chief Eco-Business.com, *interviewed 14.10.13*

Ms. Collins, Sarah, Founder and CEO "Natural Balance, Wonderbag", *interviewed 18.10.13*

Mr. Confino, Jo, Executive Editor "Guardian Sustainable Business and Adviser to Guardian Media Group", *interviewed 31.10.13*

Mr. Eagle, Nathan, Co-founder and CEO, Jana, *interviewed 15.10.13*

Mr. Engelman, Robert, Senior Adviser (former President), Worldwatch Institute, *interviewed 23.09.13*

Mr. Fullerton, John, Founder and President Capital Institute, *interviewed 04.10.13*

Ms. Grossi, Marina, President "Brazil Business Council for Sustainable Development", *interviewed 08.09.13*

Mr. Heggnes, Per, CEO IKEA Foundaion, *interviewed 17.10.13*

Mr. Jain, Bawa, Secretary-General "World Council of Religious Leaders" *interviewed 27.09.13*

Ms. Joly, Eva, MEP "Europe Écologie (the Greens)", *interviewed 09.10.13*

Mr. Kell, Georg, Executive Director, United Nations Global Compact, *interviewed 24.09.13*

Ms. Liu, Fengshu, Associate Professor, University of Oslo, *interviewed 28.10.13*

Mr. Looz, Alec, Founder, iMatter and Kids Vs. Global Warming, *interviewed 03.10.13*

Ms. Lovins, Hunter, President, "Natural Capitalism Solutions", *interviewed 22.10.13*

Ms. Mwaura, Grace, "Co-Convener, Task Force on Intergenerational Partnerships for Sustainability" International Union for Conservation of Nature (IUCN), *interviewed 10.09.13*

Ms. Ng, Jeanne, Director Group Environmental Affairs, CLP Holdings Limited, *interviewed 24.10.13*

Mr. Noone, Kevin, Executive Director, "Swedish Secretariat for Environmental Earth System Sciences at the Royal Swedish Academy of Sciences", *interviewed 30.09.13*

Mr. Randers, Jørgen, Professor of Climate Strategy, Norwegian Business School, *interviewed 22.10.13*

Mr. Simons, Bright, President mPedigree Network, *interviewed 25.09.13*

Mr. Steiner, Achim, "UN Under-Secretary-General and Executive Director", "United Nations Environment-Programme (UNEP)" *interviewed 20.10.13 in Paris*

Mr. Stuart, Tristram, Founder Gleaning Network UK and "Feeding the 5,000" campaign, *interviewed 11.09.13*

Mr. Sukhdev, Pavan, Founder-CEO, GIST Advisory, *interviewed 08.10.13*

Mr. Tan, Dr. Kim, Chairman "SpringHill Management and Inqo Investments", *interviewed 11.09.13*

This initiative is a collaboration between DNV GL and Xyntéo, an advisory firm that works with global companies on projects that enable businesses to grow in a new way, fit for the climate, resource and demographic realities of the 21st century. www.xynteo.com

HEADQUARTERS:

DNV GL AS

NO-1322 Høvik, Norway
Tel: +47 67 57 99 00
www.dnvgl.com

DNV GL

Driven by its purpose of safeguarding life, property and the environment, DNV GL enables organisations to advance the safety and sustainability of their business. DNV GL provides classification and technical assurance along with software and independent expert advisory services to the maritime, oil & gas and energy industries.

It also provides certification services to customers across a wide range of industries. Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, DNV GL empowers its customers' decisions and actions with trust and confidence. The company continuously invests in research and collaborative innovation to provide customers and society with operational and technological foresight. DNV GL, whose origins go back to 1864, operates globally in more than 100 countries with its 16,000 professionals dedicated to helping their customers make the world safer, smarter and greener.