sustainable economy in 2040

a roadmap for capital markets

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AVIVA INVESTORS

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Registered office:
Forum for the Future
Overseas House
19–23 Ironmonger Row
London, EC1V 3QN
United Kingdom

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For more information please contact:
Ivana Gazibara: i.gazibara@forumforthefuture.org
Alice Chapple: a.chapple@forumforthefuture.org

Design by: Ian Dera

Cover image: iStockphoto/AndrewLilley

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foreword

Investment is about the future. How the future turns out determines the returns on investments and the volatility of these returns. But, in turn, the pattern of investments (where capital is allocated) itself helps to determine the type of future we get. Therefore, in order to make the right decisions for our sustainable and responsible investments we need to form a plausible view of what a sustainable economy looks like and to determine what our role should be in allocating capital to enable it.

Surprisingly, there is very little investment analysis produced with a time horizon exceeding three years. That which does exist falls into two camps: those that extrapolate; and those that define limits. The extrapolators take current trends – population growth, rising affluence, patterns of energy use, etc… and proclaim: "By 2050 the global economy will consume three times as much oil/coal/wheat." Those watching the limits gravely state that oil supply has peaked, that carbon dioxide must not exceed 450 part per million; that wealth distributions must not become too skewed; and biodiversity loss cannot continue at current rates. These two perspectives are conflicting, yet both suffer from taking only a narrow view of the factors which will determine what our society will look like in 2040.

Very few commentators have attempted to reconcile the growth anticipated by the extrapolators and the challenges to current models of growth from the social and environmental limiting factors to produce a plausible and holistic view of a sustainable economy and its implications for investment, *Prosperity Without Growth* being a notable exception.

This is why we commissioned Forum to produce Vision 2040. The report articulates the problem very clearly in its 'framework for a sustainable economy', describing what we need from our economy: "*A resilient, sustainable economy that maximizes quality of life for all, so that people can develop their full potential and lead productive, creative lives within environmental limits*"; the inescapable environmental limits; necessary social conditions; and the characteristics of such an economy. It then provides clear pictures of what that economy would look like for certain sectors.

As responsible investors, we acknowledge that the capital markets currently allocate capital in a way that undermines sustainable development. Forum for the Future's work demonstrates that an estimated 776 million adults lack basic literacy skills, 2.5 billion people worldwide still do not have access to sanitation and 285 million people already suffer from diabetes. We are also approaching the limits to which the amount of land surface can be converted to cropland, and the fact that human processes convert more nitrogen into reactive forms than the combined effects from all the Earth's terrestrial processes gives a real sense of the scale of our combined activity.

Individually, these problems are deeply concerning indicators about the status and stability of our economic development. Collectively, they are profoundly worrying signs that our economy is on an unsustainable footing. We are deeply concerned that threat to financial stability could originate from our misuse of natural and social capital.

We believe that it is within our collective ability to deal with these problems. These problems do not arise from the lack of financial capital, as we have the financial firepower to deal with them now. They arise from the misallocation of capital. Indeed, the capital markets and the entrepreneurship and innovation that they fund can be the driving force behind this 2040 Vision of a globally green and just economy. For example, in dealing with the climate change problem, *green bonds can be developed that will raise a substantial proportion of the additional €2.9 trillion of capital required to build low-carbon infrastructure in Europe between now and 2020.*

Why are the markets not currently allocating capital in a way that promotes a sustainable economy? We believe that the key problems are that investors do not integrate sustainable development issues into their valuation work, or into the messages that they transmit to the people that run the companies for them. There are many reasons for this, but two stand out: (i) short-termism – for which the capital markets can be fairly criticised; and (ii) market failure – which is a lack of action by global governments and policy-makers to make the sustainable development issues actually matter to corporate cash flows. The difference between short-termism and market failure is that the former is a failure of the predictive power of investors – while the latter is a failure of governments to ensure that companies have to pay the full cost of their social and environmental externalities.

As a result of government's failure to internalise these costs into a company's profit and loss statement, the capital market does not incorporate companies' full social and environmental costs. It would be irrational for investors to incorporate companies' full social and environmental externalities into company valuation as they do not affect earnings or costs. This is why we asked Forum for the Future to consider what recommendations it wanted to make to policy-makers as well as investors.

One practical policy suggestion that Aviva is proposing is for the United Nations (UN) member states at the 2012 Earth Summit to commit to develop a global framework requiring companies to produce an annual report and accounts that integrate sustainability throughout. We are particularly keen to see sustainability integrated into the forward-looking strategy, but we also want the recent performance data as well as have the reassurance that those responsible for audit, risk and remuneration within the company are also considering this performance. In order to allow companies time to adjust, we are recommending that this be required on a comply or explain basis. We are also advocating that the quality of the integration of sustainability – or the explanation – be put to the vote at the AGM. This framework flows from the work we have been doing to encourage stock markets to take on the challenge of promoting corporate sustainability (where we have been working with the UN Global Compact, the UN Conference on Trade and Development as well as the UN Principles for Responsible Investment – see **www.unpri.org/sustainablestockexchanges**).

It is clear that in order for sustainable development to matter to markets, we need much more action by all. Long-term responsible investors understand that the financial implications of unsustainable development on pension portfolios could be catastrophic. Such investors have a duty to intervene and help shape the debate. Catalysing this report and our above Earth Summit call to action are part of Aviva Investors' contribution. We would welcome the support of our peers.

We believe the report gives rise to a great many challenges for investors. For our part, we make no claim to be adopting them now. We see the report as a guide giving us a bearing for our investment compass: which sectors are likely to grow in the transition to a more sustainable economy and will reward capital allocated to them; and which areas are best avoided.

Peter Michaelis,
Head of SRI, Aviva Investors

Steve Waygood,
Head of Sustainability Research and Engagement, Aviva Investors

AVIVA INVESTORS

executive summary

This report shows investors how they can help create a resilient, stable and sustainable economy by investing wisely and using their power to shape the development of capital markets.

Most guidance on sustainable investment focuses on how to make business as usual better, without looking at the bigger picture. Our recommendations are based on an assessment of the fundamental reallocation of capital required to achieve a sustainable economy. We believe this is the first time such an approach has been taken to sustainable investment.

Forum for the Future has created a tool which defines the characteristics of a sustainable economy that operates within safe environmental limits and enriches people's lives. Our Framework for a Sustainable Economy captures a comprehensive range of environmental boundaries and social conditions which a sustainable economy must respect. It can be applied to any sector or business and investors can use it as a pragmatic guide to analyse the long-term sustainability of their investments.

The report offers investors specific, practical guidance in five key sectors which are fundamental to a sustainable future: food; health and wellbeing; energy; mobility; and finance. It identifies critical areas in each where the scale, pace or nature of growth needs to change, and it presents a 'roadmap' giving detailed guidance on where to invest to support the development of a sustainable economy. We have based this on a 'vision' of where these sectors need to be in 30 years in order to be truly sustainable.

It also identifies the principal reasons why investment does not currently flow in a way which supports a sustainable economy and highlights structural changes that need to be made in the capital markets. The report calls on investors to play a more active role, putting pressure on businesses to build sustainability into their strategy and lobbying for government intervention to overcome barriers. We identify 10 key priorities for immediate action by investors, companies and policy–makers (see p10).

The recommendations for investors to be guided by the principles of sustainability are informed by hard-headed business sense. For example, we have a solid foundation of science which tells us that if we continue to burn fossil fuels which exacerbate climate change it will profoundly disrupt economic activity; the 2010 floods in Pakistan and drought in Russia serve as a warning. The 2011 Arab Spring has also demonstrated the impact that social instability can have on key markets, for example in the Middle East.

Sustainable Economy in 2040: A Roadmap for Capital Markets has been produced with funding from Aviva Investors. The report takes into account the latest scientific thinking on what constitutes safe environmental boundaries, the characteristics of a sustainable and fair society, and the changes in technology and behaviour that may shape key sectors. We have consulted with academics and experts in each of the five sectors, conducted extensive research and drawn on a number of existing visions to ensure we cover the full range of sustainability factors.

Aviva Investors will be using this report to guide its own investments and is already lobbying for companies to report annually on how they are addressing sustainability – one of our key recommendations. The Technology Strategy Board, which has also helped fund development of the framework, will be using an adapted version to ensure that its own investments contribute to a more sustainable economy.

Some will argue that the goal of a sustainable economy in 2040 is unrealistic. This report undoubtedly highlights that it is a massive challenge. But what is striking is that it is – in principle – possible to achieve if we deliberately set out to do so. It is also clear that the way financial markets operate over the next 30 years will be one of the most important enablers of – or barriers to – achieving that goal.

We hope this report will show investors how they can play a big part in achieving that goal by actively seeking investments aligned with a sustainable future. Forum for the Future does not underestimate the challenges, and recognises that investors cannot act alone, but many in the sector recognise the need for change, and we hope this report will help them make their case.

Characteristics of a sustainable economy

Ultimately an economy is a means to an end: the wellbeing of human societies within environmental limits. Our Framework for a Sustainable Economy (see the diagram on p9) sets out the critical environmental and social factors which must be respected by all key economic institutions.

There is growing awareness that our global economy is environmentally unsustainable. Our prosperity depends on a wide range of resources and services supplied by our planet, from fresh water, metals and minerals to crop pollination performed by bees. Most of these are overexploited and underpriced, or not valued at all in today's economies.

And the economy is not delivering quality of life for a huge section of the world's population: more than a billion people are undernourished, short of clean water and without electricity. The global population is expected to grow rapidly in the next 30 years, from 6.9 billion in 2010 to 8.8 billion in 2040, mostly in developing countries,[1] exacerbating pressure on natural resources. We believe that a sustainable economy must tackle social problems and deliver social justice.

Climate change compounds these problems, changing patterns of rainfall and agriculture, increasing the frequency and severity of extreme weather events, and threatening to displace millions of people. We need to halve global carbon dioxide (CO_2) emissions by 2050 to avoid the worst impacts, and this will require a radical restructuring of our economy away from dependence on oil and gas.

If our economy is to continue to grow while becoming more sustainable, it will have to be premised on low-carbon economic growth with radical improvements in the efficiency with which we use resources.

So the outermost ring of our diagram is concerned with the finite resources of our planet and describes the key **environmental boundaries** we need to work within.

The second ring describes the **social conditions** which we believe are necessary to support a complex, flourishing global civilisation.

The third ring describes 15 '**characteristics**' of a sustainable economy which respects these environmental and social boundaries. There is more detail on each of these in the full report.

We define our **goal** at the centre: "A resilient, sustainable economy that maximises quality of life for all, so that people can develop their full potential and lead productive, creative lives within environmental limits."

We use the terms 'boundaries' and 'conditions' instead of 'targets' because these are not optional aspirations. True, the economy or the ecosystem may not collapse if we breach one particular boundary – say, the condition on eradication of extreme poverty – as our *status quo* today certainly proves. However, in order to create a *truly sustainable economy*, we need to respect each and every one of those boundaries and conditions. Furthermore, all the boundaries defined in the framework are profoundly interlinked, and must be considered as a whole. For example, if we degrade our forests, we will miss the boundary on land use, as well as undermine the stability of our climate.

It is important to note that the framework is based on the latest available science and has been tested with a number of stakeholder groups. But it will and should change over time, as new science is brought to bear and in response to feedback from additional stakeholders.

Framework for a sustainable economy in 2040

Environmental boundaries

Greenhouse gases (E1)
Emissions of greenhouse gases are on a downward trajectory consistent with the average global temperature remaining below the 2°C threshold.

Natural habitats (E2)
Loss of natural habitats reduced to zero. All threatened species safeguarded. Areas under agriculture, aquaculture and forestry are managed sustainably to ensure conservation and biodiversity.

Waste (E3)
Most waste streams eliminated by closed-loop processes, reuse and recycling. Remaining waste streams do not exceed the carrying capacity of natural systems.

Water (E4)
Global consumption of blue water sources does not exceed 4,000 cubic km/year. Watersheds at the local level are managed sustainably.

Ocean acidity (E5)
The concentration of acid compounds in the world's oceans has peaked, and is on a downward trajectory to pre-industrial levels.

Non-renewable resources (E6)
Use of non-renewable natural resources (eg hydrocarbons and iron ore) does not threaten any of the other environmental risk boundaries; depletion rates take full account of the entitlements of future generations.

Renewable resources (E7)
Stocks of renewable resources (eg marine fisheries and forests) are managed sustainably to meet both human and broader ecosystem needs.

Soil productivity (E8)
Soil productivity is protected as the overarching priority of all sustainable land use systems; no more than 15% of global ice-free land is converted to crop land.

Chemicals (E9)
Releases of toxic chemicals are controlled in such a way as to reduce to zero any damage to natural systems.*

Atmospheric aerosols (E10)
Atmospheric aerosol loading is limited.*

Ozone (E11)
Stratospheric ozone levels maintained above 276 Dobson units.

Nitrogen & phosphorus (E12)
The amount of nitrogen removed from the atmosphere for human use does not exceed 35 million tonnes per year. No more than 11 million tonnes of phosphorus per year is allowed to flow into the oceans.*

Social conditions

Hunger (S1)
Systemic and persistent levels of hunger and malnutrition have been eliminated.

Obesity (S2)
The spread of obesity has been halted.

Poverty (S3)
Extreme poverty has been eradicated.

Health (S4)
Universal access to preventative and restorative healthcare.

Reproductive rights (S5)
All women have access to a choice of contraception and to improved reproductive healthcare.

Water & sanitation (S6)
Universal access to safe drinking water and proper sanitation.

Education (S7)
Universal access to primary and secondary education.

Shelter (S8)
Adequate shelter for all.

Information (S9)
Universal access to information.

Energy (S10)
Universal access to efficient and sustainable energy systems.

Human rights (S11)
Broad-based respect for human rights: people have the freedom to exercise choice and participate in decision-making that affects their lives.

Governance (S12)
Broad access to accountable, transparent and participatory governance systems.

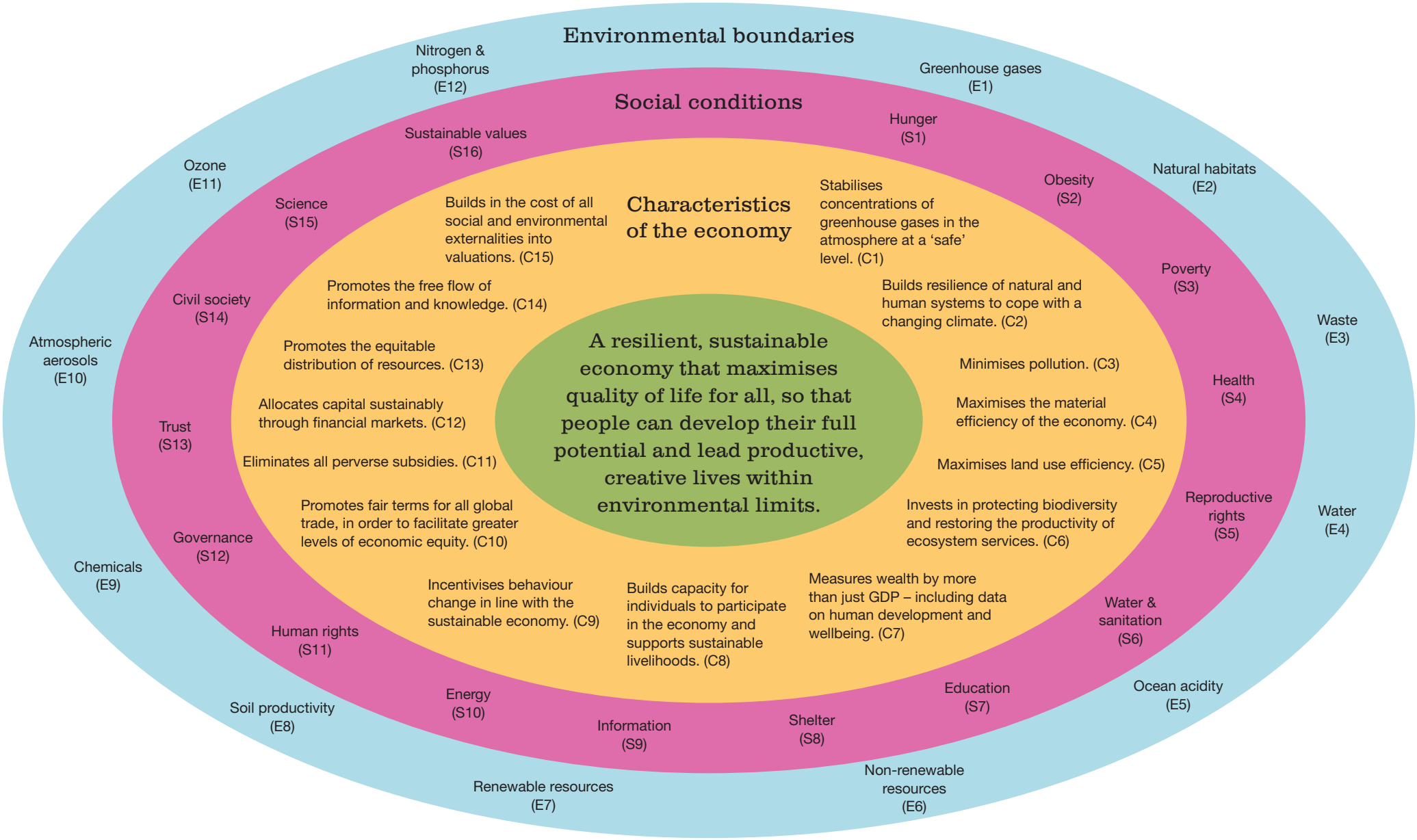
Trust (S13)
Global levels of trust in society, for people and institutions, are at an all-time high.

Civil society (S14)
Civil society plays a strong and active role in raising awareness, and strengthening accountability.

Science (S15)
Science is valued by society and accepted universally as the foundation for sound policy-making.

Sustainable values (S16)
Values consistent with sustainability are promoted through education and societal norms.

*Boundaries which cannot as yet be defined more specifically because more research in these areas is needed
For more details see Part 1


Environmental boundaries
Nitrogen & phosphorus (E12)
Greenhouse gases (E1)
Social conditions
Sustainable values (S16)
Hunger (S1)
Ozone (E11)
Natural habitats (E2)
Science (S15)
Obesity (S2)
Characteristics of the economy
Builds in the cost of all social and environmental externalities into valuations. (C15)
Stabilises concentrations of greenhouse gases in the atmosphere at a 'safe' level. (C1)
Poverty (S3)
Civil society (S14)
Promotes the free flow of information and knowledge. (C14)
Builds resilience of natural and human systems to cope with a changing climate. (C2)
Waste (E3)
Atmospheric aerosols (E10)
Promotes the equitable distribution of resources. (C13)
A resilient, sustainable economy that maximises quality of life for all, so that people can develop their full potential and lead productive, creative lives within environmental limits.
Minimises pollution. (C3)
Health (S4)
Allocates capital sustainably through financial markets. (C12)
Maximises the material efficiency of the economy. (C4)
Trust (S13)
Eliminates all perverse subsidies. (C11)
Maximises land use efficiency. (C5)
Reproductive rights (S5)
Promotes fair terms for all global trade, in order to facilitate greater levels of economic equity. (C10)
Invests in protecting biodiversity and restoring the productivity of ecosystem services. (C6)
Water (E4)
Governance (S12)
Chemicals (E9)
Incentivises behaviour change in line with the sustainable economy. (C9)
Builds capacity for individuals to participate in the economy and supports sustainable livelihoods. (C8)
Measures wealth by more than just GDP – including data on human development and wellbeing. (C7)
Water & sanitation (S6)
Human rights (S11)
Energy (S10)
Education (S7)
Ocean acidity (E5)
Soil productivity (E8)
Information (S9)
Shelter (S8)
Non-renewable resources (E6)
Renewable resources (E7)

Ten steps to a sustainable economy – priorities for action

Creating a sustainable economy will require a fundamental shift in the way that the financial markets allocate capital. Forum for the Future has identified 10 areas as priorities for action by investors, companies and government:

1. Investors should require all companies to report on their long-term strategy and how it makes the business more sustainable. It should demonstrate that they have a plan to address the impacts of future systemic risks including climate change, water stress, biodiversity, population growth, urbanisation and changing demographics.

2. Companies should report in their accounts the value of natural, human and social capital, so that investors can understand the importance of factors which are often overlooked. This will enable the strategic reporting outlined in (1) above. For example, food manufacturers should report on how they depend on the availability of water and fertile soil, and what they are doing to protect these assets. All companies should report on the value added to the business through effective management and training of staff and support for innovation. And companies should report on how the business depends on, and protects, relationships with customers and local communities. Where these data are not available, companies should set up pilot projects.

3. Financial institutions should demonstrate that the financial products and services they offer to meet the need for liquidity in the market also serve the long-term public good. In particular, they should demonstrate that they do not increase risk and instability in the system. This may require mandatory reporting.

4. Progressive fund managers should develop funds that invest in companies aligned to the vision of a sustainable economy. These funds should be designed to become increasingly resource-efficient and less carbon-intensive over time, as companies shift their business models or the fund moves investment to favour sustainability leaders. The government should offer tax incentives to these funds: this would require a reassignment of existing pension subsidies but no new spending.

5. Pension funds should ensure that all investment mandates require fund managers to take social and environmental issues into account as part of their fiduciary duty. They should set up an independent process to judge how well fund managers do this when making decisions on investments.

6. Companies (within and outside the capital markets) should change their remuneration systems so that they reward staff for performance on activities which build long-term value, such as innovation, efficiency and customer satisfaction, rather than for generating short-term financial returns.

7. Insurance companies should charge higher premiums for activities that create systemic risk by contributing to climate change, the depletion of natural resources, and social instability. This may need government support initially.

8. Financial institutions should develop and scale up financial instruments designed to fund long-term sustainable activities, such as bonds.

9. Government and other public-sector bodies should set up institutions and mechanisms which will catalyse private-sector investment into sustainable activities, where the current risk-reward profile is not attractive or there are particular political, technical or market risks. This will follow the model of the development finance institutions (for investment in the poorest developing countries) and the proposed UK Green Investment Bank (for investment in clean technologies). Additional areas for focus are agriculture, small businesses and forest protection.

10. The public and private sectors should engage in more effective dialogue about how to build a sustainable economy to enable better sharing of perspectives, skills and knowledge. Secondment schemes should be considered.

introduction

The purpose of this report

This report outlines our vision for a sustainable economy in 2040. It shows where we need to get to, and how capital markets can help get us there.

Our vision is not a prediction. It is an aspiration for the kind of future we would like to see. However, it is grounded in research and based on what we believe is feasible. We wanted to create a vision for a sustainable economy that would demonstrate solutions and galvanise action, particularly within the context of the capital markets.

The three main contributions of this report are to (i) bring together many of the boundary conditions necessary for a sustainable economy – this is covered in Part 1; (ii) provide an outline for how these boundary conditions would influence the future trajectory of key sectors which we have covered in this report (food, energy, health, mobility and finance sectors) although the framework is applicable to any other sector – this is detailed in Part 2; and (iii) translate the findings in Part 1 and 2 into specific guidance for investors on what this means for the direction of their future investments – this is in Part 3 of the report.

The need for a new vision for the economy

The backdrop to this vision for a sustainable economy in 2040 is a current 'business as usual' trajectory that will lead us to an economy that is far from sustainable in 30 years' time.

Globally we are already consuming one-and-a-half times as many resources as our planet produces, and we are on course for consumption levels equivalent to more than two planets by 2040, and six if we all lived by US standards.[2]

Our global prosperity depends on an array of the planet's resources and services eg fresh water, metals and minerals, and crop pollination – most of which are underpriced and overexploited in today's economies. And our global economic order often creates market failures that exacerbate our state of ecological deficit, through fundamentally unsustainable activities such as providing government support to fossil fuels, which in 2008 alone stood at $557 billion.[3]

In addition to the ecological deficit, we still have not addressed some critical imbalances between the haves and have-nots. We burn fossil fuels at rates that are putting unsustainable amounts of carbon into the atmosphere. We also overexploit arable land. Yet more than a billion people around the world are undernourished, water stressed and without access to electricity. With population expected to grow rapidly from seven to nine billion in the next 30 years, and with most of that growth predicted to happen in developing countries, there will be an urgent need to address issues of access and affordability against a background of resource scarcity.

Compounding all this, of course, is climate change. According to analysis by Trucost plc for the United Nations (UN) Principles for Responsible Investment and UN Environment Programme Finance Initiative, emissions generated an external damage cost of $4.5 trillion in 2008, which was some 7.5% of global gross domestic product (GDP) that year. This is projected to rise to some 12% of global GDP by 2050.[4] Over the next 30-40 years, analysts predict that the size of the global economy will more than triple in economic output.[5] In order to support those levels of growth sustainably, we will need to cut global emissions by 80% by 2050, which will require a radical restructuring of our economy towards a low-carbon pathway.

There are real limits to continued economic growth along the current pathway. We know that economic growth in some parts of the world is critical to pull people out of poverty. But resource-intensive, high-carbon growth will severely constrain human wellbeing, particularly in poorer countries, and undermine the health of our planet. We need to recognise that economic growth can also be delivered in different ways, through new technologies and new business models.

But any significant shift towards new types of growth will depend on fundamental changes in capital markets to drive investment in the right direction. The critical role of the capital markets in this transition cannot be overstated. The decisions that investors make on a daily basis can either encourage the development of new technologies and the innovation of new products and business models or support the continuation of unsustainable business.

Our vision for a sustainable economy aims to show where we need to get to, and how capital markets can help get us there.

The role of capital markets in facilitating a sustainable economy

There are many reasons why the capital markets do not support sustainable outcomes.

One reason is that investors don't always have the knowledge and tools that are needed to ensure their decisions are consistent with long-term sustainability objectives.

Our aim is for this vision to be one such tool. By articulating long-term boundaries, and providing clear guidance on the most important areas for action, we hope to provide a better knowledge base that progressive financial institutions can use. Of course, there will be many investors who do not think that an analysis of long-term sustainability is relevant to their aim of maximising their financial returns and who will not be persuaded to change their investment strategy. However, by showing that 'business as usual' is not an option within the hard limits of resource constraints and climate change, we hope that businesses and investors will think more about the process of transition to a more sustainable portfolio of investments. Investors as a whole will find it hard to maintain healthy financial returns if faced with accelerating climate change[6] and ecosystem collapse.

Progress on investment in the transition to a sustainable economy has so far been mixed. On a positive note, Bloomberg New Energy Finance says 2010 was a record year for global investments in clean power, which hit $243 billion – thanks largely to Chinese and European efforts to ramp up energy efficiency and offshore wind.[7] And worldwide there are now more than 10,000 microfinance institutions (MFIs), with over 70 million borrowers and a similar number of savers. The stock of foreign capital invested in the microfinance sector more than tripled between 2004 and 2006, and, although the rate of growth has subsequently slowed, now stands at over $10 billion.[8] But, on the other hand, witness the success of the initial public offering (IPO) from Coal India. Climate change was not mentioned once in the company's IPO document, yet its offering was oversubscribed by 15 times its original target. Investors mobilised $53 billion[9] in support of a proposition which threatens to exacerbate climate change. As the costs of climate change increase in the future, and climate regulation tightens, investors will end up being badly burned by investments of this kind.

Our research methodology

In order to create a vision framework for the sustainable economy in 2040, our starting point was to draw on the visioning work that has already been done by a number of experts in the field.

We looked at sources such as the World Business Council for Sustainable Development's recent Vision 2050, the UN Millennium Development Goals (MDGs), the Cambridge Programme for Industry's Next Economy initiative, Rockstrom's paper on planetary boundaries, Tim Jackson's *Prosperity Without Growth*[10], and many others.

Our framework includes a set of biophysical 'boundaries' and socio-economic 'conditions' that we believe need to be achieved in a sustainable economy. Our analysis here is based on the commonly stated objectives in the literature we reviewed, but draws also on Forum for the Future and Aviva's expertise, as well as on a series of consultations with external experts.[11]

Once we had established the vision framework through top-down research and analysis, and stress-tested it with a number of different stakeholder groups, we undertook extensive bottom-up trends research combined with visioning workshops. This helped us to assess where certain sectors were in terms of sustainability, and where they needed to progress in order to facilitate a sustainable economy.

Forum for the Future and Aviva jointly selected five sectors to focus on in more depth: food, energy, health, mobility and finance. The first four were chosen because of their importance to the overall economy and to the wellbeing of humans and other species. The finance sector was selected because of its overarching influence on all other sectors through its capacity to channel funding and influence activity. We also treated it as a sector in and of itself, and examined the ways in which it needs to change to facilitate sustainable capital markets.

We ran a series of workshops to identify the key 'drivers' of a particular sector – government policy, societal values and availability of capital, for example – and mapped key current trends against these drivers. In doing so our aim was to understand the status quo in each sector across a number of sustainability parameters. We then undertook a gap analysis using the boundaries established as part of the vision framework, in order to understand what would need to happen for each sector to meet its vision goals and stay within all the boundaries.

The final step was to create a guidance framework for the role of capital markets in creating a sustainable economy. This is where we identified what role organisations such as Aviva can play in facilitating the transition, both in terms of how the finance sector should act in its own operations and what action it can take to influence other sectors.

Some key assumptions underlying the vision

In creating our vision, we made a number of assumptions. You may not see them articulated as boundaries on the vision diagram, but they do underpin the framework.

One is the need to have additional room for growth in the global south in order for hundreds of millions of people to be lifted out of poverty.

To meet this particular challenge, developed countries will need to focus even more strongly on reducing the resource intensity of their economies, or face the prospect of limiting economic growth to within ecological scale, not an improbable course given the radical shift required to decouple growth from carbon emissions.[12] Developing countries will have to strike a balance between increasing energy supply and improving access while minimising adverse environmental impacts.

Fast growth in developing economies is a phenomenon that has been with us for some time. Emerging markets such as China, India and Brazil have grown rapidly over the past five years or so, and look set to grow further. By 2050 what is sometimes called the emerging world will have increased five-fold and will be larger than the developed world.[13] The names on the list of the top global economies are likely to change significantly, with China, India and Brazil all to the fore. Countries such as Mexico, Indonesia, Colombia and Malaysia will also be climbing the ranks.[14]

We are on the brink of a major shift in power towards these emerging markets, which by 2040 will have reshaped the economic landscape. We need to ensure that a transition to a sustainable economy takes this impending shift into account. That means addressing sustainability issues that are critically important in the developing world, including water conservation, education provision and access to life-saving healthcare and electricity.

One critical issue that kept coming up in the preparation of this report was population. Many experts we consulted wanted to see us address the question of how population levels affect the sustainability of the economy. According to the UN, the global population will grow from 6.9 billion to 8.7 billion by 2040.[15] Most of this growth will happen in the developing world,[16] mainly in cities. By 2040, some 65% of the world's total population will be living in urban areas, compared with roughly 50% today.[17] At least this more crowded world will also be a more demographically stable one: global population growth rates are slowing, even though the sheer numbers are currently increasing by 80 million people every year.[18] In fact, over the next 30 years, many countries will be preoccupied with the reality of demographic decline.

The rapid rate of population growth will undoubtedly challenge the sustainability of the global economy. More people means more pressure on biodiversity, fresh water, fisheries, food production, energy supply and so on. It is critical for global sustainable development that these additional people get access to adequate education and health services, avoid poverty and hunger and find gainful employment.[19]

However, we chose not to opt for a specific carrying capacity in our vision framework. Our research led us to conclude that population size alone does not necessarily preclude the possibility of a sustainable economy, although clearly there must be some upper limit beyond which natural systems simply cannot cope. We did, however, include some of the critical drivers of population growth within the framework – factors that will determine how demographic trends unfold. For example, one of the most important drivers of birth rates is the extent to which economic improvement touches the lives of families, and the lives of women in particular. Such factors illustrate the point that from a sustainability perspective population is not just about sheer numbers. It is about how fairly and equitably resources are distributed across those numbers. Poverty perpetuates population growth by keeping people in conditions where they have little or no education and healthcare, no access to family planning, limited choices and no power. When these are made available, birth rates can drop, even at modest income levels. This means that sustained investment in these areas can vastly improve demographics. According to the UN Population Fund, at least 200 million women around the world want to use safe and effective family-planning methods, but cannot do so as a result of a lack of access to information, relevant services and community support. This unmet need will grow by 40% in the next 15 years.[20]

We also stopped short of prescribing a particular level of economic growth in our vision of a sustainable economy. But it is safe to say that in the future we will need to define economic success by more than growth alone. Traditionally, a country's success has been measured by the size of its economy, based on its GDP. This has been questioned in recent years, especially in light of the current financial crisis. GDP levels only indicate the economic throughput of an economy, neglecting other key indicators of success such as people's sense of security and wellbeing. Research has shown that beyond a certain level of income and material stability, more money has a negligible or even negative impact on the quality of our lives.[21] There have been a number of alternative proposals for measuring the success of an economy, including the Human Development Index,[22] which measures a country's average achievements in terms of health, knowledge, and a decent standard of living; the WWF Living Planet Index,[23] which measures the state of global biological diversity; and the New Economics Foundation (NEF) Happy Planet Index, which shows the relative efficiency with which nations convert the planet's natural resources into long and happy lives for their citizens.[24] If we wish to hold our economies to standards that escape the tyranny of growth-based metrics, we will need to further research and test new 'hallmarks of success'.

How should the vision framework be used?

This document is a vision for a sustainable economy at large. The boundaries it articulates are not there simply to guide capital markets: they are boundaries that must be respected by all key economic institutions.

Some of the boundaries do pertain to certain institutions more than others. Our analysis suggests that not all boundaries are relevant to each and every sector, for example. However, we hope we have created a tool that is flexible enough to be applied to a number of different sectors and different types of organisations.

The outermost ring in our framework diagram (see p9) describes key **biophysical boundaries** that we need to achieve in order to remain within safe environmental limits. The circle inside that one describes the **social conditions** that we believe need to be secured for a complex civilisation to flourish.

The next circle is where we move to **economic characteristics**, which is effectively where we describe what a sustainable economy looks like. A truly sustainable economy is one that fits with the environmental and social parameters in the outermost circles. We set out the key conditions for a sustainable economic environment not only to promote environmental and social good but also to support a pragmatic approach to investment that looks to sustained economic prosperity in the long term.

Ultimately, an economy is only a means to an end. In our vision, that end is the net wellbeing of human societies. And such wellbeing necessitates living within environmental limits – this is an economic necessity, not a moral choice. We have articulated this in the central circle of our framework, which covers what we are aiming to deliver for people and communities through the fulfilment of environmental and social boundaries via economic activities.

We framed all this in terms of boundaries and system conditions instead of targets as part of this vision because we did not want to give the impression that any of these was an optional hit-or-miss proposition. The economy or the ecosystem might not collapse if we breach one particular boundary, but our assertion is that we need to respect each and every boundary and condition if we are to create a truly sustainable economy. They are all closely interconnected, and must be considered as a whole. If you degrade forests, for example, you cross the boundary on land use and undermine the capacity of the climate system to stay stable.

Our environmental boundaries are in many cases more concrete than the social boundaries. This is the nature of the beast: environmental tipping points and their consequences tend to be easier to quantify and explain. But, although they are more difficult to articulate and rationalise, social goals are just as important in the context of a truly sustainable economy. Our societies may be able to survive against a backdrop of significant inequality, or low levels of education. But we believe that if we want to have a *flourishing, thriving, diverse human civilisation*, then setting and achieving social boundaries becomes imperative.

part 1 - framework for a sustainable economy

The framework for a sustainable economy defines the characteristics of an economy that operates within safe environmental limits and enriches people's lives. It can be applied to any sector or business, and investors can use it as a pragmatic guide to analyse the long-term sustainability of their investors.

The framework captures a comprehensive range of environmental boundaries and social conditions which a sustainable economy must respect. This section gives more detail on each of these. They are illustrated in the diagram on p9.

1

Environmental boundaries

Greenhouse gases (E1). Emissions of greenhouse gases are on a downward trajectory consistent with the average global temperature remaining below the 2°C threshold.

Climate change needs little introduction – it is undoubtedly one of the big issues of the day. In the past five years, however, the agenda has shifted significantly. We have gone from a state of uncertainty about the facts to a sense that the verdict of climate science is clear and there is an urgent need for decisive action. We know that warming of more than 2°C, for example, would result in a number of disruptive impacts on our societies – from extreme weather events to mass migration and a significantly increased health burden. We also know that we have already passed the threshold of atmospheric emissions above which there is a real risk of runaway climate change. That threshold is an atmospheric concentration of 350–500 parts per million (ppm) of CO_2, and the current concentration is 387ppm.[25]

Climate change is already causing 300,000 deaths a year and $125 billion of economic losses.[26] By 2030 global warming could be costing us $600 billion a year.[27] The number of people affected by extreme weather has doubled over the last 30 years and is expected to reach 375 million a year by 2015 (currently 243 million a year are affected).[28]

The UK's Royal Society for the encouragement of Arts, Manufactures and Commerce recently published a series of papers that warn we have little chance of staying within the 2°C of warming previously identified as the 'safe space' of climate change.[29] Even if all greenhouse gas emissions stopped tomorrow, we would already be locked into a global temperature rise of at least 1.4°C because of the delayed impact between emissions (since 1750, in the case of this estimate) and temperature change.[30] At the time of the Cancun summit, scientists were warning that the agonisingly slow progress of climate talks could mean we are heading for an increase closer to 4°C, and this could occur as early as 2060 according to the worst-case scenario.[31] There might now be consensus that we need to limit warming to 2°C by 2100, but the commitments made so far by the international community are not enough to get there. They are also largely voluntary rather than carrying any regulatory weight.

Without going into a lot of detail about likely climate change impacts in a 'business as usual' scenario – which has been done extensively elsewhere – it is worth summarising what a 4°C rise would mean. In brief, global warming of more than 2°C carries a significant risk of triggering feedback loops that tip the Earth's climate system into a new, irreversible configuration. This is what scientists mean when they talk about 'runaway climate change': widespread drought and desertification, exacerbating the risk of food supplies collapsing and most probably leading to a shift of agricultural cropping to new areas. This, in turn, would be very likely to impinge on ecosystems, leading to large losses in biodiversity, forests, coastal wetlands, mangroves and saltmarshes, as well as an acidified and potentially dysfunctional marine ecosystem. Large-scale adaptation to sea-level rise would be necessary – at a level that could potentially overwhelm our ability to adapt, particularly in the regions hit hardest. These would likely include all of Africa and southern Europe.[32]

The Stern Review in 2006 estimated that if we don't act to reduce carbon emissions, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year indefinitely. In contrast the cost of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year. This is why we believe it is imperative to work towards the original boundary limiting warming to no more than 2°C, and to do so very rapidly. If we don't take decisive action now, we face much more pain and cost after 2020. As we work to limit warming, we must also ensure that the climate change impacts already in the pipeline hit a strong and resilient planet – one where ecosystems have been restored to good levels and human health is safeguarded. This is why it is critical to work towards the global warming boundary in parallel with all the other boundaries mentioned in our vision framework.[33]

Natural habitats (E2). Loss of natural habitats reduced to zero. All threatened species safeguarded. Areas under agriculture, aquaculture and forestry are managed sustainably to ensure conservation and biodiversity.

The biodiversity of the planet provides instrumental benefits to humanity, from ecosystem services such as pollination to contributions to human health through long-term climate regulation. The UN's Economics of Ecosystems and Biodiversity initiative calculates that ecosystem services are worth some $2,000 to $5,000 billion a year.[34] Therefore, apart from the ethical case for protecting biodiversity, there are clear economic gains to be made from preventing the further loss of such systems.

Yet today we are at a point of sharp decline in ecosystem functions and services. We have failed to reach the target set by the UN at the beginning of the decade to achieve "a significant reduction in the rate of biodiversity loss" by 2010. Today, the rate of extinction of species is estimated to be 100 – 1,000 times more than what could be considered natural. Up to 30% of all mammal, bird

and amphibian species are threatened with extinction this century.

The most important drivers of biodiversity loss are habitat change (such as land use changes, physical modification of rivers or water withdrawal from rivers, loss of coral reefs, and damage to sea floors due to trawling), climate change, invasive alien species, overexploitation and pollution. Of all of these, changes in land use exert the most significant influence, in particular the displacement of natural ecosystems by agriculture and urban development. The speed of climate change will also become a more important driver of change in biodiversity in the future, leading to an accelerating rate of species loss.

The most recent conference on biodiversity in Nagoya, Japan, set out an ambitious programme of action for the future. According to the 'Aichi Targets', by 2020 we have to:

- cut the rate of loss of natural habitats, including forests, by at least half
- increase terrestrial nature reserves from 13% to 17% of the world's land area
- increase marine and coastal nature reserves from 1% to 10% of the world's seas
- restore at least 15% of the areas where biodiversity is classed as 'degraded'
- safeguard at least 75% of threatened plant species in collections.[35]

Waste (E3). Most waste streams eliminated by closed-loop processes, reuse and recycling. Remaining waste streams do not exceed the carrying capacity of natural systems.

Excessive or poorly managed waste leads to environmental damage and the depletion of natural resources, and can pose a danger to human health. Biodegradable waste in landfill produces methane, which is a powerful greenhouse gas that contributes to climate change. Reducing the amount of waste produced in the first place and reusing or recycling materials where possible can help protect natural resources, reduce the production of greenhouse gases and cut the amount of land needed for landfill sites.

While statistics on waste are often difficult to find,[36] it is estimated that the European Union throws away 3 billion tonnes of waste each year, of which around 90 million tonnes is hazardous.[37] Currently, around 67% of waste is deposited in landfills, largely comprised from the estimated 2.2 billions tonnes of household and commercial waste produced globally each year.[38]

The Organisation for Economic Co-operation and Development has suggested that, by 2020, up to 45% more waste will be produced than in 1995, which would mean an increase in the dangerous levels of pollution that affect the Earth's air, water and soil that are currently created by our waste streams.[39] In addition to the environmental crisis caused by global waste, the UN Development Programme (UNDP) estimates that more than five million people die each year from disease related to inadequate waste-disposal systems.[40]

Closed-loop production processes, increased levels of recycling, responsible incineration practices and shifts in public attitudes to waste are all important measures which should be endorsed and implemented.[41]

Water (E4). Global consumption of blue water sources should not exceed 4,000 cubic km/year. Watersheds at local levels are managed sustainably.

Water is our planet's least replaceable and most essential resource. Its limits constrain the extent to which the environment can sustain plants, fish and wildlife. Our extraction of food, minerals and forest products can undermine the abundance and quality of the water supply. There is increasing competition for water – for human consumption (increasing population, increasing wealth), for industry and for support of ecosystems. Agriculture, for example, accounts for about 70% of the world's freshwater extraction. Competition is exacerbated by limited resource availability, deteriorating water quality, climate change impacts and poor management.

Globally, the world currently uses 2,600 cubic km of water per year.[42] Water limits have already been reached or breached in many major river basins across the world: There is little or no additional streamflow or groundwater for further development in the Murray-Darling Rover in Australia, the Yellow River in China, the Indus in Pakistan and India, the Amu and Syr Darya in central Asia, the Nile in North Africa, and the Colorado River in the US and Mexico.[43]

If average per capita demand did not change at all and the human population grew to nine billion by 2050, humans would withdraw 10,200 cubic km of water per year. This is more than double the safe limit of 4,000 cubic km of water per year identified by experts. However, the Outlook baseline projects that world primary food crop production will grow by 48% by 2030 while the output of animal products will increase by 46%. This will place further stress on our water reserves.[44] Given these projections, almost half of the world's population (47%) will be living under severe water stress by 2030 if no new policies are

introduced,[45] and rural areas in developing countries will be particularly vulnerable.[46]

Distribution of limited water resources must take into account levels required for human consumption as well as for agricultural purposes, while acknowledging the effects that water consumption from natural resources has upon the biodiversity of the environment.[47] For example, we need to make significant improvements in the efficiency of water use in all sectors.[48] This involves techniques such as matching water quality to use (eg use of grey water for flushing toilets), low-flow appliances and fixing leaks to avoid piped water loss. We also need to achieve a high level of wastewater treatment globally (which is currently standard in the developed world, but not elsewhere).[49] In terms of agriculture in particular, it will be key to consider how we prioritise water use for growing crops. For example, prioritising staple crop production over biofuels crops, and considering climate and water requirements when deciding where we plant certain crops,[50] as well as universally implementing efficiency solutions such as drip irrigation. Policy is critical in all this. In the rich world, the elimination of water subsidies so that prices begin to incorporate the full financial, social and environmental cost of delivering that water could be key to changing water use behaviours; and water property rights globally should be more flexible to ensure water is allocated efficiently between users, while meeting environmental demands.[51] Not to mention that policy integration between agriculture, water, energy and environment must be improved.

Ocean acidity (E5). The concentration of acid compounds in the world's oceans has peaked, and is on a downward trajectory to pre-industrial levels.

The world's oceans cover over 70% of the planet's surface, contribute half of its primary production and contain an enormous diversity of life. They also play a vital role in the Earth's life support system, regulating climate and biogeochemical cycles through their capacity to absorb atmospheric CO_2.[52] Our oceans have become 30% more acidic since the beginning of the industrial revolution, and such a change is three times greater and 100 times faster than any change in acidity experienced during the previous 21 million years. Ocean acidification, along with warming surface waters and changes in ocean mixing, may reduce the ability of the ocean to absorb CO_2, leaving more in the atmosphere and worsening its impact on the climate.

The rapid acidification of the oceans threatens the tenuous and unstable levels of CO_2 in our atmosphere as well as jeopardising marine biodiversity and food webs. In turn, this leads to significant changes in commercial fish stocks, threatening food security for millions of people and the stability of a multi-billion dollar industry.

It remains unclear to what extent marine ecosystems will be able to adapt or evolve in the light of ocean acidification. The biodiversity of the oceans will be severely affected because marine organisms which rely on calcium carbonate to construct their shells will become threatened as carbonate becomes scarcer as a result of increased levels of CO_2 and ocean acidification.[53] This pattern has already been identified in widespread coral reef erosion: as well as the high value of coral reef tourism industry being compromised, the destruction of the ocean's biodiversity and the habitats of numerous marine organisms in their ecosystems highlights the dangers of ocean acidification.

Action towards slowing ocean acidification to pre-industrial levels must be taken in order to prevent marine biodiversity and the fisheries and tourism industries from being further affected. If the current deterioration of marine ecosystems and the oceans is to be slowed down, policies must be implemented which propose observational, experimental and modelling research into ocean acidification, while the problem itself must be acknowledged by policy-makers as a major issue as they discuss international agreements concerning CO_2 emissions.[54]

Non-renewable resources (E6). Use of non-renewable natural resources (eg hydrocarbons and iron ore) does not threaten any of the other environmental risk boundaries; depletion rates take full account of the entitlements of future generations.

Critical non-renewable resources – ranging from metals to fossil fuels such as oil, coal and gas – often exist in fixed amounts, or are consumed much faster than nature can create them.

Global reserves and the amounts of various elements on the planet are difficult to predict, and what information there is often held as private information by mining companies and metal traders. Although estimates vary as to the quantity of fossil fuels that are left, it is widely accepted that they are non- renewable and that therefore they will run out at some point: the peak of oil discovery, for instance, was passed in the 1960s.[55] Moreover, the Chemistry Innovation Knowledge Transfer Network has identified nine elements that will be under serious threat in the next 100 years and seven more that are under increasing threat. And the EU has compiled a list of possible at-risk 'high-tech materials' for sustainable technologies.[56]

Incredibly, only 1% of rare earth metals and minerals are reused, compared with worldwide rates of 25-75% for commonly used materials such as aluminium, copper, lead, tin, iron and steel.[57] Many 'rare earths' are instrumental in industrial production, including the manufacture of sustainable technologies such as electric vehicles and wind turbines. In order to avoid critical shortages in the future, we need to achieve much higher recycling rates

with key resources and scaled-up closed-loop production processes. Moreover, favourable trade regimes need to be in place to ensure the supply of non-renewables meets demand globally.

Similarly, running low on fossil fuels will have a dramatic effect on the global economy – we are dependent on them for everything from electricity generation to transport and the production of materials such as plastic. Nearly 70% of electricity is generated from fossil fuels, for example.[58] We need to use these resources in a smart, efficient way that ensures their availability for future generations. But we also need to scale down our use and replace it with cleaner sources of fuel, in order to leave a more sustainable legacy for the next generation.

Renewable resources (E7). Stocks of renewable resources (eg marine fisheries and forests) are managed sustainably to meet both human and broader ecosystem needs.

Overuse of renewable resources through direct exploitation or habitat damage can reduce their capacity to replenish themselves. In some cases, it can even lead to extinctions. It can also damage the capacity of our environment to remain resilient in the face of challenges such as climate change.

For example, renewable resources such as marine fisheries provide a vital source of nutrition for a large proportion of the global population. And more than 120 million people are estimated to depend on fish for all or part of their incomes. In Africa as much as 5% of the population, some 35 million people, depends wholly or partly on the fisheries sector for their livelihood, for example.[59] The entire enterprise of fisheries is now severely threatened, as 70% of the world's fish stocks are fully fished, over-fished or beyond their sustainable limits.[60]

In addition to their natural beauty, renewable resources such as forests also provide us with critical ecosystem services: the function of carbon sequestration captures man-made CO_2 emitted into the atmosphere, and forests protect biodiversity across the globe by acting as habitats and through hydrological processes. Not to mention that forestry is an important industry. In 2009 the top 100 companies in the forest, paper and packaging sectors had sales of $318 billion.[61] Yet deforestation and forest degradation – through agricultural expansion, conversion to pastureland, infrastructure development, destructive logging, fires and so on – account for nearly 20% of global greenhouse gas emissions. That is more than the entire global transportation sector and second only to the energy sector.[62] In Southeast Asia, for example, palm oil expansion – for food and non-food purposes – is regarded as one of the leading causes of rainforest destruction.

Using and maintaining renewable resources responsibly will be key to maintaining a sustainable economy into the future. The UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) recently secured $57 million from participating countries to implement strategies for engaging with indigenous rainforest communities and forestry industry stakeholders in order to slow the degradation of renewable forest resources. And The European Commission has proposed abandoning the practice of 'discarding' (throwing unwanted dead fish back into the sea because of exceeding fisheries quotas) by 2013 as well as sanctioning other sustainable fishing methods, all of which will help to effectively manage stocks of this key renewable resources.

Soil productivity (E8). Soil productivity is protected as the over-arching priority of all sustainable land use systems; no more than 15% of global ice-free land is converted to crop land.

There is increasing competition for land in most countries. The rapid increase in the world population is driving up food and energy demand, while urbanisation is encroaching on landmass, and increases in non-food crops such as biofuels and cotton are competing with food crops for the same land. The main driver of unsustainable land use is intensive agriculture. Johan Rockstrom and his colleagues from Stockholm University propose that there should be a limit to the amount of land surface converted to cropland – 15% – to prevent human activities from causing "unacceptable" environmental damage.[63] Unsustainable land use above this boundary could trigger rapid continental-scale changes, such as the transformation of rainforest to savannah.[64] Also, the regulatory capacity of ecosystems is undermined by land use change. Unsustainable land use threatens key ecosystem services such as pollination, water catchment and soil renewal. These in turn affect critical global factors such as water supply and food production.

By 2050 the UN Food and Agriculture Organization (FAO) anticipates that we will need a 70% increase in food production to meet growing demand.[65] At the same time, however, food demand is changing towards a higher share of animal-based diets, particularly in developing countries. The FAO expects meat consumption to increase by around 22% per capita from 2000 to 2030, while dairy consumption will rise by 11% and vegetable oils by 45%. Moreover, there is competition from the energy sector: most of the crops currently used for transport biofuels are also food crops. In 2008 global land use for the production of fuel crops covered about 2% of global cropland (about 36 million hectares). The extension of

cropland for biofuel production is continuing, in particular in tropical countries where natural conditions favour high yields.[66] Simultaneously, agricultural yields are falling, from 3.6% in 1960 to 1.5% in 2000. Plausible estimates from international institutions for improvements in global yields in the next decade are 1-1.1% per year for cereals, 1.3% for wheat and coarse grains, 1.3% for roots and tubers and 1.7% for oilseeds and vegetable oils, significantly below the average rates of the past four decades. This is being exacerbated by climate change, which is already reducing average crop yields, decreasing production capacity in semi-arid regions and increasing capacity in temperate zones, and upping the frequency of extreme weather events which can disrupt food production.

We are already close to Rockstrom's suggested boundary of 15% of global ice-free land, as 12% of this area is currently converted to cropland.[67] Half of the world's tropical rainforests are gone, and large areas of grassland once open to wildlife are now fenced in for livestock ranching. And the spread of farming into natural ecosystems, especially tropical forests, continues apace. Globally, 20,000-50,0000 square km of arable land is lost annually through degradation, chiefly through soil erosion. If current trends continue, up to 20% of global cropland may be lost by 2050 and we could face a global food shortfall of up to 25%.[68] The major areas where agricultural soils are degrading are in Africa south of the Equator, Southeast Asia, Southern China, North-central Australia and the pampas of South America.[69]

To avoid going beyond the 15% boundary, farming will need to be concentrated more intensively in the most productive areas, while its wider impact will need to be contained.[70] Moreover, *how* we use our agricultural land may be just as critical as how much we use, if not more critical. For example, the environmental impact of 15% coverage with intensively farmed cropland in large blocks will be significantly different from that of 15% of land being farmed in more sustainable ways. A limit on soil degradation or soil loss could be a more useful indicator of the state of land health.[71]

In order to feed a world of close to nine billion people, we need a new green revolution, and an agricultural system that serves a sink for sequestering greenhouse gas emissions, rather than being one of their main sources. We need innovations in irrigation, in sustainable sanitation systems that recycle nutrients from toilets as fertiliser, and in tillage systems if we are to succeed in significantly raising yields on current land.[72]

As yield increases will probably not compensate for growing food demand, cropland will have to be expanded to feed the global population although so far no definitive projection is available.

Chemicals (E9). Releases of toxic chemicals are controlled in such a way as to reduce to zero any damage to natural systems.[73]

Chemical pollution has a global, ubiquitous impact on the physiological development and demography of humans and other organisms – with ultimate impacts on ecosystem functioning and structure. Persistent pollutants are resistant to environmental degradation: they accumulate in human and animal tissue and can spread throughout the food chain. Chemical pollution is slow-acting, but it can profoundly affect other planetary boundaries, such as the rate of biodiversity loss.

Persistent organic pollutants (POPs), for example, have been shown to travel vast distances from their original sources. They can be found all over the world, including in areas where they have never been used and in remote regions such as the middle of oceans and Antarctica.[74] Exposure to POPs can cause disruption of the endocrine, reproductive and immune systems; neurobehavioural disorders; and some cancers.[75] Many POPs are currently used as pesticides, or were in the past. Others are created and used in industrial processes and in the production of a range of goods such as solvents, polyvinyl chloride (used in a range of products from construction materials to clothing) and pharmaceuticals. POPs have few natural sources: humans are primarily responsible for their creation.[76]

The recommended control of stockpiles of POP chemicals as well as requirements to reduce or eliminate their release has been instructed by the European Commission since 2008.[77] Regulations affect anyone directly associated with the production, storage or placing on the market of POP chemicals. However, awareness about POPs needs to be elevated to the level of the general public, in order to endorse behaviour that shows awareness about the impact that POPs have on the environment. This would also reduce the demand for the presence of POPs in commercial and industrial practices owing to less consumer demand.

Atmospheric aerosols (E10). Atmospheric aerosol loading is limited.[78]

Averaged over the globe, aerosols made by human activities currently account for about 10% of the total aerosols in our atmosphere.[79] Aerosols tend to cause cooling of the Earth's surface immediately below them. Most aerosols reflect sunlight back into space, which means they have a cooling effect associated with reducing the amount of solar radiation that penetrates the atmosphere. The magnitude of this cooling effect depends on the size and composition of the aerosol particles, as well as the reflective properties of the underlying surface.[80] At current production levels, human-made sulphate aerosols are thought to outweigh naturally produced sulphate aerosols. Most human-made aerosols come from

the burning of coal and oil. A large fraction of aerosols also come in the form of smoke from burning tropical forests. The concentration of aerosols is highest in the northern hemisphere, where most industrial activity takes place.

The warming effect of greenhouse gases is expected to take place everywhere, but the cooling effect of pollution from aerosols tends to be somewhat regionally focused, with a greater prevalence near and downwind of industrial areas. No one knows what the outcome will be of atmospheric warming in some regions and cooling in others.

Given this uncertainty, there need to be better incentives for funding and research into this area, and policy-makers should acknowledge the need to improve our understanding of the greenhouse gas and pollution impacts of aerosols.

Ozone (E11). Stratospheric ozone levels maintained above 276 Dobson units.[81]

In the lower atmosphere near the Earth's surface (known as the troposphere), ozone is created by chemical reactions between air pollutants from vehicle exhaust, gasoline vapours and other emissions. At ground level, high concentrations of ozone are toxic to people and plants.[82] Ozone in the stratosphere absorbs most of the ultraviolet (UV) radiation from the sun. Without ozone, the sun's intense UV radiation would sterilise the Earth's surface.[83] An increase in UV radiation reaching the ground can lead to more cases of skin cancer, cataracts and other health problems.

The total mass of ozone in the atmosphere is about 3 billion tonnes.[84] Although ozone high up in the stratosphere provides a shield to protect life on Earth, direct contact with ozone is harmful both to plants and to animals (including humans). Ground-level 'bad' ozone forms when nitrogen oxide gases from vehicle and industrial emissions react with volatile organic compounds (carbon-containing chemicals that evaporate easily into the air, such as paint thinners).[85]

Chlorofluorocarbons (CFCs), found in aerosol sprays used heavily in industrialised nations over the past 50 years, have caused the breakdown of the ozone layer in some places. This reduces its capacity to absorb radiation.[86] The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in September 1987 at the headquarters of the International Civil Aviation Organisation in Montreal.[87] If compliance with this important protocol continues, the ozone depletion caused by human-produced chlorine and bromine compounds is expected to gradually disappear by about the middle of the century.[88]

Nitrogen & phosphorus (E12). The amount of nitrogen removed from the atmosphere for human use does not exceed 35 millions of tonnes per year. No more than 11 million tonnes of phosphorus per year is allowed to flow into the oceans.[89]

Modern agriculture is a major cause of large-scale nitrogen- and phosphorus-induced environmental change. At the planetary scale, the additional amounts of nitrogen and phosphorus activated by humans are now so large that they significantly disrupt the global cycles of these two important elements.

The nitrogen cycle is the process by which nitrogen is converted between its various chemical forms. This transformation can be carried out via both biological and non-biological processes. The majority of the Earth's atmosphere (approximately 78%) is nitrogen, making it the largest pool of nitrogen. The nitrogen cycle is of particular interest to ecologists because nitrogen availability can affect the rate at which key ecosystem processes operate, including primary production and decomposition. Human activities such as fossil fuel combustion, use of artificial nitrogen fertilisers and release of nitrogen in wastewater have dramatically altered the global nitrogen cycle.[90] They convert around 120 million tonnes of nitrogen from the atmosphere per year into reactive forms, which is more than the combined effects from all of the Earth's terrestrial processes. Much of this new reactive nitrogen ends up in the environment, polluting waterways and the coastal zone, accumulating in land systems and adding a number of gases to the atmosphere. Nitrous oxide (N_2O), for example, is one of the most important non-CO2 greenhouse gases and directly increases radiative forcing.

Setting a boundary for human modification of the nitrogen cycle is not straightforward. Johan Rockstrom *et al*. define the boundary by likening the human fixation of nitrogen from the atmosphere to a giant valve that controls a massive flow of new reactive nitrogen from the air to the Earth, and suggest that this valve should contain a flow of new reactive nitrogen no larger than 25% of its current value, or about 35 million tonnes of nitrogen per year.[91] Given the implications of trying to reach this target, much more research and synthesis of information is required to determine a more informed boundary.

Some 20 million tonnes of phosphorus is mined every year, and around 8.5–9.5 million tonnes of this finds its way into the oceans. This is estimated to be approximately eight times the natural background rate of influx. Research suggests that large parts of the ocean can be starved of oxygen when critical thresholds of phosphorus inflow are breached. When this occurs, it is known as an 'anoxic event', and the incidence of such events may potentially explain past mass extinctions of marine life.

Tentative modelling suggests that if there is a greater than 10-fold increase in phosphorus flowing into the oceans

(compared with pre-industrial levels), then anoxic ocean events become more likely within a thousand years.

Despite the large uncertainties involved, the state of current science and the present observations of abrupt phosphorus-induced regional anoxic events indicate that no more than 11 million tonnes of phosphorus per year should be allowed to flow into the oceans — 10 times the natural background rate. It is estimated that this boundary level will allow humanity to safely steer away from the risk of ocean anoxic events for more than a thousand years, acknowledging that current levels already exceed critical thresholds for many estuaries and freshwater systems.

Social conditions

Hunger (S1). Systemic and persistent levels of hunger and malnutrition have been eliminated.

The UN FAO defines food insecurity as "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life".[92] On average a person needs about 1,800 kcalories per day as part of their minimum energy intake, and as a critical precondition of human development. Malnutrition is the underlying cause of 3.5 million deaths among mothers and children in the developing world each year, and is responsible for 35% of the disease burden of under-fives.[93]

In the world today, many continue to go hungry, most notably in Sub-Saharan Africa (where 265 million people are undernourished) and Asia (642 million). Groups that are particularly at risk of hunger are the rural and urban poor, and victims of conflict and natural disasters. The number of people at risk of hunger has continued to grow, with progress in reducing the prevalence of hunger stalling—and even reversing itself—in some regions between 2000-2002 and 2005-2007.[94] Not enough progress is being made to meet the UN MDG target of halving the proportion of people who suffer from hunger between 1990 and 2015.

The rising cost of food is one of the exacerbating factors: at times of economic crisis the poor eat less of the most nutritious foods, such as meat, fruit and vegetables.[95] Efforts to reduce undernutrition need to be accelerated if we are to meet that target and continue to progress towards a goal of zero hunger, including increased and more accurate levels of measuring the hunger crisis, the stabilising of prices of staple foods subsequent to the economic crisis, and the leveraging of agricultural practices and product distribution in developing countries.[96]

Obesity (S2). The spread of obesity has been halted.

At the other end of the nutrition spectrum too much of the wrong kind of foods are harming our health. Diets containing large amounts of fat, sugar or salt contribute to chronic diseases such as diabetes, heart disease and cancers. These cause 60% of all deaths worldwide.[97]

In 2005, 23.2% of the world's adult population was overweight (937 million) and 9.8% (396 million) was obese. By 2030 the numbers of overweight and obese adults are projected to reach 1.35 billion and 573 million, respectively.[98] Childhood obesity is a particularly acute problem: overweight and obese children are likely to stay obese into adulthood and are more likely to develop illnesses such as diabetes and cardiovascular diseases at a younger age. An estimated 42 million children under the age of five are overweight, 35 million of them in developed countries.[99]

Obesity is one of the biggest challenges of 21st-century public health, but it is also preventable. The World Health Organization (WHO) recommendations on child obesity include limiting children's exposure to television advertising and keeping schools and playgrounds free from all forms of marketing of junk food and sugary drinks.[100] Efforts at a commercial level, targeting producers of high-calorie, low-nutritional-value food and drinks, as well as at a consumer level must be made to curb the preventable effects of poor eating. 'Fat taxes' on low-nutritional-value products, child-adapted body mass index (BMI) measurement technologies and healthy lifestyle education have all been piloted in target countries – and should continue to be implemented in order to meet a key condition for a better quality of life for future generations.[101]

Poverty (S3). Extreme poverty (income of less than $1/day) has been eradicated.

Extreme poverty is one of the most critical barriers to human development, and interacts with most other targets in our vision framework. For example, poverty is the most important barrier to accessing education, and uneducated people (especially women and girls) are less likely to attain productive employment, family-planning resources and gender equality. In turn, when these are out of reach it can lead to a vicious cycle of further poverty. And poverty is also the most important driver of poor health outcomes.

An estimated 1.4 billion people were still living in extreme poverty in 2005.[102] Despite the current economic downturn, the momentum of growth in developing countries has so far been strong enough to sustain progress on poverty reduction, suggesting that the MDG target of halving the percentage of people living on an income of less than a dollar a day can be met.[103]

However, the challenge of the economic crisis remains: poverty rates will be slightly higher in 2015 and even

beyond than they would have been had the world economy grown steadily at its pre-crisis pace.[104] We need an even stronger focus on poverty reduction going forward, in order to maintain the pace of progress and eradicate extreme poverty by 2040. Because poverty is so deeply linked with other social conditions, many of the key required areas of action can be found in this part of the report.

Health (S4). Universal access to preventative and restorative healthcare.

Protecting and promoting health is essential to human welfare and to sustained economic and social development. People rate health as their highest priority after economic concerns such as unemployment, low wages and the cost of living.[105] Keeping people healthy enough to study, work and participate actively in society has been shown to enhance economic growth, to increase political stability and to reduce the likelihood of conflict.

Millions of people suffer and die because they do not have the money to pay for healthcare. Others suffer because they do pay for care when they can't really afford it. Every year, 100 million people are pushed into poverty because they have had to pay directly for medical treatment.[106] The link goes both ways: economists believe, for example, that malaria is responsible for a 'growth penalty' of up to 1.3% per year in some African countries.[107] And only one person in five people globally has broad-based social security protection that includes cover for lost wages in the event of an illness.[108] Lifting people out of poverty is therefore the most important mechanism for raising health status and reducing health inequalities.

We have made remarkable progress in addressing many key areas of healthcare need. There have been significant improvements in malaria and HIV control, as well as measles immunisation. These measures have cut child deaths from 12.5 million in 1990 to 8.8 million in 2008, and increased 10-fold the number of people receiving anti-retroviral drugs between 2003 and 2008, corresponding to 42% of people who needed treatment.[109] Yet there are still many traditional areas of need that remain unaddressed. Of the thousands of new compounds that drug companies have brought to the market in recent years, fewer than 1% are for tropical diseases such as malaria, even though they affect huge numbers. Nearly a billion people worldwide still don't have access to reliable supplies of clean drinking water, and more than a third don't have access to adequate sanitation.[110]

Another global challenge is the rise of non-communicable disease. It is already responsible for roughly 50% of the global disease burden, and is expected to rise to 75% by 2020. The World Diabetes Foundation estimates that 285 million people – corresponding to 6.4% of the world's adult population – already suffer from diabetes. That number is expected to grow to 438 million by 2030, corresponding to 7.8% of the adult population. Diabetes is no longer a rich-nation problem, as over 70% of people with the disease now live in low- and middle-income countries. Diabetes is also the world's most costly epidemic. By 2025, it is expected that the direct costs of diabetes to society will be €300 billion, nearly double today's figure.[111]

Fortunately, many chronic diseases such as diabetes are preventable because they are caused by things like tobacco use, unhealthy diets and lack of physical activity. Preventing disease is substantially cheaper and more effective than treating it. Because healthcare costs will continue to take a steadily growing share of national income,[112] it will be increasingly important to think beyond the healthcare system to devise cost-effective preventative approaches.

A key reason for rising healthcare costs are longer lifespans. According to the WHO, by 2020 there will be over a billion elderly people on the planet, with 700 million of them in the developing world. Therefore, healthcare approaches that reduce and/or prevent the onset of support requirements for the elderly will increasingly be needed.

Last but not least, climate change will be a significant challenge to 21st-century healthcare. It stands to put the lives and wellbeing of billions of people at increased risk.[113] The major health threats associated with climate change include changing patterns of disease, water and food insecurity, vulnerable shelter and human settlements, extreme climatic events and climate-related migration.[114] The ability to adapt to a changing climate and develop resilient healthcare responses will be a key requirement in the 21st century.

Reproductive rights (S5). All women have access to a choice of contraception and to improved reproductive healthcare.

Every woman and adolescent girl has a right to reproductive health. This was recognised as part of the fundamental criteria for women's reproductive health at the Cairo Programme for Action in 1994.[115] However, despite figures that indicate an increase in contraceptive use, roughly 215 million women in developing countries continue to use traditional (and ineffective) methods of birth control or no birth control at all.[116] Less than 5% of couples in developing countries rely on male contraceptive methods (such as condoms and vasectomies), and unplanned, unwanted pregnancies are still prevalent – this is indicative of profound inequality between men and women, and the lack of access to services which help to inform women's reproductive choices.[117] It contributes to high levels of female illiteracy and domestic violence, and low levels of female employment and property ownership.[118]

Despite a pledge of $40 billion from the UN for reproductive health information and services in September 2010, funding in this area as a whole is decreasing.[119] The target set by the UN MDG was to try and reduce maternal mortality in developing countries (which represents 99% of all global maternal deaths) by 75% between 1990 and 2015.[120] Since 1990, there has been a 34% reduction, implying that a 41% reduction in the next seven years must occur for the target to be met – a bold challenge given funding limitations, increasing populations and the scarcity of resources needed to address the target.

The links between education and levels of pregnancy are very strong – in 2008, 207/1000 women giving birth in developing countries received no education, 139/1000 received only a primary education and 48/1000 had received a secondary or higher education.[121] These figures indicate that women who have greater access to information and education are better equipped to make independent choices about their reproductive health, and are better equipped to take job opportunities, thereby boosting the economy and sustaining their children's livelihoods.[122] Women who have a secondary or higher education are four times more likely (40%) to use contraception than woman who have received no education at all[123] – reducing levels of unplanned pregnancy, infant and maternal mortality and sexually transmitted diseases.

The conditions for reproductive health need to be met by providing funding and facilities for contraceptive information and services – enabling women to make active choices that facilitate their reproductive health and help promote equality. Greater access to education should also be implemented in order to foster reproductive rights. Funding for literacy schemes, awareness projects and mobile units for reproductive health have been piloted in Mali and Mauritania with positive results,[124] for example. By addressing the unmet need for contraceptive information and services in developing countries, roughly 22 million unplanned births could be avoided, roughly 25 million induced abortions could be avoided and over 150,000 maternal deaths could be prevented.[125]

Water & sanitation (S6). Universal access to safe drinking water and proper sanitation.

Water is the least replaceable and most essential resource on our planet. Our bodies need it for hydration, and its limits constrain the extent to which the environment can sustain the plants, livestock and fish upon which we depend for food. Proper sanitation ensures hygienic sewage disposal, and a clean and healthy living environment. The combination of safe water for drinking and agriculture and hygienic sanitation facilities is a precondition for achieving a number of MDGs, such as those related to poverty and hunger, child mortality, maternal health, HIV/AIDS, malaria and environmental sustainability.[126]

Today, some 84% of people in developing countries have access to improved sources of drinking water. If current trends continue, the world will meet or even exceed the MDG target of halving the proportion of people without access to safe drinking water by 2015. In particular, increased use of improved water sources in rural areas has reduced the extent to which rural communities lag behind provision in urban areas. However, an estimated 2.5 billion people worldwide still do not have access to sanitation,[127] which is half of the population of developing countries. The 2015 MDG target of halving the proportion of people without access to basic sanitation currently looks challenging. As with safe drinking water supply, rural and poor households are those worst affected. About one in four children under the age of five is underweight as a consequence partly of inadequate sanitation and health services.[128] In Southeast Asia, for example, nearly two-thirds of the population are without improved sanitation and nearly half practise open defecation, resulting in repeated episodes of diarrhoeal diseases in children.[129]

WHO studies show that meeting the MDG target would avert 470,000 deaths and result in an extra 320 million productive working days every year. Depending on the region of the world, the economic benefits of this have been estimated to range from $3 to $4 for each dollar invested.[130]

Even with the steady growth in access to safe water supplies, the longer-term future looks uncertain because water scarcity is set to grow. Almost half of the world's population (47%) will be living under severe water stress by 2030 if no new policies are introduced – over one billion more than today.[131] Most of these people will be living in developing countries. In addition, there is a high likelihood that climate change will exacerbate water stress.[132] The problem of unsafe water and inadequate sanitation is often compounded by high rates of urbanisation,[133] as cities concentrate certain risks and health hazards such as the contamination of the water supply.

In order to address the issues of access to safe drinking water and proper sanitation, governments need to recognise the direct links this has to poverty alleviation, and formulate policies accordingly. Access and coverage need to be expanded, particularly in rural area, by improving water supplies and sanitation facilities in places such as residential communities and schools. Today, there are a number of increasingly affordable technologies that can be deployed for this purpose, including solar water purification.[134] Education and awareness-raising about good hygiene practices are also key to improving behaviour and reducing the incidence of disease. And finally, we must ensure that adequate relief is provided in emergency situations when sanitation infrastructure and drinking water supplies are threatened.

Education (S7). Universal access to primary and secondary education.

Education is critical for the improvement of human lives, and is especially key to the empowerment of women and gender equality. It provides children with the tools for learning, such as reading, writing and manipulating numbers, and gives them the chance to obtain work and make a contribution to society. Literacy, in particular, is at the heart of basic education, and is essential for eradicating poverty, reducing child mortality, curbing population growth and achieving gender equality.

The biggest obstacle to education is poverty. Poverty and unequal access to schooling perpetuate high adolescent birth rates, jeopardising the health of girls and diminishing their opportunities for social and economic advancement.[135] Girls in the poorest 20% of households have the least chance of getting an education: they are 3.5 times more likely to be out of school than girls in the richest households and four times more likely to be out of school as boys in the richest households.[136] Household data from 42 developing countries show that rural children are twice as likely to be out of school as children living in urban areas.[137]

An estimated 776 million adults – or 16% of the world's adult population – lack basic literacy skills. About two-thirds are women. Most countries have made little progress in this area in recent years. If current trends continue, there will be over 700 million adults lacking literacy skills in 2015.[138] Enrolment in primary education has been rising, reaching 89% in the developing world in 2009. But the pace of progress is insufficient to ensure that, by 2015, all girls and boys complete a full course of primary schooling (the MDG target).[139]

In order to ensure decent education provision in the future, people must have access to free primary and secondary education, and we must achieve universal literacy. As points of convergence for many issues, schools must also act as critical hubs for promoting health, environmental awareness and action, academic growth, student wellbeing and connections across communities. In addition, we need more teachers in developing-world regions, and we need them to be better trained. And we need to ensure that marginalised groups, such as girls and rural dwellers, have full access to educational opportunities.

Shelter (S8). Adequate shelter for all.

Secure land tenure and property rights are fundamental to shelter and livelihoods, and a cornerstone for the realisation of human rights and for poverty reduction. Secure land rights are particularly important in helping reverse gender discrimination, social exclusion of vulnerable groups, and wider social and economic inequalities linked to inequitable and insecure access to land.[140]

More than a billion people "*still lack adequate shelter and are living in unacceptable conditions of poverty*".[141] A large percentage of these are in the urban areas of the developing world. Over the past 10 years, the share of the urban population living in slums in the developing world has declined significantly: from 39% in 2000 to 33% in 2010. However, the absolute number of slum dwellers is rising.[142] This is mainly due to rural-urban migration and population growth.

Over the first decade of this century, the annual need for additional housing in urban areas of developing countries alone was estimated to be around 35 million units. This means that some 95,000 new urban homes have to be constructed each day in developing countries in order to improve housing conditions to acceptable levels.[143] Funds need to be available for subsidised housing for the poor, as well as land earmarked for low-income housing.We are now seeing important changes in land policies, but land resources face more multiple pressures than ever before. Developing countries still lack the tools, systematic strategies and support necessary to deliver secure land rights for all. Sound land policies should protect people from forced removals and evictions. Another critical dimension is ensuring gender equality, because women face such widespread discrimination when it comes to questions of land and property.

Information (S9). Universal access to information.

Affordable access to information technology (IT) is a significant challenge, but also a huge area of opportunity for sustainable development. IT platforms such as the internet help promote and enhance access to information and knowledge. They can also be an 'accelerator' for other human development areas – by allowing people to manage their own health through access to e-health facilities, for example.

In many countries, IT is also enabling the media to contribute more to transparent, accountable politics by opening public debates and exposing corruption and abuse. The rise of social media platforms such as blogs and social networking have led to more individuals being involved in calling government and the media to account across the world. The internet and mobile telephony played a significant part in Ukraine's Orange Revolution in 2004, for example, and more recently we saw video clips of Egyptian protests on YouTube faster than on major news networks. Access to IT is also closely linked to a country's level of economic development. Research by Vodafone suggests that, in a typical developing country, an increase of 10 mobile phones per 100 people boosts GDP growth by 6%.

One of the areas in which we have seen the greatest progress over the past decade is mobile telephony. There are currently five billion mobile subscribers in the world,[144] with the fastest rates of expansion happening in the developing world. Mobile companies are increasingly developing tailor-made products for the developing world, such as ultra-low-cost handsets, and facilities such as mobile banking. There is still a large 'digital divide', however, when it comes to broadband. The International Telecommunications Union estimates that fixed broadband penetration is below 1% in many of the world's poorest countries, while access costs can be more than 100% of monthly average incomes. The Central African Republic is the most expensive place to get a fixed broadband connection, costing nearly 40 times the average monthly income there. In the world's most developed economies, on the other hand, around 30% of people have access to broadband at a cost of less than 1% of their income.[145]

A challenge in bringing more people online in developing countries is the limited availability of broadband networks. Many of the most effective development applications of IT, such as telemedicine, e-commerce, e-banking and e-government, are only available through a high-speed internet connection.[146] Further investment in the introduction of high-speed wireless broadband networks in the near future, as well as national e-inclusion programmes, would significantly increase the number of internet users in developing countries.

Energy (S10). Universal access to efficient and sustainable energy systems.

For those living in extreme poverty, a lack of access to energy services dramatically affects and undermines health, limits opportunities for education and development, and can reduce the potential to escape that poverty. None of the MDGs can be met without major improvement in the quality and quantity of energy services in developing countries. However, there is currently no MDG on energy access.

Many communities in rural areas are dependent on traditional biomass such as wood and manure to provide fuel for cooking. The International Energy Agency (IEA) recently reported[147] that 1.4 billion people, or one-fifth of the global population, do not currently have access to electricity. Most of these live in Asia, including India (400 million people) and Bangladesh (96 million). There are 585 million in Sub-Saharan Africa, including Nigeria (76 million) and Ethiopia (69 million). The problem of energy access for the poor has become even more acute because of the increased vulnerability brought about by climate change, the global financial crisis and volatile energy prices.

If current policies remain unchanged, 1.2 billion will still lack access to energy services by 2030. In the same time frame, the number of people dependent on traditional biomass for cooking will rise from 2.7 billion today to 2.8 billion. The use of these fuels in poorly ventilated homes leads to an increase in premature deaths from respiratory problems linked to smoke inhalation[148]. Families cannot keep food and medicine refrigerated, and children cannot do homework after dark.

The UN Advisory Group on Energy and Climate Change has called for a new goal on universal energy access by 2030. The IEA has estimated that $756 billion of investment will be required over the next 20 years to provide universal access to electricity and clean cooking facilities, equivalent to just 3% of the projected global energy investment in the same time period.

Human rights (S11). Broad-based respect for human rights: people have the freedom to exercise choice and participate in decision-making that affects their lives.

Human rights are rights attributable to all human beings, whatever our nationality, place of residence, gender, national or ethnic origin, colour, religion, language or any other status. These rights are all interrelated, interdependent and indivisible.[149] The recognition of the above is essential for the quality of human life. It lays the foundation for enabling everyone to participate fully in society, regardless of factors such as background, gender, religion and socio-economic status. It also enables us to respect the rights of future generations and their need for access to resources.

The second half of the 20th century has seen remarkable progress on human rights. The International Covenant on Civil and Political Rights (ICCPR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR) put into binding legal terms the rights enshrined in the Universal Declaration. These covenants were adopted unanimously by the UN General Assembly in December 1966. Together with the Universal Declaration and the optional protocols of the ICCPR, they constitute the International Bill of Rights.[150] As of January 2011, the ICCPR had 72 signatories and 167 parties, and the ICESCR had 69 signatories and 160 parties. And 111 countries have signed up to the Rome Statute of the International Criminal Court. However, non-signatories – of which there are 81 – include some of the world's most powerful governments, such as the US and China.[151] This reduces international accountability for abuses of justice.

We still have a very wide global justice gap to bridge: millions of people are subject to various kinds of abuses without having recourse to justice. In 2009, Amnesty

International recorded that people were tortured or otherwise ill-treated in at least 111 countries; freedom of expression was restricted in at least 96 countries; and unfair trials were held in at least 55 countries.[152] Human rights, however, are not just about torture and unlawful killing: poverty denies basic human rights because it widens the justice gap for the millions who are denied food, health, education and housing.

Universal support for international agreements such as the Rome Statute would strengthen international accountability, as would efforts to abide by these standards by all key stakeholders – from companies to investors to governments. Initiatives such as the MDGs also help to ensure that no group or individual's rights are marginalised. Action programmes by governments, NGOs and the general public are critical for minimising the gap in social injustice. Similarly, case studies into the results of long-term project-specific schemes, such as promoting gender equality in Sub-Saharan Africa or ensuring environmental sustainability for future generations, help clarify challenges and potential solutions.[153]

Governance S12. Broad access to accountable, transparent and participatory governance systems.

Many decisions that have a large impact on society and on the environment are made by just a few people. As these decisions affect the many, it is essential to have checks and balances in place to ensure that they are not made to benefit the few.[154] Governance systems that allow the many to impact on the decision-making of the few also need transparent media to enable individuals to make informed choices. Political, media and corporate transparency can increase levels of social trust: research has shown that there is a marked relationship in most countries between a fall in trust in national government and a rise in citizens' concern that their country is not going in the right direction.[155]

There is perhaps no better manifestation of this today than the mass anti-government protests taking place across the Middle East.

Freedom House's annual assessment of political rights and civil liberties shows global freedom suffered its fifth consecutive year of decline in 2010. The number of countries designated as 'free' fell from 89 to 87, and the number of electoral democracies dropped to 115, far below the 2005 figure of 123. In addition, authoritarian regimes such as those in China, Egypt, Iran, Russia and Venezuela continued to step up repressive measures with little significant resistance from the democratic world.[156]

Lack of accountability and transparency is the most important cause of corruption. The cost of corruption is huge globally. In Africa, it is estimated at more than $148 billion a year, a figure which massively exceeds any aid effort spent by the developing world,[157] represents roughly 25% of Africa's GDP, and increases the cost of goods by as much as 20%.[158] Corruption can also accelerate the depletion of natural resources, notably primary forests and inshore fishing grounds, which many communities rely on for their livelihoods. The Government of Indonesia has estimated that lost forest revenue due to corruption costs the nation up to $4 billion a year, or around five times the country's annual health budget.[159] In developing countries at large, corruption raises the cost of connecting a household to a water network by as much as 30%, inflating the cost of achieving the MDG on water and sanitation by more than $48 billion – an enormous figure that is equivalent to nearly half of what the world spends on international aid each year.[160]

Sadly, very few people around the world trust their governments to be transparent and accountable. Declines in institutional trust since 2004 have been greatest for national governments.[161] According to 6 out of 10 people around the world, corruption has increased over the past three years.[162] One in four people reports paying bribes in the past year, and poorer people are twice as likely as their richer counterparts to pay bribes for basic services such as education.[163] Police forces are cited as being the most frequent recipients of bribes, a problem that has worrying implications for the state of justice and the rule of law around the world.[164]

Organisations working on governance and corruption issues such as Transparency International stress that building trust and good governance is best achieved by getting representatives from government, business and civil society to collaboratively agree all key standards and procedures. And the UNDP's Principles for Good Governance spell out key conditions for good governance: broad-based participation and a consensus-based approach to decision-making; an articulated sense of direction from political leadership on how governance will foster human development; regular performance monitoring; transparent and accountable sharing of information; and respect for equity and the rule of law.[165]

Trust (S13). Global levels of trust in society, for people and institutions, are at an all-time high.

Trust is the belief that others will not knowingly act in a way that is detrimental to our interests, or, better still, the assurance that they will act in a way that serves to maximise our interests.[166] Academics have long argued that trust "is the key to the efficiency of markets and economic growth, rates of criminal offending and victimisation, morbidity and mortality, quality of life and the stability and responsiveness of democratic systems in government".[167] Evidence from the 1991 World Values Survey found that social trust and civic engagement are strongly correlated:

the greater the density of associational membership in a society, the more trusting its citizens.

The World Values surveys show that the percentage of people agreeing that "most people can be trusted" varies from over 65% in Norway to less than 3% in Brazil.[168] Generally, trust in institutions is currently higher in emerging markets, according to the 2011 Edelman Trust Barometer. The barometer suggests that "a jumbled media landscape and the domino effect of corporate and government crises have increased scepticism in key Western nations".[169]

General public trust in institutions, after rebounding somewhat in 2004, has resumed its downward slide over the past year according to the Globescan *Trust in Institutions* survey. Levels of trust are lowest in relation to national governments, the UN and global companies.[170] Within the business world, IT companies are at the top of the trust ranks, while financial institutions are currently at the bottom.[171]

Trust levels in the media world have recently been shaken by the phone hacking scandal at *The News of the World* newspaper in the UK. This incident has called into question the integrity of the media industry as a whole,[172] and further public inquiries are currently underway. Inquiries such as this one may help to restore levels of trust in key institutions, although deeply ingrained negative public opinions can be difficult to reform. As online sources of media and information proliferate and become more and more accessible to people, it will increasingly be important to ensure proactive engagement and transparency.

Civil society (S14). Civil society plays a strong and active role in raising awareness, and strengthening accountability.

Civil society is defined as the space of organised activity not undertaken by either government or for-profit business. It encompasses the voluntary and community sectors, trade unions, faith groups, cooperatives and mutuals, political parties and philanthropic foundations.[173] A strong and active civil society plays a key role in holding government to account and delivering services that are not provided by the state. Participation in civil society activities can help to strengthen communities and unite people with common beliefs and areas of interest.

The Globescan *Trust in Institutions* survey shows that institutional trust is highest in NGOs around the world, out of all key societal institutions.[174] On the other hand, civil society groups continue to face significant challenges. The UN Special Rapporteur on Human Rights Defenders, Margaret Sekagayya, has identified a number of "worrying trends" in the security and protection levels of human rights defenders, and called for "urgent and effective solutions not only by states, but also defenders themselves".[175] CIVICUS monitoring over the course of 2009 and 2010 shows a multitude of restrictions being placed on civil society in approximately 90 countries around the world.[176]

The UN has a set of recommended guideline of 'peaceful action,' within which civil society groups should operate.[177] Civil society groups can work to ensure their work is determinedly carried out with transparency, free from corruption or political bias, while avoiding the external influence of non-state actors. This 'maximum effort, maximum impact' approach, combined with adherence of other key institutions to the UN recommendation of greater accessibility to resources and greater acceptance for civil society groups, aims to provide a stronger platform for civil society groups to work towards the common good, while strengthening their accountability to the broader public.[178]

Science (S15). Science is valued by society and accepted universally as the foundation for sound policy-making.

Public understanding of the scientific basis for sustainability issues is crucial to give governments a mandate for action and policy-making.

Incidents such as 'Climategate' – where critics called into question the impartiality and transparency of climate scientists – have undermined this. A BBC poll in February 2010 found that 25% of people did not think global warming was happening. And only 26% believed it was man-made. Although the poll sample was relatively small (1,001 adults), the findings reflect a growing scepticism among the global public about climate science.[179] Similarly, 59% of the UK public believe that the government is using climate change as a back-door way to raise taxes.[180] The scientific community needs to communicate the uncertainties and probabilities used in climate modelling, and policy-making needs to be based on risk analysis rather than a search for certainty.

Despite this, there are positive signals regarding levels of trust in scientific opinion and the role that science should play in policy. It was scientific evidence of the depletion of the ozone layer that led to an international agreement – ratified by 196 countries – to reduce the main cause of man-made ozone depletion (CFCs). The General Social Survey conducted by the University of Chicago found that 85% of people thought scientists should have either 'a great deal' or 'a fair amount' of influence over global warming policy. And 71% of respondents to a survey conducted by Stanford University said they trust scientists a moderate amount, a lot or completely.[181] There are also signs that we believe we know more about science than we

used to: the proportion of people in the UK who say they are very or fairly well informed about science and scientific developments has increased significantly since 2005, rising from 39% to 56% of adults.[182]

Sustainable values (S16). Values consistent with sustainability are promoted through education and societal norms.

Unsustainable forms of development are not evenly distributed across the world. Some lifestyles lead to a greater depletion of the Earth's resources than others, and some people will be more vulnerable to changes in the earth's ecosystems than others. For example, challenges such as poverty, inequality and malnutrition are most acute in the developing world, and addressing them requires the support of wealthy, industrialised nations.[183] For this reason, it is important for people to see themselves as connected to each other and to look beyond national, cultural, biological and religious differences.

As part of this, it is necessary to understand which key values engender that feeling of connectivity and foster greater sustainability, and, above all, how we can further embed them into society. *Empathy*, for example, is believed to be an important value – both in terms of global interconnectedness and long-term thinking. Explained as "our ability to step into the shoes of another person and comprehend the way in which they look at themselves and the world",[184] empathy is thought to be "one of the most effective means of establishing equality that modern societies possess".[185] For example, developed countries today arguably do not do enough to ease the plight of those in developing countries that are already suffering from the effects of climate change – a lack of empathy across *space*. On the other hand, as a global society we are all demonstrating a collective lack of empathy with future generations by continuing to emit unsustainable levels of greenhouse gases into the atmosphere – a lack of empathy across *time*. With a lack of empathy, we are less effective at responding to environmental and humanitarian crises.

Similarly, in placing more value on *understanding*, our awareness of the fragility and interdependence of life on Earth arguably increases, and we are better able to integrate it into our existing frameworks. And the value of *respect* enables us to contemplate our 'newly understood' framework of the Earth with a renewed importance, something which many believe we need more of within modern capitalist societies, where respect for the environment and for other communities is often deprioritised in the pursuit of short-term commercial profit.

For example, research suggests that obsession with short-term results among investors, asset management firms and corporate managers leads to the unintended consequences of destroying long-term value, decreasing market efficiency, reducing investment returns and impeding efforts to strengthen corporate governance.[186] Some argue that short-termism also leads to unethical behaviour that can threaten the survival of a company, demonstrated by the collapse of Enron in 2001. Investing in a sustainable economy requires people not just to empathise with each other but also to employ long-term thinking by empathising with people who are not even born. It is only in this way that we can spot and address key economic risks and opportunities while achieving sustainability objectives.

A key way of doing this is through education: from established programmes to grassroots community outreach, values that promote a sustainable future should be infused into the education system at every level. And education systems should raise awareness of the fact that those who are most vulnerable to unsustainable forms of development often contribute the least to it,[187] in an effort to embed greater empathy where it is most needed.

Furthermore, the work of civil society groups, who work to embed a more sustainable value set into societies, offers a strong example of working towards a more sustainable economy through activities in the areas of children's education, sustainable agricultural programmes, women's empowerment and microfinance. Our deeply ingrained consumerist culture may be challenging to shift, but values-based action is a critical lever of change.

Characteristics of a sustainable economy

Taking all of the environmental and social boundaries together, we can define the characteristics of a sustainable economy.

These are important high-level principles but they only become practical and meaningful when we apply them to activities in specific sectors.

In Part 2, we present visions for the food, energy, healthcare and mobility sectors to show what those sectors might look like if aligned to these broad characteristics.

To have any chance of achieving these visions, the financial markets will need to allocate capital very differently from today. At the moment, finance does not flow in support of the kinds of activities that characterise and shape a sustainable economy. In the next section, we articulate how the financial markets will have changed by 2040 to enable the investment required to underpin the shift to a sustainable economy.

C1	Stabilises concentrations of greenhouse gases in the atmosphere at a 'safe' level.
C2	Builds resilience of natural and human systems to cope with a changing climate.
C3	Minimises pollution.
C4	Maximises the material efficiency of the economy.
C5	Maximises land use efficiency.
C6	Invests in protecting biodiversity and restoring the productivity of ecosystems.
C7	Measures wealth by more than just GDP, including measures such as human development and wellbeing.
C8	Builds capacity for individuals to participate in the economy and supports sustainable livelihoods.
C9	Incentivises behaviour change in line with the sustainable economy.
C10	Promotes fair terms for all global trade, in order to facilitate greater levels of economic equity.
C11	Eliminates all perverse subsidies.
C12	Allocates capital sustainably through financial markets.
C13	Promotes the equitable distribution of resources.
C14	Promotes the free flow of information and knowledge.
C15	Builds the cost of all social and environmental externalities into valuations.

part 2 - sector visions

We have created ‘visions’ of five key sectors in a sustainable economy in 2040: food; health and wellbeing; energy; mobility; and finance. They combine the broad ‘top-down’ principles of social and environmental sustainability set out in our framework (Part 1) with practical ‘bottom-up’ knowledge of how these sectors could evolve in the face of global trends such as technology development, the rise of China and other new economies, population growth and pressures on key resources.

We have included a number of ‘weak signals’ of the future in these visions – things happening today which give an indication of how the future may unfold.

We’ve used the visions to provide guidance on where to invest to support the development of a sustainable economy and where to avoid investment. This is examined in more detail in Part 3.

Finance in 2040

In 2040 a diverse and resilient financial system is in place. Many different types of financial institutions and instruments are thriving, including

- peer-to-peer lending for small and specialist transactions
- community-driven and cooperative models that draw on the experiences of early microcredit institutions and cooperatives
- an increased use of 'time banking' or 'banking in kind', where, for example, people provide care for others when healthy and use these 'credits' when they are elderly or ill
- venture capital funds, private equity funds and investment funds providing capital to businesses in the economy to support the different stages of their development, managed from a long-term perspective
- multinational banks and insurance companies delivering services efficiently and at scale to their global clients.

Within this framework of thriving institutions of various sizes, no organisation is too big to fail.

The principal characteristics of the finance system are outlined below.

Investors take a long-term perspective grounded in an understanding of systemic risk
Investors take a long-term perspective on the returns from their investments, and have a clear knowledge and awareness of the assets they are investing in. There is a close relationship between scientists and investors, particularly in terms of providing guidance on sustainability issues. Any misalignment between investment decisions and long-term sustainability (based largely on the latest understanding of environmental boundary conditions) is quickly picked up.

There is a wider distribution of ownership of stocks and shares
The pattern of global growth over recent decades has led to a wider distribution of ownership of stocks and shares. Greater numbers of people in developing countries have become wealthier and have invested in companies in their own countries. As incomes in developing countries have increased, differentials in labour costs have been reduced, so there is less cross-border investment into businesses where cheap labour is the only source of competitive advantage. Where there is foreign investment in assets, transparent arrangements are in place to ensure that there are also opportunities for local ownership of shares.

A large proportion of each investment portfolio is allocated to long-term instruments such as bonds
Investors continue to hold a significant proportion of their pension fund and life-assurance investments, as well as their savings, in shares. For the past three decades, however, there has been solid growth in the proportion of funds and investments that are allocated to long-term instruments offering stable long-term returns, such as bonds invested in sustainable activities.

weak signals **Increasing demand for 'green bonds'**

Green bonds will need to be developed to raise a substantial proportion of the additional €2.9 trillion ($3.9 trillion) of capital required to build low-carbon infrastructure in Europe from 2011 to 2020, according to a report by Barclays and consultancy Accenture – see:
http://group.barclays.com/Citizenship/Reporting
(*Carbon Capital: Financing the Low Carbon Economy*)

Co-investment by the public sector shares risk
The public sector supports the finance system in appropriate ways. Government-backed investment vehicles exist at the global level to support the early-stage deployment of new technologies and to promote investment in riskier markets where activities might reduce poverty. These investment vehicles follow the models of traditional development finance institutions as well as the green and social investment banks that emerged strongly during the 2010s to drive investment where market signals were weak. Private-sector investors actively engage with and invest alongside these vehicles. The array of green-investment and development banks serves to share downside risk with the private sector, but these public financial institutions are also designed to share in the upside when investments earn strong returns. These funds have grown solidly over the past 30 years, with no net cost to the public purse.

Skills and expertise are actively shared between public and private sectors
The high quality of these institutions is attributed in part to the Shared Wealth Initiative that started in 2012, funded by a group of commercial banks. This enabled secondment of

individuals from financial institutions to relevant parts of the public sector and to civil society organisations, and vice versa, to build trust and increase knowledge and skills on all sides.

Public policy is clear and consistent and informed by the latest science
Public policy has a long-term emphasis and is strongly informed by science. A government insurance scheme exists to ensure that shifts in government policy do not lead to losses for investors who have invested in good faith in line with previous policy interventions. All financial institutions are required by law to prepare recovery and resolution plans to try to anticipate and plan for future systemic risks.

Tax rates differ for profits made on primary and secondary trading
Taxes for financial institutions are structured so that the activities with a direct link to the generation of natural, social and human capital[188] are subject to lower tax rates than secondary activities designed to increase market liquidity. Derivatives are taxed at a higher rate. It has taken a while to determine how to create the distinction between these activities, but meaningful definitions are now in place.

Tax incentives are only available for investments aligned with the vision or a sustainable economy
Most countries offer tax incentives to people who save for the future, but these incentives are usually only available if the associated investments are aligned with the vision for a sustainable economy. This approach was initiated in the UK in 2013, when the £22 billion spent on fiscal incentives for pensions became dependent on investments meeting sustainability criteria.

Activities are coordinated globally
There is a trusted international council for agreeing global governance protocols, so that individual countries do not harm their competitiveness by taking robust action – for example, on remuneration or short-term risk taking. All countries have agreed the protocols, and they are reinforced through a disclosure initiative.

Governments measure more than GDP, and this approach cascades to companies
All countries measure and report on the wellbeing of their environment, communities and individuals, and these are used as the key indicators of success and progress.

The Framework established at the 10th Conference of Parties of the Convention on Biological Diversity in Nagoya in 2010 was a break-through for setting environmental goals. Government action in this area was swift, guided by the Economics of Ecosystems and Biodiversity (TEEB) project. It cascaded quite quickly down to company reporting requirements.

weak signals

Countries valuing ecosystems in their national accounts

At the UN Convention on Biological Diversity in Nagoya, Japan, in October 2010, the World Bank launched a five-year pilot programme that aims to develop mechanisms for integrating ecosystem valuation into national accounts. The project, which has secured backing from India, Mexico and the UK, will look at how the positive approaches it identifies can be applied around the world.

Natural, human and social capital are properly valued
Companies encountered many early difficulties in reporting relevant data on the ways they are dependent on human, social and natural capital and their impacts on these. But this reporting has become increasingly sophisticated in the past 30 years. An extensive range of pilots between investors and companies in the 2010s provided vital data to underpin this. Given the strong relationship between company reporting, scientific evidence and government incentive structures, this information feeds quickly through to financial valuations.

Companies report strategically on long-term sustainability challenges, supported by scenario planning
For many years now, investors have required companies to report on their long-term strategies and how these address sustainability issues. In particular, the global comply or explain requirement for Corporate Sustainability Reporting made at the Rio+20 Earth Summit in 2012 helped to improve companies' governance of corporate sustainability, making them more stable and less exposed to external shocks. This resulted in better risk management, and in more detailed consideration of exogenous risks in the system via scenario planning – particularly around how sustainability issues impact companies. This thinking by companies also helped long-term investors integrate sustainability into their portfolio investment decisions, which created a virtuous circle and reinforced company thinking. Investor integration of the data into valuation drove down the cost of capital of more sustainable companies and drove up the cost of capital of unsustainable companies.

Uncertainty and risk are reported transparently
Investors expect companies to report using a range of possible outcomes for financial performance, rather than a single projection. A precautionary approach is taken, with uncertain risks being given a strong weight (even if they are expected to take place over the long term) until their precise downside and any mitigation strategies are clear. These principles have been enshrined in international accounting standards since 2018.

Proceeds from exploiting non-renewable resources are re-invested
Sovereign wealth funds across the world are investing in ways that align with the vision for a sustainable economy. There is an international protocol governing investment in companies exploiting non-renewable resources. This requires that a significant proportion of the proceeds should be re-invested in assets that will serve future generations.

Financial products are in place to support sustainable business models
Businesses find it easy to obtain finance for activities where the business model relates to the sale of a service rather than a product. This reflects the firm establishment of an economy where this type of business model is a big part of many sectors. Banks focus on knowing their customers. They offer specialist advice to them on how their businesses can grow and develop in line with the sustainable economy.

Fund manager mandates are awarded on the strength of expertise in social and environmental issues
Capital allocation by pension funds and insurance companies is aligned with long-term sustainability. All investment mandates provided by pension funds to fund managers require that social and environmental issues are managed as part of fiduciary duty. There is an independent process for ranking fund managers on their performance in taking social and environmental issues into account in their investment decisions. Pension funds view this as a proxy for strong long-term financial performance. These changes to the system have resulted in a 'race to the top' among fund managers, who have developed a range of new analytical tools to assess long-term risk and opportunity. The minimum standards put in place through legislation in the 2020s have now fallen away as investors see the benefits of this approach.

Investments in ecosystems services are a part of portfolios
Pension funds and insurance companies are investing in long-term assets, with a much greater focus on long-term, stable instruments such as bonds. Investments in ecosystem services are now an important element of all institutional investor portfolios, developed as a way of reducing risk to the rest of the portfolio arising from natural resource degradation. Early innovations in this area were made possible through rapid growth in impact investing by wealthy individuals, and models evolved from this that could harness investment from mainstream institutional investors. In addition, investments in ecosystem services take place through the balance sheets of companies that are dependent on those services and are investing to reduce their risk or liabilities.

weak signals

Asset allocation advice to reduce risk from climate change

A report by Mercer on behalf of 14 large pension funds has reported that portfolio risk could increase by 10% in the next 20 years as a result of climate change. Mercer recommends that at least 40% of the portfolio of institutional investors should include investment in climate change mitigation and adaptation.
www.mercer.com/climatechange

Transaction costs are transparently reported
Investors demand, and fund managers provide, a detailed breakdown of the transaction costs associated with their portfolios.

weak signals

Strong growth in impact investing

A recent report by J.P. Morgan and the Rockefeller Foundation estimates the value of the emerging impact-investing sector to be between $400 billion and $1 trillion, with profit potential between $183 billion and $667 billion over the next decade. Impact investing is an investment strategy whereby an investor proactively seeks to place capital in businesses that can generate financial returns as well as an intentional social and/or environmental goal.
www.rockefellerfoundation.org/news/publications/impact-investments-emerging-asset

Insurance premiums account for systemic risk
Across the insurance industry there are higher premiums for activities that fail to manage their negative impacts on climate change, biodiversity, water availability and local communities. While initially this started as a government-supported scheme in 2015, the benefits to individual companies and the industry as a whole from reduced risk are now clear. It has been possible to keep average premiums low, and the overall benefits have been felt by the industry for many years.

Detailed weather data are captured across the world, enabling insurers to take appropriate action in partnership with the public and private sectors. This includes early-warning systems to enable managed migration from uninsurable areas or to avoid losses; weather index schemes to support individuals and businesses in vulnerable countries; and pooling schemes for major weather events.

Financial institutions 'stress test' their portfolios and use shadow pricing to show true values
Financial institutions have internal processes to ensure that their activities are aligned with a sustainable future. Valuation of investments takes full account of impacts on society and the environment, and scenario planning is used to create and test 'living wills'.[189] Where the monetary value of a company's assets and liabilities does not reflect its real value (eg because social or environmental impacts are undervalued), investors highlight this through a provision in their accounts.

This shadow pricing technique first came into mainstream use in 2012. A collaborative group of investors used data from the Carbon Disclosure Project to indicate how their portfolios would be affected if the companies they invested in were accounting for carbon at a price that reflected its environmental cost. This spread through the 2010s and 2020s as the information on companies' impacts and dependencies on other ecosystem services became clearer. It contributed to the pressure for mandatory carbon reporting and for a proper economy-wide floor price for carbon, introduced in 2015.

weak signals

Weather insurance products enabled by technology

WeatherBill helps people and businesses access insurance to reduce their risks from climate change. The company's unique technology platform makes it possible for farmers to buy tailored weather insurance online, using global weather simulation modelling and local weather monitoring systems. The company was set up by ex-Google employees.

weak signals

Pressure on the UK Government from leading companies to make carbon reporting mandatory

Under the UK's Climate Change Act, the UK Government must put forward regulations for mandatory carbon reporting by 2012 or explain to Parliament why this has not been done. Leading companies have called on the UK Government to mandate carbon reporting as soon as possible.

Remuneration structures reward behaviour that creates long-term value for society
The remuneration and appraisal system now in place, together with the prevailing investment culture, reinforces and rewards behaviour that creates value for society rather than only for individual gain. The culture of the financial markets is one in which respect for peers depends primarily on how they demonstrate that their activities support growth in human, natural, social or manufactured capital. Growth in financial capital through structuring deals or through repackaging and resale of existing assets commands little respect for individuals or institutions in the marketplace. Institutions generate limited revenue in this way, and it is the basis for remuneration for only a few specialists. It has taken time to migrate from the system of bonuses that was paid in the early 2000s, but the average multiple of lowest-paid to highest-paid individuals in financial institutions is now around 50, compared with its peak of 200 in 2009.

Financial institutions have strong partnerships with civil society groups
Strong and challenging partnerships are forged with civil-society groups. There is full transparency and reporting on the investments that each individual financial institution has made.

All individuals are trained in money matters
All individuals are trained in money matters as part of the basic curriculum all over the world, and there is a much greater understanding of credit and savings mechanisms. Financial service providers are responsible for ensuring that all users of their products understand them, and they take this responsibility very seriously. The industry was chastened by the high-profile class action in 2014 that bankrupted two high-profile investment banks accused of mis-selling complex financial products.

weak signals

Regulators identify the need for action on the potential for the mis-selling of complex products

The Financial Services Authority has warned that banks are pushing consumers into complex wealth management products that are unsuitable and are using 'aggressive' sales incentives to motivate staff. It has resolved to take firm action to protect consumers.

'Sustainable financial institutions' are clearly defined, and customers actively benchmark performance
Individuals identify closely with the institutions that provide them with financial services, and want to be associated with brands that enhance their image. Customers' selection of financial service providers is helped by a clear and widely agreed vision of what sustainable financial institutions of various kinds should look like, and by a high level of transparency. People's expectations of returns are at a level that can be reasonably sustained over the long term.

Investor guidance: financial markets

Require all investments to...
Report on their impacts and dependencies with regard to natural and social capital, whether positive or negative. This should include assessments of future risks and opportunities, and should start with mandatory carbon reporting.
Research and develop better ways of valuing natural and social capital, and better metrics to measure long-term business success.
Commit to a significant reduction in greenhouse gas emissions and the resource intensity of products and services.
Encourage suppliers to report on their own sustainability impacts (including supply-chain impacts).
Communicate effectively about what underpins any investment in terms of vision, business model, long-term strategy and approach to risk.
Introduce greater diversity at the board level, and take steps to ensure that non-executive directors are better able to challenge 'business as usual' mindsets and behaviours.
Invest in research and innovation to optimise sustainability performance.
Invest in the development of 'green' skills amongst the workforce.
Support the public-policy positions needed to deliver sustainability (see the section opposite on lobbying for more detail).
Implement and measure the impact of health and wellbeing programmes on health and absenteeism among the workforce.
Make cost-effective energy savings.
State in remuneration reports whether the remuneration committee is able to consider corporate performance on environmental, social and corporate governance (ESG) issues when setting the remuneration of executive directors.
Publish corporate sustainability strategies – or explain why they are not able to do so – and put these reports or the associated explanation to the vote at a company's AGM.
Communicate the key impacts – both positive and negative – of their products/services transparently and clearly to consumers.

Lobby governments for...
New definitions of economic success that take account of natural and social capital.
The introduction of suitable models for risk sharing in investment, particularly early-stage investment.
Stronger mandatory disclosure by pension funds about how they are thinking about the long term.
Strong international carbon mitigation targets and adaptation policies/plans that help poorer countries in particular, with a fair approach to sharing responsibility for action within and between nations.
Policies that deliver a meaningful carbon price, so that the floor price increases to at least £200/tCO_2e (tonne of CO_2 equivalent) by 2050.
Mandatory carbon reporting by companies.
Use of policy and other incentives to encourage the spread of proven new sustainable technologies and ways of working.
Public investment in infrastructure that enables waste reuse and recycling.
The development of 'green' skilling to enhance people's stewardship of land, biodiversity and ecosystem services.
A zero-tolerance approach to corruption, especially in low-income countries where more efficient tax collection would generate big wins for core public services.[190]
Financial incentives for clean energy generation.
Investment in providing universal energy access.
An end to fossil fuel subsidies.

Implement internal procedures to...

Link performance appraisal criteria and executive pay to longer-term and more qualitative targets.
Reduce the difference in pay between top executives and the lowest-paid workers from the current multiple of 200 times to a level of 20 times at most.
Enable secondment of skilled individuals to public-sector roles to help identify how to catalyse private-sector investment aligned to the sustainable economy.
Enable and reward research and innovation in areas needed for the transition to a sustainable economy.

Attribute value to…

The benefits provided by ecosystem services and biodiversity.
Water resources, particularly where scarce.
Carbon emission reductions.
Energy efficiency measures.
The infrastructure in place for ‘closed-loop’ systems (as well as physical infrastructure – this includes the social/cultural infrastructure around particular ways of disposing of waste). For example, technology to collect, segregate, transport and recycle waste.
The business savings from sustainability actions (eg efficiency, reputation and rebuilding natural capital).
The environmental/social risks faced by businesses, and the savings from mitigating these.
Increasing the resilience of local areas, by measuring the risks averted or the costs that would be incurred in rebuilding communities/ecosystems.

Provide finance to support research and educational priorities…

Communicate to the general public about the financial risks associated with sustainability issues.
Develop ‘green’ awareness and skills among the workforce in key sectors.

Food in 2040

By 2040, an interconnected and globalised food system is increasingly focused on delivering food security and supply-chain resilience in order to provide nutritious food for the world population. In the 2010s and 2020s, national policies prioritised rural development as a driver of income growth in the developing world through increased access to capital and markets, removal of subsidies and trade barriers that disadvantage low-income countries, and protection for vulnerable groups at times of crisis.[191] As a result, hunger has been virtually eliminated.

We have seen **unprecedented innovation within agriculture and food manufacturing** over the past 30 years. Technology has delivered a range of new approaches to ensure that we can feed a population of nine billion while minimising the expansion of agricultural land. This includes industrialised food production, such as artificial proteins; the targeted use of genetically modified (GM) crops to address issues such as yield levels, drought and flood resistance and nitrogen efficiency;[192] and significant restoration of derelict, degraded land. The human and environmental safety of any new GM technology is rigorously tested before deployment, as is its potential to benefit global food security, particularly the wellbeing of the most vulnerable population segments. Innovations in food technology have extended fridge-free preservation times, reducing the impact of seasonality and transport concerns.[193] Alongside this, farming and manufacturing increasingly use technology to monitor their environmental and financial performance much more closely, bringing a range of operational efficiencies.

weak signals **Phones meet farming**

Applying innovative technology in a rural setting, Indian mobile operator Tata Teleservices is helping farmers monitor and switch on irrigation pumps remotely. Nano Ganesh allows them to remotely check to see that there is electricity, and to automatically turn the pump on and off, all through a mobile phone. It helps the farmer avoid various difficulties in reaching remote water pumps, such as long travel over difficult terrain, bad weather and hazardous locations.
www.nanoganesh.com

Thanks to a combination of policy incentives, carbon-trading mechanisms and consumer pressure, **the food system in 2040 is very carbon-efficient**. This has particularly affected some of the hot-spots of food production, such as fertiliser use, livestock methane emissions, refrigerants and food waste. Resource efficiency – such as new biotechnologies, recycling and reusing materials, and minimising energy consumption – is now deeply embedded into industry practice. Small-scale and low-income farmers initially found it difficult to shift to new practices. But as the cost savings and efficiency gains of many carbon-cutting measures became more clear, the uptake increased. In addition, a range of initiatives in the 2020s helped provide finance, insurance and capacity building to help farmers transition to a low-carbon economy.

In 2040 climate-change impacts continue to play out across the world. The effects have been very different between and even within countries. Some areas have seen an increase in crop yields because of additional CO_2 in the air.[194] But other areas have suffered dramatically from temperature shifts and from changed rainfall and flooding patterns.[195] Insurance against climate-change risks became increasingly expensive in the early 2010s as impacts became worse and causality more clear, and this encouraged extensive climate-change adaptation and resilience policies from governments worldwide. Most businesses were able to plan for these changes, and it encouraged a shift in agriculture and manufacturing to more productive areas.

Water is a critical business issue, particularly in areas where water tables are low or water quality is under threat. Some areas have changed what they grow to less water-intensive crops and, in more extreme cases, shifted out of agriculture altogether. Businesses have to show that they can operate in a water-neutral way to get their licence to operate, and restorative approaches for water stewardship are the norm.

weak signals **Artificial meat substitutes**

Researchers in the Netherlands created what was described as “soggy pork”, and are now investigating ways to improve the muscle tissue in the hope that people will one day want to eat it. The scientists extracted cells from the muscle of a live pig and then put them in a broth of other animal products. The cells then multiplied and created muscle tissue. The project is backed by the Dutch Government and a sausage maker, and comes following the creation of artificial fish fillets from goldfish muscle cells. Meat produced in a laboratory could reduce greenhouse gas emissions associated with real animals.
www.telegraph.co.uk/science/science-news/6680989/Meat-grown-in-laboratory-in-world-first.html

The vast majority of **nations now recognise ecosystem services and biodiversity as a crucial sustainability issue**. In the years up to 2040, many habitats and species have been protected to preserve and rebuild ecosystems. For example, fishing was banned in the early 2010s for a number of fish species until stocks had recovered to sustainable levels; and The Rainforest Protocol of 2018 has made it illegal to convert rainforests into agricultural land. As a key land user, the agricultural sector has taken on much of the responsibility for ecosystem stewardship. Farmers and agricultural employees worldwide have largely embraced the idea, and the additional jobs created have helped rural communities to thrive. This has also been helped by the focus of restoration work on rebuilding natural capital, with government and private investment flowing in to restore ecosystem services and biodiversity. Government policy has helped incentivise this through the introduction of payments for ecosystem stewardship and ecosystem restoration bonds, which yield long-term returns to investors on the basis of cost savings resulting in avoidance of ecosystem loss.

Competition from companies in emerging markets has broken the traditional agrichemical monopolies, injecting more seed innovation into the system, supported by the growing number of seed banks around the world. Agricultural research is prioritised by many governments, particularly with regards to production efficiency, and climate-change mitigation and adaptation.

weak signals **Water desalination**

Water desalination may soon become one of the world’s largest industries. By 2040 at least 3.5 billion people will be short of water – almost 10 times as many as in 1995. The huge demand, plus new more efficient desalination technologies, will create enormous profit opportunities and bring new life to arid regions. (World Future Society)

weak signals **A greener New York City**

In the South Bronx, a new low-income apartment complex, Via Verde, is being built for a lifestyle based not on ease and speed but on exercise and healthier living through everyday activities. The development will be dotted with orchards and vegetable plots tended by the residents, bringing green spaces to places typically starved of open areas. There will be ‘pocket parks’ for exercise, and the shops in the complex will offer fresh, healthy food.
www.bbc.co.uk/news/health-11381101

While globally the system has focused on production efficiency, **in many local communities ‘slow food’, urban farming and organic production have continued to proliferate**. Food is understood as a major element of national and local culture, and helps local community cohesion. Urban agriculture, while not a major contributor to global food production, is helping develop small-scale alternative models which reduce transport costs and build local food resilience. This has increased the connection between urban and rural areas, both culturally and through the constant flow of energy and materials.

Awareness of health and wellbeing continues to be a strong driver of consumer behaviour, encouraged by the growing restrictions on advertising of unhealthy and unsustainable products. Many foods now provide additional nutritional value or health benefits, such as gene-tailored diet foods for reducing cholesterol,[196] a trend that by 2030 had helped to drive down the incidence of the majority of diet-related illnesses and obesity.

Feeding nine billion while minimising environmental impact has meant some cost rises, but, because action was taken relatively early, the changes have been less drastic than we feared in the early 21st century. Consumers can still choose from a wide range of foods, but prices of some products are higher now that environmental externalities are factored in.[197] Many high-impact products have also been reformulated, and public understanding and consumer support has also gradually shifted away from higher-impact products as a result of more and more healthy, sustainable substitutes being made available. Meat is a good example: it is still accessible, although more expensive. Demand for meat in the West reached a plateau in the 2010s, and did not increase as much as people expected in emerging markets – mitigated by rising awareness of health and nutrition, policy interventions and rising prices.

As a result of the growing body of knowledge about nutrition and sustainable food production, **people now expect much more information about their products**, and technology has enabled instant feedback on full product histories, helped by trusted simplifications and labels. This transparency has had a huge impact on raising both environmental standards and labour standards internationally, ensuring that food sector workers around the world have a living wage and improved working conditions.

By 2040 the shift towards a 'closed-loop' waste system is well underway. The food sector has played a pioneering role in this, and approaches developed for food have now started to become mainstream for other resources. Post-harvest waste has been cut in half, as a result of improvements in infrastructure and advances in crop science.[198] Virtually all food waste is now reused: for energy, animal feed or compost.[199] Communities receive incentives to develop cooperative arrangements for the reuse of food waste, and sending food waste to landfill has become completely taboo all around the world.

Investor guidance: food

Invest in...

Food sector businesses that produce low-impact products efficiently – companies that stand to profit as externalities become increasingly factored in. These include:
- water- or carbon-efficient processes and infrastructure (eg the distribution fleet and stores)
- businesses with the skills and experience to use resources more efficiently than competitors
- businesses that produce food with lower sustainability impacts than competitors (eg not requiring refrigeration, requiring less heating energy and preventing food waste)
- farms on fertile land with good nutrient and water availability.

Food sector businesses which are valuing biodiversity and ecosystem services.

Food sector businesses that are positioned to benefit from a closed-loop system. For example:
- businesses using compost or other recycled materials, rather than virgin materials
- businesses that avoid sending waste to landfill
- businesses that can take an 'industrial symbiosis' approach, linking together with other businesses in a way that waste is reused within a local system
- businesses that provide the infrastructure technologies for waste recycling (eg waste segregation, packaging, anaerobic digestion and composting).

Agricultural innovation, particularly when positioned to tackle key sustainability challenges such as yield, land availability, carbon, water, nutrition, biodiversity and hunger. These include:
- reducing the carbon intensity of fertiliser, or the amount needed
- reducing methane emissions from livestock
- selective GM innovations that help farmers reduce their environmental impacts without compromising their own economic circumstances
- low-carbon approaches to water desalination or irrigation
- technology that helps farmers to monitor soil conditions.

Agricultural innovation to deal with climate change adaptation challenges:[200]
- development of crops that are more resilient to climate change impacts (eg drought, flooding, extreme heat and extreme cold)
- developing resilient waste-management technologies for livestock farming
- minimising the effects of adaptation strategies on ecosystem services
- adaptation strategies that address social inequalities (eg differences in land tenure; lack of access to resources and services such as credit and education; and exclusion from decision-making).

Innovative approaches in food manufacturing and distribution. These include:
- reducing the carbon intensity of refrigerants
- minimising the impact of food transportation.

Commercial fortification of food (eg vitamin-A-fortified food for children and folic-acid-fortified food for pregnant women). With increasing urbanisation, fortified foods are likely to reach increasing numbers of people at risk of deficiency, at a decreasing marginal cost.[201]

Foods with clinically enhanced properties (eg probiotics and prebiotics).

Biofortification of staple crops with key vitamins and minerals, prioritising staple crops in Asia and Africa: (beans, cassava, maize, pearl millet, rice, sweet potato and wheat).

Businesses which actively seek to educate consumers about nutrition, as well as other sustainability issues relating to food production and consumption.

Develop new business models to...

Provide lower insurance costs for dealing with the impact of climate change on the food system, particularly for poorer farmers and developing countries (eg extreme weather and flooding).
Provide loans for sustainability improvements among farms, food manufacturers and retailers (eg changing processes or machinery to improve efficiency).
Provide financial products that make it easier for small producers to prosper (eg microcredit or insurance that is suited to low-income farmers).
Provide new sources of funding to food businesses which improve the livelihoods of smallholder farmers (eg ethical sourcing businesses).
Spread the financial risk of developing innovative sustainable-agriculture technologies, crops and infrastructure.
Incentivise behaviour change that reduces energy demand in the food sector (among the general public, farmers and food sector businesses).
Incentivise behaviour change among consumers (eg lower insurance premiums linked to improved nutrition).

Avoid all investment in...

Food production that breaches human and animal rights standards (eg inadequate wages, dangerous working conditions and intensive factory farming practices).
Food businesses that lobby against government-led or international actions needed for sustainability (see the section on lobbying, p36).
Technologies deployed in a way that makes farmers more vulnerable and reliant on supplies that are not within their control, such as certain GM products.
Farming or manufacturing practices that may become unviable or lose their licence to operate locally because: • they may lead to excessive soil erosion or salination • they extract water from water-scarce areas, where local populations have inadequate supplies.

Limit support for...

Technologies or approaches that reduce one particular sustainability impact, but have potentially huge environmental and social risks in other ways. For example: • approaches that may concentrate power or resources in the hands of a relatively small number of businesses or institutions, reducing the say that the general public has in food production • livestock antibiotics or hormone use that may contribute to human health problems.
Food production or retail practices that risk locking the economy into unsustainable approaches: • retail that depends on widespread car ownership • crops that will not grow without carbon-intensive or polluting impacts (eg crops that are heavily reliant on fertiliser or pesticides).
Growing highly water-intensive crops in water-stressed areas (this needs to be considered alongside food security issues).
Investment activities which may amplify the volatility of food prices (eg certain types of speculation in futures markets).[202]

Health and wellbeing in 2040

In 2040, prevention is the name of the game in healthcare. The infectious diseases that were the focus of public health policy in the 20th century have in many cases been effectively tackled – most notably because of sustainable economic growth and narrowing inequality in the developing world. We are at a point where malaria and tuberculosis have been nearly eradicated, thanks to a combination of medical breakthroughs, improvements in health infrastructure and awareness-raising campaigns. And the spread of HIV/AIDS has been halted and significantly reversed.

Sorting out sanitation issues in some cities as climate-change impacts hit was challenging, but **steady investment and rapid progress have eliminated many of the healthcare imbalances that used to exist between the developed and developing world**. Emerging markets have become firmly established, and what we used to think of as developing-world countries are now dynamic economic players on the global stage. Sub-Saharan Africa, for example, has caught up to the level of healthcare that is enjoyed by the average wealthy society. And several Asian countries have become world leaders in biotech and health education.

Global-level cooperation on challenges such as climate-related health problems and epidemic monitoring ensures quick, well-coordinated responses. Health information and health services can be accessed more easily, thanks to mobile technology and ubiquitous internet connectivity.

Maternal and infant mortality rates are negligible, because of universal access to quality reproductive healthcare, family-planning provision and immunisation drives. We officially reached a state of 'zero hunger' in 2033 – only a few years behind the UN's Diamond Development Goals target. In rare cases where people don't have full access to affordable and healthy food with easily comprehensible nutrition labels, innovative public-private partnerships step in to ensure a safe and healthy energy intake.

weak signals **Consumer-driven health**

Numetrex has developed smart clothing that monitors and displays health information to the wearer. Special sensors are knitted into the fabric of the apparel and maintain contact with the body, sensing the wearer's heart rate and relaying it to a tiny transmitter. The transmitter is snapped into a pocket in the front of the garment. It captures the heart rate data and transmits it to a watch containing a heart-rate monitor, which instantly displays the heart rate for the wearer to see.

weak signals **E-health in developing countries**

D-Tree International and BRAC help healthcare volunteers in Tanzania with mobile video tutorials during home visits.
www.d-tree.org
www.brac.net

Our healthcare burden in 2040 looks very different. The issue that the world was slow to react to has been the rapid rise in chronic diseases. Due to widespread sedentary lifestyles and poor dietary habits in the early 21st century, the global chronic disease burden grew massively – particularly in emerging markets. The soaring cost of obesity became so acute by 2019 that public health systems in many countries invested massively to incentivise healthier lifestyles. By 2040, the chronic disease burden has been reduced, but it is still the biggest cost pressure on healthcare systems, and people take prevention very seriously.

Healthcare systems themselves have been revolutionised so that some of the higher costs associated with the rise in chronic diseases have been mitigated through more effective, more efficient care. This includes the much more active role that patients now play in managing their own health. Accounting systems have been modernised so that the costs of a patient's care can be compared with the health outcome achieved, vastly improving the value for money of healthcare delivery. Consumers 'own' their personal health data and they can access it easily via a variety of digital platforms. This has made health information more visible and more shareable,

and has allowed patients and carers to monitor and respond to health conditions more easily.

Governments have also formed more effective partnerships with the private sector in order to ensure appropriate levels of funding for healthcare. Making the political case for long-term investments in preventative care is easier in 2040 as a result of the proliferation of health impact bonds. These have had demonstrable successes in cost savings, including the record-breaking returns on diabetes care investments in many countries as a result of a dramatic decrease in hospitalisations. This has reduced the financial pressure on public health systems, created better incentives for investors and improved health outcomes.

weak signals **'Fat taxes'**

New York City has tackled the US fondness for fizzy drinks with a so-called 'soda tax'. There is also potential for regulation at an EU level by the middle of the decade: experiments have already been conducted with incentives that encourage people to eat more fresh fruit and vegetables. But many policy-makers believe the option of making unhealthy, high-calorie foods more expensive will have a greater impact and is easier to implement and manage.
www.futureagenda.org/pg/cx/view#315

There is also a tougher regulatory policy dimension to healthcare in 2040. Tobacco, for example, is highly taxed and regulated because this is widely recognised as the single most important intervention in reducing non-communicable disease. In most countries, smokers can light up only in their own homes – and pay dearly for doing so, both in terms of cigarette costs and higher healthcare premiums. Other bad habits, such as excessive consumption of high-calorie, unhealthy foods, have also become costly, and consumers see junk food as an occasional indulgence – not a dietary staple.

After the global recession of the early 21st century, and with growing awareness of the importance of health and wellbeing, **many have embraced the opportunity to slow down and enjoy the simpler things in life**. The attitude shift towards a more sustainable, holistic view of life has resulted in more demand for free time and lower levels of consumption. Employers offer flexible working arrangements, allowing people to trade money for time more freely and choose a favoured working style. Employees often choose who to work for on the basis of companies' health and wellbeing policies. The elderly have a host of new solutions on hand to help them live more active, healthier lives than the previous generation.

Hybrid business models have sprung up to suit the new health landscape. There are companies that help you match your grocery shopping basket to your medical profile, and smart clothing that monitors key health information and transmits it to your doctor.

weak signals **Automated care**

McKinsey estimates that the tele-health or m-health industry will be worth over $50 billion by 2020. Firms such as GE, Philips and Siemens are all placing big bets in this area. Some technologies we are likely to see develop are the wearing of monitoring equipment, in-home sensors to track vital signs, and remote dispensing and monitoring of drugs. In 2009, for example, iRobot launched its prototype robotic telepresence nurse. Might we see a slow-down in the growth of nursing homes as a greater share of the elderly choose to live at home longer, assisted by remote care services?
www.futureagenda.org/pg/cx/view#312

Pharmaceutical companies have developed **tiered pricing models to make their products more accessible for lower-income communities**. Crowdsourcing approaches to health solutions in many places allow multiple audiences – from universities to patient groups to hospitals – to analyse health issues and respond to them. Robotic-assisted care and remote monitoring provide economically viable support for the chronically ill and elderly so that they can stay at home longer, resulting not only in happier patients but also lower hospital costs.

Investor guidance: health and wellbeing

Invest in...

- Healthcare products/services that are designed to improve access for the most disadvantaged people (eg pharmaceutical companies developing different pricing models to assist lower-income households in emerging markets, and micro-health insurance that extends healthcare access among the poor[203]).
- Water and sanitation infrastructure in the developing world.
- Hybrid business models for healthcare delivery in developing-world markets (eg leveraging social enterprise and civil society as critical sources of learning and inspiration, alongside the mainstream healthcare sector).
- Approaches that improve healthcare distribution channels (eg cold storage solutions for certain types of medicines, mobile and tele-health solutions).
- Information solutions for coordinated, more efficient care. Companies that strengthen healthcare information, technology and scientific capacity in developing countries.
- Emerging approaches to identifying infectious diseases at the earliest opportunity, in order to help prevent or restrict epidemics.
- Insurance products that provide financial rewards for health-enhancing behaviour (eg cycling to work and healthy eating).
- Insurance business models that raise funds and pool them to safeguard access to healthcare and spread financial risks.[204]
- Products/services that empower people to monitor and regulate their own health (eg online fitness coaching; portable devices that measure essential health indicators and services such as patientslikeme.com that enable consumers to learn from and educate each other through peer-to-peer networks).
- 'E-health' initiatives that help people to access information, manage their own health conditions and overcome the problem of limited access to healthcare workers (eg mobile phone applications that track health indicators and allow the sharing of data between patients and their doctors).
- Companies investing in understanding and serving older consumer groups (70% of disposable wealth globally is controlled by the over-50s[205]).
- Tools that safely assist weight loss.
- Improved, lower-cost business models for diabetes care.
- Sources of cost-effective medicines and services that can challenge the dominance of global healthcare players.[206]
- New diagnostic devices.

Develop new business models to...

- Invest in expanding access to healthcare and levels of insurance cover for the most disadvantaged people.
- Invest in increasing access to low-cost, fortified foods.
- Reward positive health behaviour (eg social impact bonds).

Avoid all investment in...

- Tobacco.
- Companies that misrepresent the nutritional profile of their products in a way that can have serious adverse effects on health and nutrition.

Limit support for...

- Manufacturers and retailers of unhealthy, high-calorie foods.
- Alcohol.

Energy in 2040

Energy systems in every corner of the world are radically different from how they were just a quarter of a century ago. The greatest changes in the energy mix have happened in the US, Europe, Japan and Australia, while many emerging economies focused more on meeting growing demand and lifting billions out of poverty.

In 2040, there are as many companies producing power as there are growing food. Neighbourhood energy companies have sprung up on every continent to supply heat and power, interconnected via new local and regional 'smart' grids that carry power to where it is needed.

weak signals **Will kitchens become the new gas stations?**

Up to half of the food produced for the US market goes to waste. Californian start-up E-Fuel has launched the MicroFusion Reactor to convert organic kitchen waste, waste wood and paper into sugar water within just two minutes. The sugar water can be distilled into home-made ethanol for fuel by the MicroFueler. The whole process is combustion-free, using semiconductor technology.

Individual devices, from electric vehicles to heat pumps, communicate via the internet to charge up and switch on when demand for power is lowest. Data on the use of power by a wide range of devices is relayed to companies to help them remotely update their products so that less energy is used. Open markets across the world's great regions allow for real-time energy trading over long distances by households and energy companies, big and small.

Global demand for energy has risen at 0.7% a year since 2010 because of to the economic growth of China, India and Brazil.[207] **But carbon emissions have still been cut**. This has been achieved primarily through increased energy efficiency (particularly in the design of buildings and vehicles) and a significant switch to low-carbon power sources. Total energy-related greenhouse gas emissions reached a high of 32 billion tonnes in 2019.[208] This heralded the 'peak decade' of the 2020s, after which the use of oil, gas and coal has fallen steeply.

weak signals **Glowing prospects**

Orb Solar is a Bangalore-based company that aims to make solar energy affordable and accessible, by combining installation and post-sale support with help in securing low-interest loans. A switch from diesel can save a company 470,000 rupees ($10,000) over 10 years. Orb Solar has 40 branches in Karnataka alone, and further franchises across India. Its success shows that India has a sustainable energy path to follow.

A strong global agreement for carbon cuts in the 2010s, accepted at the time as the only way to protect human development, led to a high price being levied for carbon emissions via an international cap-and-trade scheme. This scheme was agreed by the then developed economies in 2014.

weak signals **A flood of community energy**

Spurred into action by flash summer floods of the river Thames, West Oxford Community Renewables (WOCR) is a community-owned and -run company in the UK that offers a possible glimpse of the future of energy services. WOCR installs renewables and donates part of its profits to the Low Carbon West Oxford charity, which works with the community to save even more carbon. Local people have invested by buying shares in WOCR, and they aim to cut emissions in the neighbourhood by 80% by 2050.

Including the cost of carbon in power prices and deriving power from low-carbon sources initially resulted in a large increase in the cost of power. In order to enable equitable affordability and reduce fuel poverty in this context, governments moved away from the current pricing system of electricity becoming cheaper with higher levels of use, to the opposite: **a subsidised minimum band of power use that gets more expensive with more electricity consumption**. This was critical in ensuring broad access to affordable power. And higher power prices, in turn, made many other energy efficiency measures more economically viable.

Simultaneously, **a reformed Clean Development Mechanism and centralised international low-carbon public-private investment funds** channelled investment into decarbonising developing economies. At the same time, international agreements meant that subsidies for fossil fuels were superseded by those for renewables by 2017, dwindling away in most states soon after. As predicted, these capital shifts caused the oil price to peak in the 2020s. This choked off investment in the exploration

and exploitation of known reserves of harder-to-extract energy sources such as tar sands and oil shales.[209]

Nuclear supplies 6% and renewables 32% of the world's energy demand, and carbon-intensive energy generation is mitigated through carbon capture and storage (CCS). Given the abundance and visibility of renewable energy sources such as wind and solar installations, it still surprises some that fossil fuels provide more energy than renewables. However, it will only be a few years until the world can celebrate the day that renewables overtake fossil sources. To cope with the challenges of intermittent wind, waves and sunshine, there has been a great deal of investment in the development and deployment of energy storage and load balancing. Back-up capacity is provided by super-efficient gas turbines with CCS built in.[210]

weak signals **Walking on sunshine**

The days of slapping a brace of photovoltaic (PV) panels on our roofs as an afterthought will soon be gone. Onyx Solar and Butech, two Spanish companies, have teamed up to design a concept PV floor tile for terraced rooftops and other public spaces. The tile can easily withstand the weight of pedestrians and furniture, enabling architects to combine energy generation with recreational space.

Historians see concerns about energy security as having been the key driver for heavy investment in the energy sector by richer countries in the troubled early decades of the 21st century. Thanks to a reduction in 'energy miles', the diversification of sources and significant investment in smart grids, in 2040 we now have a reliable and secure energy supply.

The cultural and political changes that these new technology platforms have enabled took some by surprise. Countries rich in wind, marine and solar energy joined established political blocs to share resources and feed electricity into smart grids via new cable networks. This is illustrated by the emergence of strong ties between northern African states and the EU, in the new EU-NA bloc, and the supply of concentrated solar-generated electricity from the Sahara to Europe. This has required a three fold increase in transmission capacity in Europe,[211] and the story is similar elsewhere.

This energy revolution helped to democratise North African states through the ownership of solar infrastructure by local employee-run companies. This was a deliberate development strategy by the EU to stabilise the region and reduce energy imports. The EU-NA bloc is the global leader in energy efficiency, smart grids, storage and renewable energy. It derives 74% of its energy needs from renewable sources, with a target of 95% by 2050 within reach.[212] This investment came at a cost of 2% of GDP between 2015 and 2035, because of the capital investment required, but fuel savings are now paying off. Net savings are predicted to reach 3% of GDP by 2050.[213]

weak signals **The energy-aware clock**

When a group of Swedish designers looked into the failure of some energy monitors to cut householders' energy use, they deduced that – with all their figures and graphs – they are just too complicated. So they came up with the simple, stylish Energy Aware Clock that uses attractive patterns to convey real-time consumption levels.

In many regions of the world, **people have acted together locally to take ownership of their energy supply** by investing in capital projects, supported by government subsidies. In many countries local energy companies are a key political institution, with high levels of local control and ownership. This has redistributed economic wealth, reducing poverty and spreading political power more evenly. People feel that energy is one of their key connections with the rest of society, locally and globally. The profound impact of the energy grid on culture and society has been similar to that of the internet and social networking early in the century.

In 2028, universal access to electricity and 'clean' cooking was secured, an achievement that played a significant role in eradicating poverty and served to reduce premature deaths and respiratory disease. The shift to clean cooking has also been significant for conserving natural resources and biodiversity, as biomass is no longer used for cooking. All this progress is thanks to a $36-billion-a-year investment programme that was put in place by the developed countries in the 2010s and 2020s. With electricity came access to technology and information, and now the whole world feels 'online'. International

relationships are stronger too. While nations still exist, disputes and conflicts are much rarer. Universal access to electricity and global online connectedness have helped to make people feel closer to one another.

The big energy companies that have thrived in this changing world realised decades ago that their customers wanted the services that energy provides rather than energy as a product. **Now long-term service agreements drive large-scale improvements** in the efficiency of buildings, and energy bills from the 2010s are a curious reminder of the old business models.

Buildings now use 40% less energy than they did 30 years ago.[214] This transition has created an extra 100 million jobs in energy efficiency programmes,[215] with 2.5% of buildings retrofitted a year since 2010. New buildings in many regions are built to near zero-energy demand standards.[216] Floor space has increased by 33% since 2010, but the total energy demand is slightly lower. Most homes are now heated and cooled by solar and geothermal technologies. That is if they require heating at all, as most new buildings require only heat recovery and passive solar gain.

The demise of heating fuels has halved the potential rise in atmospheric pollutants responsible for health problems and environmental acidification.[217] This threat to health and economic activity was a major reason for China's decision to shift to a light industrial and service economy, with greater pollution restrictions on heavy industry. Heavy users of energy in industry, such as metal and cement recyclers, are now largely electrified or fitted with CCS driven by a global sectoral agreement. Radical innovation in building materials and flexible architecture mean that buildings are rarely demolished.

Pension funds have provided most of the capital investment for the energy transition. They were persuaded to invest by long-term carbon targets, strong carbon pricing, international cooperation, energy market reform and geopolitical stability. The Indian Government and banks led the innovation of climate bonds to transfer investment into the low-carbon transition, with $1 trillion in bond sales reached by 2014. Since then, the world has spent a total of $250 trillion on its energy systems, mostly in demand-side technologies such as vehicles and manufacturing equipment. Around $35 trillion of this has been spent on the transformation to a low-carbon energy supply.[218] This additional investment is now paying off, with $90 trillion of cost savings and a reduction in health problems associated with pollution and pressure on ecosystems. Much of this investment has transferred wealth to the new economies, leading to a substantial redistribution of wealth.

Many thought that 'decarbonising' the energy system was critical to preventing dangerous climate change this century. They were certainly right, but hindsight also shows that the radical shift has lifted billions out of poverty, protected biodiversity, improved people's health and strengthened international relations. In addition, it has enabled many people to enjoy a more sustainable way of life.

weak signals **Soil-cleansing biofuel**

A variety of fast-growing giant Napier grass is being used increasingly to produce ethanol for transport, and can also be combusted for electricity. This particular innovation hails from China, and its next port of call is Nigeria. In Guangdong Province, giant Napier grass already generates electricity for 100 households. Field research shows it can also be used for phytoremediation, which is the use of plants to extract particular minerals and metals from contaminated soils selectively, using their roots. By continually planting and harvesting these crops, you can lower the level of toxicity in the soil and make the land fit for human uses again.
www.edie.net/news/news_story.asp?src=nl&id=18941

Investor guidance: energy sector

Invest in...

Combined heat and power networks.
Carbon capture and storage (CCS) for power, cement, iron, steel and chemical plants, as well as other carbon-intensive industries.
Concentrated solar power.
Regional grid transmission.
Marine electricity cabling for marine and offshore wind connections.
Building smart grids.
Energy efficiency deployment in vehicles and buildings.
Research into and development of energy storage technologies.
Energy efficiency improvements in the iron and steel, cement and chemicals sectors, as well as other carbon-intensive industries.
Technologies that generate green jobs (eg energy efficiency).
The rapid scaling up of all forms of renewable power, starting with the most cost-effective.
New geothermal and marine technologies.

Develop new business models to...

Deliver decentralised electricity and heat generation.
Provide load balancing and smart grids.
Reward behaviour change that reduces energy demand.
Spread the risk in supporting the development of new technologies.
Supply energy as a service rather than a commodity.
Provide electricity access in rural areas of developing countries.
Enable local ownership of energy companies.
Provide an efficient market place for energy.

Avoid all investment in...

Oil shales and tar sands exploitation.
Infrastructure projects that reinforce non-smart energy networks.

Limit support for...

Deep-sea drilling for oil and gas.
Prospecting for and exploitation of new fossil-energy reserves.

Mobility in 2040

In 2040, a new mobility paradigm has emerged. People choose mobility options that are smarter, healthier and more social. This has been driven by a combination of increasing living costs, growing awareness of the environmental impacts of transport, and changing social values.

weak signals **MIT CityCar System**

A stackable, electric two-seater car designed to be used as part of a mobility on-demand system – similar to a bike-hire scheme such as Vélib, where stacks of vehicles are available for instant short-term hire at key transport hubs such as train stations and multiple other points around the city. Three or four CityCars can fit in a standard parking space. Future iterations could be integrated with the urban energy supply system – stacks of parked cars act as batteries that could 'smooth' electricity demand in a city with lots of microgeneration such as solar roofs or small-scale wind turbines.
http://cities.media.mit.edu
(select Mobility)

Behaviours that were once widespread, such as suburban living/long-distance commuting and SUV ownership, are now fringe. In their place is a **network composed of many different modes of transport, driven by user needs and connected through sophisticated IT**. Despite what the sceptics expected, developing-world markets did not follow the carbon-hungry path in transport systems that characterised industrial growth in the rich world in the 20th century. Instead, many have embraced more sustainable mobility paradigms.

Two out of three of the world's people live in cities.[219] Urban areas have become more population-dense and are increasingly centred around localised neighbourhood hubs, where people can be closer to work and play. Cities have led the way in the new mobility revolution, competing to provide the best quality of life and attract top talent to the local economy. The top cities of the world distinguish themselves on this parameter among others. They tend to connect directly to the global economy, rather than being defined by the wealth of their own host country.

New business models have emerged to cater for new urban lifestyles. Walking and cycling are considered smart, healthy alternatives and are extremely popular. Businesses support this through a variety of carrots and sticks. Most employers offer incentives *not* to travel to the office every day, encouraging people to work from a local office hub or from home. Cycling routinely earns you discounts on a range of things – from health insurance to transport to retail products.

weak signals **Country-wide wireless internet access**

Often described as 'Wi-Fi on steroids', WiMAX (Worldwide Interoperability for Microwave Access) will cover entire countries with a vibrant, high-speed wireless communications network. Internet access and other data and video applications will be available anywhere, with many applications for vehicles.
www.wfs.org/forecasts

A new mobility infrastructure provides access to a range of vehicles when and where they're needed. Car ownership has levelled off, while lift sharing, part-ownership and on-demand rentals are much more popular. Lighter, smaller vehicles – single-seat cars, scooters and cycles – are in demand because they make local travel in cities convenient, efficient and fun. Most of these modes of transport within cities are now electric.

Road lanes and cycle paths are seamlessly integrated with public transport hubs. Efficient, low-cost public transport infrastructure provides for the majority of daily journeys, making mobility accessible and affordable around the world. Governments now prioritise public transport investment – such as ultra-high-speed rail – over building road infrastructure.

weak signals **Peer-to-peer car rental**

Whip Car is the world's first peer-to-peer car rental service. Car owners can rent out their own cars when they aren't using them. Users can search for and hire cars in their neighbourhoods. This is a distributed and flexible system that uses existing cars, mediated by a trusted website with a ratings system, and requires no additional physical infrastructure.
www.whipcar.com

The average greenhouse gas intensity of new cars has been reduced by more than 50%.[220] More than 70% of global passenger-car sales are hybrids, plug-in hybrids or electric vehicles.[221] Sustainable biofuels meet 30% of global transport fuel needs,[222] although this is strictly limited to advanced and second-generation biofuels that do not encroach on food production. Renewable, low-carbon energy meets more than 50% of global energy demand, reducing emissions from the transport sector in areas such as vehicle manufacture as well as in fuel consumption.[223] The incentives for uptake of more sustainable options in the transport sector are strong, since transport pricing fully reflects the costs of environmental damage and the health impact of fossil fuels. The binding global climate change agreement ensures that these benefits are available across worldwide.

Sophisticated IT is readily available in the car, making for ubiquitous connectivity and unprecedented access to real-time information. The use of mobile communication technology allows travellers to smooth out their daily journeys, providing geospatial information about relevant services, congestion points, parking availability and so on. Drivers know instantaneously and exactly where the traffic jams are, so they can simply avoid congested routes.

Between cities, 'intelligent highways' use IT to prevent accidents, minimise congestion and create unprecedented levels of energy efficiency. The aspiration of zero road accidents is beginning to look like a realistic prospect. IT-based services have even reduced travel demand, at least for the bare necessities, as these can now be efficiently delivered to your home while you focus on more important things in life.

Air travel has increased, supported in particular by economic growth in Asia, which accounted for a large chunk of demand growth between 2011 and 2040. However, growth levels have been nothing like as high as initially predicted because ultra-high-speed rail networks – the target of large-scale investment in the early 21st century – are very cost-competitive for short-haul travel as a result of government incentives. Aircraft emissions are down by more than 50%, thanks to advanced biofuels in the fuel mix and changes in aircraft design following technological advances.[224]

Trade remains globalised, with dynamic growth in emerging markets continuing to stimulate demand, so **shipping is still a cornerstone of commercial transport**. The key difference is that clean shipping has become mainstream: emissions in this sector are down by 70%.[225] All ships in operation are 'clean ships', with new power-generation technologies to improve fuel efficiency. Low-sulphur fuels have helped to reduce polluting exhaust emissions, while refuse, sewage and cargo discharges to the sea have been reduced to zero through waste reduction and onboard recycling.[226]

weak signals **The virtually augmented city**

Seoul is running a pilot project called Ubiquitous Seoul, which offers real-time, location-based services from multiple sensors around the city. Residents can use smart phones to check the air quality, get traffic information or reserve sports pitches at local parks. People with asthma can get pollution alerts.
www.time.com/time/nation/article/0,8599,1916302- 1,00.html

Investor guidance: mobility

Invest in...

- Improvements in aspects of conventional vehicles that are already in widespread use (eg engine, transmission and fuel systems and lower-friction tyre design) to increase energy efficiency and reduce CO_2 emissions.
- Expanding electric-grid capacity to support the electrification of transport.
- Battery storage technology (which needs to improve by a factor of 10 to be competitive with power trains associated with the internal combustion engine).
- Infrastructure for recharging electric vehicles in urban areas.
- Commercial-scale development of advanced processes such as biomass-to-liquids and cellulosic ethanol and butanol.
- Public transport infrastructure.
- Ultra-fast rail lines to meet projected demand growth of nearly 90% for rail travel and freight by 2035.[227]
- IT-based networks as an alternative to physical mobility and a means of optimising journeys (eg relevant IT networks such as 'last mile' fibre and mobile wireless network communications).
- Urban planning that prioritises dense city-core development and mixed-use neighbourhoods, ensuring easy access to goods and services for urban dwellers via walking, cycling and low-impact public transport.
- Technologies and businesses that convert combustible waste into transport fuel.
- Recycling of rare earth minerals (to be brought up to a range of 25-75%, comparable with recycling rates of industrial-grade metals such as steel and aluminium, rather than the current 1%).[228]
- Mining of landfill sites for resources.
- Urban vehicle-sharing schemes.
- Initiatives that increase capacity for local sourcing and reduce demand for freight, through the development of shorter, more flexible supply chains (eg urban agriculture/aquaculture).
- Personal rapid-transit systems, which offer a higher degree of personal mobility than today's public transport systems and are more attractive substitutes for the car.
- IT-enabled vehicles (eg cars and buses fitted with automated route planning, vehicle-to-vehicle communication and automated driving).
- The design and development of ultra-small clean-fuel vehicles for cost-effective and climate-friendly personal transport.
- The development of advanced biofuels for aviation.
- The development of more efficient aircraft propulsion systems that reduce aerodynamic drag and could significantly reduce emissions.[229]
- Shipping companies that use new navigation technologies, new fuel-consumption software and advanced materials in order to reduce their environmental impacts.
- The design and construction of 'clean ships' – vessels designed and operated so that they maximise the opportunities for improved energy efficiency and reduced environmental impact.
- Initiatives and approaches that encourage and enable people to make more journeys on foot or by bicycle.
- Reallocation of urban space from private vehicles to public transport, pedestrians and cyclists.
- Initiatives that reduce travel demand (eg IT-based services such as teleconferencing).

Develop new business models to...

- Provide lower insurance costs for 'clean' vehicles – whether automobiles, trucks or ships.

Avoid all investment in...

- Transport options that do not comply with fuel-economy standards advocated by the IEA.
- Shipping companies that don't meet basic transparency standards required by independent verification bodies.

Limit support for...

- First-generation biofuels that compete with staple food production.
- Investment propositions that encourage car dependency.

part 3 - call to action

This section sets out our recommendations on how to make a sustainable economy a reality. It focuses on investors, but there are also messages for companies, governments and civil society.

Investors should actively seek ways to allocate capital to certain activities that will underpin a sustainable economy, and should continue to reassess this in the light of new technologies and new evidence. They should actively seek ways to reduce their investment in activities that are not aligned with a sustainable future. They should explore new business models that enable greater sustainability. They should engage with companies and lobby governments. This section provides more detail in each of these areas.

Actions by investors

The investor guidance in Part 2 stems from combining the top-down framework and the bottom-up sector visions. This can be translated into a set of actions that investors, companies, governments and civil society need to take to drive the transition to a sustainable economy.

In Part 3 of the report we outline the key actions required.

Investors should actively seek ways to allocate capital to certain activities that will underpin a sustainable economy, and should continue to reassess this in the light of new technologies and new evidence. They should actively seek ways to reduce their investment in activities that are not aligned with a sustainable future. They should explore new business models that enable greater sustainability. They should engage with companies and lobby governments. This part provides more detail in each of these areas.

Investors should actively seek the following types of investment...

In the food sector

Businesses that produce low-impact products efficiently – companies that stand to profit as externalities become increasingly factored in (eg water- or carbon-efficient processes and infrastructure; more efficient resource use than competitors; and farms on fertile, well maintained land).
Businesses that are positioned to benefit from a closed-loop system (eg using compost or other recycled materials, rather than virgin materials; mining landfill for resources; and providing technologies for waste recycling such as anaerobic digestion, composting).
Agricultural innovation, particularly when positioned to tackle key sustainability challenges: yield, land availability, carbon, water, nutrition, biodiversity and hunger (eg reducing the carbon intensity of fertiliser; reducing methane emissions from livestock; genetically modified organism (GMO) use, where applied in a way that minimises impacts on natural capital and does not make farmers reliant on supplies outside their control; low-carbon approaches to water desalination or irrigation; and technology that helps farmers to monitor soil conditions).
Agricultural innovation to deal with climate-change adaptation challenges (eg development of crops that are more resilient to climate-change impacts; developing resilient management technologies for livestock waste; and minimising the effects of adaptation strategies on ecosystem services, through strategies that address social inequalities).
Innovative approaches in food manufacturing and distribution (eg reducing the carbon intensity of refrigerants; and minimising the impact of food transportation).
Commercial fortification of foodstuffs and biofortification of staple crops (eg vitamin-A-fortified food for children and folic acid-fortified food for pregnant women). With increasing urbanisation, fortified foods are likely to reach increasing numbers of people at risk of deficiency, at a decreasing marginal cost.
Foods with clinically enhanced properties (eg as probiotics and nutraceuticals).

In health and wellbeing

Healthcare products/services that are designed to improve access for the most disadvantaged people (eg pharmaceutical companies developing different pricing models to assist lower-income households in emerging markets, and micro-health insurance that extends healthcare access among the poor).
Water and sanitation infrastructure.
'E-health' initiatives and other new products/services that help people to access information, manage their own health and overcome the problem of limited access to healthcare (eg mobile phone applications that track health indicators and allow the sharing of data between patients and their doctors; automated-care technology; and services such as patientslikeme.com that enable consumers to learn from and educate each other through peer-to-peer networks).
Sources of cost-effective medicines and healthcare services that can challenge the dominance of global healthcare players.
Emerging approaches to identifying infectious diseases at the earliest opportunity, in order to help prevent or restrict epidemics.
Health insurance products that provide financial rewards for positive behaviour (eg cycling to work and healthy eating).
Tools that safely assist weight loss.

In energy

Combined heat and power networks.
Carbon capture and storage (CCS) for power, cement, iron, steel and chemical plants.
Concentrated solar power.
Smart grids and regional grid transmission.
The rapid scaling up of all forms of renewable power.
Investment in new geothermal and marine technologies.
Energy efficiency improvements to buildings and vehicles, and in the chemicals, cement and iron/steel sectors.

In mobility

Improvements in aspects of conventional vehicles that are already in widespread use (eg engine, transmission and fuel systems and lower-friction tyre design) to increase energy efficiency and reduce CO_2 emissions.
Public transport infrastructure, including the expansion of electric-grid capacity to support the electrification of transport.
Battery storage technology (which needs to improve by a factor of 10 to be competitive with power trains associated with the internal combustion engine).
Infrastructure for recharging electric vehicles in urban areas.
Ultra-fast rail lines to meet projected demand growth of nearly 90% for rail travel and freight by 2035.
Urban vehicle-sharing schemes.
The development of advanced biofuels and more efficient propulsion systems for aviation.
The design and construction of 'clean ships' – vessels designed to maximise the opportunities for improved energy efficiency and reduced environmental impact.
Initiatives that reduce travel demand (eg IT-based services such as teleconferencing) and encourage people to make more journeys on foot or by bicycle.

Investors should actively seek ways to limit support for/ avoid investment in the following activities...

In the food sector

- Food production that breaches human and animal rights standards (eg inadequate wages, dangerous working conditions and intensive factory farming practices).
- Food production or retail practices that risk locking the economy into unsustainable approaches (eg retail that depends on widespread car ownership, and crops that will not grow without carbon-intensive or polluting impacts).
- Technologies deployed in a way that makes farmers more reliant on supplies that are not within their control, such as certain GM seeds.
- Farming that extracts water from water-scarce areas, where local populations have inadequate supplies.

In health and wellbeing

- Tobacco.
- Companies that misrepresent the nutritional profile of their products in a way that can have serious adverse effects on health and nutrition.
- Manufacturers and retailers of unhealthy, high-calorie foods.

In energy

- Deep-sea drilling for oil and gas.
- Oil shales and tar sands exploitation.
- Infrastructure projects that reinforce non-smart energy networks.
- Prospecting for and exploitation of new fossil-energy reserves.

In mobility

- Transport options that do not comply with fuel-economy standards advocated by the IEA.
- First-generation biofuels that compete with staple food crop production.

Investors will need to support and finance new business models that offer the following advantages...

In the food sector

- Provide lower insurance costs for dealing with the impact of climate change on the food system, particularly for poorer farmers and developing countries (eg extreme weather and flooding).
- Provide loans for sustainability improvements among farms, food manufacturers and retailers (eg changing processes or machinery to improve efficiency).
- Provide financial products that make it easier for small producers to prosper (eg microcredit or insurance that is suited to low-income farmers).
- Incentivise behaviour change that reduces energy demand in the food sector (among the general public, farmers and food sector businesses).

In health and wellbeing

- Invest in expanding access to healthcare and levels of insurance cover for the most disadvantaged people.
- Reward positive behaviour, such as cycling to work and healthy eating (eg social impact bonds).
- Invest in increasing access to low-cost, fortified foods.

In energy

- Deliver decentralised electricity and heat generation.
- Provide load balancing and smart grids.
- Supply energy as a service rather than a commodity, while ensuring an efficient energy marketplace.
- Provide electricity access in rural areas of developing countries.

In mobility

- Provide lower insurance costs for ‘clean’ vehicles – whether automobiles, trucks or ships.

Investors will also need to implement internal procedures to...

Link performance appraisal criteria and executive pay to longer-term and more qualitative targets.
Reduce the difference in pay between top executives and the lowest-paid workers from the current multiple of 200 times to a level of 20 times at most.
Enable secondment of skilled individuals to public-sector roles to help identify how to catalyse private-sector investment aligned to the sustainable economy.
Enable and reward research and innovation in areas needed for the transition to a sustainable economy.

Investors will need to attribute value to...

The benefits provided by ecosystems services and biodiversity.
Water resources, particularly where scarce.
The environmental/social risks faced by businesses, and the savings from mitigating these.
The carbon emissions and energy efficiency of business.
The innovation of clean-energy technologies and business models.

Investors will need to provide finance to support research and educational priorities...

Communicate to the public the financial risks associated with sustainability issues.
Green skills development for the workforce in key sectors (eg sustainable farming practices).
Promote the benefits of sustainable choices and technologies in food, health, energy and transport, building consumer support.
Facilitate research into sustainable alternatives (eg alternative engine systems and fuel sources for aviation and road vehicles).
Promote social and cultural change to ensure that girls have unfettered access to health, education and productive assets, particularly in developing countries.

Action by companies

Companies, supported by investors who recognise and value these approaches, should...

Report on their impacts and dependencies with regard to natural and social capital, whether positive or negative. This should include assessments of future risks and opportunities, and should start with mandatory carbon reporting.
Research and develop better ways of valuing natural and social capital, and better metrics to measure long-term business success.
Encourage suppliers to report on their own sustainability impacts, and report on supply-chain impacts.
Communicate much more about their vision, business model, long-term strategy and approach to risk.
Introduce greater diversity at board level and take steps to ensure that non-executive directors are better able to challenge 'business as usual'.
Invest in research and innovation to optimise sustainability performance.
Support the public policy positions that are needed to deliver sustainability.
Consider corporate performance on environmental, social and corporate governance issues when setting the remuneration of executive directors.
Publish corporate sustainability strategies – or explain why they are not able to do so – and put these reports or the associated explanation to the vote at a company's AGM.

Action by governments

Governments, supported by investors who lobby for these interventions, will need to focus on...

New definitions of economic success that take account of natural and social capital.
The introduction of suitable models for risk sharing in investment, particularly early-stage investment.
Stronger mandatory disclosure by pension funds about how they are thinking about the long term.
Strong international carbon mitigation targets and adaptation policies/plans that help poorer countries in particular, with a fair approach to sharing responsibility for action within and between nations.
Policies that deliver a meaningful carbon price, so that the carbon floor price increases to at least £200/tCO_2e by 2050.
Mandatory carbon reporting by companies.
The adoption of a wide range of sector-specific policy proposals set out in the individual sector visions in this report. These include strong international food security policies; better healthcare provision and increased support for family planning in developing countries; international investment funds for developing clean energy with public finance support; and the removal of all tax exemptions and subsidies that promote carbon-intensive transport.

Priorities for action

Creating a sustainable economy will require a fundamental shift in the way that the financial markets allocate capital. Forum for the Future has identified 10 areas as priorities for action by investors, companies and government:

1. Investors should require all companies to report on their long-term strategy and how it makes the business more sustainable. It should demonstrate that they have a plan to address the impacts of future systemic risks, including climate change, water stress, biodiversity, population growth, urbanisation and changing demographics.

2. Companies should report in their accounts the value of natural, human and social capital, so that investors can understand the importance of factors which are often overlooked. This will enable the strategic reporting outlined in (1) above. For example, food manufacturers should report on how they depend on the availability of water and fertile soil, and what they are doing to protect these assets. All companies should report on the value added to the business through effective management and training of staff and support for innovation. And companies should report on how the business depends on, and protects, relationships with customers and local communities. Where these data are not available, companies should set up pilot projects.

3. Financial institutions should demonstrate that the financial products and services they offer to meet the need for liquidity in the market also serve the long-term public good. In particular, they should demonstrate that they do not increase risk and instability in the system. This may require mandatory reporting.

4. Progressive fund managers should develop funds that invest in companies aligned to the vision of a sustainable economy. These funds should be designed to become increasingly resource-efficient and less carbon-intensive over time, as companies shift their business models or the fund moves investment to favour sustainability leaders. The government should offer tax incentives to these funds: this would require a reassignment of existing pension subsidies but no new spending.

5. Pension funds should ensure that all investment mandates require fund managers to take social and environmental issues into account as part of their fiduciary duty. They should set up an independent process to judge how well fund managers do this when making decisions on investments.

6. Companies (within and outside the capital markets) should change their remuneration systems so that they reward staff for performance on activities which build long-term value, such as innovation, efficiency and customer satisfaction, rather than for generating short-term financial returns.

7. Insurance companies should charge higher premiums for activities that create systemic risk by contributing to climate change, the depletion of natural resources, and social instability. This may need government support initially.

8. Financial institutions should develop and scale up financial instruments designed to fund long-term sustainable activities, such as bonds.

9. Government and other public-sector bodies should set up institutions and mechanisms which will catalyse private-sector investment into sustainable activities, where the current risk-reward profile is not attractive or there are particular political, technical or market risks. This will follow the model of the development finance institutions (for investment in the poorest developing countries) and the proposed UK Green Investment Bank (for investment in clean technologies). Additional areas for focus are agriculture, small businesses and forest protection.

10. The public and private sectors should engage in more effective dialogue about how to build a sustainable economy to enable better sharing of perspectives, skills and knowledge. Secondment schemes should be considered.

conclusion

A truly sustainable economy is one in which people can develop their full potential and lead productive, creative lives in accordance with their needs and interests, and within environmental limits. This report offers a broad vision for a sustainable economy in 2040. Through it, we have identified the key characteristics of such an economy; the environmental boundaries and social conditions that we have to respect in order to achieve it; and what that means for some of the most fundamental sectors of the economy – food, energy, mobility and healthcare.

The evidence from detailed research into these key sectors of the economy shows us that, in principle, it is possible to achieve our core vision – a resilient, truly sustainable economy that delivers the best possible quality of life. The vision is based on our current knowledge of the raw materials we have to value and manage: a given set of natural resources, some renewable and some not; a growing – but gradually stabilising – population; a known set of technologies that can be scaled up, improved and deployed; and human ingenuity. With these, we can paint a compelling picture of a sustainable world.

In practice, of course, we will only achieve the vision outlined if we make some fundamental and urgent changes. We need to change the way we buy and use things, how we value those things that we have tended to take for granted, and how we view our own rights and responsibilities.

Perhaps few of us really have an appetite for change. For many people, the world of 2011 may feel like a comfortable place. We are more and more conscious of environmental degradation and poverty, but we do not necessarily experience it first hand. We take comfort from the fact that in the past we have often found ways to address social and environmental challenges before they have become disastrous or irreversible.

This research shows, however, that we are already overstepping many key environmental boundaries. By doing so, we risk moving into dangerous and uncharted territory. In the very near future, we will have to recognise that significant shifts are needed to stay within the environmental and social boundaries we have outlined in a world of nine billion people and diminishing resources.

The fundamental change in approach that is needed will only come about if we acknowledge the need to follow a different pathway and take deliberate steps to make it happen. This is the first challenge.

Suppose we do accept that significant change is necessary. The next challenge is to avoid being overwhelmed with the enormity of the task. The vision outlined in this report can help us to visualise where we need to get to, and to take practical steps to make the vision a reality.

Our sector visions show that there can be a future in 2040 where food, healthcare, energy and mobility are accessible to all, within environmental limits. But none of this will be possible unless capital is increasingly allocated to activities aligned with a sustainable economy, and drawn away from unsustainable ones. This is the third challenge.

In this context, the way in which financial markets operate over the next 30 years will be a key factor in the progress we can make towards a sustainable economy. Many changes are needed. Some of these will rely on public policy interventions to address market failures. Others are more structural and will depend on actions by financial institutions themselves. But investors will need to actively seek investments aligned with a sustainable future, and lobby for government intervention where there are barriers.

This report is a call to action for investors to provide focused support to key sectors – as well as with investments more broadly – in order to help deliver a sustainable future.

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appendix

Stakeholder consultations

Special thanks to the following people who generously gave their time and expertise in the course of this project through interviews and workshops:

Individuals interviewed on the Sustainable Economy Framework and the 2040 sector visions:

Jason Anderson, Head, EU Climate & Energy Policy, WWF
Dr Yvonne Deng, Consultant, Energy & Climate Strategy, Ecofys UK
Tony Greenham, Head of Finance and Business, the new economics foundation
Aled Jones, Deputy Director, Cambridge Programme for Sustainability Leadership
Tom Macmillan, Executive Director, Food Ethics Council
Kavita Prakash-Mani, Head of Food Security Agenda, Syngenta
Nick Robins, Head, Climate Change Centre of Excellence, HSBC
Allen White, Vice President, Tellus Institute

Participants in a Workshop on the Sustainable Economy Framework, hosted by the Technology Strategy Board:

Sebastian Conran, Managing Director, Sebastian Conran Associates
Tom Crompton, Change Strategist, WWF
Ern Edmonds, Executive Vice President, SBU Molecular Solutions
Jack Frost, Director, Johnson Matthey Fuel Cells
Peter Harrison, CEO, Air Fuel Synthesis
Thomas Hind, Head of Economics and International Affairs, National Farmers' Union
Tim Jenkins, Head of Sustainable Economy Team, Sustainable Development Commission
Peter Lacy, Managing Director, Sustainability Services, Accenture
Richard Miller, Head of Sustainability, Technology Strategy Board
Jules Peck, Partner, Abundancy Partners
David Pencheon, Director, National Health Service Sustainable Development Unit
Mike Pitts, Sustainability Leader, Chemistry Innovation KTN
Simon Roberts, Associate Director, Arup
Anne Weir, Director, Pelagos Partnership
Beccy Willis, Vice Chair, Sustainable Development Commission

what would a sustainable global economy look like?
how can capital markets help create that sustainable economy?

Sustainable Economy in 2040: A Roadmap for Capital Markets is a report by Forum for the Future funded by Aviva Investors. It shows investors how they can help create a resilient, stable and sustainable economy by investing wisely and using their power to shape the development of capital markets.

Most guidance on sustainable investment focuses on how to make business as usual better, without looking at the bigger picture. Our recommendations are based on an assessment of the fundamental reallocation of capital required to achieve a sustainable economy. We believe this is the first time such an approach has been taken to sustainable investment.

Forum for the Future has created a tool which defines the characteristics of a sustainable economy that operates within safe environmental limits and enriches people's lives. Our Framework for a Sustainable Economy captures a comprehensive range of environmental boundaries and social conditions which a sustainable economy must respect. It can be applied to any sector or business and investors can use it as a pragmatic guide to analyse the long-term sustainability of their investments.

The report offers investors specific, practical guidance in five key sectors which are fundamental to a sustainable future: food; health and wellbeing; energy; mobility; and finance. It identifies critical areas in each where the scale, pace or nature of growth needs to change, and it presents a 'roadmap' giving detailed guidance on where to invest to support the development of a sustainable economy. We have based this on a 'vision' of where these sectors need to be in 30 years in order to be truly sustainable.

Visit www.forumforthefuture.org/project/vision-sustainable-economy/overview to find out more and download this report or the executive summary.

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Enquiries: 020 7324 3624
Email: info@forumforthefuture.org

Registered Office:
Forum for the Future
Overseas House
19-23 Ironmonger Row
London EC1V 3QN
United Kingdom

Registered charity number: 1040519
Company limited by guarantee: 2959712