WORLD GREEN ECONOMY ORGANIZATION

2018 World Green Economy Report

Inspiring innovations in business, finance and policy

UNIVERSITY OF CAMBRIDGE
INSTITUTE FOR SUSTAINABILITY LEADERSHIP

UNDP
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Resilient nations.

The World Green Economy Organization

The World Green Economy Organization (WGEO) is a global platform aimed at promoting green economy in the context of sustainable development and poverty eradication. It supports the widespread acceptance and increased importance of the green economy by linking financing, technology, capacity-building and all other elements of the enabling environment for green economy through multi-stakeholder engagement.

Serving as a platform for international cooperation and knowledge-sharing between developed and developing countries, the public and the private sectors, international organisations and other key stakeholders, WGEO aims to advance implementation of green economy policies that drive sustained, inclusive and equitable economic growth and job creation, particularly for women, youth and the poor.

To reach its vision of a thriving global green economy which is low-carbon, climate-resilient, resource-efficient and socially inclusive, WGEO drives green economy transitions through coalitions, unlocking investments and scaling up innovations in energy, infrastructure and water.

The University of Cambridge Institute for Sustainability Leadership

For 800 years, the University of Cambridge has fostered leadership, ideas and innovations that have benefited and transformed societies.
The University now has a critical role to play to help the world respond to a singular challenge: how to provide for as many as nine billion people by 2050 within a finite envelope of land, water and natural resources, whilst adapting to a warmer,
less predictable climate.

The University of Cambridge Institute for Sustainability Leadership (CISL) empowers business and policy leaders to make the necessary adjustments to their organisations, industries and economic systems in light of this challenge. By bringing together multidisciplinary researchers with influential business and policy practitioners across the globe, we foster an exchange of ideas across traditional boundaries to generate new solutions-oriented thinking.

Rewiring the Economy

Rewiring the Economy is our ten-year plan to lay the foundations for a sustainable economy, built on ten interdependent tasks, delivered by business, government, and finance leaders co-operatively over the next decade.

Advisory Panel

The authors are very grateful to the following advisors who formed an important panel to inform, steer and guide the key messages and case studies throughout the report:

- Mike Barry, Director of Sustainable Business, Marks and Spencer and a Senior Associate of CISL
- Tom Burke, CBE, Chairman and Co-founder of E3G, Third Generation Environmentalism and a Senior Associate of CISL
- Paul Turner, formerly Sustainable Business Director, Lloyds Banking Group and a Senior Associate of CISL
- Anton Cartwright, Researcher at the African Centre for Cities and a Senior Associate of CISL
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Foreword

WORLD GREEN ECONOMY ORGANIZATION

Shifting towards a greener economy provides greater opportunities for governments, investors and businesses at the same time addresses environmental sustainability and economic growth challenges.

It is our pleasure to share with you our inaugural World Green Economy Report – inspiring innovations in business, finance and policy, showcasing best practices and innovative solutions that provide a practical and flexible approach for achieving concrete, measurable progress across economic and environmental pillars of sustainable development.

The report offers clear ideas on benefits and risks of the gradual transition towards a green economy model, ensuring that natural assets can deliver their full economic potential on a sustainable basis. The report outlines real inspiring examples of how innovations in business, finance and policy can be systematically applied in the real economy.

The World Green Economy Organization (WGEO) was established as a response to the priorities and concerns identified in the field of green economy during the Rio20+ World Summit on Sustainable Development that provided a historical platform for the establishment of an international entity aimed to promote the widespread and increased adoption of green economy in the context of sustainable development and poverty eradication, and to serve as a platform for international cooperation and knowledge-sharing between developed and developing countries.

Addressed to the global decision-makers and green economy practitioners who drive the changes at the global, national and local levels, the report highlights opportunities for flowing long-term investments in innovative businesses and infrastructure, methods of creating market op portunities for private investments and facilitating the transition of economies and societies to sustainable development and greener growth.

We believe the report will enthuse policy makers, leadership of financial institutions and businesses to consider wider range of tools and opportunities in their innovative development efforts, and will encourage them to pursue green investment and innovation, thus fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.

Saeed Mohammed Al Tayer
WGEO Chairman

Foreword

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This report is about transition – in this case the transition to a green economy.

As someone who has watched the economy gradually bend in this direction over the last decade, I find the present moment quite exciting. What was once a make-believe aspiration of environmentalists has become a full-blown commercial phenomenon. Of course some companies, in some places, are less attentive to the undercurrents shaping the economy, placing themselves at strategic risk. However, a critical mass of others, from multinationals to microenterprises, is already well-progressed with the transition, literally remaking the global energy, food, transport and manufacturing systems. Where commercial opportunities are falling into alignment with policy objectives the transition is proceeding even more rapidly, as evidenced by the energy transition in China for example.

At CISL we have had the privilege to work with many companies at the leading edge of sustainability for over thirty years. We have also worked with companies which are less-developed in their thinking, but have recognised that the transition is real and want to understand where it is leading. How will a trust deficit with society combine with fintech to transform financial services? How will political decisions to phase out internal combustion engines impact the transport and energy industries, and the wellbeing of people? How will global agricultural value chains fare in a world of increasing land pressure, volatile weather and insecurity?

Finding our way to a green economy will not be easy or straightforward. New skills and relationships will be required, including with government and civil society, and new technologies will need to be managed, some of them disruptive. Yet the opportunity to serve companies which deliver profound benefits to people and the environment as a function of their core – and thriving – businesses will provide a compelling motivation for many.

This report is brimming with examples of how this is happening right across the world, from blockchain technologies enabling more transparent food supply chains to climate and resource-efficient funds, showing that a green economy is not just achievable in principle, but that it is happening in the here and now.

I commend this report to you as a reminder that the successful companies of the future will be using the prospect of a green economy to gauge how their markets will shift in response to changing commercial and public expectations of value. The transition is picking up pace. Whether you work in business, finance, government or civil society, let's make the most of this amazing opportunity that has been years in the making but is now, thankfully, a reality.

Dr Jake Reynolds
Executive Director, Sustainable Economy

Foreword

The world is going through a tremendous period of change.

This is defined by growing levels of inequality, more complex and protracted crises, and a rapid decline in the planet's ecological carrying capacity. The passage of the 2030 Agenda for Sustainable Development, the Sustainable Development Goals (SDGs), and the Paris Agreement on climate change marked a crucial moment, demonstrating a new global consensus that sustainable development needs to be anchored in green solutions if these challenges are to be overcome.

As countries move forward on this agenda, partnerships are emerging to generate new pathways for a green economy. As elaborated in this report, far from a thing of the future, the shift to a green economy is happening now. The combined market capitalization of green economy sectors - renewable energy, energy conservation, clean water provision, sustainable forestry and fisheries, plastic and solid waste recycling, green infrastructure, and sustainable cities – has now emerged as one of the largest economic sectors globally, larger than many of the traditional growth sectors that have come to shape the world economy over past decades. The green economy is the way of the future, as a new source of high-tech, added-value growth, and job creation in countries around the world. But as we look to 2030, challenges remain.

First, most of today's expansion of the green economy market is concentrated in a relatively small number of developed and emerging economies. Thus, a major challenge is to ensure that the green transition benefits all countries. This can be achieved, for example, by enhancing south-south cooperation and promoting the exchange of green growth models and solutions that can bring dividends across the SDGs, for both poverty reduction and the environment.

Second, while the unprecedented expansion of green markets is a very positive development, the fact remains that the trends of climate change, water scarcity, toxic pollution, land degradation, and biodiversity loss are outpacing current responses. The green economy transition, therefore, needs to be urgently accelerated. This entails scaling-up partnerships with the private sector, mobilizing innovative forms of green finance, and engaging the catalytic role of public policy to remove barriers for greater levels of trade and investment in environmental goods and services.

At last, but not least, we must ensure that emerging green economy solutions are geared to benefit the poor and the vulnerable in order to leave no one behind. To this end, due attention should be given, for example, to green solutions that build the resilience of the rural economy, or to opening opportunities for small and medium-sized enterprises to participate in the global green economy.

It also means mobilizing green technology, finance, and investments to expand clean energy and water solutions, waste recycling, ecosystem restoration, and green infrastructure in communities affected by conflict or disaster as a means of helping communities build back better from crisis.

The World Green Economy Organization (WGEO) has a role to address these and other priorities on the road to 2030 as a global platform to accelerate innovation and mobilize the private sector, and as a bridge for knowledge sharing and south-south cooperation. UNDP is pleased to be a partner to WGEO and the United Arab Emirates. As a hub for private sector investment and innovation, UAE is well positioned to help catalyze progress towards 2030, building on its role as one of the world's leading providers of development and humanitarian assistance, and the vision for Dubai to emerge as a global capital of the green economy.

UNDP is fully committed to supporting countries as they transition to a sustainable and inclusive development path, in line with the 2030 Agenda and the Paris Agreement. We look forward to collaborating with the WGEO in these efforts, and in ensuring that the global transition to a green economy benefits the most poor and vulnerable in society and leaves no one behind.

Achim Steiner
UNDP Administrator

Executive summary

This report was commissioned by the World Green Economy Organization to advance the sustainability agenda. It aims to illustrate the diversity and depth of innovation that is already underway towards a green economy and to highlight opportunities and priorities for action.

Shifting to a green economy will require more than marginal improvements to the innovations that underpin our economy – including technologies; products, service and business models; management practices; collaborative initiatives; and, rules and regulations. The report focuses on select best practices and innovative solutions in business, finance and policy.

Here, you will find examples to inform and inspire CEOs, investment and government leaders:

For Business

- Management practices and corporate governance
- Energy generation and demand
- Circular Economy
- Food, agriculture and rural land use

For Finance

- Green Products and services
- Management Practices
- Market-shaping initiatives

For Policy

- Carbon Pricing
- Combinational policies at city and country levels
- Collaborative initiatives

The report defines a 'green economy' as an "economic system that is low carbon, climate-resilient, resource-efficient and socially-inclusive". As such, a green economy helps address today's pressing priorities while giving direction for tomorrow's success.

From central bankers to defence analysts, there is agreement that a deteriorating climate and natural environment threatens our security and prosperity. At the same time, businesses can grow revenues, reduce costs and risk; countries and cities can develop jobs now in the industries of the future. Those who fail to act now are likely to miss out.

The extent and urgency of the challenges we face on the path toward a "green economy" are profound. The Paris Climate Agreement and the Sustainable Development Goals illustrate that the transition will require transformations that reshape our systems of production, distribution and consumption. Inevitably, the shift to a green economy will create winners and losers across specific regions, sectors and organisations. These so-called "losers" will need support throughout this transition.

But it is also wrong to think of this transition as a zero sum game with only trade-offs, for instance between production versus pollution, short-term versus long-term growth, regulation versus innovation, employment versus automation. There are many reinforcing synergies from aligned action. A stable policy environment reduces innovation risk. Patient, smart capital supports a reinforcing nexus of technologies, skills, suppliers and customers. Growing businesses help countries thrive by providing jobs and contributing to public expenditures through the taxes they pay.

Leaders across these sectors will continue to be instrumental in shaping the green economy, and this report identifies a number of actions they can take now:

Actions to be taken by leaders in:

Business

- Align organisational purpose, strategy and business models.
- Set evidence-based targets, measure and be transparent.
- Embed in operational practices and decisions.
- Engage, collaborate and advocate change.

Finance

- Ensure capital acts for the long term.
- Price capital according to the true costs of business activities.
- Innovate financial structures to better serve sustainable business.

Government

- Measure the right things, set the right targets.
- Use fiscal policy to correct externalities.
- Drive socially useful innovation.

It is possible to accelerate to a green economy where people thrive and businesses succeed: where today's pressing priorities for jobs, development and growth are secured and the most severe threats of climate change, resource shortages or ecosystem collapse averted.

It is time to act.

Contents

Part 1

Introduction

1.1 Purpose of this report

This report was commissioned by the World Green Economy Organization (WGEO) to advance the sustainability agenda. It showcases examples of best practices and innovative solutions.

The sheer volume of material emerging in this space means that no single report can hope to be comprehensive. Instead, this report tries to illustrate the diversity and depth of innovation underway around the world. By showcasing examples of these innovations we hope to demonstrate that a transition to a green economy is already well underway, but that more needs to be done if we are to meet the global challenges that we face.

This report argues that a transition to a green economy is essential if we are to address today's pressing priorities for jobs, development and sustainable growth. In this report we define a green economy as an economic system that is low carbon, climate-resilient, resource-efficient and socially-inclusive. We believe that it is the only viable way of delivering an economy in which people can thrive and businesses succeed, while respecting ecological limits. The hope is that the report provides a clear direction for a way forward so that we can take action and deliver change.

In this report you will find examples to inform and inspire you.

- For CEOs, this report is a window on coming market disruptions. The green economy cannot be ignored any more than Ford can ignore Tesla.
- For those in the finance sector, this report highlights new products and tools in a world that remains open for business.
- For policymakers, this report shows how policy leadership can kick-start and guide investments in the innovation, infrastructure and, skills needed to transition to a green economy.

The evidence is clear: acting for a green economy drives synergies that pay off. The innovations in business, the investments from finance and the policies from government reinforce each other. A stable policy environment reduces innovation risk. Patient capital supports a reinforcing nexus of technologies, skills, suppliers and customers. Growing businesses help countries thrive by providing jobs and contributing to public expenditures through the taxes they pay. A green economy enables the innovation, diversity and creativity you need to be competitive in the twenty first century. A century that will be defined by how we respond to climate change and deliver prosperity for a global population that is projected to reach 9.8 billion by 2050[1].

We can wait for others – or we can show leadership and take action now. The synergies mentioned above will not be delivered by waiting for someone else to act. We need leaders who are willing to take that next step. This report includes insights for people in business, finance and policy, so they can take leadership in delivering a green economy.

1.2 What this report means by a 'green economy'

The World Green Economy Organization defines a thriving global green economy as being one that is "low carbon, climate-resilient, resource-efficient and socially-inclusive"[2]. This is the definition that we use in this report. With the understanding that it is an economy capable of delivering the United Nations Sustainable Development Goals (SDGs, also known as the Global Goals).

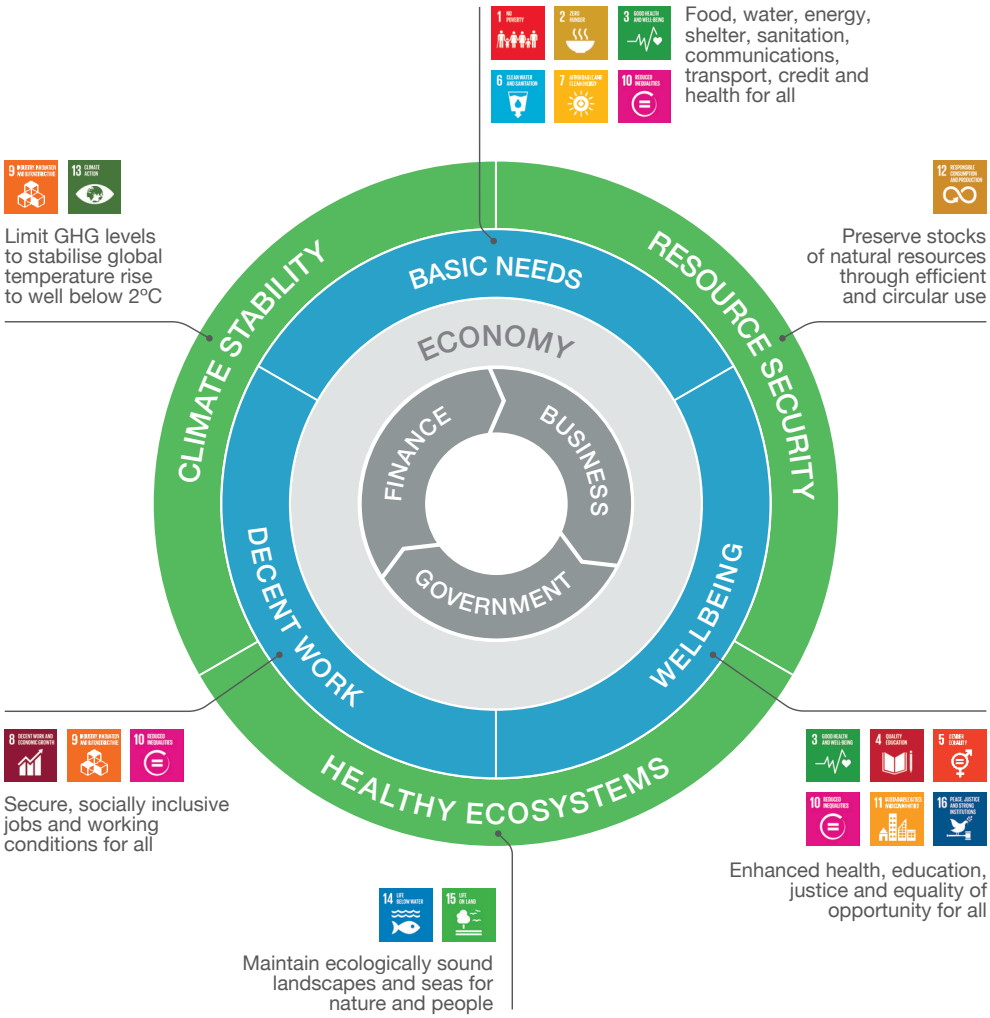
The University of Cambridge Institute for Sustainability Leadership (CISL) has summarised the key outcomes necessary for sustainable development in its 'Rewiring the Economy' strategic plan[3].

The plan arranges the 17 SDGs into six outcomes that the economy should deliver to meet the goals: basic needs, well-being, decent work, climate stability, resource security and healthy ecosystems (Figure 1-1).

Ultimately, a green economy recognises that our economies sit within, and are bounded by, natural and social systems. If these systems are placed under undue stress it can compromise the long-term viability / stability of the economies upon which we are all dependent. The three systems are intimately interlinked and the scientific consensus is clear that our global economy is now causing disruptions to a number of our environmental systems[4].

Figure 1-1: CISL's six outcomes for the 17 SDGs

Source: CISL, *Rewiring the Economy*[5]



1.3 A green economy is vital to security and prosperity

When central bankers, religious leaders, business leaders, scientists and senior economists agree that our future security and prosperity may be in danger, we should pay attention. The Bank of England Governor, Mark Carney, for example, has called climate change a *"tragedy of the horizon"*. This is because: *"...once climate change becomes a clear and present danger to financial stability it may already be too late to stabilise the atmosphere at two degrees"*[6].

The momentous Papal Encyclical Laudoto Si carried a clear call for action from Pope Francis. He writes in stark terms, noting that: *"The pace of consumption, waste and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes"*[7].

In a similar vein, the Islamic Declaration on Global Climate Change states that: *"Our species, though selected to be a caretaker or steward (khalīfah) on the earth, has been the cause of such corruption and devastation on it that we are in danger ending life as we know it on our planet… What will future generations say of us, who leave them a degraded planet as our legacy?"*[8] Leaders from other faiths have expressed similar warnings and called upon their congregations to make changes in their personal and professional lives.

In early 2017, the Business Commission on Sustainable Development (BCSD) in its paper entitled Better Business, Better World concluded that: *"Many of the drivers of growth in the past – for instance, use of fossil fuels and rapid urbanisation – are no longer sustainable in their past forms… Failures in today's development model are adding to a swelling list of global burdens that threaten future stability and shared prosperity"*[9].

In recent years, the World Economic Forum has consistently placed environmental risks as one of the most impactful to the stability of the global economy[10]**.** During 2017, three of the top five global risks are 'environmental' – whilst one of the other two risks was 'water crises', which had been labelled as societal (See Figure 1-2). Prior years, their annual global risk report has explicitly contained environmental risks, or ones which are closely related (e.g. 2016's 'severe energy price shock' is labelled economic but many of the drivers are environmental).

Figure 1-2: Top 5 Global Risks in terms of Impact 2013-2017
Source: World Economic Forum 2018[11]

Global Risks Report — The 5 risks that will have the biggest impact in the next 10 years

	rank
Weapons of mass destruction	1
Extreme weather events	2
Natural disasters	3
Failure of climate change mitigation & adaptation	4
Water crises	5

Global Risks Report — The 5 risks of greatest concern for doing business

	rank
Unemployment or underemployment	1
Fiscal crises	2
Failure of national government	3
Energy price shock	4
Profound social instability	5

The science is clear: a number of environmental systems are being pushed beyond sustainable limits (e.g. loss of biodiversity, nitrogen and phosphorus cycles, land-use change, and climate change)[12].

In the case of climate change, globally, recorded atmospheric temperatures over land and oceans have been increasing since 1880 and appear to be warming at an accelerating rate. The last three years (2014-2016) each broke the record for the warmest year ever recorded; and 16 of the 17 hottest years have been recorded since 2001. In 2016 (an El Nino year) the global (land and sea) mean temperature was 0.99°C – 1.00°C above the mid-20th Century mean[13].

A failing environment raises profound security issues. Most work has focussed on climate change, with the 2015 US National Security Strategy stating *"...clear that climate change is an urgent and growing threat to [US] national security, contributing to increased natural disasters, refugee flows, and conflicts over basic resources such as food and water. These impacts are already occurring, and the scope, scale, and intensity of these impacts are projected to increase over time."*[14]

Estimates vary of the current number of climate refugees, and of possible future numbers. Regardless of the causes of current conflicts in Syria and North Africa, the numbers of refugees fleeing to Europe in recent years has stirred difficulties for a number of governments and strained relations within the EU. There are clear political implications and these are only likely to intensify if a broader systemic approach to solving the underlying issues is not taken.

Decisions we make now will determine humanity's future. As former World Bank economist, Lord Stern, has written, *"The decisions we make over the next 15 years will determine what kind of world we will have for the rest of the century."*[15] Our economic activity going forward will determine if we are able to avoid the worst impacts of climate change and maintain stocks of natural capital.

1.4 A green economy addresses today's pressing priorities

A clear priority for many economies is the need for innovation, productivity, and jobs. Different countries and companies have different needs. Across all there is a need for higher productivity, and to be more efficient, resilient and innovative.

Acting for a green economy delivers for today's generation as well. Just as the physical impacts of climate change are in the here and now, so the benefits of acting for a green economy start today. As leading economists Stiglitz and Stern put it:

"The world's transition to a low-carbon and climate-resilient economy is the story of growth for this century… We're already seeing the potential that this transformation represents in terms of more innovation, greater resilience, more liveable cities, improved air quality and better health."[16]

The opportunity for business: grow revenues, reduce costs and reduce risk. There is evidence that business benefits from alignment with the direction of a sustainable economy[17]. It provides an impetus for innovation, creating technologies which are likely to have an enduring market need. It opens up new market opportunities. It helps increase efficiency of energy, water and other physical inputs, thereby cutting operational costs. It reduces risks in the supply chain, of stranded assets and of impacts on reputation.

The Better Business, Better World 2017 report looked at those new market opportunities, most of which relate to a green economy:

"Achieving the Global Goals opens up US$12 trillion of market opportunities in the four economic systems examined by the Commission. These are food and agriculture, cities, energy and materials, and health and well-being. They represent around 60 percent of the real economy and are critical to delivering the Global Goals."[18]

The opportunity for countries and cities: jobs now in the industries of the future. According to the 2016 Solar Job Census, one out of every 50 new US jobs was in the solar industry, and employment growth in that industry outpaced that of the overall US economy by 17 times as it increased by over 51,000 jobs[19]. The total of 260,000 US solar workers is more than the 190,000 who are employed at coal, oil, and natural gas power plants. That comes at the same time as many different types of US jobs come under pressure from automation, with estimates varying from 10 per cent to 53 per cent in some regions[20].

A transition to a green economy is both compatible with, and necessary for, poverty eradication. Some people argue that countries should get rich before they try for a green economy. But the Overseas Development Institute, a leading independent think tank on international development and humanitarian issues, says the opposite:

"There is an increasing body of evidence showing that many, if not most emissions reductions opportunities in developing countries are actually growth enhancing."[21]

1.5 If you do not act, you will most likely miss out

A clear priority for many economies is the need for innovation, productivity, and jobs. Different countries and companies have different needs. Across all there is a need for higher productivity, and to be more efficient, resilient and innovative.

Companies risk missing out on markets and losing legitimacy. Demand is shifting. Will your products still have customers? Does your current R&D pipeline have in it innovations that will solve future customers' problems? Can your suppliers, assets and staff generate what your customers will want to buy? And, if your company is not actively part of the direction society is going in, how will that affect your reputation? How will you maintain your social licence to operate if you are out of step?

Countries risk inefficient infrastructure and an uncompetitive industrial base. It is reasonable to expect the sources of comparative advantage to change. Will you have the energy, mobility and other infrastructure that is efficient and resilient? Will your industries still be relevant?

For example, 13 of the UK's 15 largest industrial sectors are less effective than global competitors in low-carbon innovation. Large parts of UK industry may therefore be at risk of losing market share to cleaner competitors in Germany, Japan and elsewhere[22].

1.6 A green economy transition is starting to happen

A green economy has begun. It is there in corporate champions around the world, from Unilever through Brazil's Natura and Tata or Mahindra in India. It is there in the cities of Singapore and Vancouver.

This report points to many innovations that are working today, and tell us something about tomorrow. By 'innovation' this report means something new compared to the status quo. This covers things like: technologies; products, service and business models; management practices; collaborative initiatives; and, rules and regulations.

1.7 The next frontier: implementing a self-reinforcing transition

Even with all these great innovations we are not moving fast enough to address the threats to our prosperity and security. Choose your issue, and discover a deepening problem. Carbon emissions may have peaked, but they are not reducing in line with efforts to keep to 1.5°C warming compared to pre-industrial levels. The window to deliver the Paris Agreement is closing[23].

Researchers have found plastic in tap water all around the world. The current rate of extinction matches that experienced at the time when the dinosaurs were wiped out[24]. Pesticides from intensified agriculture have accumulated in rivers across Germany, France, the Netherlands and the US, ultimately threatening biodiversity. In arid regions like Pakistan dust particles are heavily polluted by heavy metals from industrial and agricultural sources. This in turn has serious health consequences among the population, particularly children[25].

The shift to a green economy is more than marginal improvements. Addressing the global challenges that we face is not a matter of change at the margin. Instead, it is a much larger task, involving a fundamental reshaping not just of individual technologies but of entire systems of production, distribution and consumption[26].

Looking across the innovations in the report, and other work, there are several specific implementation challenges to highlight. These will be returned to in the final section on how key players can show leadership.

- How can we be explicit that the profound change required will have new winners and new losers, and formulate ways to address this?
- How can we make sure efforts in policy, finance and business align and reinforce each other?
- How can we act pragmatically to fundamentally reshape entire systems of production, distribution and consumption?

Get these challenges right, and we will have mutually reinforcing transition. Ambitious policy that is effectively and consistently enforced can drive investment. These push deployment of new innovations, which gives us greater experience. As we learn we can reduce the unit cost of production, which makes it easier to implement ambitious policies. There are new winners, who advocate for more ambitious policies, which drives more investment – and the reinforcing cycle continues.

Imagine accelerating to a green economy. Imagine addressing today's pressing priorities for jobs, development and growth. Imagine ensuring the world is not threatened by climate change, resource shortages or ecosystem collapse. Imagine a dynamic global economy where people thrive, businesses succeed and countries prosper.

It is time for leaders to act.

1.8 Structure of the report

The report is organised around business, finance and policy as they can make the most difference. Each of these have resources and reach which they can choose to use in different ways. Also, while they can act alone, each deeply influences the other. In line with these three themes this report includes the following sections:

- **Section 2: Innovations in business –** this section looks at energy generation and demand; circular economy; and food, agriculture and rural land use. For each of these 'sectors', the drivers of innovation often combine policy, finance and business factors. For each sector the report describes how they can contribute to a green economy, then provides business-led innovations in technologies, business models and collaborations, and finally a perspective on what next.
- **Section 3: Innovations in finance –** describes the drivers for a green economy in the finance system, before looking at the innovations coming out of financial players.
- **Section 4: Innovations in policy –** articulates the critical role of policy before highlighting recent leading edge efforts.
- **Section 5: How to show leadership and benefit from change –** outlines how businesses, policy makers and those involved in finance can take leadership to drive forward a transition to a green economy.

Part 2

Innovations in business

2.1 Contribution to a green economy

Business is the engine of a green economy. The warp and weave of the economy is enterprise. All that buying, producing and selling will need to be low carbon, climate-resilient, resource-efficient and socially-inclusive if the global economy is to become a truly green economy.

This whole chapter considers business-led innovations in different sectors. This report pulls out the following sectors as most lively, important and illustrative:

- Energy generation and demand.
- Circular economy.
- Food, agriculture and rural land use.
- Cities and built environment.

Within each sector, there are policy pushes and business pulls. The sections on each sector focus on business-led innovations. Each starts with a small description of the drivers for that in the sector, which often include policy efforts.

The rest of this introduction considers activity that cuts across many sectors. 'Business' is not one monolithic entity. Enterprises in different sectors and under different leadership act very differently. That said, there are some forces and responses which are playing out across businesses in many countries and sectors.

2.1.1 The case for business action

There have been barriers to individual businesses acting for a green economy. As the Harvard Business Review (HBR) puts it:

"We recognize a hard truth: …the need to focus on financial performance and create value for shareholders often obscures the importance of environmentally responsible corporate stewardship. Short-term rewards too often take precedence over the longer-term interests and viability of a company."[27]

But there is a strong and growing business case. In its editorial on The Future Economy the HBR continues:

"The upside of a sustainability agenda is clear…The pursuit of sustainable processes up and down supply chains can translate into immediate savings — and opportunities for innovation. Firms as diverse as Walmart and KKR are finding that reducing energy use and embracing renewable energy can be immediately profitable. Moreover, global challenges like water scarcity, severe weather events, and ecosystem degradation — coupled with a growing interest from consumers and investors in whether companies have a "green" agenda — signal that the environment will have an increasingly direct impact on companies' earnings and risk profiles."[28]

The Better Business, Better World report identified 60 sustainable and inclusive market 'hotspots' across four sectors: energy, cities, food and agriculture, and health and wellbeing[29]. It predicts economic growth in these hotspots to be two to three times faster than average GDP during the next 10-15 years, generating at least US$12 trillion and creating 380 million jobs by 2030 (Figure 2-1).

Figure 2-1: 60 biggest market opportunities related to delivering the Global Goals
Source: Better Business, Better World report[30]

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

Furthermore, as the economy shifts, the innovative companies will thrive. Moving to a green economy involves a fundamental reshaping not just of individual technologies but of entire systems of production, distribution and consumption. Companies that stand still, that try to protect their past, will have limited success. Research by University of Cambridge Institute for Sustainability Leadership (CISL) in 2017 has examined the implications for growth, risk and resilience and found that *"there is a strong commercial case for business to lead the shift to a sustainable economy that can deliver the SDGs."*[31]

Business innovation often goes beyond technology. Many of the examples of innovation provided below are physical technologies which can help companies to generate more value from using less. But many of these technologies reflect shifts in the business models companies use to create and capture value, as well as in the management processes.

There are innovations in business which cut across many sectors. Let us consider some of the big trends in technology, management practices and corporate governance that apply to many businesses as we move forward to a green economy.

2.1.2 Technology: the fourth industrial revolution

At the technology level, we currently have a 'Fourth Industrial Revolution'. This is the term used by the World Economic Forum to catch technologies across a number of fields (including robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, internet of things, 3D printing and autonomous vehicles). These build on vast improvements in information and communication technology (ICT) over the last decades)[32].

MIT Professors Brynjolfsson and McAfee compare this to the first Industrial Revolution:

"Computers and other digital advances are doing for mental power – the ability to use our brains to understand and shape our environments – what the steam engine and its descendants did for muscle power. They're allowing us to blow past previous limitations and taking us into new territory."[33]

The implication: just as with the past, this industrial revolution brings great opportunity and also disruption.

These technological advances are often crucial to innovations in many sectors. These technologies are shifting management processes, business models, industry structures and sectoral boundaries. They crop up in different ways in many of the innovations below.

CISL has described three key trends in how companies deploy technological innovations, relevant for a green economy[34]:

- Changing ways companies meet demand. 'Servitisation' – using products as and when needed for the service they provide rather than owning them outright – is spreading through several sectors (e.g. car leasing, tool hire, sharing platforms).
- Changing ways products are produced. There is a likely shift to re-distributed, regional manufacturing, facilitated by new technologies such as 3-D printing. Digital platforms make it easier to re-use, recycle, and remanufacture – and so are often key to the circular economy.
- Changing key inputs into industrial processes. Innovative materials – many using nano- or bio-technology are being developed that could promote more durable industrial products, reducing waste and improving sustainability and productivity.

Alongside the opportunity, there is a big downside to address. There is concern about the economic impact that these technologies could have on security of livelihoods and earning power. Past shifts confirm that new jobs are usually created, but these disruptions often occur at the expense of lower skilled workers who are unable to easily reskill and move into new sectors. Business and policy makers who are looking to use this cluster of technologies for economic dynamism and environmental outcomes will also need to address the effects on social inclusion.

2.1.3 Management practices

There is a great deal of experimenting with how to manage for a transition to a green economy. Companies are trying in many domains, including: different structures (a central team versus distributed); different ways to craft competitive advantage (bold public goals versus private innovation investments); and how to shift supply chains and sectors (peer collaborations, certification and more).

For example, in 2017 Hammerson, UK's largest property group became the first real estate company to set a goal to be a **Net Positive Company**. Hammerson wants to be net positive for carbon, resource use, water and socio-economic impacts by 2030[35].

Over the last two years Science-Based Targets have gained an increasing amount of traction. Science-Based Targets is an initiative that champions evidence based target setting as a powerful way of boosting companies' competitive advantage in the transition to the low-carbon economy. It is a collaboration between the Carbon Disclosure Project (CDP), World Resources Institute (WRI), the World Wide Fund for Nature (WWF), the United Nations Global Compact (UNGC), and a We Mean Business Coalition commitment[36].

By 2017, more than 300 companies had used Science-Based Targets, with a total market capital equivalent to the entire NASDAQ. These companies are aiming to achieve 30-40 per cent cuts in greenhouse gas emissions by 2030 and over 80 per cent reductions by 2050. In effect, these goals amount to reimaging the entire business model for these companies.

As Business Green journalist, James Murray, points out, this means three things at least:

1. The pressure on governments to deliver national policies in support of these corporate goals is only going to intensify. Corporates who are desperate to buy clean power will urge governments to deliver. National plans to deliver the Paris Agreement will have to be strengthened.
2. The market for the clean tech companies who can make the Science Based Targets a reality will be gargantuan. The world's largest multinationals are saying 'build this stuff at a good price and we will buy it'. This is the point that clean tech R&D has been betting on.
3. There is a widening divergence between the fossil fuel industry's projections and the implied projections of other corporate giants.

Another management innovation on the rise is using 'purpose'. Many companies have had an explicit purpose for a long time, although this is often not aligned with a green economy or the SDGs. The Big Innovation Centre surveyed the evidence in 2016 and concluded that "purpose is…the supreme organisational asset", which enables it to make long-term commitments and build competitive advantage over time[37].

Delivering a green economy requires companies to make long-term commitments and to imbed it into their core 'purpose'. The more businesses ensure that their purpose is informed by the green economy – and the more corporate governance, shareholder behaviour and corporate culture allows them to be driven by this purpose – the more chance we have of reaching a green economy.

One way companies are signalling and committing to their purpose is through B-Corps. By 2017, over 2,200 companies in over 50 countries and 130 industries are certified as B Corporations[38]. They are for-profit companies certified by the non-profit organisation B Lab to meet rigorous standards of social and environmental performance, accountability, and transparency.

For instance, Emmanuel Faber, the CEO of Danone, the global food giant, announced at the company's Annual General Meeting in April 2017 that the company planned to deepen their work with B Lab and to design a roadmap for Danone to ultimately obtain B Corp certification as a global entity. The public statement is the first of its kind by a multinational corporation, showing the growth of the purpose movement into the mainstream.

2.1.4 Corporate governance

Corporate governance matters. The expectations and pressure from investors affect the decisions management make. The signals and disclosures management give help investors perform their role as stewards.

Much corporate governance can promote the short-term. Quarterly earning reporting and expectations for returns now – rather than long-term success – are often cited by companies as holding back their efforts for a green economy.

Yet existing corporate governance mechanism can be used to push a green economy. Major investors and financial regulators are increasingly concerned about both climate-related financial risks, and about the environmental impact of corporate activities, and many are now seeking both financial performance and positive environmental impact.

In addition, NGOs such as Client Earth and ShareAction are focusing their campaigns on corporate liabilities, disclosures and responsibilities – which have significant implications for corporate governance. For example, Client Earth brought legal action against Commonwealth Bank for failure to properly disclose the risk of climate change to the business and against oil companies, on behalf of communities in California, for the cost of climate impacts on the state[39].

New organisations such as the Earth on Board initiative are making governance for a green economy easier[40]. The Earth on Board initiative is a group of leading organisations and individuals working at the highest levels of corporate governance to place sustainability at the center of business strategy (CISL, CDP, ClientEarth, WBCSD, We Mean Business, The B Team). It supports Boards to move beyond short-term financial primacy to refocus on the fundamental purpose of business and on long-term value creation for all stakeholders.

2.2 Energy generation and demand

2.2.1 Contribution to a green economy

Our current prosperity has been driven by cheap, reliable energy. The industrial revolution harnessed fossil fuels, with astonishing results on prosperity, population, longevity and quality of life.

But those fossil fuels have come at a cost and in spite of this continue to receive significant public subsidies. Burning fossil fuels adds greenhouse gases to the atmosphere, which in turn warms the planet and changes our climate. Their burning in vehicles is also a significant contributor to air pollution. Economists talk of externalities and climate change is a prime example, where the final price paid for oil does not reflect the full social and environmental costs that arise from prospecting, extracting, and processing the resource. Despite this, fossil fuels continue to receive significant public subsidies. By one estimate global subsidies amounted to US$5.3 trillion in 2015 (6.5 per cent of global GDP)[41].

What is needed: a net zero carbon economy. As CISL's publication A New Climate for Business makes clear, keeping global temperatures below dangerous levels will require transforming how the world economy sources and uses energy, with profound implications for society and industry[42]. Any less than that will not enable the world to achieve carbon neutrality (zero carbon), which must be achieved to avoid the worst impacts of climate change.

Achieving these goals will require a recalibration of the existing economic, energy, and industrial agendas and an inevitable move away from environmentally harmful subsidies. The world will need to build resilient zero carbon economies quickly, which will radically alter some business models and potentially eliminate others. In order to achieve virtual zero carbon (i.e. 90 per cent reduction) by 2050 and actual zero (net zero carbon) towards the end of this century we need to:

- Phase out fossil fuels, increase the use of renewable energy and dramatically decrease greenhouse gas emissions to reduce carbon emissions.
- Develop the capacity for 'negative carbon' emissions, which means we have to extract some greenhouse gases from the atmosphere and store them.

The Paris Agreement is a game-changer[43]. The Agreement commits countries to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". It has four far-reaching effects on innovation in business:

A clear and long-term direction of travel. The headline commitment shows where the world is going. The International Energy Agency (IEA) had estimated that US$16.5 trillion will need to be invested by 2030 to achieve the ambitious goal of the below 2°C trajectory (Figure 2-2).

Confidence in the direction. There is a new system of regular five-year review cycles through which nations are expected to increase their ambition to meet the long-term goals set out above.

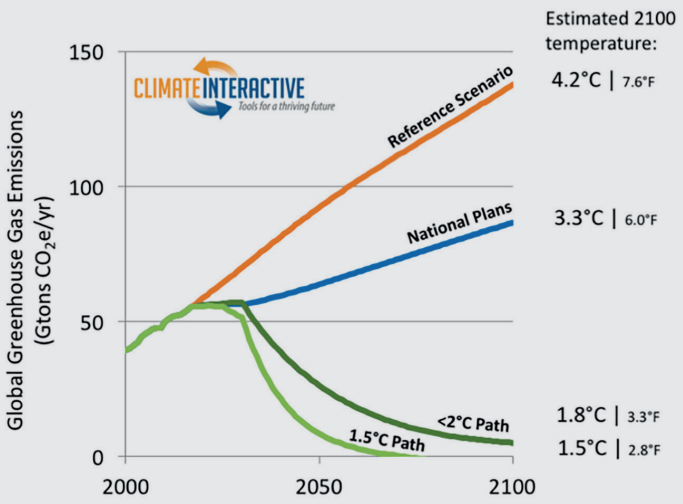
Political buy-in. At the time the Paris Agreement forged an unprecedented and universal political consensus on tackling climate change – 188 governments covering 90 per cent of the world's emissions have published their clear commitments to action, known as their Intended Nationally Determined Contributions (INDCs). The announcement by President Trump to withdraw the USA from the Agreement has possibly strengthened that consensus in the rest of the world. As Christine Lins of REN21[44], global renewable energy policy multi-stakeholder network says:

"Trump's withdrawal of the US from the Paris Agreement is unfortunate, but the renewables train has already left the station"[45].

Clarity and a level playing field. The Paris Agreement has an improved level of transparency that creates a far more level playing field for countries.

Figure 2-2: Climate change scenarios showing alternative futures

Source: Climate interactive[46]



The national contributions to climate action need to be more ambitious if we are to reach our stated target (Figure 2-2). As part of reaching the Paris Agreement, countries each set out national commitments known as Intended Nationally Determined Contributions (INDCs). With ratification these became Nationally Determined Contributions (NDCs), outlining the steps countries plan to make to reduce their emissions, to adapt and the support they need. The current NDCs do not put us on the path to 2°C, let alone 1.5°C, but the Paris Agreement requires countries to keep coming back to the table with stronger plans. As these review cycles happen, countries will need to raise their level of ambition if we are to have a chance of restricting the global temperature rise to below 2°C.

There is already policy action on climate change stimulating innovation. Before 2015, a range of initiatives and programmes were already in place to tackle climate change: the Kyoto Protocol, the EU Emissions Trading Scheme, the German green energy revolution (Energiewende), Chinese development bank support for renewables and a whole host more. These provided the drivers for many of the innovations below. The Paris Agreement is a game-changing accelerator.

The fundamentals of energy generation and use are changing. On electricity generation, the past was a small number of large fossil fuel power plants. The future is many, small intermittent renewable power sources. This changes the nature of the grid, the importance of information, timing of production, who can be a producer, the design of incentives, who has competitive advantage – in short, it changes the fundamentals. In 2016, Portugal went for four days straight on renewable energy - wind, solar and hydro-generated electricity alone[47] and Germany broke another renewables record in 2017 with coal and nuclear power responsible for only 15 per cent of country's total energy, sending electricity prices to negative figures for several hours[48].

The rest of this section looks at the exciting innovations over the last few years in energy generation and use. There are other contributions needed to achieve a zero carbon world, including in agriculture and transport. These are picked up elsewhere. Below are innovations of different types:

- Technologies, such as wind and solar.
- Products, services and business models, often using technologies in new ways or novel company strategies.
- Collaborative initiatives, where organisations are trying to accelerate the shift to a zero carbon world through innovating how they organise together.

2.2.2 Exciting innovations

2.2.2.1 Technologies

The dramatic fall in the prices of renewable generation technologies is making news on a regular basis. In the UK, the price of off-shore wind has halved in two years (2015-2017). The UK Government awarded contracts for 3.2GW of new capacity to three projects with an average price of £66 per MWh. These results mean offshore wind, onshore wind and solar are now cheaper than new gas and new nuclear projects.

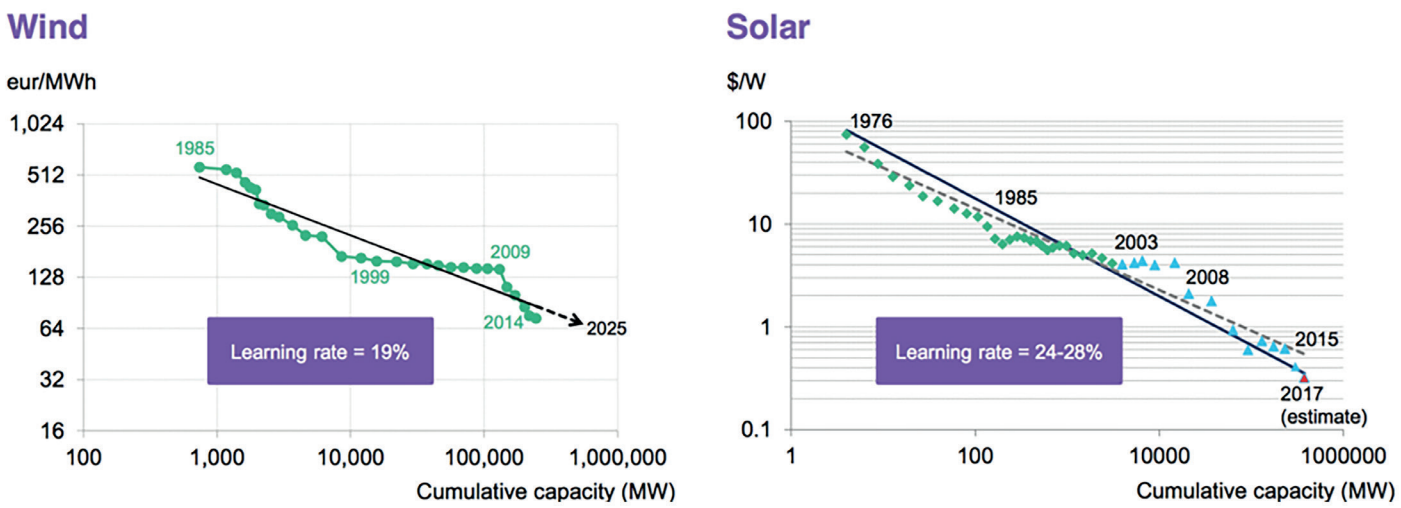
In 2016, Bloomberg New Energy Finance showed that solar costs have fallen by over 99 per cent since 1976, and 90 per cent since 2009 – with onshore wind falling by 50 per cent in that time (Figure 2 3)[49].

This is leading to some eye-catching projects. In June 2017, the financing for Phase 3 of the Mohammed bin Rashid Al Maktoum Solar Park in Dubai was completed[50]. This phase set a world-record-low tariff for solar power generation: 2.99 US cents per kilowatt-hour. On completion in 2030, the 16 square-kilometre 5000MW photovoltaic plant will be the largest of its kind in the world, generating around 2.5 million MWh of electricity per annum. Unlike conventional solar power arrays, the third phase of the solar park will use tilting panels that track the sun, thereby maximising output.

The Chinese city of Huainan has opened the world's largest floating solar farm, which is built atop a former coal mine, which had become a lake after being flooded with groundwater[51]. The 40MW power plant consists of 120,000 solar panels covering an area of more than 160 American football fields. The US$45-million investment could help power 15,000 homes. A floating solar farm is more expensive to build, in order to deal with salt and humidity from water. But, it is on an unused surface, keeping land for agriculture, for instance, and cooling from the water helps improve the efficiency of the solar panels.

As well as the very big, there is the development of micro-grids. A Solar Settlement in Freiburg, Germany comprising 59 homes that are the world's first to have a positive energy balance, with each home producing $5,600 per year in solar energy profits[52]. Hitachi Europe is working to make the United Kingdom's Scilly Isles the 'Smart Energy Islands'[53], which will be a test-bed for its work developing smart grid technologies.

Figure 2-3: Declining cost of wind and solar power
Source: Bloomberg New Energy Finance, 2017[54]



The intermittent nature of renewables makes storage crucial. In June 2017 some six Gigafactories for batteries were announced, covering Germany, Thailand, USA, and Australia[55]. This is on top of Tesla's ambitions for four, including one in China. There is now a clear route for consumers to buy batteries for their home, with Ikea and Nissan both having launched offers in recent years.

A great deal of research, development and commercialisation is focussed on creating low-cost, low-toxicity, and safe technologies that will revolutionize energy storage. Companies like Moixa have products including an all-in-one battery and inverter system suitable for any home[56]. H2GO Power is an award winning spin-out company from the University of Cambridge developing safe and low-cost hydrogen production and storage technologies[57]. Meanwhile Arriba Technologies battery energy storage technology incorporates the latest Internet of Things functionality – designed for 'Near Zero Carbon Buildings and Cities'[58].

2.2.2.2 Products, services and business models

The renewable technologies are combining with other elements of the fourth industrial revolution to open up new business models. For example, Electron, is a new platform developed by a group of blockchain and energy and e-trading professionals that will empower and streamline innovation in the energy markets.

Electron designs efficient, robust and innovation friendly systems to support the Industry's transition to smart grid infrastructure and new market norms of decarbonisation, decentralisation, digitisation and democratisation[59].

Similarly Origami Energy is using smart technology to manage supply and demand by intelligently managing distributed energy assets, via remote controls, to access the most profitable current and future value opportunities[60].

The Green Energy Options (GEO), is a young, established Cambridge enterprise business with a mission to make energy smarter. They help customers and business save money on energy bills by using smart energy devices to encouraging personal behavioural change which can demonstrate to customers what a big impact they can have on their energy bills in the home[61].

The Solar Home System provides Pay As You Go (PAYG) renewable energy at a household level. Currently the largest adoptees are in Africa and Bangladesh. Historically, those places have struggled to install a grid that makes electricity widely accessible. But it also was difficult for people to raise the finance to invest in their own solar panels.

Now, ubiquitous mobile coverage and the Internet of Things (IoT) change what is possible. M-Kpoa Solar is one of a number of companies where they finance installing a solar array in a home[62]. The customer pays for their electricity via their mobile phone in amounts they can afford. M-Kopa monitor the production and so can ensure it gets paid.

Electricity for light, food storage and more can have a profound effect on people's lives – all without emissions and in affordable payment units. In addition, the company now has data on their customers which can be used to provide a credit rating – opening up new sources of finance.

The Solar Home System also illustrates how renewable energy offers developing countries the chance to access energy without relying on bulk transmission infrastructure that is notoriously erratic.

The PAYG model is being applied to other domains, where IoT can control and monitor the use of a capital-intensive fixed asset. There are already rural water taps which do this in Africa.

In Bangladesh, the Bright Green Energy Foundation combines the Solar Home System with Solar Irrigation Pump, Bio-gas Plant & Improved Cook Stoves[63]. The business also trains woman entrepreneurs and green technicians to provide the capacity to grow developing sector.

The Fourth industrial revolution is coming to energy efficiency. The Energy Productivity Challenge (EPIC)[64], run by Energy Unlocked, discovered more business model innovation by seeking 100 exemplary companies that tackle inefficiencies in energy systems. The aim was to understand the business models that are already gaining traction in specific markets, the conditions under which they succeed – specifically in China, India, Europe, Australia, the USA and Brazil – and how to accelerate their impact.

They found 100 innovators with US$2 trillion opportunities to transform energy systems, already attracting US$770 million in investment, with business models that fall into these categories:

Energy as service	Enables a range of energy services through, for instance, microgrids, decentralised renewables, energy management in buildings or lighting as a service. LO3 Energy's TransActive Grid, the first blockchain solution for energy, enables the formation of community microgrids[65]. The first demonstration project in the USA, the Brooklyn Microgrid, enables participants to build, buy and sell local and hyperlocal community-generated energy.
Energy management as service	Enables intelligent energy use – for instance, companies that are providing robust sensing, connectivity, analytics and control over energy-consuming systems (IoT). China-based EQuota provides real-time analytics, energy management systems and carbon services, saving one leading Chinese steel enterprise around ~10 per cent of its energy, or $1m cost saving and reducing carbon by 5,000t. for higher efficiency[66].
'Infomediary'	Brokers of data between buyers and customers that assist in better understanding a market and increasingly utilise big data or artificial intelligence. UK-based The Curve has created the world's first platform for sharing energy investments – "a sort of TripAdvisor for corporate energy"[67].
Mobility as Service	Provides the capability for on-demand mobility for customers[68].
P2P Energy	A form of energy service that allows any (peer) producer of energy to sell energy to others (peers) who need it, enabling local energy.
Infrastructure as service	Provides access to infrastructure ton optimise renewable inputs or efficient utilisation of infrastructure.
Pay-As-You-Go financing	Allows customers to pay for what they need, sometimes without the need for bank accounts. ElectraSeed is an integration project to deliver modular microgrids, each serving up to 100 people, to bring energy to 12 million people[69].
Demand-side / new system architecture	These businesses are all creators and distributors of physical assets.
Flexibility Services	These companies provide access to, aggregate or manage energy demand and distributed-energy resources such as micro generation, heating, cooling and storage.
The AutoGrid Flexsuite	Energy internet applications empowers utilities and energy service providers to deliver cheap, clean and reliable energy by managing a network of distributed-energy resources in real time and at scale[70].
eMotorWerks	A novel approach to address tens of billions of dollars of inefficiencies in grids[71]. The JuiceNet Energy Services Platform aims to control 2 gigawatts of Virtual Power Plant capacity in 2020 – built from aggregated charging load of more than 250,000 electric vehicles.
Flexibility enablers	Providers of hardware or software to make flexibility services possible.

Using open source standards to drive energy efficiency investments. Energy efficiency is difficult to measure in the time units that grids use – and so people struggle to know the financial value of the avoided energy. OpenEEmeter is an open source software platform for calculating energy efficiency from smart meter data designed to make efficiency transparent, replicable, and open to all[72]. It is based on an open standard method originally developed by stakeholders in California. Efficiency companies, utilities, and regulators in five US states, are using the OpenEEmeter to track performance of portfolios of efficiency projects.

Once there is a sufficiently large portfolio there is a more predictable cash flow (rather than attempting to be 'right' on each asset). All of which means, OpenEEmeter could be a protocol which makes the value from energy efficiency savings available to be captured, at scale not just to customers as bill savings, but also for utilities to deploy as a grid resource.

2.2.2.3 Collaborative initiatives

There are a large number of collaborations aiming to support and stimulate innovation in business. For instance, RE100 is a global, collaborative initiative of influential businesses committed to using 100 per cent renewable electricity[73]. The number of companies with that commitment exceeded 100 in 2017 and continues to rise.

RE100 helps show innovators the size and direction of the market for renewables, and to target the wave of likely customers, which speeds up the innovation cycle. What is notable is the growing number of signatories.

Sustainable Energy for All has Energy Efficiency Accelerators covering different opportunities: appliances and equipment; industrial energy efficiency; lighting; building efficiency; district energy; and, transport and motor vehicle fuel efficiency[74]. Each accelerator has its own combination of companies and pubic actors to focus on new business models, specific policy questions, or market segments. The overall aim is to double the rate of improvement in energy efficiency worldwide by 2030.

The Global Off-Grid Lighting Association[75] is an independent, not-for-profit industry association. It represents over 100 members as the voice of the off-grid solar energy industry and promotes the solutions they offer. Their objective is to help the industry grow quickly but sustainably by: focusing on three core barriers to growth by mobilizing investment; creating an enabling policy environment; and providing quality assurance and consumer protection.

2.2.3 What is next?

Delivering the Paris Agreement will require more rapid decarbonisation. Even with the renewables revolution, the current projected emissions will take us past 2°C, let alone 1.5°C. Many scientists say there is limited time in which these goals are possible, with Mission 2020 saying emissions need to peak by 2020[76].

This will need a faster deployment of current and nearly-ready solutions in the coming three years. In turn, that will need policy prompts, financing and business leadership.

With electricity systems in particular, we will need to create a new 'systems architecture'. The fundamentals of energy generation and use are changing. Our current configuration of incentives, regulations and design principles has grown up with a small number of large producers. We are moving to a large number of small producers, who are also sometimes consumers. We are starting to understand that market design but more is to be done to focus value on the user while driving down emissions.

More pressure on fossil fuels and nuclear. Renewables will keep coming down in price, and the electricity grid system will become more orientated to distribute sourcing, including how to deal with intermittency. It is likely that either fossil fuel companies seeking an operating license will be compelled to make their business models carbon neutral (through unproven carbon capture and storage techniques) or that their assets (both power stations and physical reserves) will become sub-investment grade.

The new technologies of the 4IR are accelerating the transition to the green economy (see Figure 2-4).

Dealing with transition risks and impacts. In Europe, a number of utilities have looked at that future and split into a 'legacy' and a 'future' business, for instance Innogy / RWE and E.ON / Uniper. We will have to learn how to deal with these transitions, including the impacts on jobs and regions.

Figure 2-4: 44 Corporations working on autonomous vehicles

Source: CB Insights[80]

2.3 Circular economy

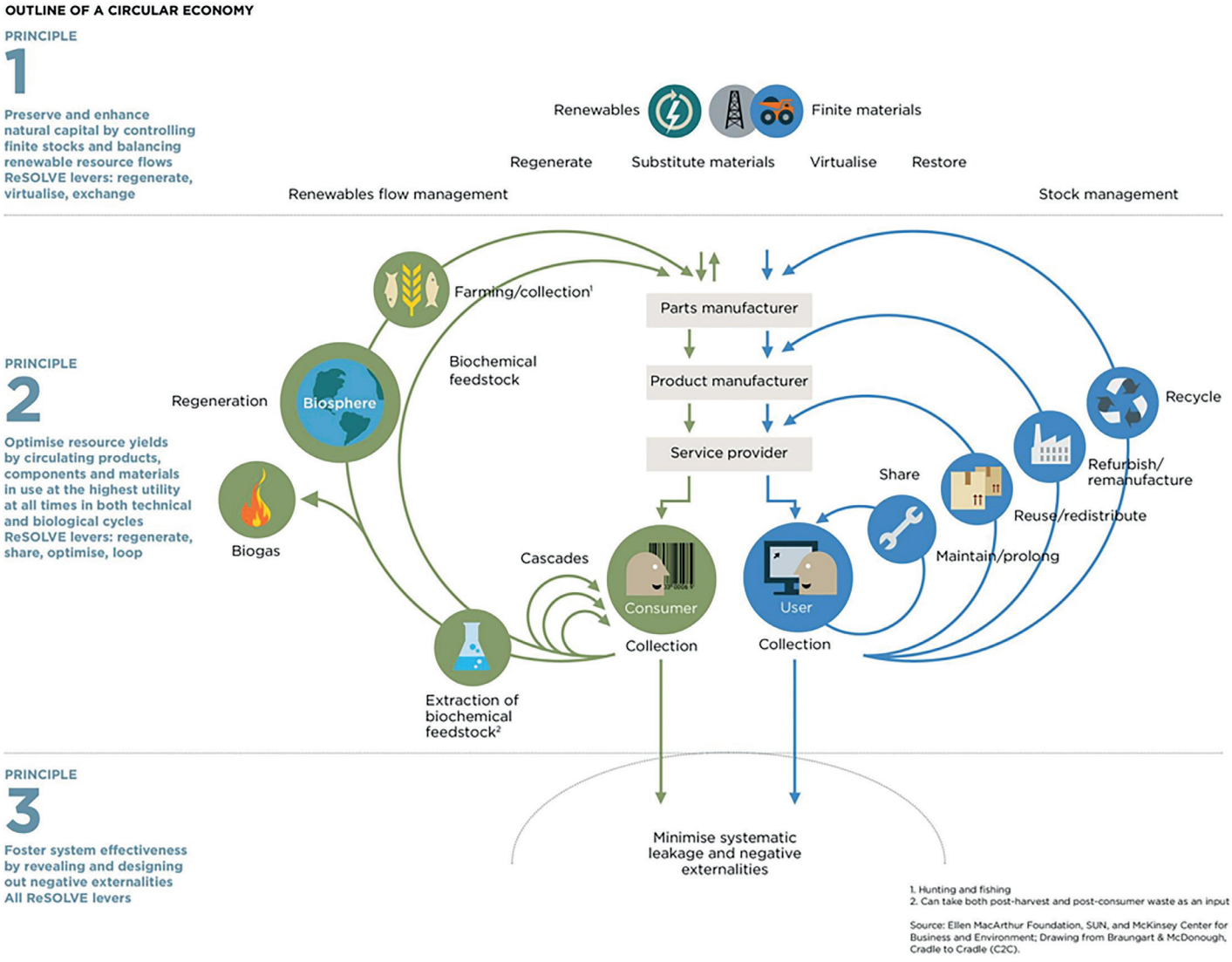
2.3.1 Contribution to a green economy

Much of the economy today is 'linear' but nature is not. For many consumer products the standard flow of material is 'take, make, use, waste'. This creates a burden on nature, on the stocks of resources that are taken in and then on the ecosystems that have to cope with the waste coming out.

In a circular economy, there are loops not lines. Resources (both finite and renewable) are designed to be used for as long as possible and then recovered and reused in the same or an alternative function – that is, they retain economic value and remain in the economic system[78]. A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. A classic depiction of the circular economy – developed by the Ellen MacArthur Foundation – is presented below in Figure 2-5.

Figure 2-5: Outline of a circular economy

Source: Ellen MacArthur Foundation, SUN and McKinsey, Center for Business and Environment[79]



Efforts on the circular economy to date have largely been driven by policy, input costs, and fears about security of supply. Policies in different countries have pushed companies to consider their waste. For instance, landfill and incineration taxes have been introduced in a number of countries across the world are enforcing the application of extended producer responsibility on a number of product streams; there are a growing number of 'zero waste' / 'circular economy' strategies being adopted by regions and cities.

Even as companies were pushed, they found opportunities. Companies that have pursued a circular economy have found many business benefits. There are often significant cost savings through increased resource efficiency. They also help companies tap into new growth opportunities that ensure the future of the company in the face of risks and changing customer expectations[80].

The fourth industrial revolution makes circularity easier, and blurs it with the sharing economy. Digital platforms in particular allow multi-sided markets, where one person's waste can find its next use, or an under-utilised asset can find a productive user. In this way businesses like ZipCar or AirBnB can be examples of both the circular economy and the sharing economy. The designation matters less than the outcome: a more resource-efficient and lower carbon economy.

2.3.2 Exciting innovations

2.3.2.1 Technologies

It is now possible to create plastic from cow's methane. American company Newlight has commercialised a carbon capture technology that combines air with methane-based greenhouse gas emissions to produce a plastic material that can match the performance of oil-based plastics and out-compete on price[81]. By weight, in its most basic form, this plastic is approximately 40 per cent oxygen from air and 60 per cent carbon and hydrogen from captured carbon emissions. It has been independently-verified as a carbon-negative material, including all energy, materials, transportation, product use, and end-of-life/disposal associated with the material.

Cambridgeshire based Aponic Ltd have developed vertical, soil-less growing designs that use 90 per cent less water than traditional agriculture, run on rain water and solar power and, due to their closed-loop, recirculating system do not emit harmful run-off into the environment whilst massively reducing the need for fossil fuels in food production. The designs can be wall or frame mounted to fill any space and their inherently modular nature generates the potential for crops to be grown in town centres, on the doorstep of customers and retailers alike – shifting the 'farm to fork' concept to one of 'plant to plate'. Furthermore, crops can be grown on low-value, contaminated land or in abandoned buildings. Food miles and expensive transit facilities are eliminated, with the point of harvest being closer to consumption. This also contributes to fresher produce and helps to reduce food waste as growing tends to be based on orders rather than bulk supplies[82].

Newlight illustrates the overlap between material innovation and the circular economy. New materials can be the result of recovering 'waste' in new ways. Also, material innovation is needed so products can keep their performance during the 'use' phase, but then be easy to go round the next loop.

Jaguar Land Rover's REALCAR is innovative in technology and industrial process[83]. When Jaguar Land Rover (JLR) is planning its future fleet – which has to have lower carbon emission for compliance reasons – they want lightweight materials, like aluminium. But creating new aluminium from bauxite is very energy intensive. That makes it a risky material to rely on in the move to a low-carbon economy. Recycled aluminium is much less energy intensive. But the aluminium used in cars is a different alloy from that used in cans, which is different again from that used in electronics. So, if you want to be able to use more recycled aluminium you either have to be confident on the recycling infrastructure will keep different aluminium alloys separate, or you have to find a way to cope with impurities.

Hence, JLR is developing a new alloy called RivAlloy, which can tolerate higher levels of impurities from aluminium scrap castings that were previously disregarded. This reduces the amount of aluminium sent to landfill, whilst also cutting transport emissions since UK materials can be used, rather than the current imports.

This is a keystone company pursuing the benefits of a circular economy, from security of supply to buttressing a licence to operate. It also shows the complexity of reconfiguring the status quo. There is an existing linear way of doing thing that is embedded into the nitty gritty of how the supplier incentives, the known performance of materials, the ownership and disposal of cars, and more. Reconfiguring to a circular economy requires innovation throughout, from the materials being used to the incentives and infrastructure that gets the aluminium back.

2.3.2.2 Products, services and business models

Businesses are changing how they operate so they can be circular. Looking at new models for resource productivity, CISL found that these changes went from redesigning value chains, reducing waste, and designing for longevity[84]. There was a focus on designing waste out of the system at an early stage, to avoid relying on end-of-life disposal activities. Business models are changing from selling a product to selling a function, or level of performance, allowing the company to retain ownership of the materials, and to move much quicker to provide customers with technology and product upgrades, staying ahead of the market.

Maersk has taken steps to increase recycling of old ships. The Triple-E class comes with a new 'Cradle-to-Cradle Passport', which will list and describe the materials used to build the vessel, where they are located, and how they can be correctly disassembled and recycled / disposed. This speeds up the process of dismantling and enables materials to be separated out for recycling more effectively[85].

Maersk has introduced a strong financial incentive for ship recycling to be carried out responsibly. The new contract terms are based on the value of the vessel at the time of sale[86]. If the scrap value of the vessel is below 25 per cent of the sale price, Maersk will not divest but will recycle the vessel according to its 'cradle-to-cradle' standards.

If the value is higher (25-40 per cent above the highest recycling price), the new owner will be required to operate the vessel for a further two years or to recycle in accordance with Maersk's standards (beyond 24 months, Maersk can no longer take on this extended responsibility).

With Bundles, you pay for washing not the washing machine. The Dutch firm Bundles installs high-quality washing machines into households[87]. Customers pay either per month or per use, while Bundles retains ownership of the washing machine. IoT connectivity allows Bundles to track usage, and any wear and tear (maintenance and servicing is included in the rental price). Customers retain a sense of control by having the option to cancel a contract at a month's notice.

Clearfleau, is an anaerobic digestion treatement speacialist firm that was set up to enable food processors to become more sustainable. With processing residues becoming more of a cost burden, Clearfleau rather designs and builds on-site anaerobic bio-energy plants that are tailored to particular sites and the liquid effluent stream is then produced. Generation of this renewable energy adds value to unwanted process residues[88].

Sanergy turns human waste in slums into useful end products in East Africa. Sanergy builds a Fresh Life Toilet, which is purchased by local residents who become franchise partners. Waste is collected on a daily basis, and converted at a centralised facility into useful end-products such as organic fertilizer, insect-based animal feed, and renewable energy (Figure 2-6)[89].

Their products are meeting East Africa's demand, helping to discplace importaing synthetic fertlizer. Sanergy demonstrates the potential social and environmental benefits of a circular economy: nutrient cycles are closed, while jobs are created through a thriving local business that can provide energy to local communities.

2.3.2.3 Collaborative initiatives

In 2017 the British Standards Institute created the first circular economy standard: BS 8001: 2017: Framework for implementing the principles of the circular economy in organisations[90]. The standard makes it easier for different players to have shared expectations and a common language – which makes coordinating across a value network easier.

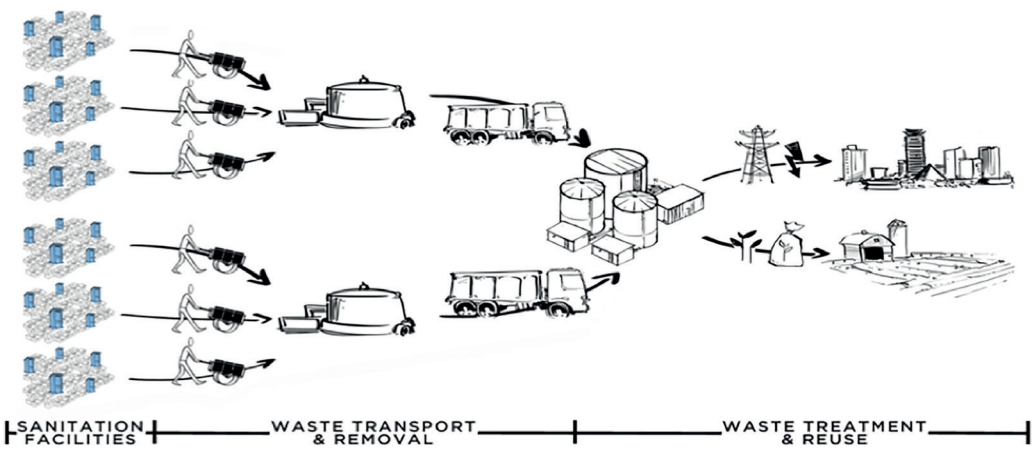
Open Source Circular Economy (OSCE) is creating a 'knowledge commons' for a circular economy[91]. OSCE's network of innovators, designers and activists aims to follow in the footsteps of open-source software by creating the knowledge commons needed to unleash the full potential of circular manufacturing. If every tractor, refrigerator, and laptop manufacturer attempts to recover, refurbish and resell only its own brand products within proprietary cycles of material flow, the system-wide regenerative potential will never be achieved. The OSCE can provide an underlying protocol that can enables circular economy for all, just like 'HyperText Transfer Protocol' was vital to enable the World Wide Web[92].

OSCE days has thousands of members across its community in more than 25 countries with hubs in Berlin, London and Cape Town. The second annual hackathon series in June 2016 had participants from across 73 cities simultaneously take part in the event. It has now moved on from annual hackathons toward more continuous activity.

A location-based approach is the shopping mall ReTuna Återbruksgalleria. Local residents drop off their recycling and donations at stores. The stores resell or use the unwanted items to create new items with an invigorated purpose. All the stores within the shopping mall have to sell used and re-purposed goods. The mall is also run as an education and capacity building centre, so more people understand how they can contribute in tangible ways to making the economy more circular and sustainable[93].

Figure 2-6: Building an integrated sanitation value chain

Source: The Sanergy Model[94]



2.3.3 What's next?

A shift towards a more circular economy is gaining traction. In many ways it is less mature than the revolution in energy generation and storage. We have only just begun to implement what is possible. As more businesses adopt today's best practice, the huge economic opportunities (cutting costs, opening up new markets, creating new jobs, and improving economic productivity) as well as the significant carbon reductions are set to become clearer. Businesses that are not already examining the potential for progress in this area would be well advised to look at it.

From waste to business model innovation. A recent CISL study found there is still a tendency for businesses to default to a waste-led framing that is too limited. This undersells the circular economy opportunity and also the complexity of the business and policy challenge. The next wave of innovation will likely be around new business models as companies move to adopt closed-loop value chains and form alliances and platforms with other actors in the value chain[95].

In a circular economy, as with other facets of a green economy, it is reasonable to expect self-reinforcing push from regulators, customers and big businesses. Whilst these pressures will vary from country to country, they are only likely to intensify over time as countries, regions, and cities try to find practical solutions for achieving their environmental and social commitments.

Policies to become more aligned and creating incentives. A key policy driver for action has been the implementation of extended producer responsibility (EPR) legislation in a growing number of countries. Work by the OECD has shown a rapid rise in the number of countries using EPR regulations to ensure that businesses contribute to the overall cost of managing their products over their entire life-cycle. They report that 361 EPR policies had been adopted by 2013, the vast majority (72 per cent) of which had been introduced after 2000[96]. These regulations are typically applied – at least in Europe – to packaging materials, vehicles, tyres, electrical equipment, batteries and waste oils, but have been introduced to cover numerous other products too: from graveside candles in Slovenia, to expanded polystyrene in Austria, or disposable cutlery in Belgium[97]. This growing coverage of products by EPR is a clear driver for businesses to take action and in recent years has likely been a motivating force, along with a range of other polices, behind growing businesses interest in the concept of the circular economy.

Towards an 'access economy'? When you combine selling a service with digital platforms, then it starts to look like customers are paying to access someone else's goods or services for a particular period of time[98]. There are the circular economy loops of reuse, repair, remanufacture and recycle, but they remain hidden from the customer.

Under 35s have been pushing access over ownership. The so-called 'Millennial' generation, born 1980-2000, are showing different priorities to previous generations. According to Goldman Sachs, the emphasis for this generation is around access, rather than outright ownership:

"Millennials have been reluctant to buy items such as cars, music and luxury goods. Instead, they're turning to a new set of services that provide access to products without the burdens of ownership, giving rise to what's being called a "sharing economy."[99]

Many of the barriers to the circular economy require systemic interventions. These include, for example:

- Shifting industrial design practice so that products are designed at the outset for reuse, repair, remanufacture and recycling in mind.
- Invest in material innovation so there are options for products that retain performance but are physically easier to maintain, reuse, remanufacture, and, eventually, recycle.
- Need for a supportive policy framework to internalise externalities and to support markets for secondary materials, for example: requirements for businesses to sort materials out for recycling; minimum standards for waste collection services offered to businesses and households; Introduction of landfill and incineration taxes (or even a tax on all residual waste); use of deposit refund schemes; taxes on single use disposable items; introduction of extended warranties; greater focus on extended producer responsibility; taxes on raw materials and synthetic fertilizers; carbon taxes; and minimum standards for secondary materials.
- Harmonisation of regulations on waste definitions data reporting, waste treatment / recycling standards.
- Cultural changes, including consumer behaviour, with companies and governments adopting 'nudge' policies to drive consumers to more sustainable choices.
- There is a need for upskilling of the workforce to be able to deliver new circular economy initiatives and to facilitate with the required maintenance, repair, and remanufacturing.

2.4 Food, agriculture and rural land use

2.4.1 Contribution to a green economy

Agriculture is at the heart of a green economy. In the coming decades the world will need to feed billions of people against a backdrop of declining soil fertility and growing water scarcity. The UN's Food and Agriculture Organization estimates that annual food production will have to increase from 8.4 billion tonnes today to 13.5 billion tonnes to provide for a projected population of 9.7 billion in 2050[100].

Solving the challenges facing long-term food security may be even more complex than decarbonising our energy supplies. There are many more decision-makers, from smallholder farmers through to big brand producers, to customers, all of whom are influenced and incentivised by government policies and driven by tight profit margins. The supply chains are more varied and more complex.

There are complex interlinkages between food, energy, water and environmental systems. The irrigation of crops, for example, can affect access to drinking water, the health of aquatic ecosystems, and hydroelectric power generation. It is simultaneously dependent on these factors, as well as others such as forest loss, watershed management, pollution, politics and the practices of other companies[101]. Government policy is a key driver in food, agriculture and land use.

2.4.2 Exciting innovations

2.4.2.1 Technologies

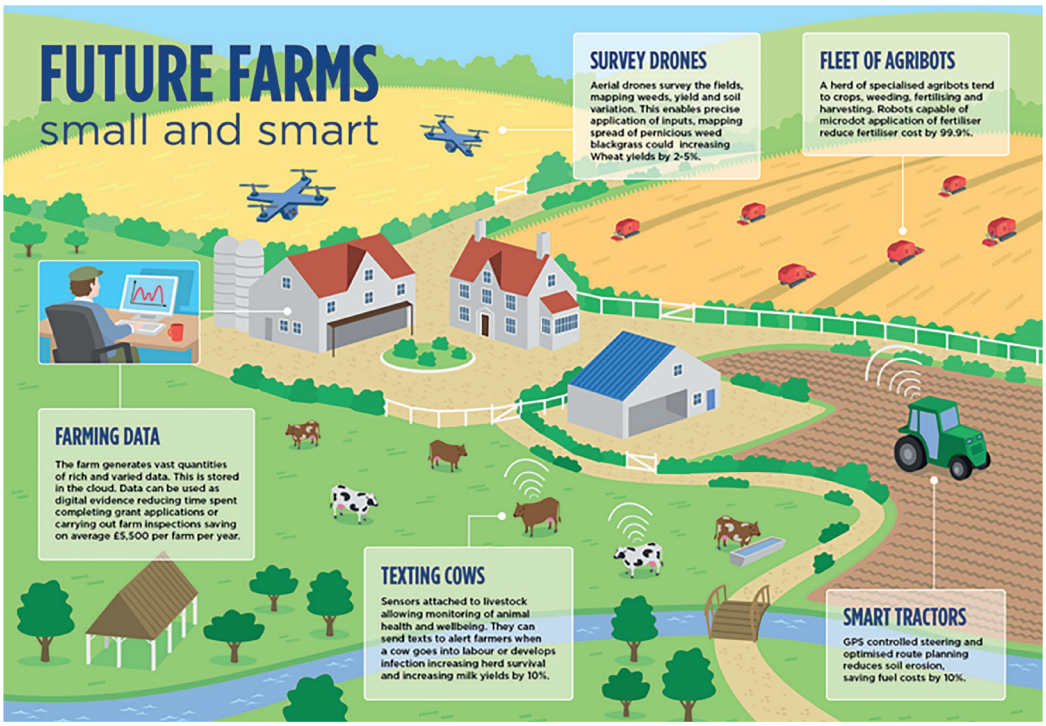
The fourth industrial revolution is being felt in agriculture, as in other industries. **There is a new generation of 'smart agriculture' equipment.** Using computer vision and artificial intelligence, Blue River Technology can detect, identify, and make management decisions about every single plant in the field. It was bought by US agricultural machinery manufacturer John for US$305 million in September 2017[102].

Digital technologies are pushing drip irrigation forward. In 2017, Netafim, the global leader in drip irrigation, launched the NetMaize app[103]. It combines farmer inputs such as planting time, soil type, field location, and irrigation system configuration, with global weather data to provide a tailored drip irrigation program for corn growers. The aim: growers are able to better forecast the irrigation needs of their corn crop and maintain precision control over the root zone environment during the plant's critical growth stages.

These are examples of 'precision agriculture'. According to Nesta, precision agriculture helps more to be done with less by using satellite data, remote sensing devices and proximal data gathering technologies to optimise returns on inputs (see Figure 2-7)[104]. In precision agriculture it is possible to adopt a 'per plant' 'per animal' approach that was not possible prior to the boom in digital technologies.

Figure 2-7: Future farms: small and smart

Source: Nesta[108]



Transparency using blockchain to track produce from farm to fork. British tech startup Provenance, a digital platform enabling brands and retailers to bring integrity and transparency to their supply chains, has raised funding from strategic investors to revolutionise consumer trust[106].

Following a successful international pilot tracking tuna through Southeast Asian supply chains, and a pilot project with the world's largest consumer cooperative to track fresh produce from origin to supermarket, Provenance has secured US$800K in private investment to complement ongoing grant funding, and enable a market launch in the UK and beyond.

Reducing food waste through better connections. According to the Food and Agriculture Authority, one-third of food produced for human consumption is lost or wasted globally, which amounts to an estimated 1.3 billion tonnes per year[107]. That means a third of the inputs are wasted, whether scarce water or fertilizers. Reducing food waste has multiple benefits.

Ghana-based CHEETAH aims to do that by coordinating across the supply chain[108]. The app amplifies the voice of companies by allowing them to share value chain shortcomings to exact accountability from officials (e.g. delays, bribes, unforeseen costs such as breakdown of vehicles due to bad road pavement conditions).

It gathers improved data on road pavement quality and post-harvest losses to help drive behavioural, policy and infrastructure improvements. It also provides on the ground intelligence to decrease unforeseen expenditure for traders.

Alternative animal feeds can increase our overall agricultural output. The production of animal feed uses a large portion of our farmland or is from fishmeal, with has consequences for the oceans.

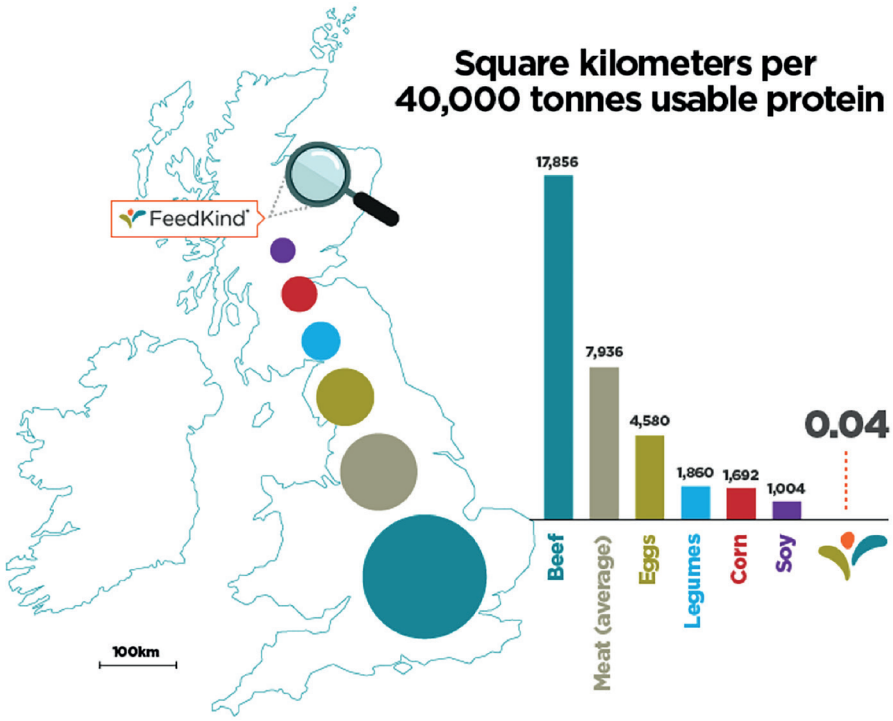
AgriProtein uses organic household waste to produce fly larvae that are used for high-protein animal feed. The first factory in South Africa was producing 250 tonnes per day by 2017[109].

FeedKind protein, by Calysta, is a family of highly digestible feed ingredients produced by a natural fermentation[110]. It composed of naturally-occurring microorganisms and does not include any animal derived by-products. FeedKind protein has increased growth rates and improved feed efficiency, perhaps because of its' high nutrient density with 71 per cent crude protein and 9 per cent crude fat.

One study showed that a commercial scale FeedKind protein plant, if used to replace soy products for fish feed, would free up enough land to feed as many as 250,000 people[111].

Figure 2-8: Figure showing the amount of UK land required to produce 40,000 tonnes of usable protein

Source: FeedKind[112]



Growing food from seawater and sunlight. Sundrop use the sun's energy to produce freshwater for irrigation (Figure 2-9)[113]. They turn it into electricity to power the greenhouse to heat and cool the crops. The ventilation also uses seawater to help cool the greenhouses, and they re-use water again and again. As a result, Sundrop grows tomatoes, peppers and other fruit and vegetables without drawing down local groundwater supplies, while reducing greenhouse gas emissions.

2.4.2.2 Products, services and business models

Brazilian Procomposto offers reverse logistics services to major generators of urban organic waste. Only about 1 per cent of Brazil's organic waste is currently treated biologically or composted, the rest being disposed of in landfill or informal dumps. Procomposto's processing system prevents organic waste from going to landfill and emitting methane, a very potent greenhouse gas. Instead, the carbon can be put back into the soil through the application of organic fertiliser produced in sustainable agricultural processes[114].

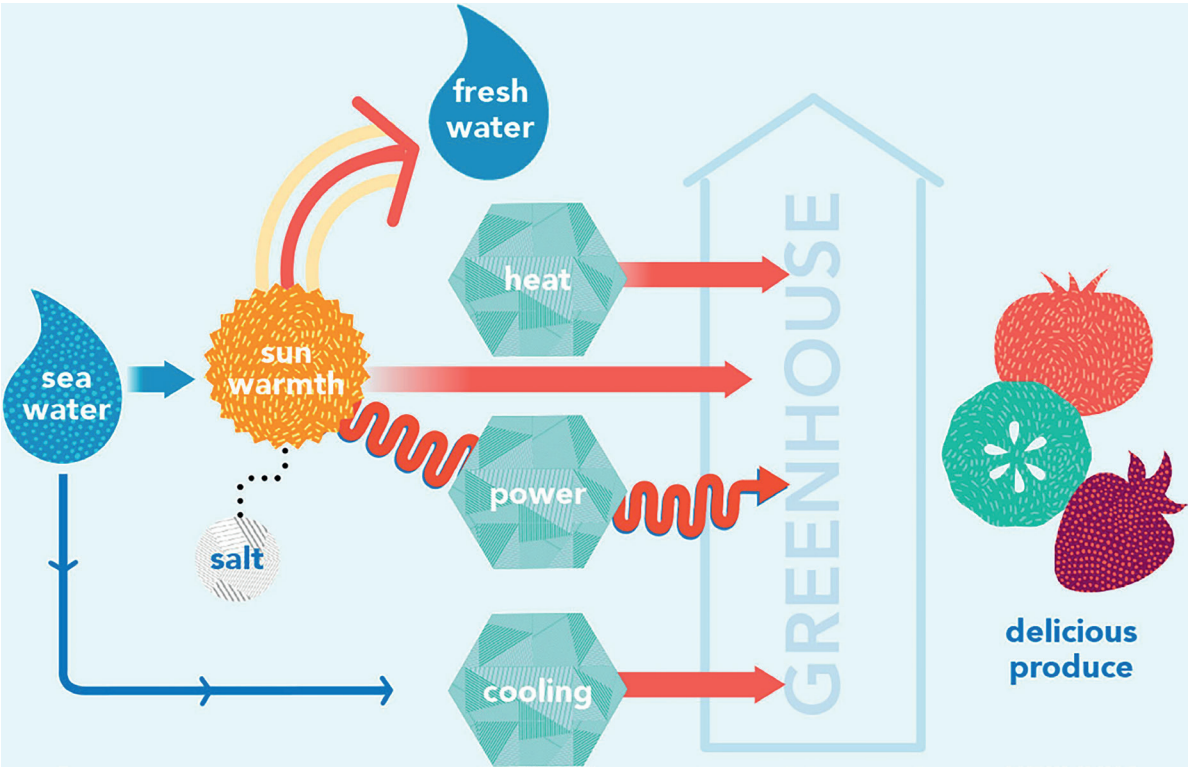
According to the Tearfund, the company's business model is suitable for the great majority of small and medium-sized cities in Brazil (i.e. cities with fewer than 50,000 inhabitants). If the technology were scaled up to cover 25 per cent of the urban waste produced in Brazil, Procomposto's model could create more than 10,000 jobs and help to reduce CO_2 emissions by the equivalent of approximately 100,000 tonnes per day.

Italian food giant Barilla is shaping consumer preferences for a green economy. Their insight is that the foods recommended to be consumed most frequently (such as vegetables, grains, pulses and fruits) are also those exerting less environmental impact, whereas the foods that should be consumed less frequently (such as meat) are those characterised by a higher environmental impact[115]. Barilla is aiming to have all of its products in the lowest section of its 'environmental pyramid'- foods rich in nutrients and protective substances with the lowest possible environmental impact' by 2020 (93 per cent in 2014).

Many big brand players are using their supply chain power to drive forward the adoption of best practice. For example, Marks & Spencer (M&S) has introduced a sustainability element to its Supplier Scorecard. Before, the focus had been through bringing suppliers together to share best practice in a supplier exchange programme. The scorecard now offers a way to spread best practice, but it also allows M&S to use incentives, so those with a higher rating get more business and more certainty[116].

Figure 2-9: The Sundrop process

Source: Sundrop Farms[117]



2.4.2.3 Collaborative initiatives

Between big business, the Consumer Goods Forum is performing an important role. The Consumer Goods Forum (CGF) is where the big brands can create pre-competitive collaborations, which help the sector to achieve green economy outcomes[118]. Examples of action areas include:

- Deforestation. Aiming for zero net deforestation by 2020 by focussing on the sourcing of key commodities – palm oil, soy, paper and pulp and beef.
- Refrigeration. CGF has brought retailers and manufacturers together, so previously unproven natural refrigeration systems are better understood and starting to be rolled out.
- Food and solid waste. The goal here is to halve food waste within own retail and manufacturing operations by 2025 (compared to a 2016 baseline).
- Measurement. CGF plans to achieve a common global system for measuring environmental impacts, starting with carbon emissions and other greenhouse gases.

A global collaboration through Protein Challenge 2040. It is the first global coalition exploring how we feed nine billion people enough protein in a way which is affordable, healthy and good for the environment[119]. In 2017, the initiative included Ahold Delhaize, Evonik, Firmenich, Hershey, Quorn, Seeding the Future, Target, Volac, Waitrose and WWF, with Forum for the Future coordinating. It is the first time that the global animal, plant and novel protein industries have worked together, with the aim of accelerating progress towards sustainable production and consumption of protein, and helping to scale impactful solutions.

The Protein Challenge has been piloting three innovations:

- **Chef's Challenge:** enlisting some of the world's leading chefs to collaborate in creating and placing more tasty plant-based options on restaurant menus, encouraging us all to eat more plants.
- **Plant Protein Stamp:** in the US, developing an on-pack protein label for consumer products.
- **Feed Compass:** to tackle issues of sustainability in animal production, it is developing an animal feed sustainability assessment tool.

Agriculture has the opportunity to pull greenhouse gases out of the atmosphere. Locking up carbon in agricultural soils could be an effective way of reducing agricultural emissions. Sequestration is thought to be critical if we are to stay below 1.5°C warming.

Hence the 4 per cent Initiative, launched by France, sets out to bring together all willing contributors in the public and private sectors under the framework of the Lima-Paris Action Agenda (LPAA) to demonstrate that agriculture, and agricultural soils in particular, can play a crucial role where food security and climate change are concerned[120]. The Initiative invites all partners to declare or to implement practical programmes for carbon sequestration in soil and the types of farming methods used to promote it (e.g. agroecology, agroforestry, conservation agriculture, landscape management). Some 170 organisations have signed up.

2.4.3 What's next?

Food security will be substantially compromised by climate instability and inefficiencies in the supply chain. Parts of the world are using up local water sources at an unsustainable rate. Soil erosion has also exposed resulted in declining soil quality and reduced agricultural productivity in many parts of the world. At the same time, a growing population will require more food, likely demanding diets which have higher environmental impacts.

A diversity and scale of innovations will be needed. The task is large and complex. There is a need to shift agricultural production tremendously, which will require many innovations of many different types.

Regenerative agriculture and landscape management are likely. Even with that diversity, each innovation will need to be contributing to a low-carbon, climate-resilient, resource-efficient and socially-inclusive economy. One way to align all the possible innovations is to ask whether they are regenerative, and to consider their impacts on a landscape scale.

Adaptation will be needed. Some amount of climate change is bound to happen. So, some regions may find that their staple crop may no longer be viable – for instance, coffee and tea-growing areas. These farmers and regions will need support as they transition to a different crop, a different sector, or a different location. Companies will need to be flexible with their supply chains, while also playing their part in the transition of former suppliers.

The links between sustainability and health are creating big opportunities. China's new dietary guidelines to halve the country's meat consumption in order to deal with obesity and diabetes could reduce greenhouse gas emissions by 1 billion tonnes by 2030. The government signed a US$300 million deal to buy lab-grown meat which according to the Good Food Institute (GFI), an organisation which promotes meat alternatives, is a *"colossal market opportunity"*[121].

Part 3

Innovations in finance

3.1 Contribution to a green economy

Finance is the fuel to a modern economy. It performs four roles: the payment system (for instance, so we can pay our bills and receive our salaries); wealth management, so we can borrow for education when young, and save for retirement when old; capital allocation, directing funds from savers and investors to companies and borrowers; and risk management, reducing the costs of bearing the risks inseparable from modern life[122].

Finance is pivotal in moving to a green economy. We need new infrastructure, and to retrofit the existing stock. We need new technologies, deployed at scale, in new business models, and in new companies. We need to help people with environmental shocks and economic transitions, with compensation, retraining and more. All this needs financing. Also, capital needs to be unlocked from the current high-carbon and resource-intensive, polluting economy[123]. The long lifespan of many infrastructure projects – often 25 to 50 years – means that what we choose to invest in now will determine our future economy and our prospects of meeting our global commitments to climate change and the SDGs.

The amounts involved are staggering – as are the opportunities. The World Bank estimates the cost of adapting to a 2°C increase in global average temperatures will be US$ 85–121 billion per year between now and 2050, an investment that will create new business opportunities for some and impose an additional burden on others. Mapping the existing investment in climate adaptation is difficult as few entities report on this as an explicit ledger item, but the Climate Policy Initiative estimated investment flows for climate adaptation of US$ 12–16 billion in 2011, implying a shortfall of US$ 69–109 billion per year in adaptation investment[124].

Long-term investors face considerable unpriced risks on their balance sheets. Environmental degradation and climate change threaten the viability of particular companies, of entire sectors and of some geographical regions. Investors may be left with assets that have suffered from unanticipated or premature write-downs ('stranded assets'). A recent working paper produced by researchers at the University of Oxford, for instance, estimate that stranded coal assets in China *"could be as much as CN¥3,086–7,201bn (US$449-1,047bn), equivalent to 4.1–9.5 per cent of China's 2015 GDP."*[125]

Macro-prudential regulation is pushing finance towards supporting the transition to a green economy. Often this occurs by pushing financial players to manage previously ignored risks.

Other examples internationally include:

- **EU High-Level Expert Group on Sustainable Finance** (HLEG). It is working with the EU's main financial regulator. The Group's interim report was published in July 2017. The foreword has two EU Commissioners arguing that *"a deep re-engineering of the financial system is necessary for it to become truly sustainable from an economic, social and environmental perspective."*[126]

The HLEG go on to state that:

"…in the aftermath of the financial and sovereign debt crises, sustainable finance could provide the best opportunity for the European Union to reorient its financial system from short-term stabilisation to long-term impact."

The HLEG identifies two imperatives:

1. *"strengthen financial stability"* by improving assessment and management of long-term risks; and
2. *"accelerate the shift to a low-carbon and resource-efficient economy".*

Put another way, the finance system needs a green economy as much as a green economy needs financing.

Finally, they argue the levels of investment required are ambitious but not excessive:

"The average investment required to meet the EU's 2030 climate and energy goals, for example, represents 2.5 per cent of projected levels of annual capital formation over the same period."

The HLEG are releasing new actions that will affect fiduciary duty of investors, accounting rules, funding for infrastructure and more.

- **Greening China's Financial System**. This task force was created by the Peoples' Bank of China (PBOC) who unveiled proposals to green the country's financial system. The so-called "green finance task force" – co-convened by the PBOC's Research Bureau and the UNEP Inquiry into Design Options for a Sustainable Financial System – initially comprised 40 ministers, regulators, academics, and financial actors, supported by international experts. It then expanded to include more than 100 institutions, which are working together to create detailed execution plans for each proposal[127].

  The task force reports:

  " …an alignment between China's green economy and financial priorities and its capital market policy priorities. Improved flows of green finance will both accelerate the transition towards a sustainable real economy and improve the efficiency, productivity and resilience of China's financial system."[128]

  In addition, transforming from a resource and pollution-intensive economy to a green economy:

  " …is now a strategic priority for China…Investment needs across key green sectors in China will be approximately RMB2.9 trillion per year from 2015 to 2020 (US$460 billion). Two thirds of this, about RMB2.0 trillion annually (US$320 billion), will need to come from domestic and international financial and capital markets, given scale limitations and priorities."

  The proposals cover four broad areas: specialized investment vehicles; fiscal and financial support; new financial infrastructure; and new legal infrastructure.

- **UK macro-prudential regulation.** Bank of England Governor Mark Carney has made it clear that:

  " Financing the de-carbonisation of our economies implies a sweeping reallocation of resources and a technological revolution. The speed at which such re-pricing occurs is uncertain but could be decisive for financial stability. There have already been a few high profile examples of jump-to-distress pricing because of shifts in environmental policy or performance."

  In the context of the continued aftermath of the financial crisis:

  " …green finance is a major opportunity. By ensuring that capital flows finance long-term projects in countries where growth is most carbon intensive, financial stability can be promoted. By absorbing excess global saving, equilibrium interest rates can be raised and macroeconomic stability enhanced. And by allocating capital to green technologies, the prospects for an environmentally sustainable recovery in global growth will increase."

  In September 2017, the UK government initiated a Green Finance Taskforce, to build on the UK's global leadership in the sector, that brings together senior leaders from the financial sector[129]. This Taskforce will work with industry to accelerate the growth of greenfinance, and help deliver the investment required to meet the UK's carbon reduction targets.

A green economy is needed for financial stability. That is one theme across all these efforts. A green economy is not merely desirable, it is an imperative.

There is momentum within the finance system toward a green economy. The UNEP Inquiry into the Design of a Sustainable Financial System has concluded that *"leading financial institutions are recognizing that sustainable development is key to their future success, as exemplified by the green bond market, with US$118 billion now outstanding"* in 2016[130]. The following sections pick up on innovations in products and services, in management practices and a number of collaborative initiatives that demonstrate that momentum.

But today's momentum remains inadequate. The UNEP Inquiry shows that *"sustainable financial flows and stocks remain marginal to the deployment of capital, worldwide."*[131]

Public investment and policy leadership is needed to unlock private capital. Public investment can be used to absorb the first risk – and signal direction – in ways that leverage in private funds.

3.2 Products and services

This section looks at innovations in the financial products and services that are being offered. It is organised into green-specific products and services, and other innovations.

3.2.1 Green-specific products and services

There are many ways to cluster products and services that are explicitly aiming to support a green economy. The Catalytic Finance Initiative (CFI) is a partnership of banks, asset managers, supra-sovereign agencies and foundations aiming to increase financing for high impact projects around the globe, aiming for US$10 billion of additional funding by 2022. CFI uses the following categories.

Green Bonds. The size of the green bond market has increased significantly in recent years, with issuance nearly doubling in 2016 from 2015 levels, from US$41 billion to US$82 billion; 2017 issuance levels are expected to come in at approximately US$150 billion[132]. Figure 3-1 shows the amount of green bond issuance for the period 2013 to 2017 (up to 31st June 2017).

The US state of Massachusetts sold the first municipal green bond in June of 2013, followed a few months later by the city of Gothenburg, Sweden (SEK500 million). The city made a second foray into the green bonds market in 2014 with a SEK1.8 billion issuance, a third issuance for SEK1 billion in 2015, and a forth issuance for SEK1 billion in 2016. Other recent issuers include the city of Johannesburg, the transport authorities of New York City, Seattle and London as well as the water authority of Washington DC.

Away from cities, other notable examples include €978 million green project bonds to refinance Meerwind in the North Sea, the largest ever renewable project bond, and the National Bank of Abu Dhabi, which has issued the Gulf region's first green bond, raising US $587 million for projects to fight climate change[133].

The growth in Green Bonds has been helped by the Green Bond Principles. These voluntary guidelines clarify the approach for issuance of a Green Bond. They help issuers be credible, ensure investors have the information necessary to evaluate the environmental impact of their Green Bond investments; and they assist underwriters by moving the market towards standard disclosures which will facilitate transactions.

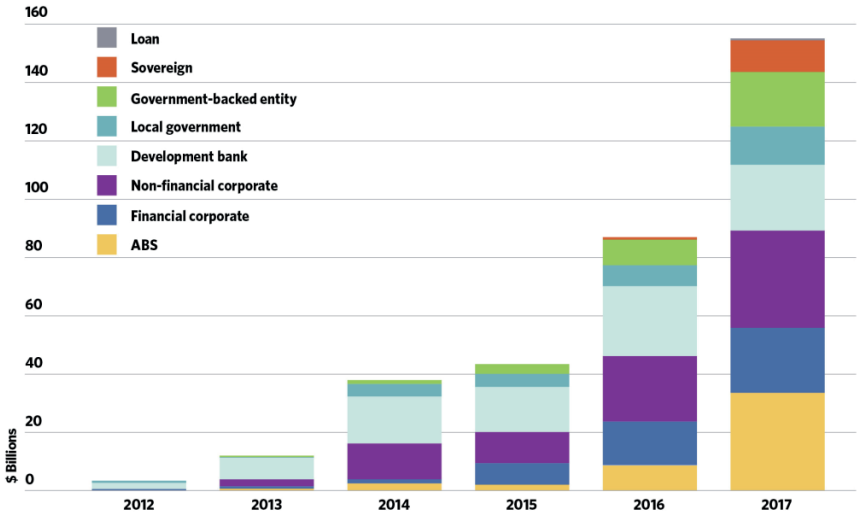
Investment-grade loans for clean energy infrastructure in OECD and emerging markets. One example here is New York Green Bank's first transactions, more than US$800 million in investments and expected to reduce annual carbon emissions by approximately 575,000 tons. The initial transaction parties include Ameresco, Bank of America Merrill Lynch, BQ Energy, Citi, Deutsche Bank, First Eastern Investment Group, First Niagara Bank, GreenCity Power, M&T Bank, Renewable Funding, Sustainable Development Capital, and Tulum Management.

Other categories in CFI are:

- **Philanthropic funds as catalytic first-loss.** One key example is a US$20 million fund to support the Global Alliance for Clean Cookstoves[134].
- **Other investments impacting the 17 Sustainable Development Goals.** An example being IFC Forestry Bond, US$152 million issued and a world-first for forestry[135].

Figure 3-1: Green bond issuance by type, 2013 - 2017

Source: Climate Bonds Initiative, January 2018[136].



3.3 Management practices

3.2.2 Other noteworthy innovations

The examples presented below look to the other roles of the finance sector, namely the payment system, and risk management.

A complimentary currency in Rabot is driving a greener local economy. The citizens wanted to be able to grow their own food. So, a 5-hectare site was converted to allotments that were made available for rent – but only payable in a complimentary currency ('Torekes' or 'towers')[137]. These are earned by undertaking green economy activities, such as, volunteering to collect litter, replanting public gardens, using a car pool, and switching to green electricity. The Torekes can be used on bus travel, cinema tickets, in local shops to buy fresh produce, and energy efficient light-bulbs. These green economy behaviours have grown, as has peoples' pride in their place.

This is one of many complimentary currencies, with more likely in the coming decade. New digital technologies, including, but not limited to, blockchain, make it possible for new forms of payment systems and intermediaries. In the past, delicate issues on the relationship to legal tender have meant governments have not welcomed these efforts. In the coming decade, the tools to set up complimentary payment systems will be available to many more people, which means a period of experimentation in complimentary currencies is coming. Rabot's Torekes show these can be harnessed for a green economy.

There are a number of innovations in using insurance to mitigate environmental risks to prosperity. The Africa Risk Capacity Insurance (ARC)[138] is a company that issues index-based parametric risk transfer contracts to countries like Kenya, Burkina Faso, and Malawi, protecting them against pre-defined levels of (reduced) rainfall occurring in specified regions during defined periods. Through ARC's risk modelling, operational plans and peer review process, countries develop a state-of-the-art view of climate risk, which results in a greater understanding and provisioning of immediate and longer-term structural resilience to these threats.

At the other end of the scale, there is micro-insurance in the Philippines for climate risks and natural hazards. The Centre for Agriculture and Rural Development Mutual Benefit Association, Philippines (CARD MBA) created the first non-life micro-insurance company to specifically address climate risks and natural hazards, covering residential property against flood, typhoon, fire and earthquake[139].

Insurance is being used to transfer environmental risks for countries and at the bottom of the wealth pyramid. What is new here is the growing range of specialist instruments, targeting different types of customer.

This section looks at innovations in management practices in finance. While management innovations are less public than product and service innovation, changes here are important. According to a Harvard Business Review article:

"Over the past 100 years, management innovation, more than any other kind of innovation, has allowed companies to cross new performance thresholds."[140]

3.3.1 Stewardship

Stewardship means the effective management of the assets by those to whom those assets have been entrusted, so that in due course those assets are handed on in better condition. The last year has mainstream investors bring green economy risks and opportunities into their asset management.

Mainstream asset managers and investment houses are flagging the investment risks of climate change. BlackRock, the world's largest asset manager, released 'Adapting portfolios to climate change: Implications and strategies for all investors', which details:

"…how climate change presents market risks and opportunities…" and shows *"how all asset owners can — and should — take advantage of a growing array of climate-related investment tools and strategies to manage risk, to seek excess returns or improve their market exposure."*[141]

In a similar vein, Schroders' Climate Dashboard was developed:

"…to manage the risks and identify the opportunities climate change presents. It provides an objective and transparent view of change to help investor's base decisions on the outcomes that are likely, rather than those they would like to see."[142]

What is new here is entry into normal practice. Mainstream players are saying that asset managers should treat climate change as a material risk and opportunity to their portfolio.

A standout example of shareholder pressure during 2017 was ExxonMobil. The board recommended to vote against a shareholder resolution calling on the world's biggest publicly listed energy company to disclose the impact on its business under a 2°C scenario. Even so, some 62 per cent per cent of the votes were in favour, including BlackRock and Vanguard. A similar proposal the year before had not gathered even 40 per cent of the votes. The Harvard Business Review called this a tipping point for climate issues, as it provide a strong signal that *"shareholders want to know more about what companies are doing to transform their operations and products to remain competitive in a low-carbon world."*[143]

At least US$5 trillion of funds have committed to some sort of divestment from fossil fuel companies. Analysis by Arabella Advisors in December 2016 found that 688 institutions and 58,399 individuals across 76 countries have committed to divest from fossil fuel companies, doubling the value of assets represented in the last 15 months, with pension funds and insurance companies the largest sectors[144].

There are also collaborations to drive the green economy in stewardship management practice. These two examples address systemic barriers to adoption

- The UK-based Red Line Voting Initiative was developed to enable pension schemes to take a more active asset ownership role[145]. The initiative has developed a set of tightly-drawn voting instructions covering a wide range of environmental, social and governance issues. When a pension scheme or other asset owner adopts Red Line Voting it gives an instruction to fund managers to vote at company AGMs in accordance with the Red Lines. This makes it easy for pension schemes to contribute to a green economy without doing their own costly analysis. It avoids fragmentation, so fund managers are receiving consistent instructions from many clients. Finally, the red lines act to transmit good practice through the finance system, setting a level to build on.
- Aiming for A is an investor coalition that is undertaking in-depth engagement with the ten largest UK-listed extractives and utilities companies, alongside expanding to become pan-European[146]. It has focussed on *"strategic resilience for 2035 and beyond"* shareholder resolutions, while using CDP performance bands and sector analysis as an initial benchmark. It exists for individual investors to fulfil their fiduciary duty and to amplify longer-term investor voices.

The trend: asset stewardship is innovating to include the green economy. As market participants understand the risks and opportunities of the green economy, they are changing the way they steward their investments, from engagement with management to the composition of their portfolios.

3.3.2 Passive management and indices

Many investors track a market-weighted index, perhaps mimicking the performance of an externally specified index by buying an index fund. Such an investment portfolio – sometimes called 'passive management' – typically gets good diversification, lower transaction and lower management fees than active funds. But if the index is blind to the green economy, then the investment decisions will ignore those risks and opportunities.

New indices are bringing visibility to the green economy. Standard and Poor's Long-Term Value Creation Index is designed to *"provide exposure to global firms that are considered on track to create long-term value."*[147] The Canada Pension Plan Investment Board (CPPIB) was a co-founder of the index, and called for global firms to move away from the singular focus on *"quarterly capitalism"* and toward a true long-term mindset of *"sustainable capitalism."*[148] As such, the index is part of creating a green economy.

Legal & General Investment Management has launched the Future World Fund, a *"multi-factor global equities index fund that incorporates a climate 'tilt' to address the investment risks associated with climate change."*[149] One of the largest corporate pension funds in the UK, HSBC Bank UK Pension Scheme, has selected the fund for its equity default option, worth £1.85 billion, in its DC scheme. This is one of the first schemes to adopt as a default, a multi-factor investment strategy incorporating a degree of climate change protection.

Osmosis Investment Management has a number of resource-efficient funds. In April 2017, the Swedish state pension fund, started the 'Osmosis MoRE World Resource Efficiency Fund – Low Volatility' which includes low-volatility stocks that are also considered efficient in their use of natural resources. The aim is to improve the carbon footprint, water efficiency and waste management of investments while keeping a low volatility profile that delivers good performance[150].

As a final example, Swiss Re has switched to benchmarks that systematically integrated environment, social and governance (ESG) criteria. This is a step forward from just using ESG as an add-on, instead making it integral to Swiss Re's investment process. This makes the company among the first to do so in the re/insurance industry[151].

Innovations in passive management are helping improve the world. The Chairman of Swiss Re, Walter Kielholz, puts it like this:

"Shifting the large institutional asset base towards sustainable investments would mark a big step forward in making the world more resilient."[152]

3.3.3 Development Banks

Development Banks have historically been strong on the economy but not on the green economy. The term covers local, national, regional or multilateral financial organizations that provide long-term capital to productive sectors and for infrastructure, often accompanied by technical and managerial assistance. In the past few had an explicit green agenda, and had been criticised for supporting investments, such as dams and coal-fired power stations, which were harmful to the environment.

Over the last decade, individual development banks have acted on the green economy. Using Bloomberg New Energy Finance (BNEF) data, Mazzucato and Semieniuk have found that public development banks have become the single biggest providers of green asset finance[153]. In the renewable energy sector alone, they provide more than 15 per cent of total asset finance, and four of them are among the top ten investors into renewables. They also found that public investors are those whose portfolios, on average, include higher-risk investments, with the most risky portfolios held predominantly by public investors (Figure 3-2).

Mazzucato in a separate paper (2015), concludes that Chinese Development Bank has been *"financing the biggest deployment of wind and solar PV parks the world has seen."*[154]

For the Asian Development Bank: *"environmental sustainability is a prerequisite for economic growth and poverty reduction in Asia and the Pacific. ADB's long-term strategic framework for 2008-2020 (or Strategy 2020) identifies environmentally sustainable growth as a key strategic development agenda, and environment as a core area for support."*[155]

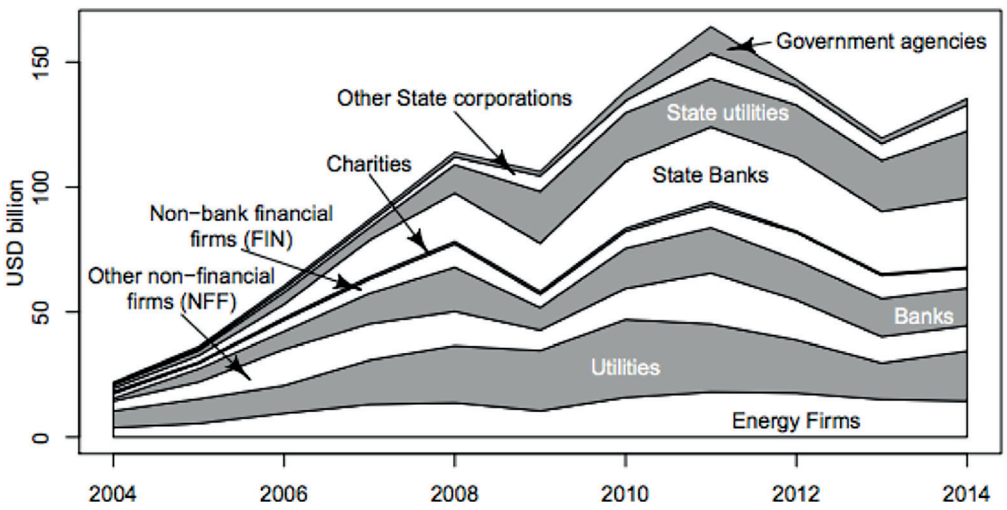
11 development banks jointly committed to the Sustainable Development Goals, including the green economy. In October 2016 The Heads of the African Development Bank, the Asian Development Bank, the Asian Infrastructure Investment Bank, the European Bank for Reconstruction and Development, the European Investment Bank, the Inter-American Development Bank Group, the International Finance Corporation, the Islamic Development Bank, the New Development Bank, the World Bank, and the International Monetary Fund all agreed to step up their efforts – individually and collaboratively – to address the challenges of the 2030 Agenda for Sustainable Development[156].

These institutions now have a joint climate action partnership aimed at helping countries to implement their Nationally Declared Contributions to the Paris Agreement and develop their adaptive capacities. They are focus on scaling up low-carbon and climate-resilient investments for sustainable infrastructure, including, in particular, speeding up the energy transition. They are doing this by, for instance, increasing the predictability and ease of access to concessional resources, such as the Green Climate Fund, and by leveraging private finance for climate investments. In addition, the IMF and the World Bank Group will provide technical assistance to countries seeking to implement carbon taxation as an efficient tool for containing emissions.

Now the most prominent development bank is withdrawing finance for fossil fuels. In December 2017 the World Bank announced it is ending its financial support for new oil and gas extraction within the next two years in response to the growing threat posed by climate change. The bank had already ceased lending for new coal-fired power stations[157].

Figure 3-2: Stacked volumes of annual asset finance by investor type

Source: Mazzucato and Semieniuk[158]



3.3.4 Measuring impact for decision-makings

Difficulties in measuring for a green economy have been a barrier to investment. It is a management truism that 'you measure what you manage, and manage what you measure'. Many aspects of decisions for a green economy are hard to measure with the accuracy people are used to from other decisions. Innovations that make measuring impact easier, also make it easier to invest as it enables more robust business cases to be developed for specific initiatives.

The Natural Capital Protocol can give investors a window into individual businesses. The Natural Capital Protocol is a framework for business to value natural goods and services as part of decision making[159]. When management disclose how they have used the protocol, investors can see the management approach to the natural world. This gives investors a chance to judge whether management are giving the risks and opportunities of a green economy appropriate weighting.

Can you match delivering a green economy with investment opportunities? Dutch pension managers APG and PGGM suggest that you can[160]. They have identified investment opportunities linked to 13 of the 17 UN Sustainable Development Goals, which include the green economy. The results of the research – which the investors have referred to as *"taxonomies"* or classifications – demonstrated areas they consider potential *"sustainable development investments"*, bridging the gap between the UN's targets and tangible investment opportunities. Measuring in this way gives the reference framework for an increasing amount of investments.

The World Benchmarking Alliance (WBA) is an example of trying to aggregate company insights for investor decision-making[161]. It aims to create a set of publicly available corporate sustainability league tables, ranking firms on the level of integration of sustainability issues in their strategy and management processes. The idea is to create a 'race to the top', where the finance sector is looking to invest in companies well set for the future. The Alliance is modelling itself on existing issue-specific benchmarks like the Corporate Human Rights Benchmark and the Access to Nutrition Index.

While the WBA has only just been launched, it indicates the direction of travel within the finance system. There is a recognition of the need for quality, consistent data, as this removes a barrier to investment decision-making. People are innovating to meet that need.

3.4 Market-shaping initiatives

There are efforts to shape the market place toward a green economy. All the innovations above influence their respective markets, but that is not their primary intent. This section focusses on initiatives that are primarily about shifting the dynamics of a market, so that it is easier for many more innovations to happen.

3.4.1 Accelerating key markets

Efforts to accelerate the rate of innovation in key market; and
Changes to disclosure.

The Banking Environment Initiative and the Consumer Goods Forum are collaborating to achieve zero net deforestation. Banks that sign the 'Soft Commodities Compact' make two commitments:

1. Financing the transformation of supply chains; and
2. Raising industry-wide banking standards[162]

The Compact is not intended to be prescriptive, but rather to lead the banking industry in developing market norms that align bank practice with net zero deforestation. The banks are changing their internal processes so that, by 2020, all corporate and investment banking customers whose operations include significant production or processing of palm oil, timber products or soy in markets at high risk of tropical deforestation can verify that these operations are consistent with zero net deforestation.

The Soft Commodities Compact has developed the market for financing one part of the green economy. The banks that have now adopted the Compact account for approximately 50 per cent of global trade finance[163].

The Global Innovation Lab for Climate Finance is a market accelerator for climate finance in developing countries. The Lab identifies, develops, and pilots transformative climate finance instruments. Specific innovations include:

- Climate Investor One is the inaugural financing facility launched by Climate Fund Managers (CFM), and incubated and developed within the auspices of the Global Lab[164]. Many renewable energy projects in the developing world face three hurdles:
  - Lack of expertise and prolonged negotiations with financiers;
  - High capital expenditure means construction debt costs at can have a disproportionate effect on their financial viability; and
  - Attracting new investors.

Climate Investor One helps project mitigate these challenges by providing expertise and support through several stages, and using equity financing, removing the need for more costly debt finance. Climate Investor One will unlock new capital through a pooled refinance fund that may be appealing to institutional investors.

In a pilot, Climate Investor One will finance nine projects to deploy 300 MW of renewable energy capacity and could reduce CO_2 emissions by 600kt per year. Due to the combination of the financing facilities, these projects would be built for 7-21 per cent less capital than a typical project, a significant reduction in costs, with clean energy provided at 9-18 per cent lower cost to consumers in developing countries.

- Energy Savings Insurance (ESI) overcomes investment barriers to energy efficiency by providing an insurance product for projected energy savings for efficiency projects undertaken by small and medium sized enterprises[165].

- Endorsed by the Global Innovation Lab for Climate Finance in 2015, the Inter-American Development Bank has led the implementation of Energy Savings Insurance, and now has projects in seven countries that will target thousands of businesses[166].

- In Columbia, ESI was launched in June 2016 aimed at promoting investments in energy efficiency in the hospitality and healthcare sectors[167]. It is expected to support about 104 firms (90 hotels and 34 clinics/hospitals) to invest in energy efficiency projects, with the aim of avoiding an estimated 13,977 tonnes of CO_2 equ. per year.

- In Mexico ESI has gone forward with FIRA, a rural development bank, and will target an investment stimulus of US$25 million in the agro-industry sector with over 190 energy efficiency projects. Other countries deploying ESI include El Salvador, Nicaragua, Brazil and Peru.

The Lab is an example of public finance and policy leadership unlocking private investment. In this way, it aims to drive billions of dollars of private investment into climate change mitigation and adaptation in developing countries.

3.4.2 Disclosure

One of the most important market-shaping efforts of 2017 was the Taskforce on Climate-Related Financial Disclosure (TCFD). Set up by the Financial Stability Board, the Taskforce had the remit to develop recommendations for voluntary climate-related financial disclosures that are consistent, comparable, reliable, clear, and efficient, and provide decision-useful information to lenders, insurers, and investors. The final recommendations were released in July 2017, after going out for consultation in December 2016[168].

Those recommendations are structured around four thematic areas (Figure 3-3):

1. Governance;
2. Strategy;
3. Risk management; and
4. Metrics and targets[169].

The recommendations are designed to be adoptable by all organisations, with disclosures included in financial filings, giving decision-useful, forward-looking information on financial impacts with a strong focus on risks and opportunities related to transition to lower-carbon economy (Figure 3-4)[170].

Figure 3-3: Core elements of recommended climate-related financial disclosures

Source: Taskforce on Climate-Related Financial Disclosure[171]

Governance

The organization's governance around climate-related risks and opportunities

Strategy

The actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning

Risk Management

The processes used by the organization to identify, assess, and manage climate-related risks

Metrics and Targets

The metrics and targets used to assess and manage relevant climate-related risks and opportunities

Figure 3-4: Recommendations and supporting recommended disclosures of the TCFD

Source: Taskforce on Climate-Related Financial Disclosure[172]

Governance	Strategy	Risk Management	Metrics and Targets
Disclose the organization's governance around climate-related risks and opportunities.	Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.	Disclose how the organization identifies, assesses, and manages climate-related risks.	Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.
Recommended Disclosures	**Recommended Disclosures**	**Recommended Disclosures**	**Recommended Disclosures**
a) Describe the board's oversight of climate-related risks and opportunities.	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	a) Describe the organization's processes for identifying and assessing climate-related risks.	a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.
b) Describe management's role in assessing and managing climate-related risks and opportunities.	b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	b) Describe the organization's processes for managing climate-related risks.	b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.
	c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.

Figure 3-5: Illustrative implementation path

Source: Taskforce on Climate-Related Financial Disclosure[173]

The Task Force has put a strong emphasis on scenario analysis for disclosure. For many companies, the material impacts of climate change are in the future and uncertain. Scenarios are a well-established method to assess potential business, strategic, and financial implications of such uncertainties[174].

As shown in Figure 3-5, the Task Force sees a path to broad understanding of climate change in the finance system.

The innovations in disclosure will accelerate activity in financial markets and inside companies:

- The instigation by the Financial Stability Board at the request of the G20 signals to financial markets that they should treat climate risks and opportunities as material.
- Companies and investors will have to work through the specific climate risks that they face. Even though the recommendations are voluntary, many countries have a requirement that companies disclose material risks.
- Over time, working through the risks and opportunities will shift investments at different levels. Fund managers will change their investments within sectors (from over- to under-exposed companies), and between sectors (from those with downside to those with upside).
- The capital reallocation will help policy direction, even as policy certainty will help unlock those investments.

3.5 What is next?

There is momentum for a finance system for a green economy. According to the UNEP Inquiry's Green Finance progress report for the G20 in July 2017, more measures related to green finance have been introduced since June 2016 compared with any other one-year period since 2000[175]. A review looking at sustainable finance (not just for a green economy) indicates that global sustainably managed assets under management have increased by 25 per cent in the two-year period from 2014 to 2016[176].

The current momentum will need to accelerate further. Even with the innovations, and the record capital allocation, the UNEP Inquiry believes the *"momentum remains inadequate to deliver the transformation needed to finance sustainable development."* There is a lot of investment required over a short period of time if we to meet climate change commitments and the SGDs.

Implementation of the TFCD recommendations and continued investor activism will accelerate disclosure. As banks, asset managers, insurers and major industries scale their commitment to inform investors around the world CISL predicts 2018 will be a watershed year for transparency.

We can expect more innovations in:

- **Market-led principles and guidelines.** Efforts like the Green Bond Principles address confusions and frictions between market participants. They help shape markets, and accelerate their growth.
- **Global knowledge-sharing and capacity-building networks.** As the markets grow, mainstream players will need to learn more. They will join existing bodies such as the UN Principles for Responsible Investment (PRI) or Principles for Sustainable Insurance (PSI), or forge new ones.
- **Risk management tools.** The primary prism in finance remains risk. People will innovate ways to address uncertainties, including the transition risks which current are holding back action.

Part 4

Innovations in policy

4.1 Contribution to a green economy

Government steers the development of the green economy- many of the examples provided in previous sections were driven forward by policy. The support for renewables helped these technologies come down the cost curve. The shifts in financial regulation are prompting the financial innovation that was outlined above.

Moving to a green economy requires more than marginal changes. Structural transformations are required to remove adverse incentives that perpetuate unsustainable growth practices and enforce positive behaviours involving a fundamental reshaping not just of individual technologies but of entire systems of production, distribution and consumption.

Most innovation, most of the time, focusses on incremental improvements. Tweaking the normal way of doing things – whether that is a technology, a management practice or a business model – gives more predictable returns. That is why there is the phenomenon of 'lock-in'. In a sector, effort tends to focus on small improvements which fundamentally leave unchanged the current configuration of technologies, management practices, infrastructure and so on.

But the structure of the global economy does change. Eventually, the existing configuration runs out of ways to improve. There is a period of 'creative destruction', where a new configuration (of technologies, business models, skills and so on) replaces the old. In this period, different actors have an increasing alignment on the likely shape of the new configuration. When these expectations are sufficiently shared, there is a 'tipping point' where the nature and direction of mainstream innovation activity can switch quickly.

We need waves of creative-destruction that aim for a green economy. We do not just need more innovation, in any direction. We need it to generate a low-carbon, climate-resilient, resource-efficient and socially-inclusive economy. But, it is not realistic to expect businesses and financial players to go in that direction voluntarily and this is where policy comes in as an important driver.

Policy can trigger and guide the mutually-reinforcing actions of business and finance. The growing number of business and financial players that are shifting to a green economy lend credibility to the transition and help to further speed up the rate of change. Ambitious policy can drive investment and bring down costs in new technologies over time. As we learn we can reduce the unit cost of production which makes it politically easier to implement ambitious policies.

The contribution of policy innovation: a virtuous circle. Policies can provide the signals and conditions necessary to adjust economic behaviours, by helping set bold targets, pursuing green growth and creating incentives and practices that stimulate finance, facilitate green innovations and create new markets.

4.2 Developments in carbon pricing

Setting a price for carbon has been a policy intervention that has been widely promoted by those wishing to curb the impacts of climate change. The policy case is clear: a carbon tax, if correctly set and cascaded down to relevant actors, will incentivise companies, households and other users to reduce their carbon emissions[177]. At the same time it can raise revenue to support the transition to the green economy. It is one example of a long-held position in environmental circles: 'tax the bads, not the goods'. The idea is to shift the burden of tax, as far as reasonably possible, from good things we want (i.e. labour) to bad things we do not want (emissions, pollution, waste)[178, 179].

There has been a flurry of activity following the Paris Agreement. Since the start of 2016, numerous new carbon pricing initiatives have been implemented, including:[180]

- **Australia** – the safeguard mechanism to the Emissions Reduction Fund launching a baseline-and-offset system.
- **Fujian, China** – a pilot Emissions Trading Scheme (ETS) in Fujian which covers greenhouse gas (GHG) emissions in 2016, in preparation for the introduction of the Chinese national ETS later in 2017. The Chinese ETS is expected to be the world's largest carbon trading market and represents a doubling of emission covered globally by a carbon price. In December 2017, China set emissions quotas for companies in the power sector, which emits 3.3bn tons of carbon dioxide annually, paving the way for the full system to be launched by 2020 (Figure 4-1).
- **Canada**, by three states:
  - Alberta – a carbon tax, covering all GHG emissions from combustion that are not covered by its existing carbon pricing initiative for large emitters;
  - British Columbia – a baseline-and-credit system in addition to the province's existing revenue neutral carbon tax;
  - Ontario – an ETS, covering GHG emissions from industry, electricity generators and importers, natural gas distributors and fuel suppliers
- **Chile** – a carbon tax which applies to CO_2 emissions from large emitters from the power and industrial sector.
- **Colombia** – an economy-wide carbon tax on all liquid and gaseous fossil fuels used for combustion.
- **Washington State, USA** – The Clean Air Rule, establishing a baseline-and-credit system which initially covers fuel distributors and industrial companies that are not considered to be energy intensive nor trade exposed.

In addition, Member States of the International Civil Aviation Organization (ICAO) have agreed on the first global sectoral carbon pricing initiative. ICAO's Carbon Offsetting and Reduction Scheme for International Aviation was adopted on 7th October 2016, capping GHG emissions from international aviation at 2020 levels.

There are new collaborative efforts to expand the use of carbon pricing. The Carbon Pricing Leadership Coalition brings together leaders from across government, the private sector and civil society. Its aim is to double the amount of global emissions covered by explicit carbon pricing mechanisms to 25 per cent by 2020, and double again to 50 per cent of all emissions within a decade[181].

They invited Joseph Stiglitz, Nobel Laureate in Economics, and Lord Nicholas Stern, to chair a High-Level Commission on carbon prices. Their conclusion, in May 2017, was that *"the explicit carbon-price level consistent with achieving the Paris temperature target is at least US$40–80 per tonne of CO_2 by 2020 and US$50–100 per tonne of CO_2 by 2030, provided a supportive policy environment is in place."*[182]

While necessary, carbon prices by themselves are not enough. As the Carbon Pricing Leadership Coalition report says, *"A combination of policies is likely to be more dynamically efficient and attractive than a single policy."* Carbon prices have a vital role to play in raising revenue (which, for instance, can be used to support people whose jobs are exposed to the transition). But they will not be enough for the time-bound transformation that is needed for a green economy.

Figure 4-1: China set to have the world's largest carbon market

Source: Financial Times, 'China moves towards launch of carbon trading scheme'[183]

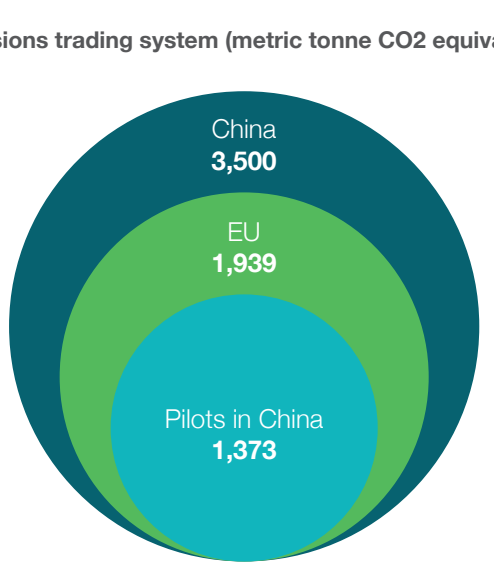
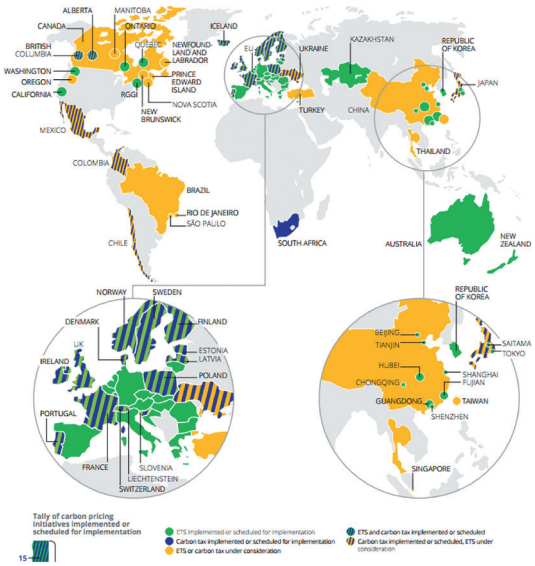


Figure 4-2: Regional, national and sub-national carbon pricing initiatives implemented, for implementation or under consideration

Source: Carbon Pricing Watch 2017[184]



4.3 Signs of combinational policies

A green economy has begun. There are some cities and countries that are deploying a combination of policies that indicate a self-reinforcing shift towards the green economy.

4.3.1 City-level examples

Vancouver is aiming to be the Greenest City in the world by 2020. It has ten interlocking plans, including: double the number of green jobs and businesses with green operations; reduce driving and make the majority of trips by foot, bicycle, or public transport, and increase amount of locally grown food.

Vancouver's 2017 Dashboard shows that:

- More than 50 per cent of all journeys are by foot, bike or public transport (remarkable for a major North American city);
- There were no instances in 2016 of breaching air quality standards
- Community-based greenhouse gas emissions have reduced by 15 per cent (compared to 2007 levels); and
- The city has added 8,000 jobs in the green economy (compared to a 2010 baseline)[185].

More importantly, the mayor of Vancouver believes the approach has rejuvenated the city. Vancouver has grown three times faster than the national average[186]. In 2017, Mercer Quality of Living City Rankings placed Vancouver top in North America (5th overall) – an indication that the city is attractive to people and businesses[187].

Dubai has a number of policies around energy that are combining for a green economy. In 2015, HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, announced the Dubai Clean Energy Strategy 2050. This has a progression of targets, to 75 per cent of renewable energy sources by 2050[188].

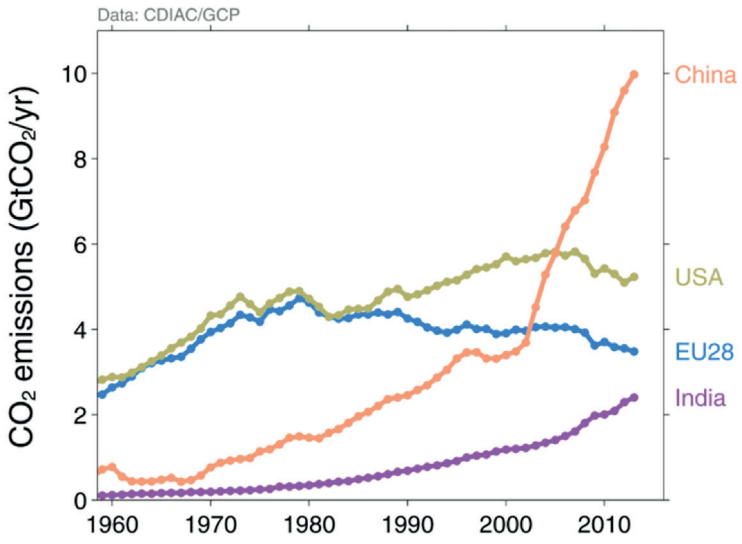
- As one of the first steps to facilitate this goal, the Dubai Electricity & Water Authority (DEWA) created the Shams Dubai solar program in early 2015. This program allows DEWA customers to install solar panels on their property, and utilize the produced solar energy to reduce their monthly electricity bill. Under 'net metering', any surplus electricity that cannot be used immediately will be credited by DEWA at the retail rate, further reducing the electricity bill in the next month.
- In 2017, DEWA launched the 'Shams Dubai Calculator' web application, to help customers easily decide on the installation of photovoltaic (PV) panels on their rooftops under 'Shams Dubai' initiative, to generate electricity from solar power[189].
- Back in 2014, the Dubai Municipality launched Green Building Regulation and Services, which covered all new public and private buildings[190]. In July 2016, Dubai launched the Al Safat ('date palm') rating system, which has Bronze, Silver, Gold and Platinum levels[191].
- Dubai's efforts sit within United Arab Emirates plans to invest US$163 billion to boost its use of alternative energy over the next three decades[192]. That should increase clean energy's share of UAE consumption from 25 per cent to 50 per cent by 2050. The country also hopes to increase energy efficiency by 40 per cent over the same period.

4.3.2 Country-level examples

China has seen exceptional economic growth over the last few decades which has been coupled with substantial CO_2 emissions (Figure 4-3). It has already been mentioned that China is launching the world's largest emissions trading scheme (ETS) not just to address climate change, but also to usher in a wider shift. The desired economy has narrower income disparities, and a greater emphasis on high-value segments of the global economy. address climate change, but also to usher in a wider shift. The desired economy has narrower income disparities, and a greater emphasis on high-value segments of the global economy[193].

Figure 4-3: CO_2 emissions for China, USA, EU28, and India, 1960 - 2017

Source: Carbon Pricing Leadership Coalition (2017)[194]



Towards an "Ecological civilization". That was listed as one of the five goals in China's overall development in 2012[195]. This provides the context for detailed efforts to green its financial system in the Innovations in Finance section above. UNEP believe that climate change and the environment were a central element of the five year plan covering 2016-2020[196].

The 2020 targets were organised in four:

- Further optimise spatial development, for instance, enforcing ecological redlines.
- Utilise resources more efficiently, including CO_2 emitted per GDP down by 40-45 per cent over 2005 levels.
- Improve the overall quality of the environment; for example, ensure that more than 80 per cent of the key rivers/lakes/water functional areas meet water quality standards.
- Establish major regulatory systems for an 'ecological civilization', including *"abandoning economic growth as the only criterion in government performance assessment and establishing a lifelong accountability system, which would ensure for the first time that environmental violations will affect an official's chances of promotion and environmental black marks will stay on the work record for the rest of his or her career."*[197]

China's big announcement on automobiles: signal and opportunity. In September 2017, China announced it will set a deadline for automakers to end sales of fossil-fuel-powered vehicles[198]. As one of the largest automobile markets in the world, this would be a spur to the whole industry. It also has the potential to give its own car manufacturers an enduring competitive advantage, through early insights, a sizeable home market and removing ambiguity in their innovation choices.

Other countries are also showing signs of combinational policies:

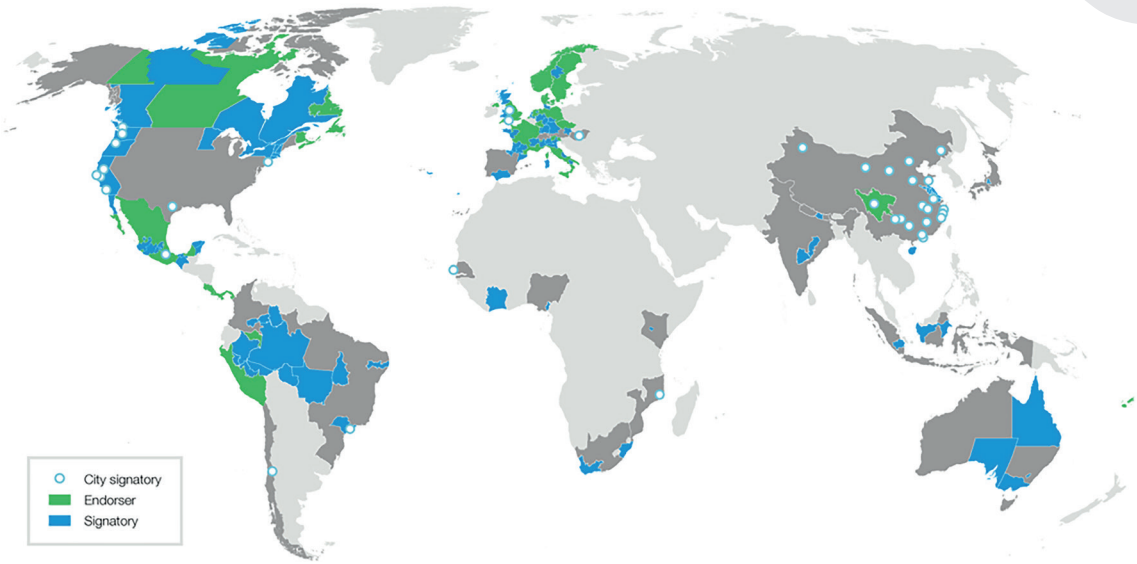
- **Singapore.** In February, Singapore became the first Southeast Asian nation to announce it will impose a tax on carbon in 2019[199]. In the same month, Singapore increased its water price for the first time in 17 years to cater for *"future demand, strengthen Singapore's water security, and continue to deliver a high quality and reliable supply of water."*[200]
- **India.** In May 2017 the government approved a new coal linkage policy which underscored India's changing energy policy—from fossil fuels to renewable energy[201]. Then in June 2017 the government committed to only selling electric cars in 2030[202].

4.4 Collaborative initiatives

The Under2 Coalition drives net-zero ambition and action at every level of government. A total of 177 jurisdictions, representing 37 countries and six continents, have signed or endorsed the Under2 Coalition (Figure 4-4)[203]. Signatories of the Coalition commit to reduce their GHG emissions by 80-95 per cent (relative to 1990 levels), or to two metric tonnes of CO_2 equivalent per capita, by 2050. Collectively, the Under2 Coalition represents more than 1.2 billion people and $28.8 trillion in GDP – equivalent to 16 per cent of the global population and 39 per cent of the global economy.

Figure 4-4: Endorsers and signatories of the Under2 Coalition

Source: The Under2 Coalition[204]



The Under2 Coalition's work is based on three work streams.

1. Developing 2050 pathway plans – supporting Under2 signatories in developing short- and long-term goals and pathways to 2050;

2. Scaling innovative policy solutions – supporting the upscale and sharing of the best policy solutions; and

3. Measuring progress – ensuring governments have the expertise and systems in place to assess their emissions accurately and track progress against their targets.

The Nordic Region is cooperating for a green economy. The five Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, have been aiming *"to create a larger regional market, give a political lead in the EU, improve joint infrastructures and provide critical mass for future developments."*[205]

The priorities have been to use Nordic strengths in a number of areas including:

- Developing Nordic test centres for green solutions;
- Working together on green-technology norms and standards;
- Working together on green procurement in the public sector; and
- Co-ordinating and improving funding for green investment and companies.

In October 2015, the prime ministers of the Nordic countries took the decision to launch a new initiative focused on Nordic solutions to global societal challenges. The Nordic countries have long striven to create more sustainable societies. The purpose is to promote solutions and innovations that address some of the most pressing global issues. The flagship projects that add to a green economy are:

- Nordic Food Policy Lab disseminates lessons learned from Nordic policies on nutrition, food waste and New Nordic Food, involving consumers in a transition to more sustainable food systems[206].
- Nordic Sustainable Cities concentrates on building networks and exporting sustainable solutions for urban development in close collaboration with national agencies and business[207].
- Nordic Energy Solutions seeks to share Nordic energy models and know-how with regional energy markets in different parts of the world and assist in the design of renewable energy systems and attractive markets[208].
- Nordic Climate Solutions focuses on Fossil Fuel Subsidy Reform (FFSR) and how progressive Nordic solutions in environmental economics, green technology and environmental policy can be deployed in the developing world[209].

In 2017, the green growth theme had maturity into a number of parallel themes. One is the Nordic Bioeconomy which is about a green transition: *"the replacement of unsustainable and fossil-based resources, through the upgrading of side streams and waste, and by creating circular and sustainable local solutions."*[210]

In September 2017 the countries adopted a joint programme for the implementation of the SDGs – which include goals needed for a green economy – under the title 'Generation 2030'[211].

This will address the main issues for the region on the SDGs: *"a green transition in the region's agricultural systems, more low-carbon energy, economic growth for all, and improved ecosystem conservation."*

4.5 What is next?

More countries and cities are expected to encourage electric vehicle adoption through regulation. The UK and France, India and Norway, and the Netherlands already announced in 2017 they will only sell hybrid and electric vehicles from 2040, 2030, and 2025 respectively. The Mayors of London, Los Angeles, Paris, Mexico city and several other major world cities also pledged to ban gasoline and diesel vehicles from "large parts" of their cities by 2030.

The Paris Agreement and the SDGs provide the global framework. We can expect more policy makers to align their efforts with these two global commitments.

Looking for co-benefits, especially heath and green economy. We can see in China, for instance, concerns about urban air quality help to shift energy generation and industrial pollution. A recent US study found that health benefits from wind and solar energy (via reduced air pollution, for instance) was far less than the subsidies received[212]. In the UK, a 'toxin tax' has already been introduced to address the poor quality in London.

Preparing for a future of shocks. There are some different economic shocks which are possible – even likely – as we go forward, for instance:

- Impact of extreme weather events. Particular regions and supply chains are vulnerable to extreme events. A single occurrence can probably be contained. But there are increasing chances of several events accumulating. Imagine a drought affecting several of the world's breadbaskets?
- Stranded assets and swift technological change. Imagine that prospective demand for electric vehicles rises faster than many projections (as has already happened with the uptake of renewables). Financial markets can exhibit herd-like behaviour which can blind them to impending shocks. Imagine the reverberations of public oil and gas firms collapsing if global action on climate change means that a substantial proportion of fossil fuels must remain in the ground.

Policymakers have a duty to prepare for shocks and mitigate the impact on society. Leading policy makers will look on shocks as an opportunity to re-orientate toward a green economy.

Preparing for winners and losers. As the transition to a green economy intensifies the disruption is likely to be much more significant for companies and sectors that fail or that are slow to respond[213]. Policy makers will need to find ways to help those who are left behind by the transition, and ensure that a robust policy framework and sound enforcement mechanisms are used to drive change.

Part 5

How to show leadership and benefit from change

5.1 Overview

The previous sections show that the green economy is of ever-greater importance.
It addresses today's pressing priorities for jobs, development and growth. It gives direction for tomorrow, so we are not threatened by climate change, shortages, or ecosystem collapse. A green economy is the only way we can have a dynamic global economy where people thrive and businesses succeed.

Even with all these great innovations we are not moving fast enough to address the risks to prosperity. The current pace of change still leaves the world exposed to unacceptable risks to prosperity and security.

We can wait for others – or we can show leadership.
The innovations in business, the investments from finance and the policies from government can reinforce each other. But we do not gain those common synergies by waiting for someone else to act. We need leaders, who are willing to take that next step.

This final section sets out a few examples of the ways in which you can show leadership. Leadership in dealing with the risks inherent in any transition, in overcoming the inertia of deeply-engrained systems, and while facing the entrenched interests of the status quo.

Each significant economic actor has a role in creating the enabling conditions for a green economy- in collaboration.
CISL's *Rewiring the Economy* plan sets out ten interconnected tasks to be delivered by business, finance and policymakers leaders[214]. These tasks are designed to lay the foundations for a sustainable economy that can deliver the SDGs – which includes creating a green economy.

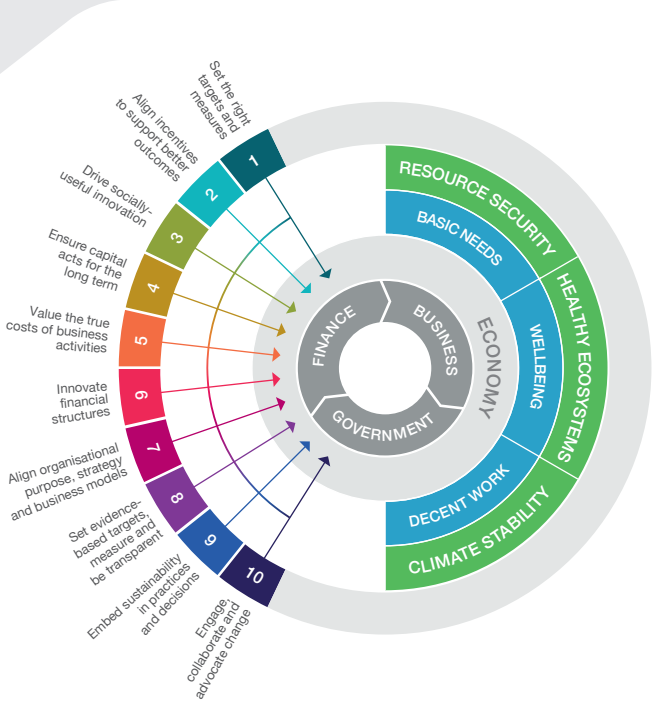


Figure 5-1: Ten tasks for business, government and finance to lay the foundations for a sustainable economy
Source: CISL, *Rewiring the Economy*[215]

Within CISL's *Rewiring the Economy* report we have organised ways to take leadership into four sections: Business, Finance, Government and Cross-cutting challenges for transformation which are highlighted in the following sections below.

5.2 Business

Business is the engine of the economy, with finance the fuel and government providing the steering. Any serious rewiring of an economy must therefore be based on for business engagement and leadership[216]. Here are four strategic enablers that businesses can progress with government, financial and educational institutions.

5.2.1 Align organisational purpose, strategy and business models

Use 'green economy' as your innovation direction. Within a commercial context businesses can explicitly set out to improve people's lives whilst operating within the natural boundaries set by the planet.

Many of the innovations in the report were the result of companies aligning themselves with a green economy. They asked themselves: is the innovation pipeline and scale of investment consistent with a pathway to maintain global temperature rise under 2°C, or even 1.5°C? Will we have the regenerative business models, which adopt circular material flows and a blend of product and service approaches, needed?

This level of disruption will be challenging. Incumbents who fit well with the past will need to change. There will be a rebalancing of corporate portfolios, creating winners and losers.

In a time of drastic change, innovators inherit the future. Businesses anticipating and proactively engaging with change stand the best chance of being winners in the new economy.

5.2.2 Set evidence-based targets, measure and be transparent

Measuring and disclosure for better management. Business leaders measure what they seek to manage, and also must measure what matters. To accelerate progress on sustainability, businesses can ensure that they measure the right things in their operational practices using appropriate social, environmental and economic criteria.

Setting ambitious goals to attract what you need. They send a strong signal to staff, partners and other stakeholders that the leadership is committed to delivering its purpose, together with the radical innovation and new thinking required to achieve it. As the Science Based Targets illustrate, this helps draw forth innovation in others, helps find allies within peers, and influences governments for supportive, ambitious policies.

Disclosure for greater financing and trust. The shifts in finance detail above indicate another benefit. Clear disclosure of how longer-term value creation is aligned with a sustainable economy will help the capital markets to allocate more financing, whether through green bonds or otherwise. Also, such transparency facilitates a more informed dialogue with stakeholders, and greater trust in the role of business in meeting global challenges.

5.2.3 Embed in operational practices and decisions

Businesses are by nature places of action. Decisions and actions taken by employees each day shape the activities of their company, from top executives to the shop floor. To deliver on bold visions and specific targets, businesses will need to act differently through their decision-making, operations, supply chains, policies, management tools, and governance. Only then will they generate the technological and other innovations that can then be scaled.

Integrate into day-to-day decision-making at all levels. This may mean new policies and methods in sourcing and production; making bold decisions which go further than required by government policies to take voluntary action on labour rights, greenhouse gas emissions, or sustainable sourcing standards, for example. It will mean difficult decisions to rebalance portfolios and activities away from those which are fundamentally unsustainable or do not contribute to the core purpose of the company, aligned with a sustainable economy.

Business must equip staff to operate in new ways. Executives must navigate the leadership dilemmas inherent in focusing on the long term whilst performing in the short term. Businesses can educate staff with the insight and understanding to be able to deliver against these targets through personal and professional development, management information, decision-making and long-term incentive plans.

5.2.4 Engage, collaborate and advocate change

Business can build public and government appetite for a green economy. Not all stakeholders – including governments – are currently on board with the challenge, let alone pedalling hard for solutions. Using corporate influence for positive policy and cultural change is an essential characteristic of a sustainable business.

A significant proportion of the information citizens and governments receive is via the communications, marketing and public relations undertaken by business. These powerful influences can be used to help stakeholders across civil society see why sustainable business makes sense; why a green economy is not only critical for survival but a great place to live and work.

Such engagement mitigates risk and unlocks opportunities for innovations. For example governments and regulators which set the rules and standards, Key starting points are customers, communities, suppliers, investors, regulators and business associations. Businesses can work with governments and communities to minimise potential negative impacts of change, such as job losses caused by industry transitions. They can enable communities to have a voice in transition planning and to be equipped with the skills to access new opportunities.

5.3 Financial players

If business is the engine of the economy, then finance provides its fuel. As a universal influence on business, the role of financing rewiring and economy is simple: to steer capital towards economic activities that support the future we want and away from activities that do not. Three collective shifts are necessary.

5.3.1 Ensure capital acts for the long term Investors of capital can demand more from their money

They can use their influence to drive long-term, socially useful value creation in the economy in the interests of their beneficiaries. In the innovations above, finance is vital to enabler innovation in others, directly through funding and indirectly through the expectations financial players have of their assets. That is why innovations in finance are crucial in the pursuit of a green economy.

Investors can reward companies for incorporating a long-term risk and value creation in their business models. Extending the time horizon in this way build alignment between the way capital is deployed and the interests of its ultimate beneficiaries – the public. This big and urgent reform faces an uphill climb against a well-known culture of short-termism. Even so, there are the regulatory efforts described above and some of the financial innovations themselves which are trying to climb that hill.

5.3.2 Price capital according to the true costs of business activities

Capital providers, and those who regulate them, can reflect social and environmental risk factors in the cost of capital. Ultimately, the assessment of risk and return that underpins cost of capital calculations dictates how it is deployed and hence which business activities are able to flourish. Some of the financial innovations above seek to change that calculus.

Currently the cost of capital rarely reflects the true costs of business activities across the equity, debt and insurance. There is more to be done to pricing and the risks having natural system that is struggling – of an unstable climate, of unhealthy ecosystems and of depleted stocks of natural resources.

5.3.3 Innovate financial structures to better serve sustainable business

There needs to be more capital flowing into business models that serve a green economy. In recent decades the innovation of financial intermediaries, such as bank, has had the effect of extracting financial value from business and society. The examples above show how, for leading financial institutions, this same powerful instinct to innovation is now underpinned by a green economy.

Businesses that are innovating to address in society is changing needs almost certainly the brightest businesses of the future. It is in the interest of financial institutions to explore the patient capital, risk-sharing mechanisms, innovation support and pasty building that will fuel that next generation of companies.

5.4 Policy makers

If business is the engine and finance the fuel, then government sets the rules of an economy, steering its development. Their role in building a green economy is simple: provide signals and conditions necessary to adjust economic behaviour, responsible to the takes in government policy, regulation, spending and public service practice. Three shifts, supported by finance and business leaders, or needed to achieve this[217].

5.4.1 Measure the right things, set the right targets

Governments can set bold targets for the environmental progress, and adopt new measures to track how well the economy is delivering. Many policies argued towards growing GDP without sufficient regards to the quality of growth achieved. Some of the policy innovations above, including the Well-Being Of Future Generations Act in Wales, are aiming for a combination of quality and quantity of growth[218].

It is vital that policymakers send clear and credible signals. They can ensure a common understanding of the direction of travel. Without clear targets backed up by integrated measures, legal mandates and political commitment, policy innovations for a green economy risk working against the grain and of producing mixed messages for business.

5.4.2 Use fiscal policy to correct externalities.

Internalising externalities. Governments can bring environmental costs in economic activities through fiscal policy, any fitting the businesses and innovations that acting for a green economy. We have already seen that carbon pricing–whether through a carbon tax water emissions trading scheme–is a growing the policy innovation. Another powerful way to reflect and manage true costs is to remove all redirect subsidies otherwise make unsustainable economic activity cheaper, for example in relation to fossil fuels, soil damage, and biodiversity loss.

5.4.3 Drive socially useful innovation

Governments can use every opportunity to create drivers and incentives for innovation aligned with a green economy. They can exemplify and enable sustainable business. Many of innovations above use technologies that were researched, developed and first commercialised with public support. Public procurement, service delivery, planning policy, education, research funding, innovation support and other leaders of industrial (and infrastructure) policy can all be harnessed to drive a green economy.

5.5 Cross-cutting challenges

Looking across the innovations in the report there are several specific cross-cutting challenges we want to highlight.

5.5.1 How can we be explicit that the profound change required will have new winners and new losers, and formulate ways to address this?

The shift to a green economy will create winners and losers. In particular, incumbents in several industries will struggle to reinvent themselves, and have every incentive to use their political reach and lobbying power to delay change. Also, people who work in those industries are likely to lose their jobs, and the regions they live in will be deeply affected. To mitigate the risks associated with the transition to a green economy, business and political leaders will have to work together to weigh the impacts on specific regions, communities and individuals and include social justice considerations in their plans.

5.5.2 How can we make sure efforts in policy, finance and business align and reinforce each other?

The examples in this report illustrate that the efforts of business, finance and policy can generate positive synergies that can help shift the structure of the economy towards a green one. The 2015 Paris Agreement gives a clear and long-term direction of travel about how to address climate change, with confidence. The Sustainable Development Goals provide a similar frame, covering an extensive set of environmental and social issues.

The commercial case for the sustainable economy, and for leading the change, is very strong. And forward looking companies, governments and finance leaders are now framing their vision of what that looks like[219].

But signals and visions cannot deliver the green economy without practical action and changes. These include changing the way we plan and design for change, how we work with each other and how we support those that cannot adapt. The deep transformations involved in delivering a sustainable economy reflect completely different levels of co-ordination, engagement and transparency[220].

5.5.3 How can we act pragmatically to fundamentally reshape entire systems of production, distribution and consumption?

There are some situations where redesigning the system architecture is needed. For instance electricity. Our current configuration of incentives, regulations and design principles has grown up with a small number of large producers. We are moving to a large number of small producers, who are also sometimes consumers. We are starting to understand that market design and more is to be done to focus value on the user while driving down emissions[221].

We will need to practice some system innovation. Rather than thinking in terms of interventions from outside, we will need to understand that all choices (large and small) are either maintaining the status quo or helping things unfold differently. Instead of a fixed ideal end point, we can pursue ever-greater potential that does not have a final destination. We will need to consider the whole of a system over the long-term, while acting on this part here in front of us now.

For instance, how can a bank shift its investment portfolio to avoid risks, realise new opportunities and sustain the operating environment in which it does business? Each step needs to be pragmatic but the effect needs to be transformational.

5.6 It is time to act

The green economy has arrived. The convergence of technological, regulatory and business model innovations are disrupting entire sectors and creating new winners and losers. Look at the global car industry, but also the food, energy, and many other sectors: the risks and opportunities have never been greater.

It is time to act.

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