SEIZING THE GLOBAL OPPORTUNITY

PARTNERSHIPS FOR BETTER GROWTH AND A BETTER CLIMATE

The 2015 New Climate Economy Report

THE GLOBAL COMMISSION ON THE ECONOMY AND CLIMATE

THE **NEW** CLIMATE **ECONOMY**

The Global Commission on the Economy and Climate

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The 2015 New Climate Economy Report

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The New Climate Economy

The Global Commission on the Economy and Climate, and its flagship project **The New Climate Economy**, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change.

The New Climate Economy was commissioned in 2013 by the governments of seven countries: **Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden and the United Kingdom**. The Commission has operated as an independent body and, while benefiting from the support of the seven governments, has been given full freedom to reach its own conclusions.

In September 2014, the Commission published *Better Growth, Better Climate: The New Climate Economy Report*. Since then, the project has released a series of country reports on the United States, China, India and Ethiopia, and sector reports on cities, land use, energy and finance. It has disseminated its messages by engaging with heads of governments, finance ministers, business leaders and other key economic decision-makers in over 30 countries around the world.

The Commission's programme of work has been conducted by a global partnership of eight leading research institutes: World Resources Institute (WRI, Managing Partner), Climate Policy Initiative (CPI), Ethiopian Development Research Institute (EDRI), Global Green Growth Institute (GGGI), Indian Council for Research on International Economic Relations (ICRIER), Overseas Development Institute (ODI), Stockholm Environment Institute (SEI) and Tsinghua University.

The Global Commission on the Economy and Climate

The Global Commission on the Economy and Climate oversees the work of the New Climate Economy project. Chaired by former President of Mexico Felipe Calderón and co-chaired by Lord Nicholas Stern, the Commission comprises former heads of government and finance ministers, and leaders in the fields of economics, business and finance.

Members of the Global Commission endorse the general thrust of the arguments, findings, and recommendations made in this report, but should not be taken as agreeing with every word or number. They serve on the Commission in a personal capacity. The institutions with which they are affiliated have therefore not been asked formally to endorse the report and should not be taken as having done so.

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Executive Summary and Recommendations

2015 is a year of unprecedented opportunity. This year's landmark intergovernmental conferences – the International Conference on Financing for Development in Addis Ababa in July, the United Nations Summit to adopt the post-2015 Sustainable Development Goals in New York in September, the G20 Summit in Antalya in November, and the UN Climate Change Conference (COP21) in Paris in December – have the potential to advance a new era of international cooperation which can help countries at all income levels build lasting development and economic growth while reducing climate risk.

A goal once seen as distant – to end extreme poverty, achieve broad-based prosperity and secure a safe climate, all together – is increasingly within reach. As the Commission's 2014 report *Better Growth, Better Climate* argued, crucial investments will be made over the next 15 years in the world's cities, land use and energy systems. They have the potential to generate multiple benefits for economic growth, human development and the environment; or they could lock countries into high-carbon pathways, with severe economic and climatic consequences. Through credible, consistent policies to drive resource efficiency, infrastructure investment and innovation, both developed and developing countries can achieve stronger economic performance and climate goals at the same time. This report shows how such actions can be scaled up through cooperative, multi-stakeholder partnerships – not just between governments, but among businesses, investors, states and regions, cities and communities.

Technological innovation, new economic trends, and new political commitments are now combining to build momentum for change. Renewable energy costs continue to decline, and energy storage and demand management technologies are being developed rapidly, creating new opportunities to build cleaner and more efficient energy systems and to expand energy access in developing countries. Carbon pricing has been adopted or is planned in about 40 countries and more than 20 sub-national jurisdictions, and over 1,000 major companies and investors have declared their support for it. In the last two years, 28 countries have launched efforts to reform fossil fuel subsidies, helped recently by lower oil prices. Cities are adopting ambitious emission reduction and air quality targets and plan to track their progress using common standards. Some 175 governments, companies, indigenous people's groups and civil society organisations have committed to halt deforestation by 2030, and leading consumer goods and agricultural trading companies are working with tropical forest countries and communities to eliminate deforestation from their supply chains. International finance to support climate resilience and low-carbon investment continues to grow; issuances of "green bonds", for example, more than tripled in the last year. And companies, investors, governments and financial regulators are increasingly integrating climate change into their investment and business strategies, creating new opportunities and competitive advantage for market leaders.

At the same time, the costs of continuing the current fossil fuel-based economic model are becoming ever clearer. Air pollution primarily related to fossil fuel-based energy and vehicle emissions leads to an estimated 3.7 million premature deaths globally each year, with millions more suffering from respiratory illnesses. Growing traffic congestion is causing serious economic costs in cities throughout the world, while road traffic accidents kill around 1.25 million people annually, over 90% of them in developing countries. Volatile oil prices are likely to continue, increasing economic uncertainty and delaying business investment. As low-carbon energy costs fall and climate policy is tightened, locking in high-carbon assets increases the risk of future devaluation or stranding.

Yet action is not yet occurring at the scale or speed necessary for structural transformation toward a new climate economy. An increasing focus in international economic forums on infrastructure for growth, the emergence of new development banks and financing mechanisms, and historically low interest rates in some economies, create a significant opportunity to stimulate low-carbon growth in both developing and developed countries. But infrastructure investments remain inadequate almost everywhere. Performance continues to be constrained by the protracted effects of the global financial crisis, deeply embedded market failures, underlying weaknesses in policies and institutions, and the inertia of a longstanding high-carbon economic model.

While CO_2 emissions are beginning to decouple from growth in both advanced and some emerging economies, this process needs to accelerate if we are to avoid the worst impacts of climate change on human welfare and the global economy. Changes in seasonal weather patterns, and the rising costs of more frequent extreme weather events such as floods and droughts, are already being felt, particularly by the most vulnerable developing countries. To hold global warming to under 2°C, as agreed by the international community, the carbon emitted per dollar of GDP in the global economy is likely to need to decline by an average of nearly 5% a year between now and 2050, compared with the current rate of under 1.5%. For developing countries, improving emissions intensity allows for strong GDP growth while total emissions peak and then ultimately decline.

Achieving a new international climate agreement in Paris would provide a vital foundation for building a lower-carbon and more resilient global economy, sending a strong signal to businesses and investors. The agreement should include a long-term goal for emissions to reach near-zero or below in the second half of the century, and a mechanism for regular strengthening of commitments. A strong and equitable package of support for developing countries is needed, through which international public finance mobilises private-sector flows, complements strong domestic financial resources, and helps enhance institutional and technological capacities.

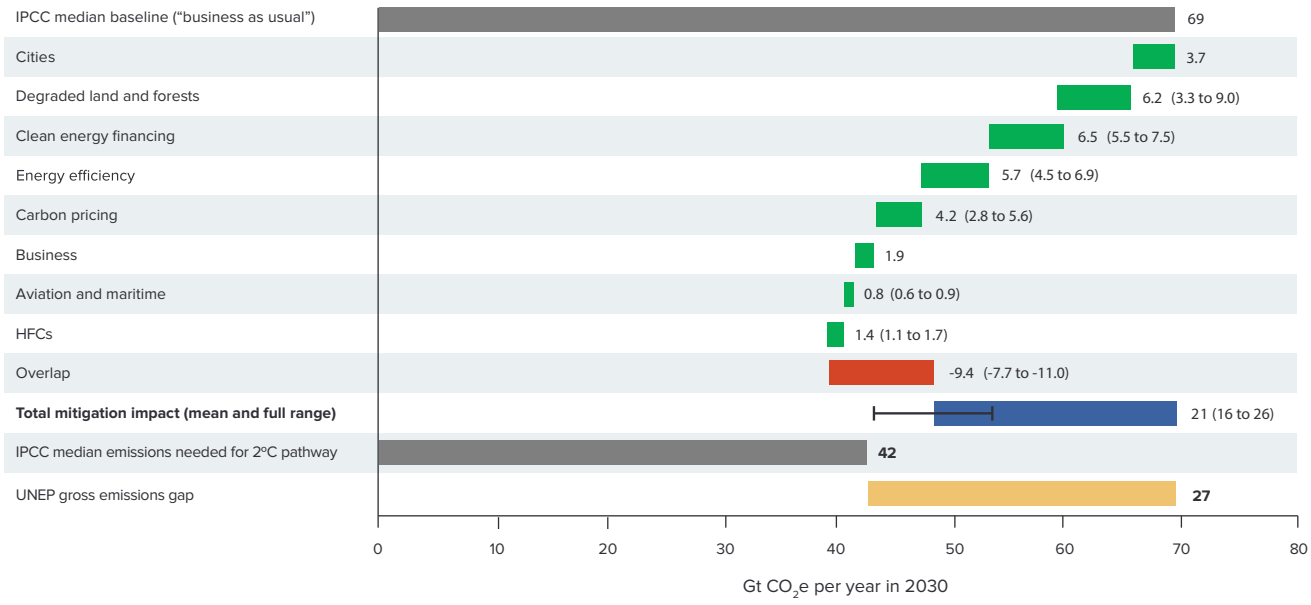
The "intended nationally determined contributions" (INDCs) that countries are submitting for Paris should be as ambitious as possible this year, but should be considered as floors rather than ceilings to national ambition over the coming years. Many INDCs already reflect historically ambitious commitments, but collectively it is likely that they will not be enough to achieve a 2°C path. As technological change, increased financing and multi-stakeholder action and cooperation create new low-carbon opportunities at lower cost, countries should aim to strengthen their commitments.

This report identifies 10 key areas of opportunity for stronger climate action which will also bring significant economic benefits. Together, these could achieve at least 59% and potentially as much as 96% of the emissions reductions needed by 2030 to keep global warming under 2°C. Cooperation of multiple kinds between governments, city authorities, businesses, international organisations and civil society can help to realise the full economic benefits of these actions. It can scale up technological change, expand markets, reduce costs, address concerns about international competitiveness, spread best practice and increase the flows of finance.

Multi-stakeholder and international partnerships can in this way strengthen current momentum, and help drive further economic growth and climate action together. The ten areas identified in the report cover the three key economic systems where economic growth and greenhouse gas (GHG) emissions are concentrated – cities, land use and energy; the three key drivers of growth – resource efficiency, infrastructure investment and innovation; action by businesses and investors; and three sectors where international cooperation is essential – reducing emissions from international aviation and shipping, and phasing down hydrofluorocarbons (HFCs). In each area, the report shows how strengthened partnerships between multiple stakeholders can catalyse significant economic benefits, as well as global emissions reductions, and identifies key commitments which can be made this year or in 2016.

The emissions reduction potential of the Commission's recommendations

Full implementation of the Commission's recommendations could achieve up to 96% of the emissions reductions in 2030 needed to keep global warming under 2°C.



Note: Bars show mean emissions reduction potential for each field with the full ranges in brackets.

Source: New Climate Economy, 2015. "Estimates of Emissions Reduction Potential for the 2015 Report: Technical Note." *A technical note for Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate. Available at: http://newclimateeconomy.report/misc/working-papers.*

The Commission makes the following recommendations:

In the key economic systems where growth and emissions are concentrated:

1. Accelerate low-carbon development in the world's cities

All cities should commit to developing and implementing low-carbon urban development strategies by 2020, using where possible the framework of the Compact of Mayors, prioritising policies and investments in public, non-motorised and low-emission transport, building efficiency, renewable energy and efficient waste management.

Compact, connected and efficient cities can generate stronger growth and job creation, alleviate poverty and reduce investment costs, as well as improving quality of life through lower air pollution and traffic congestion. Better, more resilient models of urban development are particularly critical for rapidly urbanizing cities in the developing world. International city networks, such as the C40 Cities Climate Leadership Group, ICLEI (Local Governments for Sustainability) and United Cities and Local Governments (UCLG), are scaling up the sharing of best practices and developing initiatives to facilitate new flows of finance, enabling more ambitious action on climate change. Multilateral development banks, donors and others should develop an integrated package of at least US$1 billion for technical assistance, capacity building and finance to support commitments by the world's largest 500 cities. Altogether, low-carbon urban actions available today could generate a stream of savings in the period to 2050 with a current value of US$16.6 trillion, and could reduce annual GHG emissions by 3.7 Gt CO_2e by 2030.

2. Restore and protect agricultural and forest landscapes, and increase agricultural productivity

Governments, multilateral and bilateral finance institutions, the private sector and willing investors should work together to scale up sustainable land use financing, towards a global target of halting deforestation and putting into restoration at least 500 million ha of degraded farmlands and forests by 2030. Developed economies and forested developing countries should enter into partnerships that scale up international flows for REDD+, focused increasingly on mechanisms that generate verified emission reductions, with the aim of financing a further 1 Gt CO_2e per year from 2020 and beyond. The private sector should commit to extending deforestation-free supply chain commitments for key commodities and enhanced financing to support this.

Halting deforestation and restoring the estimated one-quarter of agricultural lands worldwide which are severely degraded can enhance agricultural productivity and resilience, strengthen food security, and improve livelihoods for agrarian and forest communities in developing countries. Developing countries, supported by international partnerships between governments, the private sector and community organisations, and initiatives such as the New York Declaration on Forests, REDD+, Initiative 20x20 in Latin America, the Africa Climate-Smart Agriculture Alliance and the Global Alliance for Climate Smart Agriculture, are helping to improve enabling environments for forest protection and agricultural production, and reducing and sharing investment risk to facilitate larger financial flows. The Consumer Goods Forum and companies representing 90% of the global trade in palm oil have committed to deforestation-free supply chains by 2020, while major commodity traders and consumers are working to widen such pledges to other forest commodities. Enhancing such partnerships could enable a reduction in annual GHG emissions from land use of 3.3-9.0 Gt CO_2e by 2030.

3. Invest at least US$1 trillion a year in clean energy

To bring down the costs of financing clean energy and catalyse private investment, multilateral and national development banks should scale up their collaboration with governments and the private sector, and their own capital commitments, with the aim of reaching a global total of at least US$1 trillion of investment per year in low-carbon power supply and (non-transport) energy efficiency by 2030.

The rapid scale-up of low-carbon energy sources and energy efficiency is essential to drive global growth, connect the estimated 1.3 billion people currently lacking access to electricity and the 2.7 billion who lack modern cooking facilities, and reduce fossil fuel-related air pollution. Increasing international financing for energy access is a key priority. International cooperation coordinated by development finance institutions is helping improve the risk-return profile of clean energy projects, particularly for renewables and energy efficiency, lowering the cost of capital for investment and increasing its supply. It is also starting to drive a shift in investments away from new coal-fired power and fossil fuel exploration; this needs to be accelerated, starting with developed and emerging economies. Scaling up clean energy financing to at least US$1 trillion a year could reduce annual GHG emissions in 2030 by 5.5-7.5 Gt CO_2e.

4. Raise energy efficiency standards to the global best

G20 and other countries should converge their energy efficiency standards in key sectors and product fields to the global best by 2025, and the G20 should establish a global platform for greater alignment and continuous improvement of standards.

Cooperation to raise energy efficiency standards for appliances, lighting, vehicles, buildings and industrial equipment can unlock energy and cost savings, expand global markets, reduce non-tariff barriers to trade, and reduce air pollution and GHG emissions. Cooperation should be facilitated and supported by the G20, empowering existing sectoral initiatives, and international organisations such as the International Energy Agency (IEA), the International Partnership for Energy Efficiency Cooperation (IPEEC), and Sustainable Energy for All (SE4All). Globally, enhanced energy efficiency investments could boost cumulative economic output by US$18 trillion to 2035, increasing growth by 0.25–1.1% per year. Aligning and gradually raising national efficiency standards could reduce annual GHG emissions in 2030 by 4.5–6.9 Gt CO_2e.

For the key drivers of both economic growth and emissions reductions:

5. Implement effective carbon pricing

All developed and emerging economies, and others where possible, should commit to introducing or strengthening carbon pricing by 2020, and should phase out fossil fuel subsidies.

Strong, predictable and rising carbon prices send an important signal to help guide consumption choices and investments in infrastructure and innovation; the fiscal revenues generated can be used to support low-income households, offset reductions in other taxes, or for other policy objectives. An estimated 12% of annual GHG emissions are now covered by existing or planned carbon taxes or trading systems around the world. Businesses are increasingly calling on governments to implement carbon pricing, and over 150 now use an internal carbon price (typically around US$40/t CO_2 for oil companies) to guide investment decisions. International cooperation on carbon pricing and subsidy reform, including through the G20 and with the support of the World Bank, the Organisation for Economic Co-operation and Development (OECD) and the International Monetary Fund (IMF), can help mitigate concerns about competitiveness impacts from unilateral policy measures, improve knowledge-sharing and transparency, provide opportunities to link emission trading schemes, and reduce the costs of action.

6. Ensure new infrastructure is climate-smart

G20 and other countries should adopt key principles ensuring the integration of climate risk and climate objectives in national infrastructure policies and plans. These principles should be included in the G20 Global Infrastructure Initiative, as well as used to guide the investment strategies of public and private finance institutions, particularly multilateral and national development banks.

About US$90 trillion in infrastructure investment is needed globally by 2030 to achieve global growth expectations, most of it in developing countries. Infrastructure investment has become a core focus of international economic cooperation through the G20 and for established and new development finance institutions. Integrating climate objectives into infrastructure decisions, often at no or very modest additional cost, will increase climate resilience and avoid locking in carbon-intensive and polluting investments. International finance will have to be significantly scaled up to deliver the up-front infrastructure investments needed to achieve development and climate goals, including increased capitalisation of both national and multilateral development banks.

7. Galvanise low-carbon innovation

Emerging and developed country governments should work together, and with the private sector and developing countries, in strategic partnerships to accelerate research, development and demonstration (RD&D) in low-carbon technology areas critical to post-2030 growth and emissions reduction.

Public funding for low-carbon RD&D is currently too low to catalyse innovation for long-term growth and cost-effective emissions reduction beyond 2030. It should be at least tripled by the major economies by the mid-2020s. International partnerships enable countries to share the costs of innovation, and the knowledge generated by it. This can be of particular benefit to low- and middle-income countries, enabling them to "leapfrog" to new technologies and enhance their innovation capacity. Priority areas for low-carbon cooperative innovation include agriculture and energy access, particularly in developing countries; longer-term global solutions such as bioenergy and carbon capture, utilisation and storage; and key technologies to avoid lock-in of carbon-intensive infrastructure, including buildings, electricity networks and transport systems.

In critical fields of business and finance sector activity:

8. Drive low-carbon growth through business and investor action

All major businesses should adopt short- and long-term emissions reduction targets and implement corresponding action plans, and all major industry sectors and value chains should agree on market transformation roadmaps, consistent with the long-term decarbonisation of the global economy. Financial sector regulators and shareholders should actively encourage companies and financial institutions to disclose critical carbon and environmental, social and governance factors, and incorporate them in risk analysis, business models and investment decision-making.

Businesses are driving a US$5.5 trillion global market in low-carbon and environmental technologies and products, and many large companies are now cutting their emissions, realising significant cost savings and often enhancing profitability. Business- and finance sector-led initiatives are setting new norms for corporate action, including long-term target-setting and the integration of climate risk into investors' analysis and strategy. Initiatives such as the Tropical Forest Alliance 2020 and the Low Carbon Technology Partnerships Initiative seek to transform markets in key sectors and value chains, driving innovation and creating global low-carbon markets. Companies should work with governments, unions and other stakeholders to ensure a "just transition" to a low-carbon economy, supporting job creation, skills development and community renewal.

For key sectors where international action can unlock low-cost emissions reduction:

9. Raise ambition to reduce international aviation and maritime emissions

Emissions from the international aviation and maritime sectors should be reduced in line with a 2°C pathway through action under the International Civil Aviation Organization (ICAO) to implement a market-based measure and aircraft efficiency standard, and through strong shipping fuel efficiency standards under the International Maritime Organization (IMO).

Global aviation and shipping together produced about 5% of global CO_2 emissions, and by 2050 this is expected to rise to 10–32%. Yet they offer some of the most cost-effective emission reductions available today, particularly through improved fuel efficiency. Two new IMO standards are expected to save an average of US$200 billion in annual fuel costs by 2030. Adoption by the ICAO in 2016 of a market-based measure (an emissions trading or offset scheme) can both cut emissions and potentially generate finance for climate action or other purposes. This should be complemented by a new aircraft standard to ensure emissions reductions within the sector. The IMO should adopt a global emissions reduction target and promote fuel saving through strong operational efficiency standards and a supporting data-sharing system. These measures could help reduce annual GHG emissions by 0.6–0.9 Gt CO_2e by 2030.

10. Phase down the use of hydrofluorocarbons (HFCs)

Parties to the Montreal Protocol should approve an amendment to phase down the production and use of HFCs.

Hydrofluorocarbons, used as refrigerants, as solvents, in fire protection and in insulating foams, are the fastest-growing GHGs in much of the world, increasing at a rate of 10–15% per year. Replacing HFCs with greener refrigerants has low upfront costs and can result in both energy and cost savings. Cooperative initiatives such as through the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), the Consumer Goods Forum, and Refrigerants, Naturally! are helping countries and companies scale back HFC use. Incorporating HFCs into the Montreal Protocol could realise significant near-term gains to slow climate change and provide support to developing countries, avoiding 1.1–1.7 Gt CO_2e of GHG emissions per year by 2030, while driving significant energy efficiency improvements.

Implementing these actions will in many cases require significant investment. International and national public finance will be needed to catalyse and help leverage private finance, in particular for low-carbon energy and urban development; action to halt deforestation and restore degraded land; to build capacity; and to scale up research, development and demonstration of clean technologies and processes. The economic benefits of such investment will be substantial, even without consideration of the gains for the climate.

The Global Commission urges the international community to seize the opportunity of the unique series of meetings occurring in 2015 to put the world on a pathway to low-carbon, climate-resilient growth and development. Cooperative action, between governments at all levels and with the private sector, international organisations and civil society, can help achieve both better growth and a better climate. This will require strong and sustained political leadership. But the prize is immense. Together, a secure, prosperous and sustainable future is within our reach.

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Introduction

This is a time of unprecedented opportunity. In the second half of 2015, world leaders will agree on new Sustainable Development Goals and how to finance them, and negotiate a comprehensive new climate change treaty. Technology is advancing rapidly, redefining what is possible. New economic trends and opportunities, combined with new leadership commitments, have built real momentum for change. This was already evident when the Global Commission published *Better Growth, Better Climate* last year; it has kept growing since.

A goal once seen as distant – to end extreme poverty, achieve broad-based prosperity and secure a safe climate together – is increasingly within reach. More and more governments, businesses and communities are actively pursuing it. But significant challenges and obstacles still stand in the way.

This report focuses on how international and multi-stakeholder cooperation can accelerate progress and help overcome key barriers. Such cooperation can take many different forms: it includes partnerships between governments, but also among businesses, investors, states and regions, city and local authorities, international organisations, civil society organisations and communities. Over the last few years many such partnerships have emerged. This report identifies some of the most promising ones and suggests ways to scale them up further. It also identifies areas where new initiatives are needed. As such, it provides a menu of options for different actors to contribute to delivering both economic and climate outcomes.

Better Growth, Better Climate shows how countries at different levels of development can achieve stronger economic growth, reduce poverty, advance development goals, and reduce climate risk at the same time. It focuses on the three major economic systems where growth and emissions are concentrated – cities, land use and energy – and calls for consistent and credible policies around three key drivers of change – resource efficiency, infrastructure and innovation (see Box 1). It shows that the economic and social benefits alone would make many low-carbon policies and approaches worth pursuing. But it also recognises that the challenges that countries face in tackling these issues are deeply shaped by their history and their political and economic circumstances. Low-income countries in particular need robust international support to make progress on these fronts – and some actions are difficult for any country to take on alone.

This is why international cooperation is so crucial. It is a key lever to strengthen and more effectively distribute the flow of new ideas and technical capacity. It can mobilise and scale up finance, particularly to developing economies. It can help overcome concerns about loss of competitiveness, reduce trade barriers and increase the scale of markets. By working together, countries, businesses, cities and others can move faster and achieve greater gains.

Further international and multi-stakeholder cooperation could also significantly enhance and complement the ambition of countries' commitments under the expected new climate agreement. The pledges made to date ("intended nationally determined contributions", or INDCs) are important steps forward, but it is now clear that they are unlikely to add up to a level of emissions reduction consistent with keeping global warming under the internationally agreed limit of 2°C. The INDCs are therefore just a starting point; to avoid even more severe impacts on human well-being and economic growth than are already expected, ambition will need to rise steadily over the next 10–15 years. Cooperative action can make that easier and more cost-effective.

Part 1 of this report outlines some of the major emerging developments and trends which are creating new opportunities to achieve stronger growth and climate action together, as well as continuing challenges. It then looks at how stronger international and multi-stakeholder cooperation can advance and accelerate progress and help tip the balance towards low-carbon global growth. It discusses these different forms of cooperation, and places them in the context of the international climate negotiations. Part 2 then explores 10 areas where there are large, immediate opportunities to galvanise such partnerships, summarising in-depth analyses set out in a series of Working Papers, on which this part is based.

The international meetings taking place in the remainder of 2015[1] – in particular the International Conference on Financing for Development in Addis Ababa in July, the UN Summit to adopt the post-2015 Sustainable Development Goals in New York in September, the G20 Summit in Antalya in November, and the Paris Climate Change Conference (COP21) in December – are critical moments for the international community. The world's leaders must rise to the challenge. Failure to seize these opportunities would set back the cause of development and poverty reduction for years. But success could unleash a new era of international cooperation for better growth and a better climate. The Commission hopes this report can contribute to that success.

Box 1

Better Growth, Better Climate – Key Insights

The Global Commission on the Economy and Climate's 2014 report, *Better Growth, Better Climate*, is addressed to economic decision-makers across the world, in both the public and private sectors. It examines the large structural and technological changes already occurring in the global economy, and shows that through targeted policies and investments, countries at all levels of development can build stronger economies while substantially reducing climate risk.

A key insight of the report is that many of the policy and institutional reforms needed for revitalising growth, fostering development and improving well-being are also crucial to tackle climate risk. The opportunities for such reforms are increasing, as emerging and developing economies experience rapid urbanisation and structural change, innovation reduces the cost of a low-carbon transition, and the costs of the current economic growth model become more apparent. Many reforms can generate multiple economic, social and environmental benefits: improved economic performance and faster poverty reduction, as well as cleaner air, more liveable and vibrant cities, and greater resilience to climate change.

The report examines three key drivers of change: efficiency of resource use, infrastructure investment, and innovation. All three offer potential for both improving growth and reducing climate risk. Progress will be especially important in three key socio-economic systems that underpin a large share of the world's economic activity and greenhouse gas (GHG) emissions: cities, land use, and energy. Credible and consistent policies are needed in each, taking into account the unique circumstances, varying capacities and differing needs of countries at different levels of development.

Cities and urban areas are home to half the world's population, and account for about 80% of global economic output and around 70% of global energy use and energy-related GHG emissions. Nearly all of the world's population growth in the next two decades will occur in urban areas, primarily in developing countries; by 2050, two-thirds of the global population will be urban. How cities develop is thus critical to the future path of the world economy, development and climate. A large share of urban growth today involves unmanaged sprawl, leading to congestion, rising air pollution, and high economic, social and environmental costs overall. As discussed in Section 2.1 of this report, pioneering cities around the world are demonstrating the benefits of a different approach: more compact, connected and efficient urban forms built around mass transit. Adopting this model not only leads to more attractive and competitive cities, but higher quality of life, sustained resource savings and lower GHG emissions.

Land use is a key development concern, as roughly a quarter of the world's agricultural land is severely degraded, and forests continue to be cleared for conversion to crops and pasture, and for timber and mining. Key ecosystem services are being compromised, and the natural resource base is becoming less productive. Yet by 2050, the world's farms will need to produce 70% more calories than in 2006, due to population growth, rising incomes and changing diets. There is considerable scope to increase agricultural productivity and resilience through new methods of crop and livestock management and the restoration of degraded land, and at the same time to reduce the estimated 25% of food that is wasted globally. *Better Growth, Better Climate* recommends international cooperation to restore 500 million hectares of degraded forests and agricultural land through scaled-up investment and adoption of landscape-level approaches. It also recommends a scale-up of programmes to protect and restore forests, including reaching at least US$5 billion investment in REDD+ financing per year. Section 2.2 of this report highlights recent initiatives that can help to deliver this.

Energy use has grown by more than 50% since 1990. Energy services will need to keep rising rapidly to support continued development and bring modern energy access to the 1.3 billion people who lack access to electricity and the 2.7 billion who lack modern cooking facilities, mostly in sub-Saharan Africa and South Asia. Energy production and use already account for two-thirds of global GHG emissions, so how this new demand is met is a crucial determinant of climate risk. *Better Growth, Better Climate* stresses the need to sharply boost energy efficiency, encouraging governments to treat it as the "first fuel" – a topic discussed further in Section 2.4 of this report. It also urges an expansion of low-carbon energy production, particularly renewables, noting their falling costs and the benefits to energy security, air quality and public health. And it calls for an end to new unabated fossil fuel power: in developed countries immediately, and in emerging economies by 2025, while acknowledging the specific needs of lower-income countries. Energy markets and financing methods also need to be adapted to accommodate renewables at scale; this is discussed in Section 2.3.

Cutting across and shaping these three socio-economic systems are three major drivers of change:

Resource efficiency is essential for achieving both better growth and emissions reduction. There are numerous opportunities to boost efficiency in the use of energy, water, land, capital and other crucial resources through reforms to tackle market failures and poor policies. *Better Growth, Better Climate* recommends that governments introduce strong, predictable and rising carbon prices as part of fiscal reform strategies, prioritising the use of the revenues to offset impacts on low-income households or to finance reductions in other, distortionary taxes. Effective policies will need to be tailored to each country's circumstances. As discussed in Section 2.5, there has been considerable momentum towards both carbon pricing and fossil fuel subsidy reform in the last two years. In rural areas water, fertiliser and power subsidy reforms are likewise needed to encourage more efficient and sustainable agricultural practices.

Infrastructure investment – in transport networks, power plants and transmission systems, buildings, water and telecommunication systems – is a crucial driver of development, providing critical services and raising the overall productivity of the economy. The nature of infrastructure investment will also determine to a great extent whether economies can shift to a low-carbon path or are locked into high levels of fossil fuel use and inefficient, sprawling cities. The global economy will require about US$90 trillion in infrastructure investments by 2030 across cities, land use and energy systems, much of this in developing countries. A low-carbon transition will require a shift in the allocation of this investment, with perhaps a 5% increase in upfront capital needs – about US$270 billion per year. These higher capital costs could potentially be fully offset by lower operating costs, such as from reduced expenditure on fuel. Section 2.6 examines how infrastructure planning can be made both more resilient to climate impacts and compatible with climate mitigation goals.

Innovation is central to economic growth and productivity. Innovation, and the rapid diffusion of clean technologies between countries, is also essential to achieve low-carbon development models, making it possible to continue economic growth in a world of finite resources. Advances in materials science, digitisation, the circular economy and business models are now reshaping industrial production, and creating opportunities for developing countries to "leapfrog" over less efficient, more polluting stages of development. *Better Growth, Better Climate* argues that public support for energy research and development (R&D) should be at least tripled in major economies by the mid-2020s, to well over US$100 billion per year. It also encourages the use of pricing mechanisms, regulatory standards and public procurement to create market "pull" for low-carbon technologies. Section 2.7 highlights key areas where international partnerships to share costs and knowledge could greatly enhance national efforts, particularly to support growth and emissions reduction in emerging and developing countries.

By pursuing these approaches, *Better Growth, Better Climate* argues that economic growth, development and climate outcomes can be achieved at the same time: though some trade-offs may inevitably have to be made, countries need not choose between them. The multiple benefits of climate action include reductions in the health impacts of air pollution, in traffic congestion and accidents; lower risk of locking in stranded assets; less vulnerability to volatile fossil fuel prices and potential fuel supply disruptions; enhanced productivity of agricultural and forested lands, and associated increases in rural income; as well as the benefits of reduced climate impacts. In terms of air pollution, for example, fossil fuel-related outdoor air pollution leads to an estimated 3.7 million premature deaths globally each year, with millions more suffering from respiratory illnesses.

Yet *Better Growth, Better Climate* also stresses that shifting to a low-carbon, climate-resilient economic pathway will not be easy, and will entail additional investment in the short-term. Not all climate policies are win-win, and some sectors and businesses will lose out, even where there are overall net gains to the economy. Governments will need to commit to a "just transition", providing support for displaced workers, affected communities and low-income households. And the mix of policies used will need to be adjusted to suit different country circumstances. Strong political leadership and the active engagement of civil society and business will be crucial. Broad international cooperation is also vital, particularly to support developing countries in moving towards a lower-carbon and more climate-resilient growth model. A new international climate agreement, including robust financial commitments, is essential to lay a strong foundation for ambitious action in countries at all levels of development.

PART I: NEW OPPORTUNITIES AND CHALLENGES FOR LOW-CARBON GROWTH AND INTERNATIONAL COOPERATION

1.1 Recent trends and developments

The world is changing before our eyes. As discussed in *Better Growth, Better Climate*, new patterns of international production and trade, demographic change and technological advances have dramatically altered the shape of the global economy over the last two decades. "Business as usual" is no longer an option. Structural change is inevitable – but that change can be steered to make economies at all levels of development stronger, more equitable, more sustainable and more resilient.

Several emerging trends and developments offer new opportunities to accelerate the transition to low-carbon growth and prosperity. In this section we highlight six: rapid innovation and declining costs of clean energy technologies; the fall in oil prices as an opportunity to advance carbon pricing and fossil fuel subsidy reform; growing international attention to infrastructure investment, particularly in the context of low interest rates; heightened awareness of climate risks in the financial sector; rising interest in low-carbon growth pathways in emerging and developing economies; and an acceleration of the decline in the carbon intensity of the global economy.

These trends and developments are happening at all levels, from the global, to the regional and to the local. They are being spurred by leading companies, major cities and enlightened governments. None is decisive in itself, and in each case, major barriers and challenges still need to be overcome to achieve large-scale and lasting change. But as discussed in Section 1.2, international and multi-stakeholder cooperation can play a key role in helping overcome these challenges.

Rapid growth and record low prices for clean energy and energy storage technologies

In November 2014, a new price benchmark for solar photovoltaics (PV) was set in Dubai: a bid of just under US$60 per MWh in response to a tender from the state utility DEWA.[2] These are record lows, reflecting a global fall in the cost of solar power systems by 75% since 2000, while that of energy storage has fallen by 60% since 2005 alone.[3] In a wide range of geographies, utility-scale solar PV is being procured for about US$80/MWh.[4] This corresponds to natural gas prices in the range of US$7–10 mmbtu – still higher than the US$2–3/mmbtu seen in the shale-rich US in early 2015, but lower than the US$9–10/mmbtu prevailing in Germany and US$14–15 mmbtu in Japan.[5] This means that in an ever-growing number of countries, solar PV is now competitive with fossil fuels. A similar story can be told for wind power.[6]

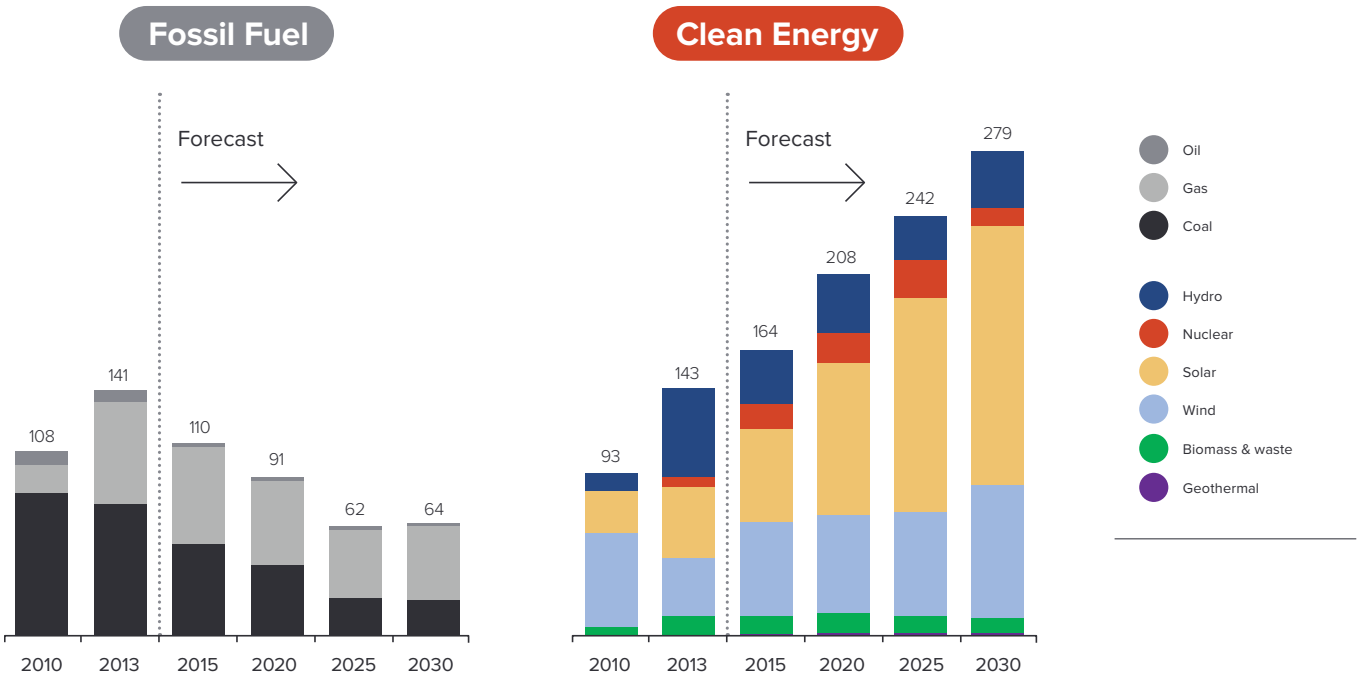
As a result of these falling costs, every dollar invested in renewables buys more capacity than ever: the US$270 billion invested in 2014 bought 36% more capacity than the US$279 billion invested in 2011.[7] Experts predict that a further rise in the competitiveness of renewable energy is now only a few years away as a result of plunging energy storage costs. The recent emergence of advanced low-cost batteries for homes, industry and utilities,[8] along with the rapid development of smart systems using digital and information technologies, is enabling the sophisticated management of demand at every level from the grid as a whole to individual homes. Radical new energy business models are now in prospect, with the potential to lead to a step-change in overall energy productivity.[9]

One result of these trends is that the share of new renewables (excluding hydropower) in electricity generation worldwide is rising – from 8.5% in 2013 to 9.1% in 2014, when renewables contributed 48% of the world's newly-added generating capacity (see Figure 1).[10] It is still not enough, but almost everywhere in the world renewable investment is growing rapidly.

Yet investment in fossil fuels also continues: in 2014, more than 1,300 GW of coal-fired capacity was in construction or pre-construction stages around the world, and major investments are being made in new sources of oil and gas.[11] At the current rate of increase of about 0.6–0.7 percentage points a year, the share of renewables in total electricity generation would still only reach 20% by 2030 – considerably less than the 41% which the IEA suggests is needed to hold global warming to under 2°C.[12] The speed of change is inhibited by several factors: continuing challenges raising the financing needed to invest in renewables; the difficulty of reforming energy markets and regulatory arrangements to enable the integration of intermittent renewables into electricity systems at scale; and continuing fossil fuel subsidies and weak or absent carbon prices, which keep fossil fuel energy prices artificially low. But in turn these challenges are spurring new efforts at overcoming them, in both national policymaking in many countries and through various forms of international cooperation. We discuss these below and in Section 2.3.

Figure 1

Annual additions to global power generation capacity (GW)



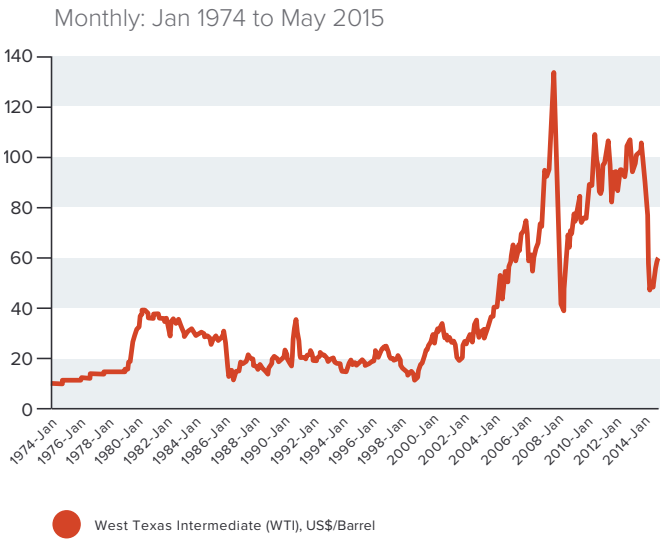
Source: Bloomberg New Energy Finance, 2015.[13]

A plunge in oil prices – and a chance to accelerate energy price reforms

Global oil prices fell by half between the middle and end of 2014 (Figure 2). At first sight, this might not seem like an opportunity for lower-carbon growth. In fact, it has raised demand for oil and gas to some extent. However, lower oil prices have also created an opportunity to pursue much-needed policy reforms. Low prices make it easier in particular for governments to reform fossil fuel consumption subsidies and adopt more efficient frameworks for energy taxation, while still keeping fuel prices affordable.

It is unclear how long this opportunity will last. There are multiple causes for the recent fall in prices, including the growth in unconventional sources such as shale oil, sluggish world demand, changes in the Organization of the Petroleum Exporting Countries (OPEC) price determination policy and a stronger US dollar. Empirical analysis suggests that supply factors played the biggest part in the recent price drop.[14] Modelling suggests that the oil price decline may increase global GDP by 0.3–0.7% in 2015, and by 0.2–0.8% in 2016.[15] However, there is little consensus on the medium-term direction of oil prices, and price predictions are in any case frequently inaccurate. What can be said is that large swings in the oil price of 25–50% over a short period are quite common, and such volatility is likely to continue. Volatility and the increased uncertainty it brings are economically harmful in their own right, delaying business investment and requiring costly reallocation of resources.[16]

Figure 2
Crude oil price (US$)



Source: FRED Federal Reserve Bank of St. Louis Economic Database[17]

Initially, there were understandable fears that the drop in oil prices might halt the rising demand for alternatives to fossil fuels, such as improved energy efficiency, renewables and electric vehicles. But this now looks unlikely, given the momentum of innovation and falling costs in renewable energy and energy efficiency. Indeed, greater energy efficiency and reliance on clean energy will provide an important hedge against the risk of higher oil prices in the future. Nevertheless, countries may need to adjust their support for clean energy in the near-term to ensure that its long-term benefits are not disrupted by the near-term decline in oil prices.[18] Enhancing international efforts to bring down the cost of capital for renewable energy and raising energy efficiency standards, as we discuss in Sections 2.3 and 2.4, will be particularly important.

A number of countries are taking advantage of the low oil prices to accelerate fossil fuel consumption subsidy reforms and the adoption of carbon pricing through carbon emission trading schemes (ETS) or carbon taxes. These reforms can help offset the near-term incentives for more fossil fuel consumption created by low oil prices, while yielding important long-term benefits for economic efficiency, energy security, government budgets, cleaner air and reduced climate risk, especially given the high volatility and uncertainty of oil prices in the future.[19] With the right approach and flanking policies to address social impacts, these reforms can be maintained even if oil prices increase. This is discussed further in Section 2.5.

As of 2015, about 40 countries and 20 sub-national jurisdictions representing almost a quarter of global GHG emissions have explicit carbon pricing policies in place or planned.[20] Taken together, the carbon pricing instruments in these jurisdictions currently cover about half of their GHG emissions, equivalent to 7 Gt CO_2e, or about 12% of global GHG emissions – triple the 4% covered in 2005. Important recent developments include the successful operationalization of pilot trading schemes in seven cities and regions in China, with a national ETS to be launched in 2016; the introduction of Korea's ETS in 2015; and the successful linking and expanding of the regional trading schemes in California and Quebec in 2014. They will be joined this year by Ontario.[21] Chile and Portugal have adopted carbon taxes, and South Africa plans to introduce one in 2016. India has increased excise taxes on diesel and petrol, representing an increase in implicit carbon prices.

It is clear that these reforms, while nationally determined, are mutually reinforcing, each making it easier for others to be introduced, as fears over competitiveness impacts are reduced and a sense of a "new policy normal" is created. As we note in Section 2.5, the various international initiatives now under way to build political support for carbon pricing, including among businesses, have the potential to expand its use much further.

Fossil fuel consumption subsidies in emerging and developing economies totalled US$548 billion in 2013, while fossil fuel exploration, production and consumption subsidies in OECD countries amount to US$55–90 billion a year.[22] But some 28 countries are now undertaking energy subsidy reforms, with reductions in consumer subsidies in countries such as Mexico, Egypt, Indonesia, Ghana, and India. Several others are considering additional steps, including Morocco and Jordan.[23] Lower oil prices have made this easier, though the political challenges remain formidable. In terms of production and exploration subsidies, low oil prices have, if anything, increased the pressure to maintain support. What countries undertaking reforms have almost all found, however, is that, while fossil fuel consumption subsidies are often introduced as a form of social protection, they are in practice regressive, with the richest 20% of the population typically capturing 40–50% of subsidy benefits, while the poorest 20% usually get much less than 10%.[24] Well-targeted cash transfers

provide more effective and efficient social protection for the poor, and many countries are now benefiting from the learning of others as policy practice spreads internationally (see Section 2.5).

A growing interest in new infrastructure investment and finance

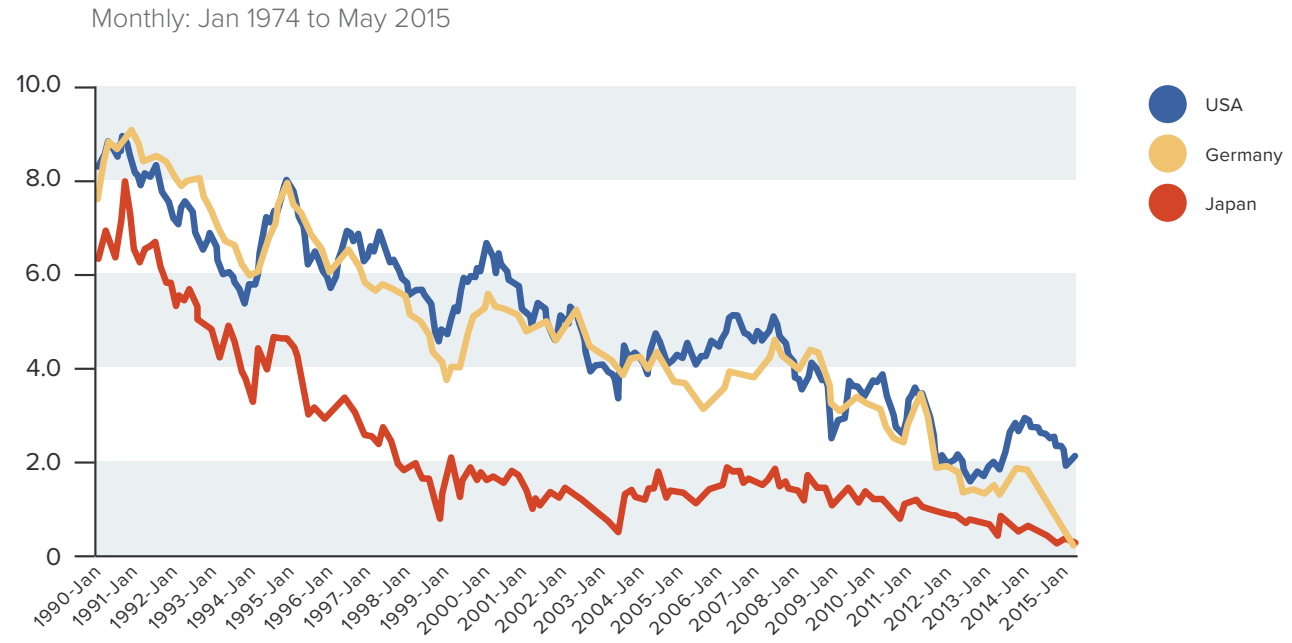
Infrastructure investment has risen to prominence on the international economic agenda in recent years. At its Brisbane Summit in 2014 the G20 established a new Global Infrastructure Initiative, along with an implementing "Infrastructure Hub", with the aim of catalysing both public and private investment.[25] Around the same time, the World Bank launched a Global Infrastructure Facility with other multilateral development banks and private sector investors to help deliver major infrastructure projects in low- and middle-income countries.[26] New multilateral and national development banks are being established with a specific infrastructure focus, notably the Asian Infrastructure Investment Bank[27] and the New Development Bank.[28] There is increasing interest in catalysing private financing of new infrastructure, particularly among institutional investors such as pension funds and insurance companies.[29] This is also a growing focus of the international discussions around Financing for Development, as we discuss below.[30]

Better Growth, Better Climate estimates that the world will need some US$90 trillion of infrastructure investment in 2015–30 (an average of US$6 trillion a year), concentrated in cities, energy and land use systems. But it points out that the choice of infrastructure is critical. Many forms of infrastructure, including roads, public transport systems, power plants, water management systems and urban buildings make significant contributions to GHG emissions, and they are also particularly vulnerable to the rising incidence of extreme weather events. If long-lived investments are made without attention to wider impacts, such as on energy security, air pollution, GHG emissions and resilience to climate damage, the world will become locked into a carbon-intensive development path with severe risks to both growth and climate. Building low-carbon infrastructure would require not much more capital, perhaps an additional US$4 trillion of investment (around 5% more), and this could well be largely or completely offset by longer term operational savings on fossil fuel costs.

Extremely low long-term real interest rates in many advanced economies provide an extraordinarily favourable financing environment for infrastructure investment. In March 2015 the real interest rate on 10-year US government borrowings was less than 0.3% (as reflected in yields on inflation protected securities). In Germany and Japan the nominal yields on 10-year government bonds were below 1% (Figure 3), which, given inflation expectations, constitute effectively zero or negative real interest rates. Given the likelihood that interest rates will rise over coming years, this presents a major and probably time-limited opportunity to finance new infrastructure at very low cost.[31]

Increasing investment in infrastructure is a powerful way to boost global economic growth, which remains mediocre. It can stimulate short-term demand in economies where it is weak, and ease supply bottlenecks and expand potential output elsewhere. Recent estimates by the International Monetary Fund (IMF) indicate sizeable and long-lasting impacts of public infrastructure spending on private investment and output. These effects are significantly larger during periods of slow growth and in countries with high public investment efficiency, which is critical to ensure that resources are not squandered on "white elephant" projects. Other studies document the impact of infrastructure in reducing poverty and distributional inequity in developing countries.[32] Given the critical need to replace old and often crumbling infrastructure in the developed world, and the huge deficit in infrastructure spending in most developing countries, this creates a major opportunity to drive global growth. But it has to be "climate-smart" – both low-carbon and climate-resilient. As we discuss in Section 2.6, it would be extremely short-sighted to build infrastructure which is immediately vulnerable to climate change impacts and/or to more stringent climate policy in the future.

Figure 3
10 year government bond yields (%)



Source: Federal Reserve Bank of St. Louis Economic Database[33]

The low real interest rates that advanced economies are enjoying are not being seen in most developing countries, which continue to face significantly higher market borrowing costs or are excluded from international capital markets altogether. Thus a major priority is to strengthen international collaboration on expanding the flow of climate-smart infrastructure finance to developing countries, as well as to tackle specific institutional and policy problems and uncertainties that inhibit private infrastructure investment.[34] These efforts should include technical and other assistance to help low-income countries strengthen their public investment management frameworks and capacities.[35]

Heightened attention to climate risks – and opportunities – in the financial sector

There is growing interest in climate risk within the financial sector. This is perhaps unsurprising in the global insurance industry, where climate risk is now widely integrated into both underwriting products and investment strategies. To increase risk transparency, the industry has embarked on a "1 in 100" initiative to develop climate risk metrics for one-in-100-year catastrophic events to be applied across private and public sector actors.[36] In the US, insurance regulators in several major states are implementing an annual Insurer Climate Risk Disclosure Survey.[37] But action is now spreading. Central banks, financial sector regulators, capital market authorities and finance ministries are also now beginning to include consideration of climate risks in the rules governing financial systems. The aim is to send clearer signals to financial markets, better aligning incentives for private investors with the true social cost of investment in fossil fuels and the benefits of clean investments.

The Bank of England, for example, is studying the impact of climate risks on the UK financial system, including both physical risks (such as catastrophic weather events) and transitional risks (related to the speed of transition to a low-carbon economy), while the Bank's Prudential Regulation Authority is reviewing the implications of climate change for the safety and soundness of insurance companies. Brazil's Central Bank has issued requirements for all banks to introduce systems for assessment of climate and other socio-environmental risks. A small but growing number of countries now have legal requirements for institutional investors to report on how their investment policies and performance are affected by environmental factors, including South Africa and, prospectively, the EU.[38] Concern about the risks of a "carbon bubble" – that highly valued fossil fuel assets and investments could be devalued or "stranded" under future, more stringent climate policies – prompted G20 Finance Ministers and Central Bank Governors in April 2015 to ask the Financial Stability Board in Basel to convene an inquiry into how the financial sector can take account of climate-related issues.[39]

Investors more generally are starting to become engaged. Following the passage of shareholder resolutions requiring BP and Shell to disclose their climate risks and strategies in spring 2015,[40] 62 institutional investors representing nearly US$2 trillion in assets called on the US Securities and Exchange Commission to push for better disclosure of such risks by oil and gas companies in general.[41] Others are now divesting from fossil fuel assets, particularly coal. Over the past three years more than 220 institutions, including colleges and universities, cities, religious institutions, pension funds, foundations and others have committed to such divestment.[42] In May 2015, Norway's sovereign wealth fund, one of the top 10 investors in the global coal industry, announced it would withdraw up to US$10 billion of investment from companies heavily reliant on coal.[43]

At the same time as attention to climate risk has been rising, there has also been increasing concern to ensure that financial systems are adequately structured to invest in the low-carbon economy. The UN Environment Programme's Inquiry into the Design of a Sustainable Financial System is conducting a two-year examination with the support of central banks and financial regulators across the world.[44] China is already working on a comprehensive framework for a "green financial system", including strengthening legal frameworks, improving information, increasing fiscal and financial policy incentives and developing its national development banks as leaders in green finance.[45]

Countries and jurisdictions such as Brazil, China, the European Union and India are also reforming regulations and incentives in order to promote the development of markets for "green bonds" and other investment vehicles for environmental and low-carbon infrastructure and assets. Issuances of green bonds (corporate, municipal or institutional bonds with proceeds earmarked for an environmentally-friendly project, or project bonds issued specifically with the backing of clean energy projects) have grown rapidly in recent years, from less than US$5 billion per year in 2007–12 to US$11 billion in 2013 and US$37 billion in 2014. Other investment vehicles are also expanding rapidly. In just two years, 15 "YieldCos" (publicly-traded companies paying dividends to shareholders from portfolios of owned renewable energy projects) have been set up in the US, Canada and Europe, with a total market capitalization of well over US$20 billion.[46] Several major global banks have made public commitments to increasing their investments in environmental and climate-related projects, including Bank of America and Citigroup.[47]

These are positive trends, yet they remain small relative to total global financial flows. There is thus great scope to scale up international financial initiatives to increase the capital allocated to low-carbon investment. We discuss this further in Section 2.3.

National development strategies are integrating green growth and climate resilience

A growing number of developing and emerging economies are building "green growth" and environmental sustainability into their national development and poverty reduction strategies. This reflects a recognition that countries in a wide range of economic circumstances can achieve their development goals through more sustainable approaches than others have pursued in the past.[48]

Rwanda, for example, a least developed country, adopted a Green Growth and Climate Resilience Strategy in 2011, aiming to mainstream climate goals into its economic development and poverty reduction plans. It aims for Rwanda to become a developed country by 2050, based on its renewable energy resources, particularly geothermal; integrated soil fertility management in its agricultural sector; and the development of high-density, "walkable" cities.[49]

Ethiopia, another least developed country, adopted a Climate Resilient Green Economy (CRGE) Initiative as part of its Growth and Transformation Plan (GTP) for 2010–25.[50] It seeks to secure "triple wins": simultaneously raising productivity, strengthening climate resilience and reducing GHG emissions, and tries to address trade-offs between these objectives. It includes initiatives to disseminate efficient cookstoves, and to introduce new soil management methods and agricultural technologies to raise yields and reduce emissions from agriculture, which will also reduce deforestation pressures. At the same time, as part of the drive to achieve middle-income status by 2025, the GTP aims to dramatically increase power generation capacity and energy access by exploiting the country's considerable renewable power potential, through hydroelectric power, wind, geothermal and biofuels.

Increasing energy production to achieve universal access and also support economic growth is a key development challenge for almost all countries in sub-Saharan Africa and for several in Asia, including India. In its 2015 report, the independent African Progress Panel led by Kofi Annan argues that the huge need to expand energy production in Africa will inevitably require continuing use of fossil fuels, including coal.[51] But the report also finds that Africa could "leapfrog" over the fossil fuel-based growth paths of developed countries and should aim to become a leader in low-carbon development, exploiting its abundant – and still barely utilised – renewable energy resources. This would require a significant increase in energy investment, amounting to around 3.4% of Africa's GDP. Countries such as Brazil have shown how energy supply can be increased rapidly; others such as Kenya and

Bangladesh are pioneering new approaches to financing decentralised solar power.[52] For example, Grameen Shakti operates a microcredit model that has financed more than 220,000 solar home systems and 30,000 energy-efficient cookstoves in Bangladesh.[53] But achieving the UN goal of universal access to energy by 2030 will require the support of the international community, including a significant scaling-up of finance and technical assistance. We discuss this further in Section 1.3.

China offers perhaps the most striking example of new policies. It has now embarked on a historic structural transformation that has global implications: both directly, because of China's role in the world economy, and indirectly, by the lessons it provides to other developing countries. China is moving away from a development model based on rapid growth in capital accumulation and energy-intensive export industries, powered largely by coal. It is seeking to move towards an economy based on growth in domestic consumption and services, with stronger innovation and more efficient resource use, powered increasingly by cleaner forms of energy. At the same time it is trying to reverse old patterns of urbanisation, which resulted in sprawl and rising air pollution. China's leaders have listed what they describe as building an "ecological civilisation" as one of the country's five top priorities guiding reforms. Severe air pollution is a key driver. In September 2013 China banned construction of new conventional coal-fired power plants in major economic areas, and in 2014 it instituted a national cap on coal consumption. Coal consumption in 2013–14 is estimated to have grown by only 0.1%, and may now have peaked.[54] At the same time, strong measures are being implemented to promote energy efficiency and expand nuclear, hydro, solar and wind power generation; China now has the most installed wind power and second most solar PV in the world.[55] Among the seven "strategic emerging industries" prioritised for economic growth in the government's 12th Five Year Plan (2011–16), five are environmental sectors, including new energy sources, energy conservation and clean vehicles.[56] China remains heavily coal-dependent, and its global growth is a major source of rising GHG emissions, but this is a serious shift in the form of its economic development.

These examples – and others in very different contexts, such as in Colombia, Costa Rica, South Korea and Indonesia – are indicative of a more widespread shift in the understanding of development paths. An increasing number of developing and emerging economies are coming to view environmental sustainability and climate action as integral elements of their growth strategies. But international cooperation – through increased flows of knowledge, financing and other resources – will for most developing countries be critical if these strategies are to be realised.[57]

The carbon intensity of the global economy is falling

The International Energy Agency (IEA) estimates that global CO_2 emissions from fossil fuel combustion held steady at about 32 Gt in 2014, the first time in 40 years that a halt or reduction in global emissions has not been associated with an economic crisis.[58] Global GDP, meanwhile, grew by just over 3%. This means that the CO_2 intensity of global GDP also fell by just over 3%. Examining these trends and future options, the IEA observes that, while definitive conclusions cannot be drawn from a single year, there are now positive signs that climate change mitigation efforts have the potential to decouple growth from emissions over the coming period.[59]

Although detailed information is not yet fully available, the slowdown in China's coal consumption and CO_2 emissions in 2014 appear to have been an important contributor to the apparent halt in global emissions growth, the result of strong policies to reduce air pollution, curb coal use, promote energy efficiency and expand low-carbon power generation capacity.[60] Efforts to increase carbon pricing, boost energy efficiency and shift to renewable energy are also helping to decouple CO_2 emissions from growth in both advanced and a range of emerging and developing economies. The reduction in the CO_2 intensity of global GDP adds to the growing body of evidence that countries can reduce GHG emissions while sustaining economic growth.

However, climate risk is still rising. The level of emissions remains extremely high, and it is still too early to conclude that it has stabilised. The IEA's 2 degrees scenario (2DS) – defined as an emission pathway which gives at least a 50% chance to keep the mean temperature increase below 2°C – provides a measure of the challenge ahead. The specific pathway explored by the IEA would entail reducing CO_2 emissions from energy consumption by almost 60% to reach 14 Gt CO_2 by 2050, with a decline to zero net emissions in the second half of the century. To get there, the IEA estimates that the world energy-intensity of GDP (broadly reflecting energy efficiency) and the carbon-intensity of primary energy consumption (broadly reflecting the share of fossil fuels in the energy mix) would both need to fall by 60% from 2012 to 2050, or by around 2.6% per year. The sum of these two measures is reflected in the CO_2-intensity of GDP. In the IEA's 2DS scenario, which assumes an average annual global growth rate of just over 3%, the CO_2-intensity of GDP would need to fall by close to 85% from 2012 to 2050, or by a global average of 5.3% a year.[61] For developing countries, improving emissions intensity allows for strong GDP growth while total emissions peak and then ultimately decline.

Table 1

Growth in world CO_2 emissions from energy and its drivers

	1980–2000	2000–2010	2010–2014
		Annual average growth (%)	
CO_2 Emissions	1.5	3.2	1.9
GDP	3.1	3.8	3.2
CO_2-Intensity of GDP	-1.5	-0.5	-1.3
Energy-Intensity of GDP	-1.3	-1.2	-1.4
CO_2-Intensity of Energy	-0.2	0.7	0.1

Sources: World Bank; IEA, 2014; Global Carbon Project, 2014; BP, 2014.[62]

Table 1 documents recent trends in world CO_2 emissions and three drivers: GDP growth, the energy-intensity of GDP and the CO_2-intensity of energy. Carbon dioxide emissions growth did slow significantly, from 3.2% per year in 2000–2010, to 1.9% in 2010–2014. Notably, a little over half of this decline was due to an accelerating decline in the CO_2-intensity of GDP, to an estimated average of -1.3% per year in 2010–2014. Because of incomplete data, we are less certain about recent trends in the components of the CO_2-intensity of GDP. Nevertheless they are moving in the right direction. The pace at which the energy-intensity of GDP is falling appears to have picked up modestly, to perhaps -1.4% a year in 2010–14. The CO_2-intensity of energy – the "dirtiness of the energy fuel mix" – was actually rising by around 0.7% a year in 2000–2010, primarily due to rising fossil fuel use in developing countries. However, CO_2-intensity growth appears to have slowed significantly in 2010–2014, and may even have stabilised. But the challenge is clear. Although GHG emissions are gradually being decoupled from growth rates, they are not doing so at anything like the rate required to put the world on a 2°C path.

This makes the need for both low-carbon and climate-resilient development strategies even more urgent. Growth in developing economies has steadily decelerated from 2010 to the present, and remains weak in advanced economies. World trade is growing at less than half its pre-crisis trend,[63] and there are concerns that global poverty reduction, which accelerated in the first decade of the 21st century, is now slowing down.[64] A billion people still live on less than US$1.25 a day, now largely concentrated in sub-Saharan Africa and South Asia, with around 2.4 billion living on less than US$2 a day.[65] Yet the continued rise in climate risk is most threatening to the global poor, who are particularly vulnerable to the impacts of climate change. Indeed, the warming towards which the world is currently headed, of 3°C or 4°C or more, could effectively reverse much of the development progress made over the last half century.[66] Adaptation programmes designed to increase resilience to climatic changes must therefore be an integral part of development and poverty reduction strategies, and need much greater attention and financing.[67] Yet adaptation alone is not enough, for without strong and early mitigation action, temperatures will continue to rise.

Both the need and the opportunity are therefore very great. By instigating a step-change in the rate of investment, particularly in infrastructure, and by ensuring that this is both low-carbon and climate-resilient, the international community has the potential to achieve multiple goals at once. It can stimulate global growth, restore progress on development and poverty reduction, and tackle climate risks. This will require serious and sustained attention to policy reform. Major obstacles – the protracted effects of the global financial crisis, the inheritance of deeply embedded market failures, weaknesses in policies and institutions, and the momentum of a high-carbon economic model built up over the last 150 years – all continue to inhibit stronger economic performance. But the potential, and the prize, are large.

1.2 The potential of international cooperation

These six recent trends and developments are all encouraging, but it is clear that none is yet occurring at a scale or pace sufficient to create a decisive shift in the direction of the global economy. As argued in *Better Growth, Better Climate*, national governments need to focus attention on the policies and institutions which can drive the necessary reforms: increasing resource efficiency, raising infrastructure investment and stimulating innovation, particularly in the three economic systems of cities, land use and energy. Box 2 summarises lessons learnt from different countries about best practices in policy-making for low-carbon growth.

National policy is critical. But the impact of national action can be greatly amplified when markets become global. The story of solar power provides an illustration. The dramatic reduction in the cost of solar PV over the last decade arose not just from advances in technology, but from governments' policy choices. The introduction of a solar feed-in tariff in Germany in 1991 led to a rapid rise in demand over the following two decades, while investment in solar manufacturing in China enabled costs to fall and supply to be expanded. The result has been the creation of a global market, expected to be worth around US$75 billion in 2016 (up from just US$40 billion just five years before),[68] with solar power in various uses now affordable throughout the world.

These and other examples – such as the comparable reduction in the costs of LED (light emitting diode) lighting over the last decade, and the rapid spread of mobile phones in Africa, which are making landlines increasingly obsolete – show how the creation of global markets and new business models can help transform individual technologies and national policies into dramatic agents of change, reducing costs, driving innovation and catalysing widespread dissemination.

Many of these processes have occurred without a deliberate process to drive them. But in many other cases, cooperation among governments and multiple other stakeholders – businesses, international organisations and civil society – has played a crucial role in scaling up and accelerating transformative change.

Box 2
National policy-making for growth and emissions reduction

Both the World Bank and the OECD have recently published studies bringing together learning and experience of successful policy-making for low-carbon growth.[69] The World Bank identifies three core principles. First, policy-makers need to plan with an eye on the long term. There are different ways to achieve short-term emissions reductions. But if the end goal is decarbonisation, it is vital that decisions now do not lock in high emissions in the future. Understanding the multiple economic, social and environmental benefits of low-carbon action, as *Better Growth, Better Climate* argues, can help long-term decision-making.

Second, carbon pricing is important, but has to be part of a wider policy package that triggers far-reaching changes in investment patterns, technologies and behaviours. The OECD shows how better alignment and integration of national policies and regulatory frameworks across ministries and sectors offers huge potential to achieve stronger impacts and reduce costs.[70] In many countries, misaligned policies are common, making policy goals much harder to achieve. A case in point is the continuing subsidisation of fossil fuel production and consumption even in countries with climate change mitigation policies. But there are many other areas where better alignment is possible, from financial prudential frameworks that inadvertently discourage long-term investment, to the continued decline in funding for energy RD&D as a share of total RD&D spending. Aligning policies in specific sectors is also important – for example, in electricity markets and urban public transport.

Third, managing the political economy of change is critical. As *Better Growth, Better Climate* argues, governments need to ensure that the shift towards a low-carbon economy is a "just transition". Not all climate policies are "win-win": although many jobs will be created, and there will be larger markets and profits for many businesses, some jobs will also be lost or need to evolve, particularly in high-carbon sectors. The human and economic costs of the transition should be managed through local economic diversification plans and support for displaced workers, affected communities and low-income households. Adequate social protection will be needed, along with active labour market policies to assist retraining and redeployment where necessary. Social dialogue and democratic consultation of social partners (trade unions and employers) and communities is important to ensure acceptance and trust. National transition plans are a valuable first step.[71]

First, such cooperation can be a powerful way of expanding markets and reducing costs. For example, over the last two years, international trade negotiations have moved towards reducing tariffs on low-carbon goods and services.[72] Convergence of national energy efficiency standards for appliances and industrial equipment can equally expand the available markets for national producers and reduce the transaction costs of exporting. Collective procurement of low-carbon goods and services by a number of city authorities and governments – in fields such as electric buses or low-carbon construction materials – offers another cooperative route to scaling up demand and cutting costs.

Second, for countries concerned that standards, carbon pricing or other climate policies could affect their international competitiveness, international cooperation can help overcome these anxieties. If multiple countries – particularly competitors – act together, this can help keep the playing field level. The same is true among businesses in globally traded sectors, which may find it difficult to take ambitious action alone. In both business and the public sector, leadership associations and "clubs" have helped support pioneers to take bolder action, both spurring them on and protecting them against internal criticism. When there is public scrutiny, the power of example can begin to change the norms of behaviour even where action is voluntary. Yet public policy reinforcement is also needed; for example, it is notable that the Tropical Forest Alliance 2020, which is working to eliminate deforestation from commodity supply chains, is not just a business coalition, but also involves governments in both forest and importing countries.

A third key benefit of international and multi-stakeholder cooperation is that it can enable extensive knowledge-sharing and capacity-building, and help identify and disseminate best practices. Opportunities for action on climate change are constantly developing, leading to a lot of "learning by doing". Many international cooperative initiatives are already facilitating the exchange of information on technologies, standards, policies and business models for climate action. They have particular value in scaling up solutions, and in transferring knowledge across countries and sectors. While historically, this has mostly involved North-South cooperation, there has been a rapid rise in South-South cooperation in recent years.

Fourth, and crucially, international cooperation is essential for expanding finance flows, particularly to the poorest countries and to sectors and activities that may not, on their own, attract sufficient private investment. This is one of the most important forms of intergovernmental cooperation, and another area where South-South cooperation is growing.[73] The multilateral development banks, UN agencies and other international organisations and partnerships are particularly important institutional vehicles for financial flows and capacity-building, with their strong capabilities in technical assistance. Achieving new agreements for future flows of both public and private finance to support sustainable development is a vital priority for both the Financing for Development and COP21 processes in 2015 (see Box 3). As we discuss in Section 2.7, financial cooperation is also important in the field of research, development and demonstration (RD&D), allowing countries and businesses to share the costs of accelerating and disseminating new technologies.

A new international climate agreement

The foundation of international cooperation on climate change is the UN Framework Convention on Climate Change (UNFCCC). Despite slow progress in recent years, negotiations are now well on the way to achieving a comprehensive new climate agreement at the Paris Climate Change Conference (COP21) in December. If countries can reach an agreement involving universal participation, it will be historic, as it will mark the first time that all countries make climate action commitments under the UNFCCC.

Such an agreement is important to create an equitable, rules-based system for the global governance of climate change. But as *Better Growth, Better Climate* argues, a strong agreement will also provide a clear signal to businesses and investors that the global economy is moving towards a low-carbon pathway. This will help shape economic expectations, spurring investment and innovation in low-carbon and climate-resilient economic activity. It will therefore in itself act to scale up global markets and reduce costs, while at the same time making the risks attached to high-carbon investment more transparent.

Box 3

Better finance for growth and climate

The major international meetings being held this year – the International Conference on Financing for Development in July, the United Nations Summit to adopt the post-2015 Sustainable Development Goals (SDGs) in September, the G20 Summit in November, and the UN Climate Change Conference (COP21) in December – provide critical opportunities to scale up investment to deliver both development and climate objectives.

In all these arenas it is crucial to take an integrated approach to building finance frameworks, so they can deliver both development and climate objectives together. While there are important differences of emphasis between the two agendas, the draft SDGs under discussion recognise significant synergies, and these need to be fully realised. Key areas in which the financing framework must be properly integrated include delivery of low-carbon infrastructure; promoting energy efficiency; building climate resilience and adaptation; halting deforestation and reversing land degradation; and fostering innovation.

Scaling up finance that supports both development and climate objectives will entail expanding domestic resource mobilisation, both public and private: this is an important need in many developing countries. But it also requires much larger international flows, in particular to developing countries, from both public and private sources. The role of multilateral and regional development banks in infrastructure, climate and other development financing needs to be significantly expanded, along with their support for efforts to establish and strengthen domestic policy frameworks. This should include increasing their capital base, allowing greater flexibility in the management of their balance sheets and streamlining decision procedures, alongside wider efforts to mainstream both climate change into investment strategies and development objectives into climate financing. (This is discussed further in Sections 2.3 and 2.6.)

While clean energy funds and other development financing vehicles have expanded greatly in recent years, more can be done. Institutional and policy problems that inhibit private investment in infrastructure and low-carbon projects urgently need to be tackled. Developing bankable projects that have the right risk-return profile to attract private-sector finance remains a challenge.

Some of the solutions include more stable policies to reduce investor uncertainty, as well as development of risk-sharing instruments, blended finance approaches and reform of financial sector regulations to increase the demand for clean infrastructure assets in institutional investor portfolios.[74] (This is discussed further in Section 2.3.) This will require strengthening institutions and policies for both public revenue and expenditure, as well as promoting development of local capital markets and financial systems. The outcomes of the Addis Conference on Financing for Development, where countries will agree how to finance delivery of the SDGs, should launch efforts to deliver on this agenda.

It is within this broader context that countries meeting at the UN Climate Conference in Paris need to agree on a new climate finance package. In Copenhagen in 2009, and confirmed in Cancún in 2010, developed countries agreed to mobilise US$100 billion per year by 2020 for developing-country climate action, from both public and private sources.[75] The Green Climate Fund, an important vehicle for delivering this finance, was operationalised last year after achieving US$10 billion in (multi-year) pledges. But a clearly agreed path on how finance will be increased to US$100 billion per year from these levels is still needed.[76] Public finance flows remain critical, particularly for adaptation and strengthening resilience. These funds, in turn, must leverage far greater sums in private investment, both domestic and international.

Continued efforts are needed to improve definitions of climate-relevant investment, to measure, report and verify financial flows and identify mobilised finance, and to understand and improve the effectiveness of such investment on adaptation and mitigation on the ground. A new UNFCCC agreement, as well as collaborative action agreed in other forums, will be essential to trigger wider action to deliver more sustainable infrastructure investment in all countries. For example, it could reinforce commitments to reduce and rationalise fossil fuel subsidies, and strengthen the assessment of climate risks and opportunities in fiscal and financial systems.[77]

Better Growth, Better Climate identifies key features of an agreement which would enhance this signalling effect (see Box 4).

Over the last 18 months, most countries have been preparing INDCs that set out their national targets, plans and policies beyond 2020 to be included in the Paris agreement; several have already been published.[78] In most countries the preparation process for these documents has required a serious – and in some cases unprecedented – analysis of how greenhouse gases are related to growth trends, and how these can be decoupled, absolutely or relatively. In many this represents an important step forward for the integration of climate considerations into mainstream economic planning.

Some INDCs represent historically ambitious commitments that will require considerable domestic effort to implement.[79] Nevertheless, initial assessments suggest that it is very unlikely that the mitigation actions pledged will add up to a global emissions reduction consistent with a 2°C pathway. Early estimates suggest that global emissions in 2030, if the current and expected INDCs are implemented, will be around 55–61.5 Gt CO_2e (up from 49 Gt CO_2e in 2010).[80] This would still be well above the median level of emissions (estimated to be around 42 Gt CO_2e) needed to have a more than 50% chance of putting the world on a 2°C path. Given the huge costs which would be involved in reducing emissions far more rapidly after 2030 – likely to involve the writing off of many assets – it may in effect risk putting 2°C out of reach.[81]

Thus it is essential that the INDCs submitted in 2015 are not only as ambitious as possible, but are also seen as the starting point, rather than the limit, of countries' climate ambition over the coming years.[82] This would follow the logic of policy-making: it is evident that policies which affect emissions a decade or 15 years into the future will not cease being made in 2015. Indeed, given the trends discussed in Section 1.1, there are strong reasons to believe that low-carbon options will become increasingly affordable and accessible. As they do so, policy-makers should be encouraged to increase the ambition of their climate targets and policies.

Box 4
A new international climate agreement

It is not the Commission's role to recommend the specific design of a new international legal agreement. But building on the conclusions of *Better Growth, Better Climate*, there are some core features which would enhance the ability of an agreement to send a clear signal to businesses, investors and governments on the future low-carbon and climate-resilient character of the global economy. These include:[83]

- A long-term goal that annual global emissions should fall to near zero or below in the second half of the century as indicated by the Intergovernmental Panel on Climate Change.
- A predictable and synchronised five-yearly cycle of commitments under which countries would gradually strengthen their emissions reduction plans over time. Countries' "intended nationally determined contributions" (INDCs) published in 2015 should be seen as foundations for their climate ambitions to 2025 or 2030, not limits to them, able to be strengthened (but not weakened) subsequently.
- Encouragement to all major economies to publish long-term economic development and growth strategies outlining how they plan to move in a low-carbon and climate-resilient direction. Though different for countries at different stages of development, the domestic political and policy-making processes needed to draw them up would greatly help businesses, investors and the wider public understand and debate the possibilities, benefits and costs of the low-carbon transition.
- Strengthened incentives and capacities for countries to address climate risks and reduce vulnerability through national adaptation plans. These would ideally incorporate action by sub-national governments and city and local government authorities, and set out the requirements on businesses and others to understand and take action to address climate risks.
- Common rules for measuring, reporting and verifying national policies and their outcomes. Such rules will ensure the credibility and transparency of commitments, and can also play a valuable role in monitoring and managing domestic policy.
- A framework for increased financial flows into low-carbon and climate-resilient investment and development. This should include the obligations of the richest countries to provide support to developing ones, and mechanisms designed to facilitate increased flows of private-sector finance.

An international agreement will contain many other provisions; this is not intended to be a comprehensive description. But an agreement which included these elements would provide a major boost to international economic confidence.

Some have already done this. The EU's INDC frames its 2030 target as a cut of "at least" 40% on 1990 levels, leaving room for deeper cuts in the context of a successful international agreement. Mexico has explicitly set two targets, one an "unconditional" GHG emission reduction of 25% below business as usual by 2030, the other a "conditional"' reduction of 40%, which could be achieved subject to progress on a variety of issues such as an international carbon price, technical cooperation and access to low-cost financial resources and technology transfer.[84] It would be helpful if this approach could be reflected in the general understanding that INDCs published in 2015 are "floors, not ceilings" – lower bounds to ambition which can be strengthened when circumstances change, either before or after the Paris conference.

Cooperation on climate outside of the UNFCCC

International cooperation on climate-related issues has also blossomed outside the UNFCCC – one of the most significant developments in recent years. This includes increased attention to climate action in other multilateral processes, such as the development of the SDGs (which include a proposed goal on climate change as well as others related to it), discussions on Financing for Development, and under the G7 and G20. But it also goes well beyond these intergovernmental processes. Multi-stakeholder initiatives have been launched on renewable energy, energy efficiency, transport, cities, agriculture, forests, short-lived climate pollutants, finance and adaptation, among others.[85] Many of these were showcased at the UN Climate Summit in New York in September 2014, an unprecedented gathering of government, business and civil society leaders.[86]

At the Lima Climate Change Conference in December 2014, the Governments of Peru and France, in association with the UN Secretary General and UNFCCC Secretariat, launched the "Lima-Paris Action Agenda", aiming to provide a platform for multi-stakeholder climate solutions at the Paris conference.[87] The UNFCCC Secretariat has established a portal where actions by non-state actors and international cooperative initiatives are registered and recognised, backed by an independently compiled database.[88] Serious efforts are now being made to produce methodologies by which these actions can be properly measured and assessed.[89]

Many of these initiatives are relatively new and still in development, however, and participation remains relatively narrow. A major expansion of cooperation is both possible and vital, if the full range of opportunities for growth-enhancing climate action are to be realised. This report in particular highlights 10 areas of international and multi-stakeholder cooperation with significant potential.

In some, there are already initiatives with considerable momentum, but which need wider participation to have significant impact. Others represent opportunities that have yet to be seized. The initiatives fall into four broad categories:

- **Common commitments or intentions by governments for national action, in some cases supported by programmes of technical assistance, regular monitoring of progress, and peer review.** In the case of infrastructure investment and energy efficiency standards, we propose enhanced cooperation among the countries of the G20, in association with others; in the fields of carbon pricing, fossil fuel subsidy reform, and support for low-carbon innovation, we argue for informal associations of "coalitions of the willing" and bilateral and plurilateral partnerships between interested countries.
- **Common commitments by non-state actors, supported by standardised methodologies, the development of rules and norms, and mutual exchange of best practice.** This model applies to our recommendations for actions by major cities and leading businesses.
- **Multi-stakeholder financing partnerships.** In a number of fields, governments can work with the private sector, international organisations and civil society to unlock flows of finance. This applies to our proposals to support degraded land restoration and forest conservation and to scale up investment in clean energy and energy access and for urban development.
- **Multilateral market regulation under a multilateral treaty.** This applies to our recommendations on reducing emissions in the aviation and maritime sectors and on phasing down hydrofluorocarbons (HFCs).

The areas identified in this report do not exhaust the full range of available opportunities for partnership or cooperation. But in each of them cooperative action could generate significant economic benefits and emission reductions – and there is potential for key commitments to be made this year or next. The first criterion is critical: in each case, there are powerful reasons for governments, cities, businesses and others to work together to implement the proposals, even without consideration of their climate impact. They will have economic benefits – both in terms of growth, employment and poverty reduction, and more broadly through improved air quality and public health, reduced congestion, improved quality of life, and more. In short, they can help generate "better growth" as defined in *Better Growth, Better Climate*.

The analysis here has also estimated their climate benefits, where possible. The methodology and numbers are explained in a separate Technical Note.[90] It is of course

not the international cooperation itself which has the mitigation potential; it is the policies and investments themselves. But cooperative partnerships can help catalyse and support that action. Some of the actions overlap with one another in terms of their impacts on emissions; these have been subtracted to arrive at the total potential.

Overall, if the recommended actions were implemented, the analysis suggests that global GHG emissions in 2030 would be 16–26 Gt CO_2e lower than under a "business as usual" scenario, i.e. if current trends were to continue with no new policies introduced. This represents between 59% and 96% of the reductions likely to be needed by 2030 to put the world on a pathway consistent with holding global warming to 2°C (see Figure 4).[91]

This shows that the emissions reductions envisaged in INDCs are only a fraction of the economically beneficial options for climate mitigation possible over the next 15 years. This is not surprising, as INDCs generally reflect what countries believe they can achieve on their own, "nationally determined". Enhanced action by a variety of other stakeholders and through international cooperation can enable them to do more.

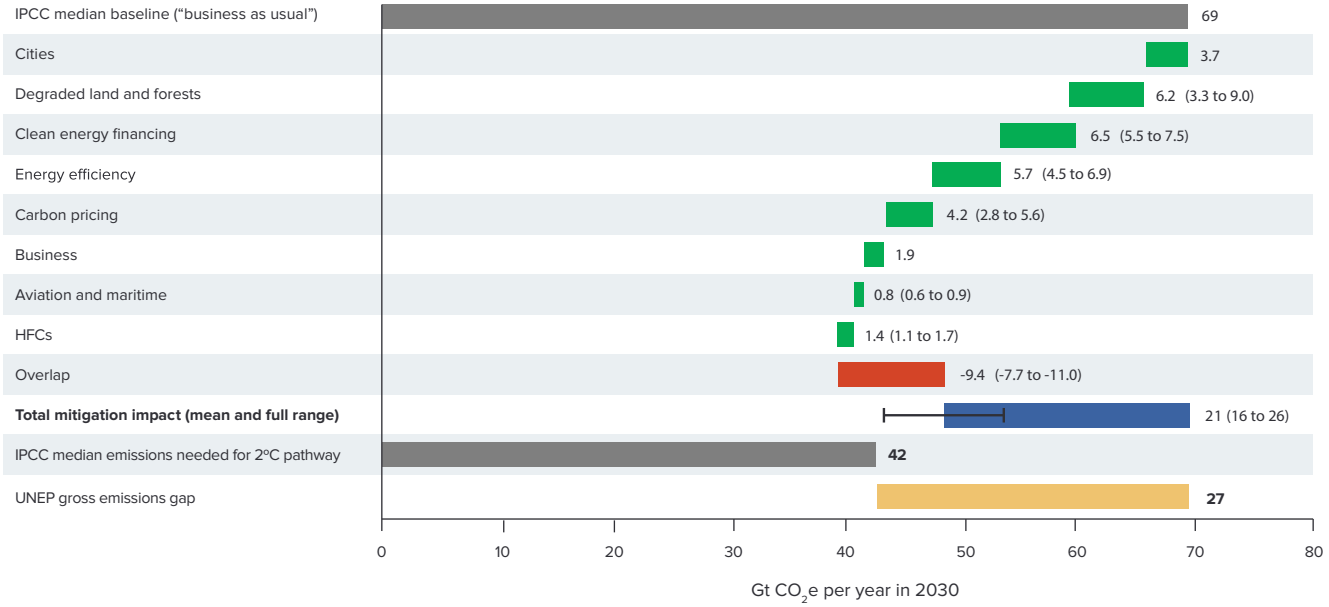
This does not mean that the emissions reduction potential from these cooperative initiatives would all be "additional" to the commitments in the INDCs (except in international aviation and shipping, where emissions are not included in national inventories). Rather, insofar as countries are not yet planning to pursue the actions recommended here, the analysis indicates the potential to raise national commitments in the future. Multi-stakeholder action and international cooperation can thus help governments achieve considerably more mitigation than they now see as feasible.

In this sense the Paris climate conference, building on the Financing for Development and Sustainable Development Goal conferences earlier in the year, creates a much broader opportunity to promote action for growth and climate. Nationally determined commitments will be the bedrock of the new international agreement. But as this report shows, national action can be supplemented, in Paris and beyond, by many forms of international and multi-stakeholder cooperation. In all the fields outlined in this report, governments, states and regions, cities, businesses, and international and civil society organisations have the opportunity to bring forward new commitments to driving low-carbon and climate-resilient growth. These have the potential to enable countries to reduce emissions much further than they can on their own. They can bring the world as a whole much closer to the 2°C pathway. And they can bring all countries the benefits of stronger economic performance, development and poverty reduction.

Figure 4

The emissions reduction potential of the Commission's recommendations

Full implementation of the Commission's recommendations could achieve up to 96% of the emissions reductions in 2030 needed to keep global warming under 2°C.



Source: New Climate Economy, 2015.[92]

PART II: KEY AREAS FOR INTERNATIONAL AND MULTI-STAKEHOLDER ACTION

2.1 Accelerate low-carbon development in the world's cities

We live in an urban era. Cities are growing at an unprecedented rate, particularly in the developing world, with 1.4 million people added to urban areas each week. By 2030, around 60% of the global population will live in cities.[93] Cities are engines of economic growth and social change, expected to produce about 85% of global GDP in 2015[94] – and they generate 71–76% of energy-related global greenhouse gas (GHG) emissions.[95] With their dense populations, concentrations of property and infrastructure, and large paved areas, cities are also particularly vulnerable to floods, storm surges and other climate impacts, particularly in coastal regions and along rivers.

All these factors make it crucial to ensure that the infrastructure investments made in cities in the next several years are both low-carbon and climate-resilient. As shown in *Better Growth, Better Climate*, cities have much to gain from adopting more compact, connected and efficient forms of development: greater economic productivity and appeal to investors, improved air quality and public health, reduced poverty and enhanced safety, and substantial avoided infrastructure and public service costs. For urban leaders, low-carbon strategies are thus as much about building healthier, more liveable and more productive cities as about reducing GHG emissions.

Mayors and local authorities increasingly recognise the economic and other benefits of climate action, and many are not only demonstrating leadership by taking action in their own cities, but engaging their peers and working to raise ambition through groups such as the C40 Cities Climate Leadership Group, Local Governments for Sustainability (ICLEI) and United Cities and Local Governments (UCLG). Members of these networks have already agreed to commitments equivalent to 0.4 Gt CO_2 in annual emission reductions by 2030.[96] And momentum is growing.

At the UN Climate Summit in 2014, urban leaders formed a new "Compact of Mayors" committed to tracking and reducing GHG emissions under a common accountability framework, while also making their cities more resilient.[97] As of June 2015, 80 cities have signed on, and many more are expected to join. The Compact builds on existing initiatives, such as the Covenant of Mayors in Europe, whose more than 6,000 signatories have set emission reduction targets and adopted sustainable energy action plans to help meet them.

But action needs to be scaled up and accelerated. Many cities, particularly in developing countries, need support from national and international institutions to transition to low-carbon development models. National policy is critical, generally determining the powers and financial resources available to city authorities. Regional and provincial governments can also play crucial roles – particularly as many are leading low-carbon action themselves, including through their own international Compact of States and Regions formed in 2014.[98] At all levels, policy and finance environments need to shift quickly and significantly to help cities, states and regions change course.

A major economic opportunity

New analysis undertaken for this report shows that low-carbon urban actions represent a US$16.6 trillion global economic opportunity.[99] This analysis builds on a 2014 study for the UN Special Envoy for Cities and Climate Change and C40, which found that 11 key low-carbon measures in the buildings, transport and waste sectors, where cities have the greatest power to take action, could generate annual savings of 3.7 Gt CO_2e in 2030 and 8.0 Gt CO_2e in 2050.[100] The largest 500 cities by population could contribute annual savings of 1.65 Gt CO_2e by 2030, nearly half the identified urban mitigation potential.[101]

To evaluate the economic case for large-scale deployment of these measures, the New Climate Economy assessed the incremental costs that cities would face if they implemented them instead of their higher-carbon equivalents. The costs were then compared with the savings these measures would generate up to 2050 through reduced energy demand, relative to business as usual.[102] The analysis was deliberately conservative, excluding savings that would accrue beyond 2050 and presenting only *direct* cost savings, not wider social, economic and environmental benefits.

Even so, the analysis makes a compelling economic case for significant low-carbon investment in cities. In the central scenario, these measures would cost US$977 billion per year on average globally in 2015–2050, but they would reduce annual energy costs by US$1.58 trillion in 2030 and US$5.85 trillion in 2050. Thus, collectively, the investments would pay for themselves within 16 years. In this scenario, the net present value (NPV) of the savings generated for cities in 2015–2050 would be US$16.6 trillion. It is important to note, however, that not all low-carbon investments will have a positive NPV, and some may also involve significant opportunity costs.

The returns would be even greater with wider policy action. With higher energy prices through fossil fuel subsidy reform and carbon pricing, together with enabling policy interventions, such as support for low-carbon innovation, the NPV of the stream of savings that the investments would generate could rise to US$21.86 trillion through 2050 (under a discount rate of 5%), which offers substantial scope to secure private-sector investment. In a scenario with lower energy prices and slower technological learning, this bundle of measures would still have a positive NPV of US$4.85 trillion with a real discount rate of 3%.

Success stories around the world – and scope for much more

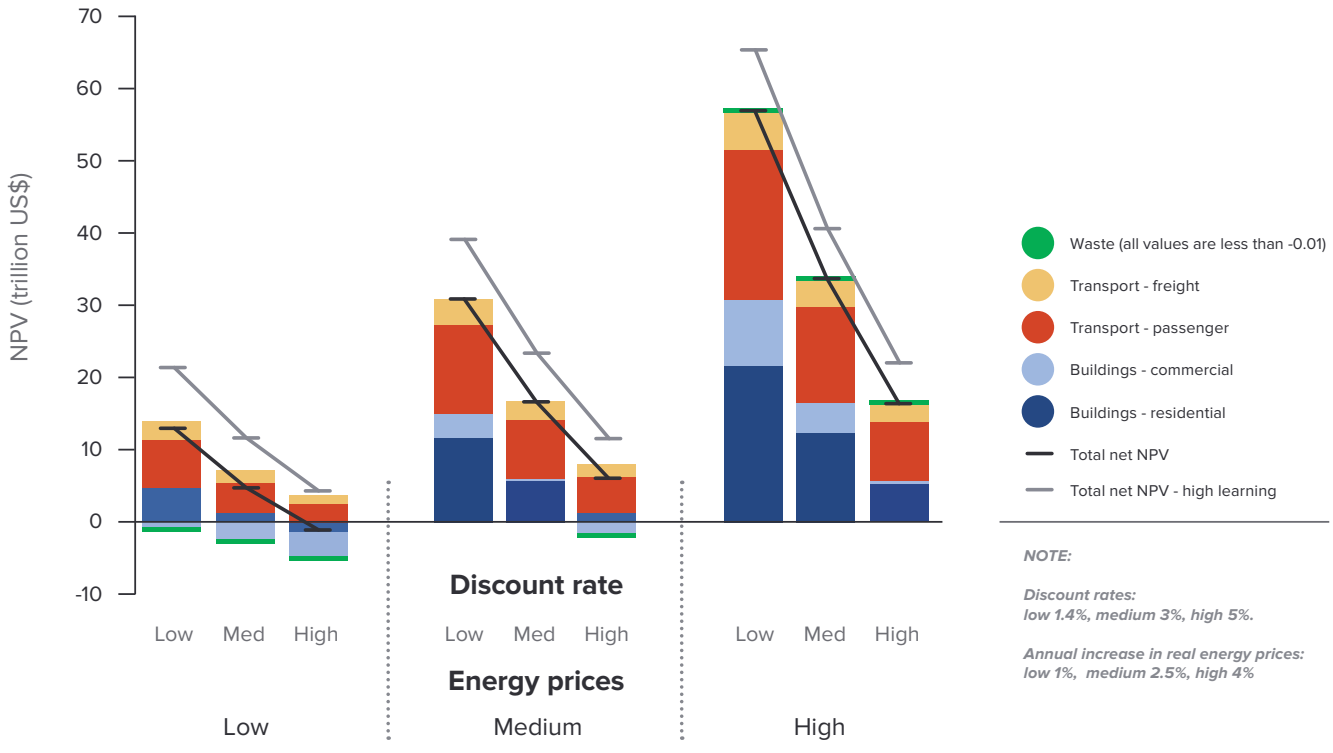
Yet the benefits of low-carbon investment go far beyond direct cost savings. Making cities more compact, connected and efficient can generate sustained urban productivity improvements and a wide range of economic, social and environmental benefits. The goal is to manage urban expansion to encourage dense, transit-oriented and liveable urban forms, and to unlock agglomeration effects and networking advantages. Such an approach could help to avoid the extensive traffic congestion that is causing serious social and economic costs in cities throughout the world, and to reduce the traffic accidents that kill around 1.25 million people annually, over 90% of them in developing countries.[103] It could also significantly reduce the cost of providing services and infrastructure for public transport, energy, water and waste. Analysis for *Better Growth, Better Climate* showed that compact, connected urban growth could reduce global infrastructure investment requirements by more than US$3 trillion in 2015–2030.[104]

Case studies of low-carbon urban actions around the world – in both developed and developing countries – show they can yield multiple benefits beyond direct energy and GHG savings. There are a growing number of success stories involving "green buildings" and energy efficiency standards for new construction, as well as for retrofits of existing buildings. Many cities are also expanding and improving mass transit, embracing bus rapid transit (BRT) in particular, which costs, on average, one-tenth as much as metro rail transit.[105] Infrastructure that makes cycling easier and safer improves public health by promoting

Figure 5

The net present value (NPV) of the urban mitigation scenario in the transport, buildings and waste sectors between 2015 and 2050[106]

Low-carbon urban actions available today could generate a stream of savings in the period to 2050 with a current value of US$16.6 trillion under a medium discount rate and medium energy price scenario.



Source: Gouldson et al., 2015.[107]

physical activity and reducing air pollution and vehicle accidents.[108] Moreover, cycling is a low-cost option that can enhance mobility for the urban poor.[109] Cities are also discovering the benefits of building distributed energy systems based on small-scale renewables, particularly as costs have dropped sharply in recent years.

International cooperation can encourage cities to raise their ambitions, and enables them to track their progress towards low-carbon goals. Not enough cities have prepared credible emission inventories or made firm emission reduction commitments, and few have long-term targets, which are crucial to sustaining emission reductions over time. Through international cooperation, standardised methodologies are being developed and implemented that may also help cities to access technical and financial assistance from international financial institutions. In turn, new international initiatives promoting common platforms for action such as the Compact of Mayors can help to promote a "race to the top", with cities competing for capital by using low-carbon strategies to boost their appeal to investors.

International cooperation can also play a critical role in equipping cities with the knowledge and skills to understand the science, economics, policy options and business models they need to identify and implement suitable low-carbon measures. Only about 20% of the world's 150 largest cities have even the most basic analytics needed for low-carbon planning.[110] International organisations such as UN Habitat and the international city networks can help to address skills gaps at the local level by training municipal staff and political leaders, particularly in emerging and developing economies. The Habitat III Conference in October 2016 will be an opportunity to discuss and learn lessons from cities, towns and villages around the world on how to achieve sustainable urban development and to identify emerging challenges.

Moreover, international institutions can help cities build institutional capacity, for example by helping to establish integrated municipal authorities to address cross-cutting challenges such as effective land use and transport planning.[111] They can support national and provincial as well as local decision-makers by providing climate-relevant data at the city scale. And they can help cities overcome the huge financial constraints many face in identifying, developing and implementing "investment-ready" programmes or projects that can attract private investment, and helping them to improve their creditworthiness. According to the World Bank, only 4% of the 500 largest cities in developing countries are deemed creditworthy in international financial markets, and investing US$1 to boost a city's creditworthiness can leverage more than US$100 in private finance.[112] Finally, international institutions can help national governments to recognise the critical role that cities play in a country's development, empower them to take action and attract investment, and support them through national policies.

The economic case for low-carbon urban development is compelling, and international cooperation, led by nations and cities and supported by international organisations, can amplify and accelerate action.

The Commission recommends that all cities commit to developing and implementing low-carbon development strategies by 2020, using where possible the framework of the Compact of Mayors, prioritising policies and investments in public, non-motorised and low-emissions transport, building efficiency, renewable energy and efficient waste management.

Development agencies and other finance institutions, city networks and organisations, and multilateral and regional development banks, should help to accelerate and scale up these efforts by developing an integrated package of US$1 billion or more[113] over five years, to support at least the world's largest 500 cities by 2020 in (i) complying with the Compact of Mayors; (ii) strengthening capacities for project preparation; (iii) enhancing creditworthiness; (iv) accessing climate finance more directly to cover the incremental up front costs of low-carbon options when agreed in partnership with nation states; and (v) improving access to platforms for knowledge-sharing and technology transfer through global city networks.[114] The package could directly mobilise at least US$5-10 billion[115] in private investment through project preparation support and leverage significant further large-scale capital to support a low-carbon urban transition. The package should build on existing leadership and efforts by cities using their own resources and prioritise filling critical resource gaps in smaller cities and cities in developing countries.

The full Working Paper from which this summary is drawn is Gouldson, A., Colenbrander, S., Godfrey, N., Sudmant, A., Millward-Hopkins, J., Fang, W. and Zhao, X., 2015. *Accelerating Low-Carbon Development in the World's Cities*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.2 Restore and protect agricultural and forest landscapes and increase agricultural productivity

Global demand for agricultural and forestry commodities – food, fuel, fibre and timber – is rising rapidly, primarily in emerging and developing economies. This creates vital opportunities for economic growth, but it also puts

pressure on natural resources. With the global population expected to grow by 1.2 billion by 2030 – and the global middle class to roughly double by 2030 – that pressure will only increase.[116] About 70% more food calories will need to be produced by 2050, while demand for wood products will increase three- to fourfold.[117]

Countries face the simultaneous challenges of raising agricultural and forest productivity, preventing deforestation, improving the governance of natural resource use and strengthening the resilience of land use systems to climate change and other threats. As argued in *Better Growth, Better Climate*, the linkages between these challenges require a holistic approach. Unless they are addressed together, fixing problems in one area will just shift them to others.

Agriculture and land use change, including change through deforestation, account for roughly a quarter of global GHG emissions. Both agriculture and forests are also already feeling the impact of climate change. Reducing emissions and increasing resilience while boosting productivity will require strong national policies and scaled-up international and multi-stakeholder partnerships to support them.

Better Growth, Better Climate examines multiple opportunities for public policy and land use practices to boost productivity and resilience while reducing emissions. This includes both supply-side measures, such as the use of new crop varieties and new techniques of livestock management, and demand-side measures, such as reducing food loss and waste. This report focuses on two critical areas that require much greater international cooperation, involving both public and private actors: investments to restore degraded agricultural and forest landscapes, and international finance to halt and reverse deforestation, supported by commodity supply-chain commitments.

An urgent challenge

A quarter of the world's agricultural land is severely degraded,[118] primarily in developing countries, and another 12 million hectares are lost each year due to poor soil and water management and other unsustainable farming practices.[119] The UN estimates that degradation of agricultural landscapes cost US$40 billion worldwide in 2014, not counting the hidden costs of increased fertiliser use and loss of biodiversity and unique landscapes.[120]

At the same time, 13 million ha of forest are being cleared each year.[121] About 30% of global forest cover has been cleared,[122] and over a quarter is degraded; only 21% remains intact.[123] The expansion of agriculture has played a key role in this. Global agricultural land area, including permanent pastures, grew by about 10% or 477 million ha in the 50 years up to 2013.[124] In the past decade, most of the forest loss has occurred in the tropics, with commercial agriculture responsible for 71% of tropical deforestation worldwide in 2000–2012, much of it illegal.[125] Wood and pulp production and, in some places, mining have also contributed to natural forest loss and degradation.

The environmental and economic impact of these trends is enormous. In 1990–2010, carbon storage equivalent to about 15% of manmade global GHG emissions was lost each year.[126] Vital ecosystem services have been compromised. The ecosystem services provided by forests, including pollination and regulation of water flows that support nearby agricultural productivity, have been estimated at US$3,100–6,120 per ha per year. This implies an additional cost of annual gross deforestation of US$40–80 billion.[127]

These trends can be reversed. Brazil has slowed deforestation by 70% since 2005, through a combination of economic incentives and law enforcement. Indonesia has extended its moratorium on new concessions for the conversion of primary forests. From China to Niger, landscape restoration projects using a variety of approaches, including "climate-smart agriculture" techniques such as no-till farming and agroforestry, are stopping erosion, re-greening land and restoring tree cover. These efforts are raising the incomes of agrarian and forest communities, boosting the productivity and resilience of land, and cutting net emissions. They are mutually supportive, making it critical that public policy reforms by national governments support the management of landscapes as a whole.

New partnerships

If these successes are to be scaled up, however, national policy in many countries will need to be supported by strong international cooperation. There is great momentum already. More than 175 governments (from tropical forest-rich countries and elsewhere), companies, civil society institutions and indigenous peoples' groups have endorsed the New York Declaration on Forests launched at the UN Climate Summit in September 2014. They pledge to work together to cut natural forest loss in half by the end of the decade, end it entirely by 2030, and restore more than 350 million ha of forests by 2030.[128]

The Global Alliance for Climate-Smart Agriculture (GACSA) was also launched at the Summit, the result of three years' collaboration to increase investment in agricultural productivity and resilience and help reduce agriculture's large carbon footprint.[129] The revamped Consultative Group on International Agricultural Research (CGIAR) and the new Global Research Alliance on Agricultural Greenhouse Gases are helping to advance

and accelerate crucial research.[130] And other initiatives are emerging, such as the business-led Low Carbon Technology Partnership initiatives on forests and on climate-smart agriculture under the World Business Council on Sustainable Development (WBCSD).

Prominent regional initiatives are also making an impact. The Africa Climate-Smart Agriculture Alliance (ACSAA) aims to see 6 million smallholder farms in Africa practising CSA within seven years.[131] Initiative 20x20 in Latin America and the Caribbean, launched at the Lima Climate Change Conference in December 2014, set out to initiate restoration of 20 million ha of degraded agricultural and forest land by 2020. So far nine Latin American and Caribbean countries and two regional programmes have committed to restoring more than 21 million ha, and more commitments are expected.

Leading businesses are also now working to ensure more socially and environmentally sustainable practices.[132] Members of the Consumer Goods Forum (CGF), an industry association representing companies with more than US$3 trillion in annual revenue, pledged in 2010 to eliminate deforestation from their supply chains by 2020.[133] In 2012, members of the CGF, including Unilever and Nestlé, partnered with a number of tropical forest countries and other governments, as well as environmental and other civil society organisations, to form the Tropical Forest Alliance 2020 (TFA 2020), a multi-stakeholder platform to eliminate deforestation from global commodity markets.[134] Several major commodities traders – including Wilmar and Cargill – have now joined them. Overall, company commitments now cover more than 90% of the global palm oil supply chain.[135]

These efforts are being supported by new technologies and tools that enable radical transparency in monitoring progress, for example Global Forest Watch, which provides near real-time data on tree cover change. By working together, governments, consumer goods companies, local producers, civil society organisations and communities have the potential to achieve change which would have been beyond any of them working on their own. The key now is to translate pledges into effective actions – from economic incentives, to effective monitoring of suppliers and improved transparency in supply chains. It is also critical to establish comparable commitments and partnerships in other commodities affecting forests, notably soy, beef, and pulp and paper.

Financing land restoration

One of the greatest challenges is how to pay for large-scale restoration of agricultural land and forests. Human-caused degradation of whole landscapes today is mainly a challenge in developing countries.[136] Governments in these countries often lack the resources to stop degradation, much less to restore land. And while commercial-scale operations are often the culprits, smallholders are also involved, and they have limited capital. Moreover, although farmers can benefit from restoration and investments in more sustainable management, through increased crop yields or new forest products to sell, some of the biggest benefits, such as better water retention, cleaner and more plentiful water supply, cleaner air, higher biodiversity and better pollination, are public goods that cannot be monetised easily by farmers and landowners.

Current global investment from all sources, public and private, in restoration and conservation of mixed landscapes is estimated at US$50 billion per year, of which about half is in emerging and developing countries.[137] On the other hand, global needs for investment in conservation and restoration have been independently estimated at US$200–300 billion per year.[138] This leaves an estimated shortfall of about US$150–250 billion per year. There is a pressing need to scale up both public and private investment, domestic and international, to fill this gap.

Official development assistance and existing private direct foreign investment in agriculture and forest-related activities in developing countries is currently less than US$7 billion per year.[139] Thus, most of the needed new investment will have to come from domestic sources and greatly expanded investment from the international private sector. The latter is likely to involve "impact investing" – private (typically internationally active) investors seeking to achieve social and/or environmental impacts along with financial returns.[140] Impact investing for landscape conservation and restoration is expected to reach at least US$6 billion total in 2014–2018, triple the level of the previous five years.[141] But much more finance is needed, and key barriers need to be overcome to ensure a good supply of deals with adequate collateral, sufficient prospects for future cash flow and acceptable risk-reward profiles. Strong domestic policy frameworks aimed at addressing the key market and governance failures which help drive unsustainable land use practises – from agricultural input subsidies to inadequately defined and defended property rights – are crucial.

Several further elements will be needed to overcome financing barriers to scale up private investment: capacity-building, concessional bridge funding for project start-ups and catalytic first-loss equity investment, which can all be funded by targeted multilateral public and philanthropic cooperation. More public and private impact investment, and partnerships between them, are required to have results at scale.

To reduce financial risks, "capital stacking" could play an important role. This is a common risk-sharing approach in which institutional or philanthropic investors typically

provide first-loss equity, impact investors provide preferred equity, and other private investors provide protected debt equity. Publicly-funded institutional investors may be able to leverage private capital on as much as a 10:1 basis by accepting a 10% first-loss for being the junior equity partner in a stacked capital deal.[142] The evidence suggests that pooling risks across institutional investors and developing expertise within one facility can lead to cost savings. Public investments will also be needed for capacity building and to underwrite start-up costs, especially in the case of smallholders. This approach is likely to be most fruitful when it is part of a broader unified approach, such as land restoration across a given region.

Making the most of REDD+

Another key area for enhanced cooperation is REDD+: reducing emissions from deforestation, forest degradation, conservation, sustainable management of forests and enhancement of forest carbon stocks. REDD+ is a system whereby forest countries make domestic commitments to maintain more forests and are then supported by developed countries. International assistance can help forest countries develop strategies and build capacity to implement national policies and develop projects to reduce emissions. Those able to deliver deforestation reductions – and reliably measure, report and verify them – can enter into carbon finance agreements with advanced economies and multilateral development banks, with a "results-based payment" for emission reductions below the agreed reference level.[143]

Results-based REDD+ works most efficiently and equitably when strong governance is in place, including clear land rights, effective land use planning and strong law enforcement. Where there is political commitment to reduce deforestation, early direct investments can help to build these critical capacities and systems. Results-based payments are not the only option, and some forest countries and donors may choose other approaches. However, results-based REDD+ schemes are inherently efficient. If they fail to deliver large-scale results, the amounts paid will be much smaller. Many forest countries and subnational jurisdictions have started down this path.

Sixty-five developing countries have joined either (or both) the UN-REDD+ Programme or the World Bank's Forest Carbon Partnership Facility (FCPF), 54 of which have had plans approved for funding.[144] Funders are also stepping up, making funds for REDD+ readiness and results-based-payments increasingly available. The Green Climate Fund will be able to provide payments for REDD+ results through the UNFCCC process (as reflected in the Warsaw Framework for REDD+). Between 2008 and the end of 2014, US$2.8 billion had been pledged to five multilateral funds that support REDD+, with an increase of two-thirds in the value of overall project approvals since November 2013.[145] REDD+ agreements can also spur enhanced national action: a pledge of US$1 billion from Norway to Indonesia, for example, has supported the moratorium on clearing forests and a mapping initiative to clarify property rights that has exposed significant overlapping and illegal forest holdings. This unprecedented transparency is helping to pave the way for private sector commitments.[146]

All these efforts are closely interlinked, and need to be addressed cooperatively to achieve synergies and avoid conflicts. For example, boosting agricultural productivity could lead to increased deforestation on adjoining lands if protection of forests is not simultaneously enforced. Similarly, forest protection in one area can simply shift deforestation to another. Yet at the same time, climate-smart approaches such as agroforestry can add tree cover while also boosting food production. Deforestation-free supply chain efforts combined with REDD+ can also dramatically change economic incentives for farmers. Most importantly, a coordinated, integrated national approach to landscape management is needed which aims simultaneously to address resource conservation and restoration, boost the productivity of land, and promote rural economic development and poverty reduction.

The Commission recommends that governments, multilateral and bilateral finance institutions, the private sector and willing investors work together to scale up sustainable land use financing, towards a global target of halting deforestation and putting into restoration at least 500 million ha of degraded farmlands and forests by 2030. Developed economies and forested developing countries should enter into partnerships that scale up international flows for REDD+, focused increasingly on mechanisms that generate verified emission reductions, with the aim of financing an additional reduction of 1 Gt CO_2e per year from 2020 and beyond. The private sector should commit to extending deforestation-free supply chain commitments for key commodities and enhanced financing to support this.

Collectively, the analysis conducted for the Commission estimates that these efforts can lead to emission reductions of 3.3–9.0 Gt CO_2e in 2030 while making agriculture more productive and resilient, and boosting the incomes of agrarian and forest communities in developing countries.

The full Working Paper from which this summary is drawn is Delgado, C., Wolosin, M. and Purvis, N., 2015. *Restoring and Protecting Agricultural and Forest Landscapes and Increasing Agricultural Productivity*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.3 Invest at least US$1 trillion a year in clean energy

Clean energy investment has grown rapidly in recent years: US$270 billion was invested in renewables in 2014, and at least US$130 billion in energy efficiency. In 2013, for the first time, the world added more low-carbon electricity capacity than fossil fuel capacity.[147] The costs of low-carbon technologies continue to fall, and new finance vehicles are starting to take off: issuances of "green bonds", for example (which go beyond just clean energy) tripled within a year, to US$36.6 billion in 2014.[148]

The case for large-scale clean energy investment is strong. In the next 15 years, energy demand is projected to grow by 25–35%, as up to 3 billion people enter the global middle class and world economic output doubles.[149] About 1.3 billion people still lack access to electricity, and many more have only partial or unreliable service.[150] But the kind of energy supply the world invests in matters a great deal. Globally, an estimated 3.7 million people die prematurely each year due to ambient air pollution, much of it related to fossil fuel combustion.[151] CO_2 emissions from fossil fuel use make up about two-thirds of global GHG emissions. For countries dependent on fossil fuels, continued oil price volatility poses significant energy security risks.[152]

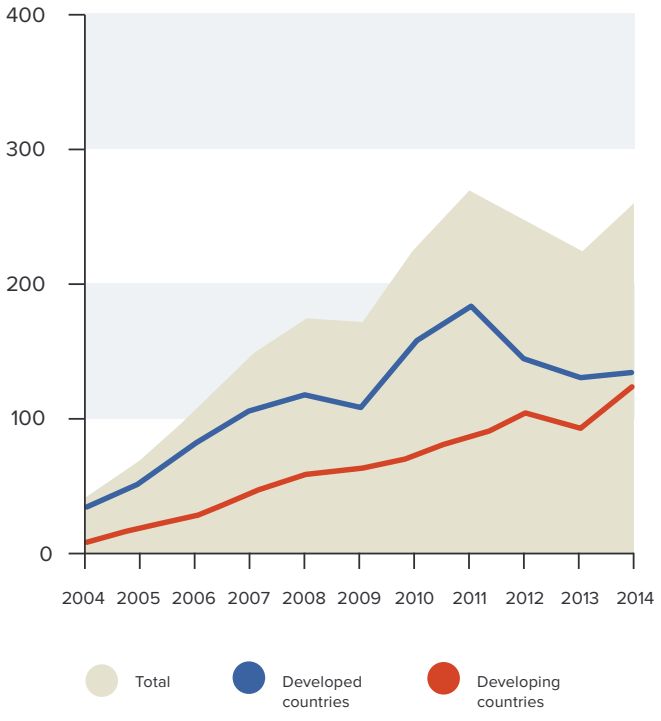
Yet about 40% of the world's electricity still comes from coal, one of the most polluting fuels.[153] And, despite rising investment in clean energy, of the US$1.6 trillion invested in the global energy supply in 2013, nearly 70% was related to fossil fuels.[154] Avoiding the many negative impacts of fossil fuel use, and meeting the goal of holding global warming to under 2°C, will require a major shift in investment.

The International Energy Agency (IEA) estimates that to achieve a 2°C pathway, annual investment in low-carbon power supply – solar, wind, hydropower, bioenergy and nuclear, as well as carbon capture and storage – will need to grow to an average of about US$520 billion per year between 2014 and 2035.[155] Energy efficiency investment in buildings and industry also needs to grow, to average about US$250 billion per year. In total, public- and private-sector investment in clean energy needs to reach at least US$1 trillion per year by 2030, while investment in fossil fuels, particularly coal, declines sharply.[156]

Such a shift is possible now, in a way that was once unthinkable, because of a dramatic reduction in the costs of clean energy technologies. Solar PV modules are about 80% cheaper than in 2008, and the cost of utility-scale solar PV has halved in four years. Solar and wind can now compete with fossil fuels with low or no subsidies in more and more places.[157] Thus, while about the same amount was invested in renewables in 2014 as in 2011 (about US$270-280 billion), it bought 35% more capacity.[158] At the same time, advances in smart grid, information technology systems, and energy storage technologies are beginning to make possible new ways of managing demand instead of increasing supply.[159] The modular nature of solar PV also enables it to bring electricity to populations far from the grid – a major need in many developing countries. Decreasing battery costs could allow solar and other renewables to make an even greater impact, enabling electricity storage off-grid in rural areas and more efficient management of grid electricity, balancing demand and providing backup during blackouts.[160]

Achieving a major shift towards clean energy investment will require new policy and finance approaches. Despite recent progress, there are still technical challenges in integrating large-scale renewables into electricity grids. And there is competition from natural gas, a cheaper and often easier alternative to coal for power generation – though it also brings problems of its own.[161] Fossil fuel subsidies and the lack of a carbon price in much of the world boost fossil fuels' price advantage. And most energy markets, regulatory frameworks and business models are still designed for fossil fuel generation, and remain ill-

Figure 6
Global renewable energy investment (US$billion)



Source: McCrone et al., 2015.[162]

adapted to the special characteristics of renewables and energy demand reduction.

Connecting projects with capital

There is no shortage of global capital for investment. But making clean energy projects, particularly those in developing countries, attractive to major private-sector investors will require a concerted international effort. Cooperation between the public and private sectors is needed to improve the risk-reward profile of low-carbon energy projects and thus lower the cost of capital and increase its supply. Policy actions can improve the investment environment for clean energy – for example, by ensuring non-discriminatory treatment of international investment; designing open and transparent procurement processes; improving the governance and regulatory quality of electricity markets; and coordinating the development of the electricity grid with deployment of clean energy generation.[163] Institutional capacity-building is also often needed.

Projects using well-established low-carbon technologies, such as onshore wind and solar, should be low-risk investments, as they have no fuel costs and are relatively simple to operate. But today, these projects are often covered by financing and market arrangements that introduce risk, ranging from currency risk to fossil fuel price volatility, which raises the cost of capital.[164] For example, renewable energy is often owned by the same investors and financed through the same structures as those for conventional energy projects, meaning that the cost of capital faced by renewables is linked to that for utilities, independent power producers and fossil fuel plants. Volatile foreign exchange rates and uncertainties around policies such as feed-in tariffs for renewable energy introduce further risk.

Measures to mitigate and reallocate risks could therefore substantially improve both the availability and the cost of capital for clean energy projects, which in turn would lower the cost of low-carbon electricity. Capital costs can make up 90% of the total lifetime cost of a renewable energy project; if clean energy projects could access low-cost, long-term finance reflecting their intrinsic production profile, the cost of low-carbon electricity could be up to 20% lower in developed economies and 30% in emerging economies.[165] Over recent years, a number of financial instruments have been developed to mitigate and reallocate risk in these ways, including credit guarantees and currency swaps, green bonds, and investment funds such as "YieldCos".[166] These are attracting increasing private-sector interest, as investors look for long-term returns and as growing coalitions of investors seek to incorporate climate concerns into their investment strategies.[167]

There are now major opportunities for international cooperation to scale up efforts to improve the risk-return profile of clean energy projects. By working together at national and international levels, governments, development finance institutions and other investors such as sovereign wealth funds, together with private-sector investors, have the capacity to mobilise the US$1 trillion in annual investment that is needed.

A key role for development banks

Multilateral and national development banks have a crucial role to play.[168] These development finance institutions (DFIs) committed US$126 billion of their own capital to climate-related investments in 2013, including adaptation.[169] The multilateral development banks (MDBs), made up of the World Bank Group and regional development banks, provided US$24 billion of this in 2013, and US$75 billion in total in the three years from 2011.[170] Among the national development banks, as of 2012, the China Development Bank had invested close to a cumulative US$80 billion in clean energy infrastructure, Germany's KfW close to US$150 billion, and the Brazilian Development Bank (BNDES) around US$50 million.[171] New DFIs based in emerging economies, including the Asian Infrastructure Investment Bank and the New Development Bank (known as the "BRICS Bank"), are also poised to become major sources of infrastructure financing.[172]

Given the importance of infrastructure to growth in developing countries, and the present large shortfall in infrastructure investment,[173] there is a strong case for an expansion of the role of MDB finance in this field. This could include an increase in their capital funding and balance sheets, a reallocation of investment priorities, an increase in risk appetite, for example in loan to equity ratios, and stronger use of new financial instruments.[174] Such reforms would enhance MDB capacity to mitigate risk and leverage greater private finance. MDBs have a particularly crucial role to play in preparing bankable projects which can attract private investment, a crucial need in many developing countries.

DFIs are also well positioned to lead efforts to strengthen international cooperation. They operate at a scale that few other actors can match, and they have experience in many roles in infrastructure finance, including making direct loans, creating targeted risk mitigation instruments and providing technical assistance. They have a key role in convening diverse stakeholders; mitigating and hedging risk; standardising data, measurement methods, projects and qualifications; providing policy support; and providing technical assistance for project development and financing. Existing activities require a concerted expansion. Cooperation among national development banks through the International Development Finance Club (IDFC)[175] and the MDBs in tracking green finance and other best practices is an important start. Initiatives such as the Global Innovation Lab for Climate Finance[176] offer valuable platforms for further cooperation between

governments and the private sector to scale up investment. At the same time, governments and regulators have a critical role to play in improving the risk-return profile for clean energy projects. The first step is to "level the playing field" by removing fossil fuel subsidies and implementing or strengthening carbon pricing policies. Other important mechanisms include stable clean energy subsidies and power purchase agreements that provide long-term revenue certainty for projects; designing electricity markets that do not expose low-carbon energy to fossil fuel price risk; reforming energy utilities and improving their credit ratings; and streamlining permitting and approval processes.[177]

Making the most of renewables to expand modern energy access, meanwhile, will require not just scaling up technologies, but also "scaling out": financing, policies and technologies to overcome existing barriers. New finance and distribution mechanisms need to be tailored to the costs and risk profiles associated with delivering these technologies to households, small businesses and other users – from solar PV to clean cookstoves and fuels, including where grid extension may be prohibitively costly.[178] New players, such as the Infrastructure Development Company Limited in Bangladesh are pioneering successful approaches. The United Nations Environment Programme (UNEP) proposal for a mini-grid pooling facility is also promising.[179] A global fund for connectivity, as proposed by the African Progress Panel, could also be an effective vehicle.[180]

If financing for clean energy were gradually raised to a global total of US$1 trillion a year in 2030, the analysis conducted for this report estimates that the additional low-carbon power supply and investment in energy efficiency could reduce annual global GHG emissions by around 5.5-7.5 Gt CO_2e in 2030.

The Commission recommends that, to bring down the costs of financing clean energy and catalyse private investment, multilateral and national development banks scale up their collaboration with governments and the private sector, and their own capital commitments, with the aim of reaching a global total of at least US$1 trillion of investment per year in low-carbon power supply and (non-transport) energy efficiency by 2030.

Donors and development finance institutions should phase out the financing of high-carbon energy systems, except where there is a clear development rationale without viable alternatives. They should significantly increase financing for energy access, including a global fund for connectivity. National governments should commit to clear, stable policy and regulatory frameworks that properly reward clean energy and reduce risks. The private sector should work with governments and regulators to scale up the use of finance and industry models that lower financing costs for low-carbon energy and energy efficiency investment, particularly for institutional investors. Private investors should also consider expanding their own commitments to financing clean energy and shifting away from coal.

The full Working Paper from which this summary is drawn is Zuckerman, J., Frejova, J., Granoff, I. and Nelson, D., 2015. *Investing at Least a Trillion Dollars a Year in Clean Energy*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.4 Raise energy efficiency standards to the global best

The world's energy systems have undergone an unprecedented expansion in the last 25 years, with energy demand growing by 50% to fuel an economy that has more than doubled in size.[181] Efficiency is an essential component of any strategy to deliver affordable, reliable energy systems, with an abundance of opportunities to reduce demand and improve the use of energy resources at a lower cost than equivalent supply-side options. It is thus increasingly referred to as the "first fuel".[182] It can reduce the need to build new energy production infrastructure and, by reducing energy demand, it plays a key role in curbing GHG emissions from the energy sector.

Greater energy efficiency can benefit countries at all stages of development, but particularly fast-growing economies trying to achieve universal energy access with limited resources. Yet many opportunities go untapped because of misaligned incentives, lack of information and other market failures. This makes energy efficiency standards particularly important. As part of a wider policy package, they can be an effective means of changing consumer and business behaviour, and driving product innovation. International cooperation can amplify the benefits by aligning and gradually raising efficiency standards around the world. Converging towards "global best" standards in key sectors such as appliances and lighting, vehicles, buildings and industrial equipment would unlock energy and cost savings, expand global markets, reduce non-tariff barriers to trade and reduce GHG emissions.

Substantial international efforts to improve energy efficiency are already under way. The International Partnership for Energy Efficiency Cooperation (IPEEC), the Clean Energy Ministerial, the UN Sustainable Energy for All (SE4All) initiative, and the Global Best Practice Networks, among others, are providing platforms for collaboration, working to analyse energy efficiency options, to design model policies and to identify finance mechanisms. Through the "en.lighten" initiative, led by the United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF), more than 60 countries have committed to reduce inefficient lighting by 2016. The Global Fuel Economy Initiative is helping more than 20 countries improve vehicle fleet efficiency. The IEA is also

playing a prominent role, through its Energy Efficiency Working Party and the Energy Technology Network, which covers all sectors including its Energy Efficient End Use Equipment (4E) initiative. SE4All has identified 168 institutions and at least 145 initiatives around the world focused on energy efficiency.[183]

The G20, in collaboration with these major international initiatives, could provide a powerful platform for expanding and accelerating action. In November 2014, the G20 approved a plan for voluntary collaboration on energy efficiency, and IPEEC and other organisations are helping identify next steps for implementation.[184] The G20 is strategically important because its members make up 80% of global energy consumption and dominate manufacturing and associated knowledge and capital. For example, 94% of vehicles are produced in G20 countries, so G20 action would have a major influence on uptake of efficient technologies worldwide.[185] The G20 is thus particularly well-placed to enhance the diffusion and stringency of energy efficiency standards and raise performance in key markets. The November meeting of the G20 in Turkey offers a major opportunity to act.

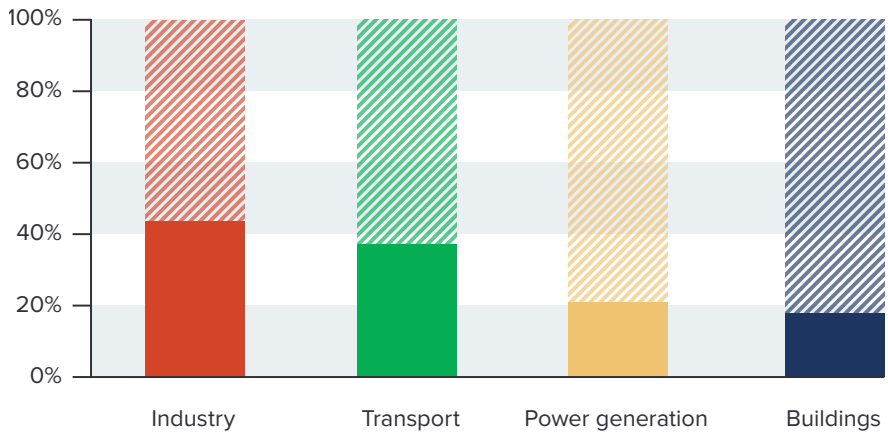
Energy efficiency has huge economic value that is increasingly recognised. It can reduce fuel and energy bills, spur economic growth, and lead to reduced air pollution and GHG emissions. Modelling for the International Energy Agency (IEA) shows that the global uptake of economically-viable energy efficiency investments could boost cumulative economic output by US$18 trillion to 2035. This has been assessed in macroeconomic models to increase growth by 0.25–1.1% per year, with associated increases in employment.[186] Energy efficiency increases output because it frees up resources for other, more productive investments, which is why the IEA estimates that efficiency measures yield benefits up to 2.5 times the avoided energy costs.[187]

Some of these gains can be offset by the "rebound effect", whereby consumers use part of the savings to buy more energy or other energy-using goods and services. Still, the overall benefits can be substantial. Between 1974 and 2010, energy efficiency saved more energy in IEA member countries than was provided by any single supply-side resource.[188] While 2010 energy use was 20% higher than in 1974, it would have doubled without energy efficiency measures. Energy efficiency is good for energy security as well. A more energy-efficient economy is less susceptible to supply disruptions or price shocks associated with volatile fossil fuel prices, and can serve to drive down energy prices.[189]

Finally, energy efficiency can reduce GHGs cost-effectively;[190] in fact, it is crucial for tackling climate change. To stay on a 2°C path, the IEA shows the energy-intensity of GDP would need to decline by 64% by 2050,[191] meaning that if economic output triples, there would only be a 20% increase in primary energy use. Of the total energy-sector GHG reductions needed by 2050 for a 2°C pathway, the IEA envisions 38% coming from improved efficiency in end uses.[192] As shown in Figure 7, there is great untapped

Figure 7
Long-term energy efficiency economic potential by sector

IEA projections to 2035 show that as much as two-thirds of energy efficiency potential will remain untapped unless policies change.



Realised energy efficiency potential

Unrealised energy efficiency potential

NOTE: These energy efficiency potentials are based on the IEA New Policies Scenario outlined in the World Energy Outlook 2012. Investments are classified as "economically viable" if the payback period for the up front investment is equal to or less than the amount of time an investor might be reasonably willing to wait to recover the cost, using the value of undiscounted fuel savings as a metric. The payback periods used were in some cases longer than current averages but they were always shorter than the technical lifetime of individual assets.

Source: IEA, 2014.[193]

potential for energy efficiency across sectors.
Public policy has played a role in the reduction of energy-intensity of GDP observed in the last 10 years, and a clear picture is emerging of best practices. Key components of a good "policy package" to overcome market failures and other barriers include "getting prices right" for energy (e.g. through carbon pricing and phasing out fossil fuel subsidies); providing incentives for innovation; providing information to overcome habitual choices and ease decision-making; providing effective financing; and regulation through energy efficiency standards.[194]

Countries vary significantly in their energy productivity (GDP per unit of energy used). Some variations are due to the different sectoral make-up of economies, and levels of development,[195] but the wide divergence between the stringency of energy efficiency standards is also a key factor. This means that significant economic savings are going untapped in those countries where standards are lower. Unaligned standards also add greatly to transaction costs for firms trying to sell into different national markets.

There are therefore strong economic grounds for countries to raise their standards over time, gradually converging towards the "global best". This does not mean that all countries would have the same standards. There are likely to be differences for countries at different stages of development. Rather, the goal would be to converge toward a smaller number of standards.[196] Adoption of these standards would be voluntary, and they could be applied in different ways. In some cases, countries may require all products to achieve a minimum performance level, such as for new buildings. In others, such as for domestic appliances, minimum energy performance standards can be set, but labelling products can also be important, allowing consumers to choose. The US Energy Star labelling scheme provides an example.[197] Vehicle efficiency standards (such as in the US and EU) are often applied as an average across the range of models sold by individual manufacturers. In all cases an important principle is that standards should be subject to continuous improvement – the "global best" is not a static concept but a constantly evolving one. Japan's "Top Runner" approach for appliances, for example, achieves this by basing future minimum standards in a given product class on the highest level of energy efficiency currently available.[198]

Any design process for convergence will need to include strong coordination between relevant governments, best practice networks, domestic and international regulators, and industry. And it should be open to the widest possible membership, as a basis for policy exchange, dialogue and lesson-learning. Enforcement of standards, which is essential, is often a challenge for countries with limited resources; here, exchange of good practice can provide vital assistance. Lastly, the approach to standards should be part of a coordinated policy package for energy efficiency. International efforts should also incorporate issues such as support for building effective governance systems, delivering upfront finance for energy efficiency investments, and providing information to consumers.[199]

The Commission recommends that G20 and other countries converge their energy efficiency standards in key sectors and product fields to the global best by 2025, and that the G20 establish a global platform for greater alignment and continuous improvement of standards.

To support further action on energy efficiency, international organisations, with business and national governments, should work towards internationally accepted product definitions, metrics for energy efficiency, test protocols, and better information provision. Institutions such as IPEEC, IEA and SE4All can help in the collection of comparable data, policy analysis, and to advise countries on setting energy efficiency standards.

A programme of gradual convergence to global best standards in appliances, lighting, vehicles, buildings and industrial equipment could save 4.5-6.9 Gt CO_2 in emissions by 2030, with significant financial savings and benefits to productivity.[200]

The full Working Paper from which this summary is drawn is Bishop, R., 2015. *Raising Energy Efficiency Standards to the Global Best*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.5 Implement effective carbon pricing

A growing number of countries, sub-national governments and businesses are recognising the value of putting a price on carbon and phasing out fossil fuel subsidies. They are cooperating internationally to overcome barriers to these reforms and to accelerate progress.

A strong, predictable and rising carbon price – applied through a carbon tax or a cap-and-trade system – is a particularly efficient way to advance climate and fiscal goals.[201] It sends important signals across the economy, helping to guide consumption choices and investments towards low-carbon and away from carbon-intensive activities.[202] It can also raise fiscal revenues for productive uses. About 40 national and over 20 sub-national jurisdictions have now adopted or scheduled a price on carbon, covering an estimated 7 Gt CO_2e, or about 12% of annual global greenhouse gas (GHG) emissions.[203] This is triple the coverage a decade ago but is far short

of what is required.

In 2014 China launched two pilot regional emissions trading schemes (ETSs), bringing the total to seven; France and Mexico implemented carbon taxes; Chile approved a carbon tax, to start in 2018; and California and Quebec linked their cap-and-trade programmes. In January 2015, South Korea launched its ETS – one of the world's largest – and Portugal enacted a carbon tax. In April, Ontario announced it will launch an ETS linked to the California and Quebec schemes. Next year, China plans to transition to a national carbon pricing system, and South Africa plans to introduce a carbon tax. The European Union is tightening its Emissions Trading System (EU ETS).[204]

After years of business opposition, many major companies, including in high-emitting sectors such as oil and gas, are now endorsing carbon pricing as well.[205] They see it as a way to drive efficiency and profitable new business opportunities. More than 1,000 businesses and investors signalled their support for carbon pricing at the UN Climate Summit in September 2014, including BP, British Airways, Cemex, Braskem, Royal Dutch Shell, Statkraft, Unilever, Statoil and DONG Energy.[206] In May, at the Business & Climate Summit 2015 in Paris, 25 global business networks representing more than 6.5 million companies called for "robust and effective carbon pricing mechanisms as a key component to gear investment and orient consumer behaviour towards low-carbon solutions and achieve global net emissions reduction at the least economic costs".[207] In addition, at least 150 companies in diverse sectors use an internal carbon price in assessing investments.[208] Major oil companies such as Shell, BP, Exxon-Mobil and ConocoPhillips use a price of US$40 per tonne of CO_2e or more.[209]

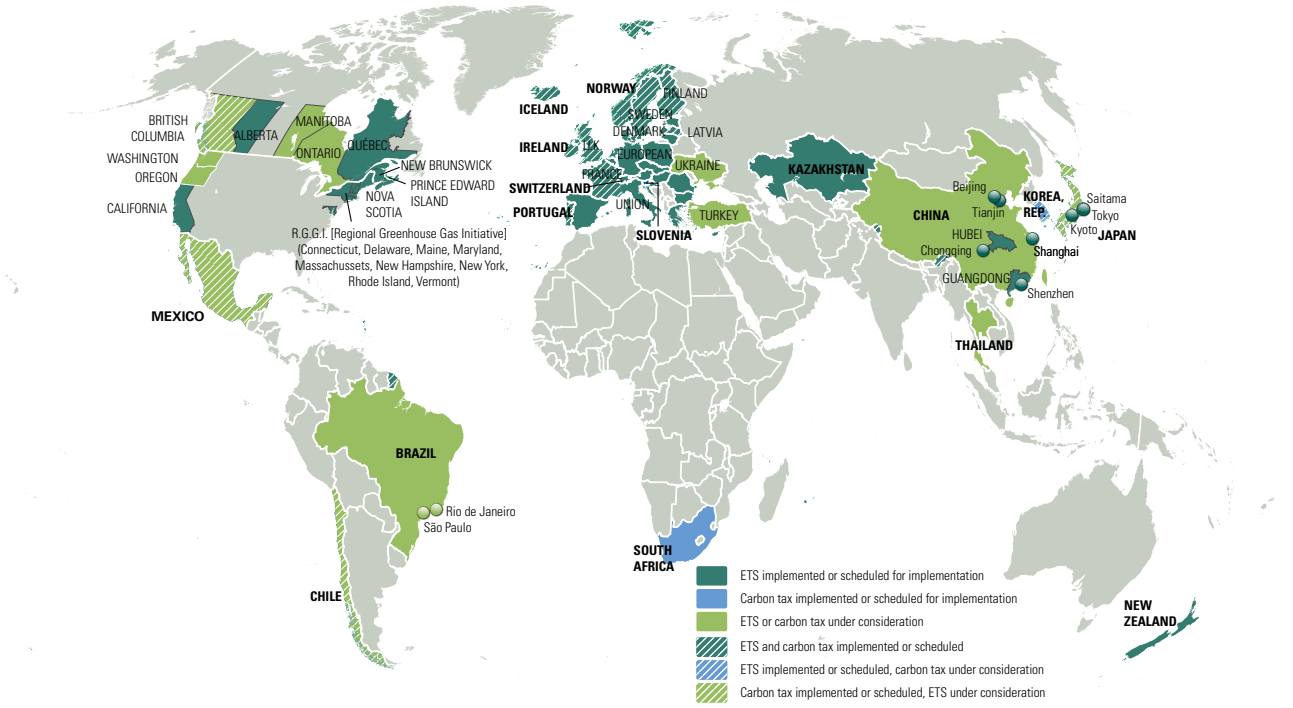
The economic case

The growing support for carbon pricing reflects a recognition that it is not only good climate policy, but also a useful way to raise government revenue – one that is less distorting than many existing taxes such as on labour and business activities. The Canadian province of British Columbia has used its carbon tax revenue, around 3% of the total budget,[210] to lower income and corporate taxes and compensate low-income households. Quebec and California use their permit auction revenues to fund low-carbon technology advancement. EU ETS auction revenues are used by Member States to fund innovation and climate- and energy-related activities, among other things.[211]

The evidence on carbon pricing suggests that it is effective at reducing emissions without harming the economy. In the US, for example, the nine states that participate in the Regional Greenhouse Gas Initiative (RGGI) have cut their

Figure 8

Summary of existing, emerging and potential carbon pricing instruments (emissions trading schemes and tax).



Source: World Bank, 2015.[212]

emissions by 18% and their GDP has grown by 9.2% in 2009–2013. By comparison, emissions in the other 41 US states fell by only 4%, and their GDP grew by 8.8% over this same period.[213] British Columbia's carbon tax was increased from CD$5 in 2008 to CD$30 in 2012, and over this period helped to reduce per capita GHG emissions by about 10% (compared with a 1% reduction in the rest of Canada), without any adverse impact on GDP.[214]

Yet concerns that pricing carbon will hurt industrial competitiveness continue to restrain action. As a result, most explicit prices are still quite low, less than US$10 per tonne of CO_2, and often without any mechanism or plan to increase them. Furthermore, a number of countries have provided exemptions or special treatment to their most polluting energy-intensive industries, thus limiting the effectiveness of the carbon price.

International cooperation can help to overcome this barrier. Instead of pushing for border carbon adjustments (BCAs) to try to "level the playing field" between countries of differing climate ambition, trading partners can coordinate the introduction of carbon prices of roughly comparable levels to overcome competitiveness concerns. By working together, countries can also benefit from knowledge-sharing on best practice, greater transparency, and the opportunity to link trading schemes.

Equally important is to phase out fossil fuel subsidies, which are effectively negative carbon prices. Subsidies to fossil fuel consumption in emerging and developing economies totalled US$548 billion in 2013,[215] while fossil fuel exploration, production and consumption support in OECD countries amount to US$55–90 billion a year.[216] Governments increasingly recognise that these subsidies are harmful to both the economy and the climate, and in the past two years alone, 28 have attempted reforms. The International Monetary Fund (IMF) has classified 12 of these as successes (leading to a permanent and sustained reduction of subsidies), 11 as partial successes, and five as unsuccessful.[217] International cooperation can help create a level playing-field across trade partners or in a region. It can also help disseminate knowledge about what works best. For example, phasing in reforms over several years, as part of a broader fiscal reform package, and using in-kind transfers to more directly support poor and vulnerable households and to ease the impact of reforms.[218]

A prime opportunity to act

Conditions are now particularly favourable for both carbon pricing and fossil fuel consumption subsidy reform, due to the fall in global oil prices over the last year, combined with lower gas and coal prices.[219] While these low prices may not last, in the short-term they can help to offset the energy price increases resulting from these measures, making it easier for consumers and businesses to adjust and reducing political resistance.[220] It is notable that a number of countries, including Mexico, India and Indonesia, have seized the opportunity to advance reform of fossil fuel subsidies over the last year. Many of these reforms are expected to be permanent.

G20 countries have already agreed to phase out inefficient fossil fuel subsidies, and several are now acting with support of international institutions such as the IMF, the IEA, the OECD and the World Bank.[221] The Asia-Pacific Economic Cooperation (APEC) economies have made a similar commitment. Now is the time to build on these commitments and introduce meaningful explicit carbon prices across countries at the same time.

Governments that choose to act have considerable support available. The Carbon Pricing Leadership Coalition, which brings together leaders from across government, the private sector and civil society, is working to increase knowledge on effective carbon pricing systems, and helping to define the business and economic case for carbon pricing.[222] The World Bank Partnership for Market Readiness (PMR) has also helped to accelerate action, supporting countries in the preparation and implementation of carbon pricing instruments and other climate policies.[223]

If carbon pricing were widely adopted around the world, rising to an average of US$50 per tonne of CO_2 in 2030 and including partial fossil fuel subsidy phase-out, the analysis conducted for this report estimates that global emissions could be reduced by 2.8-5.6 Gt CO_2e. The economic benefits of these reductions, including the incentives for innovation and investment and efficiency from carbon prices, will drive a future of more sustainable and low-emissions growth.

The Commission recommends that all developed and emerging economies, and others where possible, commit to introducing or strengthening carbon pricing by 2020, and should phase out fossil fuel subsidies.

Governments should integrate these measures into broader fiscal reform strategies, prioritising the use of resulting revenues to offset impacts on low-income households and other productive uses such as financing reductions in other distortionary taxes. Coalitions of willing governments should work together to enhance efficiency and minimise competitiveness impacts, building on existing peer-review processes to share knowledge, and reporting annually on progress. All major businesses should adopt internal carbon prices in their business strategies, and actively support carbon pricing policy.

The full Working Paper from which this summary is drawn is Rydge, J., 2015. *Implementing Effective Carbon Pricing*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.6 Ensure new infrastructure is climate-smart

Infrastructure is a foundation for economic growth. Robust, efficient power grids, water and sewer systems, transportation systems and communications networks are essential to modern economies and societies. They shape our economies in profound ways, determining whether people drive, walk, cycle or ride public transit, whether we remain dependent on fossil-fuelled power or move towards renewables, and whether heavy downpours cause devastating floods or landslides, or storm water is efficiently channelled out to sea.[224]

Emerging and developing economies face high demand for new infrastructure to support growing populations, increased consumption and new industry, and many also have major maintenance backlogs on existing infrastructure systems. Even in developed economies, much infrastructure is outdated and sometimes decaying due to chronic underinvestment.[225] As *Better Growth, Better Climate* shows, around US$90 trillion in infrastructure investment is needed by 2030 to achieve global growth expectations.[226] That is equivalent to around US$6 trillion per year, but current annual global investment is estimated at only around US$1.7 trillion. About 60% of the investment needed is in emerging and developing countries.

Most infrastructure assets last for 30–50 years or longer, so the choices made in the next 15 years, particularly about energy, transport and urban design, will shape the trajectory of economies for many decades. The challenge is thus twofold: to mobilise sufficient finance, and to ensure that infrastructure investments are chosen well to provide a foundation for sustained growth, prosperity and resilience. Getting these investments wrong will waste resources on assets which may not stand up to future climate change impacts, and exacerbate risks if they directly or indirectly lock in high emissions for decades. High-carbon investments may also increase dependence on price-volatile fossil fuels – and risk being devalued or stranded under future climate policies.

As shown in Figure 9, global aggregate infrastructure investment requirements to 2030 are projected to be around US$89 trillion. Shifting to low-carbon infrastructure would add about US$4 trillion in investments, an increase of less than 5%. The reason for the small increase is that the higher capital costs of investment in energy efficiency and low-carbon energy would be largely offset by capital savings from lower investment in fossil fuels, electricity transmission and distribution, and from a shift to better-planned and more compact cities. The additional upfront investment costs will of course need to be financed. But over their lifetimes, they could yield substantial savings – particularly from avoided fuel use – and other benefits that would largely offset any additional upfront capital investments. The case for ensuring that new infrastructure and upgrades alike are "climate-smart" – both climate-resilient and low-carbon – is thus very strong.

In recent years infrastructure investment has become a core focus of international economic cooperation, notably through the G20 and the development finance institutions (DFIs). The G20 established in 2014 a new Global Infrastructure Initiative, along with an implementing "Infrastructure Hub", with the aim of catalysing both public and private investment.[227] The World Bank now hosts the Global Infrastructure Facility (GIF), a platform to facilitate the development of public-private partnerships (PPPs) to mobilise private-sector and investor capital for infrastructure projects.[228] The African Development Bank (AfDB) has established the Africa50 Infrastructure Fund, aiming to accelerate infrastructure development, and plans to raise US$3 billion in equity capital to begin operations.[229] New multilateral and national development banks are being established with a specific infrastructure focus, notably the Asian Infrastructure Investment Bank (AIIB)[230] and the New Development Bank.[231]

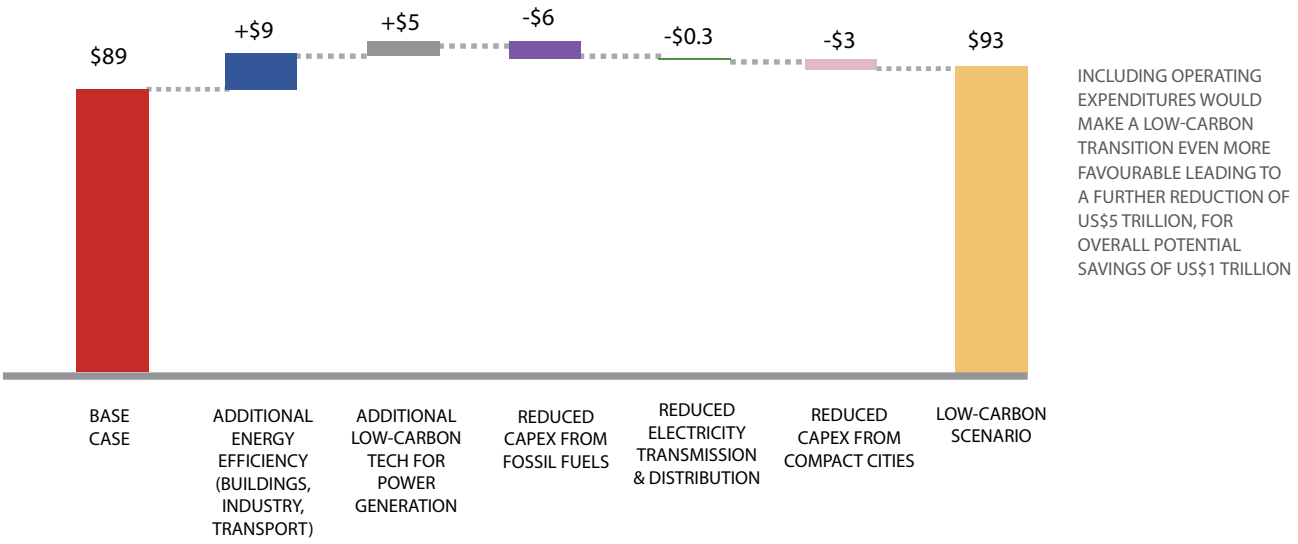
Yet the G20 Global Infrastructure Initiative largely ignores the close links between infrastructure investment and climate change, as do many national and local government planning processes: too often infrastructure and climate policies exist in separate silos. This creates potentially costly inconsistencies, sends mixed signals to investors, and heightens the risk of short-sighted infrastructure decisions.

The importance of sustainable infrastructure for growth in developing countries makes it a priority for international financing, particularly by national and international DFIs. They can help to tackle market failures in the provision of private finance, for example by providing guarantees and other instruments to reduce policy or technical risks, by providing technical assistance and sharing best practices. As indicated in Section 2.3, there is a strong case for expanding the balance sheets and increasing the capital commitments of the multilateral development banks (MDBs), enhancing their capacity to mitigate risk and leverage greater private finance. [232]

International cooperation can also help mainstream climate into infrastructure investment, particularly through the DFIs. For example, several DFIs, including the World Bank, the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), as well as a number of bilateral finance institutions, are committing to halting unabated coal project financing. The MDBs have worked together for some years on how to shift their own investments and leverage other finance for climate-smart infrastructure, and continue to draw out lessons of good

Figure 9

Global investment requirements 2015-2030, US$ trillion, constant 2010 dollars



Source: Global Commission on the Economy and Climate, 2014.[233]

practice, but this effort will need to extend to national development banks and the newer MDBs. Making best practices the norm, across all DFIs old and new, national and multilateral, will help ensure that all capital is deployed toward low-carbon investments.

Progress is already being made: for example, the MDBs and the International Development Finance Club (IDFC), a network of national and sub-regional development banks, have agreed to work together to track and develop best practices for greening finance.[234] Fully mainstreaming climate issues into infrastructure investments around the world will require rethinking policy and planning processes, overall and for individual projects. Approaches will need to be tailored to each country and financial institution, but should follow two high-level principles:

- All infrastructure policies, plans, and projects should build in resilience to the risks of climate changes projected during their lifetimes.
- All infrastructure policies, plans and projects should be consistent with countries' adopted climate targets and policies and long-term ambitions, and able to be justified in the context of the global long-term goal of holding average global warming to under 2°C.

In particular, it would be sensible for the G20 to adopt these principles as part of its Global Infrastructure Initiative and its other related programmes, such as its Voluntary High-level Principles of Long-Term Investment Financing by Institutional Investors and in the work of the G20 Climate Finance Study Group.[235] They would also be appropriate for adoption by DFIs, national development banks and sovereign wealth funds. And they could usefully steer the decisions of private investors, particularly those considering medium and long-term structural risk to project assets and portfolios, and those seeking ways to enhance long-term value creation.[236]

Integration of climate-smart principles into infrastructure decision-making needs to happen at three levels: in the design and alignment of overall strategy and policy, in the composition and balance of infrastructure plans and portfolios considered as a whole, and in relation to individual projects. Alignment of government policy is particularly crucial, as inconsistency between government policies inhibits investment and raises the cost of capital.[237] Once the overall strategic direction is set, a range of methods and instruments are available to mainstream climate at the project level.[238] This needs to happen at the technical assessment stage, where technological and process options and alternatives are considered that will achieve the project aim; at the economic assessment stage, which involves measuring net impacts of the project on welfare; and at the financial assessment stage, where costs and revenues of the project are assessed.[239]

The Commission recommends that the G20 and other countries adopt key principles ensuring the integration of climate risk and climate objectives in national infrastructure policies and plans. These principles should be included in the G20 Global Infrastructure Initiative, as well as used to guide the investment strategies of public and private finance institutions, particularly multilateral and national development banks.

Governments, development banks and the private sector should cooperate to share experience and best practice in mainstreaming climate into infrastructure policies, plans and projects, including through the G20 Global Infrastructure Initiative.

The full Working Paper from which this summary is drawn is Rydge, J., Jacobs, M. and Granoff, I., 2015. *Ensuring New Infrastructure is Climate-Smart*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.7 Galvanise low-carbon innovation

Innovation is a fundamental engine of long-term productivity and growth,[240] and is critical for delivering low-carbon growth in particular. As *Better Growth, Better Climate* highlights, advances in digitisation, materials science and biotechnology, along with new business models, have the potential to transform markets and dramatically cut resource consumption.[241] For example, it is estimated that "circular economy" models, which minimise resource and energy use and maximise recycling, could add up to US$1 trillion to the global economy by 2025.[242] But while existing technologies, widely applied, could achieve medium-term climate goals, more innovation is needed to support the transition to a 2°C pathway. International cooperation can help accelerate progress and spread the benefits of innovation around the world – particularly to emerging and developing economies.

Important collaborations are already under way. In November 2014, the US-China Clean Energy Research Center was expanded to cover joint research on clean vehicles, building energy efficiency and clean coal.[243] The Low Carbon Technology Partnerships Initiative, a collaborative platform to accelerate diffusion of existing technologies and develop public–private partnerships (PPPs), was launched in May 2015.[244] And since 1995, the International Energy Agency has increased the number of non-IEA members in its energy technology initiatives sevenfold.[245] In agriculture, the Consultative Group for International Agriculture Research (CGIAR) is channelling about US$1 billion per year into RD&D to develop more productive and resilient crop varieties and to test improved agricultural techniques particularly suited to developing countries.[246] Still, there is scope to do much more.

Innovation occurs through a complex ecosystem of actors, institutions, interconnecting networks and economic and social contexts, and at various stages in the life-cycle of technologies, from basic research to mass deployment. Within this system, investment in research, development and demonstration (RD&D) is particularly important for the development of new technologies and processes.

Public spending support for research has long been recognised as economically justified, since it generates knowledge spillovers and benefits to society as a whole.

But current levels of RD&D investment in energy and agriculture – the main sources of GHG emissions – are very low.

Public funding for energy-related RD&D in IEA member countries was US$18.2 billion in 2013 – three-quarters of it for low-carbon technologies. This is more than 20% higher, in absolute terms, than in 2008,[247] but as a share of GDP, energy-related RD&D is less than half what it was in the early 1980s.[248] Private investment is similarly low.[249] Global public funding for agriculture RD&D was US$32 billion in 2008, and its share of overall public RD&D expenditure was only 3% in advanced economies.[250] It is in this context that *Better Growth, Better Climate* calls for major economies to triple public energy-related RD&D spending, with the aim of exceeding 0.1% of GDP, and for a doubling of R&D in agriculture and agroforestry.[251]

Most innovation activity has historically been in advanced economies, which registered about 80% of climate-related patents in 2000–2011.[252] In 2013, they still accounted for about 74% of total RD&D in renewable energy.[253] Activity in emerging economies is growing, however, particularly in China, which accounted for about 21% of global renewable energy R&D spending in 2013.[254] India, Brazil, and to a lesser extent, Russia, Mexico and South Africa are also making substantial RD&D investments, mostly through state-owned enterprises.

Not all countries need to be at the frontier of RD&D, but at the very least, they need to be able to adopt and adapt innovations developed elsewhere. However, innovation ecosystems vary widely across countries, with generally lower absorptive capacity in low- and middle-income countries.[255] This poses significant challenges for development, particularly for countries wishing to pursue low-carbon pathways. There is huge potential to "leapfrog" to new, clean technologies, but it requires sustained effort over many years to develop the innovation skills, institutions and knowledge networks to support innovation activities and technology uptake.[256]

Investing in climate-related innovation would be particularly beneficial for emerging and developing economies, where emissions are growing most rapidly and climate vulnerability is particularly stark. Rather than belatedly adopting technologies developed elsewhere, often at significant expense, countries can seize the opportunity to develop their own, locally-adapted solutions, which can in turn help drive industrial production and economic growth, as well as cutting emissions and improving resilience. These solutions could also become valuable exports, and be shared with other developing countries as a form of South-South cooperation.

Public funding for RD&D is particularly needed in technologies which will be required to reduce emissions after 2030. The IEA describes the current status of all such low-carbon technologies as "off track".[257] A number of areas are in particular need of stronger RD&D effort:

- **Agriculture and bioenergy**, including, for example, improvements in climate-resilient seeds and livestock feed. Bioenergy with carbon capture and storage is a key component of many emissions reduction scenarios in the second half of the century, but needs considerable further research effort.[258]
- **Buildings and construction**, including building envelope technologies, which are projected to deliver 10% of cumulative energy emissions reductions between the IEA's 6°C and 2°C scenarios by 2050.[259]
- **Electricity networks**, including smart grid and energy storage technologies, where further RD&D is needed on the integration of supply and end-use technologies. There is also a major need for further research on using off-grid renewables and batteries to facilitate energy access in low-income countries.
- **Transport systems**, particularly in urban areas. The IEA projects that transport could provide 19% of cumulative energy emissions reductions between its 6°C and 2°C scenarios by 2050.[260]
- **Carbon capture, use and storage,** which may be crucial in post-2030 mitigation efforts. Studies suggest that a major delay in its availability could increase total discounted mitigation costs by 138% to 2100.[261] The IEA projects that CCUS could provide 13% of the cumulative energy emissions required for a 2°C scenarios by 2050.[262]

International cooperation can enable countries to share costs and risks, link RD&D activities to early market formation, increase knowledge-sharing, combine global capabilities, and build capacity. International efforts may involve national innovation programmes directly supporting RD&D activity by overseas entities; direct bilateral collaboration (such as IEA Implementing Agreements); and intergovernmental or non-governmental programmes supporting international activity (such as the Climate Innovation Centres[263]). International cooperative efforts on public RD&D should aim to enhance and complement, rather than distort or displace, domestic public RD&D programmes and existing private sector efforts.

The role of the private sector is vital. It is private companies – mostly multinationals and early-stage investors – that currently drive most international cooperation. Overall data on RD&D shows that spending by multinational innovator companies outside their home countries[264] accounts for at least 10–20% of private-sector RD&D activity. In the case of smaller high-innovation countries, over 60% of their private-sector RD&D might come from foreign enterprises.[265] This includes, among other things, setting up global networks of innovation centres, joint innovation projects or ventures between multiple firms in different countries, foreign investment by venture capital, and combinations of all of the above.

The private sector tends not to invest in lower-income countries, however. International innovation activities tend to be heavily concentrated in countries with mature innovation ecosystems and large short- to medium-term market potential. For example, around 90% of US companies' overseas innovation activity is in Europe, Japan, Canada, China, Brazil and India.[266] Cooperative mechanisms such as voluntary patent pooling, open-source innovation and open licensing agreements are therefore needed to enable the rapid diffusion of key low-carbon solutions, while still providing the private sector with incentives to innovate.[267]

Experience to date suggests a number of principles that should be incorporated into the design of new or existing international co-operative efforts on RD&D. Lessons from national RD&D efforts and initiatives such as CGIAR suggest that it is important to achieve sufficient scale to ensure the basic foundations of a robust innovation ecosystem. This includes priority-setting processes, systems for quality assurance and evaluation, and mechanisms for intellectual property management. Long-term commitments that build trusting, effective relationships are particularly important; the IEA energy technology initiatives suggest that decade-long initial commitments may be needed. And strong public-private partnerships are crucial. Technology "challenges", where different technological solutions are sought to a general problem, may also be useful: an "Apollo" project for clean energy has recently been established, and there is clear potential for similar programmes in other key fields.[268]

The Commission recommends that emerging and developed country governments work together, and with the private sector and developing countries, in strategic partnerships to accelerate research, development and demonstration (RD&D) in low-carbon technology areas critical to post-2030 growth and emissions reduction. This includes innovation in agriculture; in longer-term solutions such as bioenergy and carbon capture, utilisation and storage; and in ways to avoid lock-in of carbon-intensive infrastructure (buildings, electricity networks, transport systems). There is also a critical need for cooperation to target or adapt innovations to developing-country needs.

The full Working Paper from which this summary is drawn is Eis, J., Gradwell, P. and Bishop, R., 2015. *Galvanising Low-Carbon Innovation*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.8 Drive low-carbon growth through business and investor action

Major businesses generate a large share of global greenhouse gas emissions: nearly 15% come from the largest 500 companies alone.[269] Yet businesses also drive technological innovation and low-carbon economic activity. And while major companies and business associations previously often opposed climate policy – some still do – many now demand it. Most recently, at the Business and Climate Summit in Paris in May, business associations whose networks represent 6.5 million firms called for strong climate action and a new international climate agreement.[270]

Companies are increasingly integrating climate change into their business and investment strategies. Tackling climate change is a huge business opportunity: the global market for low-carbon and environmental goods and services was estimated at US$5.5 trillion in 2011–12, and is growing at over 3% per year.[271] Businesses are developing new products and services to seize this opportunity; identifying and addressing climate risks in their operations and supply chains; and reducing their GHG emissions. This is starting to happen across a variety of sectors, including energy-intensive ones such as cement, chemicals, and iron and steel, where emissions are large and significant reduction poses undeniable challenges.[272]

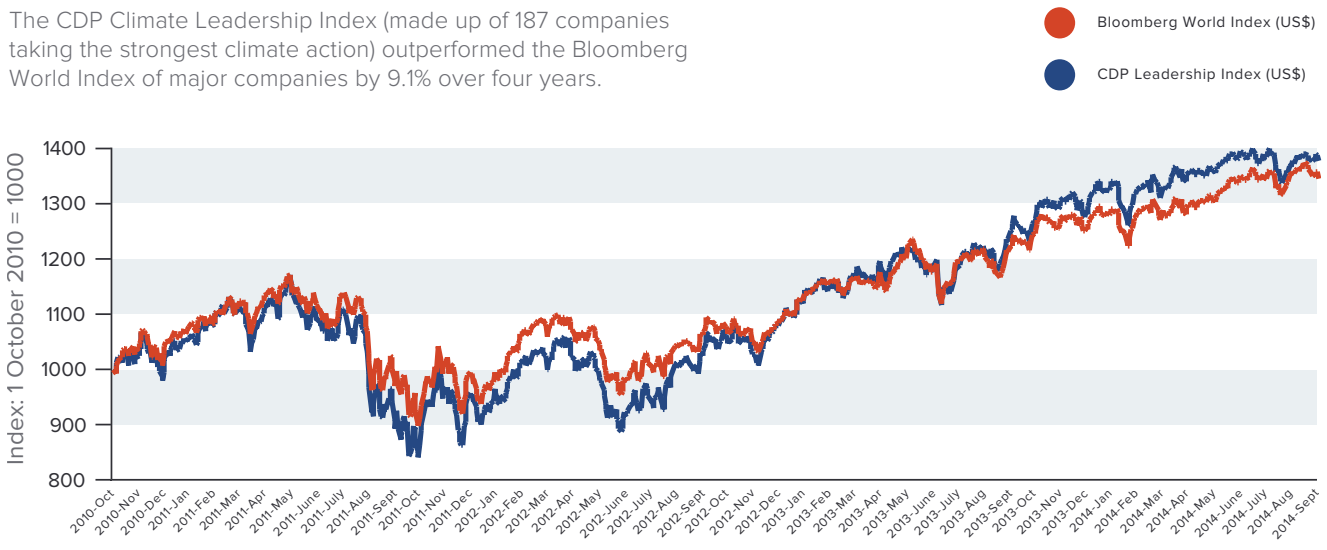
The corporate reporting initiative CDP[273] estimates that in 2014, almost 1,400 companies reporting to it (59% of the sample) achieved an aggregate of 700 Mt CO_2e of emissions reductions through implementation of more than 90,000 projects.[274] This is roughly equivalent to the 2012 emissions of France and the Netherlands combined.[275] In the past such actions were generally motivated by the requirements of policy, corporate social responsibility, or the anticipation of future policies. But increasingly they are driven by a clear business case.

Companies typically reduce their emissions by improving energy efficiency and adopting lower-carbon technologies, processes and operating methods. Such actions can unlock significant savings in energy, resource and fuel costs, and also boost productivity and innovation. Among the Fortune 100, 53 companies reported saving a combined US$1.1 billion in 2013 from energy efficiency, renewable energy and other emission reduction initiatives – an average of over US$10 million per company.[276] In an analysis for the We Mean Business coalition, CDP found that in 2013, the global average internal rate of return (IRR) on low-carbon projects by companies reporting to them was 11%, though there was significant variation by country and investment type, with some much higher.[277] Indeed, there is growing evidence that emissions reduction does not undermine profitability, and may even enhance it.[278] The CDP Climate Leadership Index (made up of companies taking the strongest climate action) has outperformed the Bloomberg World Index of top companies by 9.1% over the past four years (see Figure 10).[279]

Figure 10
CDP Climate Leadership Index vs. Bloomberg World Index

Monthly Oct 2010 to Aug 2014

The CDP Climate Leadership Index (made up of 187 companies taking the strongest climate action) outperformed the Bloomberg World Index of major companies by 9.1% over four years.



Source: Adapted from CDP, 2014.[280]

Shareholders, customers and other stakeholders are also pushing businesses to take climate action. A global survey in 2013 found more than 80% of asset owners and nearly 70% of asset managers viewed climate change as a material asset risk.[281] Of the 2,345 companies reporting to CDP in 2014, 88% considered climate change a risk to their operations.[282] In April and May 2015, shareholders of Shell and BP passed resolutions requiring the companies to report the actions they were taking in relation to climate change, including emissions management, asset resilience, research and development in low-carbon technologies, and support for public policy.[283]

Yet there is much greater potential.[284] A large share of major businesses around the world have yet to adopt emissions reduction targets and plans,[285] and many of those that have are relatively limited in their ambition. Only a very small number of companies have set long-term (2030 or later) targets which can be considered to be in line with a sectoral 2°C pathway.[286] An analysis of 70 of the world's largest publicly listed corporate emitters, across the aluminium, cement, chemicals and electric utilities sectors, found that 21 had targets up to 2020 which could be considered consistent with a 2°C sectoral pathway, but only 7 had targets to 2030 or later.[287] Twenty others had non-2°C or "irrelevant" targets, and the rest had none at all. It is clear that efforts need to be extended and ambitions raised if businesses are to achieve a low-carbon transformation.

Raising businesses' climate ambition

Most climate actions by businesses to date have been undertaken by individual companies acting alone. But in recent years, several business-led cooperative initiatives have emerged to set new norms and expectations for how businesses should respond to climate issues.

Some initiatives focus on establishing targets, or common commitments or standards. The GHG Protocol, for example, provides common international standards for business emissions reporting.[288] The Science Based Targets initiative goes further, encouraging companies to set medium- and long-term emissions reduction targets consistent with a global 2°C trajectory. The initiative provides a rigorous methodology based on sectoral shares of total emissions, in order to give these targets independent credibility.[289] Similarly, signatories to the RE100 initiative agree to source their electricity from 100% renewable sources, with a clear time frame for reaching their goal.[290]

In the finance sector, a growing number of initiatives aim to set standards for responsible behaviour. The Principles for Responsible Investment (PRI) includes around 1,400 asset owners, investment managers and service providers representing more than half the world's institutional investment capital. PRI members report having engaged more than 1,660 companies in around 60 countries, seeking improvement in environmental, social and governance (ESG) policies and practices, including carbon emissions disclosure, targets and corporate lobbying on climate policies.

The market for investments including some form of ESG now represents around a third of all assets under management, and evidence and practice suggest that consideration of ESG factors can reduce risk and improve investment and business performance.[291] Under the Montreal Pledge, meanwhile, asset owners and investment managers commit to measuring and disclosing the carbon footprint of their assets. The aim is to have at least US$3 trillion of assets covered by the pledge by the end of 2015.[292] More radically, the Portfolio Decarbonisation Coalition encourages asset holders to decarbonise their investment portfolios.[293]

But individual business action is rarely sufficient to transform whole markets and sectors in a low-carbon direction. For this a critical mass of companies is needed to build economies of scale, shift demand, and advocate for consistent regulatory policies. A number of initiatives have emerged over recent years seeking to catalyse the low-carbon transformation of specific sectors, value chains, technologies or products in this way.

The Low Carbon Technology Partnerships initiative (LCTPi), for example, has brought together about 100 companies to accelerate the development and deployment of low-carbon technologies in key fields. Some LCTPi action plans are focused on energy-intensive sectors, such as the Cement Sustainability Initiative, and in chemicals; others focus on technologies such as carbon capture and storage and advanced biofuels. The LCTPi involves dialogue with governments on removing policy barriers and the formation of public-private partnerships for research, demonstration and development.[294]

Similarly, the Tropical Forest Alliance 2020 (TFA 2020) aims to transform markets for key agricultural commodities, with producers, traders and consuming companies all committing to eliminate deforestation from their supply chains. The aim is to extend current commitments for palm oil to other commodities such as soy, beef, and pulp and paper.[295] Under the Soft Commodities Compact of the Banking Environment Initiative, major banks representing 20% of the international financing of agricultural commodities are developing new financing solutions for sustainably sourced commodities.[296]

There is significant scope for such initiatives to be developed in other sectors, particularly among energy-intensive industries and the oil and gas sector.[297]

Wider attempts to transform the financial sector are also under way. The United Nations Environment Programme (UNEP) Inquiry into a Sustainable Financial System is working with central banks and financial regulators to examine how the financial system as a whole can help support the low-carbon transition. It argues for an expansion of the scope of risk management to include climate factors, and mechanisms to facilitate the flow of capital into low-carbon investment. Through the Focusing Capital on the Long Term initiative, a group of major investors is proposing ways to reorient investment practices away from "short-termism", through changes in asset manager contracts, benchmarking, evaluation and incentives and clear statements of investment beliefs.[298] The Climate Bonds Initiative aims to drive the expansion of new financial instruments for low-carbon investments.[299]

These initiatives have been accompanied by a rise in business-led climate advocacy. New coalitions are calling for clear, long-term and stable low-carbon policy signals to guide investment and innovation. Formed in 2014, We Mean Business brings together seven global associations to amplify the business voice.[300] At the UN Climate Summit last September, the Global Investor Coalition brought together 350 investors with combined assets of US$24 trillion to call for stronger climate policy.[301] Business advocacy could also play a crucial role, together with trade unions and community organisations, in working to ensure a just and efficient transition to a low-carbon economy, by helping affected workers and communities, for example in coal mining and energy-intensive sectors, to shift into new sectors of employment.

It is too soon to know how successful these initiatives will be. But they offer the potential to shift the huge resources of business investment and innovation towards driving a low-carbon transition. More broadly, there is a need to engage businesses all around the world, not just in developed countries. The prize is to align business interests more closely with the requirements of a 2°C pathway, to drive deeper emissions reductions and expand low-carbon markets.

The Commission recommends that all major businesses adopt short- and long-term emissions reduction targets and implement corresponding action plans, and all major industry sectors and value chains agree to market transformation roadmaps, consistent with the long-term decarbonisation of the global economy. Financial sector regulators and shareholders should actively encourage companies and financial institutions to disclose critical carbon and environmental, social and governance (ESG) factors and incorporate them in risk analysis, business models and investment decision-making.

The finance sector should expand long-term and responsible ownership and financing practices, and improve its capabilities, incentives, standards and rules in order to facilitate the decarbonisation of the global economy. Businesses should adopt common standards for measuring, reporting and verifying emissions data using best practice protocols, and include their results in integrated financial reports. Businesses should work to ensure that trade associations and other groups representing them do not act to block action on climate change, and speak out when they do.

The full Working Paper from which this summary is drawn is Whittington, E., Bartlett, N., Chessum, C., Reuvers, S. and Jacobs, M., 2015. *Driving Low-Carbon Growth through Business and Investor Action*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.9 Raise ambition to reduce international aviation and maritime emissions

Global aviation and maritime shipping combined produce about 5% of global CO_2 emissions, and by 2050 their share is projected to rise to 10–32%.[302] While domestic aviation and shipping are covered under national policies and emission inventories, emissions from international aviation and shipping, which make up a majority of emissions in each sector, are not.[303] They need to be addressed through internationally coordinated policies, in order to ensure efficiency in these global markets and minimise potential competitiveness impacts.

The UN governing bodies of these sectors, the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO), have both made efforts to adopt policies for reducing international emissions, for which they are responsible, since they were directed to do so 17 years ago through the Kyoto Protocol. But progress has been very slow. In 2013, the IMO set design efficiency standards for new ships, and ICAO is due to decide in 2016 on the implementation of a market-based measure to control emissions from 2020.

Several cost-effective options are available for further reducing emissions from aviation and shipping, mainly from more efficient fuel usage. New aircraft technology and harmonised air traffic management systems also offer opportunities to continue lowering fuel costs in aviation. In shipping, it is estimated that taking full advantage of already available efficiency measures could save over US$30 billion in fuel costs each year for the industry and avoid 300 Mt CO_2 per year by 2030.[304]

International aviation

Aviation is a major economic sector, central to trade and to growth for both developing and developed countries. Aircraft carry about 35% of world trade by value, although only 0.5% by volume.[305] The airline industry is growing rapidly: revenue has doubled in the past decade, from US$379 billion in 2004, to US$733 billion in 2014,[306] and passenger bookings are forecast to double to over 6.5 billion by 2032.[307]

Aviation is also a major contributor to global greenhouse gas (GHG) emissions, accounting for 13% of fossil fuel use in transport and about 2% of global CO_2 emissions.[308] International aviation consumed 142 Mt of fuel in 2010, producing about 448 Mt of CO_2 emissions, up from 185 Mt CO_2 in 1990.[309] Given the growing role of aviation in the global economy, trade and business, ICAO expects international aviation emissions to rise to 682–755 Mt CO_2 by 2020.[310] Further, aviation's non-CO_2 emissions at high altitudes exacerbate the impact on warming to 2-4 times greater than that of CO_2 alone.[311]

Controlling aviation emissions growth will not be easy, but it is crucial given the size of the sector's emissions. On the demand side, there is a need to provide viable alternatives to flying – such as high-speed rail and wider use of communications technologies that reduce travel needs. Within the sector, the focus needs to be on improving fuel efficiency and shifting to cleaner fuels.

Both domestic policy and ICAO-led international policy have a role to play in incentivising such changes. At the domestic level, several countries including Japan, Brazil and others have implemented jet fuel taxes for domestic flights, and Norway has levied a carbon tax on domestic aviation since 1991.[312] In June 2015, the US Environmental Protection Agency took initial steps toward regulating aviation emissions.[313] Emissions from flights within the EU are covered by the EU Emissions Trading System (ETS),[314] but longstanding legal agreements, including the 1944 Convention on International Civil Aviation and numerous bilateral agreements, have effectively prevented taxation of fuel for international aviation.[315]

Fuel is a major cost for the industry: US$208 billion in 2013, or 30% of total costs,[316] so fuel efficiency measures are economically attractive. And there is considerable room for improvement: there was a 27% difference in the fuel efficiency of the least and most fuel-efficient US airlines in 2013.[317]

Fuel efficiency can be improved through improved infrastructure, operational measures such as reducing the weight of on-board equipment, and improved aircraft design and materials. "Winglets", for instance – up-tilted wingtip devices that reduce aircraft drag – can cost over US$1 million per aircraft to install, but improve fuel efficiency by 4% and pay for themselves in about two to three years (depending on fuel cost).[318] Beyond these types of improvements, however, further emissions reductions from aviation may be quite costly and options are limited. Some carriers are also testing specialised biofuels; as in other sectors, however, there are questions about biofuels' life-cycle emissions, sustainability and cost-effectiveness.

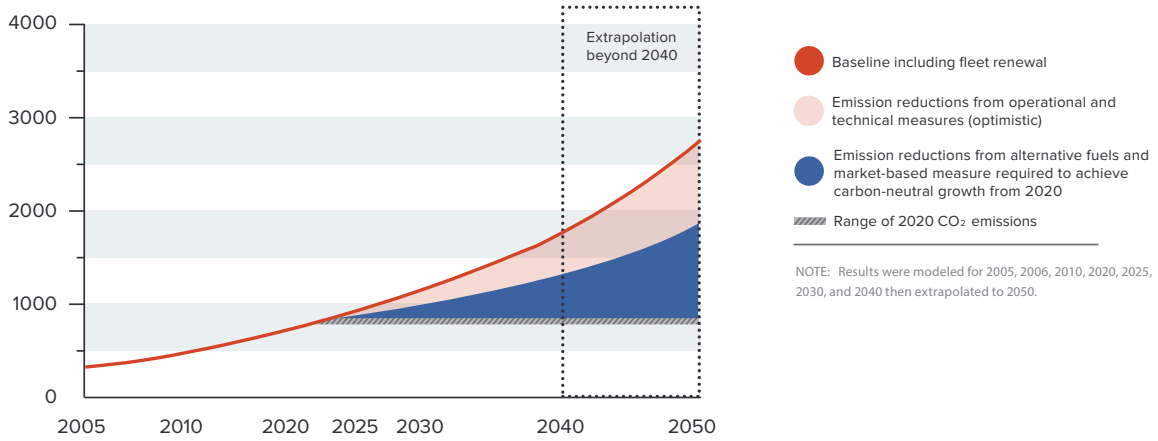
Policy action is needed to accelerate progress. While regulation through the EU or domestic policy is an option, acting through ICAO would ensure a harmonised approach across the sector globally, increasing coverage and reducing administrative burden. Yet ICAO has moved slowly since the 1997 Kyoto Protocol suggested it take action, drawing considerable criticism.[319] At the 37th ICAO Assembly in 2010, governments set aspirational goals to improve fuel efficiency by 2% per year and make international aviation's growth from 2020 onwards "carbon-neutral", but these commitments are not binding and are unlikely to amount to the reductions needed for a 2°C pathway.[320]

Through ICAO, governments, civil society and the industry are also developing a global CO_2 standard for new aircraft to be agreed in 2016.[321] The coverage of this standard has not yet been finalised. If only "new types" of aircraft are included under the standard, then just 5% of the global fleet would be covered by 2030. If all "new in-production" aircraft are included, fleet coverage would rise to 55% in 2030.[322]

These efforts are unlikely to be sufficient to meet the industry's targets, however, so ICAO has also taken steps to establish a market-based measure (MBM) to "bridge the gap" (see Figure 11). ICAO is due to take a decision on the measure in 2016, which would be fully implemented in 2020.[323] Three options are currently being considered: an offset scheme in which carriers purchase permits or offsets to cover CO_2 emissions above an agreed level; an offset scheme with revenue, applying a fee per unit traded and using the funds to assist developing countries with implementation, for example; or a global emissions trading scheme, which would cap total emissions from the sector, issue allowances for this amount, and distribute or sell them at auction to carriers.[324] A simple offset scheme is favoured by some industry groups, and most discussions in ICAO are focused on it; but all three options remain on the table, and the potential to generate revenue makes the option two options particularly attractive.[325]

An ICAO study found that an MBM to cap net emissions at 2020 levels could require offsetting 464 Mt CO_2 in 2036, roughly half of projected emissions. ICAO has estimated that if carbon prices rose from US$30 in 2020 to US$45 in 2035, an MBM would only slow international aviation growth slightly, to 107% in 2020–2036, against a baseline of 110%.[326] The additional cost to airlines would be US$10/

Figure 11
CO_2 emission trends from international aviation (Mt/year)



Source: Adapted from ICAO, 2013.[327]

seat for a long-haul flight of 10,000–12,000 kilometres, and US$1.50/seat for a short-haul flight of 900–1,900 km, with most models suggesting that almost all the cost would be passed on to consumers.[328] Global industry profits in the year 2036 would be US$33.3 billion, US$0.4 billion lower than in a baseline scenario.[329]

A key issue in the design of any MBM is its distributional impact – particularly how it will affect developing countries. ICAO decided in 2012 that any MBM should accommodate "the special circumstances and respective capabilities of developing countries".[330] One way of achieving this would be to provide financial support to affected low-income countries, or to only buy offsets from developing countries. Some have also suggested exempting some routes or countries.

International shipping

International shipping carries about 90% of world trade by volume, on a fleet of more than 50,000 ships.[331] Demand for maritime transport has risen significantly: total cargo on international seaborne trade grew from 2.6 billion tonnes in 1970 to 9.5 billion tonnes in 2013.[332] Emissions from shipping have also increased sharply, to 949 Mt CO_2 in 2012, or 2.7% of global CO_2 emissions, up from 1.8% in 1996.[333] By 2050, the IMO projects that CO_2 emissions from shipping will rise by 50–250%.[334]

Because of the global nature of shipping, international action is essential for effective regulation. A ship can be owned by a company based in one country, registered in another, and operated out of a third.[335] Because shipping companies operate in so many different countries, the transaction cost of having different policies in different states would also be prohibitively high. However, IMO has made little progress thus far.

Virtually all GHG emissions from shipping arise from the fuels used in ship engines.[336] Shipping consumes 250–325 Mt of fuel per year,[337] about 85% of which is heavy fuel oil (HFO).[338] Shipping is generally more efficient in terms of emissions than other forms of transport, but ship efficiency varies widely based on design, fuel and power sources, and operations.[339] Even ships with similar designs can operate with vastly different efficiencies[340] – the most efficient crude oil tanker is about one-fifth as fuel-intensive as the least efficient.[341]

Key drivers of operational efficiency are speed (a 10% slower speed reduces fuel use per hour by 27%[342]) and utilisation rate – fully loaded ships are most efficient. Reliable data on operational efficiency are scarce, however, which remains a significant challenge. Design efficiency, meanwhile, depends on ship size, shape, capacity, power and other technical features.[343] It has declined by about 10% in new ships since 1990, in part because high freight rates encouraged more block-like, less hydrodynamic designs, but began improving again in 2008.[344]

Fuel represents 50% or more of a ship's operating cost, and there are several cost-effective ways to increase fuel-efficiency.[345] For example, polishing propellers more often can increase efficiency by 4%, and costs just US$13 per tonne of fuel saved (at US$300–800 per tonne).[346] One company has found that a fouling-resistant hull coating applied to a bulk cargo vessel at a cost of US$360,000 saved about 5,400 tonnes of fuel over nine years, a 22% efficiency improvement.[347] At a fuel cost of US$300 per tonne, the technology would fully pay itself back in just over two years, and over US$1.2 million would be accrued in net savings over nine years.

Two systemic market failures have kept the industry from embracing and rewarding energy efficiency measures.[348] First, there is little reliable information on ship efficiency and the expected gains from different technologies and operational measures. Second, incentives are split between the ship owner and charterer. Though individual contracts vary, ship charterers often bear some or all of the fuel costs, while the owner is responsible for the ship's technology and design. Fully embracing available efficiency measures could significantly reduce the sector's emissions, as illustrated in Figure 12 below.

Several independent initiatives have emerged to address the lack of transparency around fuel efficiency of ships in the industry, to enable charterers to inform their choice of carriers with information on expected fuel costs. For example, the organisations RightShip and Carbon War Room provide a public rating system of over 70,000 vessels that grades each ship on design efficiency.[349] The Clean Shipping Index provides a similar service, rating carriers on all pollutants, including NO_X, SO_X, particulate matter, chemicals, and on-board waste.[350] However, these voluntary initiatives do not yet have full industry-wide influence, and they lack a single, standardised methodology for evaluating efficiency.

Tailored financing schemes to support energy efficiency investments have also emerged, including the Sustainable Shipping Initiative's Save As You Sail (SAYS) and the Self-Financing Fuel-Saving Mechanism (SFFSM) driven by Carbon War Room and University College London.[351]

In both models, a third-party financier pays for the upgrades, and the cost savings are shared between the third party, owner and charterer (depending on who is paying for the fuel).

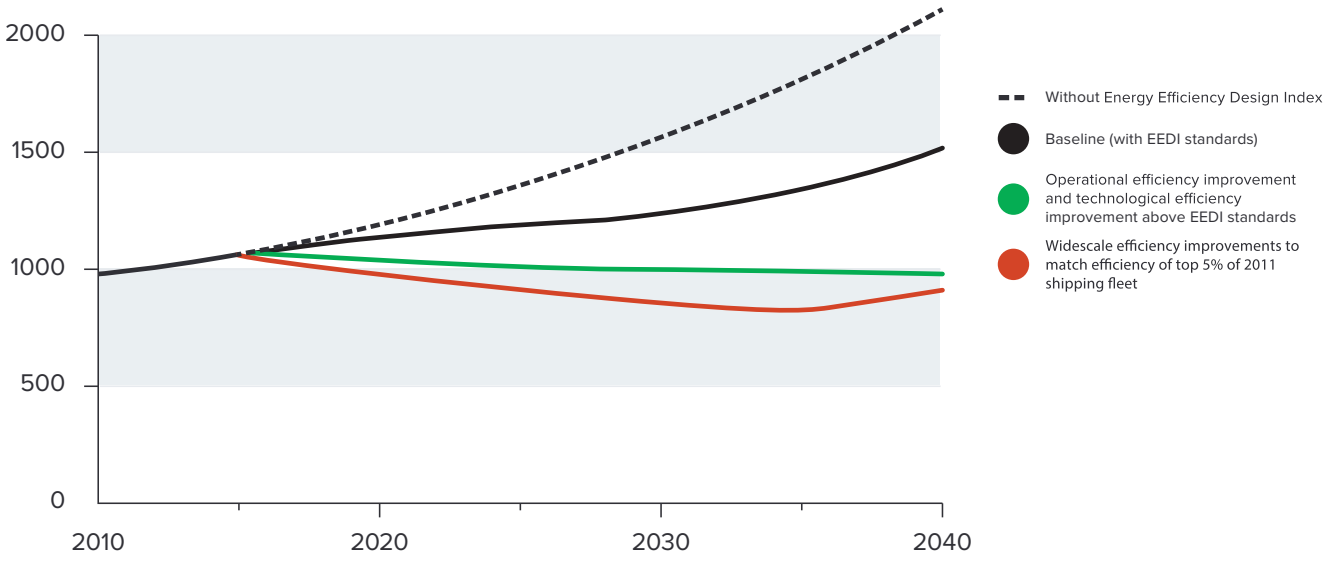
The IMO has declared that shipping "will make its fair and proportionate contribution" towards achieving global climate change mitigation goals.[352] It has adopted two key approaches: the Energy Efficiency Design Index (EEDI), which requires new ships built from January 2013 to meet an efficiency standard that will be raised over time,[353] and the Ship Energy Efficiency Management Plan (SEEMP), a tool that ships are required to use to identify energy-saving measures (though they are not required to adopt them).[354] The EEDI and SEEMP are expected to save an average of US$200 billion in fuel costs and 330 Mt CO_2 annually by 2030 at marginal cost in the near term.[355]

Still, these policies are not enough to stem the rapid growth in shipping emissions due to increased transport demand.[356] Several additional policy proposals were submitted to the IMO in 2010, including an emissions offset scheme, a fuel tax, and mandated energy efficiency targets, but they have not been taken up. In May 2015 the Republic of the Marshall Islands – the third-largest flag registry in the world – submitted a proposal to the IMO's Marine Environmental Protection Committee (MEPC) for the adoption of a global emission reduction target.[357] However, the Committee decided to focus instead on finalising the emissions data collection system.

Figure 12

International shipping fleet CO_2 emissions scenarios (Mt/year)

If the entire fleet achieved the efficiency of 2011's industry leaders by 2035, shipping's total emissions could decrease while shipping activity doubles.



Source: ICCT, 2013.[358]

Given the constraints that have hindered take-up of cost-effective efficiency measures to date, there are strong grounds for the IMO to adopt operational efficiency requirements that apply to all ships. These could be complemented by a trading scheme that would permit highly efficient ships to sell their extra "efficiency credits" to less efficient ships. These requirements would need to be ramped up over time to motivate continual improvement and adoption of cutting-edge technologies.

The Commission recommends that emissions from the international aviation and maritime sectors be reduced in line with a 2°C pathway through action under the International Civil Aviation Organization (ICAO) to implement a market-based measure and aircraft efficiency standard, and through strong shipping fuel efficiency standards under the International Maritime Organization (IMO).

ICAO should take a decision in 2016 to start implementation of a market-based measure (MBM) from 2020, which can be ratcheted up and has the potential to raise revenue which could support climate action or other priorities. It should also introduce in 2016 a stringent aircraft CO_2 standard. Governments and airlines should also make further efforts to develop and expand the use of sustainable biofuels. An MBM could reduce in-sector emissions by 0.2–0.3 Gt CO_2e per year in 2030.

The IMO should adopt a global emission reduction target. To increase use of cost-effective fuel-saving technologies and practices, the IMO should create a transparent, global system to provide reliable data on operational efficiency, and accelerate the process to establish ambitious operational efficiency standards for all ships. Charterers, banks and ports should incorporate fuel efficiency considerations within their operations, thereby creating incentives for more efficient ships. Broad adoption of these measures could reduce emissions by 0.4–0.6 Gt CO_2e per year by 2030.

The full Working Paper from which this summary is drawn is Gençsü, I. and Hino, M., 2015. *Raising Ambition to Reduce International Aviation and Maritime Emissions*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

2.10 Phasing down the use of hydrofluorocarbons (HFCs)

Hydrofluorocarbons (HFCs) are the fastest-growing group of greenhouse gases in much of the world, with emissions of major HFCs rising by 10–15% per year.[359] Developed to replace chemicals being phased out under the Montreal Protocol on Substances that Deplete the Ozone Layer, they are used as refrigerants in air conditioners and other products, to make insulating foams, and as solvents. They do not harm the ozone layer, but are potent greenhouse gases, with particularly large near-term climate impacts.[360]

Developed countries already include HFCs in national emissions inventories under the United Nations Framework Convention on Climate Change (UNFCCC). But to catalyse rapid action and mobilise finance, more than 100 countries now support amending the Montreal Protocol to phase down the production and use of HFCs with the highest climate impact. Such a phase-down could avoid 1.1–1.7 Gt CO_2e of HFC emissions per year by 2030,[361] while driving significant energy efficiency improvements with both economic benefits through energy savings and climate benefits. The Montreal Protocol includes a Multilateral Fund which could help finance HFC phase-down in developing countries.

Momentum on HFCs is also building at the national level and in the private sector. The EU, the US and China have all committed to controlling HFCs more stringently and increasing the availability of alternatives. A diverse group of governments, businesses and others is tackling HFCs through the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC). The Consumer Goods Forum, with more than 400 member companies, will start phasing out HFCs in refrigeration in 2015.[362] Refrigerants, Naturally! – an initiative by Coca-Cola, PepsiCo, Red Bull, Unilever and others – is working to eliminate the use of HFCs in those companies' operations.[363]

Driving these actions is a strong sense of urgency. The HFCs now used as substitutes for ozone-depleting substances (ODSs) can trap 100–4,000 as much heat in the atmosphere over 100 years, per tonne, as CO_2.[364] And while proper handling and disposal can reduce emissions, every HFC-using device is a small "bank" of potential emissions for decades to come. Without fast action, the climate impact of HFCs could grow as much as 30-fold by 2050,[365] eroding the benefits of global mitigation efforts.

Moreover, phasing down HFCs with high global warming potential (GWP) would cost relatively little. The US Environmental Protection Agency (EPA) estimates that HFC emissions could be reduced by more than 40% in 2030 through measures that are cost-effective today.[366]

Though in some areas (e.g. medical and technical aerosols, fire protection applications), there are still no good alternatives to high-GWP HFCs, in most areas they are widely available and affordable.[367] The drinks manufacturer Heineken, which now uses non-HFC refrigeration where technically and legally feasible (about two-thirds of units worldwide), found HFC-free units cost about 15% more at first, but the price difference has narrowed as

larger numbers were purchased. The new units are also 38% more energy-efficient than conventional ones, of which 10–15% is due to the refrigerant (hydrocarbons), and the rest to technological improvements.[368] Coca-Cola, which had installed 1 million HFC-free coolers as of January 2014, reports a 40% improvement in its cooling equipment energy efficiency since 2000.[369] Recent low-GWP refrigerant demonstration projects presented by the CCAC calculated energy savings of 15–30% and carbon footprint reductions of up to 60–85% for refrigeration in food stores.[370]

Overall, about 55% of HFCs used in 2010 were in residential, commercial and industrial refrigeration and air conditioning; another 24% were in mobile (vehicle) air conditioning; 11% in foams; 5% in aerosols; 4% in fire protection systems; and 1% in solvents.[371] As in the food and beverage industry, HFC-free equipment in other sectors has been found to be more energy-efficient, reducing costs and GHG emissions.[372]

For motor vehicle air conditioning, for example, the replacement chosen by most automakers supplying EU, Japanese and North American markets costs about US$100 more per unit initially, and another US$2 each year. But the units save an estimated US$37–48 in fuel each year, paying for themselves in less than three years.[373] Preliminary estimates by the Lawrence Berkeley National Laboratory (LBNL) also suggest that combining technically available energy efficiency improvements in room AC systems with a transition to low-GWP refrigerants would yield greater GHG emissions reductions than either measure alone.[374] In India, the energy savings would be enough to avoid building 120 medium-sized power plants in the next 15 years.[375]

The Montreal Protocol has several advantages that would allow Parties to quickly and efficiently implement effective controls for HFCs, including a well-established infrastructure, expert panels, institutional experience phasing down nearly 100 similar chemicals, and dedicated implementation tools, including the Multilateral Fund.

The idea to bring HFCs under the Montreal Protocol was first proposed in 2009 by low-lying island states. Four proposals are now on the table, submitted by the Federated States of Micronesia, the Philippines, and six other island states; jointly by Mexico, Canada and the United States; by the European Union; and most recently by India, reversing its previous opposition. All focus on reducing HFC production and consumption under the Montreal Protocol, and leave accounting and reporting of HFCs under the UNFCCC.

The 2015 North American proposal suggests a staged phase-down, with developed countries starting right away and developing countries being given a 10-year grace period, as was done with ozone-depleting substances. This measure could avoid an estimated 94–115 Gt CO_2e of cumulative HFC emissions by 2050.[376]

A key strategy for slowing and reversing the growth in HFCs is to help countries that are currently phasing out hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol to "leapfrog" over high-GWP HFCs and move directly to available low-GWP alternatives where feasible. Leapfrogging HFCs in the phase-out of HCFCs would be considerably less expensive than a conversion first from HCFCs to HFCs and then from HFCs to low-GWP alternatives. Combining this with energy efficiency improvements would provide added climate benefits – and cost savings – from reduced energy use.[377]

In April 2015, the Open Ended Working Group (OEWG) of the Montreal Protocol held an extraordinary meeting on HFCs, where countries agreed "to study the feasibility and ways of managing HFCs", with a view to establishing a Contact Group at the OEWG meeting scheduled for 20–24 July in Paris. If progress continues, an HFC amendment could be adopted as soon as the Meeting of the Parties in Dubai in November 2015.

The UNFCCC could further speed the phase-down of high-GWP HFCs by encouraging Parties to include an HFC phase-down in their "intended nationally determined contributions" (INDCs) to the Paris climate agreement.[378] The Parties could also extend HFC reporting and accounting requirements to developing countries.

The Commission recommends that the Parties to the Montreal Protocol approve an amendment to phase down the production and use of HFCs.

Countries that do not yet have regulations in place for phasing down HFCs should begin developing and implementing such regulations alongside appliance energy efficiency standards. Major companies should commit to phasing out HFCs through cost-effective cooperative action programmes such as those of the Consumer Goods Forum and Refrigerants, Naturally!. The UNFCCC should encourage countries to include HFC phase-down in their INDCs and extend HFC reporting to all countries.

The full Working Paper from which this summary is drawn is Borgford-Parnell, N., Beaugrand, M., Andersen, S. and Zaelke, D., 2015. *Phasing Down the Use of Hydrofluorocarbons (HFCs)*. A New Climate Economy contributing paper for *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. Available at: http://newclimateeconomy.report/misc/working-papers.

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The estimates made for this report are mostly ranges to allow for various uncertainties, with the median values expressed in Figure 4. The emissions potential of the actions in each area have been estimated individually; when added together the overlaps between them have been subtracted, using conservative assumptions.

The baseline is taken from modelling scenarios reviewed by the IPCC and analysed in: UNEP, 2014. *The Emissions Gap Report 2014*. United Nations Environment Programme, Nairobi. Available at: http://www.unep.org/publications/ebooks/emissionsgapreport2014/. That report estimates the median level of emissions in 2030 as 69 Gt CO_2e.

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The actions proposed in this report are estimated to have an aggregate emissions reduction potential in 2030 of 16–26 Gt CO_2e once the overlaps between them have been subtracted. This represents 59–96% of the gross emissions gap. A full description of the methodology used to estimate the emissions reduction potential in this report is published at http://static.newclimateeconomy.report/wp-content/uploads/2015/07/estimates-of-emissions-reduction-potential-for-the-2015-report.pdf.

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developing world which may have less recourse to domestic resources and have more pronounced skill gaps. On creditworthiness, this is the estimate of the assistance required per city to improve creditworthiness, not necessarily to reach creditworthiness.

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The report states: "According to the provisions of Article 2.2 [of the Kyoto Protocol]: '*Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases...from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively*'. Unlike other sectors, responsibility for cutting international aviation emissions was not given to individual countries (parties). Instead reductions should be achieved by Annex 1 Parties working through international bodies that regulate these modes of transport – ICAO for aviation and IMO for maritime transport."

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