

Creating Markets for Climate Business

An IFC Climate Investment
Opportunities Report



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Creating Markets for Climate Business

*An IFC Climate Investment
Opportunities Report*



Creating Markets, Creating Opportunities

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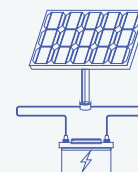
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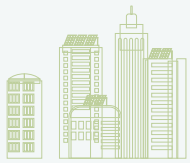
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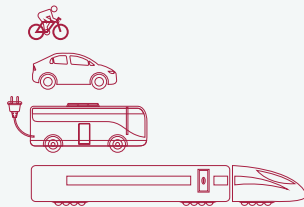
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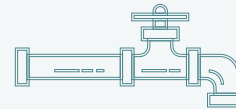
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Foreword



Philippe le Houérou
Chief Executive Officer, IFC

A dangerously warming planet is not just an environmental challenge—it is a fundamental threat to our way of life and threatens to put prosperity out of the reach of millions of people. In 2015, governments acted decisively by establishing the Paris Agreement, which aims to stabilize the climate before the end of this century. Unlike previous commitments, the Agreement took a bottom-up approach in which 189 countries submitted national commitments that sent a clear signal to businesses and investors around the world: a low-carbon future is coming.

As we seek to address climate change, we need to remember that the lion's share of economic growth, infrastructure needs, and related carbon pollution will take place in rapidly growing emerging economies. This creates a unique opportunity: to ensure that this growth is sustainable and resilient, while creating jobs, improving livelihoods, and offering positive returns on investment. Last year, IFC studied the national

commitments submitted by 21 emerging market countries as part of the Paris Agreement, and found \$23 trillion in investment opportunity if they achieve their targets by 2030. This report builds from that effort by providing information for investors, banks and companies about the most attractive climate investment opportunities, while offering governments a set of best practice policies and measures that have been proven to attract private investment.

The way to deliver on the Paris climate pledges is to create vibrant markets for climate business. The good news is that many countries are already making progress. Over \$1 trillion in investment is already flowing annually into climate-related projects; with the right policy frameworks in place, trillions more will be triggered.

Witness the Mobisol Pay-As-You-Go business model, which is providing over 60,000 affordable solar home systems in East Africa, via payment through mobile phones. This has led to an expanding set of local jobs and has the added benefit of establishing credit histories for customers that had previously lacked them. There is also a growing market for green buildings. In the four years since its inception, IFC's EDGE has resulted in the certification of more than three million square meters of green floor space, and is now available in more than 130 countries. In Vietnam, a consortium of 12 developers has pledged to certify projects green with IFC's EDGE program.

Agribusiness is increasingly investing in climate-smart practices that deliver increased productivity, enhanced resilience and reduced emissions—thereby helping countries to achieve their climate and food security goals. IFC client Kingenta is helping China achieve its target of zero growth in fertilizer use by transforming to an integrated solutions provider that supports farmers with high-quality and locally tailored fertilizers and

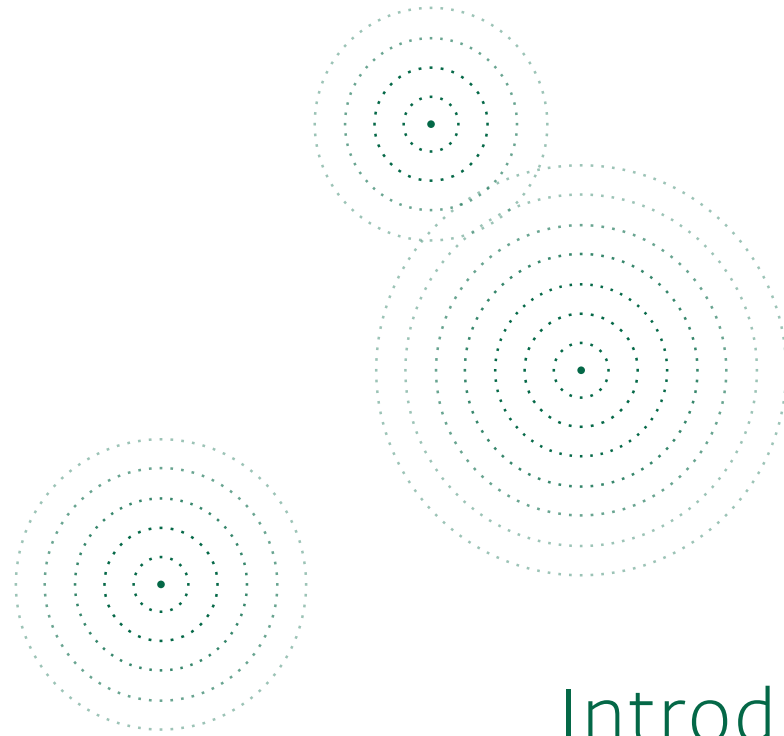
advice. These activities will improve yields while promoting healthy soil, clean groundwater and reduced greenhouse-gas emissions. The City of Buenos Aires is demonstrating how local governments can create markets for urban transport and waste that are attractive for private investors. It has launched an ambitious \$400 million transportation plan to boost urban connectivity, decrease congestion, and ease pollution by reducing the use of cars through a bus rapid transit line and bike sharing stations; and is also advancing climate-smart waste management and green buildings. Finally, we can and must increase private investment in adaptation and resilience. IFC recently used blended finance to invest in the Mocuba Solar plant, which delivers climate resilience for Mozambique by diversifying the electricity mix, while producing electricity that is cheaper and cleaner than fossil-fuel-based alternatives.

IFC is also using financial innovations such as green bonds to make it easier for investors to participate in climate business. Colombian banks Bancolombia and Davivienda became the first private banks in Latin America to issue green bonds in April 2017; other private banks in the region are expected to follow. And in October 2017, Fiji became the first emerging market to issue a sovereign green bond, raising 100 million Fijian dollars (\$50 million) to support climate change mitigation and adaptation.

IFC is privileged to play a key role in advancing climate solutions with the private sector. Since 2005, we have provided advice and invested more than \$18 billion in long-term financing for climate business. In the last fiscal year alone, we provided more than \$4.7 billion in climate-smart financing, including more than \$1.7 billion mobilized from other investors. IFC is committed to step up as an advisor, investor and partner with our clients and governments to build on this success and grow new markets for climate business.

Acronyms

BRT	Bus rapid transport	MW	Megawatt
CSA	Climate-smart agriculture	MWh	Megawatt-hour
EBRD	European Bank for Reconstruction and Development	NDC	Nationally determined contribution
EDGE	Excellence in Design for Greater Efficiencies	OECD	Organisation for Economic Co-operation and Development
ESCO	Energy service company	PAYG	Pay-As-You-Go
GDP	Gross domestic product	PPP	Public Private Partnership
GHG	Greenhouse gas	PV	Photovoltaic
GPS	Global positioning system	REDD	Reduce emissions from deforestation and forest degradation in developing countries
GW	Gigawatt	SE4All	Sustainable Energy for All
GWh	Gigawatt-hour	SSA	Sub-Saharan Africa
IRENA	International Renewable Energy Agency	TWh	Terawatt-hour
KWh	Kilowatt-hour	VAT	Value-added tax
LED	Light-emitting diode		



Introduction



Introduction

Climate change presents us with perhaps our biggest challenge. In recent years, we have seen growing evidence of the effects of climate change. Greenhouse-gas pollution continues to build up in the atmosphere, causing more intense storms, floods, droughts, and heat waves. In recent years, we have seen growing certainty and evidence of climate change impacts, with supply chains disrupted, increased commodity price volatility, and severe impacts on communities. The World Bank Group’s *Turn Down the Heat* report warns that even more dangerous effects are still to come unless humanity changes course.¹

In 2015, governments acted decisively, putting in place the Paris Agreement to tackle climate change before the end of this century. Unlike previous commitments, this agreement took a bottom-up approach—189 countries submitted national commitments with targets to increase investment in renewable energy, energy efficiency, sustainable infrastructure, and climate-smart agriculture. These commitments sent a clear signal to businesses and investors around the world: a low-carbon future is coming.

Achieving the Paris Agreement will create significant investment opportunities. If the commitments are realized, they will create over \$23 trillion in investment potential in 21 large emerging markets between now and 2030.²

Governments are not the only ones taking action. More than 1,000 businesses and hundreds of local governments have made ambitious climate commitments, and are putting their pledges into action by investing in low-carbon solutions (Box 1). There is growing proof that clean energy and other climate-smart investments are becoming

the norm for companies. In 2016, 190 of the Fortune 500 companies reported saving \$3.7 billion through renewable energy and energy-efficiency efforts alone.³

Engaging the private sector in climate-smart investments will be essential to achieving the goals of the Paris Agreement. In many sectors, private finance already plays a large role; the Climate Policy Initiative estimated that in 2014, private capital made up over 60 percent of \$392 billion in annual climate finance flows.⁴ However, meeting the ambitious targets set in Paris will require trillions of dollars more in investment. The New Climate Economy initiative estimates that the world needs to double its current investment—to about \$6 trillion per year—between now and 2030 just to meet global infrastructure needs.⁵ Two-thirds of this investment is needed in low- and middle-income countries, which have gained an increasing share of global gross domestic product (GDP) since 1990.⁶ Growth has accelerated not only in large economies such as China and India, but also in many smaller countries in Asia, Africa, and Latin America. This means that nearly all projected economic growth—and related greenhouse-gas emissions growth—is expected to come from developing countries.⁷

Climate change is a business opportunity and markets are growing. The climate challenge is an opportunity—one in which the private sector is ready to invest. Businesses are increasingly finding innovative solutions to reduce greenhouse-gas emissions at a profit in sectors like renewable energy, climate-smart agriculture (CSA), green buildings, and sustainable transport, while generating jobs and making cities cleaner, healthier,

Business and local governments: Leading on climate change

Any effort to decarbonize the economy at the local, regional or global level requires business engagement. Public policy plays a key role in stimulating innovation by requiring or incentivizing businesses to reduce their emissions. Business and investor leadership is also key. This leadership has been growing steadily since the United Nations Secretary General's Climate Summit in 2014, and was in evidence at the Peru, Paris and Marrakech climate talks. The Non-State Actor Zone for Climate Action now includes commitments by more than 2,000 companies and over 450 investors.⁸

"More than 600 companies, based in 47 countries, representing a market capitalization of more than \$15 trillion have now made bold commitments to climate action. They include over 300 of the world's biggest companies committing to set a science-based target, indicating their commitment to the Paris Agreement. The momentum is unstoppable."

— **Nigel Topping**, Chief Executive Officer, We Mean Business coalition

Local governments are also vital actors in addressing climate change. Cities consume two-thirds of the world's energy and generate 70 percent of global

carbon emissions. The Business and Sustainable Development Commission estimates that energy-efficient buildings, clean vehicles, urban public transport and resilience-building in cities represents an opportunity of over \$1.1 trillion globally by 2030.⁹ To tap into these low-carbon, private sector solutions, cities are adopting land rights reforms, improving access to resilient, low-carbon infrastructure, and providing incentives for private investment.

For example, the City of Bogotá's bus rapid transit (BRT) system—featuring dedicated bus lanes, elevated stations, and smart card payments—has saved commuters as much as 40 minutes per day and reduced air pollution by 40 percent, making public transit an attractive alternative to driving. Other cities, including Buenos Aires, Johannesburg and Cape Town, are building and expanding similar networks as part of an emphasis on transit-oriented development—making green and efficient mobility a priority. In Izmir, a city of 4 million people on Turkey's Aegean coast, municipal authorities have tackled growing congestion and air emissions through investments in a new ferry service, metro line, tramway, and a smart traffic lights network. Izmir also received a domestic AAA credit rating for local

currency lending, sending a signal of confidence to investors.

IFC's Cities Program¹⁰ is engaging in these types of strategic investments with cities around the world by taking a holistic view of needs and offering solutions in urban transportation, water and waste management, street lighting, affordable housing, energy efficiency, and climate resilience. IFC's global network enhances its ability to mobilize commercial financing for priority projects, connect cities with capital markets, and help improve creditworthiness through financial management training.

"Cities are leading the way in confronting climate change, and they would be doing even more, even faster, if they had greater access to funding. This is a big challenge that we can start to address with practical steps, like helping cities improve their credit rating, measure their funding needs, and connect specific projects with lenders. The more power we can give cities, the more investment opportunities we can unlock."

— **Michael Bloomberg**, United Nations Special Envoy for Cities and Climate Change

and more resilient. Nowhere is this more evident than in China, which became a green energy leader after the government designated renewable energy as a strategic industry. It now has more than one-third of the world's wind power capacity and a quarter of its solar power, and is leading a revolution in battery technologies.¹¹ Africa has seen 62,000 jobs created from renewable energy development, with thousands more expected as the continent realizes its potential to tap into more than 1,100 gigawatts (GW) of solar power capacity, 350 GW of hydropower capacity, and over 100 GW of wind power capacity.¹²

“The Paris Agreement has been called a \$20 trillion investment opportunity. Whatever the precise figure, it is certainly an economic opportunity with profound social and environmental benefits too. I would urge all businesses, corporations, financial institutions, and investors to fully align with the goals of the Agreement—in support of governments, in support of people everywhere.”

— **Patricia Espinosa**, United Nations Framework Convention on Climate Change Executive Secretary

Annual global investment in climate business solutions is over \$1 trillion, and is accelerating. The combined markets for renewable energy (\$297 billion), energy storage (\$2.5 billion), green buildings (\$388 billion), climate-smart urban transport (\$288 billion), water recycling (\$23 billion), and municipal waste management (\$160 billion) are today worth more than \$1.1 trillion. In 2016, global renewable power generation capacity rose by 9 percent; a fourfold increase from 2000. For the second year in a row, renewable energy accounted for more than half of the new power generation added worldwide.¹³ Solar power is getting cheaper much quicker than anticipated: photovoltaic (PV) module prices have reduced 72 percent since 2009, and experts forecast another 67 percent reduction by 2040.¹⁴ Wind energy is also making major advances in cost and performance. Electricity delivery and use is becoming a decentralized, community-based business, particularly in Africa and Asia, where communities are using smarter energy by combining small-scale solar, and batteries. Electric vehicles are also gaining popularity as battery costs continue to drop (down

73 percent since 2000 and 50 percent since 2014)¹⁵ and governments invest in charging infrastructure. In 2017, France, India, and Norway set aggressive targets to phase out gasoline-powered vehicles in the next 15 years. Bloomberg New Energy Finance forecasts that electric cars will be cheaper than conventional cars without subsidies between 2025 and 2030.¹⁶ Global renewable power providers like Enel are beginning to combine batteries with solar PV to produce power after dark in sunny places where power is expensive, such as in mining operations in Chile.¹⁷ All of these changes will require governments to respond with targeted policies to ensure that renewable providers are fairly paid for their services.

“Open cross-industry partnerships spanning along the value chain will bring new opportunities for the efficient consumption of clean energy. A digitized grid, coupled with a sound investment framework, will allow for unprecedented interactions between all the actors of the energy system.”

— **Francesco Starace**, Chief Executive Officer, Enel Group

This rapid growth is expected to continue. Bloomberg New Energy Finance projects \$6 trillion in new investment in wind and solar power between now and 2040. Global electricity markets will be completely reshaped, with wind and solar as the two largest generators of power, and fossil fuels making up less than a third of capacity.¹⁸ Just less than half of global investment in new power capacity to 2040 will be in Asia Pacific, with \$4 trillion going to China and India.¹⁹

Successful climate business markets are on the rise. \$388 billion was invested in energy-efficient buildings globally in 2015, up 9 percent from the previous year.²⁰ While this investment has been centered in developed countries so far, rapidly growing urban populations in countries like China and India will account for much of the new growth. Energy-efficient heating, ventilation, and air conditioning is currently a \$76 billion global market.²¹ Businesses and cities are collaborating to develop low-carbon, resilient urban infrastructure to provide citizens with sustainable transport, water, and waste management services. Over the next decade, trillions of

dollars will be invested in transport infrastructure, with many climate-smart investment opportunities for businesses, including electric vehicles, BRT, light rail, and multimodal transport and logistics. The global waste market is already worth \$154 billion and is expected to double by 2020, while water supply and sanitation services require more than \$13 trillion in investment between 2016 and 2030. Companies are partnering with local governments to offer low-carbon water savings and recycling services, as well as waste-to-energy systems. Climate-smart agriculture is also a rapidly expanding market, as food producers strive to meet growing demand for modern, sustainable diets. Between 2004 and 2013, global investment in the agribusiness sector tripled to more than \$100 billion. Climate-smart agricultural practices are gaining ground as businesses seek to address the combined challenges of food security and climate change.

Government action is accelerating market development. Addressing climate change requires large-scale economic transformation, with major changes in the energy system, industrial processes, heating and cooling, transport systems, urban infrastructure, land use and consumer behavior. Countries have adopted more than 1,200 climate change laws, up from 60 two decades ago. Renewables now receive direct policy support in nearly 150 countries.²²

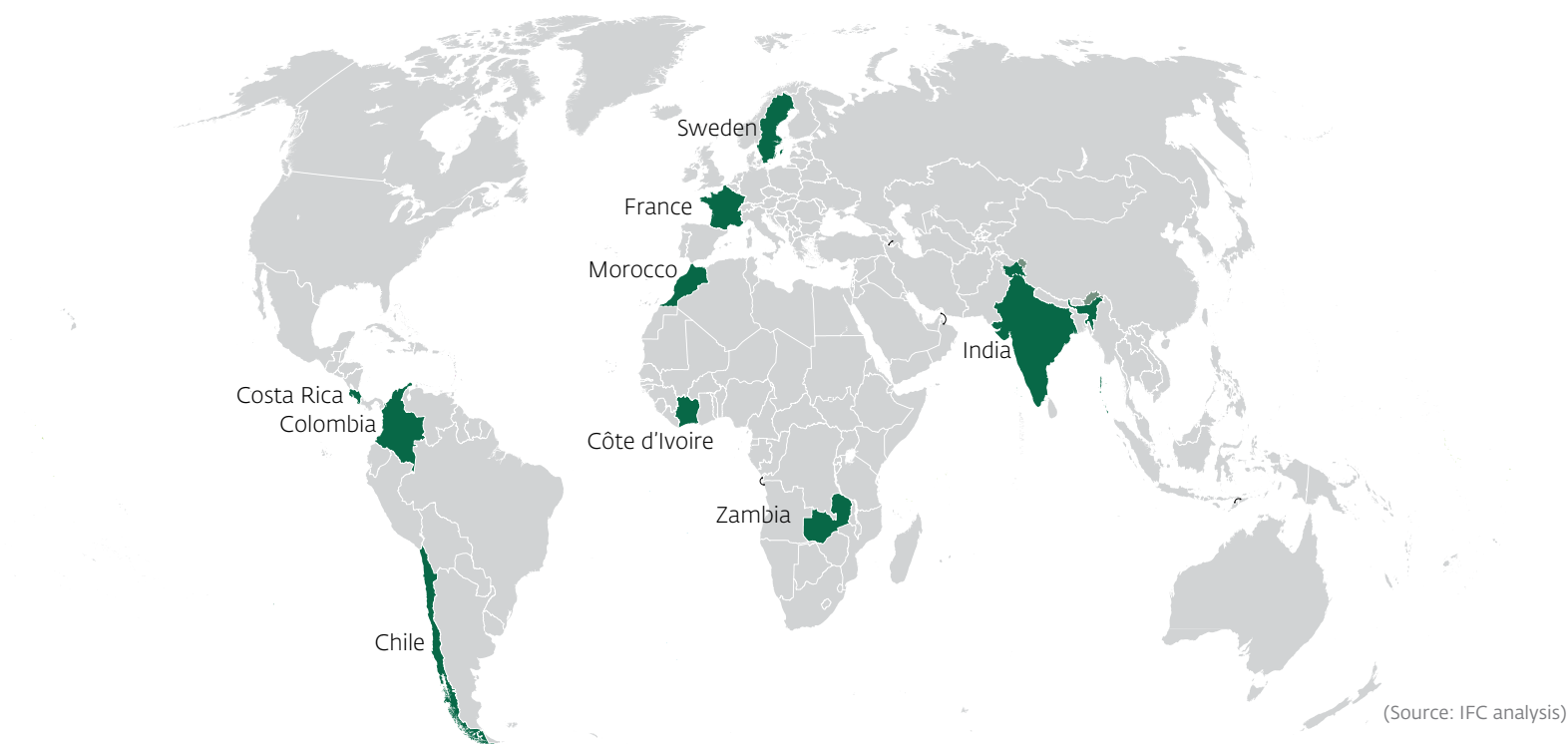
The implementation of the Nationally Determined Contributions (NDCs) submitted as part of the Paris Agreement will only accelerate the market for climate-friendly solutions. Several countries are starting to implement these targets, with a focus on creating a positive climate for private investment that results in a pipeline of bankable projects for investors (Figure 1).

“The top priority for governments and business should be to convert the targets agreed and the pledges made at Paris into vibrant markets for climate business. This is the growth story of the future, and is the only way to deliver lasting and inclusive prosperity.”

— **Nicholas Stern**, Chair, Grantham Research Institute on Climate Change and the Environment, London School of Economics



FIGURE 1: Countries are making progress in creating markets for climate business



 **COSTA RICA**

Supportive policies for EVs and renewables will help Costa Rica become **carbon neutral by 2021**

 **COLOMBIA**

Colombia's **10-year National Climate Policy** prioritizes sectors for investment; the **Sostenible Fund** will raise capital

 **CHILE**

Chile's new **National Climate Action Plan** will accelerate private investment in renewable energy

 **SWEDEN**

Sweden recently raised ambition to be **climate neutral by 2045**

 **FRANCE**

Plan Climat raises France's climate ambition with strong targets for EV, renewables and carbon pricing

 **MOROCCO**

Already a clean energy leader, Morocco is using **public-private initiatives** to achieve its NDC

 **CÔTE D'IVOIRE**

Cote d'Ivoire aims to generate **42 percent of power from renewables** by working with IFC to attract private investment

 **ZAMBIA**

Scaling Solar is helping Zambia to attract low-cost solar investment and deliver energy access

 **INDIA**

India is already on track to **exceed its NDC targets for solar and wind energy** due to strong policies and incentives



CHILE

During the last decade, Chile has established itself as one of the top 10 renewable energy markets. The government introduced competition in electricity markets, which has resulted in a stronger grid with dramatically reduced electricity production costs.²³ The country has also worked to diversify its renewable energy base away from hydropower to a mix of solar, wind, and geothermal power. This has resulted in reduced energy imports. Chile's NDC builds on this success, setting a carbon intensity target to reduce carbon dioxide emissions by 30 percent below 2007 levels by 2030. In August 2017, the country launched the National Climate Action Plan, with the goal of doubling its current renewable electricity generation from 45 percent of the energy mix to 90 percent by 2030.²⁴



COLOMBIA

In June 2017, Colombia announced a 10-year National Climate Policy for comprehensive management plans that integrate climate considerations into local and territorial development plans, as well as national energy and infrastructure sector strategies. The government also established a new fund, Colombia Sostenible, to raise public, private, and international funding for NDC implementation.²⁵ The private sector has been contributing ideas for innovative climate solutions through efforts like the banking sector's Green Protocol, which is developing climate-smart agriculture financing tools, and the National Association of Industrialists' Clean Energy Investment Accelerator, which is demonstrating the potential for rooftop solar electricity.²⁶

“Colombia is committed to fiscal policies and reforms that help us to successfully implement the Paris Agreement, as shown in the tax reform approved last year where we included a carbon tax, among other climate related provisions that are part of our sustainable development agenda. From instituting carbon taxes to strengthening social and economic resilience, finance ministers have access to a wide range of public policy instruments which could help their countries to manage the effects of climate change.”²⁷

— **Mauricio Cárdenas**, Minister of Finance, Colombia



COSTA RICA

The government aims to be the world's first carbon-neutral economy by 2021, with 100 percent renewable energy by 2030. The Seventh National Energy Plan 2015–2030 sets a clear path for private investment in Costa Rica's low-carbon future: it currently has tax exemptions for renewables, tenders for new projects, and net metering to facilitate development. A new law to promote the use of electric vehicles will exempt electric and plug-in hybrid cars from tax, and another law proposes to ban petroleum vehicles by 2030.²⁸



CÔTE D'IVOIRE

In its NDC, Côte d'Ivoire committed to reduce greenhouse-gas emissions by 28 percent compared to business as usual by 2030.²⁹ To achieve these targets, the government has developed a plan for implementation and monitoring of the proposed actions, and recognizes the importance of developing a well-defined resource mobilization strategy comprising public and private financing.

“Cote d’Ivoire has strong ambitions to scale up cost-effective, reliable renewable energy; we are pleased to work with IFC to engage the private sector to help achieve our targets.”

— **Thierry Tanoh**, Minister for Petroleum, Energy, and Renewable Energy Development



FRANCE

In June 2017, France adopted the Plan Climat, which includes a new long-term objective to be carbon neutral by 2050. This is significantly more ambitious than the country’s NDC.³⁰ Plan Climat includes a commitment to use carbon pricing to phase out coal power plants by 2022, and to increase the share of renewable energy to 32 percent by 2030. It also aims to end the issuing of new licenses for hydrocarbon exploration or the renewal of existing permits by 2040. The government has set a target to phase out all greenhouse-gas-emitting cars by 2040, when only hydrogen-powered or electric vehicles may be sold.



INDIA

By some estimates, India is already on track to exceed its NDC target of reducing greenhouse-gas emissions intensity by up to 35 percent by 2030.³¹ Its success in creating markets for solar power, estimated at more than 13 GW in capacity in 2017, has led the government to expand its National Solar Mission. The new target is 175 GW of installed solar energy by 2022—five times the original target. Guided by the National Wind Energy Mission, with a target to install 60 GW by 2022, India is now the world’s fourth largest wind power generator. The government also recently announced a commitment to end the sale of gasoline-powered cars by 2030.

“India aspires to global leadership on climate action, by setting ambitious solar targets and directing that all cars sold in the country be electric by 2030. For companies like Mahindra, this represents a way to reinvent ourselves and deliver profits—and prosperity—for all.”

— **Anand Mahindra**, Chairman, Mahindra Group



MOROCCO

Morocco is integrating its NDC targets into the country's policy framework, including leveling the playing field for renewable energy by reducing fossil-fuel subsidies. The country's NDC sets a 52 percent renewable energy generation target for 2030, and is making strong progress. In early 2016, 35 percent of the country's energy mix was renewable, largely as a result of the Noor I solar park in Ouarzazate.³² The government has also created innovative new public-private entities to help increase capacity and awareness about climate change solutions, including 4C Maroc, also known as the Moroccan Competence Center for Climate Change. 4C Maroc establishes a platform for dialogue between Moroccan ministries, private sector actors, and civil society groups to develop implementation roadmaps and investment plans.³³



SWEDEN

Sweden has already successfully decoupled its economic growth from greenhouse-gas emissions growth through supportive policies that include carbon taxes. In June 2017, the country officially committed to achieving carbon neutrality by 2045, five years earlier than its previous plan. Its new climate legislation will provide the long-term conditions for business and society to implement the transition. Sweden now has long-term climate goals that go beyond 2020 and an independent climate policy council that reviews climate policy.³⁴



ZAMBIA

Zambia's NDC aims to boost off-grid and decentralized renewable energy systems. This will help address frequent blackouts and power shortages in the country. The government has joined the World Bank Group's Scaling Solar Program and completed its first private auction in May 2016 to build two large solar plants (600 megawatts [MW] capacity in total). The lowest bid was just over \$0.06 per kilowatt-hour (kWh)—the cheapest solar power to date in Sub-Saharan Africa and among the lowest tariffs in the world.³⁵ By comparison, diesel-fired power costs about \$0.20 per kWh and is subject to price volatility.

“There can be no doubt that developing countries will be at the forefront of the green economic revolution, bringing jobs in clean energy, improved air quality and more productive land.”

— **Ngozi Okonjo-Iweala**, Co-Chair of the Global Commission on the Economy and Climate; Chair of the Board of Gavi, The Vaccine Alliance



IFC: Creating markets for climate business

Since 2005, IFC has developed expertise in creating markets for climate business, cultivating innovative partnerships and financing products for key sectors such as climate-smart agriculture, green buildings, low-carbon cities and renewable energy. In 2016/17 alone, IFC's climate investments totaled \$3 billion, covering 90 projects in 41 countries. It mobilized an additional \$1.8 billion from other investors. These investments are also delivering significant environmental value. The latest fiscal year's investment and advisory projects reduced more than 6.7 million metric tons of greenhouse-gas emissions, equivalent to taking 1.4 million cars off the road. IFC will work closely with businesses, investors, and governments to build on this success and grow new markets for climate business.


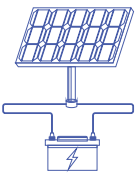

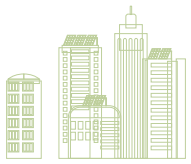
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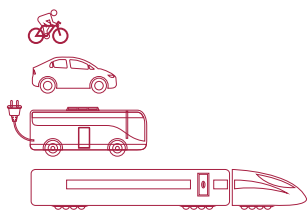
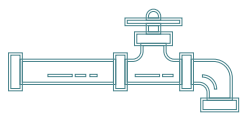

Creating markets for climate business

This report has been designed to help inform private companies and investors about the myriad opportunities that exist in climate business around the world. It will help governments translate their climate ambitions into successful markets for climate business. It synthesizes the lessons learned from several decades of successful market creation across the globe, spanning sectors and regions. The following chapters offer guidance for creating markets in seven key climate business sectors:

- Grid-connected renewable power
- Off-grid solar and storage
- Climate-smart agriculture
- Green buildings
- Climate-smart urban transport and logistics
- Climate-smart urban water infrastructure
- Climate-smart urban waste management

Each of the sectors has a market snapshot and growth forecast, along with a set of proven policies and regulations, financial innovations, and business models. The final chapter, *Making It Happen*, outlines cross-cutting solutions like green finance and blended finance—which strategically use limited amounts of public finance and regulation to mobilize much larger sums of private capital. It highlights important policy solutions like reducing fossil fuel subsidies and pricing carbon, which are key to level the playing field for low-carbon investments. Finally, it showcases two solutions to help cities attract private capital for climate-smart urban infrastructure: enhancing city creditworthiness and creating public-private partnerships.

Sector	Market snapshot	Highest growth markets	Key actions to attract private investment
<h3 data-bbox="136 170 361 251">Grid-Tied Renewables</h3> 	<ul data-bbox="472 170 934 430" style="list-style-type: none"> • In 2016, over 160 GW of renewable energy capacity was built • This was \$280 billion in investment, 2X fossil-fuel investment • China & India are the leading markets, with nearly 1/2 new capacity added • Over 100 countries targeted renewable energy in their NDCs 	<ul data-bbox="976 170 1438 462" style="list-style-type: none"> • There is \$6 trillion in new investment potential in wind and solar power up to 2040; half in Asia-Pacific region • Africa is attracting solar investment, with 170 MW in Algeria and 500 MW in South Africa • China led in wind power additions in 2016, with 23.4 GW new capacity • Battery storage markets are expected to reach 21 GW by 2025 	<p data-bbox="1459 170 1669 194">Step 1: Set a target.</p> <p data-bbox="1459 211 1921 267">Step 2: Put in place smart, market-responsive policies.</p> <p data-bbox="1459 284 1879 341">Step 3: Ensure that other policies are not inhibiting market growth.</p> <p data-bbox="1459 357 1963 414">Step 4: Adapt policies to meet the evolving needs of the electricity market.</p>
<h3 data-bbox="136 495 388 576">Off-Grid Solar and Storage</h3> 	<ul data-bbox="472 495 934 690" style="list-style-type: none"> • The global energy storage market was \$2.5 billion in 2016, with hot markets in Sub-Saharan Africa and South Asia • 89 million people in the developing world own at least one solar light • 31 NDCs target off-grid solar and storage 	<ul data-bbox="976 495 1438 722" style="list-style-type: none"> • Investment in emerging market energy storage will grow from \$2.5 billion to \$23 billion in 2025 • Sub-Saharan Africa has the greatest growth potential • Pay-as-You-Go companies raised \$223 million in capital in 2016 	<p data-bbox="1459 495 1648 519">Step 1: Set a target.</p> <p data-bbox="1459 535 1900 592">Step 2: Publicize a grid expansion plan to give confidence to developers and investors.</p> <p data-bbox="1459 609 1921 665">Step 3: Provide targeted incentives to encourage deployment.</p> <p data-bbox="1459 682 1921 738">Step 4: Allow different electricity tariffs for mini-grids and rooftop PV.</p> <p data-bbox="1459 755 1963 779">Step 5: Provide microfinance, training and education.</p>
<h3 data-bbox="136 795 409 876">Climate-Smart Agriculture</h3> 	<ul data-bbox="472 795 934 1079" style="list-style-type: none"> • Agriculture is a \$5 trillion global industry, supporting 500 million farmers and responsible for 10% of consumer spending and 30% of greenhouse-gas emissions • Over the last 40 years, global meat consumption has grown 2X and will continue to grow • Over a third of all food that is grown is wasted • 61 NDCs specifically target CSA 	<ul data-bbox="976 795 1438 885" style="list-style-type: none"> • By 2032, food demand will increase 20%, driven by growth in the developing world. • Food production will need to increase 70% 	<p data-bbox="1459 795 1921 876">Step 1: Mainstream climate-smart agriculture into national policies and sector development plans.</p> <p data-bbox="1459 893 1953 950">Step 2: Address inefficient government price and subsidy regimes to reward CSA.</p> <p data-bbox="1459 966 1890 1023">Step 3: Invest in strategic infrastructure to facilitate CSA investment.</p> <p data-bbox="1459 1039 1858 1096">Step 4: Promote outreach, training, and agribusiness centers of excellence.</p>
<h3 data-bbox="136 1112 430 1153">Green Buildings</h3> 	<ul data-bbox="472 1112 934 1242" style="list-style-type: none"> • Energy-efficient building investment was \$388 billion in 2015 and is growing • 86 countries target energy-efficient buildings in their NDCs 	<ul data-bbox="976 1112 1438 1299" style="list-style-type: none"> • Energy-efficient buildings need nearly \$300 billion annual investment to achieve climate stabilization • ESCOs have emerged as a key business model; global revenues were \$24 billion in 2015 	<p data-bbox="1459 1112 1900 1201">Step 1: Develop regulatory tools, including building codes, government procurement, appliance standards and performance labels.</p> <p data-bbox="1459 1218 1900 1299">Step 2: Build capacity via public awareness, awards, audits, ratings and certification, workforce training and technical assistance.</p> <p data-bbox="1459 1315 1921 1396">Step 3: Provide targeted incentives, revolving loan funds, risk guarantees and energy performance contracts.</p> <p data-bbox="1459 1412 1942 1494">Step 4: Encourage utilities to act via advanced metering, demand response, time-based tariffs, subsidies and ESCO support.</p>

Sector	Market snapshot	Highest growth markets	Key actions to attract private investment
<h2 data-bbox="136 170 399 251">Transport and Logistics</h2> 	<ul data-bbox="462 170 924 487" style="list-style-type: none"> • Over 750,000 EVs have been sold—a \$163 billion market • Governments are creating markets for EVs by phasing out combustion engines in the coming decades • Bus Rapid Transit is an attractive urban mobility option—over 150 global cities now have BRT systems • Over 80 countries target transport in their NDCs 	<ul data-bbox="966 170 1428 389" style="list-style-type: none"> • Investment in transport infrastructure will grow to \$900 billion per year by 2025 • The Asia-Pacific will attract over \$8 trillion in investment through 2025 • Doubling vehicle efficiency and enabling fuel switching could save \$8 trillion cumulatively by 2050 	<p data-bbox="1459 170 1953 251">Step 1: Avoid the need for urban commuting via better urban design, bike lanes and consolidated freight centers.</p> <p data-bbox="1459 267 1953 381">Step 2: Shift from personal vehicles to other modes of transport with BRT, metro systems, travel demand management, fiscal measures and PPPs.</p> <p data-bbox="1459 397 1953 511">Step 3: Improve technology for passenger vehicles and freight via fuel economy standards, tax rebates, EV infrastructure and automation and optimized routing.</p>
<h2 data-bbox="136 544 399 665">Climate-Smart Water Infrastructure</h2> 	<ul data-bbox="462 544 924 755" style="list-style-type: none"> • More governments are looking to the private sector for climate-friendly water supply and treatment investment • In 2015, private sector water investment totaled \$5.3 billion • More than 100 countries mention the water sector in their NDCs 	<ul data-bbox="966 544 1428 747" style="list-style-type: none"> • Investment for water supply and sanitation could exceed \$13 trillion by 2030, with \$8 trillion needed in the Asia-Pacific region alone • The global market for water recycling technologies is \$23 billion, and rapid growth will continue 	<p data-bbox="1459 544 1953 649">Step 1: Establish water access, cost recovery and service quality goals, increase inter-government coordination and foster water-smart public awareness.</p> <p data-bbox="1459 665 1953 747">Step 2: Ensure financial sustainability by implementing water pricing and removing subsidies.</p> <p data-bbox="1459 763 1953 876">Step 3: Make public-private cooperation deliver increased water efficiency via guarantees, PPPs, project preparation funds and performance-based contracting.</p> <p data-bbox="1459 893 1953 974">Step 4: Build capacity through training, regional cooperation, public awareness, home/equipment certification, auditing and benchmarking.</p>
<h2 data-bbox="136 998 399 1128">Climate-Smart Urban Waste Management</h2> 	<ul data-bbox="462 998 924 1356" style="list-style-type: none"> • The global waste market may reach \$2 trillion by 2020 • Over the past 2 years, \$300 billion in waste processing investment projects have attracted capital • 800 waste-to-energy facilities were worth \$7.4 billion in 2013 • Waste recovery and recycling markets are around \$265 billion • Over 80 countries include waste in their NDCs 	<ul data-bbox="966 998 1428 1185" style="list-style-type: none"> • Strong waste-to-energy investment is likely; the Asia-Pacific and Latin American regions will see the most growth • Between 2009 and 2013, waste generation increased by 15 percent each year in Brazil and China 	<p data-bbox="1459 998 1953 1088">Step 1: Achieve economies of scale by aggregating waste flows and developing regional plans/partnerships.</p> <p data-bbox="1459 1104 1953 1161">Step 2: Use an integrated waste management approach to attract private investment.</p> <p data-bbox="1459 1177 1953 1258">Step 3: Get the prices right via cost recovery through taxes, volume-based fees and other means.</p> <p data-bbox="1459 1274 1953 1356">Step 4: Put incentives in place through appropriate WTE pricing, mandates for compost and other sector policies.</p> <p data-bbox="1459 1372 1953 1421">Step 5: Raise consumer awareness to reduce non-recoverable waste streams.</p>

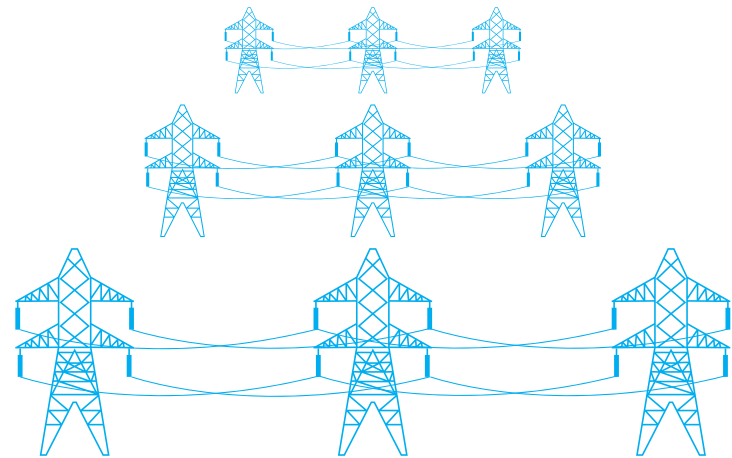


Grid-Connected Renewable Power

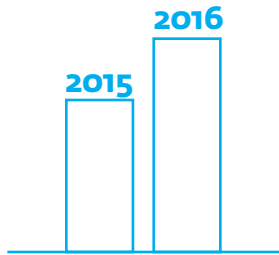
Key indicators



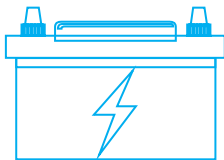
There is **\$6 trillion** in new investment potential in wind and solar power between now and 2040; half of this potential is in the **Asia-Pacific region**. There will be up to **\$11 trillion** cumulative investment by 2040, mostly in emerging markets.



In 2016, over **160 GW of renewables capacity** was built around the world accounting for **\$280 billion investment, double what fossil fuels received**. **China and India** lead market development, with nearly **50%** of new global capacity.



Over 100 major companies are creating markets by committing to go **100% renewable energy**.



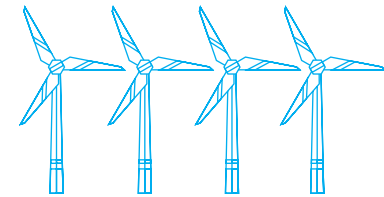
Battery storage markets are expected to **reach 21 GW by 2025**, driven by cost reductions of over 50%.



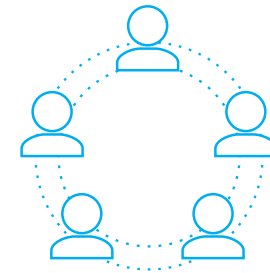
In 2016, **75 GW of solar PV** was built around the world—equivalent to 31,000 panels installed every hour.



Africa is beginning to attract major solar investment, with **Algeria** (170 MW+), **South Africa** (500 MW+) and **Zambia** leading the way.



China led in global wind power installation in 2016, building over 23 GW.



Over 100 countries targeted grid-connected renewable power in their NDCs.



Grid-Connected Renewable Power

1.1 Summary

Renewable power is transforming the global electricity system, with new capacity and investment values consistently outstripping performance in the fossil-fuel sector. In 2016, more than 160 GW of solar, wind, hydropower, geothermal, and biomass capacity was built around the world, equivalent to twice the United Kingdom's total installed capacity. This means that 62 percent of capacity added to the system that year was renewable, representing an investment of almost \$297 billion, more than double the investment in fossil fuel and nuclear generation.³⁶

There is increasing demand for renewable energy in emerging markets, led by China and India. According to Bloomberg New Energy Finance, in 2016 China added 34.5 GW of solar power and India added 4.1 GW— together accounting for more than 50 percent of new global solar capacity. Similarly, China and India added 23.4 GW and 3.6 GW of wind power respectively in 2016, accounting for half of global capacity added that year. Brazil, Jordan, and South Africa are other emerging markets with significant new investment in renewable energy.

Policies are accelerating market creation. A total of 114 countries targeted renewable energy growth as part of their national commitments to the Paris Agreement, sending a strong signal to investors and companies. To implement these targets, governments are increasingly using market-creating policies like renewable energy auctions. More than 20 countries held auctions in 2016.³⁷ This has led to increased

competition, with record-breaking bids achieving the lowest installed cost for renewables to date.

There is growing corporate appetite or customer-sited renewable energy. Led by the RE100 initiative (see Box 3), companies from diverse sectors are committing to power 100 percent of their global operations with renewable energy. This includes technology giants like Intel, Google, Apple, and Amazon, as well as banks like Goldman Sachs—the first U.S. bank to sign a corporate power purchase agreement—and consumer-oriented companies like Unilever.³⁸ In 2016, Dalmia Cement from India became the first cement company to join the RE100. IFC banking clients also cite renewable energy as the top priority for their climate business.

Increasing cost-competitiveness, policy support, and corporate demand means that the forecast is good for renewable energy. According to the International Energy Agency, cumulative investment in renewable energy could reach between \$7 trillion and \$11 trillion by 2040.³⁹ Much of the new investment will be concentrated in solar PV and wind power in developing markets. Innovation and economies of scale have cut the cost of solar PV by half since 2009, and the cost of wind power keeps falling as turbine size grows and lessons are learned. These advances have seen solar and wind reach costs comparable with non-renewables in a growing number of countries, which has boosted investor confidence and driven the sector's growth.

Policies are still needed to ensure strong market growth, including supportive frameworks that facilitate an increasing amount of variable renewable energy on the grid. Smart policies and market reforms are

TABLE 1: NUMBER OF COUNTRIES TARGETING RENEWABLE ENERGY IN THEIR NDC⁴⁰

Region	Renewable energy	Solar	Wind	Hydro	Biofuels	Geothermal	Solar, utility scale	Waste-to-energy	Ocean	Waste
East Asia and Pacific	24	15	10	9	14	6	5	1	4	
Europe and Central Asia	7	5	5	6	2	2		1		
Latin America and Caribbean	22	9	13	9	11	6		4	2	1
Middle East and North Africa	14	10	8	2	1	3	1	4	1	1
Oceania	2									
South Asia	6	4	4	4	5		3	3	1	1
Sub-Saharan Africa	37	32	24	32	23	6	8	4		
Western Europe	2									
Total	114	75	64	62	56	23	17	17	8	3

(Source: World Bank, INDC Database; see indc.worldbank.org)

needed to incentivize energy storage, so that it can help balance the grid and manage supply. Policies should ensure that renewable power providers are not disadvantaged as they enter the grid. Countries where renewables are at an early stage of development will need to work with stakeholders to develop a plan for grid expansion.

The sector will continue to grow as countries implement their climate targets. The countries focusing on renewable energy in their NDCs have many technology-specific targets and actions to achieve, as shown in Table 1. Because solar and wind receive the most attention, this chapter will focus largely on these two technologies.

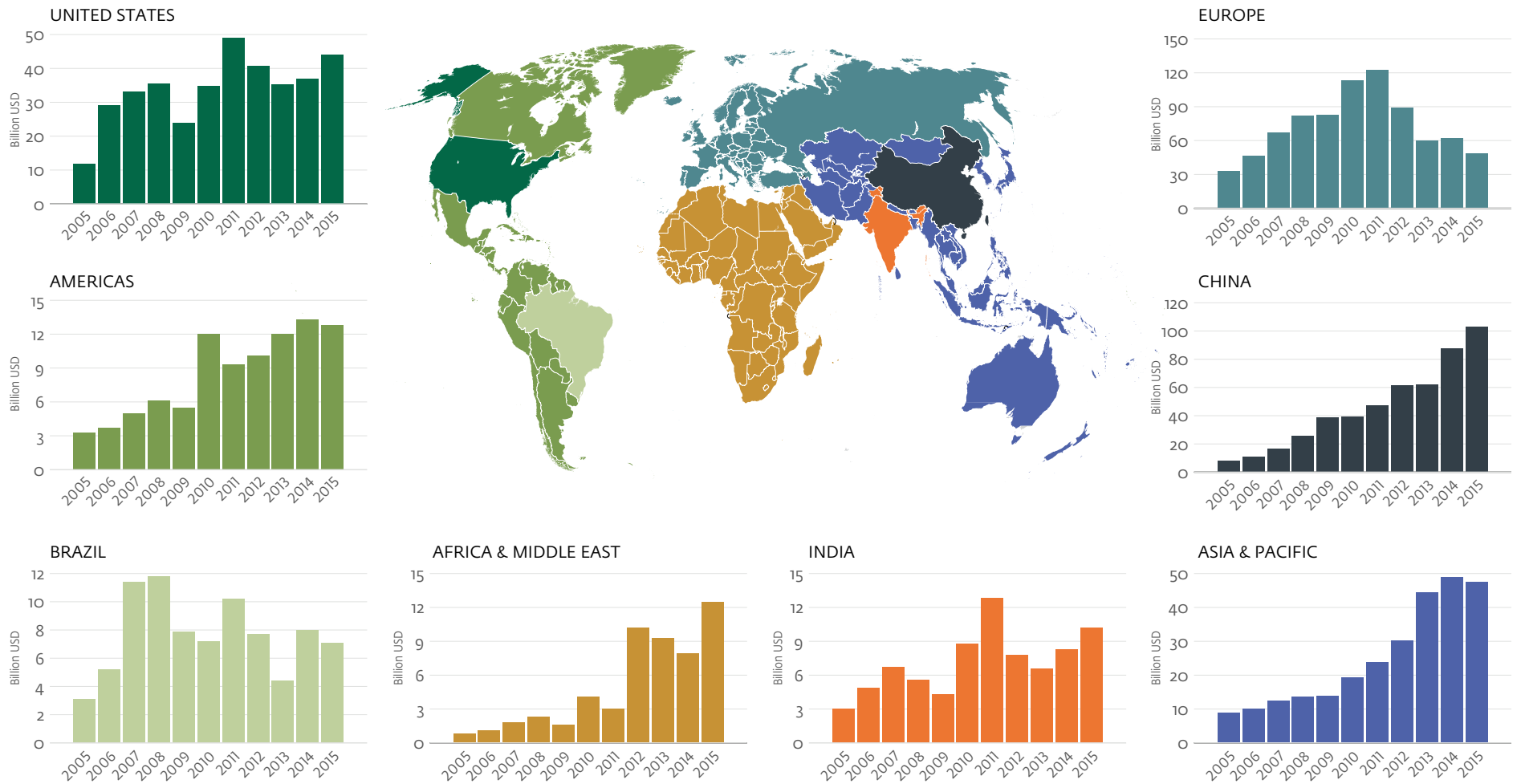
1.2 Market snapshot and growth potential

Renewable power deployment continued to break records in 2016.

More than 160 GW of new renewable power capacity was added in 2016—the largest annual increase in renewable power capacity to date. This represents about 62 percent of the power added to the grid that year, which means capacity in renewables outpaced fossil fuels by a ratio of almost 2:1.⁴¹ Solar PV had the largest capacity increase, with 75 GW added in 2016, followed by wind (55 GW) and hydro (25 GW).⁴²

Investment in renewable energy remained robust in 2016, at \$297 billion (including large hydropower), falling slightly by 3 percent because of falling costs and fewer hydro plants coming online.⁴³ Emerging markets accounted for just over half of this investment (Figure 2). China remained the largest investor, accounting for almost 30 percent

FIGURE 2: Global investment in renewable power



(Source: Bloomberg New Energy Finance)

of global financing in 2016. After China, India (\$8.7 billion) and Brazil (\$7 billion) were the other two developing countries among the top 10 markets for non-hydro renewable energy investment.⁴⁴

Renewable power markets are expected to maintain strong growth.

The International Energy Agency expects total deployed renewable energy capacity to grow from more than 2,100 GW in 2016 to between about 2,800 GW and 3,000 GW by 2021; this will result in between \$7-11 trillion in cumulative investment in the sector.⁴⁵

The cost of solar and wind power is expected to continue to fall. The cost of wind was 66 percent lower in 2016 than in 2009 and solar PV costs decreased by more than 85 percent.⁴⁶ Costs are expected to continue to drop, with a 66 percent decrease for solar PV, a 47 percent decrease for onshore wind, and a 71 percent decrease for offshore wind by 2040.⁴⁷ These projected reductions are largely the result of cheaper technology and equipment, better operation and maintenance regimes, and increased efficiency from larger initiatives, especially in wind.⁴⁸ Bloomberg New Energy Finance expects installed solar capacity to increase 14-fold by 2040, while wind is projected to grow fourfold.⁴⁹

The nascent energy storage market is poised for growth. Clean Technica expects global energy storage to grow seven-fold, from about 3 gigawatt-hours (GWh) in 2016 to more than 20 GWh in 2025.⁵⁰ Although costs are more difficult to predict, a steep fall in the cost of storing energy is anticipated. 2016 saw a 12 percent drop in utility-scaled lithium-ion batteries from the previous year; this trend is expected to continue as production ramps up globally.⁵¹

Favorable prices and policies have led to increased corporate interest.

Commercial and industrial customer demand is becoming a major driver of growth for the renewable industry. Corporate renewable energy demand has increased from about 500 MW in 2010 to a peak of 5.3 GW in 2015, with 3.25 GW in the United States alone.⁵² Despite slowing to 4.5 GW in 2016, largely due to changes in the U.S. market, record capacity in Europe, the Middle East, Africa, and the Asia Pacific helped sustain demand.⁵³ Initiatives like the RE100 (see Box 3) are enabling further growth, with some of the largest companies in the

world committing to procuring 100 percent of their electricity from renewable sources.

SOLAR PV

Solar PV overtook wind as the fastest growing renewable energy technology in 2016. A total of 75 GW of solar PV was built around the world—the equivalent of 31,000 panels installed every hour.⁵⁴ China was the global leader, followed by the United States, Japan, India, and the United Kingdom, which together accounted for 85 percent of new construction. The largest additions in Africa were by South Africa (over 500 MW) and Algeria (over 170 MW), while Zambia claimed the lowest-cost solar PV bid on the continent (see Box 5).

Continued cost reductions may see the global market double by 2021.

The solar PV sector attracted \$114 billion in investment in 2016. This represents a fall of about 4 percent year-on-year, demonstrating that cost reductions are allowing more capacity to be built for less money. Achieving cost-competitiveness across most countries is expected to increase investment in solar, creating major demand for energy storage and electricity market reform. Solar PV is forecast to increase from 303 GW of total installed capacity at the end of 2016 to between 550 GW and 650 GW by 2021.⁵⁵

Grid-tied distributed solar, i.e. rooftop solar for residential and commercial consumers, is set to grow in key emerging markets like India. In 2016, there was nearly \$40 billion invested in rooftop and other small PV projects.⁵⁶ The United States invested the most (more than \$13 billion), followed by Japan (\$8.5 billion, down from about \$27 billion in 2015), and China (\$3.5 billion). India's small-scale solar sector is poised for growth, driven by the government's ambitious target to install 40 GW of rooftop solar power by 2022.

WIND

Wind power remains the second largest source of renewable energy after hydro, accounting for almost 22 percent of total renewable capacity. A total of 55 GW of wind power was built in 2016, increasing total global wind capacity by about 12 percent to 487 GW. China led construction,



RE100: Big business creating markets by committing to 100 percent renewable power

RE100 was launched in 2014 at Climate Week in New York as a global initiative of influential businesses committed to using 100% renewable electricity. It is spearheaded by The Climate Group, in partnership with CDP, as part of the We Mean Business Coalition. Its membership has ranged from companies involved with information technology and finance to consumer discretionary and healthcare.

RE100 membership is diversifying. 2015-16 saw RE100 welcome five members from China and India. RE100 now counts three major automobile manufacturers (BMW Group, General Motors and Tata Motors Limited) and a leading cement maker (Dalmia Cement) among its members. As of September 2017, 111 companies have joined the initiative, surpassing the original goal of 100 members and accounting for 150 terawatt-hours of electricity demand annually—equivalent to the demand of Poland or Sweden.

Most members have committed to achieving 100% renewable electricity by (or before) 2024. Renewable Energy Certificates purchases (60%) and green tariffs were the most popular purchase routes for members to achieve their targets in the United States and Europe in 2015. RE100 witnessed increasing use of corporate power purchase agreements and on-site generation in 2016, with many members planning to use these options in future.

www.theRE100.org

building 23.4 GW of wind, followed by the United States, Germany, India, and Brazil.

Major investment and cost reductions may see wind power capacity more than double by 2026.⁵⁷ The sector attracted \$112 billion in 2016, down 9 percent year-on-year but yielding more capacity, again reflecting lower costs of installation. The average total installed cost of wind power has fallen by two-thirds between 1983 and 2014, and may fall by a further 12 percent by 2025. The cost of electricity from new turbines is likely to fall even faster, because efficiency gains, increased use, and better logistics are making the electricity produced by new turbines considerably less expensive—potentially falling by up to 34 percent by 2025. Wind power is forecast to rise from 487 GW of total installed capacity at the end of 2016 to around 1,110 GW by 2026.^{58,59}

UTILITY-SCALE STORAGE

Utility-scale energy storage is emerging as a high-growth market that can play a role in supporting the development of renewable energy.

Energy storage technologies can be broadly categorized as follows:

- Mechanical (such as flywheel, pumped hydro)
- Electrochemical (batteries)
- Chemical (hydrogen, synthetic natural gas)
- Thermal
- Electromagnetic (capacitors).

They are being developed to address different needs, including managing supply and demand, and balancing loads when renewables are not operating. There is no single best storage technology. The optimal choice depends on parameters such as density, round-trip efficiency, cycle life, ambient temperatures, safety needs and cost. The cost of different storage options depends on scale, application and siting. Prices for large installed grid-scale battery storage systems are approaching \$300-350/kWh today, and are expected to be around \$250/kWh in the early 2020s. This is based on today's cost of a Lithium-ion battery pack at \$220/kWh.⁶⁰

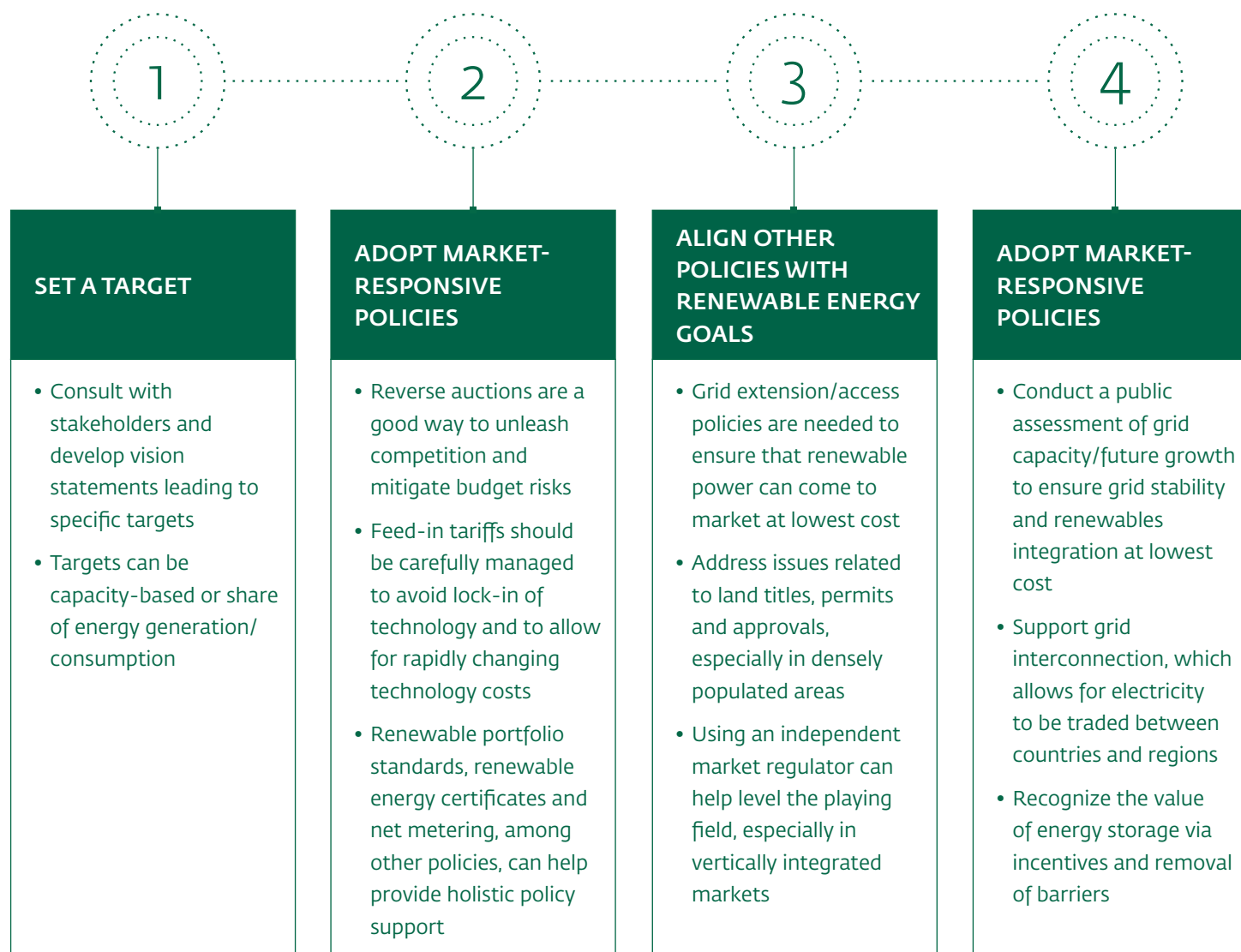
Pumped storage remains the biggest storage technology by capacity, but battery storage is growing fast. Pumped storage is a conventional

technology that pumps water uphill to a reservoir during times of excess capacity, and then releases it through a hydroelectric turbine to generate electricity when it is needed. It accounts for 96 percent of the world's storage. However, lithium-ion electrochemical storage is the subject of growing interest, since it is the most common battery type in electric vehicles and has benefited from major research and development investment in recent years. This has supported a 65 percent cost reduction from 2010 to 2015.⁶¹ Clean Technica expects global energy storage to grow from about 2.9 GWh at the end of 2016 to 21 GWh by 2025.⁶² Half of this storage will take place “behind the meter,” meaning it will be installed on the customer's side of the utility meter to reduce the customer's utility bill. The largest markets for grid-connected energy storage by 2025 will be the United States, Japan, China, Germany, Australia, the United Kingdom, and India, with eight countries expected to breach 1 GWh of storage in their markets. While the markets are smaller, activity is also growing in Kenya, South Africa, and the Philippines.⁶³

1.3 Creating markets for grid-connected renewable power

While the market outlook is strong for grid-tied renewable energy, policies are still needed to address risks, including uncertainty about grid access, unclear land titles, and a high cost of financing. Governments can foster attractive markets for grid-tied renewables through setting targets, adopting supportive renewable energy policies, ensuring non-renewable policies align with renewable energy goals, and adapting policies to manage dynamic market needs as the share of renewables in the energy system grows (Figure 3). In addition, countries where renewables are at an early stage of development can develop a comprehensive plan for grid expansion, in partnership with large electricity customers, developers, investors and utilities. To help facilitate an increasing amount of variable renewable resources, countries should provide policy frameworks, market reforms and incentives for energy storage so that it can help balance the grid and manage supply. Finally, policies should ensure that renewable power providers are not disadvantaged as they attempt to connect with the system.

FIGURE 3: Steps to create markets for grid-connected renewable energy



STEP 1: SET A TARGET.

Most governments develop clean energy white papers and vision statements in consultation with industry and affected stakeholders.

These actions signal a country's clean energy ambitions and help to ensure that plans are achievable and broadly supported before targets are set. More than 150 countries have set national renewable energy targets.⁶⁴ Some countries develop technology-specific targets and frame them in terms of capacity. For example, India's National Solar Mission aims to have 100 GW of solar power by 2022. Other targets are expressed in terms of a share of final energy consumption. For example, the European Union intends to have at least a 27 percent share of renewable energy consumption by 2030, encompassing energy end-uses such as electricity, heat, and transport fuels. Other factors to consider in setting a target include the ease of monitoring progress, incentivizing generation rather than capacity, making targets mandatory rather than aspirational, stakeholder engagement to generate support for the target, and the existence of supportive policies.⁶⁵

STEP 2: PUT IN PLACE SMART, MARKET-RESPONSIVE POLICY FRAMEWORKS TO ACHIEVE THE TARGET.

In many countries, preference for feed-in tariffs is giving way to auctions. But the local context, such as the state of the electricity market, fuel subsidies, and the relative cost of electricity, is an important determinant in the success of market development policies.

Renewables auctions are an increasingly popular tool to encourage usage in a controlled manner. Sometimes called "reverse auctions", this approach involves the government or utility setting a target for the amount of renewable energy it wants to acquire, then asking developers to offer project bids, including the electricity price required to build and operate the project under a long-term power purchase agreement. Once bids are received, the authority awards contracts to winning proposals based on criteria such as price and project feasibility until the targeted capacity is achieved. As renewable energy technology costs fall, this method helps to manage the challenge of determining market prices and mitigates budgetary risks associated with other policies such as

feed-in tariffs.⁶⁶ Auctions have been successful in advanced renewable markets like Germany and the United Kingdom, as well as in emerging economies like Brazil, Chile, India, Mexico, and South Africa.⁶⁷

Feed-in tariffs remain a popular policy tool, but must be managed carefully. About 70 countries have some type of feed-in tariff,⁶⁸ which sets a fixed price per unit of renewable energy in the electricity grid. Different technologies may attract different tariffs depending on technology costs and location. With rapidly changing technology costs, commercial sensitivities around pricing, and accelerating learning rates, creating fair and durable feed-in tariffs is challenging. This can be addressed by integrating flexibility mechanisms into tariff policy, such as rates that decline predictably over time and regularly scheduled rate reviews.

Other policy instruments include the renewable portfolio standards and renewable energy certificates. Portfolio standards ensure distribution utilities and direct consumers procure a certain share of their electricity from renewable sources, usually in some form of timely increment. This can be expanded to include storage technologies. While the standards have helped create markets in advanced economies like the United States and the United Kingdom, it has had mixed results in emerging markets, including India, which tried a form of portfolio standards in the early 2010s. Renewable energy certificates—whereby the owner claims the emissions and other benefits associated with renewable energy generation—are tradable financial instruments that can be used by utilities and large independent consumers to fulfill their renewable obligations. They are usually implemented together with portfolio standards to fulfill obligations when there could be physical shortage of renewable electricity. Creating similar certificates for storage capacity can monetize storage and encourage the use of renewable energy, supported by the system-level cost savings that storage can deliver. The state of the electricity market, in addition to supply and demand, determines the appropriateness and success of renewable portfolio standards and energy certificates.

Net-metering policy can be used in tandem with other policy instruments (especially feed-in tariffs) to support customer-sited renewable energy on the grid, especially residential and corporate rooftop solar and other customer-sited installations. It allows

Creating markets for grid-tied renewable energy

ARGENTINA: RENEWABLE ENERGY AUCTIONS

In 2016, Argentina embarked on a series of energy sector reforms with the arrival of new President Mauricio Macri. Following a 15-year hiatus of international investor interest in Argentina, the Macri administration realized the importance of establishing a bankable, best-practice power purchase agreement regime and energy auction process to achieve competitive electricity generation costs and increase investment. The government of Argentina teamed up with IFC's Global Power team to draft a power purchase agreement and structure the bid process, which included:

- **Reducing the retail price**, which will advance competition.
- **Tailoring bidding criteria** by defining and adhering to capacity limits and quotes, and allowing for market opening measures and a simpler approach to the bidding process.
- **Including international arbitration in the power purchase agreement** to ensure project bankability.

- **Standardizing environmental and social standards** by ensuring IFC performance standards are applied for each project.
- **Incorporating a guarantee of off-taker obligations** to backstop ongoing payments and termination payments.

Following IFC's advice and the implementation of a World Bank guarantee, Argentina successfully completed two energy auctions in October and November 2016, awarding 1.5 GW of wind and 900 MW of solar projects to local and international bidders. The November auction resulted in average pricing of \$53/MWh for wind and \$55/MWh for solar. The auctions are estimated to bring in \$3.5 billion in investment over the next two years and grow renewable energy from just under 2 percent of the current energy mix to at least 8 percent by 2018.

WESTERN BALKANS: DEVELOPING PARTNERSHIPS TO SCALE UP SMALL HYDROPOWER

IFC used a holistic strategy to grow the small hydropower market in the Western Balkans. The approach involved:

- Working with governments to improve the investment climate.
- Helping energy companies strengthen project concepts, technical designs, and business plans.
- Helping clients secure financing.
- Supporting local banks to boost internal capacity and process renewable energy loans.
- Organizing business-to-business workshops and databases to match international companies and local developers for joint ventures.

The result was the development of a \$1.1 billion investment program in 500 MW of small-scale hydro projects in the region, generating 2000 GWh/year. IFC provided \$28 million in financing for these projects and mobilized another \$40 million. The Small Hydro program is now being replicated in Nepal, with similar plans under development in East Asia Pacific and Sub-Saharan Africa.

www.ifc.org





Scaling Solar in Zambia

Solar power is an increasingly affordable, quick-to-build solution for countries in need of additional electricity. Scaling Solar, launched by the World Bank Group in 2015, provides an easy-to-follow process to plan, procure, and launch grid-connected solar projects within two years using private sector financing. It offers governments the tools to quickly increase energy generation at stable low tariffs and allows developers to bid on well-structured, standardized projects through a competitive, transparent process that reduces risk and costs.

Zambia was experiencing daily blackouts, stemming from drought that had crippled its hydroelectric capacity, when it became the first country to sign up for Scaling Solar in 2015. The government aims to build two large solar plants as part of its long-

term strategy to generate 600 MW from solar. In May 2016, the program completed its first auction, choosing from seven prequalified bids. The lowest bid was just over \$0.06 per kWh, which is fixed for 25 years. This is the cheapest solar power to date in Sub-Saharan Africa and among the lowest solar tariffs in 2017.

Zambia's Scaling Solar debut is expected to meet its targets and deliver 73 MW of solar power capacity within two years. It is the region's first utility-scale solar project outside South Africa. While a partial risk guarantee helped mitigate off-taker risk, Zambia has demonstrated that market solutions and private sector financing for low-cost renewables in low-income countries are feasible.

www.scalingsolar.org

homeowners and commercial and industrial consumers to sell excess electricity back to the grid, offsetting their costs and creating an additional incentive to use renewables. Net metering has been used widely in North America and Europe and is gaining traction in emerging markets—especially in China and India—but delays in market reform are a challenge. Regulations for a competitive wholesale and distribution market and open access have been difficult to implement, but are catalytic to market development.

Other fiscal credits and incentives such as accelerated depreciation and generation-based incentives can be used with some of the policy instruments discussed above to enhance market creation. Market regulators can make the issuing of operational permits and the approval of utility modernization plans contingent on storage.⁶⁹

STEP 3: ENSURE THAT OTHER NON-RENEWABLE POLICIES ARE NOT INHIBITING MARKET GROWTH.

Countries are developing solutions to manage challenges related to renewable energy technologies. These include:

- **Creating policies to ensure renewable power can come to market.** The best renewable energy resources are often in less populated areas far from the grid, which means built capacity may remain unconnected to the grid.⁷⁰ This can be overcome by extending the grid, or preparing approved construction sites with grid connectivity, as has been done in India, where the government prepared sites with prebuilt grid connections for large solar power projects.⁷¹
- **Addressing issues related to land titles, permits, and approval processes.** When renewables are developed in densely populated areas, secure access to land is a challenge. In addition to land acquisition, the permit and approval processes often create unanticipated project delays in developing countries, especially for large wind farms and solar installations. Innovative solutions that focus on underused land, such as India's canal-top solar installations, can help address land challenges,⁷² while providing secure land tenure can help make land markets much more efficient. Streamlining the permit and approval processes can also help accelerate project development.

India: Creating markets for grid-connected renewables

India's government is targeting 175 GW of installed renewable power capacity by the end of 2022, including 100 GW from solar, 60 GW from wind, 10 GW from biomass, and 5 GW from small hydro.

Reverse auctions have played a major role in achieving the cost-effective use of renewable energy while minimizing government risks. Tariffs continue to break record lows, with the winning bid for 250 MW of solar PV in April 2017 at \$0.05/kWh, continuing a long-term trend that has seen auction prices fall by 70 percent since 2010.⁷³ To avoid failure in the auction process, and recognizing the limits of transmission infrastructure to transport electricity from India's solar PV hotspots to demand centers, a major green energy corridor is being built in partnership with Germany's GIZ via a €1 billion soft loan from the German development bank KfW.⁷⁴

As the share of renewables on the grid grows, India is focusing on energy storage. In 2016, the government mandated that storage be included in a 100 MW solar tender in Andhra Pradesh and a 200 MW solar tender in Karnataka Saurabh.⁷⁵ Renewables make up about 17 percent of India's total installed capacity, and its most recent renewable electricity roadmap aims for 40 percent by 2030. The move towards specifying storage requirements shows that India is transitioning towards a future-oriented grid that requires storage to maintain frequency control, balance the grid, and manage the inherent intermittency of renewable energy.

- **Using independent and non-discriminatory regulation to ensure that renewable generators, who are often new market entrants, are not disadvantaged.** This is particularly important when renewable generators are selling electricity to a utility with thermal generation interests. Without a strong, independent regulator ensuring market competition, incumbents might discriminate against renewable generators and independent power producers.

STEP 4: ADAPT POLICIES TO MEET THE EVOLVING NEEDS OF THE ELECTRICITY MARKET.

When renewables are at an early stage of integration, it is best practice for authorities to conduct a public technical assessment of grid connection capacity and tailor grid investments with the growth of renewables in mind. As renewable penetration grows, ensuring grid stability is of paramount importance. Electricity market reforms can be used to incentivize the right types of generation capacity and reduce demand during peak periods. Support for grid interconnection allows electricity to be traded.⁷⁶ In addition, it is important that wind and solar plant outputs are reflected in planning for the wider power system. A well-balanced portfolio of wind and solar PV plants can contribute to grid stability without needing to expand the grid. Building plants in different locations also helps ensure a smoother output of power, enabling better management.⁷⁷

Energy storage contributes to grid stability, and incentives can help encourage storage use.⁷⁸ For example, the United Kingdom has undertaken major electricity market reforms to incentivize investment in secure, low-carbon electricity,⁷⁹ and California has developed energy storage mandates requiring its major utilities to procure 1.3 GW of storage capacity by 2020.⁸⁰ In June 2017, the state of Massachusetts introduced a comprehensive program for energy storage. Targets were set for 600 MW of installed capacity by 2025.⁸¹ New York is expected to follow suit soon. Success in developed country markets could send a strong signal to developing countries.

Regulation and market design are key for storage. Energy storage can deliver several benefits to the grid. The business case for storage is easier to make if storage assets can participate in different markets at

different times, for example via intermittent short charges/discharges for frequency regulation, via load reduction during peak hours, or via shifting renewable generation over several hours. Market design should allow for “value stacking” of different applications and for storage to operate both as a generation and transmission asset.

INNOVATIVE FINANCING MODELS

Yieldcos are an influential financial innovation in the renewables industry. A yieldco is a publicly traded company focused on dividend growth, created by a parent or standalone energy company. The yieldco owns and operates renewable assets, promising contracted predictable cash flows while maintaining tax advantage.⁸² It allows parent companies to finance large-scale projects while ensuring access to lower capital costs. The first yieldco was started in the United States in 2012 and grew to 10 companies with a peak market capitalization of almost \$28 billion by 2015.⁸³ After a challenging year in 2015, owing to the low oil price and the effects of renewable energy company SunEdison’s bankruptcy, the yieldco market is slowly making a recovery.⁸⁴

Securitizing assets, particularly for residential solar, is another financial innovation promising lower capital costs. Solar asset-backed securities are emerging as a credible debt financing instrument in the U.S. residential solar market. IFC is helping to demonstrate the viability of asset-backed securities structures for rooftop solar in India (see Box 7), and then translate this for other emerging markets.⁸⁵

Project financing is central to the future health, direction, and momentum of the energy storage industry.⁸⁶ It is a transition away from reliance on self-funding, captive lending, and government grants, signaling technology maturity and growth. In 2017, CIT Bank, Macquarie Capital, and Advanced Microgrid Solutions provided the industry’s first financing for an energy storage project—a 50 MW fleet of behind-the-meter systems in West Los Angeles.⁸⁷ SUSI Partners, a Swiss investment manager, recently closed the first round of its Energy Storage Fund with a pool of €66 million. Another €14 million is already committed for the second round of financing.⁸⁸

Can the asset-backed securities market finance solar?

The India Innovation Lab for Green Finance is a public-private initiative that aims to drive green growth in India. IFC is working with the lab secretariat, the Climate Policy Initiative, to refine the program's structure.

The proposed financing program will provide affordable and accessible debt financing to developers of solar rooftop projects that target institutional, commercial, and industrial customers, and demonstrate the viability of a sustainability-focused asset-backed securities structure for the Indian market.

In the first phase, the program will establish a loan book (warehouse line) to provide loans to creditworthy solar rooftop projects. In the second phase, the loans will be refinanced by issuing green asset-backed securities, initially to local institutional debt investors. The composition of the loan pools will have to meet certain underwriting criteria. The size and timing of the bond issuance will depend on market conditions and investor appetite, and may be issued on a rolling basis.

www.climatefinancelab.org/the-labs/india



1.4 Initiatives, tools, and resources



The **International Energy Agency (IEA)** works to ensure reliable, affordable and clean energy for its 29 member countries and beyond, and has a wealth of data, policy perspectives, technology roadmaps and outlook reports on renewable energy.

www.iea.org



The **International Renewable Energy Agency (IRENA)** is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy.

www.irena.org



The **Renewable Energy Policy Network for the 21st Century (REN21)** brings together governments, NGOs, research institutes and academia, international organizations and industry to learn from each other to advance renewable energy.

www.ren21.net



The **Renewable Energy and Energy Efficiency Partnership (REEEP)** focuses on advancing the renewable and energy-efficiency market, particularly in developing countries, primarily by de-risking and scaling up clean energy business models.

www.reeep.org



Sustainable Energy for All (SE4ALL) is a global initiative to achieve universal energy access, improve energy efficiency, and increase the use of renewable energy.

www.se4all.org



The **International Solar Alliance (ISA)** is a common platform for cooperation to advance deployment of solar energy through innovative policies, projects, programmes, capacity-building measures and financial instruments.

www.isolaralliance.org



The **Global Solar Council (GSC)** is an international organization founded in 2015 to coordinate the efforts of the world's solar energy associations.

www.globalsolarcouncil.org



The **Global Wind Energy Council (GWEC)** was established in 2005 to provide international representation for the wind energy sector.

www.gwec.net



The **Global Energy Storage Alliance (GESA)** was established in 2014 to bring together energy storage and clean energy industry associations for knowledge sharing and advancement of energy storage solutions.

www.globalesa.org



The **RE100** is a collaborative global initiative uniting more than 100 businesses committed to 100 percent renewable electricity, working to increase demand for—and delivery of—renewable energy.

www.re100.org



The **Regulatory Indicators for Renewable Energy (RISE)** is a global policy scorecard that assesses policy and regulatory frameworks for energy access, energy efficiency and renewable energy.

<http://www.worldbank.org/en/topic/energy/publication/rise---regulatory-indicators-for-sustainable-energy>



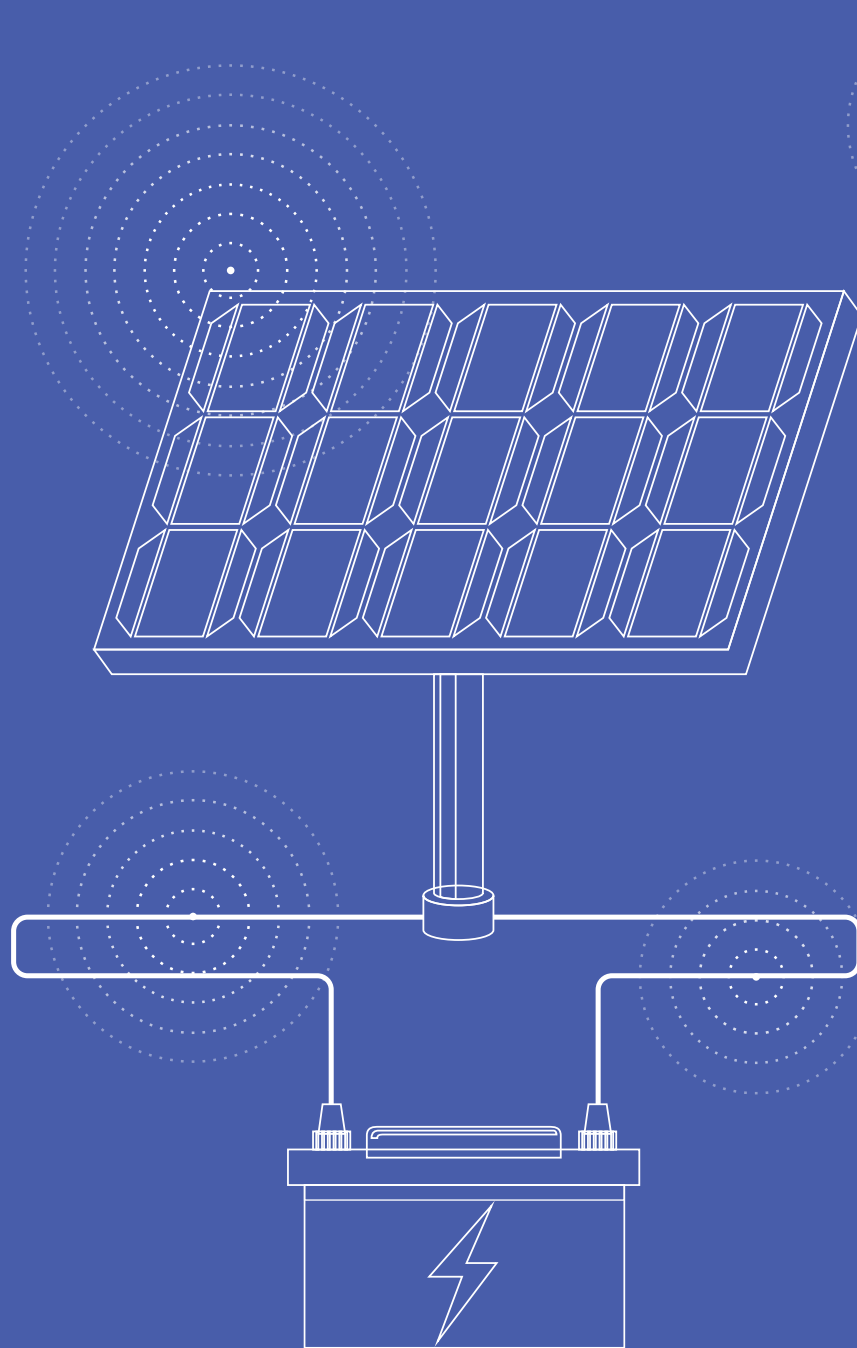
The **Energy Sector Management Assistance Program (ESMAP)** is administered by the World Bank Group, and focuses on increasing the knowledge and technical capacity of low- and middle-income countries to achieve a sustainable energy solution.

www.esmap.org



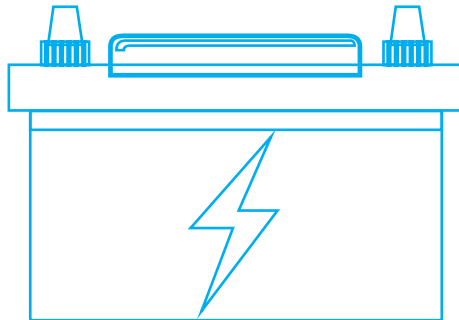
The World Business Council for Sustainable Development's **Low Carbon Technology Partnerships initiative (LCTPi)** is a joint public and private initiative to accelerate low-carbon technology development. Renewable energy is one of the solutions that the WBCSD and its member companies have identified as critical to reach climate stabilization.

www.lcpti.wbcsd.org

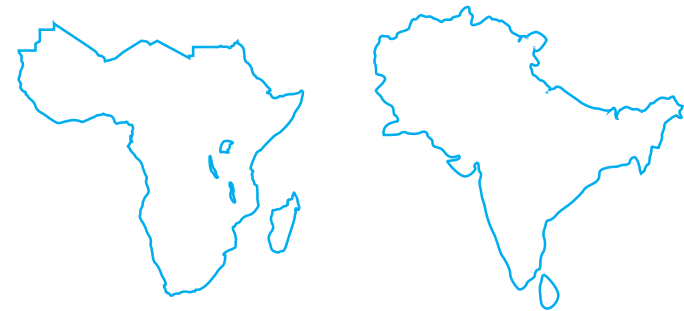


Off-Grid Solar and Storage

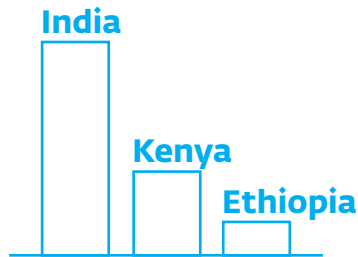
Key indicators



Cost reductions in batteries and solar PV have opened up many new markets—the number of off-grid systems grew by 41 percent between 2015 and 2016, with **8.2 million** systems sold.

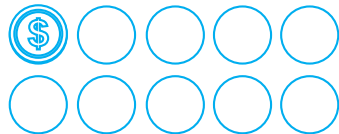


Sub-Saharan Africa and **South Asia** dominate the off-grid market. There are now **over 100 off-grid solar companies globally** and 20 million quality certified solar lights have been sold. **89 million people** in the developing world own at least one solar light.



India leads the off-grid solar market, with over 3 million systems sold in 2016; **Kenya** was 2nd with 1.2 million, and **Ethiopia** third with 500,000.

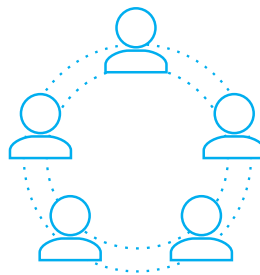
pay-as-you-go



PAYG solar business models raised **\$223 million** in capital in 2016.



Annual investment in energy storage in emerging markets was 2.5 billion in 2016 and is expected to reach **\$23 billion** in 2025.



31 NDCs include targets for this sector.





Off-Grid Solar and Storage

2.1 Summary

Providing energy to communities with limited access to formal energy grids remains the main driver for off-grid solar power and distributed storage. These off-grid technologies include solar lanterns, solar home systems, mini-grids and micro-grids, and distributed battery storage. Solar lanterns and solar home systems provide enough electricity to power lights and charge cellphones, while mini- and micro-grids support demand from residential, industrial, and commercial customers. Moreover, small-scale energy storage can create autonomous mini-grids that provide households with uninterrupted electricity access and/or on-demand electricity service.⁸⁹

The off-grid solar market is dominated by emerging markets, mainly in Sub-Saharan Africa and South Asia. Ethiopia, Kenya, and Tanzania are the leading markets in Africa, accounting for 66 percent of units sold, while India leads the way in Asia.⁹⁰ In less than a decade, more than 100 companies around the world have been created to focus on standalone solar lanterns and solar home systems. By July 2015, 20 million solar lights had been sold. Today, about 90 million people in the developing world have at least one solar lighting product in their home.⁹¹ Bloomberg New Energy Finance predicts that one in three households globally will use off-grid solar by 2020.⁹²

Cost reductions and advances in technology are enabling large-scale deployment of distributed solar PV and mini-grids. The dramatic drop in the costs of solar PV and lithium-ion batteries and advances in energy

storage solutions have opened up new off-grid applications that were previously too expensive. Globally, the number of off-grid solar systems in use grew by 41 percent between 2015 and 2016, with the 8.2 million systems sold representing about 50 percent of sales of all off-grid products in that period. Investment in micro- and mini-grids has also accelerated, with the global market expected to reach \$200 billion.⁹³ There are now over 220 mini-grids in operation; in 2015-2016, mini-grids accounted for \$68 million of equity, debt and grants raised.⁹⁴

New business models have reduced transaction costs and introduced a more reliable way to pay for solar home systems and mini-grid applications. Pay-As-You-Go (PAYG) solar companies raised \$223 million in capital in 2016, while \$75 million was raised in debt and equity finance for mini- and micro-grids in East Africa and Southeast Asia alone.⁹⁵ This growth is expected to continue, particularly in the storage sector: annual investments in storage of all types in emerging markets are forecast to grow from about \$2.5 billion in 2016 to \$23 billion in 2025, with China and India leading the way.⁹⁶ This will result in 80 GW of new storage capacity compared to the estimated 2 GW existing today, only a small fraction of which will be in remote applications.⁹⁷

There are still barriers preventing strong off-grid markets, including a failure to capture the value of off-grid solar and storage in regulations, challenges with permitting, and challenges accessing suitable finance. Governments are beginning to address these by recognizing the role that off-grid technologies play in electrification and providing supportive policies, including differentiated tariffs, clear technical and safety

TABLE 2: NUMBER OF COUNTRIES WITH SUBSECTORS INCLUDED IN THEIR NDC

Region	Off-grid solar	Mini-grid	Off-grid renewable energy
East Asia and Pacific	4	2	1
Europe and Central Asia			
Latin America and Caribbean	3		1
Middle East and North Africa	3		
North America			
South Asia	1	1	1
Sub-Saharan Africa	6	4	4
Total	17	7	7

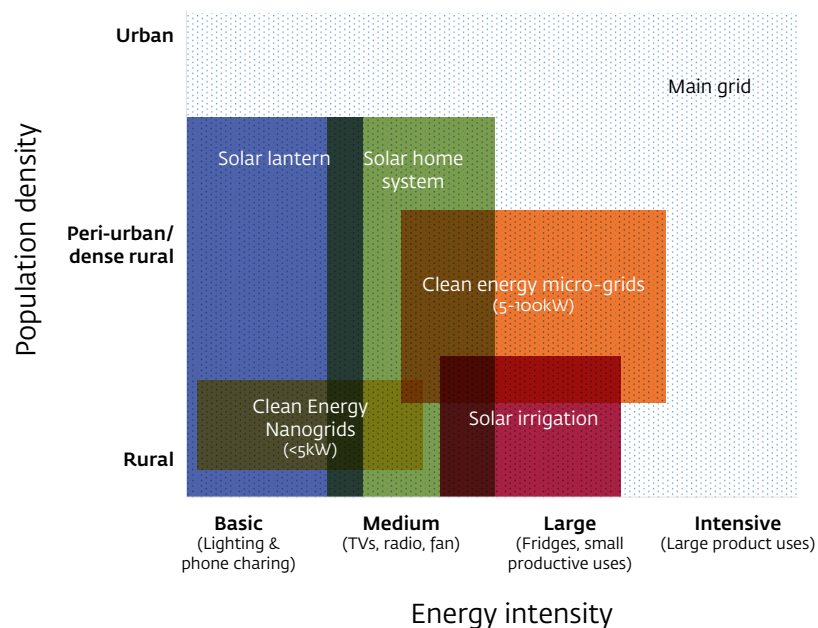
(Source: World Bank, INDC Database; see indc.worldbank.org)

standards, and targeted financial incentives and duty exemptions for equipment and operations. The inclusion of these technologies in 31 NDCs (see Table 2) provides further evidence that mini-grids are promising investments.

2.2 Market snapshot and growth potential

All of the off-grid solar market segments (solar lantern and solar home systems, mini- and micro-grids, and off-grid storage) are developing rapidly. The most active markets are in Bangladesh, East Africa, Ghana, India, and Nigeria. Sales of solar home systems are largest in India, where sales rose from 2.6 million units in 2015 to more than 3 million units in 2016.⁹⁸ Sub-Saharan African countries rounded out the top five countries with the most sales in 2016, with sales of 1.2 million systems in Kenya, 0.5 million in Ethiopia, and 0.4 million each in Tanzania and Uganda. These markets are becoming commercially viable, and more businesses are spreading to markets like the Democratic Republic of Congo.

FIGURE 4: Off-grid solar market segments



(Source: IFC, Hystra)

With a low electrification rate (35 percent of households connected to electricity overall), Sub-Saharan Africa has the greatest growth potential for off-grid solutions, though opportunity also exists in Bangladesh, India, Indonesia, and Pakistan.⁹⁹ South-Central Asia is the second largest market for distributed solar systems, with sales growth of 19 percent between 2015 and 2016.¹⁰⁰

OFF-GRID SOLAR

Solar PV costs are falling rapidly—a trend that is expected to continue—making solar home systems an increasingly attractive solution.

Innovation, increased production, and the implementation of lessons learned from experience have reduced the price of solar PV by 58 percent since 2010.¹⁰¹ Increased cell efficiency has driven down costs by reducing the surface area and associated materials needed to produce the same output. Large additional cost reductions are still to come from improved solar modules and other components, with the total cost of rooftop systems expected to fall by more than 20 percent by 2021 in countries like India and China.¹⁰²

Sales of off-grid solar systems are growing rapidly, especially in India.

The use of off-grid solar systems (including pico-solar and systems less than 100 watts) grew by 42 percent globally between 2015 and 2016 to 8.1 million systems, representing about 50 percent of sales of all off-grid products in that year. Sales of off-grid solar systems in 2016 were led by India (3.1 million systems), Kenya (1.2 million), and Ethiopia (500,000 million). Pico-scale products—lightweight, portable solar panels—are the most common types of systems, comprising 94 percent of all off-grid solar products. Sub-Saharan Africa and South Asia together accounted for more than 80 percent of global sales in 2016.¹⁰³

The PAYG business model is changing the viability of rural electrification, and PAYG companies are attracting significant investment, especially in East Africa. PAYG solar companies raised \$223 million in 2016, up from just \$3 million invested in 2012.¹⁰⁴ The mobile-enabled PAYG business model is revolutionizing the commercial viability of rural electrification: it allows people to make small payments over time, making solar products accessible to low-income households. The PAYG business model is being used by more

than 32 companies in at least 30 countries. Companies like Lumos Global, Mobisol (see Box 8), M-KOPA, d.light, and BBoxx are already connecting thousands of homes each month using rooftop solar home systems. The model is now being applied to other areas like clean cooking and water pumping. Mobile PAYG is particularly well established in East Africa, where mobile phone penetration is relatively high, and is gaining popularity in West Africa and Southern Asia. In the future, data from PAYG customers may be used to establish credit histories, improving access to finance.¹⁰⁵

New business models will expand markets for energy storage. High upfront costs for residential products remain a challenge, especially among the poorest households. Pico-solar projects package lightweight, portable charging panels with electrical appliances, making solar home systems more affordable. The success of innovative PAYG schemes in East African markets could be rolled out more broadly. A major challenge for distributed energy storage is developing ways to share the financial benefits of energy storage systems between consumers and the project developer.

MINI-GRIDS

The falling cost of renewables is making micro- and mini-grids more cost-effective than extending the grid in some markets. Investment in micro- and mini-grids continued to accelerate in 2016, with the global market expected to reach \$200 billion.¹⁰⁶ Markets are maturing to allow grids to accept power for less than 24 hours, so that systems can be turned off when there is insufficient renewable energy to meet demand. In addition, mini-grid systems that can provide constant power are widely available.¹⁰⁷

Small islands are becoming an attractive market for distributed solar and storage mini-grids. This is largely driven by the need for small islands to reduce their overreliance on imported petroleum products, which have cost, ecological, and energy security risks. The World Bank's Energy Sector Management Assistance Program is behind the Small Island Developing States "DOCK" Support Program, which provides advice and investment support to small island developing states looking to transition to clean technology. Solar projects include the Regional Solar

Mobisol makes solar power affordable in East Africa

Mobisol GmbH is a leading PAYG solar energy service company in East Africa. It seeks to make renewable energy solutions affordable for consumers who lack access to grid electricity through an innovative lease-to-own business model. It has developed a high-quality, modular solar home system that has an embedded metering system. This allows customers to pay through a 36-month payment plan via mobile money payment platforms. To date, the company has sold over 60,000 units in Rwanda and Tanzania, which is equal to more than 4 MW of total installed capacity.

In 2016, IFC was invited to partner with FMO, the Dutch development bank, to help Mobisol accelerate growth in Kenya, Rwanda, and Tanzania; expand into new markets such as Nigeria, Uganda, and

Zambia; and fund new products and services, such as insurance products and microloans. IFC invested more than €5.4 million in the company and expects the following:

- **Access to energy:** Mobisol is scaling up off-grid power solutions in Sub-Saharan Africa to people without access to electricity. It is expected to provide energy access to more than 4 million people by 2021.
- **Environmental and health benefits:** Solar home systems displace the use of fossil fuels, such as kerosene and diesel, or car batteries, which pollute the environment and come with health and safety hazards.

- **Job creation:** Mobisol's expanding sales and distribution network, as well as customer service offerings, supports small business and creates local jobs.
- **Establishing credit histories for the unbanked:** By offering customers a chance to pay for the solar home system over time, Mobisol enables unscored and unbanked individuals to build a credit history, resulting in enhanced financial inclusion. Customers have gone on to buy other products such as appliances or access to school loans using the same payment technology after they have paid off their Mobisol loan.

www.ifc.org



Mali's mini-grid

Mali has a decentralized rural electrification model with more than 60 private operators—mainly diesel mini-grids and solar home systems—managed by the Malian Agency for Development of Rural Electricity. Integrated energy planning is key to Mali's approach to rural electrification. The electrification agency works with local authorities and developers before granting concessions. Explicitly stating what the options are for developers as the national grid expands provides some degree of certainty. Having a centralized agency and a committed policy framework has also allowed Mali to attract donor funding for off-grid electrification projects.

<https://pwc.to/2hNBGyR>

PV Scale-up Project in the Caribbean and the Cabo Verde Distributed Solar Energy Systems.¹⁰⁸ Tesla and SolarCity recently helped the island of Ta'u in American Samoa to completely move from petroleum to solar and storage (see Box 10).

Distributed energy service companies are attracting investment for micro- and mini-grids. These companies tend to provide fee-for-service electricity and usually follow a build-own-operate structure. Distributed energy service companies typically use solar-hybrid systems with smart metering technologies, although applying the PAYG model to the companies' mini-grid systems is also being explored.¹⁰⁹ In 2016, \$75 million was raised in debt and equity finance by distributed energy service companies in East Africa and Southeast Asia alone.¹¹⁰ Blended finance approaches can help accelerate commercial viability for new business models by encouraging new investors to enter the market (see Making it Happen chapter).

OFF-GRID STORAGE

Major investment and deployment is expected in energy storage, which is a key component of off-grid systems. Energy storage in emerging markets will likely grow by more than 40 percent annually in the coming decade, adding about 80 GW of new storage capacity to the estimated 2 GW existing today, though only a small fraction of this will be for off-grid applications.¹¹¹ Annual investments in storage in emerging markets are expected to grow from about \$2.5 billion in 2016 to \$23 billion in 2025.¹¹² About half of the growth is expected in China, with \$7 billion in India, \$4 billion in South Asia, \$3 billion in North Africa and the Middle East, \$2.5 billion in Sub-Saharan Africa, and \$2 billion in Latin America and the Caribbean.¹¹³ Including energy storage in off-grid systems increases reliability and user satisfaction, and allows mini-grids to provide power 24 hours a day.

Lithium-ion batteries are the dominant storage technology for off-grid applications, and continue to decrease in price. The cost of lithium batteries used in portable electronics and electric vehicles has fallen 65 percent since 2010, opening up new off-grid applications that were previously too expensive.¹¹⁴ Cost reductions have been driven by rapidly increasing production capacity, as well as technical advances,

Creating markets for off-grid solar in the Pacific

SOLAR AND BATTERY STORAGE MICRO-GRID REPLACING DIESEL IN TA'U ISLAND, AMERICAN SAMOA

Like most small islands, islands in American Samoa have traditionally been powered by diesel generators. Aside from the environmental cost, this means that islands are susceptible to high transport costs and supply and cost risks from a volatile commodity like oil. In 2017, the island of Ta'u managed to completely move away from diesel by installing a solar and battery storage-enabled micro-grid that can supply all of the island's electricity needs.

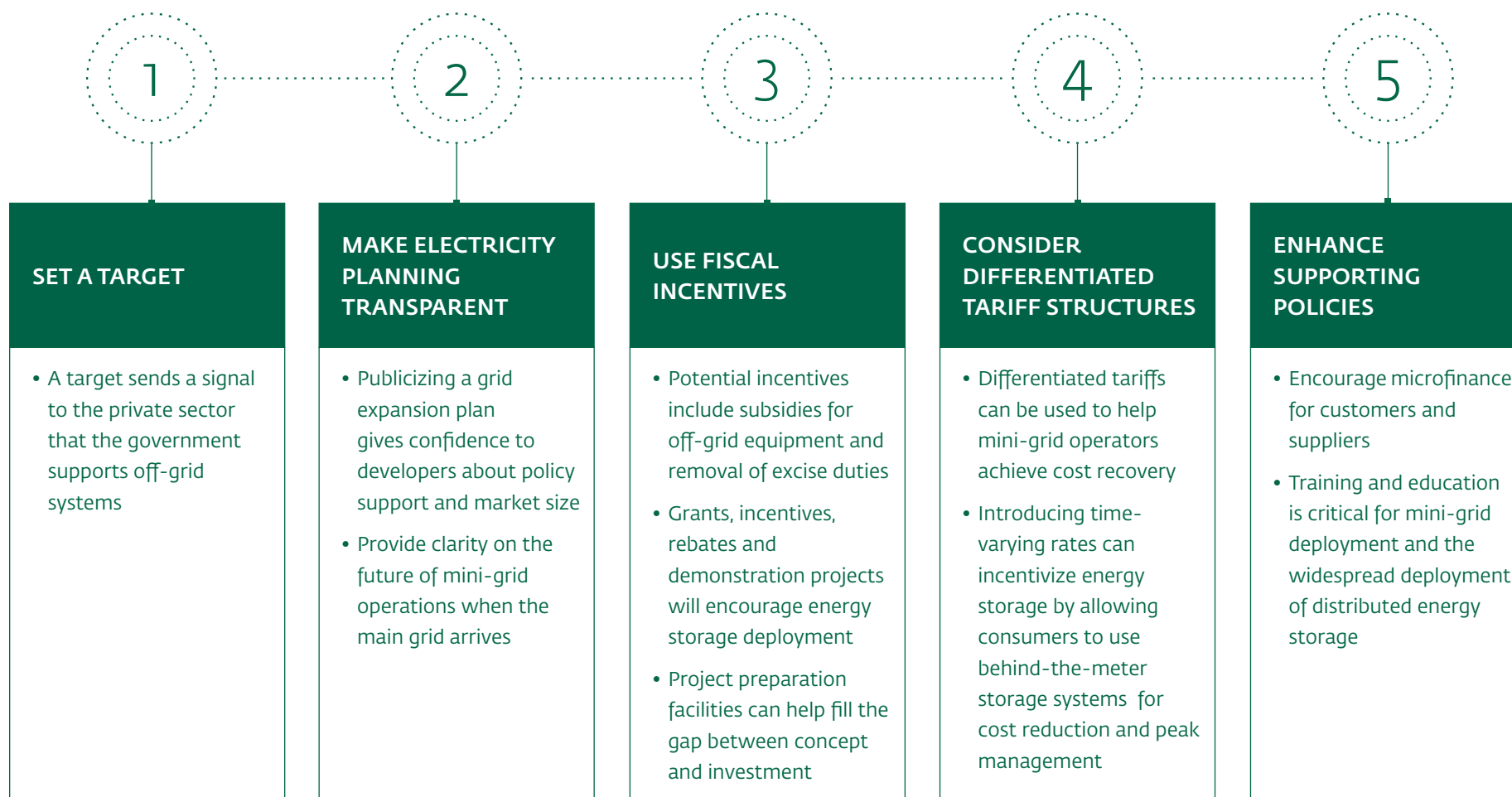
The project involved a 1.4 MW solar micro-grid, backed by 6 MWh of battery storage. SolarCity provided the solar installation while 60 Tesla Powerpacks secured the storage requirements. The project took a year to implement and was financed by the American Samoa Economic Development Authority, the Environmental Protection Agency, and the U.S. Department of the Interior. It is expected to save more than 100,000 gallons of diesel fuel per year, in addition to ensuring a reliable and secure supply of energy on the island.

OFF-GRID SOLAR ENERGY IN PAPUA NEW GUINEA

In Papua New Guinea, about 80 percent of the population have no access to electricity. Since 2014, more than 1.3 million people, or 16 percent of the country's population, have gained access to phone charging and energy services. Over the next two years, Lighting Papua New Guinea is expected to build a market for a further 300,000 people with access to PAYG and other smart solar products. IFC provided business connections, market intelligence, and consumer education that allowed global solar manufacturers enter the market.

For more information, see: blog.solarcity.com/island-in-the-sun/ and <http://bit.ly/2y27Txj>.

FIGURE 5: Steps to create markets for off-grid solar and storage



including thicker electrodes and higher voltages.¹¹⁵ Lithium-ion batteries are estimated to account for 80 percent of global energy storage installations by 2025.¹¹⁶

2.3 Creating markets for off-grid solar and storage

Off-grid solar and storage markets have tremendous promise, but investors and companies still face risks and barriers. These include a lack of clarity on the role of off-grid storage in overall national and local energy plans, a failure to capture the value of off-grid solar and storage in regulations, challenges with permitting, and low access to finance on suitable terms.¹¹⁷ Governments can address these risks by taking a holistic approach that includes target setting, planning for expansion, smart policies and incentives (including different tariff structures) and other policies (Figure 5).

STEP 1: SET A TARGET.

Targets signal to private players that the government supports off-grid systems. Several countries have developed distributed solar targets: Rwanda aims to reach 22 percent of its population with distributed renewable energy systems by the 2018 fiscal year, increasing its off-grid power generation to 22 MW. Tanzania announced a target of 1 million solar installations by the end of 2017, which is expected to supply solar electricity to 10 percent of the nation's population and create over 15,000 jobs.¹¹⁸

STEP 2: MAKE ELECTRICITY PLANNING TRANSPARENT.

Making electricity grid expansion plans public helps give confidence to developers making investments in off-grid equipment.¹¹⁹ The government of Rwanda is providing clear policy support for solar home systems and mini-grids in the country's short-term electrification plan. The governments of Kenya and Sierra Leone have both indicated that mini-grids are part of their national electrification strategy, while the Nigerian Electricity Regulatory Commission has recently stated that



Fluidic Energy provides a cleaner alternative to diesel

Fluidic Energy, headquartered in Scottsdale, Arizona, is a privately held provider of energy storage solutions. Founded in 2007, the company supplies zinc-air batteries to support critical loads and backup power applications worldwide, particularly in Southeast Asia. IFC invested \$7 million in the company in 2013.

The company's products include remote site management, multi-year performance warranties, and innovative financing terms. Its rechargeable metal-air battery system provides low-cost backup power to cellular towers connected to unreliable electricity grids. This novel technology, which Fluidic has already deployed in countries such as Indonesia, helps reduce the costs of sustaining mobile networks in rural areas and offers a cleaner alternative to diesel generators and lead-acid batteries.

<http://bit.ly/2wQ2O8S>



Securitization of renewable assets is helping to lower the cost of capital for BBOXX

In 2015, BBOXX, a leading PAYG company based in the United Kingdom, partnered with Oikocredit, a Netherlands-based investor, to structure the first securitization of off-grid solar assets in the world. Using 12 years' worth of data it had collected, BBOXX structured asset-backed notes called distributed energy asset receivables. These notes represent a bundle of customer contracts. Their value is based on future receivables on the customers' contracts. The initial pool of notes consisted of 2,400 customers with a low risk of default based on repayment history. Oikocredit bought the first issuance for 52 million Kenyan shillings (\$508,000), which gave BBOXX enough capital for about 1,200 solar home systems.

<http://bit.ly/2eTRyUs>

electricity distribution companies may now use mini-grids as a bridge technology to accelerate electrification activities.¹²⁰

To sustain the market for mini-grids, clarify what will happen when the main grid arrives.¹²¹ Typical options that can be developed for mini-grid owner-operators if the grid arrives include:

- Converting from a power producer to a power distributor and buying electricity from the main grid for resale to customers.
- Selling electricity to the interconnected grid operator and ceasing sales to retail customers.
- Selling the distribution grid to the interconnected grid operator and receiving compensation for the asset.

STEP 3: CONSIDER OFFERING FISCAL INCENTIVES TO ENCOURAGE DEPLOYMENT.

Kenya, Rwanda, and Tanzania all removed value-added tax (VAT) on solar products in the 2015 fiscal year.¹²² Tanzania also offers subsidies for mini-grids, storage systems, and renewable energy equipment, as well as some duty exemptions for mini-grid enabling technologies.¹²³ India removed excise duties on off-grid solar systems in 2014. In 2015, Uttar Pradesh, the Indian state with the most people lacking access to energy, announced plans to waive its VAT on solar energy equipment. Other incentives, such as grants and rebates, can further help to stimulate the energy storage market.

STEP 4: CONSIDER ALLOWING DIFFERENT ELECTRICITY TARIFF STRUCTURES DEPENDING ON THE SIZE AND OTHER CHARACTERISTICS OF MINI-GRIDS OR ROOFTOP PV.

Tanzania applies differentiated rules to distributed energy service companies that allows them to charge cost-reflective tariffs that differ from the national tariff, depending on the size of the mini-grid. India's Ministry of New and Renewable Energy developed a Best Practice Guidebook on State Level Solar Rooftop PV Programmes that includes options for setting differentiated tariffs.¹²⁴ It can also be valuable to introduce time-varying rates, which incentivize energy storage by

allowing consumers to use behind-the-meter storage systems to reduce electricity costs and better manage peak loads.¹²⁵

STEP 5: ENHANCE SUPPORTING POLICIES

Encourage microfinance for customers and suppliers. Governments can support microfinance independently or by arranging financing with multilateral institutions and managing it through domestic programs. Under the microfinance model, households and businesses may take out a small loan from a bank to cover the cost of renewable energy equipment. For example, the Renewable Energy Microfinance and Microenterprise Program initiative by Arc Finance offers small loans that have benefited more than 1 million people across Haiti, India, Kenya, Nepal, and Uganda by supporting the sale of 200,000 distributed renewable energy products.¹²⁶

Provide training opportunities to ensure successful deployment of mini-grids and distributed energy storage. The Massachusetts Energy Storage Initiative recommends that the state, national government, and electricity regulators educate city and educational institutions, electricity distribution companies, and energy managers about policy options and savings opportunities available through distributed storage, especially when paired with time-of-use pricing.¹²⁷ For solar and mini-grid deployment, education and training is also essential. IRENA offers an online training platform called Project Navigator that provides guidance on how to develop bankable renewable energy projects, including mini-grids and solar home systems.¹²⁸

INNOVATIVE FINANCING MODELS

In addition to implementing supportive policies, innovative financing models can help unlock private investment in solar power. Traditionally, most solar home system business models were based on equity financing. But as off-grid solar business grows, their capital needs are changing, and they are increasingly seeking international grants and equity financing to address the high costs of local debt. One solution being advanced is US-India Clean Energy Finance, a project preparation facility that aims to provide access to energy in underserved regions of India by supporting early-stage distributed solar project development.

A partnership between the Indian Ministry of New and Renewable Energy, the Overseas Private Investment Corporation, and a consortium of foundations, the initiative provides project preparation support that will catalyze long-term debt financing for distributed solar power. The Climate Policy Initiative serves as the program manager.¹²⁹

Larger players are using the debt market to raise capital. Off Grid Electric, which operates in Rwanda and Tanzania, raised \$45 million in December 2015 through a debt facility, with capital from the Packard Foundation, CeniARTH, the Calvert Foundation, and USAID, among others.¹³⁰ Nova Lumos in Nigeria secured a \$50 million debt facility from the Overseas Private Investment Corporation in November 2016.¹³¹

More tested businesses can move towards securitizing assets, which helps lower the cost of capital and opens up opportunities to attract/leverage additional investment. In 2015, in a first of its kind, PAYG company BBOXX managed to securitize its off-grid solar assets and raise more than \$500,000 through a Dutch investor, Oikocredit (see Box 12). While it remains relatively new and small in scale, securitization can provide the necessary financing tool for larger PAYG and distributed energy service companies to access debt financing and diversify risk.

Lighting Global: Developing the off-grid solar industry

To support growth of the off-grid solar industry, IFC launched Lighting Global. This program supports market development by reducing risk for businesses in this sector and encouraging private sector investment through quality assurance, market intelligence, and business support. It has teams in 10 countries: Afghanistan, Bangladesh, Ethiopia, India, Kenya, Myanmar, Nigeria, Pakistan, Papua New Guinea, and Tanzania.

The program created an internationally recognized quality assurance standard for solar systems and products up to 350 watts—the Lighting Global

Quality Assurance framework. This standard ensures performance for buyers, users, and investors in the sector, reducing risk and catalyzing competition and innovation. The International Electric Technical Commission has adopted these standards, and country governments are now adopting it as a minimum standard to import products. More than 23 million Lighting Global quality-verified products have been sold since 2008, eliminating over 25 million metric tons of greenhouse-gas emissions.

Lighting Global is the primary information source for the sector. It produces industry sales information,

charts the industry's development (the Market Trends Report), and convenes a biannual meeting for the industry (the Global Off-Grid Solar Forum and Expo). These publications and events have made IFC an authority on the sector, and investors, new company entrants, donors, and established companies in the sector rely on Lighting Global products to inform investment and strategy.

www.lightingglobal.org



2.4 Initiatives, tools, and resources

Scaling Solar

Scaling Solar brings together a suite of World Bank Group services under a single engagement aimed at creating viable markets for solar power. The “one-stop shop” program aims to make privately funded grid-connected solar projects operational within two years and at competitive tariffs.

www.scalingsolar.org



Lighting Global is the World Bank Group's platform to support development of commercial markets for modern energy services for the more than 1.2 billion people in the world without access to electricity.

www.lightingglobal.org



The **International Energy Agency (IEA)** works to ensure reliable, affordable and clean energy for its 29 member countries and beyond, and has a wealth of data, policy perspectives, technology roadmaps and outlook reports on renewable energy.

www.iea.org



Sustainable Energy for All (SE4ALL) is a global initiative led by the former Secretary-General of the United Nations, Ban Ki-moon to achieve universal energy access, improve energy efficiency, and increase the use of renewable energy.

www.se4all.org



The **International Renewable Energy Agency (IRENA)** is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy.

www.irena.org



The **Global Off-Grid Lighting Association (GOGLA)** is a neutral, independent, not-for-profit association created to promote clean, quality off-grid lighting solutions that benefit society and businesses in developing and emerging markets.

www.gogla.org



The **Global Solar Council (GSC)** is an international organization founded in 2015 to coordinate the efforts of the world's solar energy associations.

www.globalsolarcouncil.org



The **Energy Sector Management Assistance Program (ESMAP)** is administered by the World Bank Group, and focuses on increasing the knowledge and technical capacity of low- and middle-income countries to achieve a sustainable energy solution.

www.esmap.org



The **Global Lighting and Energy Access Partnership (Global LEAP)** is the Clean Energy Ministerial's energy access initiative, and is led by the U.S. Department of Energy.

www.globalleap.org



SIDS DOCK is an initiative of the Alliance of Small Island States to provide the small island developing states with a collective institutional mechanism to assist them transform their national energy sectors.

www.sidsdock.org



The **Global Network on Energy for Sustainable Development (GNESD)** is a United Nations Environment-facilitated network of Centers of Excellence dedicated to improving energy access for the poor in developing countries.

www.gnesd.org



The **Regulatory Indicators for Renewable Energy (RISE)** is a global policy scorecard that assesses policy and regulatory frameworks for energy access, energy efficiency and renewable energy.

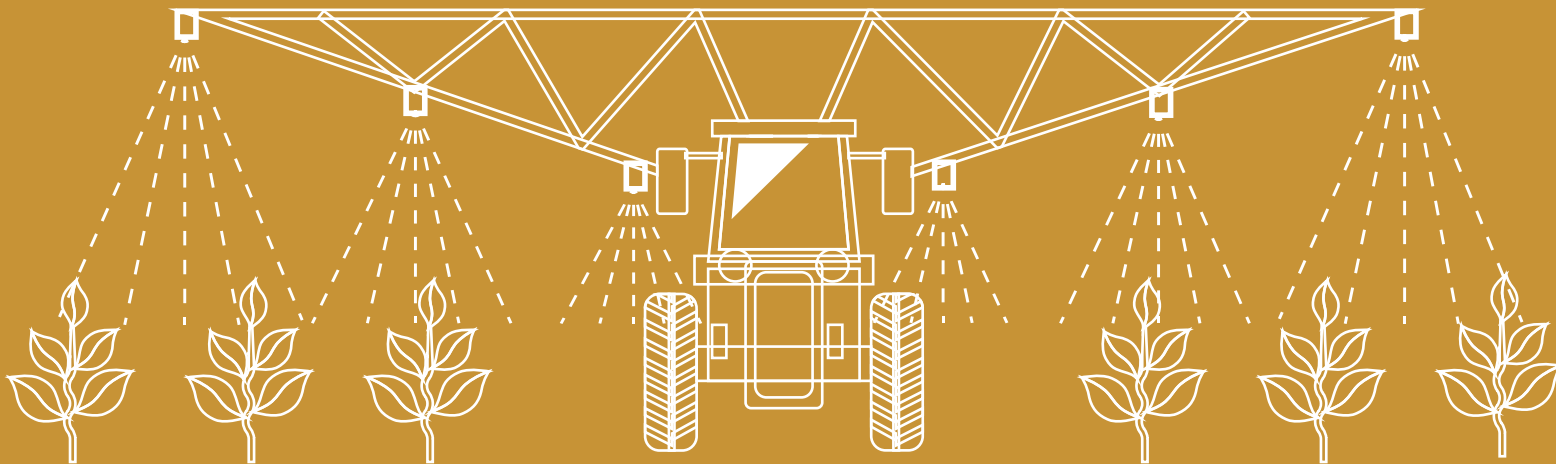
<http://www.worldbank.org/en/topic/energy/publication/rise---regulatory-indicators-for-sustainable-energy>



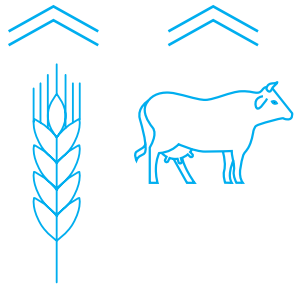
The **Islands Energy Program** is an initiative of the Rocky Mountain Institute supporting the development of more than 20 off-grid projects in the Caribbean islands.

www.rmi.org/our-work/global-energy-transitions/islands-energy-program/

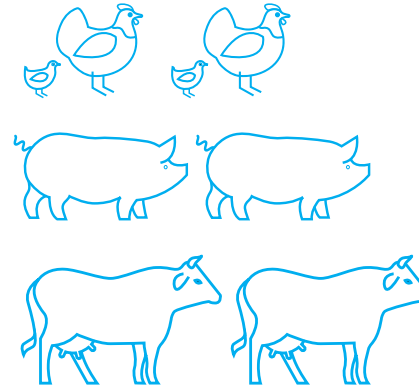
Climate-Smart Agriculture



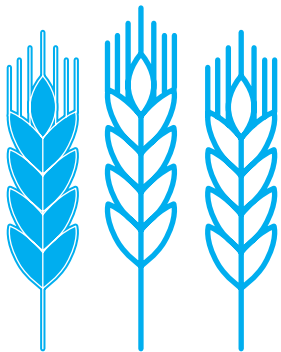
Key indicators



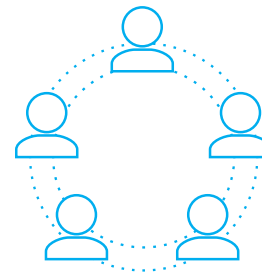
Food demand is expected to increase **20%** over the next 15 years, driven by the developing world. This will require increasing food production **70%**.



We have seen a **doubling** of meat consumption over the past 40 years.



Over **one third** of all food that is grown is wasted.



148 NDCs include agriculture in their targets.





Climate-Smart Agriculture

3.1 Summary

The agriculture sector drives many economies, but must evolve to meet growing food demand while adapting to a changing climate. The global population is expected to reach 9 billion by 2050, and food demand is estimated to increase by 20 percent globally over the next 15 years, with the greatest increases projected in Sub-Saharan Africa, South Asia, and East Asia.¹³² In addition, the sector will be negatively affected by climate change—with floods, droughts, heat waves, wild fires, and rising sea levels threatening farmers and businesses along the entire supply chain.

Food and agriculture are a \$5 trillion global industry that represents 10 percent of consumer spending and 30 percent of greenhouse-gas emissions.¹³³ Since 2004, global investments in the sector have grown threefold to more than \$100 billion in 2013.¹³⁴ Agriculture supports about 500 million smallholder farmers. In developing countries, it is the largest source of incomes and jobs.¹³⁵ Therefore, boosting the productivity, profitability, and sustainability of agriculture is essential for fighting hunger, increasing jobs, and ensuring climate-resilient growth.¹³⁶

Climate-smart agriculture is a set of practices and business models that can help reduce emissions and build resilience. It aims to address both food insecurity and climate change by improving resilience against climate impacts, reducing greenhouse-gas emissions, and increasing productivity in farming. The private sector is increasingly investing in climate-smart practices and new business models. IFC has defined three strategic focus areas. The first involves helping companies to enhance

productivity in livestock agriculture—generating more meat and milk per animal—through a combination of genetics, feed substitutes and supplements, and improved farm operations. This leads to lower methane emissions per animal. The second focus area involves helping farmers to grow more food with fewer inputs through innovative practices such as precision agriculture, efficient irrigation, and optimizing the amount of fertilizer used. The third focus area involves helping clients to reduce post-harvest food losses, improve food security, and boost incomes by investing in improved warehouses and silos, cold storage facilities, better logistics and distribution, and consumer education programs.

Companies, communities, and governments share an interest in creating markets for climate-smart agriculture. Governments are incorporating climate-smart policies and support measures into broader public policy, expenditure, and planning frameworks at all levels of government. Climate-smart agriculture requires coordination between agencies across different sectors (agriculture, energy, infrastructure, environment, and finance), and close partnerships with farmers' groups and the private sector. Securing land rights also provides an enabling environment for investments in sustainable water and land management. For the private sector, an integrated approach to providing incentives has shown promise, as have financial innovations like warehouse receipts and weather-based, or index, insurance. Through the World Bank Group's Making Climate Finance Work in Agriculture initiative, investors and financial institutions are learning how to invest in climate-smart

TABLE 3: NUMBER OF COUNTRIES WITH SUBSECTOR INCLUDED IN THEIR NDC

Region	Agriculture: General	Climate-smart agriculture	Agricultural waste	Livestock	Irrigation	Crops	Fertilizers
East Asia and Pacific	11	5	4	4	2	5	2
Europe and Central Asia	12	2	3	3	3	1	1
Latin America and Caribbean	19	6	4	7	4	3	2
Middle East and North Africa	8	11	4	3	5		2
North America							1
Oceania	1						
South Asia	3	5	1	5	4	3	2
Sub-Saharan Africa	22	32	8	24	18	23	5
Western Europe	3						
Total	79	61	24	46	36	35	15

(Source: World Bank, INDC Database; see indc.worldbank.org)

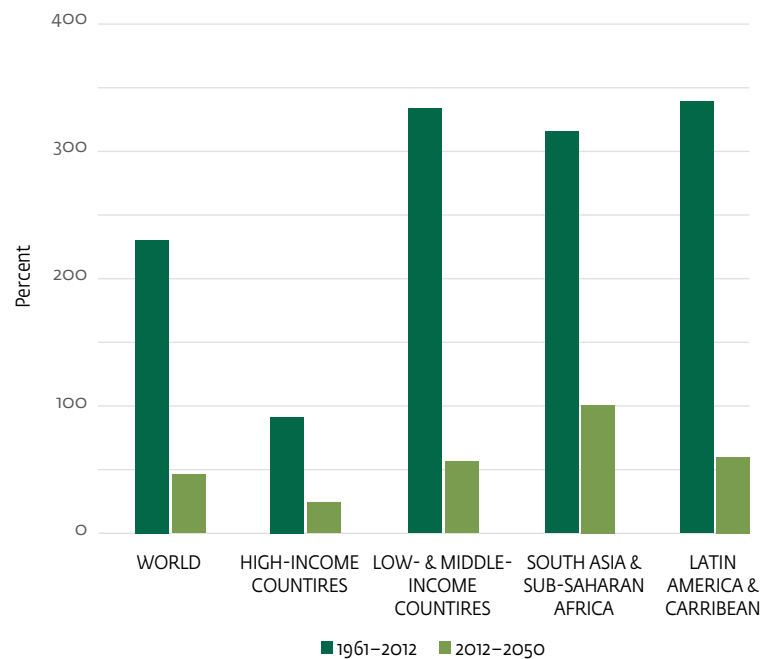
agriculture using new business models and finance mechanisms.¹³⁷ Companies, communities, and governments share an interest in creating markets for climate-smart agriculture. To provide a common framework and provide incentives, governments are incorporating climate-smart policies and support measures into broader public policy, expenditure, and planning frameworks at all levels of government. One risk is a lack of coordination between agencies across different sectors (agriculture, energy, infrastructure, environment, and finance), farmers' groups and the private sector. Climate-smart agriculture creates a platform to encourage this cooperation. There are also risks related to securing land rights. Appropriate financing is also needed to deliver working capital

to farmers. Some of these solutions are likely to come, as countries implement their NDCs (see Table 3).

3.2 Market snapshot and growth potential

Food demand is growing. The world's population is expected to reach 9 billion people by 2050, with most growth occurring in developing countries. This will lead to higher food demand. Rising income levels will also raise demand for protein, processed food and other agricultural products. Together, these trends might require raising overall gross agricultural output by 50 percent by 2050 (Figure 6); in select countries, production may need to nearly double.¹³⁸ The Food and Agriculture Organization projects that under a moderate 2050

FIGURE 6: Global agricultural output growth and demand projections



Source: Based on FAO (2017).¹³⁹

economic growth scenario, global annual cereal production may need to grow by 1 billion metric tons compared to 2005-07, while meat production may need to grow 200 million metric tons to a total of around 460 million metric tons.¹⁴⁰

A thriving agricultural sector has been the basis for successful economic growth in many countries. Investment in agriculture creates food surpluses, keeps food prices low, and creates jobs for rural communities. Europe, North America, and China have successfully followed this development path. More recently, Vietnam, Latin America, and Sub-Saharan African countries have focused on agriculture to grow their economies.¹⁴¹ However, satisfying the world’s food needs requires much greater private investment. Global investments in the food and agribusiness sector tripled between 2004 and 2013 to more than

\$100 billion.¹⁴² Successful private investment in agriculture requires a strong understanding of crops and geographies, as well as complex local value chains that include agricultural machinery, seeds, fertilizer, data providers, transport and logistics, food production and processing, and retailing. There is a growing number of climate-smart agricultural practices and technologies that range in effectiveness in emerging markets; the successful scaling up of solutions will require knowledge of the technical feasibility and economic viability of specific measures, as well as identifying and addressing the risks associated with investment.

Agriculture contributes to—and is affected by—climate change.

Agriculture and forestry are major drivers of climate change, accounting for up to 30 percent of global greenhouse-gas emissions.¹⁴³ Most of these emissions come from meat and milk production and the expansion of agriculture into forested areas. Farmers across the globe are experiencing more droughts, floods, and heat waves that are increasing production variability and pushing already vulnerable populations into poverty and potential climate migration, as farmers seek new sources of income. Climate change also increases food price volatility, which drives up food prices and increases the risk of food insecurity.

The World Bank Group describes climate-smart agriculture as an integrated approach to managing landscapes—cropland, livestock, forests, and fisheries—that addresses the interlinked challenges of food security and climate change.¹⁴⁴ Climate-smart agriculture aims to achieve three outcomes:

1. **Increased productivity:** Produce more from existing farms to improve food and nutrition security and boost the incomes of 75 percent of the world’s poor, many of whom rely on agriculture for their livelihoods.
2. **Enhanced resilience:** Reduce vulnerability to drought, pests, disease, and other shocks; and improve capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns.
3. **Reduced emissions:** Pursue lower emissions for each calorie or kilogram of food produced, avoid deforestation from agriculture, and identify ways to store carbon.



A growing number of companies are concerned that the effects of climate change will disrupt their supply chains and their ability to grow sustainably and profitably. In addition, more companies are making commitments to reduce their impact on the environment by, for example, integrating climate-smart agriculture into their business models, or pledging to use only renewable energy. Agriculture input providers are developing innovative technologies to increase production efficiency, resilience, and yield. These technologies include precision agriculture (such as use of drones, soil testing, sensors, efficient irrigation, and GPS-enabled machinery) as well as improved animal nutrition and breeding methods. Companies are also becoming more fully integrated with local farmers by providing advice and solutions rather than inputs only. In addition, some investors and large commercial banks are beginning to establish strict criteria on what they can invest in.¹⁴⁵

EFFICIENT ANIMAL PROTEIN

Livestock consumes a large and growing volume of global natural resources. The world's 20 billion farm animals graze on roughly 30 percent of all terrestrial land, and one-third of cropland is devoted to producing animal feed. Roughly one-third of the world's freshwater resources are used for livestock production and processing. Global meat consumption has doubled over the past 40 years, and further growth in meat and dairy consumption is expected as incomes rise and urbanization accelerates, especially in developing regions.¹⁴⁶

Methane from digestion is the main source of emissions from livestock, and is especially high in developing countries. Emissions are influenced by the quality of feed as well as the age and weight of livestock at slaughter. These differences lead to a vast range of emissions between regions. South Asian beef produces ten times more methane than Eastern European beef on average, and methane emissions from milk production in Sub-Saharan Africa are about ten times larger than in Western European milk production, according to the Food and Agriculture Organization.¹⁴⁷

Improving animal productivity and health can reduce emissions while creating attractive investment opportunities. The projected surge in demand for meat in emerging markets creates opportunities for

IFC's approach to climate-smart agriculture

IFC provides investments and advice that contribute to the three pillars of climate-smart agriculture. It has identified the following focus areas:

- Helping animal protein producers to increase their productivity (reduce greenhouse-gas emissions per kilogram of meat or liter of milk) through a wide range of measures, including manure management, improved nutrition and animal health, better genetics, and other feed-to-food conversion efficiencies in livestock and aquaculture.
- Precision agriculture through integrated agriculture input suppliers (reduce greenhouse gases per unit of land or food produced) as a platform to promote precision farming technologies (such as soil testing, water solutions, appropriate use of fertilizers, and pest control) and financing to increase farmers' productivity and resilience.
- Helping producers, traders, and processors to reduce post-harvest waste and losses of food by, for example, optimizing food transport logistics and developing cold chain and storage infrastructure (including green or EDGE-certified warehouses).

www.ifc.org/climatebusiness



Kingenta: An integrated solutions provider

In 2015, China indicated that it is targeting “zero growth” in consumption of nitrogen and phosphate fertilizers by 2020. In response, Kingenta, a leading producer of nitrogenous and specialty fertilizer in China, started transforming its business model from a pure manufacturer of fertilizer to an integrated solutions provider that supports farmers with high-quality and locally tailored fertilizers, and advice.

IFC is investing \$200 million to help Kingenta implement a \$1 billion program that will upgrade 10 conventional single-nutrient fertilizer plants to produce higher efficiency/specialty fertilizers and establish a platform of 300 crop-production service centers across eight Chinese provinces. These service centers will provide agronomic services and farmer training, as well as increase the adoption of soil testing and precision farming practices,

thereby improving crop productivity and reducing input waste. These investments will help promote appropriate use of fertilizer to mitigate nitrogen and phosphate overuse, reducing related impacts on soil quality, groundwater, and greenhouse-gas emissions.

The project expects to increase crop productivity across 3.8 million hectares of land farmed by 3 million farmer families. Yields are expected to improve by between 10 percent and 40 percent as farmers gain direct access to quality inputs, training, and climate-smart farming practices. In addition, these investments may reduce 377,000 tons of equivalent carbon dioxide per year through appropriate fertilizer.

www.ifc.org

companies in meat production and supporting industries such as livestock, feed, and vaccines. Making feed conversion more efficient and climate-smart, so that animals produce more meat while consuming the same amount of feed, is a profitable opportunity for companies that specialize in genetics, feeding, fertility, and farm management.

INCREASING FOOD PRODUCTIVITY

Depleting natural resources, climate change, and reduced agricultural productivity are negatively affecting growth in the global food supply. For example, by 2030, the gap between anticipated water withdrawals and existing supply may reach 40 percent.¹⁴⁸ This puts pressure on governments and business to innovate, by expanding to new locations and applying tools and practices that lead to “precision agriculture.”

Emissions from agricultural soils have been growing rapidly, particularly in developing countries. Manure is a valuable agricultural input, especially in developing countries, where the cost of synthetic fertilizers is relatively high. Spreading manure on cropland helps to increase soil fertility and stabilization, increase water retention capacity, reduce erosion, and increase microbial density. However, manure also contributes to greenhouse-gas emissions: methane is produced when manure is stored, and nitrous oxide is released when manure is spread on croplands. Strategies to reduce emissions from manure include capturing and using methane as biogas, and preventing methane-producing conditions. Sealing manure and collecting and burning methane for heat or electricity is another effective option. Composting manure also reduces greenhouse-gas emissions.¹⁴⁹

Fertilizer has significantly increased agricultural productivity and helped reduce the pressure on forests, but over-application of fertilizer is wasteful, polluting, and emissions-intensive. Fertilizer demand was roughly 187 million metric tons in 2016, up by 30 million metric tons from 20 years ago, and is projected to grow at about 1 percent per year to 2030.^{150,151} Appropriate application of fertilizer leads to improved yields, especially on irrigated land. But over-application results in excessive greenhouse-gas emissions and other environmental consequences like eutrophication, where water runoff from fields causes an excessive build-up of nutrients in water bodies, leading to dense plant

growth and depleted oxygen levels. The likely explanations for excessive use of fertilizer include a lack of knowledge and training, subsidized fertilizer prices, and poverty-driven risk aversion.

Precision agriculture aims to improve productivity and address emissions from fertilizer and energy use by observing, measuring, and responding to site-specific conditions. It may involve:

- **Precision application of fertilizers** (for example, using data from sensors, soil tests, and satellite measurements to inform which type, how much and where fertilizer should be applied).
- **Use of waste biomass for energy** (for example, rice husk gasification) and as cover crops.
- **Improved energy efficiency** (for example, reducing diesel use by tractors/pumps/equipment). Solar pumps, when combined with drip irrigation systems, offer a low-carbon way to access water. However, the uptake has been slow. To expand the use of solar pumps, the initial investment cost needs to be reduced and subsidies for electricity addressed.¹⁵²
- **Improved water efficiency** (through, for example, drip or precision irrigation, or laser leveling of soil). The adoption of modern micro-irrigation technologies like drip irrigation not only reduces the amount of water needed per unit of food produced, but also decreases a farm’s reliance on chemical fertilizers and facilitates low- or no-till farming.
- **Drought-, salt-, and heat-tolerant seeds** can help reduce the effects of climate change on farmers.

REDUCING FOOD LOSSES

Global food losses are enormous. The Food and Agriculture Organization estimates that about a third of all food that is grown is lost due to infestation, spoilage, waste, ineffective processing and transport, inefficient logistics, and consumer preferences/waste.¹⁵³ This is equal to 1.3 billion metric tons of wasted food, which results in emissions of more than 4 metric gigatons of equivalent carbon



Policies and practices to reduce post-harvest food loss

- Evaluate opportunities to reduce food waste along the value chain, taking into account infrastructure needs and bottlenecks and the need to invest in new storage facilities.
- Set a standard for reduction in food waste; establish targets and plans of action to achieve them.
- Provide appropriate technologies (such as storage containers and sealed bags).
- Introduce training programs for value chain actors for packaging, processing, post-harvest handling, and distribution.
- Raise consumer awareness via food labeling (sell by/use by dates) and introduce social awareness campaigns to promote consumer reduction in food waste.
- Provide incentives for investments in systems to redistribute food and reuse discarded food.
- Improve data collection and knowledge sharing on food waste among value chain actors.

Source: World Bank¹⁵⁴

dioxide—an amount greater than all countries, other than the United States and China, emit annually.¹⁵⁵

Improved transport and storage are greatly reducing food losses.¹⁵⁶ Reducing food waste in emerging markets is a large investment opportunity, particularly in logistics and transport. In China alone, the cold storage and transportation market generates \$12 billion to \$18 billion in revenues; this market is expected to grow by between 10 percent and 15 percent annually to meet the country’s expanding food demand.¹⁵⁷ Given that most food loss and waste in developing countries occurs during production and after it is harvested, the greatest potential for reduction is investment in infrastructure related to storage, transport, cold chains, and distribution, together with skills development.¹⁵⁸ Commercial farms are increasingly replacing traditional storage spaces made from locally available resources like mud bricks, wood, or straw with modern storage facilities, which tend to be illuminated, ventilated, and equipped with screens and moisture barriers.¹⁵⁹ Opportunities to extend food shelf life and improve packaging to reduce downstream waste also exist.

Investment in cold storage and warehouses is growing rapidly, driven by China and India. The total capacity of refrigerated warehouses was 600 million cubic meters in 2016, an increase of 8.6 percent since 2014. According to the Global Cold Chain Alliance, this was driven by considerable new construction in emerging markets, especially China (30 million cubic meters) and India (10 million cubic meters).¹⁶⁰ Globally, the cold chain market is projected to reach \$271 billion by 2022, with an annual growth rate of 7 percent.¹⁶¹ Technology advances in cold storage are helping to phase out hydrofluorocarbons—a potent greenhouse gas—and reduce energy consumption. Technology advances are also allowing use of cold storage in warmer climates.¹⁶²

FIGURE 7: Steps to create markets for climate-smart agriculture



Kenya: Integrating climate change into agricultural sector planning

Several lessons can be drawn from Kenya's mainstreaming of climate change into its national planning and development strategies during a 2012 update to its National Development Plan. It used the most up-to-date socioeconomic, geographic, and climatological information to assess risks and vulnerabilities to develop mitigation and adaptation scenarios. "Champions" were identified in key ministries, including the Ministry of Planning, the Ministry of Energy, and the Ministry of Environment. A cost-benefit analysis and other tools were used to prioritize actions, and existing initiatives were reviewed to determine how they could incorporate climate considerations. This built on practitioners' familiarity with the subject matter and minimized learning costs. It also framed climate change as a cross-cutting issue, rather than exclusively an environmental one, which built a constituency of support for climate-smart activities. Finally, it monitored results and outcomes so that lessons could be used when new opportunities for climate mainstreaming arose. The result was a more integrated approach to mitigation and adaptation, which may serve as a model for other countries.

Source: McFetridge & Murphy, 2012; Mitchell & Maxwell, 2010¹⁶³

3.3 Creating markets for climate-smart agriculture

The majority of agricultural investments are not yet climate-smart, and data on private investments in agriculture and information on their sustainability are lacking.¹⁶⁴ Accelerating investment in climate-smart agriculture will require agreement across government, the private sector, farmers' groups, and agricultural scientists. National policies create enabling conditions for agricultural investment. Key policy actions include removing inefficient public subsidies and food pricing programs; establishing rural credit, land tenure rules, and property rights; supporting research and extension services; offering innovative financing models like warehouse receipts; and fostering new insurance models like weather-based crop (index) insurance.

STEP 1: MAINSTREAM CLIMATE-SMART AGRICULTURE INTO NATIONAL POLICIES AND SECTOR DEVELOPMENT PLANS.

This requires engaging ministries of finance, planning and energy to work with their agricultural and environmental counterparts. The NDCs provide an important platform for integrating climate change into agricultural sector planning. The commitments made in NDCs can promote climate-compatible development and reduce poverty in the agriculture sector. They can also provide an opportunity for groups of countries to develop regional climate-smart policies, recognizing the common challenges that they face.

Different levels of government will need to play distinctive roles to roll out climate-smart agriculture investments. While the national government usually serves as regulator, funder, and provider of scientific information, local governments need to help promote climate-smart agriculture by mobilizing and supporting farmers and adapting regulations to align with local circumstances. Setting up learning platforms and extension programs—rather than ad hoc consultations—is important for delivering and refining climate-smart programs over time.¹⁶⁵

Enabling factors that encourage climate-smart agriculture include secure land/property rights, good transport infrastructure, regulations and fiscal

policies that incentivize climate-smart investment, adoption of food laws and standards that allow for export, and agricultural extension practices to train farmers on climate-smart methods.

STEP 2: ADDRESS INEFFICIENT GOVERNMENT PRICE AND SUBSIDY REGIMES.

Governments often maintain prices through subsidies for inputs such as fertilizer, energy, water, and seeds. The Food and Agriculture Organization recommends that price support and energy subsidies recognize and reward climate-smart practices, and enable value addition, commercialization, and trade. For example, input subsidies designed to support a more efficient and timely use of fertilizers.¹⁶⁶ Fertilizer subsidies can be climate-smart if they increase yield and enhance plant growth and the storing of carbon in the soil. However, to ensure precision fertilizer application, the price support should be accompanied by training and improved access to reliable information on rainfall.¹⁶⁷ Subsidizing energy use in farms may lead to negative climate impacts, by contributing to overuse of water in water-scarce areas. Inadequate water regulation and pricing lead to water waste, contributing to drainage and salinity problems in irrigation-dependent countries. These issues can be addressed through water pricing (where appropriate), support for technologies, and awareness raising.¹⁶⁸

STEP 3: DEVELOP A FOCUSED AGRICULTURAL SECTOR DEVELOPMENT PLAN THAT ADDRESSES INFRASTRUCTURE.

In many countries, poor infrastructure limits investment in climate-smart agriculture.¹⁶⁹ Governments can address this obstacle by concentrating investment on infrastructure in a “breadbasket” region (a major cereal-producing region), or in a particular infrastructure corridor. Mali, for example, is considering a pilot breadbasket program for its Sikasso region. The initiative aims to raise cereal production by 60 percent through a combination of yield increases and limited expansion onto new land. There will also be strong support for export development, new roads and warehouses, and measures for climate mitigation and adaptation (such as water harvesting and locally adapted drought-



Uruguay: More efficient agriculture production at a rapid pace

Uruguay has long been at the forefront of managing and conserving natural resources, particularly soils. Uruguayan producers, supported by public policies and research, use many climate-smart practices. For dairy production, the majority of practices are focused on water distribution throughout the property and the use of supplementary irrigation in strategic areas of the dairy farm (on about 10 percent of the total area). In the case of rain-fed agriculture (soybean, maize, wheat), given that more than 70 percent of the area is cultivated by medium and large companies, climate-smart practices such as direct seeding and land-use management plans have higher levels of adoption. Integrated crop management is the most common climate-smart practice for intensive vegetable production (citrus, deciduous plants, horticulture). It includes techniques for soil, pests, and disease management that help stabilize and/or increase production and reduce use of agrochemicals.

Source: World Bank¹⁷⁰

resistant seed).^{171,172} Another approach is an agricultural development corridor, in which commercial farms and facilities for storage and processing are concentrated around a major infrastructure project.¹⁷³

Agriculture depends heavily on infrastructure: road, rail, ports, equipment, and buildings. However, any infrastructure investment needs to be made climate-resilient. To reduce the impact of extreme weather events on infrastructure, governments have successfully developed preventative actions and instruments tailored to the region. This includes long-term plans that consider the redesign, relocation, and rebuilding of major agricultural transportation routes, while landscape planning considers integrating irrigation systems with natural wetlands and waterways that act as buffers against climate shocks.¹⁷⁴

STEP 4: PROMOTE OUTREACH, TRAINING, AND CENTERS OF EXCELLENCE.

Establish agribusiness centers to provide farmers with appropriate technologies, training, and information. These centers of excellence can be part of existing government agriculture extension services, or new entities established to help farmers to learn practices from one another, and can also create economies of scale by aggregating, for example, collection and storage from multiple farms. They also allow for the rapid spread of new ideas, technologies, and business models related to climate-smart agriculture. The centers can partner with financial institutions to offer farmers inventory credit. In addition, governments can facilitate climate information services—often via mobile phones—to help smallholder farmers and agribusiness better manage weather variability, particularly rainfall changes. To foster improved on-farm weather monitoring and reduce risk, governments can provide timely weather information.

Governments are attracting investment in climate-smart agriculture by engaging the private sector through partnerships and outreach efforts. Private sector groups to be consulted include smallholder farmers, input suppliers, warehouse operators, buyers, traders, and international trading companies. In addition, domestic financial institutions can be educated on the business models for climate-smart agriculture to identify opportunities to increase investment. Dealers and other

middlemen perform important roles in linking small-scale farmers to markets or providing inputs appropriate for local crop and soil conditions. Governments and donors rarely have the local knowledge or capacity for these jobs. International trading companies can contribute technologies and management skills, while also buying commodities.

INNOVATIVE FINANCING MODELS

Access to sufficient financing is vital to create markets for climate-smart agriculture, as farmers often do not have access to credit because financial institutions see them as high risk. Implementing climate-smart agriculture often involves upfront investments that take time to result in productivity gains, and market premiums for sustainable produce rarely provide sufficient margins to fund climate-smart programs.¹⁷⁵

Improved access to long-term finance is especially important in tree crop cultivation, where replacing older trees with newer, higher-yield varieties may lead to short-term revenue losses. A range of publicly supported incentives, regulations, extension programs, and market access can unlock investment.

International investors also have concerns about foreign exchange rate risk when considering agribusiness investments in emerging markets. The Climate Finance Lab is piloting the Long-Term Foreign Exchange Risk Management instrument, which will provide tools to address currency and interest rate risk for climate-smart agriculture projects in developing countries.¹⁷⁶

Warehouse receipts systems—whereby inventory credits can be written for inventory or products held in storage—are an effective way to enhance agricultural livelihoods and reduce post-harvest losses. When backed by appropriate policy frameworks,¹⁷⁷ they allow stored produce to be used as collateral, and inventory credits can then be sold, traded, and used as financial instruments. This mobilizes credit to farmers, smooths out market prices, increases the market power of farmers (who can sell produce when they want), reduces agricultural risk, and reduces post-harvest losses as farmers seek out better storage conditions.¹⁷⁸ IFC's Global Warehouse Finance Program is extending this concept (Box 20).

Governments creating positive environments for investment in climate-smart agriculture¹⁷⁹

MOROCCO'S PLAN VERT

Morocco's Green Plan ("Plan Vert") is an integrated approach to providing incentives for climate-smart agriculture. It takes a dual approach to addressing water scarcity in its river basins. In irrigated areas, Plan Vert provides incentives for improving water management and conservation and for integrating national value chains with international markets. In rain-fed areas, it increases access to social services and supports participatory natural resource management initiatives. It also supports replacing arable crops with more drought-tolerant ones such as olive trees. Plan Vert is implemented through a range of policy measures, and it receives support for specific technical innovations.

COLOMBIA

Colombia has focused on integrated landscape planning within a broader strategy for sustainable agriculture and forestry. A mix of policies and incentives has resulted in sustainable increases in livestock productivity by encouraging landscape-based mixed agriculture/forestry systems. The objective is to introduce trees and improved pasture in livestock grazing lands. This improves fodder and shade, lowers heat stress for animals, and reduces soil degradation. Results have included increased meat and milk yields, improved water infiltration, increased bird populations, reduced methane emissions, and greater capture of carbon dioxide.

ZAMBIA

The Zambian government provides technological advice to farmers, supplemented by modest support for producers to help them overcome the upfront costs of moving to sustainable land management practices in cropping and livestock. Five climate-smart techniques are being used: retaining crop residues; concentrating tillage and fertilizer application in a permanent grid of planting basins or series of planting rows; completing land preparation in the dry season; weeding aggressively to reduce plant competition; and intercropping/rotating nitrogen-fixing legumes on 30 percent of the cultivated area. While these practices are delivering significant benefits, barriers continue to prevent adoption—pointing to the continued need for training and institutions.



Climate finance innovations can also contribute to investment. Countries are working with international financial institutions and donors to explore how financiers in developing countries can partner with climate finance investors to further their investments in climate-smart agriculture. They are experimenting with blended finance (concessional or below market rates), innovative risk management tools (including credit scoring and the use of artificial intelligence), first loss and partial risk guarantees, new investment vehicles that meet the risk-return profile of different investors, and bonds.¹⁸⁰ These efforts are helping to connect food companies, climate finance investors, and governments with domestic and international financial institutions, as many farmers and agribusinesses are willing to adopt new practices and technologies but lack the necessary capital to do so.

Index-based insurance supports climate-smart agriculture by protecting lenders and providers of agricultural outreach products against weather events. Index-based, or parametric, insurance uses an independently developed index, typically weather-related for agricultural application, to predetermine payouts for clearly defined hazards. This ensures that claims are paid out quickly. Domestic policy is often needed to facilitate this type of insurance; governments can help by regulating index insurance under domestic law and supporting the needed data infrastructure (see Box 20).

Enabling access to finance for farmers

THE GLOBAL WAREHOUSE FINANCE PROGRAM HELPS FARMERS IN AFRICA

In 2017, IFC, together with the Global Agriculture and Food Security Program, invested \$5 million in risk-sharing facilities with partner banks in Rwanda and Tanzania to finance farmer cooperatives. The money enables farmers to buy higher-quality agricultural inputs, produce food crops, and provide working capital for the aggregation and storage of harvested crops during the post-harvest period.

The World Food Program arranges input supplies (including seeds, fertilizer, and crop protection) and crop insurance. IFC is also providing advice to farmers in partnership with World Food Program partners, including the Alliance for a Green Revolution in Africa. The project aims to benefit more than 65,000 local smallholder farmers to increase their productivity through practices that contribute to climate-smart agriculture. More importantly, through this initiative, IFC will be helping farmers access markets through the offtake contracts from the World Food Program and other platform partners.

An early success has been in Burkina Faso. The agricultural sector employs 80 percent of Burkina Faso's active population, with cotton being the most important crop. The sector is being negatively affected by climate change, including higher average temperatures, more severe dry seasons, and increased frequency of crop diseases. Recognizing this, the government prioritized climate-smart practices in its NDC. IFC and the World Food Program have helped farmers to access finance to increase production while conserving land by using rain-fed water storage and climate-smart irrigation techniques, which are expected to raise yields by up to 30 percent. The investment will also avoid production losses through more efficient collection and storage. The project will result in a sustainable, more resilient supply of cotton to SOFITEX, the country's largest producer.

THE GLOBAL INDEX INSURANCE FACILITY

The Global Index Insurance Facility (GIIF) is a dedicated World Bank Group's program that facilitates access to finance for smallholder farmers, micro-entrepreneurs, and microfinance institutions

by providing catastrophic risk transfer solutions and index-based insurance in developing countries. It has facilitated more than 1.5 million contracts, with \$151 million in sums insured, covering about 6 million people, primarily in Sub-Saharan Africa, Asia, and Latin America and the Caribbean.

Providing access to finance for the vulnerable, insurance is an important tool to address poverty. Unfortunately, agricultural insurance and disaster insurance are either unavailable or prohibitively expensive in many developing countries. Index insurance is an innovative approach to insurance provision that pays out benefits on the basis of a predetermined index or loss of assets and investments resulting from weather and catastrophic events, without requiring the traditional services of insurance claims assessors. It also allows for the claims settlement process to be quicker and more objective. Funded by the European Union, Germany, Japan, and the Netherlands, the Global Index Insurance Facility is managed by the World Bank Group as part of the Finance & Markets Global Practice.

www.ifc.org

3.4 Initiatives, tools, and resources



The **Food and Agriculture Organization (FAO)** is a specialized agency of the United Nations that leads international efforts to defeat hunger. Climate-smart agriculture is one of the 11 corporate areas for resource mobilization under the FAO's strategic objectives; as such, FAO offers a variety of outlooks, data, and policy tools to countries seeking to advance solutions.

www.fao.org



CGIAR is a strategic alliance of countries, international and regional organizations and private foundations that was established in 1971 to disseminate the knowledge of agricultural science to benefit developing countries. Its Research Program on Climate Change Agriculture and Food Security addresses the increasing challenge of global warming and declining food security on agricultural practices, policies and measures.

www.cgiar.org



The **Global Alliance For Climate-Smart Agriculture (GACSA)** is an inclusive, voluntary and action-oriented multi-stakeholder platform on CSA hosted by the FAO.

www.fao.org/gacsa/en/



The **International Food Policy Research Institute (IFPRI)** is an international agricultural research center founded to improve the understanding of national agricultural and food policies to promote the adoption of innovations in agricultural technology.

www.ifpri.org



The **International Fund for Agriculture Development (IFAD)** is an international financial institution and a specialized agency of the United Nations dedicated to eradicating poverty and hunger in the rural areas of the developing world.

www.ifad.org



The **World Food Programme** is the food-assistance branch of the United Nations and the world's largest humanitarian organization addressing hunger and promoting food security.

www.wfp.org



The **Adaptation of African Agriculture (AAA)** was started upstream of COP22 and aims to reduce the vulnerability of Africa and its agriculture to climate change.

www.aaainitiative.org



The World Business Council for Sustainable Development's **Low Carbon Technology Partnerships initiative (LCTPi)** is a joint public and private initiative to accelerate low-carbon technology development. CSA is one of the solutions that the WBCSD and its member companies have identified as critical to reach climate stabilization.

www.lcpti.wbcsd.org



Champions 12.3 is a coalition of executives from governments, businesses, international organizations, research institutions, farmer groups, and civil society dedicated to inspiring ambition, mobilizing action, and accelerating progress toward achieving Sustainable Development Goal Target 12.3 by 2030.

<https://champions123.org>



The **Climate-Smart Agriculture 101 guide** provides a comprehensive set of recommendations, tools, and resources to help countries implement climate-smart agriculture.

<https://csa.guide>



The **World Bank Group** has developed a series of country-specific profiles and tools to advance climate-smart agriculture.

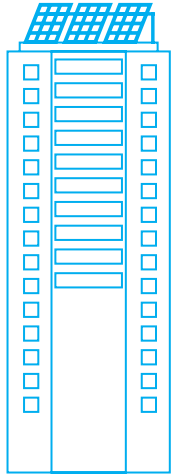
<http://www.worldbank.org/en/topic/climate-smart-agriculture>



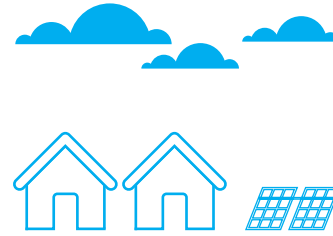
The **Global Cold Chain Alliance** represents all major industries engaged in temperature-controlled logistics, and works to reduce food waste and loss throughout the value chain.

www.gcca.org

Key indicators



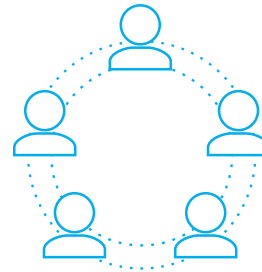
Green buildings investment was **\$388 billion** in 2015, and green buildings are at least a 3.4 trillion opportunity through 2025.



Building energy efficiency needs an **additional \$296 billion a year** to meet climate targets; the biggest opportunities are in developing countries.



ESCO markets were **\$24 billion globally** in 2015.



86 countries target energy-efficient buildings in their NDCs.





Green Buildings

4.1 Summary

Urbanization presents a large opportunity for green buildings. Today's buildings generate 19 percent of energy-related greenhouse-gas emissions and consume 40 percent of electricity globally.¹⁸¹ By 2050, the built environment is expected to double¹⁸² due to high population growth and urbanization trends. Most of this growth will occur in emerging markets, particularly in middle-income countries. The adoption of resource-efficient “green” building practices offers a chance to secure emission cuts at a low cost and lock in energy and water savings for decades.

Most of the growth in the global building market is expected to come from developing countries, driven by growing populations, urbanization, and increased incomes.¹⁸³ The rapid growth in construction in these countries, along with the urgency of mitigating climate change, makes green buildings an important solution. In 2015, investment in green buildings was mainly in Organisation for Economic Co-operation and Development (OECD) countries—70 percent in the G7 countries alone. But the building market is also growing in China and India, accounting for 19 percent and 2 percent of investment in green buildings respectively.

IFC sees a \$3.4 trillion green buildings investment opportunity through 2025 in key emerging markets, driven by policies, technology advances and increased awareness. Total investment in energy-efficient buildings

in 2016 reached \$406 billion, with an incremental investment of \$133 billion, a 12 percent increase from 2015.¹⁸⁴

Countries and cities must map out their own pathways. Understanding the local context is essential for identifying the appropriate policies, such as improving building design, to create a market for green buildings.

A blend of regulatory, financial and voluntary interventions will address risks and support greater investment. Voluntary green building rating systems have paved the way for mandatory regulations by increasing awareness among professionals, consumers, and policymakers. Examples from around the world show that financial incentives (such as low interest rate loans, tax reductions, and subsidies) and non-financial incentives (such as expedited permitting and green certification) are having a positive effect. These positive results can be reinforced by governments enforcing building codes, embedding energy-efficiency practices, and mandatory benchmarking of energy use. Businesses are responding with new business models, such as green mortgages and energy service companies (ESCOs). As countries implement the buildings and demand-side efficiency targets in their NDCs, they can address some of these issues (Table 4).

4.2 Market snapshot and growth potential

Resource-efficient building practices are helping economies move onto a greener development path. Green building is the practice of creating and using more resource-efficient and environmentally friendly models

TABLE 4: NUMBER OF COUNTRIES WITH SUBSECTOR INCLUDED IN THEIR NDC

Region	Buildings	Demand-side efficiency: Buildings
East Asia and Pacific	11	3
Europe and Central Asia	8	2
Latin America and Caribbean	9	6
Middle East and North Africa	10	7
North America	1	0
South Asia	3	2
Sub-Saharan Africa	11	13
Total	53	33

(Source: World Bank, INDC Database; see indc.worldbank.org)

of construction, renovation, operation, maintenance, and demolition. Green construction offers a chance to secure emission cuts at a low cost and lock in energy and water savings for decades. While environmental pressures are compelling reasons to build responsibly, green buildings create additional benefits. Operational savings quickly recover capital costs; renewable energies reduce infrastructure investment; innovative products stimulate job creation; and reduced reliance on fossil fuels leads to energy security.

About \$388 billion of the \$4.6 trillion spent on construction was invested in green buildings in 2015. Global investment in energy-efficient buildings in 2015 was \$118 billion, up 9 percent from the previous year.¹⁸⁵ Most of this investment was in developed countries, as well as in China and India, which accounted for 19 percent and 2 percent respectively.¹⁸⁶

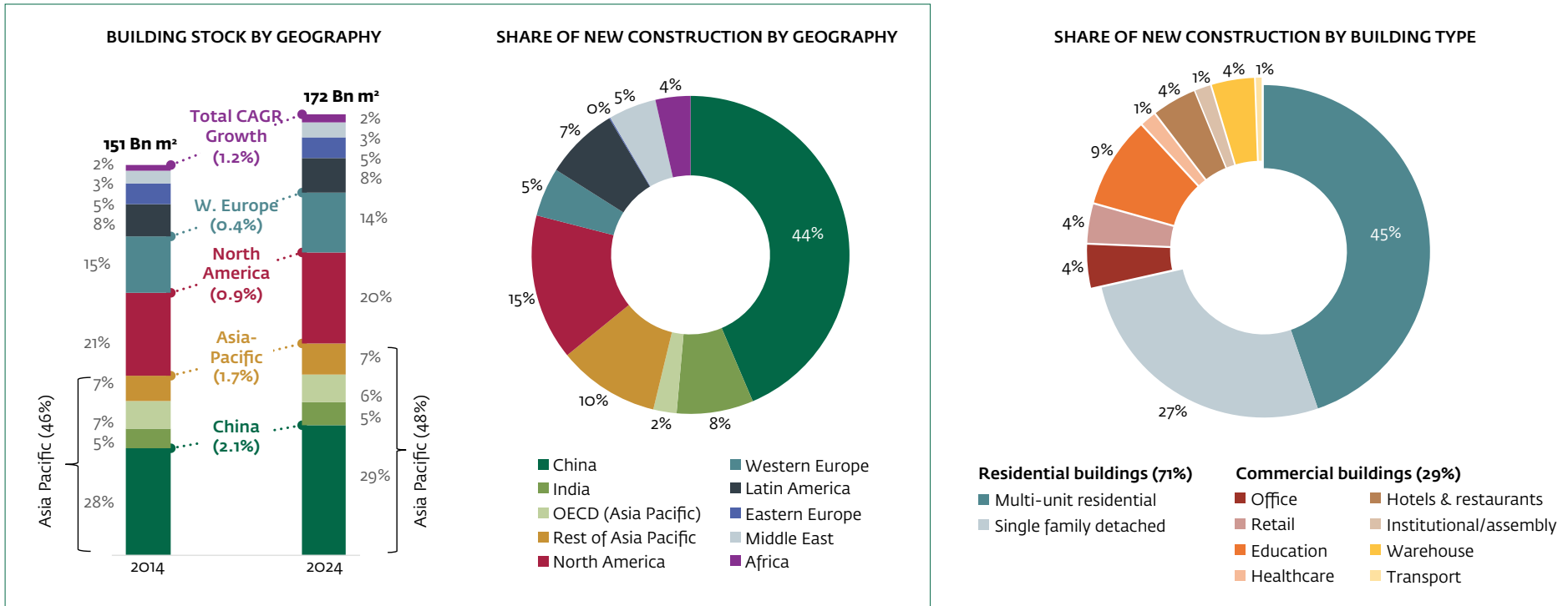
Markets for constructing buildings are expected to grow fastest in the Asia-Pacific region, led by China. Figure 8 shows the expected growth

in building stock between 2014 and 2024; with China at over 40 percent of new buildings, followed by India at 8 percent. This creates an opportunity to create new markets for green buildings, driven by the increased uptake of green practices, standards and technologies in new construction. Among building types, the residential sector shows highest growth potential—this means that market creation efforts will need to be tailored, given that codes and standards are easier to apply to commercial buildings than more dispersed, smaller players in the residential construction market.

MARKET OPPORTUNITIES FOR GREEN BUILDINGS

Expected growth in emerging markets creates a large opportunity for green buildings. The sector is expected to grow at 1.2 percent annually, and most of this growth is expected in residential buildings in developing countries, particularly in Asia.¹⁸⁷ IFC's EDGE Program (See Box 21) recently analyzed green buildings market growth and found a

FIGURE 8: Medium-term market outlook for the building sector



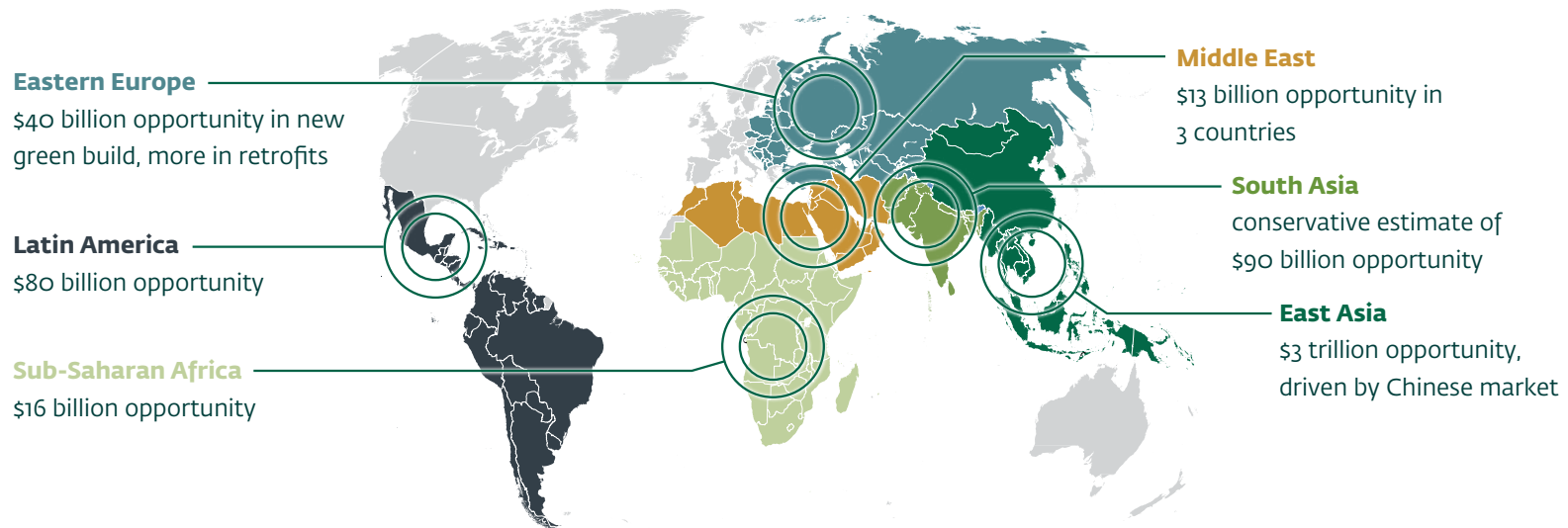
Note: CAGR = compound annual growth rate

(Source: Navigant Research (2015), Global Building Stock Database (Square Meters)⁸⁸

\$3.4 trillion investment opportunity through 2025 in 36 countries (see Figure 9).¹⁸⁹ Regional highlights include:

- In Latin America, green buildings markets are established in Brazil, and are taking off in Argentina and Colombia, leading to a forecast of \$80 billion in green buildings opportunities through 2025, with \$70 billion in residential and \$10 billion in commercial construction.
- In Eastern Europe, there is a contraction of the building stock, so IFC’s analysis focused only on new buildings. Projected markets for new green construction are at \$42 billion through 2025, with \$13 billion for commercial and \$28 billion for residential buildings.
- In the Middle East and North Africa, IFC found \$13 billion in opportunity in Egypt, Jordan and Morocco, split between the commercial (\$2 billion) and residential sector (\$11 billion).
- The rest of Africa is expected to see high construction growth, particularly in residential buildings. While the green buildings market is nascent, South Africa, Kenya, and Ghana are establishing sizeable markets. For the region, IFC found \$4 billion in commercial green buildings potential and \$13 billion in residential sector opportunities, for a total of \$17 billion.
- South Asia is dominated by India, which is experiencing very high construction rates. IFC conservatively estimates a \$12 billion commercial market and a \$76 billion residential market through 2025.
- East Asia will be dominated by China, which is seeing high construction growth as well as ambitious green building policies. The total regional investment opportunity is over \$3 trillion through

FIGURE 9: Emerging market green buildings potential



(Source: IFC's EDGE Program¹⁹⁰; Map: World Bank)

2025, split between \$726 billion for commercial and \$2.4 trillion for residential buildings.

Building envelopes make up the largest share of investments in green buildings. They constitute the physical barrier between the interior and exterior of the building, where energy-efficient insulation, reflective coatings, windows, and doors can improve performance. Several cost-effective low-tech solutions and clever architectural designs are becoming increasingly popular. Examples include natural ventilation, which reduces reliance on mechanical ventilation, and increased indoor vegetation, which cools the building while reducing its carbon footprint. In developing countries, the biggest opportunity is in new buildings with green envelopes.¹⁹¹

Falling prices of technologies like LED have resulted in a rise in energy-saving lighting, but the market remains largely untapped. The

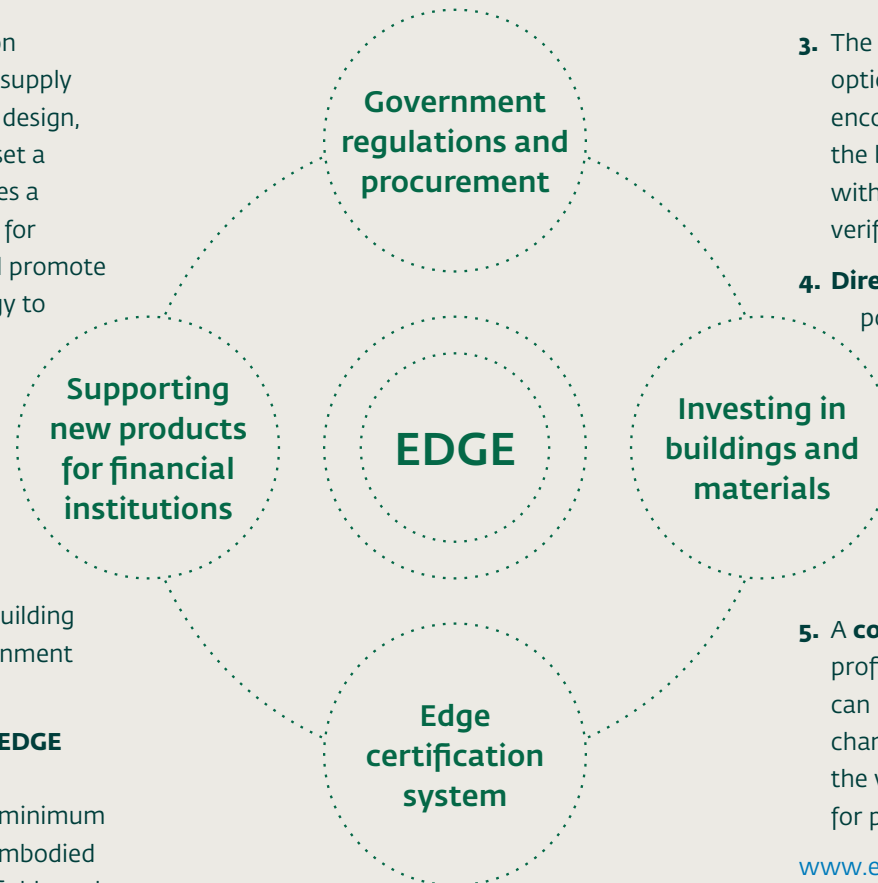
International Energy Agency estimates that only 1 percent of the potential energy savings have been achieved in lighting.¹⁹² The United Nations Environment Programme estimates that there were still 7 billion incandescent lights in use in 2016, providing huge growth potential for energy-efficient lighting. Growing penetration of LEDs will continue to reduce unit costs.

Energy-efficient heating, ventilation, and air conditioning are a \$76 billion global market. This amounted to nearly 28 percent of total investment in energy-efficient buildings in 2015, with incremental investment of \$27 billion.¹⁹³ Demand in emerging markets for cooling is growing rapidly from a small base: in India, for example, around 5 percent of homes have air conditioning.¹⁹⁴ District cooling¹⁹⁵ is emerging as a way to provide centralized cooling to a large population, saving energy, reducing costs, and improving efficiency.

Green buildings market creation: A priority for IFC and the World Bank Group

IFC's Green Buildings Market Transformation Program helps to create a virtuous cycle of supply and demand for resource-efficient building design, construction and ownership. The aim is to set a metrics-driven definition of what constitutes a green building, reward property developers for building green, increase regulatory pull, and promote direct investment. Following is IFC's strategy to promote green building growth:

1. **An enabling environment** of supportive government policies that raises the bar through increasingly greener building codes. Governments can provide the right mix of incentives to the private sector and raise public awareness about the benefits of green building ownership. IFC offers expertise on government policy reform.
2. A metrics-driven definition through the **EDGE green building standard and scalable certification system** that focuses on a minimum achievement of less energy, water and embodied energy in materials. The standard is verifiable and leads to demonstrated reductions in utility costs.



3. The identification of low-cost, high-return design options through **easy-to-use software** that encourages architects and engineers to choose the best design practices and solutions, combined with a fast, inexpensive certification system to verify that the standard has been met.
4. **Direct investment** in IFC's own green buildings portfolio, **mobilization** through its banking partners, and support for **new product development** such as green mortgages, green bonds and green construction financing. EDGE can be used to streamline eligibility procedures and the reporting needs of financial institutions as they move towards green investment portfolios.
5. A **collection of evidence** that building green is profitable for all parties in the ecosystem. This can best be achieved through a network of global champions and certification entities who support the verification, rewarding and collection of data for proof of concept reporting.

www.edgebuildings.com

The energy efficiency of buildings could be improved by up to nearly 70 percent by enhancing building envelopes and using high-performance equipment.¹⁹⁶ This requires coordination between national and local policies and across the entire value chain in the building sector. Policy measures will need to be complemented by investment in research and development and innovative business models.

INNOVATIVE BUSINESS MODELS

ESCOs have emerged as a key business model for improving energy efficiency in buildings. ESCOs improve energy efficiency in buildings through energy-savings projects. They typically invest in energy-efficient technologies for commercial buildings and earn royalties on the energy savings without owning the building. Generally, the energy savings that their interventions generate are used to pay back their investment, with the ESCO bearing the risk if energy savings do not materialize. Royalties and ownership of the energy-efficient upgrades are negotiated using energy performance contracts.

ESCOs are particularly prominent in China, with Chinese ESCO revenues at \$13 billion, U.S. revenues at \$6 billion, and European Union revenues at \$3 billion in 2015. This made up the bulk of total global ESCO revenue, which totaled \$24 billion that year. ESCO revenues increased by 7 percent in both China and the United States in 2015. Income from energy performance contracts is exempt from tax for the first three years in China, which has increased the feasibility of ESCOs.¹⁹⁷ In 2015, the Indian government launched Energy Efficiency Service Limited, the largest public ESCO in the world, to initiate projects and help unlock the country's energy-efficiency market, estimated at between \$10 billion and \$35 billion.¹⁹⁸ The Una Jyoti by Affordable LEDs and Appliances for All program has been instrumental in the growth of India's LED market. As the ESCO market matures, the potential exists to expand such contracting and business models globally.



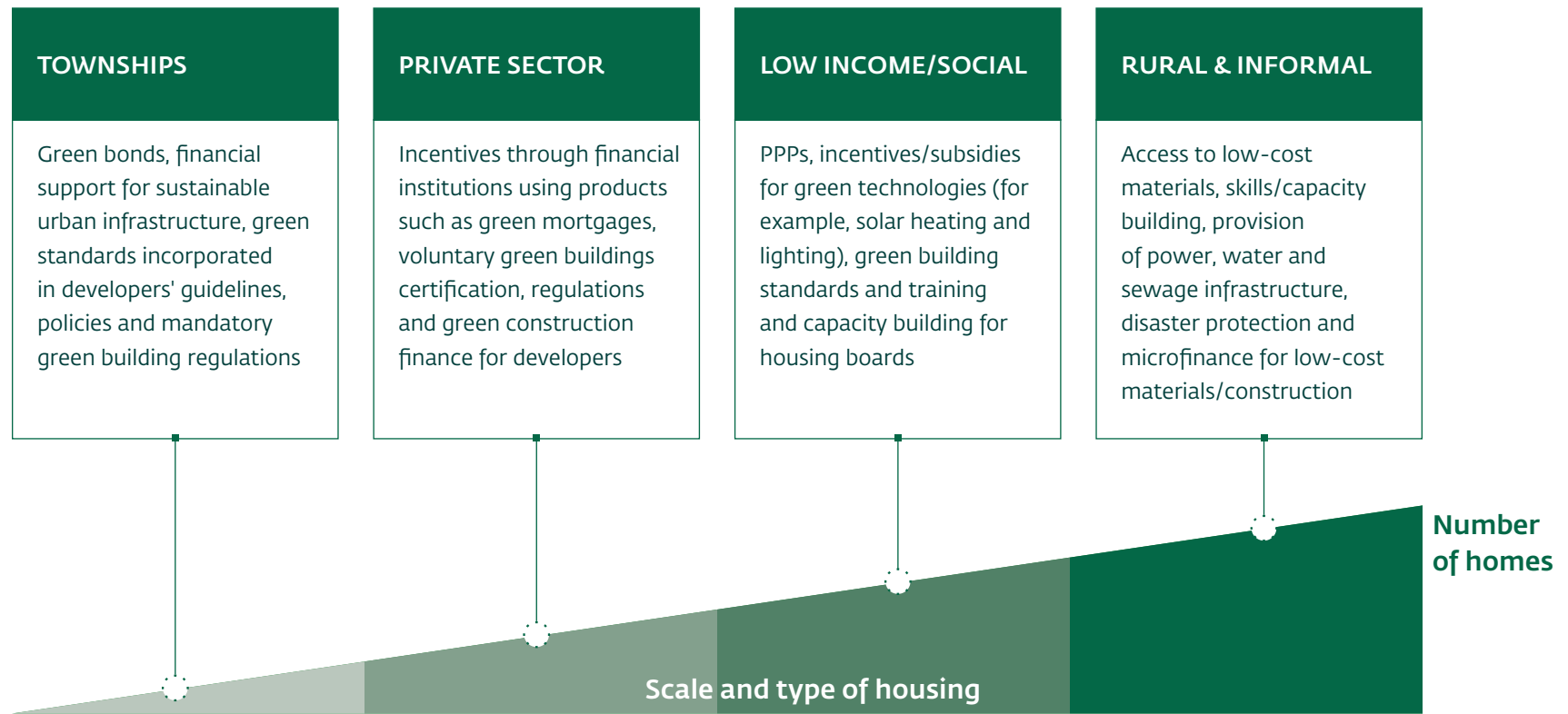
EDGE certification in Ghana: The Exchange Complex

Designed by Dar Al-Handasah and HOK Architects, The Exchange Complex was the first EDGE-certified hotel complex in Ghana. Located close to Kotoka International Airport, the project was financed and developed by UK development finance institution CDC and private equity fund Actis in partnership with Mabani Holdings. The 98,000 square-meter development is currently under construction, with an estimated completion date of July 2018.

The Exchange Complex features office and residential buildings, retail space and public outdoor space. The property includes an EDGE-certified Radisson Blu hotel, underscoring the commitment of brand owner Carlson Rezidor in promoting green buildings in Sub-Saharan Africa. More than 100 of the apartments in the complex will be EDGE-certified, with residents benefiting from a 28 percent reduction in monthly utility bills due to low-E coated glass, energy-saving lighting systems, low-flow plumbing fixtures and efficient air-conditioning systems.

www.edgebuildings.com

FIGURE 10: Interventions based on type of housing



(Source: IFC Analysis)

4.3 Creating markets for green buildings

A blend of regulatory, financial, and voluntary interventions will address barriers that prevent greater private investment in green buildings, including voluntary rating systems, building codes, tailored financial incentives and greater action by utilities.

IMPORTANCE OF LOCAL CONTEXT

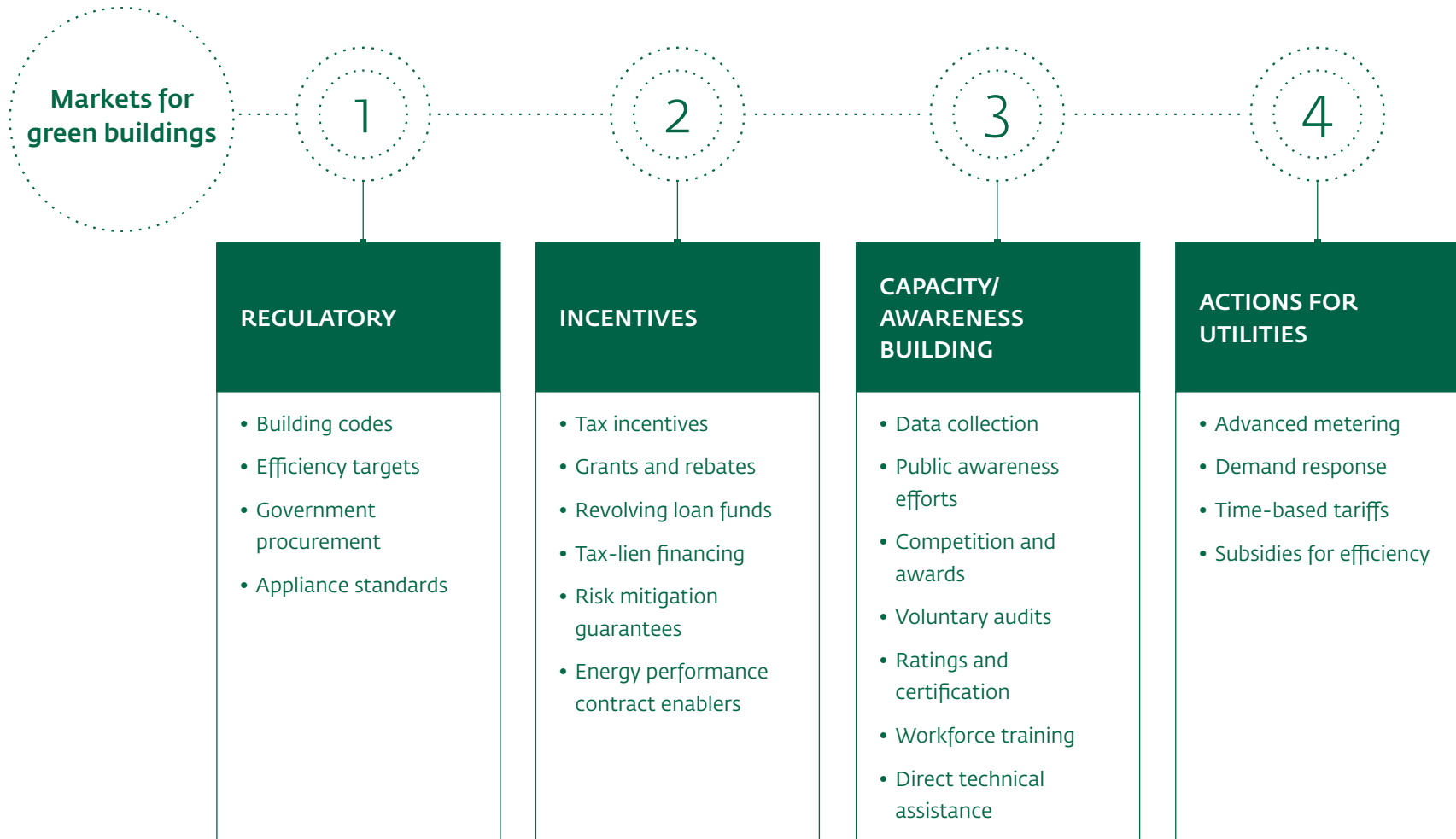
The segmented nature of the building sector has hindered the development of green buildings, especially in large developing countries.

The sector is segmented by income and building types, and the type of players, opportunities and technology, policy, and market instruments needed to construct green buildings are markedly different depending on the location and type of building. When creating a market, it is important to consider the different roles of the various stakeholders, including national and local government, utilities, and market players like builders and project developers.

Countries or cities can map out their own policy pathways.

Understanding the local context is essential for identifying the correct policies. For example, if the growth in new buildings is substantial, there

FIGURE 11: Creating a market for green buildings





IFC's role in developing Jakarta's building code

Indonesia is one of the world's largest greenhouse-gas emitters, with its building sector accounting for more than a quarter of the country's total energy use in 2004—and this share is expected to rise to nearly 40 percent in the next two decades. Jakarta's provincial government has set a target to reduce its greenhouse-gas emissions by 30 percent by 2020 and approached IFC to help it develop a green building code.

The code sets energy and water-efficiency requirements for large commercial and high-rise residential buildings. It applies to both new and existing buildings, but with different requirements. Compliance with the code is mandatory and integrated into the building permit application process for this particular property market segment.

Implementation of the code is expected to reduce energy consumption in large commercial and high-rise residential buildings by between 17 percent and 36 percent, potentially cutting about 2.7 million tonnes of equivalent carbon dioxide per year by 2020.

To soften the impact of the increased first cost, the government is considering financial and other incentives. IFC is also setting up investment facilities through other financial institutions to finance the construction of new buildings meeting or exceeding the green building code requirements. These facilities could finance construction loans for developers as well as "green mortgages" for buyers.

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is greater room for policies on making new buildings green as opposed to policies on retrofitting. Central mandates such as building codes may be effective for offices and urban townships, but are likely to be expensive and ineffective for informal housing, where local solutions could be implemented. Identifying simple, low-cost measures to promote green building, such as improving the design of building envelopes, could be a cost-effective way to encourage growth in the market.

Policy and market interventions should be targeted to the local situation and reflect input from key stakeholders. Opportunities to increase “green” elements exist at each stage of a building’s life. Policies play an important role in aligning various stakeholders’ interests.

STEP 1: DEVELOP REGULATORY TOOLS.

Regulatory tools can be a mixture of building codes, efficiency improvement targets, and minimum energy performance standards for lighting and appliances.

Building codes can be an effective way to increase a building’s energy efficiency.¹⁹⁹ Codes and standards can set minimum thresholds for energy performance for new or existing buildings. These often require certification or have equivalent standards to certification programs. For example, the European Union will require that all new buildings be nearly zero energy from 2021 onwards.²⁰⁰ In India, the adoption of building energy codes is increasing, with 23 of 36 Indian states and territories having either adopted (or are in the process of adopting) the country’s Energy Conservation Building Code.²⁰¹ Building codes can be implemented both at the national and subnational level, can be mandatory or voluntary, and must be tailored to local conditions. The national or provincial government usually sets the code, while local governments are responsible for adapting and implementing them.

Minimum energy performance standards can shift producer and consumer behavior towards energy-efficient technologies. Lighting is a relatively simple product that makes up a large share of energy use, and so is often one of the first technologies targeted, with several countries, including Brazil, the Philippines, and Venezuela, aiming to phase out incandescent lightbulbs.^{202,203,204} By 2012, 33 countries had lighting

policies in place.²⁰⁵ Such policies have been aided by the dramatic decline in LED bulb prices.²⁰⁶

Energy performance labels compare electricity and water use against a national or local benchmark to encourage property owners to adopt green technologies or retrofits. Efficiency standards and labeling for appliances now operate in more than 80 countries, covering more than 50 different types of appliances and equipment in the commercial, industrial, and residential sectors.²⁰⁷ India introduced energy-efficiency labeling in 2006 for air-conditioning units. The market share of five-star products increased from 1 percent in 2008 to 21 percent in 2014 as consumers switched to more efficient products.²⁰⁸

STEP 2: BUILD CAPACITY AND AWARENESS.

Lack of reliable data and awareness about energy efficiency and green building can hinder the design of successful policies and efforts to create a viable market. Availability and transparency of data on energy consumption in buildings can enable owners, operators, and tenants to make informed energy management decisions and aid in better policy and program design. Voluntary audits can identify the technologies and building structures that drive energy consumption and suggest improvements.

Development of green building benchmarks can be accelerated through ratings and certification programs. These programs help organize building data into a standardized format that can be used to develop a building benchmarking scheme, which is crucial for differentiating buildings in the real estate market. Competitive awards for building developers could spur the development of benchmarks by rewarding best performers. Singapore’s Green Market Certification Scheme and the Green Market Award have been instrumental in the Building and Construction Authority’s push to develop a benchmark and green building master plan.

Green building certifications positively influence decisions to buy real estate. There is a high demand among buyers for green buildings as they may benefit from utility bills that are up to 20 percent lower. Green buildings also tend to have a higher resale value. In the United States

TABLE 6: EXAMPLES OF FINANCIAL INCENTIVES

Energy-efficiency loan guarantees in Bulgaria²⁰⁹

Instituted with the help of the World Bank and the Global Environment Fund, the Energy Efficiency and Renewable Sources Fund (EERSF) provides loans at interest rates of between 5 to 10 percent for up to seven years. A minimum equity investment of between 10 and 25 percent is required from project developers, depending on the proposed financing model. The EERSF has also developed a portfolio guarantee for ESCOs that can cover up to 5 percent of potential defaults.

Tax incentives for building energy-efficiency investment in Moscow²¹¹

Russian taxpayers are entitled to a three-year exemption on corporate property tax for newly introduced energy-efficient systems such as air conditioners, elevators, and computer technology. For tax purposes, investments in energy-efficient equipment can also qualify for accelerated depreciation at twice the standard rate.

Thailand's Encon revolving loan fund²¹³

The Thai government introduced the Encon Revolving Loan Fund to enhance investment in energy-efficiency measures buildings. It was financed by a levy of \$0.001/liter on petroleum products and provides low-interest loans to energy-efficiency projects, including ESCOs.

Green Mark incentive scheme, Singapore²¹⁰

This scheme includes a cash incentive for upgrading and retrofitting that co-funds up to 50 percent (capped at \$3 million) of the costs of installation of energy-efficient equipment and professional services in existing buildings. It also has an energy audit to determine the efficiency of the air-conditioning plants. The Singapore Building and Construction Authority funds 50 percent of the cost for conducting the energy audit.

Building retrofit program, Seoul²¹²

Through the Building Retrofit Program, the Seoul Metropolitan Government provides low-interest loans to buildings and ESCOs to reduce costs. The Seoul government offers eight-year loans at an annual interest rate of 1.75 percent for up to \$1.87 million for each project.

Free energy efficiency retrofit program for low-income families in Houston²¹⁴

The city partnered with electricity distribution company CenterPoint to offer free energy-efficiency retrofits to low-income families. The utility hired contractors to do the work, leading to cost savings for families.

Qualiverde Program in Rio de Janeiro²¹⁵

Under the Qualiverde Program, projects with the certification are eligible to receive tax incentives, property tax reductions, or exemptions from some local building regulations.

(Source: IFC, WRI Ross Centre for Sustainable Cities)

and the European Union, green certified homes can sell for between 4 percent and 9 percent more.²¹⁶ Green certification can also make buildings eligible for lower interest rates and tax rebates or exemptions.

Direct technical assistance can help build expertise in policy development, legal and governance frameworks, and implementation and evaluation of projects. Accreditation systems of building professionals, accredited training institutions for the construction labor force, licensing and verifying the credentials of building professionals, quality control processes for building materials, professional codes of practice, and other locally meaningful regulatory packages can help ensure compliance with building codes. For example, the National University of Singapore provides formal training in energy management through its Singapore Certified Energy Manager Program. Singapore also has an accreditation scheme for ESCOs to enhance services.

Governments can use public sector construction to develop experience in green building through direct technical assistance and workforce training. Projects to construct green buildings help increase the skills of people involved in the project and, once complete, the buildings can be used to showcase green technologies to architects and the public. Governments can also use these building projects to dispel financial concerns by making the capital and operating costs publicly available.

Customer preferences can also be shifted through education and awareness programs. Lighting can be an easy win, because energy-efficient technologies often have the lowest lifetime cost. China's Green Lights Program includes disseminating information about efficient lighting through mass media outlets and displaying their products to familiarize shoppers with energy-efficient options.

STEP 3: PROVIDE TARGETED INCENTIVES.

Low interest rate loans from government can support investment. Such schemes have been introduced in Austria, Germany, Japan, the Netherlands, South Korea, and Switzerland.²¹⁷ In Lebanon, the Central Bank, supported by the European Union, provides subsidized loans to small businesses that want to invest in saving energy.²¹⁸ A €14 million grant from the European Union unlocked \$128 million in investment,



Punjab National Bank Green Construction Bond

As part of its Eco-Cities Program for India, IFC invested nearly \$76 million in green bonds issued by Punjab National Bank to help construct green residential buildings. The bank, which is one of India's largest housing finance companies, uses the funds to finance residential projects based on recognized green building standards, including EDGE. The bank's green bond is the first issuance designated to green buildings in India and IFC is the sole investor. The investment helps the bank to develop a committed green lending practice and grow its green loan portfolio.

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the majority of which went into green buildings.²¹⁹ Risk mitigation guarantees can help lower the cost of investing in green buildings and energy-efficient technologies.

Grants and subsidies for green building projects, green retrofits, and ESCO business models are effective in fostering investment. China offers a 30,000 yuan reward for buildings with a three-star certification or a subsidy of 45 yuan per square meter for a two-star certified building. Chinese subsidies for ESCOs have resulted in energy savings and the reduction of over 130 million tons of carbon dioxide per year.²²⁰

Tax incentives continue to serve as a primary motivator for investors in green building. In China, income from energy performance contracts is tax exempt for the first three years and then has a reduced rate for three years.²²¹ In the United States, property and corporate tax reductions have encouraged private investment.²²²

STEP 4: ENCOURAGE UTILITIES TO TAKE ACTION.

Utilities enhance the energy efficiency of buildings, especially in urban areas. As service providers for energy and water, they have direct relationships with consumers and can collect energy and resource usage data, which are crucial in making buildings more efficient. They can also enhance building efficiency by controlling resource use through pricing and tariff mechanisms.

Revenue decoupling shifts utility behavior from a focus on sales to a focus on service provision. It involves disassociating a utility's profit from its sales and instituting a variable rate of return to meet revenue targets. According to the Center for Climate and Energy Solutions, 14 states in the United States have implemented revenue decoupling for electric and gas utilities.

Modulating tariffs through measures like time-based tariffs can help change consumption habits, especially for large consumers. Utilities can further encourage these tariffs by investing in smart grid infrastructure such as advanced metering and demand response. It could also encourage the market of ESCOs and demand response companies to evolve.

Direct financial assistance like utility public benefit funds and on-bill financing can help investment in energy efficiency in buildings. Utilities could include a small, additional cost to the utility bill that is used to finance energy-efficiency projects. More sophisticated programs like on-bill financing can help individuals repay their investment in energy efficiency on their utility bills. Mexico, for example, has a program that allows individuals to repay their energy-efficient refrigerator through their electricity bill. The program is set up so that households should save more on energy each month from the refrigerator than they pay to repay the loan.²²³

Utilities can also encourage the market for ESCOs to take off through partnerships or by providing financial rebates for energy-efficiency measures. Since 1990, ESCOs have delivered \$30 billion in infrastructure improvements for greater energy efficiency in the United States alone. About one-third of ESCO projects in the public and institutional sectors, which make up 80 percent of all projects, used utility rebates that provided roughly 16 percent of the total project cost.²²⁴

INNOVATIVE FINANCING MODELS

In addition to the various forms of financial incentives discussed, instruments such as green construction bonds, green mortgages, and green mortgage-backed securities could be used.

The green bond market is maturing and emerging as a potential source of financing in the real estate market (see final section of this report). Projects qualifying as green could range from new buildings to retrofitting and refinancing existing buildings.²²⁵ Building rating systems such as Leadership in Energy and Environmental Design, Building Research Establishment Environmental Assessment Method, or IFC's EDGE could be used to assess the eligibility of green projects.

Financial instruments geared towards individuals offer promise. Possible instruments include home improvement loan instruments like the energy-efficient mortgage or green mortgages, green rewards, green building insurance, and a green building certification pricing break. Green mortgages allow users to finance the incorporation of energy-efficient technologies and designs into existing or new buildings through a reduced utility bill.

As the green debt market matures, green mortgage securities are emerging. The underlying assets are mortgages, loans, and other debt instruments. In 2016, Obvion, a wholly owned subsidiary of Rabobank in the Netherlands, issued the first green residential mortgage-backed securities, backed by residential loans on new and retrofitted energy-efficient houses.²²⁶

Financial innovations are also targeting green refurbishment and affordable housing. For example, the Low Carbon Workplace Fund finances the refurbishment of existing buildings. The fund is a partnership between the Carbon Trust, fund manager Columbia Threadneedle Investments and property developer Stanhope. The business model revolves around acquiring of commercial office buildings and refurbishing them to high energy-efficiency standards, before leasing them to commercial tenants. Further, Carbon Trust encourages the occupiers to minimize their energy consumption and carbon emissions by ensuring support for day-to-day performance. The fund has invested in eight properties valued at over £200 million.²²⁷ Another innovative financial solution targets impact investors for affordable housing. IFC client International Housing Solutions has successfully blended catalytic and commercial capital to build demand for low-cost green homes in South Africa. By including such technologies as solar PV and smart meters, it has achieved EDGE certification for thousands of its new properties, enabling the real estate investment management company to measure and market the benefits of its green residential portfolio.²²⁸

Outreach initiatives are also helping accelerate the development of a global asset class for energy-efficiency investment in buildings. The Investor Confidence Project, developed by the Environmental Defense Fund is helping to accelerate the development of a global market by standardizing the way in which energy-efficiency projects and energy savings are calculated and measured. The project develops consensus frameworks in the United States and in Europe to provide a foundation for consistent, predictable, and reliable energy-savings outcomes. Standardization is expected to increase deal flow and reduce transaction costs.²²⁹



4.4 Initiatives, tools, and resources



The **World Green Building Council** is a coalition of green building councils from around the world with membership from organizations in 80 countries. It also represents over 30,000 property and construction companies.

www.worldgbc.org



The **Green Building Performance Network (GBPN)** was founded in 2010 with the mandate to advance knowledge and expertise globally on building energy performance and the structure to achieve it. It works with regional research partners in the United States, Europe, China and India.

www.gbpn.org



The **International Energy Agency (IEA)** works to ensure reliable, affordable and clean energy for its 29 member countries and beyond, and has a wealth of data, policy perspectives, technology roadmaps and outlook reports on energy efficiency in buildings.

www.iea.org



The **WRI Ross Center for Sustainable Cities** is the cities and urban development research arm of the World Resources Institute. Within the Ross Center, the Building Efficiency Initiative focuses on the building sector and efficient urban development.

www.wrirosscities.org



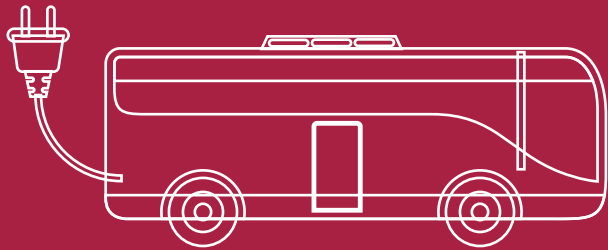
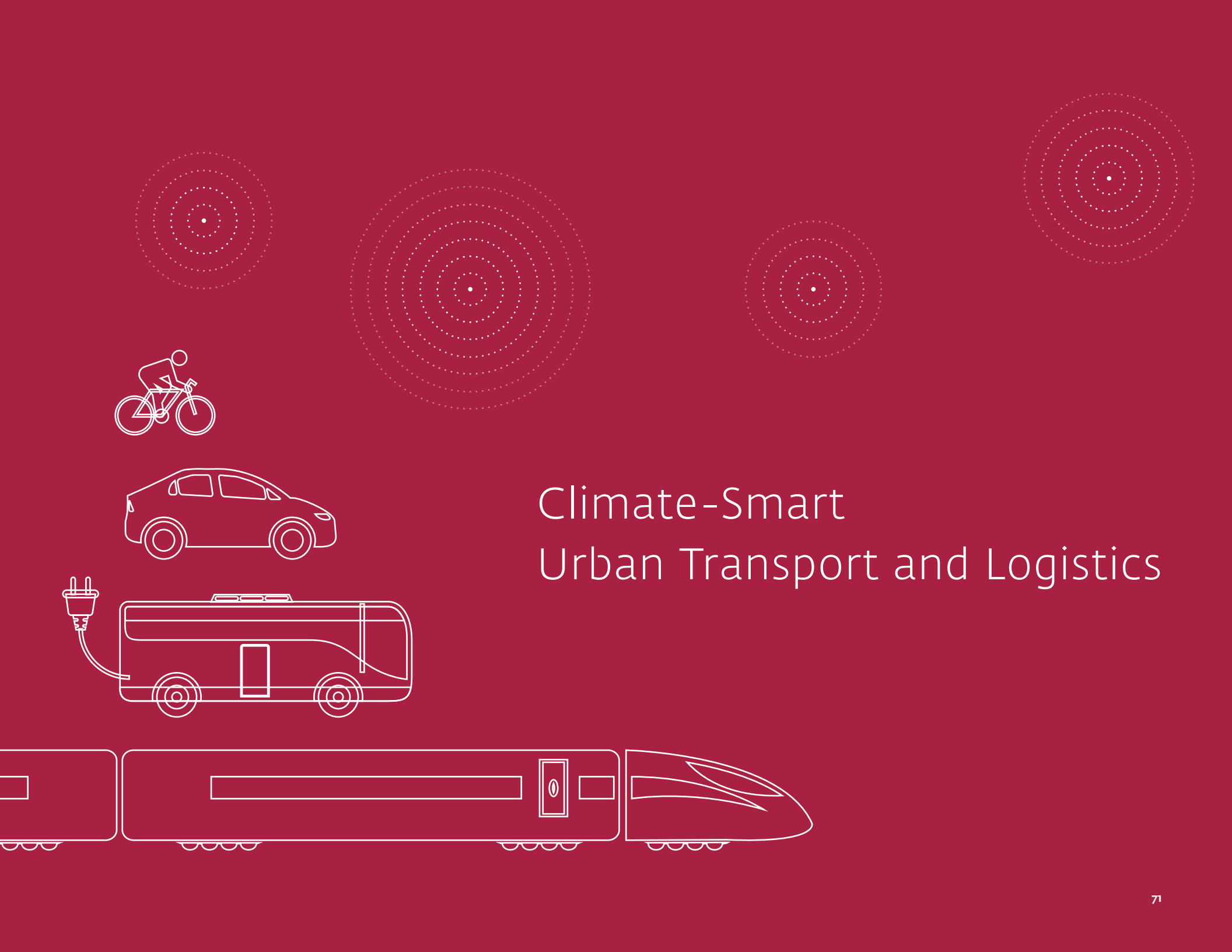
The **UNEP Sustainable Buildings and Climate Initiative (UNEP-SBCI)** is a partnership of major public and private sector stakeholders in the building sector working to promote sustainable building policies and practices.

www.staging.unep.org/sbci



The **Global Alliance for Buildings and Construction (Global ABC)** was launched at COP21 with the aim of fostering the development of appropriate policies for sustainable energy-efficient buildings, which allows a concrete value chain transformation of the sector.

www.globalabc.org

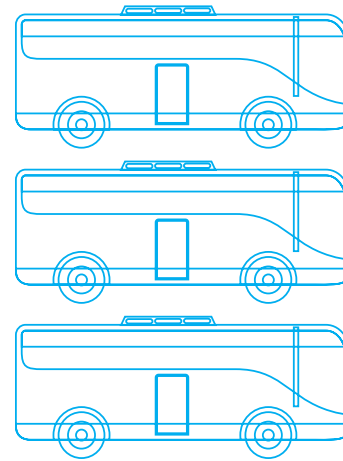


Climate-Smart Urban Transport and Logistics

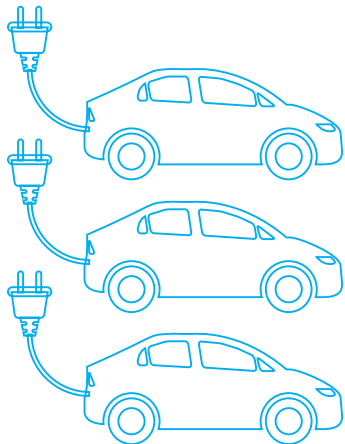
Key indicators



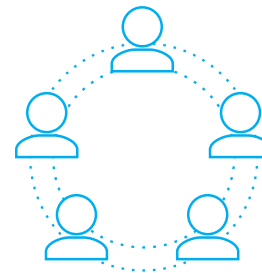
The next decade will see **trillions** invested in road, rail, port and airport infrastructure; the Asia-Pacific region alone presents an **\$8 trillion** investment opportunity.



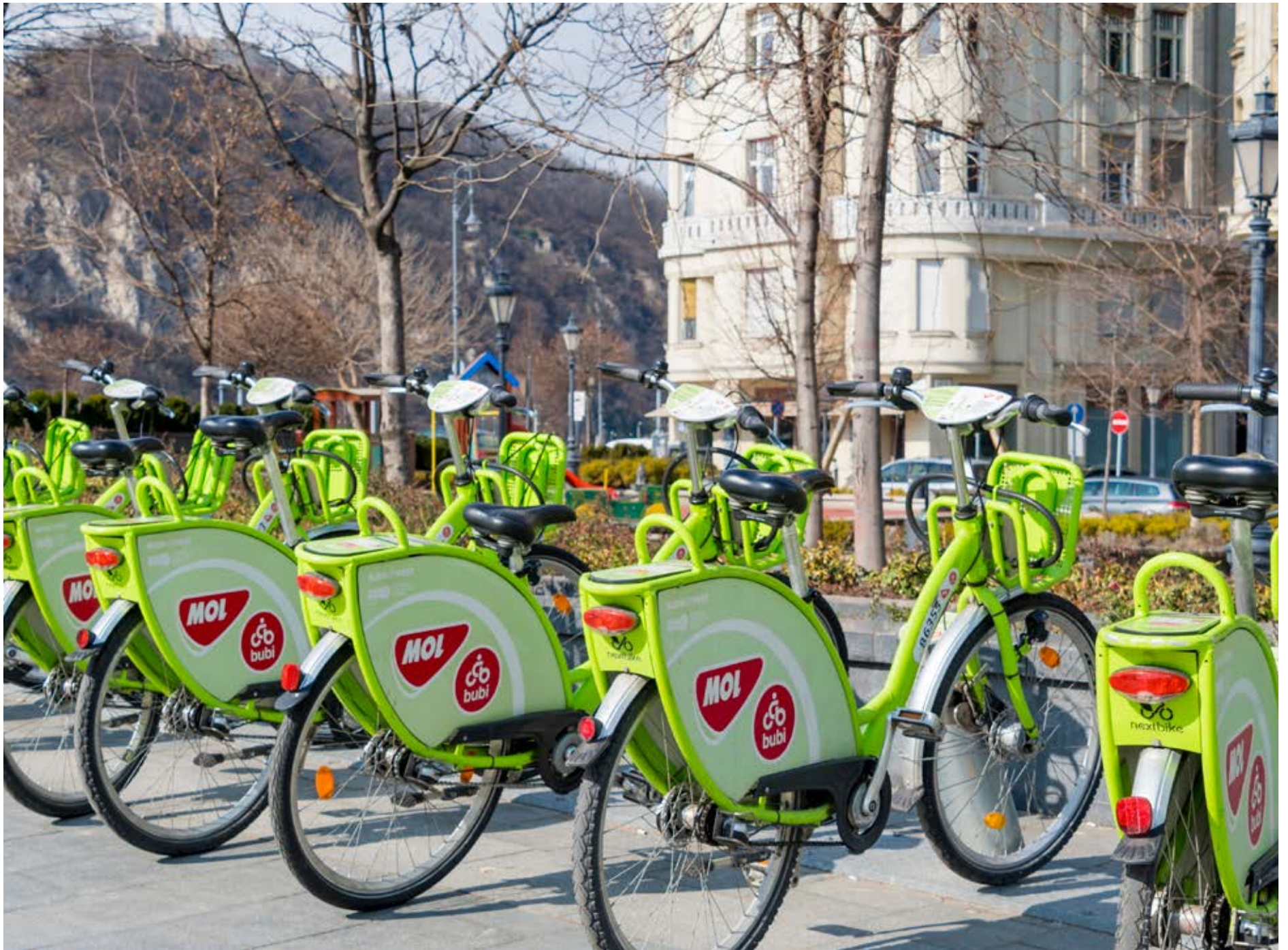
Over **200 global cities** are using BRT systems for greener transport, operating 450 corridors along more than 5,600 kilometers.



Over **750,000 EVs** were sold in 2016, making a **\$163 billion market**.



Over 80 countries targeted transport in their NDCs.





Climate-Smart Urban Transport and Logistics

5.1 Summary

The next decade will see trillions of dollars invested in transport infrastructure. Regionally, total investment in road, rail, port, and airport infrastructure between 2016 and 2025 will be led by the Asia Pacific (driven by China) at more than \$8 trillion, with \$5 trillion in roads and about \$2.3 trillion in rail.²³⁰ Investment in transport infrastructure is expected to grow at an average annual rate of 5 percent, from \$557 billion per year in 2014 to \$900 billion per year by 2025.²³¹ Sub-Saharan Africa will have the fastest average annual growth rate of over 11 percent, while Western Europe's growth rate is expected to decline.

There are many private investment opportunities in transport. BRT and light rail systems require infrastructure that is often financed and operated by the private sector. Cities and mayoral initiatives are at the forefront of greening urban transport and attracting private investment. Transport accounts for about 18 percent of total human-caused greenhouse emissions. BRT is proving to be an attractive low-carbon option, especially in Latin America. Rail and light rail is also a highly efficient low-carbon way of moving people in cities.

Tighter fuel efficiency standards, biofuel blending, and electric and plug-in hybrid electric vehicles are driving decarbonization and saving money. Doubling vehicle efficiency and enabling fuel switching for vehicles with internal combustion engines could save \$8 trillion cumulatively by 2050.²³² Electric vehicles already represent a \$163 billion market and

more than 750,000 of them were sold in 2016 alone.²³³ Governments are setting up mandates to accelerate the deployment of electric vehicles.

Governments are adopting an *avoid-shift-improve* strategy to address the barriers to low-carbon urban transport. *Avoid* measures involve reducing the need for commuting through urban planning, land-use efficiency, and transit-oriented development strategies. *Shift* instruments improve trip efficiency and encourage a shift towards public transport, biking, and walking. *Improve* strategies enhance vehicle technology, fuel efficiency, and transport infrastructure.

Clean air, reduced traffic congestion and resilient infrastructure are a major government focus; NDCs and local policies aim to deliver these solutions via investment in cleaner transport. Targeted policies are encouraging climate-smart transport investments, growing markets, and enabling private sector involvement. This is set to continue, with over 80 countries identifying the transport sector as an area of focus in their NDCs (see Table 7).

5.2 Market snapshot and growth potential

Rapid urbanization in emerging markets presents transport challenges and opportunities. By 2050, an additional 2.5 billion people are expected to live to in urban areas.²³⁴ According to the International Transport Forum's *Transport Outlook 2017*, global demand for urban mobility will be 95 percent higher in 2050 than in 2015, with a 185 percent increase in non-OECD countries. Global road freight

TABLE 7: NUMBER OF COUNTRIES WITH SUBSECTOR INCLUDED IN THEIR NDC

Region	Transport: General	Transportation infrastructure	Public transport	Vehicle fleet	Infrastructure and roads	Urban transport	BRT	Transport planning
East Asia and Pacific	18	5	10	6	4	3	2	1
Europe and Central Asia	8		2	3	4	3		1
Latin America and Caribbean	15	1	7	12	4	1		2
Middle East and North Africa	8		4	6	2	1	2	
North America	1							
South Asia	6	2	3	4	3		1	1
Sub-Saharan Africa	24	2	12	9	8	9	1	6
Western Europe	2		1					
Total	82	10	39	40	25	17	6	11

(Source: World Bank, INDC Database; see indc.worldbank.org)

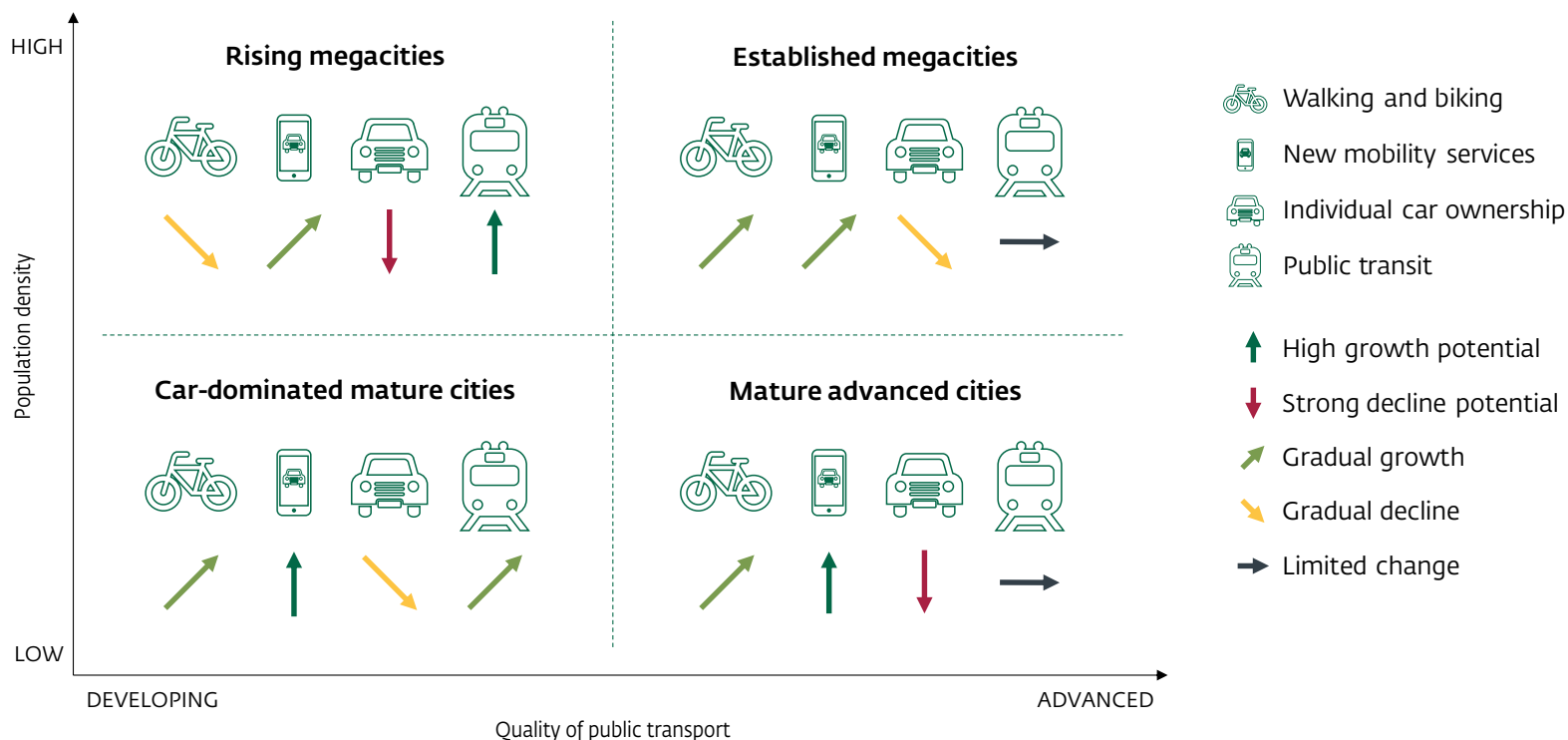
activity is also expected to more than double between 2016 and 2050. Emerging market countries, particularly China and India, account for 90 percent of that increase.²³⁵

Making urban transportation and logistics sustainable will require new thinking around urban design, infrastructure investment, energy-efficiency technology, and business models. Figure 12 illustrates that most developing country cities will require efficient cars and new technologies, as well as new investment in public transport infrastructure. Businesses are already responding with mobility and logistics solutions that reduce trip lengths, reduce carbon emissions, and enhance non-motorized transport options.

TECHNOLOGY TRENDS AND MARKET OPPORTUNITIES

Fuel economy standards continue to drive vehicle efficiency. According to the Global Fuel Economy Initiative, the average fuel economy of light duty vehicles entering the market between 2005 and 2015 has shown strong improvement globally. Turkey made the most progress, followed by the United Kingdom and Japan.²³⁶ These improvements have been driven by fuel economy standards and technology enhancements. However, new light vehicles entering emerging markets were less efficient than those entering industrialized countries. This presents an opportunity to improve fleet efficiency in developing countries and drive significant new investment.

FIGURE 12: Type of cities and potential change in urban mobility



(Source: McKinsey)²³⁷

Electric vehicle sales are growing rapidly, led by China. Electric vehicle markets are growing faster than anticipated. In 2016, annual sales grew by 40 percent year-on-year to reach 750,000. Today, the total global stock of electric vehicles exceeds 2 million. Annual sales in China reached over 330,000, followed by 160,000 in the United States, 215,000 across Europe, and most of the remainder in Japan and Canada.²³⁸ About 60 percent of these sales were battery electric vehicles, with plug-in hybrid electric vehicles making up the balance. China also leads in the electrification of other modes, with 200 million electric two-wheelers, up to 4 million low-speed electric vehicles, and more than 300,000 electric buses.²³⁹ Market penetration remains concentrated in

the developed world; Norway leads with a 29 percent market share, followed by the Netherlands with more than 6 percent, and Sweden with over 3 percent. China, France, and the United Kingdom have a collective market share of nearly 2 percent.²⁴⁰

More countries are encouraging electrification of passenger cars. Electric vehicle markets are expected to accelerate as a result of government mandates, low-cost battery manufacturing, and investments in charging infrastructure. Norway aims for all of its new car sales to be electric by 2025, and is using a 25 percent VAT exemption to help achieve this goal.²⁴¹ France also recently announced that it would end sales of gasoline-based vehicles by 2040. But electric vehicle ambitions are not

limited to advanced economies. India recently announced that it will only sell electric vehicles by 2030, and is working on a plan to achieve this target.

Auto manufacturers are responding to these goals. Volvo expects to build only electric or hybrid cars by 2019.²⁴² The top 10 manufacturers with electric car ambitions aim to sell between 9 million and 20 million units by 2020. The International Energy Agency²⁴³ estimates that there could be between 40 million and 70 million electric vehicles on the road by 2025.

Accelerating electric vehicle production at this rate will require significant new battery manufacturing capacity, equivalent to about 10 new Tesla-style “gigafactories.”²⁴⁴ Batteries have historically been a cost-limiting factor for electric vehicles, but investment in battery technology has led to a 65 percent drop in the cost of lithium-ion batteries since 2010.²⁴⁵ The rapid growth in public charging stations—increasing by 72 percent in 2016 to 320,000 globally—is helping address concerns regarding the distances electric vehicles can travel.²⁴⁶ **As a result, cities are increasingly investing in buses and other electric transit solutions.**

Electric vehicles also have a role to play in freight transport. Last-mile freight transport tends to be the most inefficient leg of the journey, but, especially with the rise of online shopping, demand is growing significantly. Electric light duty trucks can significantly reduce air and noise pollution, which could enable night-time deliveries and decongest streets.²⁴⁷

BRT is a popular way to rapidly decarbonize intra-city public transport. BRT has the largest ridership in Latin America, with more than 20 million passengers a day, followed by Asia at about 9 million passengers a day.²⁴⁸ Europe’s BRT systems carry about 2 million passengers a day, with Oceania and Africa each carrying about 420,000 people daily. Brazilians use BRT the most, with nearly 12 million passengers per day across 33 cities using 124 BRT corridors. In total, 205 cities have a BRT system, operating 450 corridors along more than 5,600 kilometers of road.

Light rail transit has growing private sector interest. Light rail transit includes light rail, tram, monorail, metrorail, subway, airport rail links, and other forms of passenger trains. It can be the backbone of a city’s



The city of Buenos Aires is creating markets for climate-smart transport and buildings

Buenos Aires accounts for nearly half of Argentina’s GDP and hosts six million passengers traveling through the city each business day. The city has embarked on an ambitious \$400 million transportation plan to boost urban connectivity, decrease congestion, and ease pollution by reducing the use of cars. With support from a \$50 million IFC loan, the city is building a new 3.5 kilometer BRT line connecting Paseo Colon to Avenida Alem, one of the busiest traffic corridors in Buenos Aires, as well as bus interconnection terminals. IFC funds are also being used to create 88 new bike-sharing stations and add 33 kilometers of dedicated bike lanes. IFC is also advising the city to promote green buildings standards and improve solid waste management, transport systems and energy efficiency in public buildings.

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Creating markets for light rail in Izmir, Turkey

Izmir, Turkey's third largest city and its main port on the Aegean Sea, is a vibrant city with nearly 4 million inhabitants. In 2015, IFC and the Multilateral Investment Guarantee Agency helped finance an extension of Izmir's light rail network. IFC provided a €12 million loan and mobilized another €23.5 million through the Multilateral Investment Guarantee Agency's role as guarantor of a parallel loan provided by ING Bank. Other lenders include the French Agency for Development and the European Bank for Reconstruction and Development.

The finance package, nearly €72 million in total, will support Izmir Metropolitan Municipality's work to increase metro ridership through the acquisition of 85 light rail transit vehicles, adding capacity as new stations are opened. IFC previously invested €55 million and coordinated a further €110 million for two urban tram lines in March 2014. The Multilateral Investment Guarantee Agency issued more than €66 million in guarantees to the commercial lenders on this project.

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public transit system, facilitate radial access to a city's downtown center, and complement other modes of public and private transport to manage high-capacity routes. Globally, light rail systems carry up to 45 million passengers daily. Many systems are being planned and built in the Middle East, North Africa, and Asia, and are being considered in Latin America as a complement to the BRT system. Nearly 400 cities around the world have a light rail system, operating 2,300 lines along 15,600 kilometers. In 2015, 850 kilometers of new track were under construction, with a further 2,350 kilometers in planning.²⁴⁹

Green logistics can help reduce emissions from trucks, which generate over 40 percent of transport sector emissions in Africa, China, India, and Latin America.²⁵⁰ The global logistics market is projected to reach \$2.2 trillion by 2022, with the Asia-Pacific region accounting for 34 percent of revenue.²⁵¹ Beyond fuel efficiency standards, green logistics can reduce emissions significantly by restructuring supply chains, replacing a mode of transport with another to make the first less congested, improving vehicle use and energy efficiency, and decarbonizing the energy mix.²⁵²

INNOVATIVE BUSINESS MODELS

Ride-sharing platforms like Uber and Lyft have dramatically changed personal transport. Ride sharing has a large market in major developing countries. Didi-Chuxing in China and Ola in India are among the top five ride-sharing companies in the world. Car-sharing business models are attracting interest from car manufacturers and technology companies. BMW's DriveNow and Daimler's Car2Go are helping reduce the need for vehicle ownership.

Smart new forms of transport, such as shared mobility and autonomous vehicles, are potentially revolutionary investment markets. Self-driving vehicles provided a market worth \$30 billion in revenue in 2014. This is set to swell to \$250 billion by 2030.²⁵³ Autonomous vehicles are likely to be particularly compatible with another innovative trend: the use of shared taxis and taxi buses (either manned or autonomous) offering door-to-door shared transport.²⁵⁴ These systems, led by the private sector, could significantly reduce emissions at a low cost, even with the current reliance on internal combustion engine vehicles, and are compatible with low-emissions alternatives such as electric vehicles.

But bringing this technology to emerging markets could be hindered by infrastructural and regulatory constraints.

The sharing economy is now being used to improve the fleet efficiency of freight transport. Uber started a freight business recently and is already drawing competitor start-ups like Doft and Convoy. In emerging markets, where freight efficiency improvement has huge potential, start-ups like Huochebang in China and BlackBuck in India are leading the way in streamlining and maximizing fleet efficiency (see Box 27). As fewer vehicles are needed with these smart shared mobility systems, investment opportunities are likely to shift to smaller-scale, specialized vehicle manufacturing and services and enabling infrastructure.²⁵⁵

5.3 Creating markets for climate-smart urban transport

Policymakers are approaching climate-smart urban transport through a variety of means. At regional and national levels, the electric vehicle market is being driven by mandates, initiatives, and related policies. Municipal transit plans help policymakers evaluate and compare public transit modes such as BRT and light rail. Their development, construction, and operation are being cost-effectively delivered through PPPs that unlock commercial finance and expertise.

Given the expected growth in vehicle ownership, technology alone will not address the expected growth in greenhouse-gas emissions from transport. Investment in road infrastructure is needed and continues to attract private investment through PPPs (see Box 28). Continued reliance on traditional modes of mobility will exacerbate congestion and urban sprawl, despite growth in road access. As a result, NDC targets are less focused on road infrastructure and more on vehicle fleets, public transport, and fuel.

To address risks and barriers preventing greater private investment in low-carbon transport, policymakers can adopt an avoid-shift-improve strategy—a holistic and system-wide urban mobility solution. They can also invest in PPPs and use tailored financing solutions.

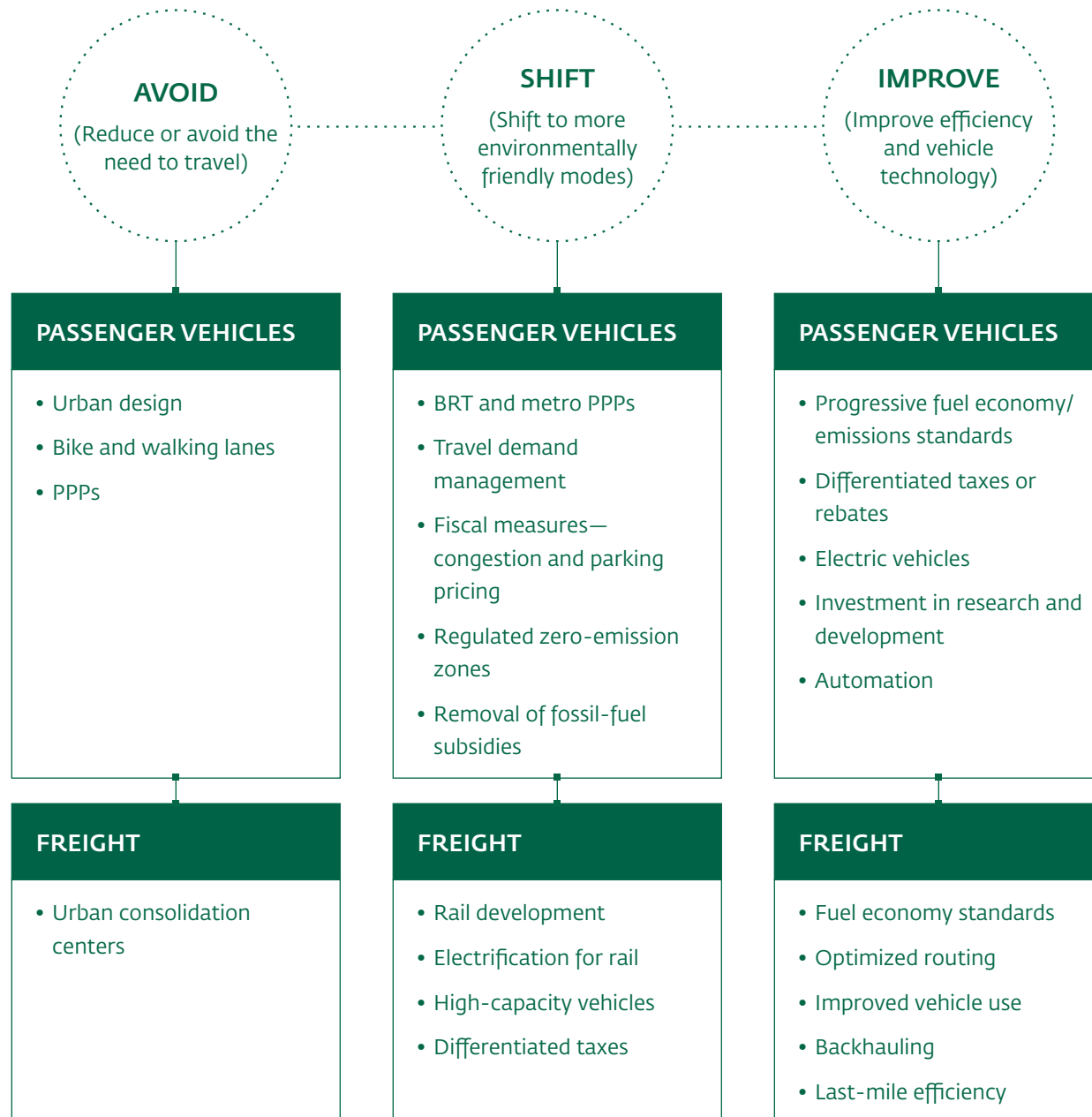


Uber for trucks: IFC's investment in Huochebang and BlackBuck

IFC Venture Capital recently invested in two start-ups in e-logistics—Huochebang in China in 2016 and BlackBuck in India in 2017. Huochebang has developed an online platform that connects and coordinates truckers, shippers, and service centers. It reduces empty miles and waiting times between loads, making shipping more environmentally friendly. At the end of 2016, it was working with 2.3 million truckers and 350,000 shippers across about 1,000 service centers in more than 360 Chinese cities. A China Daily article reported that the Huochebang handles as much as 100,000 orders and processes up to \$120 million in shipping fees every day.²⁵⁶ Similarly, BlackBuck in India operates an online marketplace to connect shippers to truckers seeking work, while maximizing the load carried by the trucks. It works with more than 100,000 trucks across 300 locations.

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FIGURE 13: Creating markets for climate-smart urban transport



STEP 1: “AVOID”—REDUCE THE NEED FOR URBAN COMMUTING.

Focus on system efficiency and reduce the need for urban commuting through smart urban planning, land-use efficiency, and transport demand management. Transport investments and metropolitan land-use management that lead to concentrated development around mass transit corridors is not easy to accomplish but is very much in the interest of cities. City planners and designers in newer, evolving cities in emerging markets can develop compact, transit-oriented cities that encourage people to walk (see Box 29). Other measures could include enabling increased access to information and communications technology for teleworking.

In the context of freight, the avoid strategy can take the form of urban consolidation centers, which are logistics facilities relatively close to the geographical area of consumption. Governments can incentivize the creation of these centers through tax rebates or by subsidizing their operational costs. Urban consolidation centers have had mixed results and a careful study of underlying market realities is needed before encouraging such investments.

STEP 2: SHIFT—MOVE FROM PERSONAL VEHICLES TO OTHER MODES OF TRANSPORT.

Improve trip efficiency by moving from personal vehicles to public transport, biking, and walking. Paris, for example, adopted an urban mobility plan in 1998 that included mass transit, parking, and traffic management. The plan later included dedicated bus lanes, a bike-sharing program (Vélib’), and an electric-car-sharing program (Autolib’). Driving in Paris fell 24 percent between 2001 and 2010, while regional rail into the city increased by nearly 30 percent, metro trips rose by 18 percent, and bus travel increased by 10 percent.²⁵⁷ IFC’s engagement with Buenos Aires is taking a similar system-wide approach to improving urban transit (see Box 25).

Encouraging ride sharing to complement public transit can reduce vehicle ownership. Ride sharing is mostly initiated by entrepreneurs, but governments can encourage these initiatives through monetary and non-monetary incentives. Monetary support for the initial and operational stages, which can take the form of direct aid or tax relief,



**Transport PPPs:
Manila Light Rail Extension**

Manila’s Light Rail Transit Line 1 has been an integral part of the urban transport system for 30 years. However, years of underspending on maintenance has deteriorated the system, reduced the available train fleet, and raised safety concerns. Population growth and urban sprawl also meant that the line needed to be extended to new communities to help more people commute to jobs in the city and remove cars from the road. With IFC advisory assistance, the Philippine government has secured a PPP for the operation and maintenance of Line 1 and the construction and operation of the 12-kilometer Cavite extension. Once complete, the project is expected to benefit more than one million daily passengers, yield over \$310 million in fiscal benefits, and reduce carbon dioxide emissions by 40,000 tons per year (equivalent to taking 8,500 cars off the road).

www.ifc.org



A city for pedestrians in Tianfu District Great City, China

Transit-oriented development creates compact, walkable mixed-use areas around high-quality public transport. Tianfu District Great City in southwest China has used this model to reduce greenhouse emissions and congestion, and enhance livability. It is building a new satellite city near Chengdu for 80,000 people. The streets are designed so that any location can be reached in 15 minutes on foot. Motorized vehicles will be allowed on half the roads; the rest are for walkers and cyclists.

Source: McKinsey 2015²⁵⁸

can help address some of the early-stage risks involved. Government can also directly fund pilot projects.²⁵⁹ For example, Hangzhou in China initiated a successful system of public bike sharing in 2008, which helped demonstrate the viability of the model for other Chinese cities. Non-monetary measures could include integrated transport planning, conducive parking policies, incentives for sharing rather than owning cars, and raising political and public awareness.

Government action can take the form of direct investment in infrastructure like the public metro, BRT, or light rail through public funding or PPPs. Removing fossil-fuel subsidies, implementing a congestion tax, and introducing zero-emission zones could encourage people to change the way they commute. Building biking and walking lanes could also help in this regard.

STEP 3: IMPROVE—UPGRADE AND OPTIMIZE TECHNOLOGY AND INFRASTRUCTURE.

Enable vehicle technology, improve fuel efficiency and optimize transport infrastructure. Policymakers can encourage people and vehicle manufacturers to improve vehicle efficiency and technologies, by, for example, promoting alternative fuel vehicles with incentives, improving fuel economy standards, and reducing speed limits. As the developed world moves to electrification, automation, and shared mobility for transport, developing countries have the opportunity to adopt new technologies and business models too. While vehicle automation remains challenging, electrification has emerged as a viable option for cities in developing countries.

Fuel standards can directly improve efficiency and reduce costs, especially for urban freight, where fuel remains the largest contributor to trucking costs. In Ethiopia, the use of Euro II fuels excludes the possibility of importing older trucks from Europe or the United States, which means it has a newer and more fuel-efficient fleet than some of its neighboring countries.²⁶⁰ Fuel-blending mandates and targets, particularly for biodiesel, are an effective way to encourage freight efficiency. Fuel standards need to be combined with fleet modernization programs, including financial incentives, tax reductions, or scrappage programs promoting the replacement of old vehicles.

To promote the electric vehicle market, governments have developed mandates and supporting regulations and increased research and development spending.²⁶¹ Research and development efforts have prioritized improving lithium-ion battery performance, decreasing battery costs, and enabling large-scale battery manufacturing. Stronger ambition in the electric vehicle market needs to be complemented by national and subnational government mandates. For example, California’s 2016 Zero Emissions Vehicles Action Plan aims to have 1.5 million such vehicles on the road by 2025.²⁶² Regulations like CAFÉ standards in the United States tighten maximum emissions from fleets, encouraging the use of electric vehicles. Mandates around charging infrastructure also play a crucial role in enabling large-scale use of electric vehicles. For example, according to a China Daily article, China intends to deploy 100,000 charging stations in 2017.²⁶³

Support electric vehicle markets through consumer incentives. These can take the form of rebates, tax breaks, or exemptions, based on the technology used or emission levels. Other instruments, typically offered by municipalities, include exemptions from city-center congestion charges, free parking, or access to priority lanes.

INNOVATIVE FINANCING MODELS

PPPs for transport can offer a safe and stable long-term investment opportunity, with reasonable returns for private investors if projects are well planned and risks are appropriately managed.²⁶⁴ Developing a national policy and regulatory framework for PPPs is an important step in mobilizing private sector investment in transport infrastructure.

Transport PPPs offer secure and stable long-term revenue. For example, in 2012, local government’s 70 percent share in the port of Rotterdam paid out €65 million in dividends.²⁶⁵ PPPs need not be funded with tolls, but they offer an opportunity to make tolls politically acceptable. Because free-flow tolling is now feasible, tolls can reduce congestion, ensure an adequate mix of public and private transport, and help finance maintenance and new infrastructure.²⁶⁶ Transit-oriented development strategies also create opportunities for municipalities to address financing challenges by using profits from urban development to subsidize transport investment.



Emission standards and fleet modernization in India

India has been implementing an ambitious fuel emission standards program since 2009. The latest norms have been in effect since April 2017 and new vehicles must comply with this standard. Based on European standards, its Bharat stage emission program has progressively become more stringent. India recently decided to skip the fifth stage in its program and implement the sixth stage by 2020. In addition, the country is discussing a draft of the Voluntary Fleet Modernization Program, which includes tax benefits and discounts to owners to replace their older heavy-duty vehicles. The program aims to retire all vehicles bought before 2005—those below the emission standards currently in place.

Source: GIZ 2016²⁶⁷ and International Council on Clean Transportation 2016²⁶⁸

A PPP plan comes together in Santiago, Chile

Between 2000 and 2008, a 225-kilometer system of urban highways was built in Santiago, Chile's capital. The system was divided among eight PPP concessions. Most of the funding to pay for the \$3 billion investment will come from electronic toll collections over the next 20 to 30 years.

Santiago built this system in less than a decade through a PPP program planned and executed by a division in the Ministry of Public Works, which has

authority over streets and highways across several municipalities. The program began in the early 1990s, along with studies on building urban highways. A law was passed to regulate concessions in 1996, and PPPs were put to tender between 2000 and 2005.

But the system's origin dates as far back as the late 1950s and early 1960s. Planners anticipated that Santiago's rapid growth, which had begun in the 1940s, would eventually transform it

into a polycentric city covering a substantial, expanding area. It was crucial to plan and build streets connecting metropolitan subcenters and municipalities, avoiding trips passing through the city center. The plan anticipated the necessary transport investments, reserved strips of land for roads, and gradually executed the investments to put the plan to work.

Source: World Bank 2014²⁶⁹



5.4 Initiatives, tools, and resources



The **International Energy Agency (IEA)** conducts a broad range of transport research and analysis, focusing on ways in which countries can improve energy efficiency in their transport sectors and shift to lower-carbon fuels.

www.iea.org



The **International Transport Forum (ITF)** at the OECD is an intergovernmental organization with 59 member countries that acts as a think tank for transport policy and organizes an annual summit of transport ministers.

www.itf-oecd.org



The **Global Fuel Economy Initiative (GFEI)** involves multiple organizations working together to secure real improvements in fuel economy, and maximize the use of existing fuel economy technologies in vehicles across the world.

www.globalfuelconomy.org



Union Internationale des Transports Publics (UITP) is the International Association of Public Transport and it brings together all public transport stakeholders and all sustainable transport modes.

www.uitp.org



The **WRI Ross Center for Sustainable Cities** is the cities and urban development research arm of the World Resources Institute. Within the Ross Center, the EMBARQ initiative focuses on sustainable urban mobility.

www.wrirosscities.org



The **Institute for Transportation and Development Policy (ITDP)** is a global nonprofit that provides technical expertise to accelerate the growth of sustainable transport and urban development around the world.

www.itdp.org



The **International Council on Clean Transportation (ICCT)** is a research nonprofit with a focus on environmental performance and energy efficiency of transportation.

www.theicct.org



The **Partnership on Sustainable Low Carbon Transport (SLoCaT)** is a multi-stakeholder partnership of over 90 organizations established in 2009 to provide a global voice on sustainable transport.

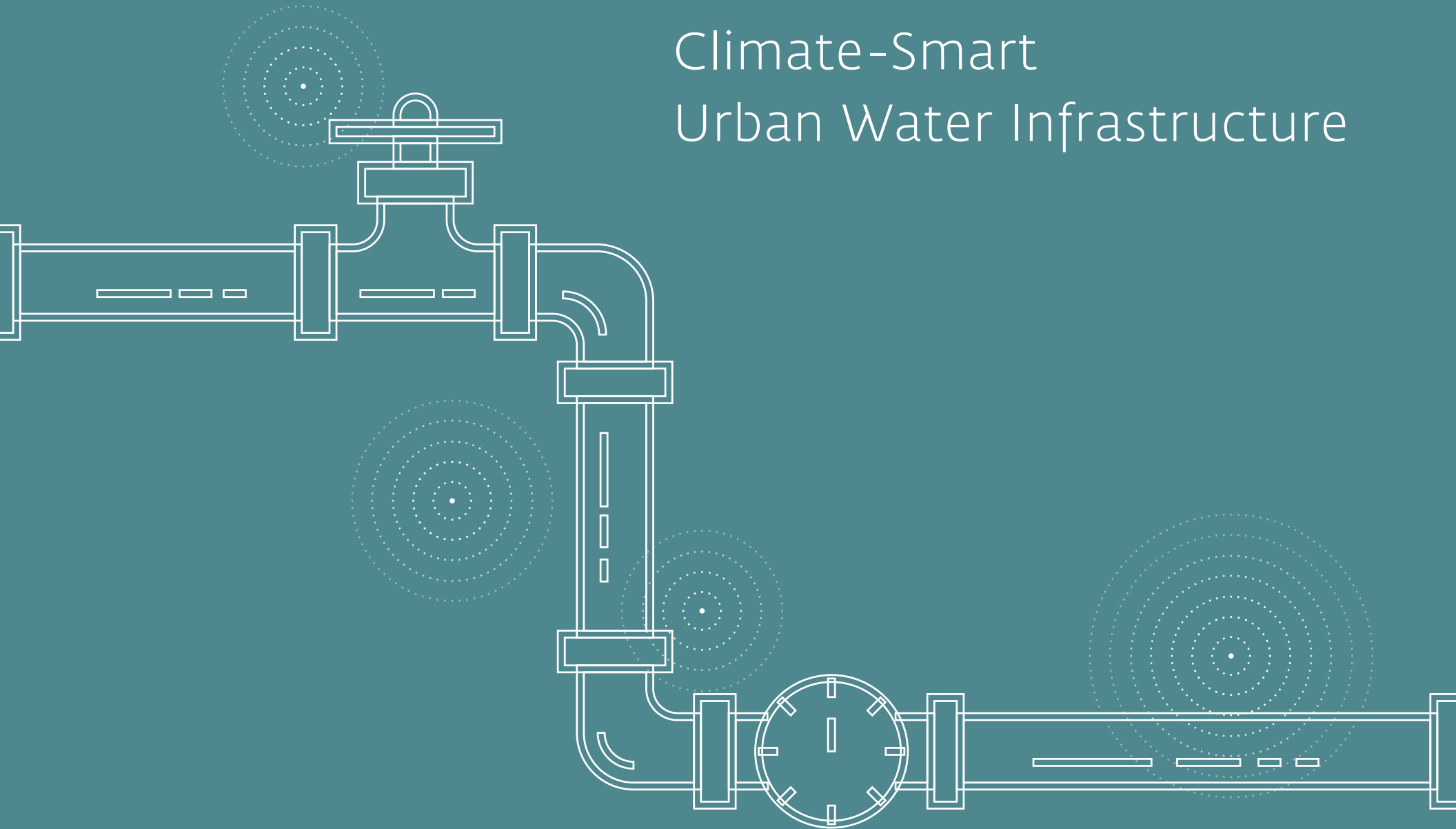
www.slocat.net



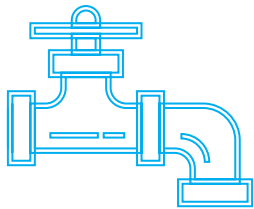
The **Sustainable Mobility for All (SuM4All)** is a World Bank led global, multi-stakeholder proposed in 2016 at the United Nations (UN) Climate Action Summit and established in 2017 with the purpose of realizing a future where mobility is sustainable.

sum4all.org

Climate-Smart Urban Water Infrastructure



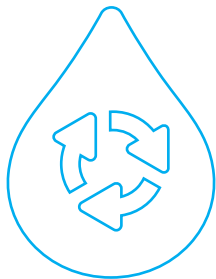
Key indicators



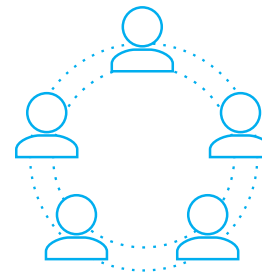
Investment in urban water infrastructure could exceed **\$13 trillion to 2030.**



In 2015, private sector water investment totaled **\$5.3 billion.**

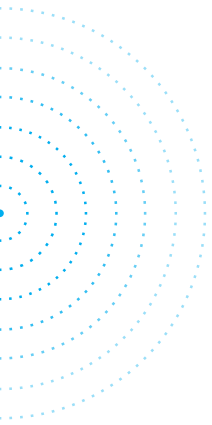


The global market for water recycling technologies was **\$23 billion** investment in 2013, and is growing.



More than **100 countries** mention the water sector in their NDCs.





Climate-Smart Urban Water Infrastructure

6.1 Summary

Water and wastewater infrastructure demand in cities is large and growing due to rapid urbanization. The OECD²⁷⁰ estimates that the required investment for water supply and sanitation could be more than \$13 trillion between 2016 and 2030. The Asian Development Bank (2017) estimates an investment need of almost \$8 trillion in the Asia-Pacific region alone during the same period.²⁷¹

Urban water infrastructure is critical for climate mitigation and adaptation. A carbon-neutral water sector could deliver up to 20 percent of the mitigation pledged under existing NDCs.²⁷² Water savings and recycling can mitigate climate change by reducing the energy used by water systems and using waste-to-energy systems. The sector can also help ensure that people are resilient to the increasing frequency and severity of climate change events, such as droughts and floods. Water efficiency is becoming increasingly important due to the gap between supply and demand.

Governments are increasingly looking to the private sector to invest in climate-friendly water supply and treatment technologies. Historically, the share of investment from commercial sources has been low. Given the investment required, however, governments are expected to source a larger share of commercial financing. In many middle-income markets this shift is already taking place. In 2015 alone, private sector water investment totaled more than \$5 billion.²⁷³

Commercial finance in the water sector faces challenges and risks.

Investments in water efficiency (including in waste-to-resource or desalination systems) should be available and attractive to all water service providers, irrespective of ownership. To attract commercial finance, governments can provide predictable regulatory frameworks and help foster innovative business models. Water pricing at predictable and sustainable levels can enhance cost recovery and increase the creditworthiness of utilities. PPPs, including the use of performance-based contracts, are helping to finance urban water management and efficiency improvement projects. Blended finance solutions can also help share risks efficiently, and address equity and affordability issues. Increasingly, there will be more opportunities to mobilize commercial finance simply through borrowing in domestic markets. More than 100 countries mention water in their NDCs (Table 8); offering an opportunity to address many of these issues.

6.2 Market snapshot and growth potential

TECHNOLOGY TRENDS AND MARKET OPPORTUNITIES

Water infrastructure investment will need to grow rapidly to meet demand. Planned global investment in water infrastructure is \$10 trillion by 2030.²⁷⁴ This will need to grow substantially to ensure adequate and sanitary water supply in line with countries' growth ambitions and the effects of climate change. Water is becoming increasingly scarce. Based

TABLE 8: NUMBER OF COUNTRIES WITH SUBSECTOR INCLUDED IN THEIR NDC

Region	Water management	Water supply	Water conservation and reuse	Wastewater	Water infrastructure	Water treatment	Water efficiency	Water sanitation
East Asia and Pacific	6	8	2	4	1			
Europe and Central Asia	3	1	1	2	2	1	1	
Latin America and Caribbean	13	6	8	3	6	2	2	
Middle East and North Africa	9	4	8	6	2	3	3	
North America	3	3	3	3	2	1		1
South Asia	29	13	11	8	9	4	4	
Sub-Saharan Africa								2
Western Europe								
Total	63	35	33	26	22	11	10	3

(Source: World Bank, INDC Database; see indc.worldbank.org)

on trends in population, climate, and urbanization, water demand could exceed supply by 40 percent in 2030.²⁷⁵ Public financing is unlikely to be available at the scale necessary to meet these needs, creating an opportunity for private investment. The private sector could provide up to half of the investment required for water supply.²⁷⁶

Water equipment and technology suppliers are growing, especially in large emerging markets. All major segments of the supply chain are expected to grow by more than 2 percent per year globally, with these annual growth rates potentially reaching up to 25 percent in emerging markets such as China and India (Figure 14).²⁷⁷

Wastewater offers strong opportunities for private sector investment.

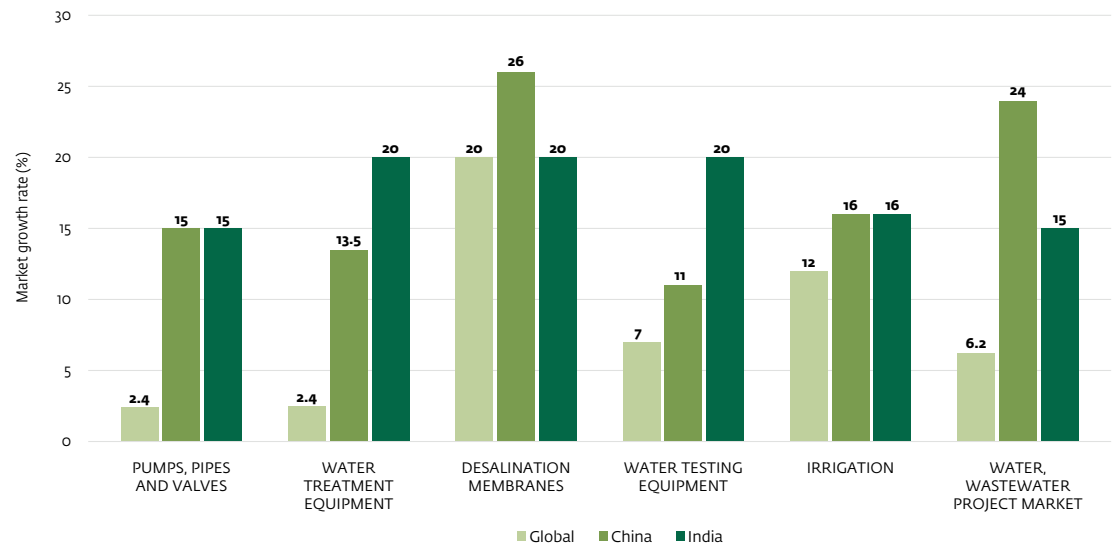
Wastewater treatment and recycling encompasses a range of processes used to reuse wastewater or allow it to be safely returned to the environment. It includes technologies that extract energy from wastewater streams, such as biogas generation, which can be used to generate electricity. Climate-related wastewater treatment opportunities include energy efficiency, waste-to-energy, and water recycling solutions. Wastewater treatment and recycling usually results in sewage sludge as a by-product. Businesses are finding innovative, profitable uses for this sludge (see Box 32), including as soil conditioner and for compost.

Organica Water: Developing innovative wastewater solutions

Organica Water has designed and manufactured a sludge biological wastewater treatment system that allows treated effluent to be reused in a cost-effective manner.²⁷⁸ The system has lower infrastructure and capital costs than conventional wastewater treatment systems, with a low physical and environmental footprint.²⁷⁹ The U.S.-based company has been in operation since 1988 and began raising investment in 2008. In 2013, it raised over \$12.6 million from a range of financiers. In 2015, it raised more than \$9 million from a consortium including IFC, XPV Capital Corporation, Iinvest Partners (through their Electranova fund), and Gamma Capital Partners. The latest round of funding will be used to develop an online project that will allow Organica to further spread its cost-effective, low-emissions wastewater treatment systems.

www.ifc.org

FIGURE 14: Growth in water market segments



(Source: Impax (2013), Investing in Water: Global Opportunities in a Growth Sector, London, UK)

The water recycling and reuse market has recently doubled, and this is set to continue. BCC Research²⁸⁰ estimated the global market for water recycling technologies at \$23 billion in 2013, more than double the 2012 market size. Industrial water reuse and desalination technologies are expected to reach a total market value of \$12 billion by 2025.²⁸¹ Improving water efficiency through new technologies is also an \$8 billion market and is growing—the 2017 Global Opportunity Report²⁸² ranked smart water technologies, such as smart meters and pipes, as the top innovative business opportunity.

The need for water-efficient infrastructure is growing and offers a significant opportunity for private investment with quick payback rates. Up to 40 percent of potable water is estimated to be lost in existing water systems.²⁸³ Water efficiency covers improving the productivity of water treatment plants and distribution systems, as well as water-intensive industrial users. Better management of the water supply network by optimizing pumping, pressure, and distribution systems can significantly reduce water losses in the short term, but ultimately some renovation or replacement of supply pipes may be required. Improved

eMalahleni Water Reclamation Plant

At Anglo American Coal South Africa, water treatment plants are used extensively to treat mine-affected water. The flagship eMalahleni Water Reclamation plant, built by Anglo American in partnership with BHP Billiton and the eMalahleni Municipal Council in 2007, treats around 25,000 cubic meters of mine-affected water every day to meet the potable water needs of nearby mines while providing drinking water for 80,000 people. The treatment process produces gypsum-based

by-products, which are used in the manufacture of cement and fertilizer industries. Gypsum is also used for making building materials—it is mixed with cement, clay and water and baked to produce bricks, blocks and panels for building homes. Anglo American has built 60 houses from the gypsum-based building materials.

https://unfccc.int/files/secretariat/momentum_for_change/application/pdf/3_water_reclamation.pdf



Renewable desalination offers climate-friendly water supply

Desalination technologies turn saline water into potable water by extracting minerals. It is a rapidly growing market in the Middle East and China: China is estimated to have spent more than \$4 billion on desalination technologies between 2013 and 2015.²⁸⁴ However, most desalination technologies, such as seawater reverse osmosis, are energy intensive, so they can only be considered climate smart when they are paired with renewable energy sources. Desalination of brackish water offers opportunities to produce lower-cost water because it is less energy intensive, but it is unlikely to be a main alternative water source in the future because of the limited volume of brackish water worldwide.²⁸⁵

The market for renewable-powered desalinated water is small but growing. In 2012, IRENA estimated that, globally, just 1 percent of desalinated water came from renewable sources. The falling cost of both renewable energy and desalination technologies is expected to see this share increase substantially. The cost of desalination has decreased significantly over the last 30 years, from about \$2.50 per cubic meter in 1972 to \$0.65 per cubic meter in 2010.²⁸⁶ Renewable desalination systems are already cost-competitive with conventional technologies in many regions due to the rapidly dropping costs of renewable energy.²⁸⁷ The world's largest solar-powered desalination plant is due to be constructed in the Saudi Arabian city of Al Khafji. The plant is estimated to cost \$130 million and provide 60,000 cubic meters of water daily.²⁸⁸

pricing schemes will also encourage efficient water allocation and use. The costs and market growth rates of water-efficiency technologies vary significantly across equipment, region, and application, but most investments in water efficiency create positive returns within three years, contingent on cost-reflective water pricing regimes.²⁸⁹

Improving water efficiency through new technologies is a growing market. The 2017 Global Opportunity Report²⁹⁰ ranked smart water technologies, such as smart meters and pipes, as the top innovative business opportunity. The market for water-smart technologies is expected to grow from more than \$8 billion in 2016 to over \$20 billion in 2021.

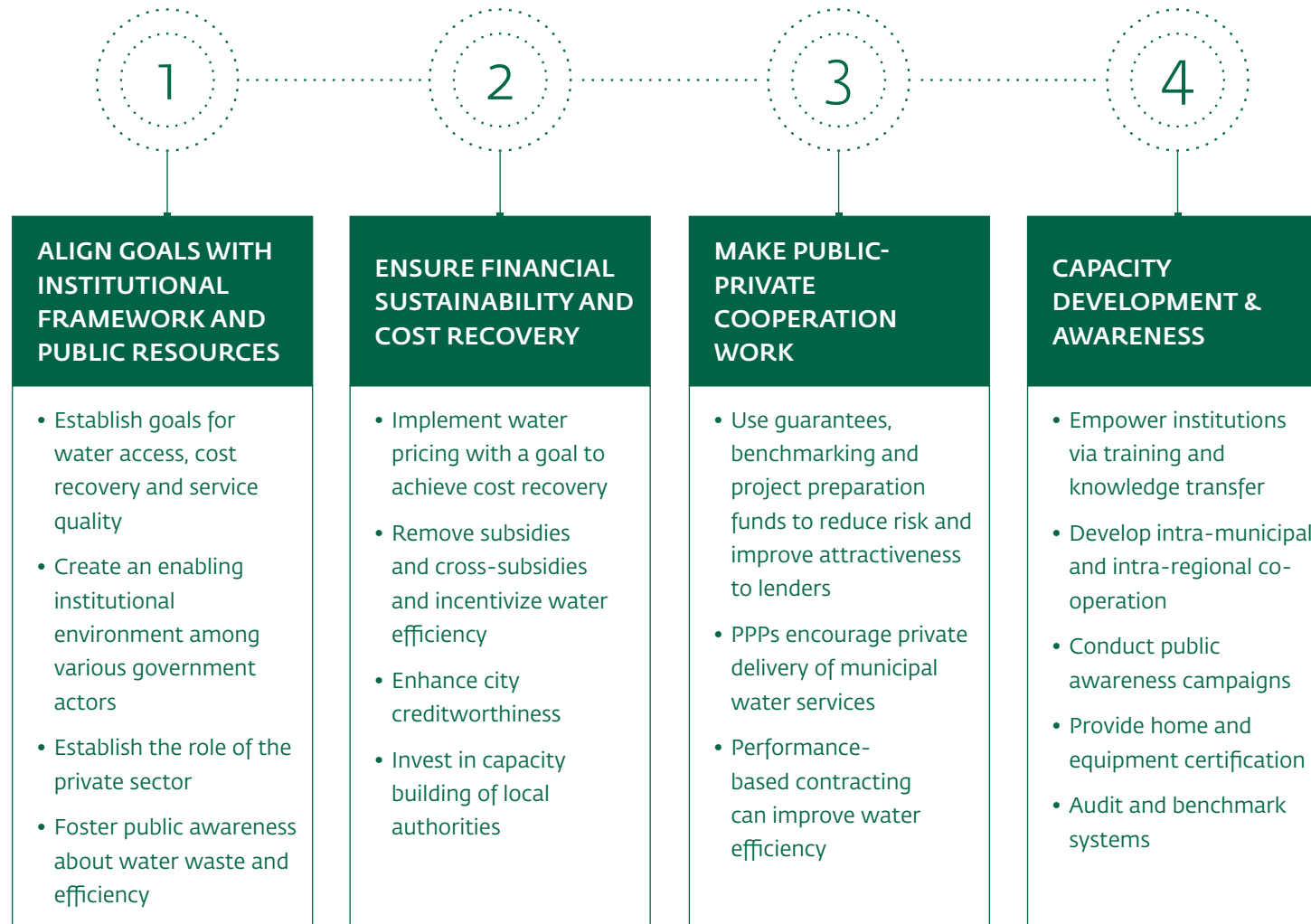
6.3 Creating markets for climate-smart urban water investment

Country-specific challenges and risks need to be addressed to attract commercial finance in water. Countries vary significantly in their level of water scarcity, as well as in their use of water pricing and receptiveness to commercial finance. This highlights the need for a nuanced, locally tailored approach to attract water sector investment, supported by strong and sustained political support.

There is a range of options available to support private investments and improve efficiency in the water sector, from full privatization of assets to small-scale management contracts. The choice of approach will depend on the public sector's capacity to engage with the private sector, as well as the need to attract commercial funding. Private sector solutions can improve service and efficiency, but they need to be combined with the necessary regulatory and legislative safeguards required for the management of a service that is normally a natural monopoly.

Involving the private sector in water infrastructure will help ensure sustainable access to water services. A sustainability analysis should address health, environment, economy, socio-cultural, and technical issues across the value chain.²⁹¹ Ensuring adequate availability of baseline information through data collection and surveys will lead to better-informed decisions. Sustainability and cost-benefit analysis should

FIGURE 15: Creating markets for climate-smart urban water infrastructure



Changing the way we think about water in cities

The World Bank's integrated urban water management approach is "a flexible, participatory and iterative process, which integrates the elements of the urban water cycle (water supply, sanitation, stormwater management, and solid waste management) with both the city's urban development and river basin management to maximize economic, social and environmental benefits in an equitable manner."²⁹² It is more a way of thinking than a methodology.

The approach can enhance water security and health, reduce environmental impacts, and improve system-wide performance.²⁹³ Since the 1990s, the World Bank has applied the integrated urban water management approach in cities in Africa, Central Asia, Europe, and Latin America.

The local conditions in each city are an important consideration in tailoring the approach for each engagement. In general, the city should face multiple water-related challenges that can be solved through an integrated approach (water scarcity, flooding, drainage, pollution), and have strong governance and institutional capacity to drive the process.

www.worldbank.org

go hand in hand with identifying market opportunities for new climate-smart water solutions.

STEP 1: ALIGN SECTOR GOALS WITH INSTITUTIONAL FRAMEWORK AND PUBLIC RESOURCES.

Regardless of public or private provision of water and sanitation services, governments committed to best practice establish the policy, planning, and governance framework required. Major sector reforms will be needed in most countries. It is important to secure sustained political support for water sector reforms that may be needed, including a gradual transition to sustainable water tariffs. Sector policies need to be realistic, fully funded, and integrated with investment plans that include cost recovery and well-defined, targeted subsidies. Incentives can be used to improve performance. Policies need to encourage mobilization and efficient use of public funding from tariffs, charges, and government taxes.²⁹⁴

Establish goals and strategies for the sector's growth. Clear goals and targets for water and sanitation, including water access, network extension, cost recovery, and reliability of services,²⁹⁵ strengthen common understanding and alignment across government and key stakeholders. Several countries have successfully adopted the integrated urban water management approach for the efficient, equitable, and sustainable development and management of urban water resources within the context of larger urban planning issues such as land use, housing, energy, industry, and transport (see Box 35).²⁹⁶ This approach can enhance capacity building and encourage greater private sector confidence in the sector.

Use challenges to drive sector goals and strategies that lead to innovative solutions. For example, in Cairo, water scarcity issues motivated the city to develop PPPs for the treatment and reuse of wastewater (see Box 36).

Create an enabling institutional environment. A common challenge in countries, regardless of public or private provision of services, is the lack of an enabling institutional environment. The water sector is particularly vulnerable to political interference. Private organizations generally view

Private sector solutions for water scarcity in Cairo

With only a third of Egypt’s population connected to a sewer system—and rapid urbanization straining already overburdened infrastructure—fast-growing cities like New Cairo and 6th of October faced significant water challenges. The government sought World Bank Group support for a cost-effective and safe wastewater treatment facility that would mobilize private sector participation in both cities. In 2006, the Public-Private Infrastructure Advisory Facility, a multi-donor technical assistance facility focusing on PPPs, assisted the government with preparing the conceptual framework and transaction model for a new wastewater treatment facility for New Cairo.

With support from IFC’s PPP advisory team, the government was able to structure and close its first

PPP project in 2009: the New Cairo Wastewater Treatment Plant. The plant mobilized private investments of about \$200 million and serves more than 1 million residents. Treated wastewater from the plant is being used to irrigate agricultural land and urban green areas, reducing freshwater demand. In addition, sludge from the plant serves as fertilizer to increase agricultural productivity and boost economic growth. It also opened the market for regional and international investors to work on other PPP projects, including a wastewater treatment plant in the 6th of October. The Public-Private Infrastructure Advisory Facility provided technical support, helping the government define the mandate and operating environment and advising on policy issues related to project design.

<https://ppiaf.org>





Implementing water pricing

An optimal water price should recoup the full costs of supply and reflect water scarcity. However, most water tariffs in developing countries only recoup about 20 percent of their full cost.²⁹⁷ Even most water pricing instruments used in developed countries are insufficient and inequitable.²⁹⁸ Appropriate water prices create a reliable revenue stream and change the underlying economics of water projects, which attracts private investment. But creating optimal water prices is a political endeavor that often faces resistance from affected communities.

There are ways to successfully address the politics of water pricing. Sustainable water tariffs can be phased in over time to allow communities to adjust. At the same time, rising block tariffs—where

users pay different prices for different “blocks” of consumption—can ensure that vulnerable users are not priced out of the market while providing a reliable revenue stream for private investors.²⁹⁹

Subsidy use and reform is another way to make water pricing feasible and socially acceptable. Subsidies, such as reduced water access fees, lump sum transfers, and vouchers, can help lessen the burden of higher water prices on low-income households.³⁰⁰ As a first step, harmful subsidies, such as foregone revenue from low environmental pollution charges and direct subsidies to water and sanitation providers,³⁰¹ can be reformed without incurring the same political resistance that changing water prices might.

water infrastructure as a low-return, high-risk investment. To address this, governments have successfully developed a predictable and reliable regulatory environment and ensure that regulators are not susceptible to political interference.³⁰² It is also important that regulators are properly funded and can attract and retain high-quality staff. Enhancing governance and legislation, including property and contractual rights, adequate competition law, and dispute settlement mechanisms, is essential to attracting the private sector.³⁰³ Access to capital markets is also important.

Avoid public funding crowding out commercial finance. Effective mobilization and allocation of public finance, through taxes, tariffs, and subsidies, is crucial for the sector. But this funding should be used prudently in a manner that does not crowd out opportunities for commercial finance.³⁰⁴

Ensure financial sustainability and cost recovery. Given the significant investment required for water and wastewater provision, adequate cost-recovery mechanisms need to be in place to ensure financial sustainability. Cost-reflective water pricing is critical to recover costs and stimulate private investment (see Box 37). Tariffs provide an effective way to recover capital, operational, and maintenance costs from users.³⁰⁵ Tariffs and subsidies should incentivize consumers and service providers in a way that contributes to national objectives.³⁰⁶ To ensure water-efficient consumer behavior and price recovery, it is important for water pricing to be supported by strong governance frameworks. Water pricing is unlikely to succeed without strong institutions for monitoring and enforcement, which will in turn help ensure continuity and reduce political risk.³⁰⁷

Include public awareness in strategies and demand management programs to change water-use behavior. This can include awareness-raising campaigns targeted at homes, businesses, and municipalities; equipment certification programs; auditing and benchmarking systems; and efficiency funds (see Box 38).



Behavioral change strengthens water demand management in Singapore

To reduce water consumption by 10 percent for businesses and 10 liters a day for households, Singapore embarked on a behavioral change campaign. The focus was on raising awareness about the true value of water. It also introduced a water-efficient homes certification program (including mandatory installation of low-flow taps and toilets) and a water-efficiency fund to incentivize business to manage demand. The campaign was partly financed by a tariff restructuring that penalized inefficient users (tax rate of 45 percent imposed on household use exceeding 40 cubic meters a month). The campaign was a success, reducing per capita water use from 165 liters a day to 152 liters a day, and resulting in local communities and businesses adopting more than 20 catchments and water sources.

www.2030wrg.org



Subnational financing and water infrastructure in Brazil

Companhia Catarinense de Aguas e Saneamento is a majority state government-owned water and wastewater utility in Santa Catarina, Brazil. In 2010, IFC helped the utility with its efficiency and management upgrade program. It involved strengthening the company's commercial viability, saving energy and water resources, and improving subsidies for the poor. Through the project, the utility installed and replaced water meters, updated customer data, and purchased equipment and training.

IFC helped the utility secure a loan of 40 million Brazilian reais, linked to the inflation index and secured by tariff receivables. This prepared the company for financing from banks and local investors at attractive terms, and helped diversify its funding sources. The project led to energy and water savings, helped low-income residents, and improved competitiveness.

Source: IFC 2010³⁰⁸

STEP 2: IMPROVE PERFORMANCE OF SUBNATIONAL BODIES AND UTILITIES.

Improving operational and capital efficiency allows service providers to deliver better, more cost-effective services, freeing up resources to enhance or extend services that can help justify increased tariffs and transfers from government sources.³⁰⁹ A more efficient service delivery body also encourages private sector confidence.

Incentivize efficiency. Utilities can be technically and commercially inefficient, particularly in developing countries.³¹⁰ A better-performing utility mobilizes capital more efficiently, improving creditworthiness and access to commercial financing. Incentives for improving efficiency come from policymakers and trickle down through local governments and service providers, including management and technical staff. Key considerations for promoting efficiency include ensuring service standards are clear, improving the transparency of financial performance and employee levels, measuring customer satisfaction, instituting performance benchmarks, accounting for energy costs of water delivery systems, and identifying and mitigating risks.³¹¹

Enhance creditworthiness. Only 4 percent of water and sanitation service providers in low- and middle-income countries are creditworthy.³¹² Even when service providers are creditworthy, they do not always have access to commercial lenders if the local financial market is not sufficiently mature. A country's policy and market environment can help utilities become creditworthy. Beyond water tariffs and transparency in subsidies, fiscal guarantees and clarity on the relationship between national and subnational authorities enhances private sector confidence. Subnational financing, such as municipal bond markets and local-currency-linked loans also makes water infrastructure more attractive to private investors (see Box 39).

STEP 3: MAKE PUBLIC-PRIVATE COOPERATION WORK.

Even if service providers are efficient and well governed, lenders may not immediately respond to new lending opportunities when they are presented. Certain financing tools, such as guarantees, benchmarking,

Johannesburg Water: A PPP success story

Johannesburg Water showed how performance-based PPPs can succeed in meeting development and climate objectives in the water sector. The municipality set out to establish a privately operated utility in Johannesburg, South Africa, in 2000, when city water and sanitation services were facing bankruptcy. Through an international tender process, it awarded a five-year management contract to a consortium led by SUEZ Environnement of France, which created the Johannesburg Water Management utility. By the end of the contract in 2006, the utility had met 90 percent of its contractual targets and had overseen marked improvements in cost efficiency, racial diversity among employees, environmental compliance rates, and financial performance. It has since evolved into an independent company (Johannesburg

Water), with the municipal government as the sole shareholder and an annual turnover of R1.6 billion.³¹³

The company has expanded into energy generation. It has installed biogas-to-electricity generation in several wastewater facilities. Biogas scrubbing and combined heat and power cogeneration projects were installed in 2012 at the Northern Wastewater Treatment Works and Driefontein Wastewater Treatment Works. Both are significant facilities: the Northern plant is the largest wastewater operation in Johannesburg. The initial installation provided more than 1 MW of clean energy, covering 18 percent of the plant's electricity consumption. Five biogas power plants, totaling more than 17 MW, are planned, with an expected average payback period of about five years.³¹⁴

Source: Johannesburg Water





Reducing water losses through performance-based contracting in Ho Chi Minh City

Non-revenue water is water in the system that is not billed because of leaks or commercial failures. Efficient management of non-revenue water offers significant financial and environmental benefits.

Ho Chi Minh City is the largest city in Vietnam and its water supply is managed by the Saigon Water Corporation. The corporation set a target of reducing non-revenue water from 35 percent in 2004 to 26 percent in 2010. Within this context, the city partnered with the World Bank to develop a performance-based contract.

The contract that emerged was a five-year design, build, and operate contract with a strong performance element. Payments included a fixed fee, a lump sum price per district metering area, a performance fee per cubic meter of leakage reduced, and a bill of quantities for unforeseen works and connecting new customers. The Saigon Water Corporation monitored the project, with support from a specialist consultant.

creditworthiness assessments, and project preparation funds,³¹⁵ can be used to reduce risk in the sector and make it more attractive to lenders. Provision for competent and independent regulators, transparent and competitive bidding processes, and adequate due diligence and monitoring and evaluation can help make public-private cooperation work. There are three main approaches in this context: the PPP model, the performance-based contract model, and blended finance.

PPPs are an effective way to encourage private sector investment for municipal water services. The availability of a sovereign guarantee—a government’s agreement to take or refrain from certain actions affecting the project—is often pivotal in PPP arrangements. The private sector brings technical and managerial expertise, innovation and greater financing capacity. This can increase the service provider’s creditworthiness and open up further opportunities for commercial finance (see final section for more detail on PPPs).

Performance-based contracting, where remuneration is based on outcomes achieved, can improve water utility efficiency. Many of the performance-based contracts in emerging markets are focused on reducing non-revenue water (water that is “lost” before it reaches the consumer, through leaks, for example). Through these contracts, utilities can access the capacity and equipment that they lack. Results-based payments increase the incentive to reduce leaks and improve inadequate billing systems, reducing the risk of non-performance. However, it is important that a clear benchmark to measure performance is established at the start of a contract.

Blended financing is useful for markets that lack commercial sector coverage or have high risk.³¹⁶ As several of donor projects in middle-income countries have demonstrated, blended finance can be a useful tool in lowering the capital cost and correcting market failures, enabling access to commercial finance (see final section of this report). Blended finance can also be used to demonstrate the viability of a new business or as once-off support to initiate self-sustaining, cost-recovering projects and utilities.

Blended financing for As-Samra Wastewater Treatment Plant in Jordan

Jordan is one of the most water-scarce countries in the world. The As-Samra Wastewater Treatment Plant was built in 2008 to treat wastewater for the 2.3 million inhabitants of Amman, while supplying quality irrigation water to the surrounding region. However, the country's rapid population growth and influx of refugees tested the limit of the plant's capacity (both in terms of the volume of wastewater received and solids processing) sooner than anticipated. For this reason, the government put a blended financial package in place to finance the expansion of the As-Samra Wastewater Treatment Plant.

The project was undertaken by the Samra Wastewater Treatment Plant Company Limited, a private operator recruited in 2012 to finance,

upgrade, and operate the treatment plant. The financial package included public funds provided as "viability gap funding," including contributions from the government (\$20 million) and a grant from the Millennium Challenge Corporation (over \$90 million). The viability gap funding helped leverage an additional \$110 million in private financing and reduced the capital costs, while enabling the project to become financially viable.

The As-Samra Wastewater Treatment Plant expansion project became operational in October 2015, increasing the average daily capacity of the plant from about 260,000 cubic meters per day to more than 360,000 cubic meters per day.

Source: World Bank 2016³⁷





STEP 4: INVEST IN CAPACITY BUILDING.

Capacity building helps local authorities manage the commercial and legal processes involved in private sector participation in the water sector. It also improves efficiency. Municipal and regional cooperation should be encouraged to share knowledge and resources. Utility company management also needs the autonomy to set incentives that motivate the workforce—proper pay and incentives are vital to recruiting and retaining talent.³¹⁸ National and local governments can provide the leadership required and support designated agencies, while establishing or enhancing sector performance measurement. In turn, utilities can enhance capacity building through energy and cost accounting and instituting pilot programs for improved water management. City authorities can also work with multilateral banks to enhance training and peer-to-peer learning. Finally, public awareness campaigns can help build capacity among households and water consumers along the water use chain to use water-efficient technologies and practices.

INNOVATIVE FINANCING MODELS

The Water Financing Facility, spearheaded by the Global Innovation Lab for Climate Finance, aims to mobilize private capital in the form of institutional investment from sources such as pension funds and insurance companies to aid national adaptation and mitigation goals in the water sector. It seeks to coordinate this finance with public funding and international impact investment to help bridge the investment, infrastructure, and sustainability gaps countries are facing.³¹⁹ In April 2017, the Dutch government announced a €10 million commitment for the Water Financing Facility in Kenya. The facility will periodically issue bonds for water and sanitation projects in Kenya, with the first taking place by the end of 2017. The global facility aims to expand into two more countries, planned for 2018, contingent on raising an additional €21 million in donor funds.³²⁰

Pay for Success, also referred to as social or environmental impact bonds, provides an innovative way for water service providers to attract financing. Investors are paid back based on whether the service provider delivers an outcome (such as water savings), as measured by independent evaluators.

DC Water's environmental impact bond

Washington, D.C. has antiquated stormwater infrastructure, with a combined sewer system designed 150 years ago. This means both raw sewage and stormwater flow through the same pipes into DC Water's treatment facilities. During heavy rain or snow, the volume of water and sewage exceeds the pipes' capacity and, by design, bypasses the treatment facility and is discharged directly into local rivers. It results in 2 billion gallons of sewage overflowing directly into Chesapeake Bay every year.

To address this challenge, DC Water initially started to build a \$2.6 billion tunnel system to capture the

additional sewer outflow. However, halfway into the 20-year project, green infrastructure (such as rain gardens, permeable pavements, green roofs, and rain barrels) started emerging as a potential solution that could soak up precipitation and slowly release it into the sewer system, potentially preventing overload and requiring fewer tunnels. But green infrastructure had never been deployed at the scale DC Water was planning, creating technological and financial risks.

The solution came in the form of an environmental impact bond, which allowed DC Water to structure the financing to transfer the risk to investors. With

Quantified Ventures as broker, DC Water raised the United States' first environmental impact bond—a \$25 million tax-exempt bond sold to the Calvert Foundation and Goldman Sachs Urban Investment Group. While standard municipal bondholders invest in the issuer's ability to repay on schedule, DC Water's investors bet on whether green infrastructure will produce outcomes "as expected," "better than expected," or "less than expected." Investor returns are tied to project outcomes.

Source: Quantified Ventures³²¹

6.4 Initiatives, tools, and resources



The **Global Water Partnership** is an multi-stakeholder international network in the water sector, with a goal of fostering an integrated approach to water resources management.

www.gwp.org



The **International Water Association (IWA)** is nonprofit organization and knowledge hub connecting water professionals around the world to find solutions to global water challenges.

www.iwa-network.org



The **2030 Water Resources Group (WRG)** is a public-private-expert-civil society platform to help government water officials and their partners accelerate reforms to ensure sustainable water resource management for the long-term development and economic growth of their country.

www.2030wrg.org



An initiative of the World Resources Institute (WRI), **Aqueduct** measures, maps and understands water risks around the globe.

www.wri.org/our-work/project/aqueduct



United Nations Water (UN-Water) coordinates the efforts of United Nations entities and international organizations working on water and sanitation issues.

www.unwater.org



The World Bank Group's **Water Scarce Cities Initiative** offers a new avenue for knowledge sharing on urban water management by creating and sustaining stronger connections between cities facing water scarcity, and enabling urban water practitioners, global thought leaders and institutions to share solutions specific to that context.

<http://pubdocs.worldbank.org/en/588881494274482854/Water-Scarce-Cities-Initiative.pdf>



The **United Nations Global Compact's CEO Water Mandate** mobilizes companies to advance water stewardship, sanitation, and the Sustainable Development Goals—in partnership with the United Nations, governments, peers, civil society, and others. The mandate offers a platform and a set of tools to share best and emerging practices and to forge multi-stakeholder partnerships to address challenges related to water scarcity, water quality, water governance, and access to water and sanitation.

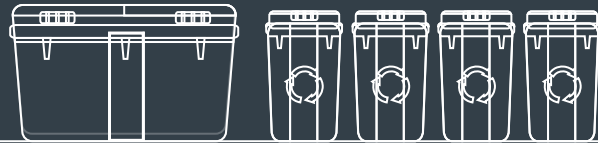
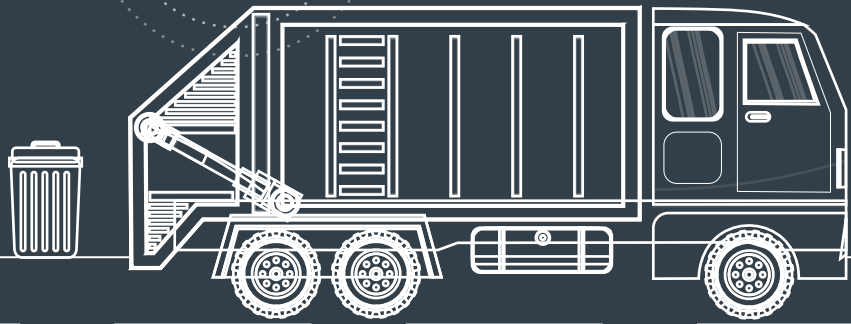
<http://ceowatermandate.org>



Business Alliance for Water and Climate (BAFWAC) was jointly launched by CDP, the CEO Water Mandate, SUEZ, and the WBCSD. BAFWAC companies commit to analyzing and sharing water-related risks to implement collaborative response strategies; measuring and reporting water use data; and reducing impacts on water in operations and throughout the value chain.

<https://bafwac.org>

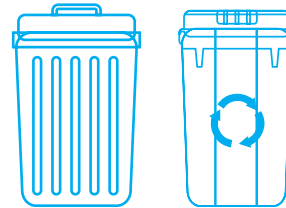
Climate-Smart Urban Waste Management



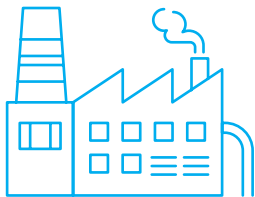
Key indicators



The global waste sector is expected to reach **\$2 trillion** in investment by 2020.



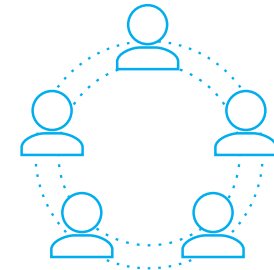
Waste recovery and recycling markets were around **\$265 billion** in global revenue in 2016.



The global waste-to-energy market includes **800 plants** and is at **\$7.4 billion** in revenues.



The **Asia-Pacific** and **Latin American** regions will see the most growth in waste market opportunities.



Over 80 countries include waste in their NDCs.





Climate-Smart Urban Waste Management

7.1 Summary

Waste management is a large and growing global business opportunity.

Between 2011 and 2025, levels of waste generation in cities are expected to increase from 1.3 billion metric tons to 2.2 billion metric tons per year.³²² Countries around the world are modernizing their waste systems, leading to formalization of the sector and safer waste disposal. Cities allocate one of the largest budgets to municipal solid waste, which is also one of the largest employers. The global services market for municipal solid waste was estimated at \$160 billion in 2013 and could be worth \$300 billion by 2020, with most growth coming from emerging markets.³²³

The Asia-Pacific and Latin American regions will see the biggest growth in opportunities in the waste sector as a result of rapid urbanization.³²⁴

Between 2009 and 2013, waste generation increased by 15 percent each year in Brazil and 16 percent in China.³²⁵ The World Bank expects China to produce twice as much urban solid waste as the United States in 2030.³²⁶

Climate-smart solid waste management encourages innovation in technologies. Local governments and the private sector are innovating to reduce the greenhouse-gas emissions associated with solid waste management, while also providing energy and other resources. Climate-smart options include energy generation via the capture and use of landfill gas for energy, refuse-derived fuel, climate-smart transport of waste via route optimization and low-carbon fuel use, and recycling

and reusing waste (including e-waste recycling, composting, and sustainable packaging). Emerging technologies such as advanced thermal conversion technologies (pyrolysis, gasification, plasma gasification) and applications for waste-to-liquid fuel may create new investment opportunities in the waste sector.

There are a number of risks and challenges preventing private sector investment in climate-smart urban waste. Cities can attract private sector participation by extracting value (and energy) from recoverable materials, selecting appropriate technologies, and working more closely with the informal waste collection sector. Local and national governments can also put in place regulatory and enforcement frameworks, establish economic incentives and cost-recovery mechanisms such as feed-in tariffs, and help drive waste-conscious consumer behavior. Governments can also foster innovative new business approaches, such as PPPs, microfinancing and micro-privatization.

Realizing the potential of climate-smart technologies to reduce greenhouse-gas emissions, over 80 countries have targeted solid waste management in their NDCs (see Table 9).

7.2 Market snapshot and growth potential

The volume of solid waste being generated in cities is growing rapidly as a result of urbanization and rising household income levels.³²⁷ Collecting and disposing of solid waste safely is important to ensure public health.

TABLE 9: NDCS TARGETING WASTE MANAGEMENT

Region	Waste: General	Solid waste	Waste-to-energy	Recycle, reuse, reduce
East Asia and Pacific	16	5	6	4
Europe and Central Asia	12	4	1	1
Latin America and Caribbean	13	6	3	3
Middle East and North Africa	9	6	3	4
South Asia	3	3	4	4
Sub-Saharan Africa	27	15	14	8
Western Europe	4		1	
Total	84	39	32	24

(Source : World Bank, INDC Database; see indc.worldbank.org)

While many middle-income countries have made significant progress in modernizing solid waste management, collection is still about 50 percent in low-income countries, with much lower rates in some countries. Waste collection is particularly difficult in rural areas and informal settlements in large urban centers. It is estimated that at least 2 billion people worldwide still lack access to solid waste collection.³²⁸

Globally, waste management—including waste-to-energy, municipal solid waste, industrial waste, and sustainable packaging—is almost a \$1.5 trillion market that could grow to \$2 trillion by 2020.³²⁹ In 2011, cities across the world generated about 1.3 billion metric tons of solid waste. Driven by rapid population growth and economic development, solid waste levels are expected to increase to 2.2 billion metric tons by 2025 and more than 4 billion metric tons by 2100.³³⁰ As the waste sector matures in most advanced countries, the largest investment opportunities will be in emerging economies with increasing waste flows, such as India.

Municipal solid waste services were worth \$160 billion in 2013 and could be worth nearly \$300 billion by 2020.³³¹

Markets for climate-smart urban waste management will grow as countries and cities implement their climate goals. Methane emissions from municipal solid waste management contribute 12 percent of global methane emissions and 5 percent of global greenhouse-gas emissions.³³² Solid waste management is one of the most important services a city provides; in low-income countries as well as many middle-income countries, it is the largest single budget item for cities and one of the largest employers.³³³ To address methane emissions from waste, initiatives like the C40 Waste to Resources Network are working with cities like Auckland in New Zealand and Guangzhou in China to manage waste as a resource by reducing waste generation, enhancing recycling, and reusing valuable materials.³³⁴

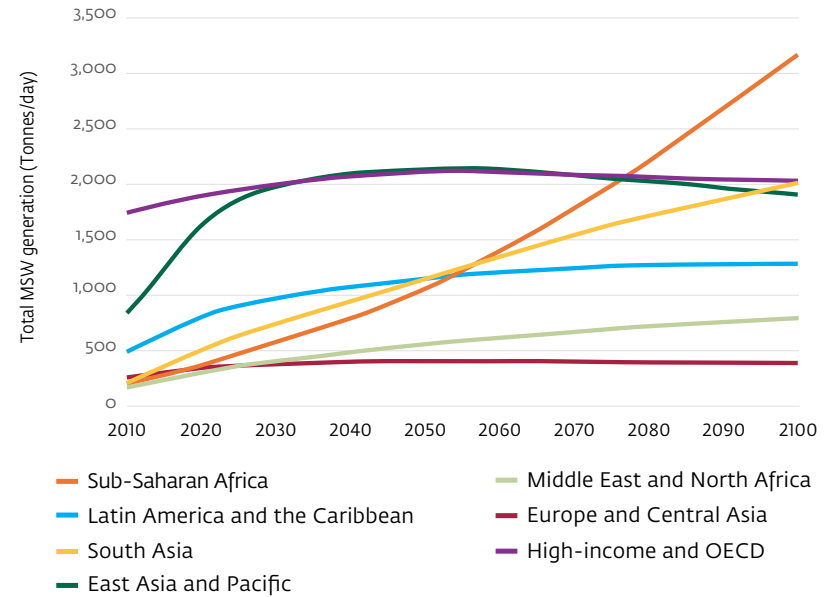


Western Cape Industrial Symbiosis Programme: Connecting companies for waste reuse

The Western Cape Industrial Symbiosis Programme is a free service that connects companies in South Africa so that they can realize new business opportunities by reusing residual materials, energy, water, assets, logistics and expertise. The program is funded by the Western Cape Department of Economic Development and Tourism under its green economy portfolio and is delivered by GreenCape, the province’s sector development agency for the green economy. The program works with a broad range of industries and companies to create mutually beneficial links between member companies. To date, the Programme has diverted over 1,750 tonnes of waste from landfill, saving nearly 5,000 tonnes of carbon dioxide and 5.1 million South African rands (\$373,000) while generating an additional 7 million South African rands (\$512,000) of revenue. The pilot’s success has served as a foundation for a national industrial symbiosis program, and has helped inspire similar programs in KwaZulu-Natal and Gauteng in South Africa.

<http://greencape.co.za/wisp/about-us/about-us/>

FIGURE 16: Total municipal solid waste generation by region



(Source: Global Waste Management Outlook, 2015)

TECHNOLOGY TRENDS AND MARKET OPPORTUNITIES

Resources are recovered from waste to use for other purposes, such as recycling, composting, and energy generation. Global activity in new waste processing facilities is high. Over the past two years, projects to process waste worth more than \$300 billion have been initiated, with \$85 billion directed to processing municipal solid waste. Most of this investment activity is in industrialized countries, including biomass-to-energy projects.³³⁵

WASTE-TO-ENERGY

Strong investment in waste-to-energy is forecast as policymakers work with businesses to unlock the environmental and energy benefits. The global waste-to-energy market was worth \$7.4 billion in 2013, with about 800 waste-to-energy facilities combusting 130 million

metric tons of municipal solid waste.^{336,337} It is forecast to grow to more than \$80 billion by 2022.³³⁸ Estimates suggest waste-to-energy could produce over 470 terawatt-hours of electricity, equivalent to the electricity consumption of Brazil, by 2022.³³⁹ New technologies are also emerging. Thermal combustion and non-thermal combustion (anaerobic digestion and fermentation) are most commonly used, but the costs of advanced thermal (plasma arc gasification, plasma gasification, pyrolysis, and thermal depolymerization) are decreasing.³⁴⁰

REFUSE-DERIVED FUEL

Refuse-derived fuels are increasingly being used for commercial purposes. These solid fuels made from processed waste are used as an alternative fuel in industrial plants (including the cement industry and coal plants), or directly in a waste-to-energy facility. Co-processing of waste in cement kilns is already widely employed across the European Union, but there is large potential for further uptake in other regions.³⁴¹ For example, in Poland, the cement industry consumes about one-third of refuse-derived fuels produced.³⁴² Companies are also exploring ways to convert refuse-derived fuels into aviation fuel, offering the sector a low-carbon fuel option.³⁴³

MATERIAL RECYCLING AND RECOVERY

Waste recovery and recycling markets represent \$265 billion in global revenue.³⁴⁴ Recycling provides income, conserves resources, and reduces waste management costs. Driven by regulations and incentives, recycling rates in countries belonging to the OECD have increased over the past 30 years. In lower-income countries, the informal sector can achieve good recycling rates for solid waste.³⁴⁵ Market share and growth rates vary substantially across material types. The global market for post-consumer scrap metal is estimated to be 400 million metric tons annually; the market for recycling cardboard and paper is 175 million metric tons. Their combined market value is \$30 billion a year.³⁴⁶ The attractiveness of recycling solid waste differs depending on the type of material. Metals, high-grade paper, and in some places high-quality plastic (PET) pay for themselves (see Box 46), while recycling lower-grade paper, plastics, glass, wood, and textiles often represents a net



Supporting private players in the waste-to-energy sector in China

Canvest is the 11th largest waste-to-energy company in China, with a daily processing capacity of nearly 20,000 metric tons of municipal solid waste as of August 2017.³⁴⁷ In April 2016, IFC provided a five-year convertible loan of about \$60 million to help the company expand its waste-to-energy business in a sector dominated by state-owned enterprises. The investment helped Canvest to reduce methane emissions, identify an energy source, and develop ways to dispose of the waste. Demonstrating further confidence in the company, in April 2017, IFC exercised its conversion rights to convert its outstanding loan into shares, translating into a 4.9 percent shareholding of Canvest.³⁴⁸

www.ifc.org



IFC invests in recycling plastic

PetStar was formed in June 2006 to establish a bottle recycling facility in Toluca, Mexico. The facility converts post-consumer polyethylene terephthalate bottles into food-grade, recycled PET resin, which is then sold to the Mexican soft drinks bottling industry. Key elements of the project included:

- Developing a social responsibility program to improve access to education for waste collectors and their children.
- Using a suitable financing structure to enable limited recourse project financing.
- Entering into contracts with equipment suppliers and product off-takers.
- Accessing long-term funding that mobilized other suitable lenders.

www.ifc.org

cost.³⁴⁹ Some municipalities invest in recycling mainly to reduce the net cost of waste management.

Electronic waste recycling and reuse is a growing market. “E-waste” is discarded electronic waste. The global market for e-waste recycling and reuse was nearly \$10 billion in 2012 and is expected to exceed \$40 billion in 2019.³⁵⁰ This growth is driven by increasing e-waste streams and reuse and recycling rates in emerging markets, particularly China.

SMART TECHNOLOGIES AND SUSTAINABLE PACKAGING

By 2014, sustainable packaging became a \$27 billion market, growing at nearly 4 percent annually across three distinct segments: reusables, recyclables, and degradables.³⁵¹ The trend is expected to accelerate, driven by consumer demand and producer and regulatory push for more sustainable packaging. The food and beverage sector constitutes the largest source of demand for sustainable packaging.

Smart technology is emerging in the solid waste sector, with products including solar power trash compactors, integrated waste management systems, and GPS-based route optimization solutions for trash collection. One example is the Bigbelly solar power trash compactor, which allows for up to six times the quantity of trash to fit into the same volume as a traditional disposal unit. It also has an integrated device that alerts municipalities when the container is full, enabling more efficient waste collection. Based on these models, the global market for smart waste collection technology is expected to grow from \$58 million in 2016 to over \$224 million in 2025.³⁵²

BUSINESS MODELS

Innovative business models are attracting private investment in waste. Waste falls under the mandate of municipal governments, which are the dominant investors in the sector. However, as with the water sector, municipal governments can face fiscal constraints and technical capacity shortages, particularly in developing countries. PPPs and micro-privatization efforts can help mobilize the private sector to invest in waste management.



Promoting e-waste recycling in India

Established in 2008, Attero Recycling Private Limited is a pioneer in the nascent domestic e-waste recycling market in India. It uses a proprietary technology to extract various metals from e-waste. IFC helped the company integrate the informal sector into its supply chain. The project focuses on collection centers and public awareness campaigns about proper disposal of electronic and electrical assets. In 2010, IFC’s Venture Capital group invested \$5 million in equity to further expand the company’s capacity to collect and recycle e-waste.³⁵³

www.ifc.org



Sysav: A PPP in waste-to-energy

Sysav is a good example of a successful and long-running waste PPP. It is a public-private company established in 1974 by 14 municipalities in Malmö, Sweden. Supported by a municipal charge of €200 per household for waste management services, Sysav's investments include more than €2 billion in waste-to-energy from 2003 to 2008, €10 million for a food waste pre-treatment plant, and about €30 million for 15 new recycling centers. Sysav succeeded because of close municipal government cooperation, sufficiently high household waste charges, and adequate waste streams. These are all factors that emerging markets can try to emulate to promote PPPs in the waste sector.³⁵⁴

WASTE PPPS

PPPs can help local governments access expertise, financing, and services. New approaches in PPPs in the waste sector combine public sector leadership, private sector skill and efficiencies, community involvement, and innovative financing methods (see final section of this report). Successful PPPs in municipal solid waste start by quantifying the content and volume of the existing waste stream, and then examine appropriate technologies, environmental standards, community engagement, and the availability of experienced private partners. Local governments have established special agencies to help them acquire the skills needed to establish PPPs, such as the China Public Private Partnerships Center.³⁵⁵ To assist governments in China that seek to establish PPPs in the waste sector, the center provides screening, training, and technical support, as well as financial assistance through loans and grants, and operational and contract guidelines.³⁵⁶

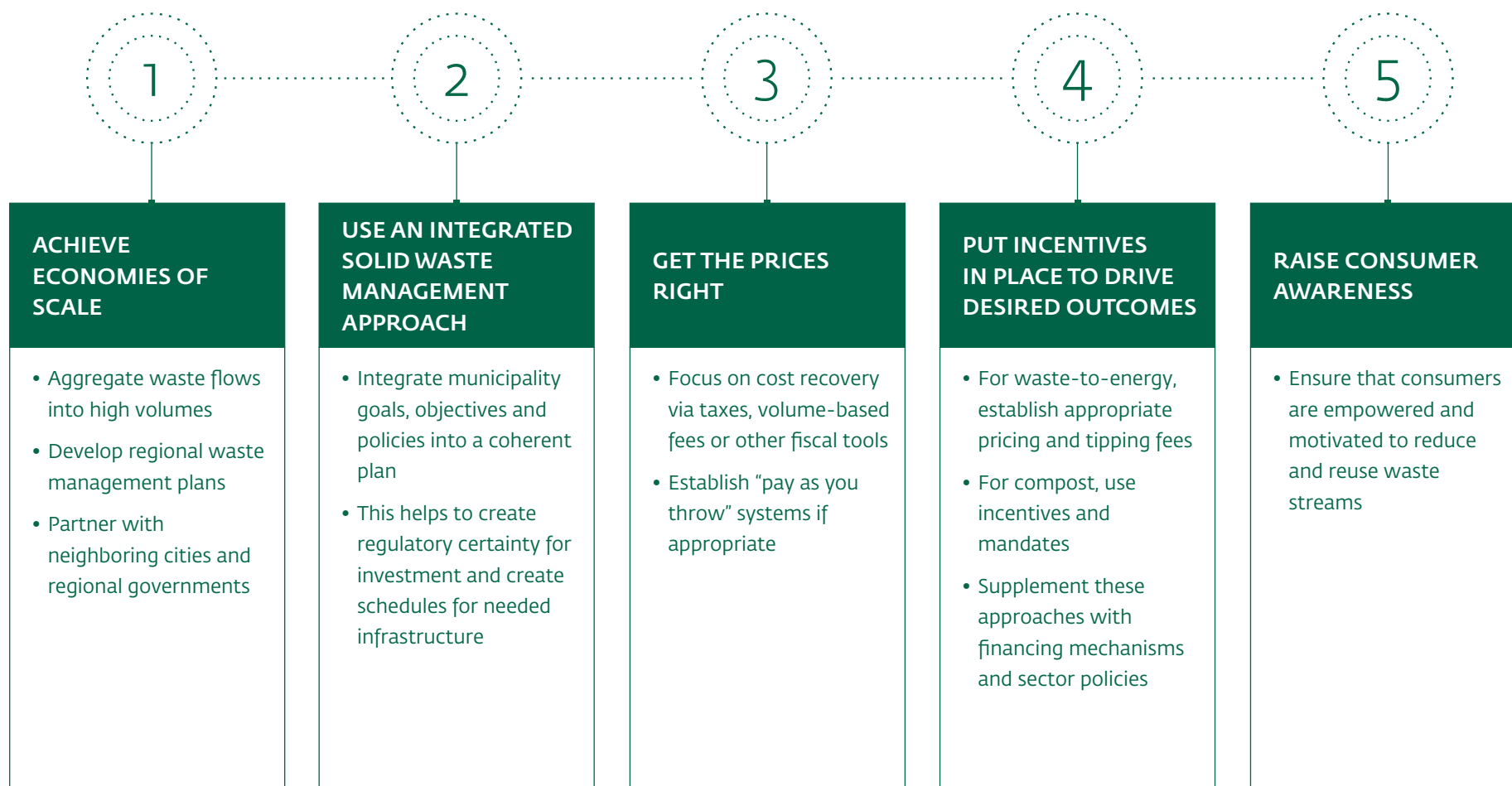
MICRO-PRIVATIZATION

Micro-privatization is a new option for providing community waste services. It involves community-based enterprises providing waste services to neighborhood zones consisting of a few hundred households. This approach has been successful in East Africa, where collection rates and institutional capacity are low: the city of Dar es Salaam in Tanzania uses more than 55 micro-enterprises to provide waste collection.³⁵⁷ Other East African cities are working to replicate this success.³⁵⁸

7.3 Creating markets for climate-smart waste investment

To efficiently manage growing amounts of waste in a climate-smart way, the private sector can contribute technical skills, organizational capabilities, and flexibility. But private sector involvement alone will not solve all the problems. National and local governments can help by aiming for economies of scale and using an integrated solid waste management approach. They can also focus on cost recovery and pricing by using targeted incentives. Finally, consumer and household outreach

FIGURE 17: Steps to create markets for climate-smart waste management





Integrated solid waste management

Integrated solid waste management provides a comprehensive approach to managing waste, and is based on the hierarchy of waste management: reduce, reuse, recycle—often adding a fourth “R” for recovery. These waste diversion options are followed by incineration and landfilling. It acknowledges the critical role that the community, employees, and local (and increasingly global) ecosystems play in ensuring effective waste management.

Integrated solid waste management consists of three interdependent and interconnected dimensions, which need to be addressed simultaneously when designing a solid waste management system: stakeholders, elements, and aspects.

- **Stakeholders:** Individuals or groups that have an interest or roles in the sector. All stakeholders

should be identified and, where practical, involved in creating a solid waste management program.

- **Elements (process):** The technical aspects of solid waste management. All stakeholders affect one or more of the elements. The elements need to be considered when creating a solid waste management program to ensure it is efficient and effective.
- **Aspects (policies and impacts):** The regulatory, environmental, and financial context in which the waste management system operates. Specific aspects can be changeable, for example, a community increases influence or environmental regulations are tightened. Measures and priorities are created based on these various local, national, and global aspects.

Source: World Bank 2012: What a Waste³⁵⁹

and education is vital to reduce waste streams and maximize recovery of useful resources.

STEP 1: ACHIEVE ECONOMIES OF SCALE.

Ensuring adequate waste volume is crucial to justify investment in infrastructure and technology. Economies of scale and well-managed reverse supply chains are needed. Aggregating waste flows into high volumes will ensure more value can be recovered. Developing regional solid waste management plans and working in partnership with neighboring cities and regional governments helps to share costs and risks, and makes the investment more attractive to the private sector.

STEP 2: USE AN INTEGRATED SOLID WASTE MANAGEMENT APPROACH.

This helps to create regulatory certainty for investment and schedules for needed infrastructure. The plan should be financially robust and review all potential options. It can also provide an assessment of the potential to reduce greenhouse-gas emissions. The plan should be underlined by transparent and reliable data and forecasting for its duration. It should include an outline of the detailed plan and schedule of public consultations.³⁶⁰

STEP 3: GET THE PRICES RIGHT.

Various cost-recovery strategies can be used to pay for waste management services. Landfill taxes have proven to be effective in regions like Western Europe, but need to be managed in developing countries to avoid illegal dumping.³⁶¹ In South Korea, volume-based waste fees have resulted in lower waste generation and increased waste reuse.³⁶² Municipalities have successfully used direct billing, property taxes, and sales taxes to support municipal solid waste management, as well as “pay as you throw” systems that make polluters pay for disposal.

STEP 4: PUT INCENTIVES IN PLACE TO ACHIEVE THE DESIRED OUTCOMES.

For waste-to-energy solutions, establish appropriate pricing and tipping fees. Pricing support can come from feed-in tariffs, renewable energy



Policies are helping foster waste-to-energy markets in China

China has implemented various policies to encourage private investment in waste-to-energy. The government grants concessions to private partners to build, finance, and operate waste-to-energy plants.³⁶³ China's 12th five-year plan targets more than \$12 billion worth of investment for waste-to-energy—about half of the country's total investment in municipal solid waste.³⁶⁴ Furthermore, waste-to-energy plants benefit from a tax exemption of 5 percent, a feed-in tariff of \$0.04/kWh, and tipping fees ranging from \$9.30/metric ton to \$14.30/metric ton.³⁶⁵ These policies make China an attractive waste-to-energy market for the private sector. For example, backed with a funding package from the Asian Development Bank that is based on PPPs with municipal governments and agreements with 10 commercial banks, Dynagreen Environmental Protection Group is set to build nine new plants by the end of 2018.



Pilot Auction Facility: Innovative climate finance for urban waste solutions

In May 2016, 21 companies took part in a pilot online auction managed by the World Bank Group. The nine winners received \$20 million in financing to reduce methane emissions from waste management. The auction was the second in a series of pilots by the Pilot Auction Facility for Methane and Climate Change Mitigation, which tests multiple auction formats that are intended to attract private sector investment while efficiently reducing emissions.³⁶⁶

auctions, renewable energy certificates, access to qualified end users, preferential grid access, and wheeling fees. The European Union is the leading marketplace for waste-to-energy due to its Waste Framework Directive. This directive, combined with a price on carbon under the European Union's Emissions Trading System and national renewable energy support mechanisms, provides profitability and predictability for waste-to-energy providers in countries such as Germany and Sweden.³⁶⁷ China provides an example of a national market that uses a combination of financing, economic instruments, PPPs, and feed-in tariffs to drive growth in waste-to-energy plants (see Box 50). The World Bank Group is also innovating new financial tools to help finance methane emissions reductions in the waste sector via the Pilot Auction Facility (see Box 51).

Financial and contractual approaches help secure private sector investment in waste. Governments can encourage private sector investment in climate-smart waste infrastructure and services through subsidies, tax credits, grants, funds, and compensation for facility hosting. Incentives can be paired with long-term contracts to provide private partners and investors with predictable waste and revenue flows. For example, in Quebec, Enerkem, a firm that generates cellulosic bioethanol from non-recyclable household waste, invested 115 million Canadian dollars in a methanol-to-ethanol unit at its production facility in Edmonton. This private equity investment is driven by a guarantee from the city to provide a consistent waste supply for the next 25 years and a payment of 75 Canadian dollars per metric ton of waste used.³⁶⁸ The long-term contract and reliability provided by the city has provided the certainty for Enerkem to undertake significant, long-term investments in refuse-derived fuel production.

STEP 5: RAISE CONSUMER AWARENESS.

This is key to ensuring that consumer behavior supports waste reduction, recycling, and reuse of easily converted waste streams. For example, the success of the Waste Electrical and Electronic Equipment Centre in Kenya hinges on outreach campaigns that collect and encourage recycling of e-waste (see Box 52).

Changing consumer behavior in Kenya

The Waste Electrical and Electronic Equipment Centre shows how social education can help ensure business profitability. In Kenya, an average of 3,000 tons of e-waste is generated each year with little capacity for proper management. In response, in 2002 the center was established. It is run by local entrepreneurs and supported by various national and international sponsors. It sources e-waste through local campaigns aimed at households and then separates waste into two streams: repair and refurbishment and recycling and dismantling. Worldloop provided seed capital, which is tied to meeting the center's collection targets. The center is now 73 percent self-sustaining.³⁶⁹



7.4 Initiatives, tools, and resources



The **International Solid Waste Association (ISWA)** is a nonprofit association that promotes and develops professional waste management worldwide.

www.iswa.org



The **Climate and Clean Air Coalition's Municipal Solid Waste Initiative** aims to reduce emissions of methane and other short-lived climate pollutants from the solid waste sector. This government-led initiative runs webinars and shares information through its knowledge platform.

<http://www.waste.ccacoalition.org/>



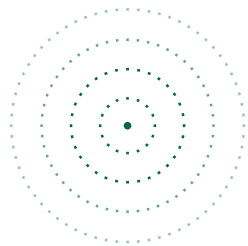
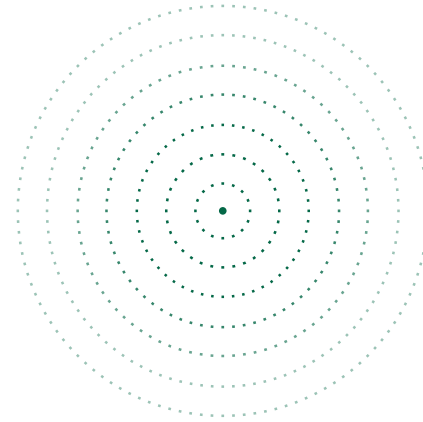
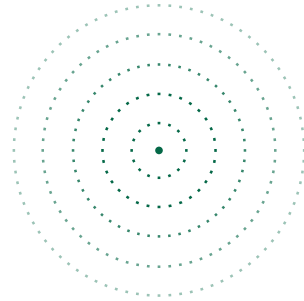
The **C40 Cities Waste to Resources Network** aims to help cities accelerate the transition from solid waste management to sustainable materials management, including resource recovery, through dialogues and resources on topics such as segregated collection, waste minimization, food waste avoidance, greenhouse-gas accounting, and vision/roadmap setting.

<http://www.c40.org/networks/waste-to-resources>



The **World Economic Forum's Platform for Accelerating the Circular Economy** partners with the Ellen MacArthur Foundation to accelerate the transition to the circular economy through Project Mainstream—a CEO-led initiative to increase business-driven innovations in the sector.

<https://www.weforum.org/projects/circular-economy>



Making It Happen: Cross-Cutting Solutions for Market Creation

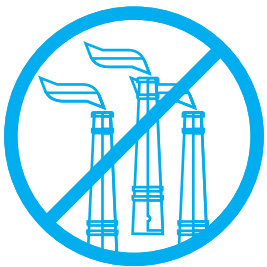
Key indicators



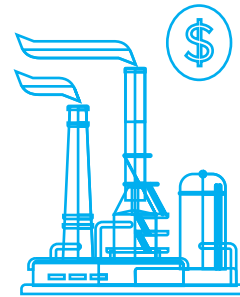
More than **two-thirds** of institutional investors are planning to increase low-carbon investments.



The global green bonds market was **\$221 billion** in 2017, and saw a **6x rise** between 2013 and 2016.

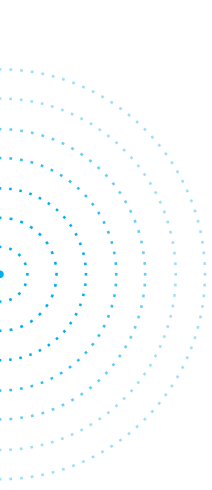


Nearly **30** countries have implemented progressive fossil fuel reforms.



Over **half of countries** will use a carbon price to achieve their climate targets; **1400+** companies are putting in place internal carbon pricing.





Making It Happen: Cross-Cutting Solutions for Market Creation

This report has shown that markets are being successfully created to leverage more private financing for low-carbon sectors. To accelerate the creation of markets, countries can take certain steps as they begin to implement their commitments. To maximize the use of scarce public resources, governments are ensuring that public policies, financial regulation and investment conditions are designed to enable shifting investment flows into climate business. This includes helping to grow demand for green finance, using blended finance in a way that maximizes scarce public funds, and putting in place the right policies and incentives—such as carbon pricing—that level the playing field for investors.

When considering how to attract private finance for low-carbon investment opportunities, it is important to ensure that different investment risks are identified and allocated appropriately between private investors, public entities and consumers. Many risks, such as construction and operating costs, are generally better managed by private investors. Other risks are better managed by governments or development banks, or transferred to consumers. If private investors are asked to address risks they are not well-placed to manage (e.g., policy and planning risks), financing costs will be much higher, or private investors may not be interested in the investment. A strategic approach to identifying and allocating risks could help to significantly reduce the overall costs of financing clean infrastructure. In two renewable generation case studies CPI-Energy Finance analyzed, they found cost savings of 10 to 40 percent (see Box 53).

The issue of enabling greater private sector investment in climate adaptation and resilience measures is also quickly emerging as a top priority for governments and business (see Box 55).

PATHWAYS TO GROW GREEN FINANCE

Recognizing the vital role of the financial sector in delivering the Paris Agreement, policymakers are putting in place financial regulations and catalyzing financial innovations to align with a greener future. Green finance has risen to the top of the G20's political agenda and is central to the economic development strategies of China and Europe.³⁷⁰ Central banks, financial regulators, and other government bodies are taking a variety of actions, including standardizing what counts as “green,” mandating environmental stress tests for financial institutions, asking for improved climate risk disclosure and reporting, implementing tax incentives, reducing capital requirements for green loans, and ensuring fiduciary duties encompass sustainability.

The market is shifting and green finance is becoming mainstream. A recent HSBC survey shows that more than two-thirds of institutional investors are planning to increase low-carbon-related investments to tackle climate change and accelerate the transition to a clean energy economy. Growing investor appetite for low-carbon investments is strongest in Europe (where 97 percent of investors have expressed interest), the Americas (85 percent), and Asia (68 percent). The Middle East (19 percent) is the only region to experience an annual decline in this trend.³⁷¹

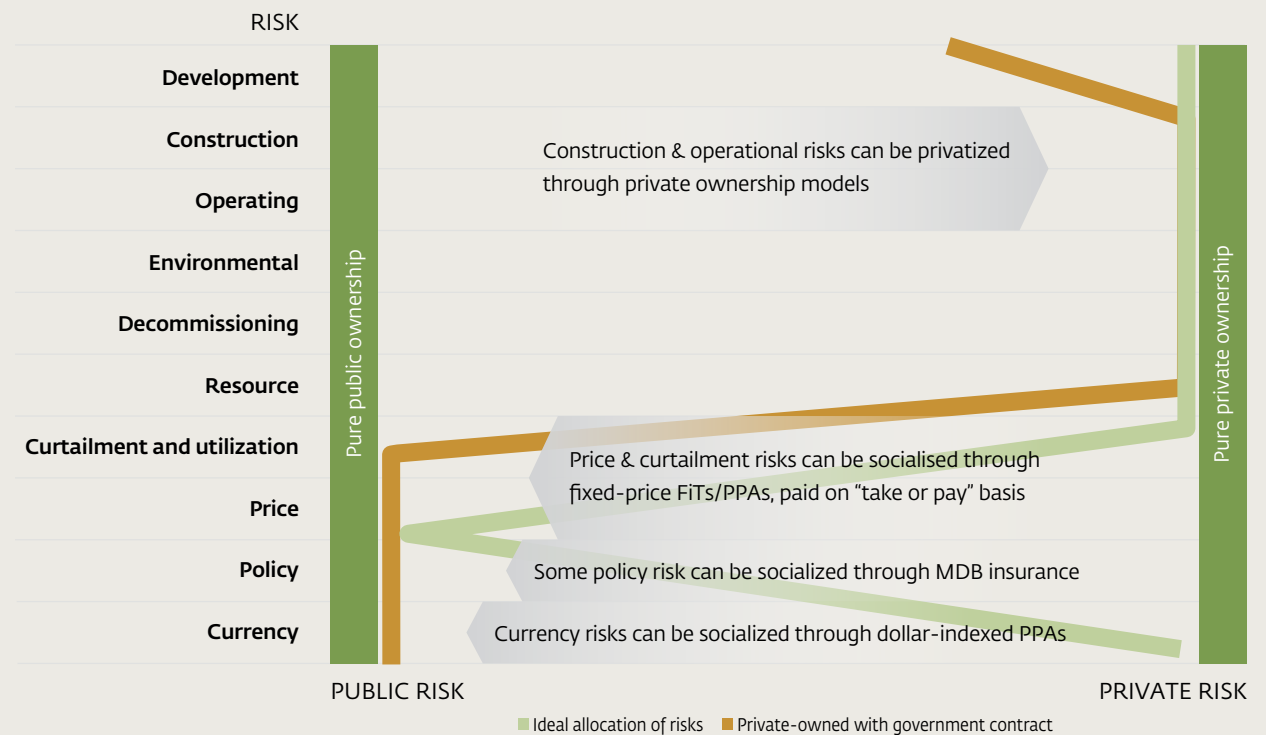
Getting the risk allocation correct is fundamental to lowering the cost of investments

The right allocation of risks varies depending on the type of investment and the country context. This ideal allocation of risks can then be achieved through a blend of ownership models, policy, regulation and specific finance instruments. Figure 18 shows a stylized example of optimal risk allocation for solar investment in a developing country. This approach to choosing ownership models and policy/finance instruments can be applied across all types of infrastructure investments.

For example:

- Construction and operational cost risks, typically best managed by private investors, can be privatized through private ownership models.
- Price and curtailment risks are more difficult for private investors to manage. Risk exposure here has a major impact on the private cost of capital with little offsetting benefit in operating efficiency. Curtailment risks can sometimes be addressed through long-term fixed price power purchase agreements with a state-owned utility or paid on a “take or pay” basis. Policy risks can also be partially transferred from private investors through development bank policy risk insurance or guarantees.

FIGURE 18: Illustration of achieving an optimal risk allocation for a solar investment in a developing country

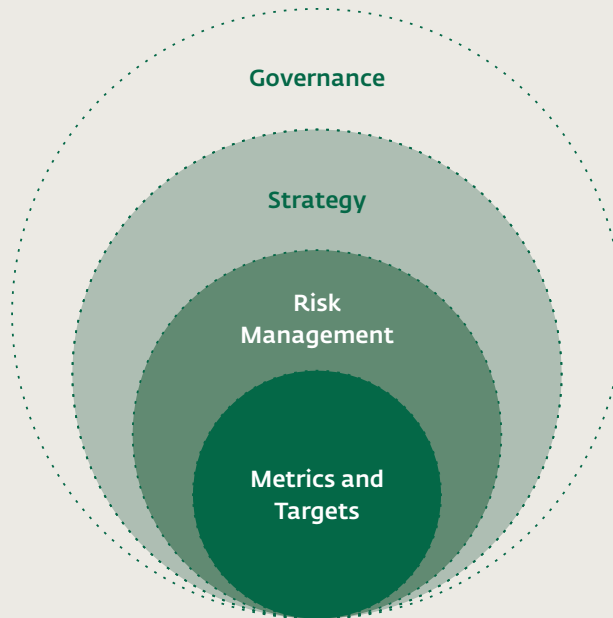


(Source: edited from Climate Policy Initiative³⁷²)

The Task Force on Climate-Related Financial Disclosures: Understanding climate risk and opportunity

The Financial Stability Board established the Task Force on Climate-Related Financial Disclosures to develop recommendations for more effective climate-related disclosures that “promote more informed investment, credit, and insurance underwriting decisions,” that in turn “would enable stakeholders to understand better the concentrations of carbon-related assets in the financial sector and the financial system’s exposures to climate-related risks.”³⁷³ The task force developed four recommendations on climate-related financial disclosures that apply to organizations across sectors and jurisdictions. The recommendations are structured around four thematic areas that represent core elements of how organizations operate:

- **Governance**— The organization’s governance of climate-related risks and opportunities.
- **Strategy**—The actual and potential effects of climate-related risks and opportunities on the organization’s business, strategy, and financial planning.
- **Risk management**—The processes used by the organization to identify, assess and manage climate risks.



- **Metrics and targets**—The metrics and targets used to assess and manage relevant climate-related risks and opportunities.

The Task Force also encouraged forward-looking information through scenario analysis, including a two degree Celsius or lower scenario, to help investors and other stakeholders understand how resilient organizations’ strategies are to climate-related risks.

There have been strong statements of support from market actors, including members of the World Economic Forum’s Alliance of CEO Climate Leaders.³⁷⁴ In addition, 13 of the world’s leading banks, with more than \$7 trillion in assets, have launched a pilot program to implement the task force’s recommendations, with support from the United Nations Environment Programme Finance Initiative.³⁷⁵

“These recommendations are very welcome. The impact of climate change and the transition to a lower-carbon economy deserve board-level scrutiny and governance. Independent research commissioned by HSBC shows that less than a quarter of companies currently disclose their environmental impact. This makes it very difficult for analysts and investors to assess and compare how sustainable these companies are. These recommendations are a practical and pragmatic response to the need for consistent and comparable climate-related financial disclosure.”

— **Stuart Gulliver**, Chief Executive Officer, HSBC³⁷⁶

www.fsb-tcfd.org



Knowledge is power: Building private sector climate resilience

Events like heatwaves, droughts, storms, and floods are becoming stronger and more frequent. The global costs of extreme weather and climate events are already on the order of tens of billions of dollars annually—in the United States alone in 2016 they amounted to more than \$50 billion.³⁷⁷ These dramatic changes can have significant effects on companies' operations and market conditions in general. Given that information is central to operations and investments, the ability to anticipate and manage the direct and indirect effects of climate change is an increasing concern for business.

A recent report³⁷⁸ done by the National Business Initiative in South Africa surveyed businesses on emerging climate adaptation practices, challenges and needs. Companies asked for locally relevant climate data and tools to help them better understand impacts on a facility and operational level. This reinforces findings of an earlier adaptation market study³⁷⁹ done in Turkey by IFC, which found that companies want information about changing climate conditions that are relevant for their operations and investments.

Many companies are becoming more climate resilient by incorporating improved climate

information in their business decisions. Bodegas Torres, a Spanish winemaker that produces wine in Spain, Chile and the United States and distributes its products to over 140 countries, is using models to examine the impacts of increased frequency and intensity of heatwaves and droughts in the future. Having that information allows the company to address risks, by investing in grape varieties that are better adapted to changing conditions and by introducing new management practices. The company is also acquiring land where climate conditions today do not allow proper grape ripening but where, the models show, conditions will be optimal in the near future.

Better climate information can also help insurance companies structure and offer products that can protect against the new weather extremes. While businesses are adapting their operations to the new climate normals, financial impacts of the new extremes—weather events that have low probability of happening even when accounting for the current effects of climate change—can be mitigated by using such insurance products.

Some multilateral development banks are developing informational tools and products to help improve

climate resilience and adaptation interventions in the private sector. For example, in addition to providing financing, IFC is developing sectoral climate risk management tools that help companies assess the effects of climate change on their operations, and informational tools that identify adaptation options and investments for specific sectors. These tools begin to respond to the private sector's need for locally relevant climate change data.

For example, a tool for the forestry and pulp and paper industry evaluates events that can be expected in the near future at specific locations, such as forest fires, drought, the spread of pests and diseases, and changes in precipitation and floods. It also shows the geographical change in the optimal growing zones for commercial species, allowing companies to identify new regions where species may be successfully grown. Similar tools are available for other sectors, such as ports and waterways, roads, and airports. The African Development Bank is developing a new adaptation benefit mechanism³⁸⁰ that seeks to help private clients identify adaptation investments by communicating a price signal that spurs developers to adopt resilient technologies.



China leads the way to greener finance

China needs to mobilize private capital on a massive scale to finance the carbon-emission reduction it has pledged to achieve. China introduced Green Credits in 2012³⁸¹ and is, to date, the only country to have introduced standardized mandatory reporting on green loans for its largest banks. It has established the world's biggest green credit market, with more than \$1 trillion in green credits.³⁸² The loans cover energy saving, green transport, pollution treatment, and resource recycling. China has also created guidelines to encourage private capital to invest in green sectors while restricting investment in polluting industries. It plans to use public funds to improve the returns on green projects, through interest subsidies, for example, while reducing perverse subsidies and raising taxes on pollution.

"There is a strong momentum globally to use green finance solutions to drive private investment needed to address environmental and climate challenges. China has developed definitions and disclosure rules for several green finance products, including green loans and green bonds, and is aggressively pushing for new instruments such as green investment funds, green insurance and carbon finance. The central and local governments will introduce additional incentives to unlock private capital at the scale for green and sustainable investment."

— **Dr. Ma Jun**, Chairman of Green Finance Committee of the China Society for Finance and Banking and Co-chair of G20 Green Finance Study Group

Pathways that governments can take to catalyze green finance flows include: leveraging green lending through the commercial bank market, supporting the green bonds market, or establishing a green investment bank (as well as blended finance, see section below). Regardless of which pathway is taken, there are three basic principles that apply:³⁸³

- Establish green finance typologies and standards consistent with policy targets and green finance needs.
- Set clear guidelines for evaluating and selecting green projects, and managing money flows.
- Ensure transparency and reporting to track progress and avoid “greenwashing” (when an entity claims to be more environmentally friendly than it really is), which could undermine confidence in green finance.

GREEN LENDING

Green lending practices are at various stages of development in different countries. A bank's response to environmental challenges depends on its size and capacity, as well as the market and regulatory context in which it operates. Challenges include:

- No universally accepted framework for green lending.
- A maturity mismatch for lending: Short-term funding of long-term assets.
- Lack of environmental, social and governance information.
- The inability of the banking sector to fully assess the highly complex and evolving risks associated with climate change (see Box 54).

A survey of IFC's financial clients in 2016 revealed that 61 percent of the responding institutions provided climate-related or green financing, but only a small percentage of bank lending is explicitly classified as green because of a lack of consistent, easily accessible definitions.³⁸⁴ Banks' lending capacity is also constrained by capital requirements—depending on the state of capital markets, banks can consider selling or securitizing their loan books to address this issue. To address green finance

challenges, G20 members—and China and Germany in particular—have prioritized green finance (see Box 56).

The market is innovating. Dutch Bank ING recently launched a new type of green loan for general corporate expenditures. The loan does not have conditions for the green use of proceeds; instead, a company’s overall sustainability performance and rating determine the interest to be paid on the loan. If the rating goes up, the interest rate goes down—and vice versa. For example, in April 2017, electronics giant Philips entered a revolving credit facility of €1 billion with ING using this approach. The deal is the first in the syndicated loan market where the pricing is linked to the lender’s sustainability rating. It is supported by a consortium of 16 banks, including Goldman Sachs, HSBC, and Morgan Stanley. This innovation recognizes that sustainable companies are better credit risks and provides an additional incentive for companies to improve their sustainability performance. ING funded more than €27 billion to clients aiming to green their operations in the first two quarters of 2016 and the market is growing.³⁸⁵

GREEN BONDS

A green bond is distinguished from a regular bond by its proclaimed commitment to exclusively use the funds raised to finance projects with clear environmental benefits. Green bonds can provide long-term sources of debt capital to match the funding required for long-term green infrastructure projects, helping countries achieve their climate targets. While there are currently no global standards for green bonds nor a definition of “green” in the context of eligible assets, there are several initiatives that underpin the generally used nomenclature. The Green Bond Principles,³⁸⁶ Climate Bond Standards,³⁸⁷ assurance providers and benchmark indices all play an important role in promoting transparency and integrity in the development of the green bond market through various frameworks, taxonomies and qualifying criteria on bond issues and categories of eligible projects. Green bonds can directly finance or refinance investments that could allow for “recycling” of lending capacity, leading to increased lending. Green bonds are increasingly attracting a much more diverse base of investors, pooling in new capital into climate business. As project sponsors learn more about green bonds,



Colombian banks: creating markets for climate business via green bonds

The Colombian banking sector has taken the lead in Latin America in addressing climate change by deploying green bonds to scale up climate finance. Bancolombia and Davivienda were the first private banks Latin America to issue green bonds, mobilizing private finance that will help Colombia achieve its NDC pledge of reducing emissions by 20 percent. Bancolombia is using the funding to step up its lending to green buildings that reduce water and energy consumption by as much as 40 percent, while Davivienda will finance projects that address flooding risk, improved water management and the production of cleaner energy. IFC fully acquired both issuances, opening the door for institutional investors to invest in these instruments in the region, and helped the banks to follow the Green Bond Principles, helping establish this standard as the reference for new issuances. Other banks in the region are expected to follow this example.

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Green finance innovations continue to create new markets

IFC recently partnered with the asset management company Amundi to launch the world's largest green bond fund dedicated to emerging markets—the **Green Cornerstone Bond Fund**. The \$2 billion fund will buy green bonds issued by banks in developing countries, which in turn will encourage more local financial institutions to issue green bonds by increasing global demand and building local markets.

"This innovative partnership with IFC is a major achievement for Amundi, the leading European asset manager. This project highlights the strong capabilities in green financial innovation of Credit Agricole Group. I consider this project as a game changer: it is both an investment opportunity for institutional investors and it will have an impact on society by accelerating the shift of emerging markets toward a green economy."

— **Xavier Musca**, Amundi SA

Zurich Insurance Company recently fulfilled its pledge to buy \$2 billion of green bonds—about three-and-a-half years after announcing the target.

The company could have met its mandate sooner, but part of the objective was to help the market grow and develop. Zurich has invested in more than 120 green bonds from 75 issuers in seven currencies.

"The next stage of the evolution of the market is probably one in which there's much more clarity and objectivity in the assessment of greenness."

— **Urban Angehrn**, Group Chief Investment Officer, Zurich Insurance Group

The market is also testing new green bond models, including the green sukuk³⁸⁸ and green coupon bonds like **IFC's Forest Bond**. The first green sukuk was recently issued in Malaysia by Tadau Energy, a renewables company. The proceeds of the 250 million Malaysian ringgit (\$58 million) bond will be used to finance a 50 MW solar power project. The green sukuk could encourage green finance growth in Islamic regions in the Middle East, Asia, and Africa. In October 2016, IFC issued a Forest Bond, a first of its kind, to reduce emissions from deforestation and forest degradation (REDD) and develop sustainable

economic opportunities for communities in Kenya. The bond gives investors the option of getting repaid in either carbon credits or cash, and raised \$152 million—with \$12 million targeted directly at reforestation efforts.³⁸⁹

Financial institutions are also collaborating as never before to open up new markets for climate business for climate business, including via the **Catalytic Finance Initiative**.

"We launched the Catalytic Finance Initiative in 2014 to accelerate investments into high-impact clean energy and other sustainable opportunities. Financial innovation and capital play a critical role in the transition to a low-carbon economy. Together with our partners, including IFC, we have already succeeded in raising more than \$8 billion for investments. This is demonstrating the power of partners working together on innovative green finance to achieve a greater collective impact."

— **Anne Finucane**, Vice Chairman, Bank of America

projects are structured in a manner to attract green bond financing which should in time increase project pipelines.

The growth in green bonds and investor demand indicates that the market could significantly help increase green capital flows. The size of the global green bond market stands at \$221 billion in 2017, and saw a six fold rise between 2013 and 2016.³⁹⁰ While this is impressive, there is ample room for growth.

Initially, the market was driven by multilateral institutions, but now there is a range of issuers, with an increasing number of corporations, banks, municipalities, and governments issuing green bonds. The European Investment Bank, German development bank KfW and the World Bank are still the largest issuers, but Chinese SPD Bank is in fourth place, and among corporates, Iberdrola, TenneT Holding, and French energy companies EDF and Engie round out the top 10.³⁹¹ The geographic base is also expanding. Since 2016, about 35 percent of green bonds were issued in emerging markets.³⁹² The first sovereign green bond was issued by Poland in December 2016, followed by France in January 2017. Sovereign issuance is expected to grow; in October 2017, Fiji became the first emerging market to issue a sovereign green bond, raising 100 million Fijian dollars, or \$50 million, to support climate change mitigation and adaptation.³⁹³

Green sovereign bonds allow governments to raise capital to implement infrastructure plans in line with their NDCs. A sovereign green bond can provide liquidity and scale to a market, attracting other corporate issuers and new investors. It can also improve collaboration between ministries and improve policy certainty in the country. Green bonds are playing an increasing role in helping cities to finance climate-smart urban infrastructure. Green bonds issued to fund climate-smart cities grew to \$10 billion in the first half of 2017, up by 61 percent from the previous year.³⁹⁴ However, few cities in emerging markets have issued green bonds, largely as a result of their low credit standing. Johannesburg in South Africa issued a 1.5 billion rand green bond in 2014 and Cape Town issued a 1 billion rand green bond in 2017. These bonds fund renewable energy, water, and sanitation projects.



The green bond market faces several challenges, including an insufficient pipeline of bankable projects, a lack of commonly accepted standards and definitions, underdeveloped local bond markets, and a scale mismatch between projects, bonds, and institutional investors. To address these issues, policymakers can develop green bond guidelines and build market capacity through dedicated green bond market programs. These programs may focus on enhancing credit to improve the rating of the bond, introducing tax incentives for investors or issuers, and reducing the cost of bond issuance and reporting.

All green finance approaches—green banking, green investment banks, and green bonds—send a positive signal to the marketplace and other countries that a country or region is seeking to become a leader in private low-carbon investments. It is important to note that they complement, but do not replace, the need for progressive climate policies that create the conditions to stimulate low-carbon investments.

GREEN INVESTMENT BANKS

Governments can establish dedicated green investment entities to overcome investment barriers and leverage public finance. Green investment banks are entities that are established to facilitate private investment in low-carbon and climate-resilient infrastructure. They catalyze investment by decreasing risks, increasing market transparency, and improving investor and lender understanding of low-carbon investments. Many green investment banks take on risks that other financial actors would avoid by providing some type of concessionality, such as longer loan tenors. There is a similarity between these entities and blended finance approaches (see below).

Thirteen governments (national, provincial/state, and local) have tested different models for green investment banks—nearly all in OECD countries.³⁹⁵ They have successfully mainstreamed new technologies and business models, and brought in private capital. While green investment banks differ in scope and approach, they have similar mandates, have the independence to design and implement interventions, and share a focus on cost-effectiveness and performance. Governments have capitalized these banks using a variety of funding sources, including

government appropriations and programs, revenue from carbon taxes, emissions trading schemes, utility bill charges, and bonds.

Green investment banks use a range of financial instruments, including senior and subordinate loans and equity. They also use various risk management strategies such as loan loss reserves, guarantees, or insurance alongside warehousing, securitization, co-investing, on-bill financing and leasing. These banks typically have a mandate to avoid “crowding-out” private investment and often finance riskier projects, such as new technologies with less attractive risk-return profiles. Banks can demonstrate accountability and validate performance by using metrics to measure and track their performance, including emissions reductions, the private investment mobilized per unit of bank spending, and rates of return.

When setting up a green investment bank, it is important to consider:³⁹⁶

- **Administration, mandate, and independence.** Will the bank be a new entity, or can existing entities be adapted?
- **Capitalization and financial sustainability.** How much capital is needed? How will the bank be funded? Will there be a profit or other leverage target established?
- **Leadership and staffing.** Green investment banks require strong private sector expertise in transacting business, building a financially sound portfolio, and mobilizing private capital. The staff should be independent of the political decision-making process.
- **Oversight, transparency, and accountability.** How will success be tracked and reported? What are the most important targets?

In emerging markets, green investment banks should ideally be set up as public-private partnerships that can combine public resources with private sector expertise and investment rigor. One example of this approach is Tata Cleantech Capital Limited, a joint venture between Tata Capital and IFC. Tata Cleantech has worked with over 40 clients to identify, evaluate and fund renewable energy, energy-efficiency and water treatment investments.³⁹⁷ This model can be repeated to scale up investments in other regions.

Mocuba Solar: Blended finance for mitigation and adaptation in Mozambique

Mozambique's electrical grid infrastructure has not kept pace with domestic demand for accessible and reliable modern energy supply.³⁹⁸ Only 40 percent of Mozambican households have access to electricity—with rural electricity access at 27 percent.³⁹⁹

Responding to these challenges, Norway-based independent power producer Scatec Solar partnered with Mozambique's electricity utility (Electricidade de Moçambique) and Nortec, Norway's development finance agency, to develop the country's first utility-scale solar PV plant in Mocuba. The \$76 million project will help deliver power to a rural area in one of the least-developed regions. Mocuba Solar will also contribute to climate resilience and adaptation

by diversifying Mozambique's electricity generation mix and reducing dependence on the country's isolated northern grid. The project, operated under a 25-year power purchase agreement with Electricidade de Moçambique, will also produce electricity more affordably than fossil-fuel-based alternatives.

Representing its first engagement in Mozambique's renewable energy sector and first solar PV project in Sub-Saharan Africa, IFC arranged a \$55 million debt finance package for the Mocuba Solar project. This includes a \$19 million loan from IFC, \$19 million from the Climate Investment Fund's Pilot Program for Climate Resilience, and a \$17 million syndicated loan

from the Emerging Africa Infrastructure Fund. The project also received a \$7 million viability gap funding grant from the Private Infrastructure Development Group. The remaining \$14 million in project costs was raised by selling of equity in the project company, Central Solar de Mocuba S.A. While recent macroeconomic instability has shaken investor confidence in Mozambique, projects like Mocuba are demonstrating how Mozambican renewable energy projects remain a viable and attractive opportunity for commercial financing.

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HOW CAN BLENDED FINANCE HELP DELIVER NDC INVESTMENT GOALS?

Blended finance—combining concessional funds and commercial financing—can help create markets in climate-smart industries and contribute to a country’s transition to a low-carbon economy. Private sector investors and financiers generally look for a track record before making investment decisions, but emerging sectors and new companies have limited or no history of operational and financial performance, which makes them a high risk for investors. Blended finance demonstrates to private developers and financiers that these sectors can be profitable, which in turn can stimulate a series of follow-on investments, often on fully commercial terms. Most, if not all, NDCs will require new and additional investments in climate-friendly technologies and projects, particularly from the private sector. Blended finance can play an important part to catalyze these investments.

When done well, blended finance serves as a highly effective catalyst for high-risk, nascent markets in developing countries. Since 2010, IFC has blended \$442 million in concessional climate finance from donors to support climate mitigation and adaptation investments. These concessional funds leverage about \$1.4 billion in IFC cofinancing and roughly \$4 billion in third-party financing. These investments have supported pioneering projects, including innovative energy-efficiency financing in Turkey, solar PV facilities in Thailand, and a solar PV plant in Mozambique.

Poor use of concessional climate finance in private sector investments can lead to market distortions, such as over-subsidization, windfall gains, and inappropriate risk allocation, that undermine market creation and transformation. Proper use of blended finance requires a careful understanding and navigation of these potential pitfalls, by promoting adherence to high standards of governance by private sector clients and entities that undertake blended finance operations.

CREATING MARKETS FOR GREEN INNOVATION

The investment needs in green sectors for developing countries are expected to be immense, with huge opportunities for local firms.

According to a report released by the World Bank Group, *Building Competitive Green Industries*, up to 25 percent of climate investments in developing countries are available for local small and medium enterprises.⁴⁰⁰ Innovation is taking place in many emerging markets as clean technology is transformed into commercial business opportunities. Another World Bank Group report, *Innovations for Scaling Green Sectors*, outlines how advances in renewable energy, climate-smart agriculture, and clean water create opportunities for companies to address development challenges with cleaner, more climate-friendly technologies and practices.⁴⁰¹

There are many opportunities to grow green enterprises in a range of selected climate markets, including solar home systems, community water purification, and drip irrigation.

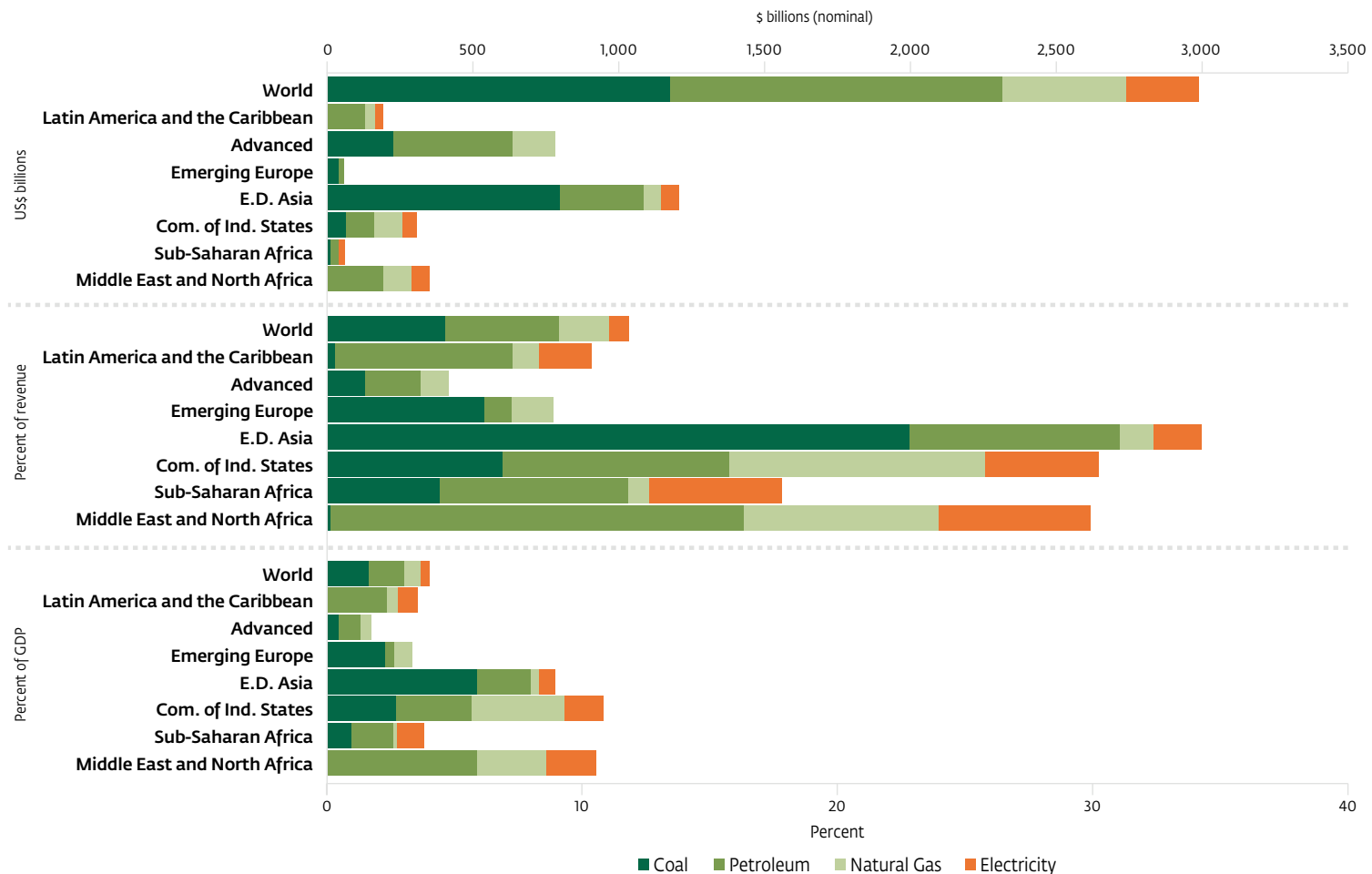
The first factor to consider is how climate-related sectors differ from other sectors. Green sectors are different from other sectors in that the majority of green enterprises deliver physical products to market and are highly dependent on the quality of regulatory regimes and the public sector in general. Green businesses can have high upfront capital needs and commonly take longer to reach profitability than enterprises in more well-established sectors.

Emerging models offer lessons for how governments can create markets that drive climate innovation with successful local private sector participation. World Bank Group initiatives like Climate Competitive Industries⁴⁰² and the Climate Technology Program⁴⁰³ help local private sector actors take advantage of opportunities for climate innovation. These and other efforts provide a blueprint for actions that governments can take to foster private sector-led innovation in this area.

Although experimentation and iteration are needed to encourage new green markets to grow, there are a few specific actions that stakeholders, including governments, development finance institutions, entrepreneurial



FIGURE 19: Projected fiscal benefit of removing fossil-fuel subsidies and reforming the price of energy



(Source: Coady et al., 2015)

support organizations, and impact investors, can take to encourage green sectors in developing countries.

GETTING THE PRICES RIGHT: FOSSIL-FUEL SUBSIDY REMOVAL AND CARBON PRICING

An important tool to attract private finance for the low-carbon transition is to get the prices right—eliminating counterproductive subsidies and putting a price on carbon pollution. Finance ministries

play a central role in achieving national climate targets. They can integrate cost-effective climate policies into national development strategies and budget processes, eliminate fossil-fuel subsidies, reflect the cost of externalities in energy prices, address equity and competitiveness in mitigation policies, and put in place fiscal buffers and contingency plans to ensure fiscal sustainability. Recognizing this pivotal role, the World Bank Group has created the Climate Action Peer Exchange, a forum for peer exchange for finance ministers. The initiative brings

together finance ministers, senior technical staff, and other relevant stakeholders to design climate-smart macroeconomic policies, discuss fiscal policy measures for mitigating the impact of climate change, and develop financing strategies for implementing NDCs.⁴⁰⁴

SUBSIDY REFORM

Countries pay enormous subsidies to fossil-fuel producers and consumers. These payments frustrate progress toward NDC implementation, and deprive governments and industry of funds that could be used to finance a transition towards a more sustainable future. Subsidies also decrease the competitiveness of low-carbon businesses by discouraging investment in renewable energy and energy efficiency. Fossil-fuel subsidies amounted to about \$5.3 trillion in 2015, or 6.5 percent of global GDP.⁴⁰⁵ The International Monetary Fund estimates that eliminating subsidies in 2013 would have reduced global carbon emissions by 21 percent and fossil-fuel-related air pollution deaths by 55 percent, while raising revenue of 4 percent of global GDP.⁴⁰⁶ Subsidy removal will also provide a significant portion of the \$90 trillion needed to finance the sustainable infrastructure the world needs by 2050.

Many countries have made progress in reforming subsidies for fossil fuels across a range of sectors. For example, Egypt raised fuel prices by 78 percent in 2014 and is doubling electricity prices over the next five years; Indonesia raised gasoline and diesel prices by an average of 33 percent in 2013 and by another 34 percent in 2014; India eliminated diesel subsidies in October 2014 after incremental increases over the preceding two years; Iran raised gasoline prices by 75 percent in April 2015; and Malaysia raised fuel prices by between 10 percent and 20 percent in 2013, and again in 2014.⁴⁰⁷

The New Climate Economy recently collected a series of case studies on fossil-fuel subsidy reform, and found the following key elements of successful government approaches:⁴⁰⁸

- Mobilizing resources to support a robust reform process.
- Providing clear, open, and honest information on the scale of subsidies, their costs and effects, who pays and who benefits, plans for reform, and complementary measures to be adopted.

- Creating new institutions or strengthening existing ones to support reform.
- Using the fiscal space created for wider public goods.
- Reallocating the resources saved to those groups most affected by reform by adopting complementary measures.
- Setting credible and predetermined timeframes for phasing out subsidies, staggering the elimination of different subsidies, and ideally undertaking reform as part of broader sector- or economy-wide reforms.

CARBON PRICING

Complementing subsidy removal, governments can use carbon pricing to level the playing field for private investment in cleaner solutions, while generating revenue that can be used to help transition away from fossil fuel and other industries. There has been a strong resurgence in interest in carbon pricing in recent years, with 81 NDCs mentioning carbon pricing as a strategy to achieve their targets. Over 42 national and 25 subnational governments are pricing carbon today, covering 15 percent of global emissions. Progressive companies are taking note and pricing carbon internally, while supporting government pricing policies through initiatives like the Carbon Pricing Leadership Coalition.⁴⁰⁹ More than 1,400 companies, including more than 100 Fortune Global 500 companies with collective annual revenues of about \$7 trillion, are using an internal carbon price or plan to do so soon.⁴¹⁰

The Carbon Pricing Leadership Coalition, OECD, and International Monetary Fund developed the FASTER Principles for Successful Carbon Pricing, which capture the elements of a well-designed carbon pricing system:⁴¹¹

- **Fairness:** Reflect the “polluter pays” principle and contribute to distributing costs and benefits equitably, avoiding disproportionate burdens on vulnerable groups.
- **Alignment of policies and objectives:** Use carbon pricing as one of a range of measures that facilitate competition and openness, ensure

equal opportunities for low-carbon alternatives, and interact with a broader set of climate and non-climate policies.

- **Stability and predictability:** Implement carbon prices, within a stable policy framework, that give a consistent, credible, and strong investment signal.
- **Transparency:** Be clear in design and implementation.
- **Efficiency and cost-effectiveness:** Ensure that design promotes economic efficiency and reduces the costs of emission reduction.
- **Reliability and environmental integrity:** Allow for a measurable reduction in environmentally harmful behavior.

Carbon pricing is attractive to business because it generates new revenue streams that can be used to enhance and support the creation of new low-carbon markets. In addition to supporting low-income households, the Carbon Pricing Leadership Coalition reports that revenues have been used to support low-carbon energy, energy efficiency, research and innovation, climate-friendly infrastructure, and international commitments.⁴¹² For example, between 2009 and 2012, the states in the Regional Greenhouse Gas Initiative in the Northeastern United States directed more than 70 percent of revenues from their cap-and-trade program to energy efficiency and renewable energy projects that are estimated to save consumers more than \$2 billion in energy use and deliver 8 million tons of carbon reductions.⁴¹³

“Carbon pricing is a key instrument to anchor addressing climate change into our economic system. Putting a price on carbon will create an economic incentive to speed up the transition to a low-carbon economy and will unlock the private innovation—and capital—needed to make the transition from fossil fuels to the renewable century. In anticipation of this inevitable policy opportunity, over 1,200 businesses—including Royal DSM—are already working to ‘future proof’ their companies, by applying an internal carbon price, for example to their investment decisions.”

— Feike Sijbesma, Chief Executive Officer, Royal DSM



PUBLIC-PRIVATE PARTNERSHIPS

As local governments move to build the low-carbon, resilient waste, water and transport infrastructure that they need to meet the demands of their citizens, they are increasingly looking to the private sector for solutions. One tool municipalities are employing is PPPs. Many of today's climate-related infrastructure projects are PPPs by definition, even if the partnership is not explicit. The government needs the infusion of capital, and the innovation, smart technology, and cost-effectiveness that comes with it, and the private sector is looking for healthy returns and a clear business model that is driven by predictable regulations, permits and incentives. PPPs are an important vehicle to promote cost-effective infrastructure projects that spur innovation. PPPs can contractually set minimum performance standards that reduce emissions from the business-as-usual infrastructure investment—for example, deploying energy-efficient LED streetlights with specific energy-savings targets, transforming hundreds of tons of municipal waste into renewable power, or minimum loss reduction targets for water supply. Other possibilities include contractual incentives for utilization of renewable energy, including access to a power purchase agreement or to concessional financing. Governments can use incentives in a PPP to drive technology innovation, such as via advanced scheduling/logistics software for urban transport systems. The competitive bidding feature of PPPs also ensures that developers maximize cost efficiency to have the least-cost bid, saving money for the government and consumers. PPPs can also serve to pilot new approaches, and simultaneously contribute to the preparation of applicable regulations and contractual frameworks—this develops a model and a framework that can pave the way to create new markets. Finally, PPPs allow local governments to address climate resilience in public infrastructure investments, given that they tend to be longer-term (25 years or more) concessions, thereby allowing the government to require that future climate impacts like increased floods or sealevel rise be taken into account in the project's design and operation.

CITY CREDITWORTHINESS

To attract funds from private investors for climate-smart urban infrastructure, cities need to be creditworthy. This includes having credible accounting mechanisms, sound financial management systems, independent auditing of local government finance and performance evaluation for local government services. Estimates reveal that only 4 percent of the 500 largest cities in developing countries are creditworthy in international financial markets and 20 percent in their domestic context. Creditworthiness is a key requirement for cities to unlock the long-term resources they need to finance their capital investments. By reaching investment-grade creditworthiness, local governments will be able to tap into capital markets and other sources of sub-national borrowing.

To address this need, the World Bank Group launched the City Creditworthiness Initiative. This effort includes City Creditworthiness Academies with hands-on learning programs that teach city leaders the fundamentals of creditworthiness and municipal finance. Using a preliminary online self-assessment toolkit, participants develop a customized preliminary action plan of specific institutional reforms, capacity building, and other actions that will improve their creditworthiness and their ability to plan, finance and deliver infrastructure services. Complementing the Academies, City Creditworthiness Implementation Programs provide in-depth, multi-year, on-the-job, customized technical assistance programs to help local governments strengthen their financial management and performance, and, wherever possible, pursue market-based financing transactions for climate-smart infrastructure projects. So far, 261 local authorities across 30 different countries have participated in the Academy training.⁴¹⁴

SUPPORT, TOOLS AND RESOURCES TO CREATE MARKETS

As countries move to implement their climate strategies, now more than ever the private sector is needed—and is ready—to provide technology solutions, financing and business models. With the right mix of enabling policies, incentives and targeted finance, the trillions of dollars that are needed to construct low-carbon infrastructure, finance climate-smart

PPP success stories

BHUBANESWAR STREETLIGHTING, INDIA⁴¹⁵

Through this PPP model, the City of Bhubaneswar sought bids that offered the highest energy savings, with a minimum savings of 30 percent. The winning company committed to save 75 percent on current energy consumption on the existing street lighting system by retrofitting 20,000 streetlights. The winning bidder will invest in and manage Bhubaneswar's street lighting system and receive payments generated by realized energy savings. The project is expected to generate annual savings to government of \$100,000 and reduce greenhouse-gas emissions by an estimated 10,500 tons of carbon dioxide annually. IFC has replicated this project in Gujarat and taken it to scale in Odisha state by rolling it out in five cities. Bhubaneswar is part of India's Smart City program.

BELGRADE WASTE MANAGEMENT/ WASTE-TO-ENERGY PPP

The city of Belgrade signed a PPP contract with Suez Groupe SAS of France and Japan's Itochu Environment Investment to build and operate a new waste treatment and disposal complex for 25 years. The project includes a waste-to-energy plant that will produce electricity and heat for the city.

This is Serbia's first large-scale PPP. By successfully closing the nation's first PPP transaction, IFC has helped Belgrade demonstrate the fitness of the country's new regulatory framework and institutions, which are necessary for Serbia to implement PPPs on a large scale. The success of this project will help the country bring more projects to the market and generate greater private sector investment in its municipal infrastructure.

The city government was concerned by the environmental threat posed by the city's growing waste problem. The city's existing landfill in Vinča is the largest landfill in Europe. It was designed in the 1970s. "Vinča" is now a 50-meter-high pile of untreated garbage, releasing leachate and gas from rotting waste, polluting the soil and air, and causing numerous spontaneous fires. With the city generating 500,000 tons of waste each year, this needed to be fixed. With this PPP, Belgrade can begin turning its growing environmental problem into a renewable energy asset, making it a cleaner and more livable city and helping it comply with European directives on waste management and diversion rates.

www.ifc.org

Achieving creditworthiness: The city of Arusha, Tanzania

In August 2014, the Creditworthiness Partnership with the Rockefeller Foundation set out to support the City of Arusha—member of the 100 Resilient Cities network—in facing a revenue collection challenge. The City Creditworthiness Initiative performed an assessment of revenue sources, a review of the legal environment, and a study on enhancing the operational design of the government’s information collection on revenue sources.

As a result, the city has experienced an average increase in its revenues of nearly 30 percent. As Arusha is the first city to operationalize this collection system, the findings are relevant for other cities in Tanzania. The positive impact that the system has had in the city is now being scaled

up country-wide with support from the World Bank and the national government. Early in 2017, the government rolled out the system to all local government authorities, and currently the use of the collection system has been adopted by 158 out of 168 municipalities.

The analysis and recommendations are also being used to inform the design of a second additional financing of the World Bank-funded Tanzania Strategic Cities Project, currently under preparation and have helped identify where the gaps and issues experienced by the city are and how they can be addressed.

www.worldbank.org/en/topic/urbandevelopment/brief/city-creditworthiness-initiative

agriculture and construct green buildings can become a significant investment opportunity.

A variety of platforms and initiatives are working to address the growing need for public-private collaboration that achieves NDC targets by scaling up private sector investment in climate business. These include the **NDC Partnership** (See Box 62), the **NDC Invest** initiative led by the Inter-American Development bank,⁴¹⁶ the **Low-Emissions Development Strategies Global Partnership**, which recently launched the **NDC Investment Accelerator**,⁴¹⁷ as well as **NDCi Global**, a community resource to aid implementation and investment in NDCs.⁴¹⁸

“There’s plenty of private investment money potentially available for sustainable investing. But investors need clear market signals, and a confidence that governments are serious. This is where NDCs can help hugely, in setting the direction of travel for the coming decades. We now need to develop private-sector friendly policies, finance and partnerships that will make these goals a reality.”

— **Andrew Steer**, President, World Resources Institute

There are many solutions that have already delivered a strong start towards achieving the promise of the Paris Agreement. By working together to create markets for these solutions, we can accelerate ambition—and investment—at the scale that is needed.



NDC Partnership: Accelerating action and Mobilizing Finance

The NDC Partnership is a global coalition of countries and international institutions working together to mobilize support and achieve ambitious climate goals, while enhancing sustainable development. Launched at COP22 in Marrakesh, the NDC Partnership aims to enhance cooperation so that countries have access to the technical knowledge and financial support they need to achieve large-scale climate and sustainable development targets as quickly and effectively as possible, and increase global ambition over time. The Partnership is guided by a steering committee made up of developing and developed nations and international institutions, and co-chaired by the governments of Germany and Morocco.

IN-COUNTRY ENGAGEMENT

The Partnership engages directly with ministries and other stakeholders to assess needs and identify opportunities for collective action across sectors, regions, and international partners. Through the Partnership, members provide targeted and coordinated assistance so that nations can effectively develop and implement robust climate and development plans. Leveraging the skills and resources of multiple partners towards a common objective, and delivering with speed, is a unique value proposition that the Partnership brings.

KNOWLEDGE SHARING

The Partnership's Knowledge and Research Services help countries implement their NDCs by fostering learning between countries and by making information easily accessible. The Partnership raises awareness of and enhances access to climate support initiatives, best practices, analytical tools, and resources. Information to address specific implementation needs is made available through online portals, as well as communities and networks that generate opportunities for knowledge sharing.

The NDC Toolbox Navigator, launched in May 2017, is a database of tools, resources, and advisory services to help countries implement their NDCs. It will soon be complemented by Climate Watch, an exciting new data platform that brings together data sets on historical emissions, socio economic indicators, NDC content, links to the Sustainable Development Goals, and emissions scenarios.

MOBILIZING FINANCE

Mobilizing finance is key to successful implementation of the NDCs. In-country, the Partnership engages closely with finance ministers and works to bring environment and finance ministries into greater alignment. The Partnership

supports governments in framing a "Partnership Plan," to help connect stakeholders that can provide technical assistance and mobilize investments.

Equally important, the NDC Partnership helps countries learn about financing opportunities. The NDC Funding and Initiatives Navigator, introduced in November 2016, is a searchable database of funding, capacity building, and technical assistance available to support NDC planning and implementation that includes upcoming grants and technical support for which countries and organizations can apply.

"We have to do our utmost to achieve the goals of the Paris Agreement and of the 2030 Agenda. Supporting our partners quickly and effectively is key. That is why we have co-founded the global NDC Partnership. With its strong focus on cooperation and collaboration, this coalition of developed and developing countries is linking the global climate and sustainable development agendas. We can only achieve these goals if we manage to mobilize the private sector. The sooner our focus shifts from cost to opportunity, the faster we will be successful."

— **Dr. Gerd Müller**, Federal Minister for Economic Cooperation and Development, Germany

www.ndcpartnership.org

EBRD: Combining policy support, technical assistance and finance to support the green economy

Preserving and improving the environment are central features of a modern, well-functioning market economy. Recognizing this, the European Bank for Reconstruction and Development (EBRD) launched the Green Economy Transition approach in 2015 to support projects with meaningful environmental benefits. The initiative seeks to increase the bank's annual volume of green financing from an average of 24 percent over the previous 10 years to 40 percent by 2020. To this end, the bank uses a combination of financing, technical assistance, and policy dialogue to deliver sustainable climate mitigation and adaptation investments. The bank has had notable successes using this approach in the Kyrgyz Republic and Kazakhstan.⁴¹⁹

BUILDING ENERGY EFFICIENCY IN KYRGYZ REPUBLIC

The EBRD engaged with the Kyrgyz State Agency for Construction and Architecture to develop energy performance legislation. The law was adopted in early 2012, and included a legal responsibility for building owners and instruments to promote energy efficiency. The bank helped Kyrgyz authorities harmonize technical standards

used in building construction with the legislation, including establishing a state registry of energy certificates and inspection protocols, and drafting rules and procedures for accreditation of green building professionals. By creating a positive policy environment for energy-efficiency improvements, the Kyrgyz Republic has seen growing private investment in building energy efficiency. In 2012, the EBRD launched a financing facility for local banks to lend money to building owners and operators for energy-efficiency investments. The initial credit facility of \$20 million was increased to \$35 million in 2016 to accommodate increasing demand.

RENEWABLE ENERGY IN KAZAKHSTAN

More than 70 percent of Kazakhstan's electricity is produced in ageing coal-fired plants. The energy sector accounts for 80 percent of the country's carbon emissions. The EBRD has worked with the government to develop a Sustainable Energy Action Plan and renewable energy legislation. It has also facilitated a series of policy dialogues and provided technical support, resulting in the introduction of a cost allocation system, draft feed-in tariff support for renewables, concession award procedures,

standardized power purchase agreements, and national standards for grid interconnection. In 2016, the EBRD supported the government's passing of green economy legislation that removed several remaining barriers to financing renewable energy. The bank has cofinanced the installation of three renewable energy projects, including a solar power plant in Burnoye. In 2017, the Burnoye facility doubled its capacity with the bank's support, making it the largest renewable energy generator in Central Asia.

"The business model of the EBRD is particularly suited to scale up climate financing by combining in a practical manner policy dialogue, project preparation, capacity building and investment with a focus on the private sector. Through this approach, the EBRD has developed a broad range of climate mitigation and adaptation activities which already account for over a third of its total annual investment. Climate action with scale and reach!"

— **Josué Tanaka**, Managing Director of Energy Efficiency and Climate Change, EBRD

www.ebrd.com

Making it happen: Tools, initiatives and resources



The **Global Innovation Lab for Climate Finance** helps to identify, design and pilot the next generation of climate finance instruments for all sectors.

www.climatefinancelab.org



The **Climate Bonds Initiative** is an international organisation working to promote investment in projects and assets necessary for a rapid transition to a low-carbon and climate-resilient economy.

<https://www.climatebonds.net/>



The **Green Bonds Principles** are voluntary process guidelines that recommend transparency and disclosure and promote integrity in the development of the green bond market by clarifying the approach for issuing green bonds.

<https://www.icmagroup.org/Regulatory-Policy-and-Market-Practice/green-social-and-sustainability-bonds/green-bond-principles-gbp>



The **UNEP Inquiry into the Design of a Sustainable Financial System** works to accelerate the transition to a green economy by identifying best practice, and exploring financial market policy and regulatory innovations.

www.unep.org/inquiry



The **World Bank Group's InfoDev Climate Technology Program** helps high-growth, clean-tech firms commercialize and scale the most innovative private sector solutions to climate change, and hosts the Climate Innovation Network, which convenes a global conversation that spreads the diffusion of innovative business models across borders and attracts public and private finance.

www.infodev.org/climate



The **UN Global Compact Climate Action Platform** is designed to help business and investors to contribute to enhancing and accelerating NDC and sustainable development goals action and implementation. The Platform is led by the UN Global Compact together with UNEP, UNFCCC, PRI and WRI.

www.unglobalcompact.org/sdgs/action-platforms



The **Global Commission on the Economy and Climate** comprises former heads of government and finance ministers and leaders in the fields of economics and business to provide authoritative and independent evidence on the relationship between actions that strengthen economic performance and those that reduce the risk of climate change.

<http://newclimateeconomy.net>



The **Carbon Pricing Leadership Coalition** is managed by the World Bank Group, and comprises over 200 governments, business and civil society groups working together to accelerate the uptake of successful carbon pricing around the world.

www.carbonpricingleadership.org



The **World Bank Group's Public-Private Partnerships** efforts help to strengthen data, build capacity, develop tools, promote disclosure and encourage stakeholder engagement around PPPs as a solution.

<http://www.worldbank.org/en/topic/publicprivatepartnerships>



The **World Bank Group's City Creditworthiness Initiative** provides cities with hands-on learning programs that teach leaders the fundamentals of creditworthiness and municipal finance.

<http://www.worldbank.org/en/topic/urbandevelopment/brief/city-creditworthiness-initiative>



The **NDC Partnership** is a global coalition of countries and international institutions working together to mobilize support and achieve ambitious climate goals, while enhancing sustainable development.

www.ndcpartnership.org



Climate Action in Financial Institutions is a coalition of public and private financial institutions around the globe aiming to adopt a pathway to systematically integrate climate change considerations across their strategies, programs and operations.

www.mainstreamingclimate.org



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