THE ECONOMICS OF CLIMATE CHANGE IN THE ASIA-PACIFIC REGION

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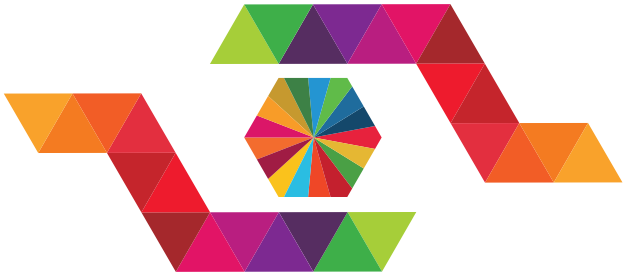

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Printed in Bangkok
ST/ESCAP/2761

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Advance Copy for the first session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA 1), the twenty-second session of the Conference of the Parties (COP 22) and the twelfth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP 12), Morocco, 7-18 November 2016.

This material is also available online at:
www.unescap.org/resources/economics-climate-change-asia-pacific-region

FOREWORD

The leadership of countries from Asia and the Pacific was vital in making the Paris Agreement a reality. Indeed, Fiji was the first country in the world to ratify the Agreement. The region is now set to play a key role in implementing the Paris Agreement. But this represents a major challenge for a region that is, on the one hand, the most vulnerable in the world to the impact of climate change, and that, on the other hand, contributes over half of the world's total greenhouse gas emissions. Six out of the ten top global emitters are in the Asia-Pacific region.

Limiting temperature increases to well below the two degree limit agreed to in Paris requires emissions to decline globally by 40 to 70 per cent below current levels by mid-century. To play its part in this, the Asia-Pacific region must base its future economic prosperity on creating the systems, technologies and capacities that cannot only revive or maintain growth, but also ensure inclusive, resilient and low-carbon approaches.

Stepping up to this challenge in the Asia-Pacific region requires a stronger understanding of the economics of climate change. The costs of inaction are estimated to reach as much as 10 per cent of our GDP by the end of the century. The estimated investment required to achieve the two degree target is 4 per cent of GDP over the same time period. Developing and prioritising national emissions reduction actions that are cost-effective and aligned with sustainable development strategies is pivotal to collectively achieve climate goals. Importantly, this also requires identifying, quantifying and harnessing the multi-sectoral co-benefits of emissions reductions, notably reducing the air pollution that is impacting urban dwellers in our major cities.

While the knowledge base on the economics of climate change is still evolving, national best practices in the use of economic approaches are emerging across the region. Enhancing regional understanding in this area will allow policymakers to prioritise the optimal mix of low cost and efficient abatement and adaptation initiatives. In turn this will reinforce the increasing ambition and effectiveness of Asia-Pacific countries' Nationally Determined Contributions.

This report recommends five key actions to address climate change in the Asia-Pacific region: 1) ensure adaptation to climate change and improve resilience; 2) phase out fossil fuel subsidies; 3) encourage renewable energy and energy efficiency; 4) implement carbon pricing; and 5) expand climate finance. These recommendations require strong political leadership and effective sectoral policy reform. The report also points to some leading examples of actions already being taken by countries in the Asia-Pacific region towards these priorities. Some countries, such as Indonesia and India, have already undertaken fossil fuel subsidy reform, while others have focused on adopting renewable energy on a broad scale, most notably China.

Regional cooperation will be instrumental to building capacities and sharing knowledge, particularly with and among the least developed countries, but also in coordinating more ambitious region-wide solutions in finance, technology, infrastructure and resilience. Action by many larger economies will generate positive spillovers for smaller economies such as access to lower-cost technologies, policy experience and other public goods.

The Asia-Pacific region is preparing to play its part in the global solution to climate change, while at the same time pursuing sustainable development through the framework of the 2030 Agenda. ESCAP is fully committed to support its fifty-three member States in realizing their climate change and resilience ambitions, in particular the least developed countries and small island developing States through capacity-building, policy dialogues and the sharing of experiences and information.

Shamshad Akhtar
Under-Secretary-General of the United Nations and
Executive Secretary, United Nations Economic and
Social Commission for Asia and the Pacific

HIGHLIGHTS

The Asia-Pacific region is at the forefront of the impacts of climate change and is uniquely positioned in global efforts to manage climate change. Higher temperatures, sea level rise, and extreme weather events linked to climate change are having a major impact on the region, harming its economies, natural and physical assets, and compounding developmental challenges, including poverty, food and energy security and health. Without climate-oriented development, climate change could force more than 100 million people from the region into extreme poverty by 2030, wiping out the gains in poverty reduction achieved over the last decades. At the same time, the region accounts for 53 per cent of global emissions and the high-growth path on which many of the region's economies themselves on, means this contribution will grow without fundamental policy interventions.

The economics of climate change offers critical insights into the costs and benefits of both inaction and action on climate change. Since the seminal work by Stern in 2006, our understanding has further evolved. Estimates of the costs of inaction have gone up, while those of action have decreased, mainly due to lower technology costs. We also have a better understanding of efficiency savings and significant co-benefits that can be reaped in transitioning to a low-carbon, climate-resilient economy.

Newest estimates for the Asia-Pacific region show that growth will be significantly impacted by climate change. Without climate action, GDP in the region could decrease by as much as 3.3 per cent by 2050 and 10 per cent by 2100, relative to the base case. The economic costs associated with disasters across the region are also increasing. Damage to property, crops and livestock from disasters increased from US$52bn annually to over US$523bn between 1970 and 2015. The costs of attaining a 2°C scenario for the region are estimated at approximately 0.1 per cent of GDP annually or 4 per cent by 2050, relative to business as usual. The co-benefits of climate action offset many of the costs of emissions reduction and emerging advanced technologies offer future prospects of lower abatement costs.

Taking into account the urgency of the climate change challenge and the focus on implementation subsequent to the entry into force of the Paris Agreement, countries in the region are no longer looking at what should be done, but rather how it can be done. To facilitate this, this paper identifies five key priority areas of the climate change response for the Asia-Pacific region, and the economic policies and instruments that can be used to achieve them. First, adaptation to climatic changes and improved resilience are the most immediate challenges. Second, priority must be placed on pricing carbon to provide long-term incentives for economic actors to switch to low-carbon pathways. Third, countries should phase out fossil fuel subsidies, as their distortionary effect hinders energy efficiency and clean energy alternatives. Fourth, initiatives to accelerate the uptake of renewable energy and energy efficiency solutions are needed for emissions reductions, energy security and energy access. Fifth, adequate climate financing is required to allow the region to realize its climate ambition and take advantage of the opportunities that climate change offers.

Regional cooperation will help address many of these issues and enhance the ongoing national effort to implement ambitious climate change actions. Regional cooperation has a role in addressing the harmonization of carbon pricing initiatives and possible linking of markets, as well as in developing internationally transferred mitigation outcomes (ITMOs), increasing technology cooperation, implementing SDGs, and helping raise climate ambitions by tapping into subnational networks including cities, companies and civil society.

1. Ensure Adaptation to Climate Change and Improved Resilience

Regardless of the progress made in mitigation efforts by the global community over the coming decades, climate change is already occurring. Adapting to climate change is therefore essential. Striking the right balance between mitigation and adaptation investments is an ongoing challenge for policymakers, especially in the Asia-Pacific region. Adaptation efforts can take several forms – altering farming practices and crop varieties, building water reservoirs, enhancing water use efficiency, changing building codes, or constructing sea walls. Adaptation to climate change and putting in place multi-hazard early warning systems provides largely local benefits.

There are two critical areas for adaptation in the region, agriculture and cities. A good deal of autonomous adaptation to climate change in the region's agricultural sector is already being observed, including the adoption of measures such as changes in sowing dates, a switch to drought-tolerant or flood-resistant crops, and the use of salinity-tolerant varieties of rice. Despite this, the rural poor, who have the lowest capacity to undertake adaptation, will remain among the worst affected by the impacts of climate change. There is a need for policy to enable and empower this group to better withstand and adapt to the climate risks, e.g. through diversifying their household incomes and providing access to microfinance, insurance or social safety nets. The economics of adaptation shows that governments hold the responsibility of making the long-run decisions about investing in adapting infrastructure to withstand the impacts of climate change, better disaster risk management, effective land-use planning, and facilitating as well as disseminating relevant knowledge on future climate change, technology and conditions to support adaptation in cities.

Effective adaptation interventions represent good development and, tend to be no-regret measures that would have been undertaken even in the absence of climate change. While it is difficult to arrive at an aggregate estimate of the costs and benefits of agricultural adaptation in the region, modelling work in the region suggests benefits in the value-added of the sector could be large, even reaching 10 per cent. The damage costs of flooding exacerbated by climate change are likely to be substantial to cities and in the range of 2 to 6 per cent of regional GDP.

2. Phase Out Fossil Fuel Subsidies

Phasing out fossil fuel subsidies should be at the top of the region's policy reform agenda. Subsidies on fossil fuels distort incentives in favour of fossil fuels at the expense of cleaner energy. They have large negative economic, social and environmental impacts. Beyond their contribution to fiscal imbalances and public debt, subsidies depress investment in the energy sector, which can hamper energy supply and exacerbate economic losses. International experience suggests that successful fossil fuel subsidy reform will be part of a larger energy sector reform agenda. Elements for successful reform include social support through subsidy targeting and cash transfers; institutional reforms to facilitate market-level pricing; facilitating improvements in energy efficiency and a transparent communications strategy.

Limited carbon budgets to keep the world within the internationally agreed temperature goal suggest that only about one-fifth of total global coal reserves can be exploited up to 2050. Efforts must be made to keep much of that coal in the ground and the region will be a key to this undertaking considering that currently about 85 per cent of its electricity generation is sourced from coal. Currently, the fiscal gain from removing energy subsidies amounts to around 10 per cent of the region's GDP, and in terms of share of government revenue, it exceeds 30 per cent. For the Asian region, eliminating subsidies (together with carbon pricing) would have many co-benefits, including reducing CO_2 emissions by 18-25 per cent, and air pollution deaths by around 55-60 per cent. The resulting welfare gains are also significant, in the range of 5-7 per cent of regional GDP.

3. Encourage Renewable Energy and Energy Efficiency

To encourage energy efficiency and renewable energy take-up, experience in the region shows that a policy mix of targets, regulations, standards, labelling and fiscal incentives work well to accelerate energy efficiency improvements. As fossil fuel subsidies are phased out and carbon pricing gains hold, prices approach their real costs, making energy efficiency improvements more desirable. For renewable energy investments, providing clear long-term policy signals, overcoming the region's high cost of capital and shortage of long-term investment capital, and de-risking investments, are important to catalyze private sector investments. This can include guarantees, subsidized loans or regulatory targets such as portfolio targets.

Macroeconometric models have attempted to quantify the benefits of reaching the three goals of sustainable energy for all (SE4ALL) contained in SDG6. Globally, this would lead to an increase in GDP of 1.1 per cent, and in global welfare of at least 2.7 per cent, boost direct and indirect employment in the sector to 24 million, and enhance trade. A study for Japan found that adding 23.3 GW of solar PV would lead to an increase of almost 1 per cent in national GDP. For the region, most of the positive GDP impact stems from increased investment in renewable energy deployment, and is found to be higher if it entails a higher rate of electrification. The welfare impact is found to be much higher (4-8 per cent relative to the baseline) in individual countries in the region, especially India, Indonesia, China and Japan, mainly due to the reduced health impact of air pollution. These gains would be further magnified if this objective was met by expanding energy access. The number of jobs in the sector would also be roughly doubled in the five countries of the region included in the study, creating an additional 6.6 million jobs.

4. Ensure Effective Carbon Pricing

Carbon pricing is a key reform to correct the underlying market failure of climate change. Pricing carbon economy-wide results in price signals that drive low carbon pathways by businesses and consumers, and stimulates clean technology and process innovation, while also supporting long term behaviour change. Credible and long term carbon prices have the potential to induce fundamental and long term shifts in infrastructure, technology and behaviour, which form the basis of a low carbon economy. Many countries in the region have implemented emission trading schemes at sub-national or national levels and others are under development. The main policy imperative is to increase the effective carbon prices across key countries in the region as these are currently too low to provide adequate incentives to pursue a low-carbon path, and to expand carbon markets by linking them to each other to reap greater cost efficiency opportunities. Carbon pricing can raise valuable public revenue through the auction of permits and the collection of carbon taxes. Estimates suggest that the introduction of the new national ETS in China would potentially double the total value of ETSs and carbon taxes globally to about US$100bn. Additional economic benefits depend on how the revenue collected is used. Studies are consistently showing that among the various instruments available to reduce CO_2 emissions, carbon prices are the most likely to produce economic growth and increase the level of productivity.

5. Climate Finance

As climate change continues to progress and extreme weather events become more frequent and more severe, the need for adaptation finance for developing countries also continues to grow. At current estimates, adaptation finance needs of developing countries are in the range of US$140bn to US$300bn per annum. On top of this, incremental investment from 2015 to 2050 to decarbonize the Asian energy sector alone is estimated at a net US$21tr or US$600bn per annum. But, compared to annual GDP, these amounts are relatively modest ranging from 0.1 per cent today to 4 per cent by 2050, mainly because the benefits of decarbonisation include higher energy efficiency, lower fuel costs and lower operating expenditures as well as substantial health benefits from reduced air pollution and its associated economic and health impacts. Scaling up climate finance will require identifying and addressing the barriers to investment and access to finance. Adequate carbon pricing and the integration of long-term policy frameworks for the low-carbon transition into national planning and budgeting will be important elements to support climate investment. Financial regulation will also play an important role in easing the risks for private investors thereby unlocking private finance, as will green bonds. Grant finance should be used increasingly to catalyze other sources of financing rather than as standalone project finance and vulnerable countries in the region require additional help to ensure that they can access available sources of grant financing.

ACKNOWLEDGEMENTS

This report was prepared under the overall direction and guidance of Shamshad Akhtar, Under-Secretary General of the United Nations and Executive Secretary of the Economic and Social Commission for Asia and the Pacific. Kaveh Zahedi, Deputy Executive Secretary, Stefanos Fotiou, Laura Lopez and Kilaparti Ramakrishna provided valuable advice and comments. The report was prepared by Laura Altinger Zahar, with contributions from ESCAP staff including Michael Williamson of the Office of the Executive Secretary. Valuable research assistance was provided by Caroline Turner, Joao Lopes Resende and Borja Fernandez Martinez.

The graphic design was created by QUO Bangkok Ltd. and the layout and printing were provided by Clung Wicha Press with the excellent support and facilitation of Nucharat Tuntiwigit, and Patricia de la Torre Rodriguez of the ESCAP Strategic Publications, Communications and Advocacy Section.

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ACRONYMS

AAL	Average Annual Loss
ADB	Asian Development Bank
AFOLU	Agriculture, Forestry, Other Land Use
APEC	Asia-Pacific Economic Cooperation
CAPEX	Capital Expenditure
CDM	Clean Development Mechanism
CHP	Combined Heat Power
CPLC	Carbon Pricing Leadership Coalition
DRE	Distributed Renewable Energy
ECRs	Effective Carbon Rates
ERF	Emissions Reduction Fund
ETS	Emission Trading Scheme
EU-ETS	European Union Emission Trading Scheme
EV	Electric Vehicle
FCPF	Forestry Carbon Partnership Facility
FITs	Feed-in Tariffs
GCF	Global Climate Fund
GDP	Gross Domestic Product
GHGs	Green House Gases
IMF	International Monetary Fund
ITMOs	Internationally Transferred Mitigation Outcomes
JCM	Joint Credit Mechanism
LCCR	Low Carbon Climate Resilient
LCOE	Levelised Cost of Electricity
LDC	Least Developed Country
MBI	Market Based Instruments
MDBs	Multilateral Development Banks
MRP	Market Readiness Proposal
MRV	Monitoring, Reporting and Verification
MSR	Market Stability Reserve of European Union Emissions Trading System
NDCs	Nationally Determined Contributions
OECD	Organisation for Economic Cooperation and Development
OPEX	Operating Expenditure
PAT	Perform, Achieve and Trade
PMR	Partnership for Market Readiness
PV	Photovoltaic
R&D	Research and Development
RBF	Results-Based Finance
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, and the Role of Conservation, Sustainable Management of Forests, and Enhancement of Forest Carbon Stocks in Developing Countries
RPS	Renewable Portfolio Standards
SDG	Sustainable Development Goal
SDM	Sustainable Development Mechanism
SE4ALL	Sustainable Energy For All
SIDS	Small Island Developing States
SOE	State Owned Enterprise
UNFCCC	United Nations

INTRODUCTION

Higher temperatures, sea level rise, and extreme weather events linked to climate change are having a major impact on the Asia-Pacific region, harming its economies, natural and physical assets, and compounding developmental challenges, including poverty, food and energy security and health. Many countries in the Asia-Pacific region are geographically vulnerable and highly exposed to the damaging impacts of climate change. Without climate-oriented development, climate change could force more than 100 million people into extreme poverty by 2030, wiping out the gains in poverty reduction achieved over the last decades.[1]

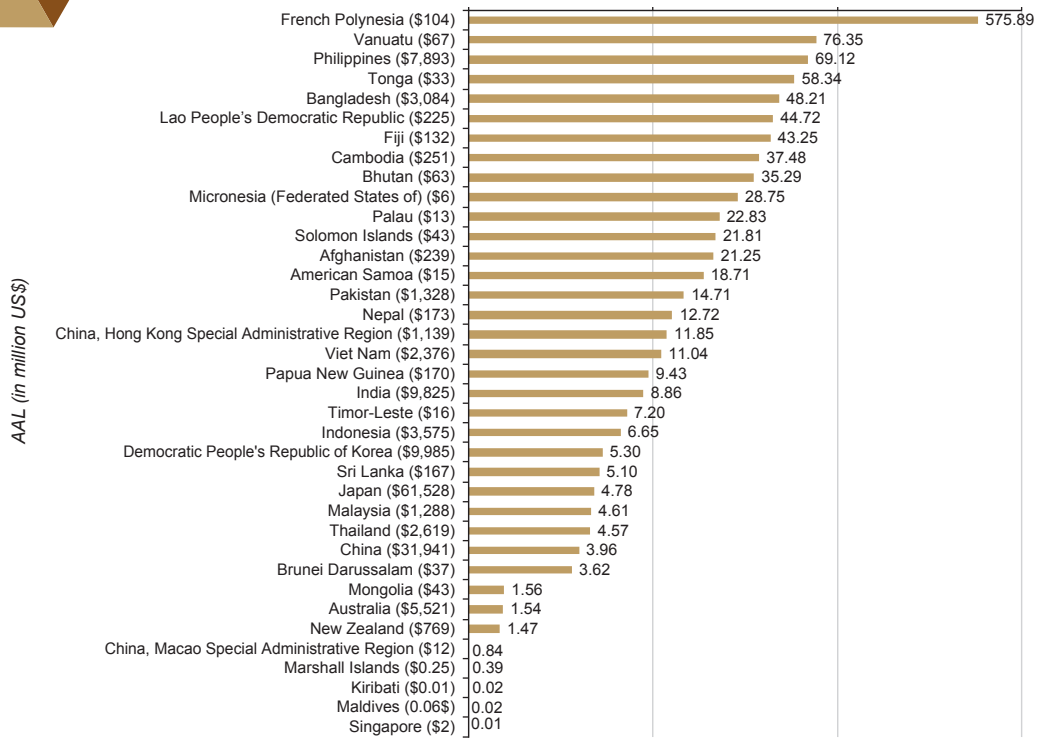
The economics of climate change rests on the premise that climate change represents a major market failure where the costs of greenhouse gases (GHGs) emissions are not borne by those who emit them. Climate change is a long-term threat with inter-generational implications, characterized by uncertainty and non-negligible risks of major, irreversible change. It is global in scope and deals with non-marginal economic effects.

The Stern Review on the *Economics of Climate Change* prepared for the UK Government in 2006 demonstrated how economics can address this challenge and sheds light on the global costs of inaction and action.[2] Ten years on, this analysis still remains relevant, although our understanding of the costs and benefits has evolved. Essentially, the costs of inaction have shifted upward as our scientific understanding improves, while the costs of action have decreased due to the steep drop in the cost of green technologies, the efficiency savings that can be reaped in the transition to a low-carbon, climate-resilient (LCCR) economy, and the significant co-benefits it brings with it.

Climate change has already taken hold in the Asia-Pacific region.[3] A 2°C scenario is expected to cause more frequent and severe coastal inundation and erosion, wildfires, heavy precipitation and drought.[4] Establishing a causal link between extreme weather and climate change is fraught with difficulty, yet science now takes the consensus view that global mean temperature rises are associated with a higher incidence of extreme weather events.[5]

In 2015, the Asia-Pacific region continued to be the world's most disaster prone region. 160 disasters were reported in the region, accounting for 47 per cent of the world's 344 disasters. The region bore the brunt of large scale catastrophic disasters with over 16,000

Figure 1 **Annual Average Losses/Social Expenditure (in %)**



Source: UNISDR (2015).

fatalities — more than a two-fold increase since 2014. Asia and the Pacific incurred more than US$45.1 billion in economic damage in 2015 and even higher indirect losses. These numbers, however, are gross underestimates as there is no systematic assessment of the cost of all disasters that struck the region, especially slow-onset disasters such as droughts, heat waves, forest fires and haze. Cumulatively, disasters have affected 2.24 billion people in the region and caused damage amounting to over $400bn since 1970, representing an ongoing erosion of development assets, such as local infrastructure, dwellings, schools, health facilities, and roads. The economic costs associated with disasters across the region are increasing. As a proportion of GDP, the damage has also been trending upward from 0.16 percent in the 1970s to 0.34 percent in the decade between 2005 and 2014. On an annual average basis, the costs of disasters to the region have increased from US$1.8bn during the 1970s, to US$73.8bn between 2004 and 2013, a forty-fold increase, representing 49 per cent of global average annual losses.

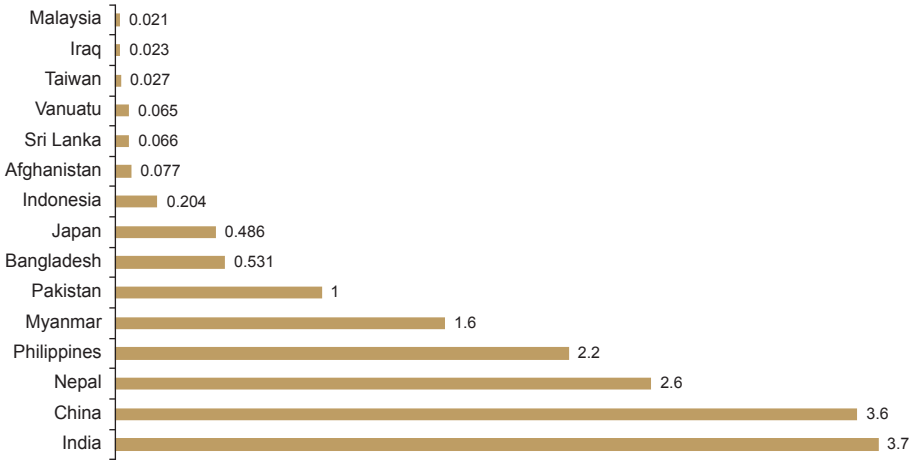
Future losses from disasters are measured by the average annual loss (AAL) metric. This represents the amount countries should set aside each year to cope with future hazards. Estimates of the AAL show that eighteen countries in the Asia-Pacific region have a ratio of above 10 per cent relative to social spending (Figure 1), and range all the way to 76 per cent (Vanuatu). Sixteen countries in the region had AAL-to-gross-fixed-capital-formation ratios above 5 per cent. These ratios show the enormous future developmental impact that disasters represent for the region. Indeed, compared to Europe and Central Asia, small island developing States (SIDS) are expected to lose on average 20 times more of their capital stock annually in disasters. The AAL in the SIDS represent around 20 per cent of their total social expenditure, compared to only 1.19 per cent in North America and less than 1 per cent in Europe and Central Asia.

In the Asia-Pacific region, the impacts of these hazards are compounded by rising exposure of people and their assets, and still significant socio-economic vulnerability despite decades of growth. Vulnerability is aggravated by low incomes and low adaptive capacity. The primary driver of increased exposure in developing countries has been rapid, unplanned development in hazard-prone areas caused by rapid urbanization. This is a major issue in the Asia-Pacific region where the urbanization rate is expected to reach 50 per cent in the next decade, up from the current 40-45 per cent.

Another impact has been the large population displacements in the region (Figure 2). Out of 19.2m new displacements in 2015, associated with disasters, 84 per cent occurred in the Asia-Pacific region.[6] Fifteen countries in the region recorded displacements of more than 20,000 people in 2015. More frequent extreme weather events associated with climate change are expected to increase the number of displaced people to an estimated 150m to 200m by 2050. The total number of people at risk of sea-level rise in the region is in the order of 150 million, mainly affecting Bangladesh (26m), China (73m), India (20m), small island states and others (31m).[7] The issue of climate-induced displacements promises to rank as one of the foremost human crises of our times.[8]

Figure 2

New displacements associated with disasters 2015 (in millions)



Source: IDMC (2015).

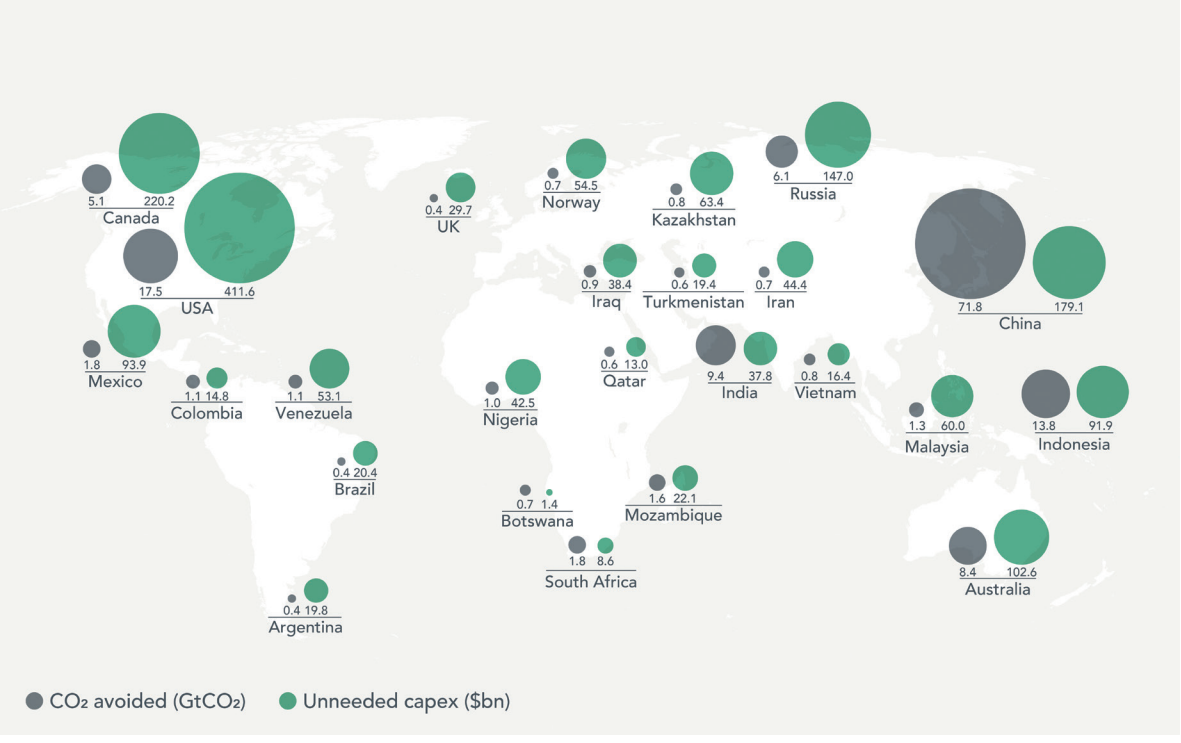
Moreover, there are financial risks arising from climate change that percolate through three main channels, namely physical risks to assets; liability risks that stem from injured parties, e.g. financial losses caused by the failure of companies to disclose or take into account climate change risk; and, most importantly, transition risks such as investments in fossil fuels that will lose their value in the light of a limited carbon budget, also known as 'stranded assets' – in effect a 'carbon bubble'.[9] In the Asia-Pacific region, China followed by Australia, India and Indonesia all have significant amounts of capital invested in new projects that are not needed in the 2°C scenario (Figure 3). Together with the US, these four countries account for over 90 per cent of unneeded capital expenditure.

Studies have analysed the economic impact of climate change in the region and across the main economic sectors using integrated assessment models.[10] The costs to the region of inaction are significant. Newest estimates for the Asia-Pacific region show that growth will be significantly impacted by climate change. GDP in the region could decrease by as much as 3.3 per cent by 2050 and 10 per cent by 2100 relative to the base case.[11]

In addition to avoiding these costs, there is a clear macroeconomic case for action on climate. Since the global crisis, the growth outlook has weakened, with average annual GDP growth for developing Asia at 5.8 per cent for 2010-14, down from 7.3 per cent for 2005-9. Clear policy frameworks for encouraging private investment to flow to long-term projects in countries with carbon-intensive production to transition to a LCCR economy are needed.[12] However, to minimize financial risks, it is important to avoid an abrupt re-pricing of assets, or popping of the carbon bubble. Providing the right information to markets about climate-related financial risks will help to define a predictable path for a smooth transition to an LCCR world.

Asia has an important stake in implementing the Paris Agreement. Annual average emissions in the region have been growing at over 4 per cent over the last two decades, higher than any other region. Five of the global top ten GHG emitters in absolute terms are now situated in the region, namely China, India, the Russian Federation, Indonesia and Japan. Even in per capita terms, the Russian Federation, Japan, Indonesia and China are now all above the global average of around 7tCO_2e. Looking to the future, continued high

Figure 3 **Estimates of Unneeded Capital Expenditure and Avoided CO_2, 2015**



Source: Carbon Tracker (2015).

economic growth, population growth and urbanization are expected to keep the region on a high-emissions pathway, doubling in volume by 2050, unless measures are taken.

The Asia-Pacific region can reap large economic returns from transitioning to a LCCR model. Under a 2°C scenario, economic losses are limited to a mere 1.4 – 1.8 per cent by 2050 and to 2 per cent by 2100. The potential gains are found to be greatest for India, Indonesia and East and Southeast Asia.[13] These numbers reflect the many co-benefits from climate action, including reduced air pollution, reduced transport congestion, and more energy security. Once costed, these benefits can be quite substantial for the region. For example, in China, air pollution has been linked to 1.23 million premature deaths in 2010 and damages of around 10-13 per cent of GDP. Similarly in India, air pollution damage was equivalent to 6-8 per cent of GDP.[14] By achieving so many co-benefits, climate action can play an important role in implementing the 2030 Agenda.

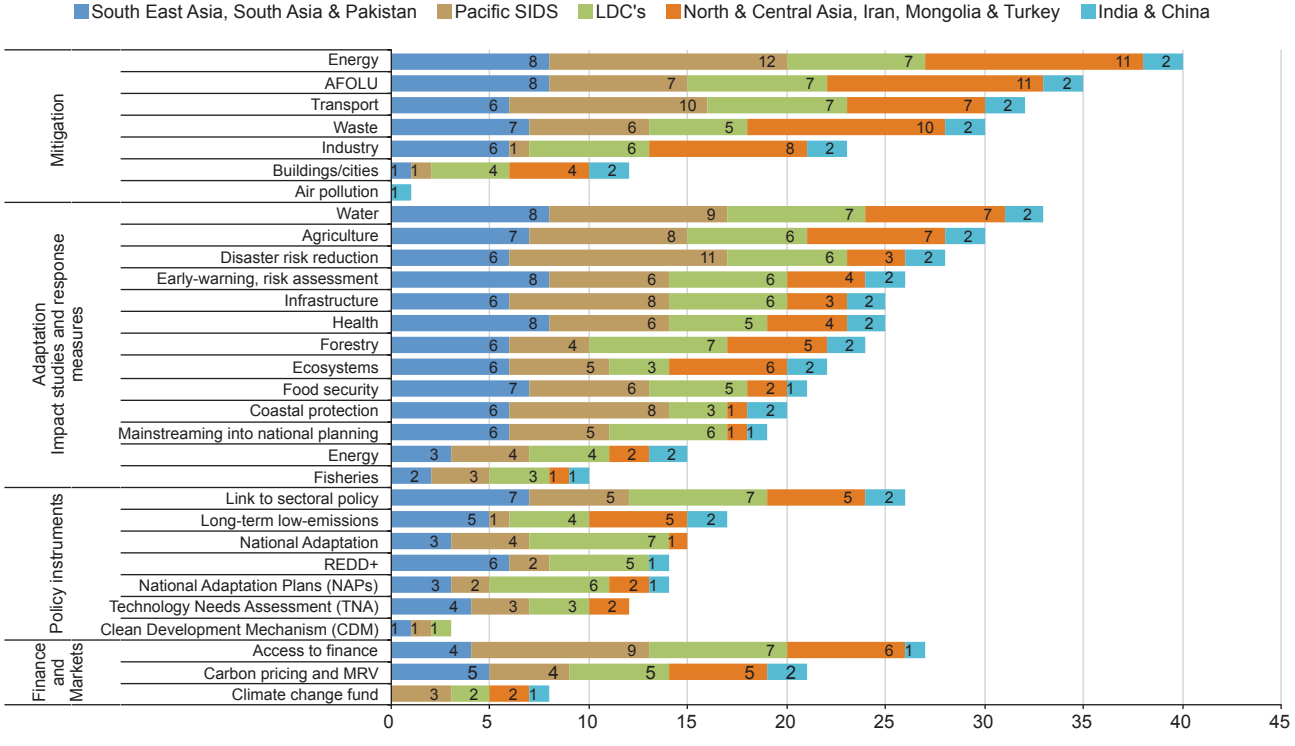
Over the past decade, the costs of climate action have decreased, mainly due to lower technology costs, and the efficiency savings of transitioning to a LCCR economy. Efficiency savings result mainly from energy efficiency improvements and reduced operating costs of a LCCR economy. Attaining a 2°C scenario would cost the region approximately 0.1 per cent of GDP annually or 4 per cent by 2050, relative to business as usual.[15] Costs will be further explored in the context of financing in Chapter 5.

Countries in the Asia-Pacific region are committed to taking on this challenge. In their nationally determined contributions (NDCs) under the Paris Agreement virtually all countries pledged to reduce their emissions relative to a baseline, or set other, largely energy-related, targets to that effect. Figure 4 below shows the priorities of countries in the Asia-Pacific region for mitigation, adaptation and other cross-cutting issues. Reflecting the region's unique characteristics, mitigation priorities are centered on energy as well as agriculture, forestry and other land use (AFOLU), transport, waste and industry, mirroring the main sources of emissions in the region. To strengthen adaptation, countries in the region are prioritizing the water and agriculture sectors, as well as disaster risk reduction strategies.

The current targets contained in NDCs still fall far short of the ambition needed to stay within the long-term temperature goal agreed to in Paris. A new study

Figure 4

Number of Parties that referred to an area in their intended Nationally Determined Contributions



finds that current commitments in the NDCs will only contain the mean global temperature rise to 2.9°C.[16] The Asia Pacific region will need to step up to this challenge by at least doubling ambitions contained in current NDCs by 2030.[17]

A broad policy mix will be required to achieve the ambitious goals set out in the Paris Agreement at a reasonable cost. This will include market-based instruments (MBIs), such as carbon pricing and subsidies, which use markets or prices to provide incentives for polluters to correct the climate externality, as well as regulatory and information instruments, and voluntary approaches.

The remainder of this paper identifies five key priority areas of the climate change response for the Asia-Pacific region, and the economic policies and instruments that can be used to achieve them. The first is to adapt to climate change and to improve resilience *inter alia* by strengthening disaster risk reduction and improving social protection. The second is for carbon pricing to be strengthened to provide sufficient incentives for economic actors to switch from fossil fuels towards low-carbon solutions. Third is to phase out fossil fuel subsidies as part of a larger engagement on energy sector reform. Fourth, countries should accelerate the uptake of renewable energy and energy efficiency. Fifth, is to ensure adequate financing is available to allow the region to meet the challenges and take advantage of the opportunities that climate change offers. Green finance can also help to address the transition risks of moving to a LCCR economic model.

Regional cooperation can address the harmonization of carbon prices to expand the size of carbon markets and reap their full benefits, technology cooperation, SDG implementation, and raise ambition through subnational networks including cities, companies and civil society.

1. ADAPTING EFFECTIVELY TO CLIMATE CHANGE AND STRENGTHENING RESILIENCE

Adaptation to climate change responds to the unavoidable impacts of climate change and is critical to reducing vulnerability and achieving sustainable development. Adaptation measures are undertaken by the public or private sectors through policies, infrastructure investments, new technologies, or behavioural change. Adaptation to climate change provides largely local benefits and is complementary to mitigation, without which the costs of adaptation rise sharply.

Adaptation is a complex phenomenon, not just because it is so closely intertwined with development, but also because there are several other challenges which stand out.[18] First, there are many stakeholders in adaptation and actions undertaken benefit them in different ways. Economics dictates that governments must facilitate those actions that have a wider benefit or constitute a public good. Adaptation actions that result in private benefit will take place autonomously and are typically short-run in nature. By contrast, responsibility for longer-run adaptation decisions rests with government. Second, adaptation involves decision-making under uncertainty. This poses challenges such as assessing the risks of climate change and forecasting that are inherently uncertain, and using limited data or incomplete models. Yet, governments need to form a view about costs and benefits over several decades to underpin its investment decisions. Third, financial constraints hinder an efficient adaptation response, especially among the poor.

Some of the key Governments actions related to their adaptation response will include (1) investing in, and adapting, major infrastructure to withstand the climate change impact, (2) managing disaster risks, (3) providing effective land-use planning, and (4) facilitating better information on climate change. Making effective infrastructure investments and their prioritization entails incorporating climate change adaptation into long-term development plans and reflecting these priorities in policy and budgets. Many of these expenditures would be justified even without climate change, so climate change adaptation is essentially about choosing no-regret development measures. In this sense, adaptation is an extension of good development practice which limits exposure and reduces vulnerability.

Adaptation can have potentially large macroeconomic benefits but these are difficult to quantify. Based on computable general equilibrium modelling, a study in Vietnam found that adaptation benefits were largest in the agriculture sector and were in the range of 10 per cent of sector value-added relative to baseline in 2050. It also found a significant 27 per cent addition in value added for the Central Highlands, a region characterized by vulnerable population groups and a high incidence of poverty.[19] In terms of costs, estimates suggest that costs of climate change to Asian cities will be substantial.[20]

Adaptation in the Asia-Pacific region

There are two critical areas for climate change adaptation in the region's climate change response, namely agriculture and cities.

Adaptation in agriculture

The Asia-Pacific region is still largely rural, and that is also where poverty is most endemic. Globally around three-quarters of the world's 1.2 billion extremely poor live in rural areas. Climate change is projected to have mainly negative impacts on food and agricultural production in the region and, therefore, also on the livelihoods of the rural poor. It is critically important to build resilience to climate change into agricultural systems in the region and to devise appropriate adaptation strategies for rural households.

In practice, there is already substantial autonomous adaptation taking place across the region. Autonomous adaptation actions in the agricultural sector relevant to the Asia-Pacific region include changes in sowing dates, switching to drought-tolerant or flood-resistant crops, and adoption of salinity-tolerant varieties of rice.

However, the rural poor will have more limited options in forming their response to the climate change threat. This is because they have much more limited capacity to manage risks and to identify and implement effective actions. For example, they often lack access to credit or have no formal title to assets. Other barriers they face include lack of land tenure security, limited access to information or capacity to use it, and a lack of social safety nets to cushion against external shocks.

The role of governments will be to protect the poor and vulnerable and to enable and empower them to better withstand and adapt to the climate risks they are exposed to. This means offering smallholders opportunities to improve their income and food security. Diversifying household incomes of the rural and urban poor will reduce their vulnerability to the climatic stresses. Another adaptation strategy can be to adopt sustainable intensification, which raises productivity and lowers production costs while conserving natural resources. Governments need to work with smallholders to build their capacity. Finally, governments also have a role in providing access to (micro-) finance and tailoring social safety nets accordingly. Interventions need to go hand-in-hand with policies for broader agricultural and rural development, but placing a stronger focus on climate risks.

Adaptation in Asian mega-cities

Climate change will compound existing risks to cities in the region. Cities in Asia are subject to an increase in flood-prone areas associated with climate change, in many cases reaching two-thirds of the urban areas. This will also lead to a substantial increase in people exposed to flooding. For example, in Bangkok in 2050, the number of people exposure to flooding by a 1-in-30-year event will rise between half and three quarters, while in Manila, an additional 2.5 million people will be exposed to a 1-in-100-year flood in 2050.[21]

The damage costs to cities will be substantial. For example, for Bangkok, additional costs imposed by climate change from a 1-in-30-year flood in 2050 are estimated to be in the range of two per cent of its GDP and these estimates triple when the costs of land subsidence are taken into account. In Manila, estimates suggests that damage costs could reach 6 per cent of regional GDP for a similar event. The largest component in these losses stems from the damage to buildings.

Four main actions stand out as priorities for cities to adapt effectively to the climate change risk. First, cities should address the land subsidence, and factors associated with it, as this issue greatly increases damage costs. Urban authorities must also manage other contributory factors to the damage, e.g. the presence of solid waste in drains and waterways or poor dredging of canals. Second, climate risks must be integrated into city and regional planning and develop city-level strategic frameworks accordingly. Policy and regulatory reforms, investments and capacity-building will all be important elements of the strategic framework. It will also be important to collect, manage and facilitate the knowledge base related to the climate risks and associated socioeconomic data that can be used to restrict future development in hazardous locations. Developing climate-based risk scenarios will be critical for urban planners. Similarly, building codes to flood-proof buildings can drastically reduce damage costs. Finally, urban adaptation efforts need to include both hard infrastructure, as well as green infrastructure measures such as ecosystem-based adaptation. For example, this can include the rehabilitation of mangroves or of urban wetlands to improve and strengthen flood resilience. Finally, risk-based insurance can decrease the costs of climate change by providing incentives that encourage action to reduce risk and can also be an important source of information to catalyse autonomous adaptation. For insurance markets to work effectively, insurance companies need accurate data on climate change impacts and likely damage. This is still a major constraint in emerging Asia-Pacific that needs to be addressed. Targeted policy measures can address the issue of the lack of access to insurance by the poorest in society, including social safety nets to reduce vulnerability.

Managing effective adaptation to climate change is still very challenging. It requires sufficient information, capital and capacity, all of which are lacking in developing countries of the region. Adaptation has limits as there will always be residual damage from climate change that people able to cope with or adapt to, widely referred to as 'loss and damage'. Strategies must be adopted to help manage disaster risk now and improve people's livelihoods and well-being. The most effective strategies offer development and mitigation co-benefits in the relatively near term and reduce vulnerability over the longer term.

2. FOSSIL FUEL SUBSIDY REFORM IS REQUIRED TO MOVE TO A LOW-CARBON ECONOMY

Global energy subsidies are significant and in the next few years, are expected to grow. If left unaddressed, they could generate a significant fiscal burden for public finances. For countries in the region that are shifting toward increased coal-based power and will soon have to import substantial amounts of coal, the exposure to international coal prices will convert the indirect subsidy to a direct subsidy with significant fiscal costs if domestic coal prices are not allowed to rise. The same is true for natural gas.

The carbon budget of 565-886 Gt CO_2 to 2050, compatible with a 2°C warming scenario means that only around one-fifth of total existing fossil fuel reserves can be burned by 2050.[22] Efforts are needed to keep much of that coal in the ground and the region will be central to the success of this undertaking considering that currently about 85 per cent of the regional electricity generation is powered by coal.

Fossil fuel subsidy reform to phase out consumer and producer subsidies will be a key element to rebalance economic incentives away from fossil fuels and in favour of cleaner sources of energy. It can also help to achieve the SDGs, due to the significant and negative macroeconomic, environmental, social and equity implications of energy subsidies.

Impact of energy subsidies

Energy subsidies have broad economic ramifications. Beyond their contribution to fiscal imbalances and public debt, subsidies depress investment in the energy sector. They cause losses for producers, limiting their ability to expand energy production, and discourage private investment. This hampers energy supply and leads to economic losses. Firms and households in developing countries often need to resort to own generation, which imposes significant costs on them, over and above the price of electricity from the public grid. Second, they crowd-out productive pro-poor spending in the social sectors which boosts growth in the longer-run. In many countries in the region, so-called post-tax subsidies, which are essentially made up of the energy subsidy plus an adjustment to take into account the costs of the externalities caused by fossil fuel consumption, considerably outpace social spending. For example, in 2010, Uzbekistan had post-tax energy subsidies of over 35 per cent of GDP, around seven times its critical social spending in health and education. A similar picture emerged in Turkmenistan and Iran. Third, subsidies lock in economic development into a high energy-intensity mode, which can make countries uncompetitive especially when energy prices increase. Fourth, in the case of net energy importers, higher energy consumption caused by subsidies puts pressure on the balance of payments unless higher international prices can be passed through to domestic fuel prices to mitigate the effect. Finally, they promote capital- and energy-intensive activity and associated technology choices, which are at odds with the need to generate employment in developing and emerging economies.

Box 2.1

Political support for fossil fuel subsidy reform

There is political support to address the phasing out of fossil fuel subsidies in the region. The G20, which includes regional economies such as Australia, China, India, Indonesia, Japan, the Republic of Korea and Russia, has committed to eliminate subsidies for coal, oil and gas in the medium term. In 2009, APEC leaders committed to phase-out fossil-fuel subsidies and have a voluntary peer review mechanism in place. This agenda is also contained in the SDG framework (Goal 12).

Box 2.2

Global energy subsidies

Global energy subsidies are substantial. Based on the 'price-gap' approach,[23] a simple approach comparing the current domestic prices in each country to the benchmark, IMF (2013) estimates the global amount of energy subsidies in 2011 at US$480bn, equivalent to 0.7 percent of global GDP or two percent of total government revenues.[24] In comparison, Husar&Kitt (2016) estimated these subsidies to be at around US$550bn annually on average over the period 2011 to 2014, or just over US$100 per barrel. About half of these subsidies pertain to petroleum and the other half, in roughly equal proportions, to electricity and gas subsidies. Energy subsidies are concentrated in oil exporting countries, which comprise mostly developing or emerging economies.

For consumer subsidies, post-tax subsidies can be calculated as an additional measure to take into account the need for fiscal revenue and for the negative consumption externalities, i.e. the impact of energy consumption on global warming; on local air pollution and health; and on traffic congestion, accidents and road damage. Post-tax energy subsidies were much larger, due to the fact that energy products are taxed less than other products and that they command prices that fall far below the levels needed to account for their negative externalities, reaching US$ 1.9tr in 2011, according to IMF (2013a), equivalent to 2.5 per cent of GDP or 8 per cent of government revenue. However, Coady et al. (2015) calculate much higher global post-tax energy subsidies, equivalent to 5.8 per cent of GDP in 2011 and as high as 6.5 per cent in 2015, with coal accounting for the largest share (3.9 per cent in 2015).

Energy subsidies have significant environmental implications. Subsidies distort resource allocation decisions by encouraging wasteful fossil fuel consumption and reducing incentives for investment in renewable energy. This leads to higher global warming, more air pollution, greater traffic congestion, accidents and road damage. Subsidies of diesel can lead to the overuse of irrigation pumps, and the over-cultivation of water-intensive crops, resulting in a depletion of groundwater.

Energy subsidies have social and equity dimensions. Energy subsidies are highly regressive and benefit mainly the higher income groups. The highest income quintile in low- and middle-income countries receives on average around six times more in subsidies (43 per cent) than the poorest quintile (7 per cent). Gasoline has been found to be the most regressive energy product. As poorer households have a higher price elasticity of demand, the removal of subsidies and consequent price spike in energy prices can have a significant impact on poor households, underscoring the need to couple any fossil fuel subsidy reform with targeted social transfers to mitigate these effects. Energy subsidies also crowd out pro-poor spending, especially in areas of health, education and social protection. Despite often being viewed as a tool for redistributing oil wealth in oil-exporting countries, the above suggests that subsidies are not an efficient instrument for distributing wealth.

Trends in Asia-Pacific

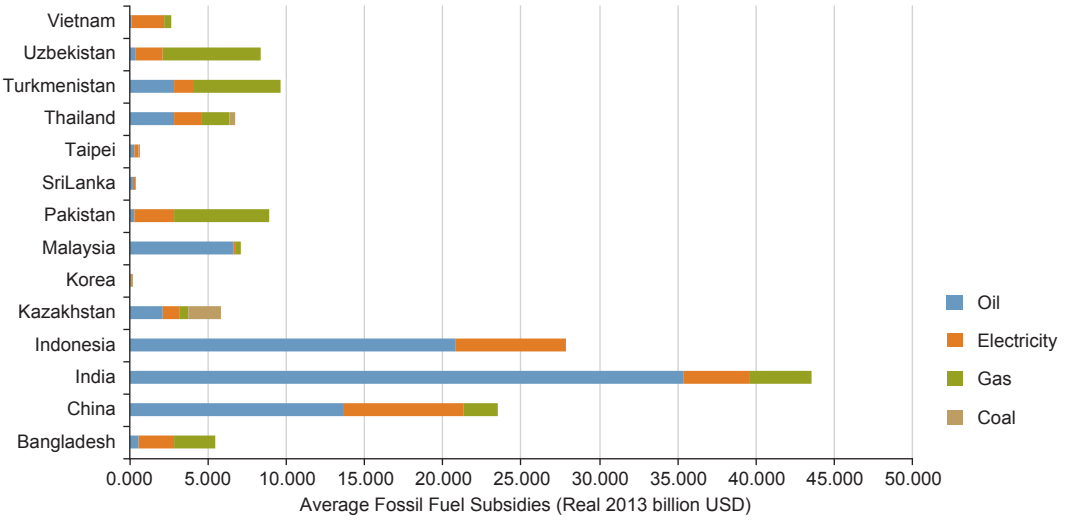
Asia made up around one-third of global energy subsidies in 2013.[25] Regarding composition, the subsidies were overwhelming concentrated on petroleum products and electricity, accounting for some 90 per cent of the total. The region is home to some major subsidizing nations (Figure 5). Based on estimates for 2014, Iran's fossil fuel subsidies amounted to around 20 per cent of GDP, followed by Russia and India (both around 10 per cent), Indonesia (7 per cent) and China (4 per cent).[26]

In absolute terms, China and Russia were among the top three subsidizers, with US$279bn and US$116bn respectively. In post-tax terms, Coady et al. (2015) calculate that the Asia accounts for the largest share of global post-tax subsidies, namely just under 60 percent.[27] Looking at total subsidies, this region represents a staggering 16-17 per cent of regional GDP, with coal subsidies dominating the picture, reflecting the substantial undercharging for coal's environmental impact.

Energy subsidies impose a large fiscal cost. Modelling results estimate the fiscal gain from removing energy subsidies for 2013 data in the order of US$3bn globally, with around two-thirds of this pertaining to the Asian region.[28] In terms of regional GDP this amounts to around 10 per cent, and in terms of share of government revenue, it just exceeds 30 per cent.

Figure 5

Asia-Pacific Fossil Fuel Subsidies, 2012-2014 (average pre-tax, real 2013 US$ bn)



Source: IEA (2012).

Coady et al. (2015) calculate that eliminating the full post-tax subsidies in 2015 would raise government revenue by $2.9 trillion (3.6 per cent of global GDP), cut global CO_2 emissions by more than 20 per cent, and cut pre-mature air pollution deaths by more than half. For the Asian region, the percentage reduction of CO_2 emissions is in the range of 18-25 per cent, while the reduction of air pollution deaths is around 55-60 per cent. The resulting welfare gains are also very large, in the range of 5-7 per cent of regional GDP. If fiscal gains are recycled towards reducing distortionary labour taxes or increasing productive social spending, the total welfare gain would be magnified. An examination of post-tax energy subsidies shows that around three-quarters of these are related to local environmental damage and the remaining quarter pertain to the impact on global warming. This suggests that, in addition to the fiscal gains, energy subsidy reform would have large benefits to the local populations.

Energy subsidy reform

Phasing out energy subsidies is a complex challenge.[29] First, as the full cost of these subsidies is only partially reflected on budget, there is a general lack of awareness about the magnitude of subsidies. Second, there may be a perceived lack of trust in the government to re-distribute the fiscal savings of reform to benefit the wider population and to protect vulnerable groups. This is particularly challenging in the case of oil exporters where subsidies are widely viewed as a means to redistribute the benefits of rich natural resource endowments. Third, governments can also be concerned by potential inflation caused by higher energy prices post-reform, and the short-term impact of higher prices on growth and competitiveness. Fourth, vested interests can be particularly vocal in blocking reform. Finally, there are concerns about the adverse impact that reform can have on the poor.

Experience from different countries suggests that there are at least six common elements to successful fossil fuel subsidy reform. To reduce subsidies, an appropriate policy mix is needed, which should include the following elements: (1) improving delivery of social support through subsidy targeting and cash transfers; (2) institutional reforms to facilitate market-level pricing of energy (and depoliticize pricing); (3) appropriate phasing-in and sequencing of price increases, differentiating across energy products; (4) facilitating improvements in energy efficiency (as a way to reduce the energy intensity of large energy consumers, especially state-owned enterprises); (5) a comprehensive energy sector reform with clear objectives together with a good understanding of its impacts and broad stakeholder consultation; and (6) a transparent communications strategy.

Building on the political momentum, practical next steps for Asia-Pacific countries should include:

- Reform of coal subsidies through an environmental tax should be at the top of the policy agenda to limit the environmental damage from coal consumption;
- Introduction of mechanisms to reflect the gradual

increase in costs and acceptable profits towards efficient prices of electricity and petroleum products and to avoid shocks to the economy, including through inflation;
- Speeding up the creation of competitive energy markets, especially electricity markets;
- Strengthening of the electricity block tariff scheme, which provides a cross subsidy from high- to low-consuming users;
- Improvement of the operational efficiency of state-owned utilities to provide a source of price decreases;
- Strengthening of other social safety nets to mitigate the impact from rising electricity prices that cannot be offset by cross-subsidies alone (or potentially strengthen social safety nets enough to replace tariff subsidy);
- Consider temporary relief measures for energy-intensive firms;
- Ensuring that the fiscal gains from energy subsidy reform are redirected to spending in the social sectors;
- Communicating to the public the benefits of price reform (and the cost of a status quo) and the measures being taken to mitigate the impact of price increases; and
- Continuing building strong, transparent mechanisms for setting prices, including by increasing linkages between relevant ministries.

3. ACCELERATING THE ADOPTION OF ENERGY EFFICIENCY AND RENEWABLE ENERGY MEASURES

Energy demand in the Asia-Pacific region is rising rapidly due to economic growth, population expansion and urbanization. Projections show that energy demand will almost double in the Asia-Pacific region by 2030. Meeting this demand will be critical to supporting the region's economic growth. At the same time, rising GHG emissions from fossil fuel use and the resulting challenges of local air pollution and negative health impacts mean that cleaner energy solutions are needed to displace traditional carbon-based energy sources. In addition, the region still has not achieved comprehensive energy access, with over 400 million people in the region still without access to electricity. Energy efficiency and renewable energy, including distributed systems, are central to the solution.

Energy efficiency

Energy efficiency is typically seen as the cheapest climate change mitigation option. It includes both the reduction of losses along the energy production, transmission and distribution chain, as well as reduction in end-use, without diminishing the outputs delivered. Many energy efficiency measures typically pay for themselves in that they generate greater savings than their costs, and are therefore known as 'no-regret' options. Investments in energy efficiency can yield two- to four-fold returns in lifetime cost savings.[30]

Over the past decade and a half, international experience has shown that mandatory targets are key to achieving energy efficiency take-up. These are seen as a necessary complement to pricing policies. Globally, around one-third of final energy demand was estimated to be covered by mandatory efficiency policies in 2015, up from around one-tenth in 2000. The average performance levels mandated by policies have tightened by 23 per cent over the last decade.

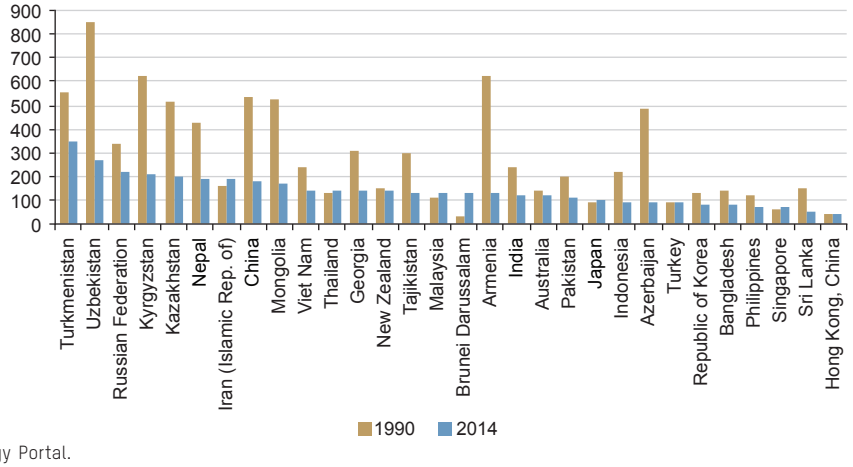
Energy intensity in the region (Figure 6) is still much higher than that of developed countries. For example, energy intensity levels in China were still 50 per cent higher than the OECD average in 2015. Nevertheless, energy intensity in region is being steadily reduced. In China, it improved by 5.6 per cent in 2015, up from an annual average of 3.1 per cent over the previous decade. In China's power sector, energy efficiency gains in 2015 avoided the need for over US$230bn in investment for new (mostly coal-fired) electricity generation. This was equivalent to avoided emissions of a staggering 1.2 billion tonnes of CO_2 in 2014, as much as Japan emits annually.

In the Asia-Pacific region, the biggest growth in the coverage of energy consumption by mandatory policies over the last decade has been in the industry sectors of China and India through their Top 10,000 and PAT programmes, which set mandatory energy intensity targets. These programmes cover around 85 per cent of China's industrial energy consumption, and 40 per cent of that in India. Fuel consumption standards have also been part of the effort to drive energy efficiency gains. For example, Chinese fuel economy gains were 2.3 per cent annually between 2013 and 2015, despite a 26 per cent drop in retail petrol prices. This improvement was driven by China's first corporate average fuel consumption standards in 2012.

The region has recently implemented many policies to boost energy efficiency. Japan's updated Law on Building Energy Conservation aims to reduce energy consumption in buildings through labelling and incentives that reward energy efficiency performance improvements for new buildings and building retrofits. In the Philippines, the Energy Efficiency Action Plan and Roadmap pursues 39 initiatives across sectors. Vietnam

Figure 6

Total energy intensity, 1990 - 2014 (kg of oil equivalent per 1,000 US$ GDP, in 2005 PPP)



Source: Asia Pacific Energy Portal.

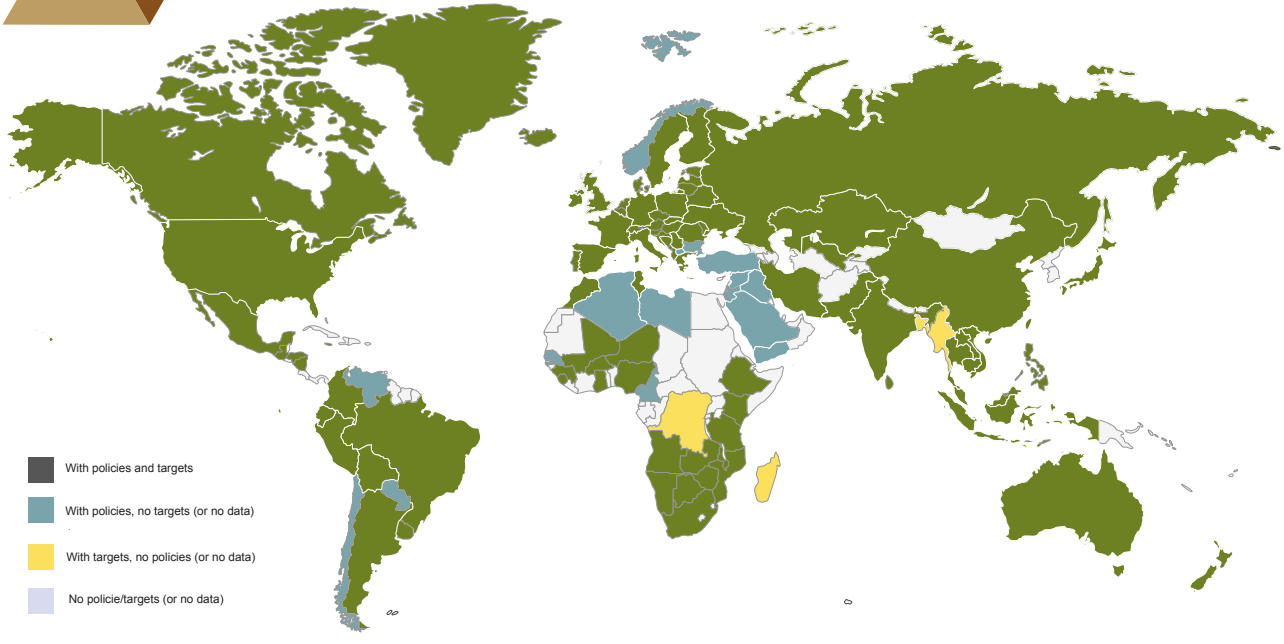
has a Law on Energy Efficiency and has introduced mandatory labelling for certain market segments.

Many energy efficiency measures can also be linked to renewable energy. In 2014, Japan adopted its Strategic Energy Plan which contains energy-efficient interventions. In the same year, Indonesia set targets for achieving a higher share of RE in its energy mix through *inter alia* energy efficiency measures.

As fossil fuel subsidy reform progresses and carbon pricing gains hold, bringing prices closer to their real costs, this will make energy efficiency improvements more desirable. Green bonds have been a substantial source of capital for energy efficiency especially in the transport, industry and buildings. Concessional loans, credit lines, and partial risk guarantees provided by development finance institutions, as well as climate finance, have been important sources of financing.

Figure 7

Countries with Energy Efficiency Policies and Targets, 2015



Source: REN21 (2016).

There is huge potential for the region to enjoy much greater energy efficiency gains in the future. As buildings account for around a third of global total final energy consumption, and the building stock is rapidly expanding in the region to accommodate population growth, economic growth and urbanization trends, there is huge potential for energy efficiency improvements in the residential sector, especially in building design, heating and cooling, lighting and household appliances. In addition, the region is the world's manufacturing hub and therefore offers enormous potential for electricity savings from industrial energy efficiency measures. However, in the context of rising standards of living in the Asia-Pacific region, one of the key challenges will be for energy efficiency improvements to keep pace with growing demand.

Moving forward, countries in the region need to focus on expanding the coverage of existing energy efficiency targets, building on their successes and complemented by pricing policies that rebalance consumption and investments in favour of clean energy solutions. Carbon pricing will be a critical component of this.

Renewable energy

In order for renewables to displace fossil fuels, their relative price will be an important factor. Cheaper fossil fuels can undermine the prospects for renewables especially where they are substitutes. In practice, the steep price drop of fossil fuels between mid-2014 and early 2016, when Brent crude fell 76 per cent, while coal and US natural gas dropped by almost 60 per cent, do not appear to have had a material impact on the demand for renewables.[31] This is attributable to the fact that oil is not a substitute for wind and solar energy, that gas prices outside the US remained far above US levels, and that energy decision-makers do not make investment decisions about new installations based on spot prices. Coal investment also increasingly carries with it the risk of future stranded assets as discussed in Chapter 2 on fossil fuel subsidy reform. Second, renewable energy is becoming increasingly cost-effective due to the steep drop in the price of technologies. Third, once the externalities caused by fossil fuels are priced, which is increasingly occurring as the region implements fossil fuel subsidy reforms and imposes carbon taxes, renewables become increasingly cost-effective.

Renewables also offer inherent advantages, such as their speed of deployment. Wind farms can be built in less than a year, while installing solar parks can take less than half a year. By contrast, coal and gas plants take many years to build and nuclear plants require even longer, often over a decade.

The economic case for subsidies to support renewables and energy-efficient technologies rests on the need to overcome market barriers to their development and deployment, while helping to reduce GHG emissions. In principle, taxing carbon-intensive fuels through a carbon tax is an economically more efficient way to internalize the environmental externalities than subsidizing cleaner fuels but, as will be discussed in the next chapter, can be politically difficult to implement. Therefore, targeted subsidies for clean energy play an important role in reducing GHG emissions, as part of a larger portfolio of market-based, regulatory and voluntary or information-based measures. However, such subsidies can impose potentially large costs on the budget and their impact on reducing emissions is more indirect. The case for subsidies is stronger when pricing instruments, such as carbon markets, fail (because of high enforcement costs) or when the target activity is a strong substitute for the activity it is replacing, e.g. in the case of renewable energy replacing gas and coal power generation.

Renewables such as wind and solar have lifetime costs that are heavily concentrated at the development and construction stage and modest during the operating stage – because the feedstock is essentially free and the ongoing labour requirement is limited to monitoring and maintenance. On the other hand, fossil fuel generation has a cost profile that is spread out over a project's lifetime, with initial costs a smaller share of the total and the feedstock, its transport and handling, representing a much higher share of the total. Global estimates for 'levelised cost of electricity' (LCOE) from renewable technologies[32] that capture the all-in cost of generation (project development, construction, financing, operation and maintenance) show that costs for solar and wind have been decreasing.[33] Recent decreases in LCOEs for PV and onshore wind were caused by financial support provided by governments for their deployment at scale, which resulted in declines in the costs of manufacturing of those technologies, while their productive output has increased. For 2013, LCOEs for onshore wind, geothermal (flash plant), landfill gas, large and small hydro and combined heat power (CHP) were already all in the same range as natural gas and coal-fired generation. On-shore wind decreased by some 18 per cent over the period 2009 to 2013.

Modelling efforts have quantified the sustainable development co-benefits of doubling the global share of renewables in the energy mix by 2030. This is one of the three objectives of the Sustainable Energy for All (SE4ALL) initiative contained in SDG7 of Agenda 2030. On the basis of a macroeconometric model, in addition to its environmental impact, implementing this

objective would lead to an increase in global GDP of 1.1 per cent, in global welfare of at least 2.7 per cent, in direct and indirect employment in the sector to 24 million, and would enhance trade. Many of these co-benefits will depend on sufficient financial resources being directed to the sector.[34]

Trends in the Asia-Pacific region

Renewable energy deployment in the Asia-Pacific region has seen remarkable growth in recent decades, supported by enabling policies such as subsidies and targets, and steep cost reductions for the principal technologies such as solar and wind. This is due to a number of advantages it offers, especially improved energy security, cost-effectiveness, a much smaller environmental impact, rapid deployment, and facilitating energy access. The business case for renewable energy is further enhanced by the socioeconomic co-benefits it offers.

Recent moves towards greater subregional and regional electricity interconnectivity can play a highly supportive role for the large-scale exploitation of wind, solar, and hydropower. Given the seasonal nature and temporal variation of many of these resources, the cross border trade of electricity energy surplus to energy deficit countries can enhance energy security, lower prices and increase lower emissions through exploiting new renewable energy sources.

New investments in China alone (US$103bn) were just over one-third of the global total in 2015, while the regional share for Asia as a whole (US$161bn) represented 56 per cent, mostly driven by solar and wind technologies. Within this total, Japan attracted US$36.2bn, followed by India at US$10.2bn and South Korea at US$1bn. In terms of technologies, the bulk of capacity and investment growth was in solar and wind technologies, both on- and off-shore. In China, on-shore wind secured US$42bn and off-shore wind around US$6bn. In India, utility-scale solar attracted US$4.6bn, up 75 percent year-on-year, while wind drew another US$ 4.1bn.

The LCOEs of onshore wind in India and China were amongst the lowest in the world, mainly due to low capital expenditure costs and despite costly debt financing. With more concessional financing, this could be lowered further. At the other end of the spectrum, Japan had a very high LCOE driven by high capital costs and high OPEX. A very similar picture emerges for solar PV, which saw even steeper cost declines of almost 60 per cent over the same period, brought about in part by industry turmoil and oversupply.

However, bottlenecks included problems connecting to transmission infrastructure and high operations and maintenance costs (O&M). National electricity monopolies in some developing countries are resistant to variable wind and solar generation. In China, there is also the issue of a supply glut in the face of slowing electricity demand and transmission bottlenecks, which has led to the curtailment of the output of some wind farms.

The prevalence of renewable energy targets in the region have played a key role in the strong growth of renewable energy capacity and investments in the region. Long-term, ambitious targets demonstrate political commitment to renewable energy and act as a signal for investors. To help achieve their targets, complementary fiscal incentives and public financing options have been adopted, and tracking tools have been implemented. As shown in the Table 1 below, countries in the region that have adopted economy-wide targets in the region include China, Indonesia, Lao PDR, Thailand and Vanuatu. A notable trend in the region has been increased renewable energy targets for power generation by both China and India. For example, India set solar and wind targets of 100GW and 60GW, respectively, for 2022; while China set these levels at 150GW and 250GW, respectively, by 2020. Several Pacific island states also introduced 100 percent renewables targets in their NDCs.

Renewable Portfolio Standards (RPS) or electric utility quotas are also used to promote RE. In the Asia-Pacific region, Australia, Japan, India, China, the Philippines and Korea mandated these, and at sub-national level, twenty-seven Indian states.

Renewable energy feed-in tariffs (FITs) for power generation have also played an important role in boosting investment for renewables in the region. Feed-in tariffs are currently going through a transition, as countries are adapting rates and design in the face of changing market conditions, technological innovation, increasing deployment, and falling prices. New rates were introduced by Malaysia and Pakistan, while revisions to solar and wind FITs have occurred in China, Japan, the Philippines and Thailand. For example, in Japan, the relatively generous FITs helped to propel small-scale solar projects of less than 1MW to US$31.7bn in 2015. A revision of the policy regime to further support solar PV is currently being considered in Japan and could take the form of a constant-rate annual tariff reduction, a flexible reduction rate in the tariff depending on the amount commissioned, or an auction programme.

Table 1

Renewable Energy Policy Instruments and Incentives in the Asia-Pacific region, 2015

Country	Regulatory Policies							Fiscal Incentives and Public Financing				
	Renewable energy targets	Feed in tarriff / premium payment	Electric Utility quota obligation / RPS	Net meeting / Net billing	Transport obligation / mandate	Heat obligation / mandate	Tradable RED	Tendering	Capital Subsidy, grant, or rebate	Investment or production tax credits	Reduction in sales, energy, VAT or other taxes	Energy production payment	Public inverstment, loans or grants
Australia	R	○	•		○	○	•	N*	○				R
Azerbaijan	•												•
Bangladesh	R							•	•		•		•
China	R	R	•		•	•		N	•	•	•	•	•
Fiji	•									•	•		
India	R	•	•	R*	R	○	•	N	•	•	R	•	•
Indonesia	R	•	•		R			•	•	•	•		•
Japan	R	R					•	•	•		R		•
Kazakhstan	•	•					•		•				
Korea (the Republic of)	•		•	•	R	•	•		•	•	•		•
Kyrgyzstan			•						•		•		
Malaysia	•	R	•		R						•		•
Marshall Islands (the)	•										•		
Micronesia (Federated States of)	•			○									
Mongolia	R	•						•			N		
Myanmar	R										•		
Nepal	•	•					•	•	•	•	•		•
New Zealand	•			○					•				•
Pakistan	•	R		N	•		•		○		R		•
Palau	•		•										
Philippines	•	R	•	•	•			•	•	•	•	•	•
Russian Federation (the)	•	•						R	•				
Singapore	R			•				•					•
Solomon Islands													
Sri Lanka	•	•	•	•	•				•		•	•	•
Tajikistan	•	•									•		•
Thailand	R	R			R						•	•	•
Turkey	R	•			•			N	•				•
Uzbekistan								•					
Vanuatu	R	•									•		
Viet Nam	•	•			•		•		•	•	•		

- • Existing national (could also include subnational)
- ○ Existing sub-national (but no national)
- N New (one or more policies of this type)
- R Revised (one or more policies of this type)
- N* New sub-national
- R* Revised sub-national

Source: REN21 (2016).

Table 2

Share of Primary and Final Energy from Renewable Sources, Targets and 2013/2014 Shares in the Asia-Pacific region

Country	Primary Energy			Final Energy		
	Current Share	Target	Target Date	Current Share	Target	Target Date
Armenia	16%	21%	2020			
Azerbaijan	0.05%					
Bangladesh					10%	2020
China				11.1%	**20%**	**2030**
Fiji					23%	2030
France				14.3%	**25%**	**2020**
					32%	**2030**
Indonesia		25%	2025			
Japan	5.8%	14%	2030			
Korea (the Republic of)		4.3%	2015		11%	2025
		6.1%	2020			
		11.0%	2030			
Lao People's Democratic Republic(the)					**30%**	**2025**
Mongolia		20-25%	2020			
Nepal		10%	2030			
Netherlands				6%	16%	2020
Palau		20%	2020			
Thailand					**30%**	**2036**
					25%	2021
Vanuatu					**65%**	**2020**
Viet Nam		5%	2020			
		8%	2025			
		11%	2050			

Source: REN21 (2016).

Competitive bidding has gained momentum in the recent past with many countries in the region resorting to auctions or tenders as a mechanism for awarding contracts and achieving efficient, market-driven pricing. This mechanism has been widely employed at a sub-national level. For example, in late 2015 and early 2016, India awarded solar projects to bids of US$64 per MWh (Fortum Finnsuurya Energy in Rajasthan) and US$68 (SunEdison and Softbank in Andhra Pradesh). In 2015, the Australian Capital Territory launched a second utility-scale wind auction. In the Middle East two large scale solar projects won reverse auctions in 2016 with bids of under US$30 per MWh, driven by low cost labour and finance.

Outside the power generation sector, Asia-Pacific countries have lagged behind other regions in adopting policies to promote renewables in heating and cooling as well as in the transport sectors. Most of the support in the heating and cooling sector has been directed to solar water heating. Building code mandates have been used at the local level to promote renewable heat. Financial incentives and public financing have also been directed to renewable heat for industrial processes, e.g. in Australia. In the transport sector, policy has been focused on renewable fuels and electric vehicles (EVs). In 2015, Lao PDR set a 10 percent target for the use of biofuels in its transport fuel by 2025 and Japan is preparing the introduction of biofuels for air transport by 2020. The most common form of regulatory support for the renewable transport sector was biofuel blend mandates, including in India, Indonesia, Malaysia and Thailand. Regarding EVs, it can be expected that this area will receive much more regulatory attention in the coming years, including directly linking EVs and renewable energy.

Countries have introduced public finance mechanisms to support their RE policies. In the region, this has predominantly entailed RE tax incentives, such as in India, Mongolia and Pakistan, or increasing public funding for R&D in clean energy technologies, for

example, Australia's commitment to support energy storage projects with an US$80m grant.

Regarding impact, a country study for Japan found that adding 23.3 GW of solar PV would lead to an increase of almost 1 per cent in national GDP.[35] Most of the positive impact on GDP occurs from increased investment for renewables deployment, and is found to be higher if it entails a higher rate of electrification. The welfare impact is found to be much higher (4-8 per cent relative to baseline) in individual countries in the region, especially India, Indonesia, China and Japan, mainly due to the reduced health impact of air pollution. These gains would be further magnified if this objective was met by expanding energy access. The number of jobs in the sector would also be roughly doubled in the five countries of the region included in the study, creating an additional 6.6 million jobs.[36]

A sanguine view of the boom in renewables needs to be counterbalanced by the fact that coal power generation capacity has also been increasing in the region. The figures for 2015 show that the region was responsible for 85 per cent of the 85GW of new coal capacity commissioned, with China accounting for half of this, India representing another quarter and the rest of Asia 10 per cent. Projections from major forecasting organizations show that power generation emissions will only peak in the second half of the 2020s, with around half of the increase in emissions up to 2040 due to coal-fired generation.

Distributed renewable energy systems

In the Asia-Pacific region, more than 400 million people have no access to electricity and many more rely on traditional biomass for heating.[37] Distributed renewable energy systems (DRE) across the region already provide energy to rural communities and peri-urban areas where connections to energy grids are too expensive or non-existent. DREs offer huge co-benefits including improved health through the displacement of indoor air pollution, and can boost household income, women's empowerment, and educational attainment. DREs continued to grow rapidly, with technologies focused on clean cook stoves, solar lighting systems, solar home systems, micro- and pico-hydro systems, small-scale wind turbines, and biogas systems.

DREs were financed from a variety of sources. These included debt capital and equity financing from impact funds and development banks, as well as crowdfunding, microfinance and third-party leasing. Carbon finance also played a role in the scale up of the deployment of clean cook stoves. Innovative business models also saw partnerships between energy and telecommunications companies offering combined energy services and their affordable financing through payment plans administered via mobile phones.

Net metering has been used extensively to support small-scale distributed RE deployment by providing generators with credit or payments for excess on-site generation. In many cases, these have been offered in conjunction with other instruments such as FITs or auctions. Nepal and Pakistan provided net metering for plants less than 1MW, while at sub-national level, 21 Indian states adopted this policy. This measure is increasingly being adapted to take into account new technical standards for grid connection but also to impose taxes or fees on generators or to revise downward the payments, as pressure mounts from electric utilities or private citizens about their rates and revenue concerns.

4. INTRODUCING STRONG AND PREDICTABLE CARBON PRICING

There are a number of carbon pricing instruments that can accelerate the transition to a LCCR economy. The two main pillars are carbon taxes and carbon markets, which include emissions trading schemes, and results-based financing mechanisms such as the Reducing Emissions from Deforestation and Forest Degradation and sustainable management of forests, conservation of forest carbon stocks and enhancement of forest carbon stocks (REDD+). Non-market instruments complement these market instruments and have an important role to play. They include technology or performance-oriented regulations, bans on certain products or practices and licensing requirements. Voluntary and information-based approaches include ratings, labelling and certification, inventories, and corporate initiatives.

Carbon pricing

Carbon pricing comprises carbon taxes, and emission trading schemes (ETS). In theory, the main advantage of carbon pricing is that it constitutes the most economically efficient way to reduce emissions by deferring to private firms and individuals to find and exploit the lowest cost ways for reducing emissions. This holds in a perfectly competitive permit market and in the absence of uncertainty. Its cost-effectiveness can be further enhanced if the public revenues it generates are channelled to further enhance welfare, thereby reaping a 'double dividend'. Carbon pricing provides strong incentives to reduce carbon emissions

by signaling information to consumers and producers alike about the carbon content of goods and services, enabling a shift in consumption to goods or services with lower carbon content, either for consumption or as input into the production process. Further, it provides a market signal that helps spur innovation in low-carbon products and processes.

The fundamental difference between a carbon tax and a carbon market is that the former fixes the price of carbon and lets the quantity fluctuate, while a market fixes the quantity of carbon emissions and lets the price fluctuate. With a carbon tax, the producer of the externality is taxed at a rate equal to the social cost imposed through the externality. It carries low administrative costs and can be administered through existing institutions. Taxes are usually preferable in cases where pollution originates from many diffuse sources as pricing these will be more difficult to achieve through an ETS than a tax, e.g. households, farmers, or small- and medium-sized enterprises. In developing countries, an advantage is that a carbon

Box 4.1

Global carbon pricing schemes and initiatives

Forty national jurisdictions and over 20 cities, states, and regions have adopted carbon pricing initiatives across the globe. These make up almost a quarter of global GHG emissions and cover, on average, carbon pricing initiatives cover about half of the emissions in these jurisdictions

The European Union Emissions Trading Scheme (EU-ETS) is the cornerstone of the EU policy framework to achieve the region's 40 per cent reduction target for total emissions by 2030, relative to base year. It currently makes up the world's largest carbon market. Recent attempts to tighten supply in order to reduce the supply glut in unused allowances that have caused carbon prices to plummet since 2008, have met with moderate success. Due to the postponement of the auctioning of 300 million allowances in 2015, the surplus of CO_2 emission allowances in the EU-ETS declined by 17 per cent in 2015, representing the first significant decrease since 2008 and causing some upward movement in EU carbon prices. This bodes well for international carbon markets. However, the surplus remains substantial, equivalent to one year's worth of CO_2 emissions cover by the EU scheme.

Moving forward, recent policy developments to address the current surplus through a market stability reserve (MSR), combined with the proposed steeper annual decline of the number of allowances from 2021 onwards, is expected to put the EU-ETS back on track to achieve a 43 per cent emissions cut by 2030 relative to 2005. In addition to absorbing surplus allowances, the MSR will build resilience to supply-demand imbalances and enhance synergies with other climate and energy policies.

The Clean Development Mechanism (CDM) under the Kyoto Protocol of the UN Framework Convention on Climate Change entered the second commitment period from 2012 to 2020. The CDM has proven to be a successful mechanism in terms of the number and diversity of mitigation projects it has catalyzed in a cost-effective way, but also because of the capacity it has built in many developing countries to implement a stringent MRV system and the awareness about carbon markets that it has built. International demand for Kyoto credits is almost exhausted. A number of initiatives exist aimed at resuscitating this demand by paying above-market price for credits through results-based finance (RBF) initiatives, and rescuing 'stranded' CDM projects. These initiatives include the Norwegian Carbon Procurement Facility, the World Bank's Pilot Auction Facility, the Carbon Partnership Facility and the Carbon Initiative for Development. In the second commitment period, the CDM was re-oriented to achieve penetration in the least-developed countries.

In the interim period between 2013 and the Paris Agreement, the Partnership for Market Readiness (PMR) has supported countries to assess, prepare, and implement carbon pricing instruments in order to scale up greenhouse gas mitigation. It also serves as a platform for countries to share knowledge and work together to shape the future of cost-effective climate change mitigation. This is a global partnership of over thirty countries, with 18 countries implementing their market readiness proposals, which have encompassed pilot ETSs and carbon tax schemes, as well as Nationally Appropriate Mitigation Actions.

There is renewed political support and interest witnessed by the recent launch of the Carbon Pricing Leadership Coalition (CPLC) that brings together governments, business and non-government organizations (NGOs) to accelerate the uptake of carbon pricing. Various other political groupings support this objective, including the G7 Carbon Market Platform. The global aviation sector has also just agreed to a new international carbon offsetting mechanism from 2021. The World Bank's Networked Carbon Markets initiative facilitates cross-border emissions trading.

tax is easier to administer than a full-fledged ETS which requires solid governance and higher capacity. In practice, carbon taxes have also been used as a means of transitioning to an ETS system at a later stage. However, due to the unknown price elasticity of demand for carbon, the actual environmental outcome of a tax remains unknown. Taxes are politically 'visible' as compared to tradable permit systems, and hence may be less amenable to easy adoption and compliance. Imperfectly competitive markets, such as monopolistic power suppliers, will reduce the welfare gains from the carbon tax as the additional costs will be passed through to the consumers and the incentive to find cheaper emissions abatement options will not be binding. Finally, carbon taxes can also be regressive so attention needs to be paid to the impacts on low-income households and ways to alleviate those.

Emissions trading systems create a market for the externality by assigning tradable property rights. Emissions trading systems provide certainty over pollution emissions levels. In theory, they provide a means to reduce emissions at the lowest possible cost, both within and across countries. This is because companies covered by the system will sell permits as long as their market price exceeds their marginal abatement costs, i.e. those who can reduce emissions most cheaply will do so, achieving the reduction at the lowest possible cost to society. A trading scheme provides flexibility to build political support for the scheme through permit allocation rules, such as providing free permits to existing emitters. However, this practice impinges on the cost-effectiveness of a scheme and raises equity concerns; it is widely credited with having brought about the collapse of the EU carbon prices under the EU-ETS and undermined the scheme's effectiveness. Further, ETSs have significant transaction costs, many linked to insufficient market liquidity.

Carbon pricing can raise valuable public revenue through the auction of permits and the collection of carbon taxes. Estimates suggest that the introduction of the new national ETS in China would potentially double the total value of ETSs and carbon taxes globally to about US$100bn. Additional economic benefits depend on how the revenue collected is used.[38] Studies are consistently showing that among the various instruments available to reduce CO_2 emissions, carbon prices are the most likely to produce economic growth and increase the level of productivity.[39]

One of the main criticisms levelled against carbon pricing is that they are much too low to encourage firms to shift investments towards lower-carbon technologies. For example, the IEA found that the carbon price would need to be at least US$65 per ton before power plants would switch from coal to natural gas. The OECD calculates that 90 per cent of carbon emissions from energy use are priced below the EUR30 mark per tonne, which represents the minimum estimate of negative externalities associated with carbon. An examination of effective carbon rates (ECRs) across key countries in the region shows that the region has ample scope to increase ECRs across its sectors. Given the expanding scope of its carbon markets, it is incumbent on the region to strengthen carbon pricing.

There has been a proliferation of results-based financing instruments such as REDD+, a carbon pricing instrument that specifically targets the huge potential of enhancing carbon sinks for mitigating emissions. It is highly cost-effective, and could potentially reduce the cost of global mitigation action by two-fifths. As with other carbon pricing instruments, one of the key challenges to effective implementation of the REDD+ is the credible MRV of forest stocks and their changes.

Non-market instruments

Non-market instruments complement the use of carbon pricing. These include regulatory and voluntary approaches. The regulatory approach encompasses technology or performance-oriented regulations, bans on certain products or practices and licensing requirements. Voluntary approaches include ratings, labelling and certification. Such instruments are typically applied in the case that MBIs do not work well, for example when price signals entail a weak response by economic agents as is the case when emissions at source are costly to monitor or cannot be adequately proxied. Under such circumstances, performance- or technology-oriented regulations can be a good alternative policy instrument.

However, performance or technology standards are not cost-effective because they impose the same constraints to firms that have cheap abatement options. Performance standards are less costly than the latter as they offer greater flexibility in selecting abatement options that are most suitable to their situation. Moreover, standards cannot deliver a double dividend since they do not raise fiscal revenues.

Other information-based tools, such as pollutant and transfer registers, can be used for benchmarking purposes, and, through public advocacy, can produce a better environmental outcome. For example, emissions or pollutant release (and transfer) registers entail an

Box 4.2

What is new for carbon pricing in the Paris Agreement?

The Paris Agreement has put new impetus into flagging carbon markets around the world. Signaling that carbon markets will continue to play a role in a future climate regime has helped to spur reform efforts across global carbon pricing initiatives.

Article 6 of the Paris Agreement contains new provisions for carbon market mechanisms as a means to implement Parties' mitigation commitments contained in their NDCs. In addition to non-market approaches, it foresees two types of market instruments, namely internationally transferred mitigation outcomes (ITMOs) and a new Sustainable Development Mechanism (SDM). The details for these instruments still need to be fleshed out.

The new SDM is expected to be structured based on the Clean Development Mechanism (CDM), but will take into account its perceived weaknesses and apply the lessons learned. These include the large transaction costs and long time lag for registering projects, the emphasis on project-based vs. sector-based mechanisms that limited the reach of the instrument for mitigating emissions, the lack of redress options to query a Board decision, questions about the environmental integrity of the outcomes and double-counting, the current glut in supply of Kyoto credits, the onerous monitoring, reporting and verification (MRV) requirements, not enough emphasis on how projects were achieving 'sustainable development' and related social, environmental and human rights related safeguards, and the difficulty of proving 'additionality'. A new SDM will therefore be expected to incorporate a larger role for the host country, a less onerous MRV system and go beyond offsetting to ensure a contribution to net mitigation.

The ITMOs will help to link existing and future subnational, national, regional and international carbon pricing initiatives and market-based approaches. These might include credits from the Japanese Joint Crediting Mechanism (JCM) or the Reducing Emissions from Deforestation and Forest Degradation (REDD+).

Currently implemented bilaterally in eight countries in the region, the Japanese JCM offers co-financing of low-carbon technologies in host countries to offset emissions toward achieving Japan's emission reduction target. The Government provides up to 50 per cent of co-funding to an international consortium with Japanese companies to implement a given project. Therefore, this mechanism can also be viewed as facilitating the take-up of low-carbon technologies. The Joint Committee consisting of representative from both sides vets the projects and approves the allowed methodologies. As of October 2016, 26 GHG emissions abatement methodologies had been approved in ten countries as JCM methodologies by each Joint Committee, respectively. The MRV of the emissions removals takes place and, as a rule, is less stringent than the Kyoto MRV requirements but, at the same time, effectively leverages existing knowledge present in host countries that was acquired through the CDM process. In practice, both CDM and REDD+ systems are being used as a basis for the MRV of the JCM. In fact, in 2015, the JCM was expanded to capture REDD+ projects.

Many countries in the Asia Pacific region are members of the REDD+ mechanism and are also included in the Forestry Carbon Partnership Facility (FCPF). Maintaining their forests and sustainably managing their forest carbon stocks will play an important role in their mitigation response.

obligation on firms covered by these instruments in different jurisdictions to report their emissions of pollutants, including GHGs, helps to achieve emissions reductions and facilitates better-informed decision-making. By making this information public, civil society is empowered to benchmark firms' emissions performance over time and to identify those firms within a sector who have done poorly. The Asia-Pacific region is lagging behind other regions in major initiatives of this type.

Voluntary corporate initiatives to internalize the price of carbon are also taking hold in the region. Corporate carbon pricing is becoming a prevalent tool for corporate strategic investment decisions, helping companies to consider the impact of climate change on their businesses and allowing them to shift to lower-carbon business models.

Trends in the Asia-Pacific region

In the Asia-Pacific region, two new national-level carbon pricing initiatives have been implemented since 2015 and a number of subnational or sectoral schemes have been piloted or implemented (see Figure 8).

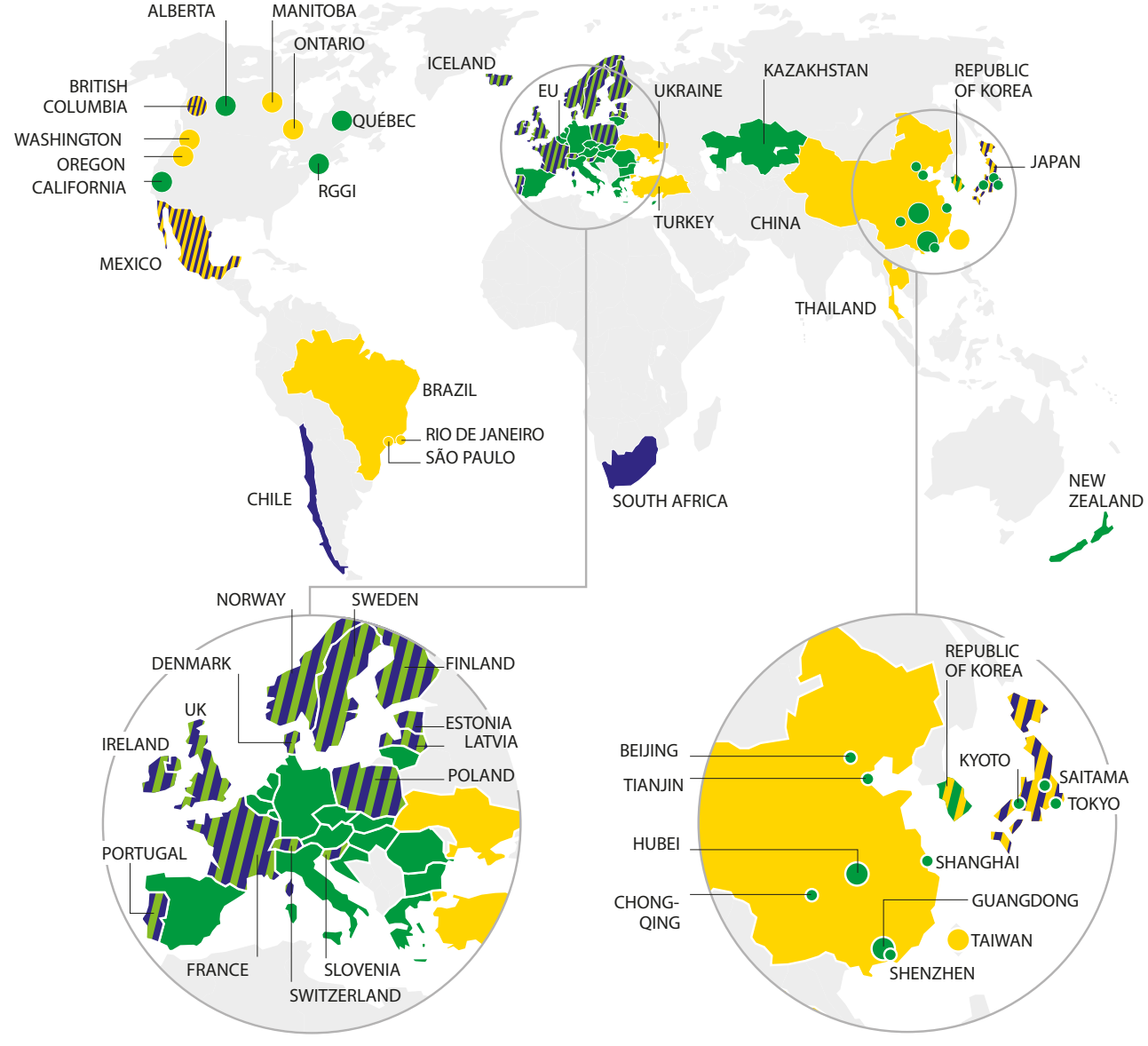
- The ETS in the **Republic of Korea** began on 1 January 2015. It has seen low volumes of transactions since it began and may need to be recalibrated. The emissions base of the ETS covered around 70

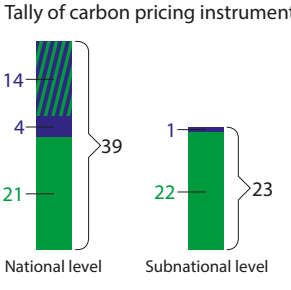
per cent of emissions of both the industry and the electricity sectors each. According to the OECD, permit prices from the ETS were the main component of the ECRs in the industry and electricity sectors. ECRs consisted of specific taxes on energy use, primarily in the road sector, and permit prices from the ETS, primarily in the industry, residential and commercial, and the electricity sectors. Korea was found to price around 92 per cent of its carbon emissions from energy use, with 16 per cent priced above benchmark. Most of these emissions were from road transport.

- The safeguard mechanism in **Australia** to limit and price emissions of large enterprises starting in July of 2016 has established a new ETS. This expands the scope of the Emissions Reduction Fund (ERF), which has been used since April 2015 by the Government to purchase emission reduction credits from the voluntary market through auction. Both will be reviewed in 2017. Australia also has taxes on energy use, pricing 23 per cent of carbon emissions from energy use. According to the OECD, an ECR above benchmark (EUR 30 per tCO_2) applied to 20 percent of its emissions, most from road transport. Carbon emissions from energy use in electricity and agriculture and fisheries were not priced. Most unpriced emissions stemmed from energy used in the industry and the electricity sectors.
- The most anticipated development was the announcement by **China** that its national ETS will commence in 2017. This would establish the world's largest carbon market but also help to push up the share of global emissions covered by carbon pricing to over half. Five municipalities, Beijing, Chongqing, Shanghai, Shenzhen and Tianjin, and two provinces, Guangdong and Hubei implemented emission trading systems to help meet the targets on carbon and energy intensity and composition, laid out in the 12th National Development Plan. These are widely credited as having paved the way for a national carbon market. China is in the process of setting up a pilot covering four provinces to host pilot markets for energy consumption permit trading. ECRs consisted primarily of specific taxes on energy use. According to the OECD, 18 per cent of carbon emissions from energy use were covered by a price, and 8 per cent were priced above benchmark. Most of these emissions stemmed from the road sector. Unpriced emissions were found primarily in the industry, residential, commercial, and electricity sectors. In total, 9 per cent of emissions were estimated to be covered by the subnational emissions trading systems. The overlap between the emissions covered by taxes and emissions trading systems was very small.
- There was an operational ETS in **Kazakhstan** but it was temporarily suspended in 2016 while the government revises the rules on the issuance of emissions allowances, free allocation and the price stabilisation reserve.
- Other sectoral or subnational mechanisms have been applied in the region. **Japan** has linked its two schemes, the Saitama and Tokyo ETSs. The second phase which began in 2015 saw an increase in emission reduction targets but their emissions base is still small relative to national emissions. ECRs in Japan consisted primarily of specific taxes on energy use. According to the OECD, Japan priced 83 per cent of carbon emissions from energy use, with 16 per cent priced above benchmark. Most of these emissions were from road transport.
- In **India**, the government introduced a coal tax per ton of coal produced in India or imported, along with an energy efficiency trading programme for major Indian industries, namely the 'Perform, Achieve and Trade (PAT)' programme. In 2012, the Government introduced a pilot carbon market in Gujarat, Tamil Nadu and Maharashtra. Similarly to China, the Indian Government has favoured a small-scale piloting approach at subnational level before considering the introduction of a national scheme. ECRs consisted entirely of specific taxes on energy use. According to the OECD, India priced 53 per cent of carbon emissions from energy use, and 2 per cent were priced above benchmark, all from road transport. Most unpriced emissions were from the industry, residential and commercial sectors. Since 2012, India has increased tax rates on fuels for road transport and on coal.
- In **Indonesia**, ECRs consisted entirely of specific taxes on energy use, and only applied to fuels used in road transport. According to the OECD, Indonesia priced 17 per cent of carbon emissions of energy use, none above the benchmark.
- In the **Russian Federation**, ECRs have consisted entirely of specific taxes on energy use. 13 per cent of energy related CO_2 emissions are priced but none above the benchmark. Most unpriced emissions are from industry, the residential and commercial, and electricity sectors.
- A number of implementing countries in the Asia-Pacific region are participating in the **PMR**, and implementing their market readiness proposals (MRP) which encompass different carbon pricing mechanisms and associated MRV systems. Under this initiative, China has focused on the design of their national ETS, especially the inclusion of their power sector and state-owned enterprises. India has built an integrated GHG data management system, developed an off-grid Renewable Energy Certificate

Figure 8

Summary map of existing emerging and potential regional, national, and subnational carbon pricing initiatives (ETS and tax)





- ETS implemented or scheduled for implementation
- Carbon tax implemented or scheduled for implementation
- ETS or carbon tax under consideration
- ETS and carbon tax implemented or scheduled
- ETS implemented or scheduled, tax under consideration
- Carbon tax implemented or scheduled, ETS under consideration

The circles represent subnational jurisdictions. The circles are not representative of the size of the carbon pricing instrument, but show the subnational regions (large circles) and cities (small circles).

Note: Carbon pricing instruments are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date.

Source: World Bank and Ecofys (2016).

programme and expanded the sectoral coverage of their Perform Achieve and Trade system. Indonesia has piloted an MRV framework in the power and cement sectors. Thailand has designed its Energy Performance Certificate scheme, implemented a database and MRV system, conducted a study on the legal framework for the ETS and prepared the Low Carbon City Program (LCC) and associated Fund. Finally, Vietnam has designed and developed a market-based pilot instrument in the steel sector, and designed no-regret measures in solid waste sector. All these initiatives are geared towards the eventual expansion of carbon pricing instruments, including into fully-fledged ETSs.

- Companies are also adopting shadow carbon pricing on a voluntary basis. A recent survey of 5759 companies shows that one in five companies are already adopting an internal price on carbon with large year-on-year increases recorded in the Asian region (China 35 per cent increase, India 63 per cent, Japan 51 per cent, Korea 33 per cent). In 2016, the UN Global Compact called for a minimum internal carbon price of US$100 per tCO_2e by 2020 to be consistent with the global climate goals.

Moving forward, countries in the region need to explore ways of increasing their ECRs and work towards harmonization and linking of markets in order to achieve the larger efficiency gains that this would bring. In addition, it will offer new opportunities to forge ITMOs. This will also strengthen and harmonize critical MRV systems and help to avoid an unnecessary proliferation of different systems. Countries need to make full use of existing MRV systems in their countries, such as the REDD+, the CDM or the JCM to further capitalize on carbon market opportunities.

5. SCALING UP CLIMATE FINANCE FOR LOW-CARBON, CLIMATE-RESILIENT DEVELOPMENT

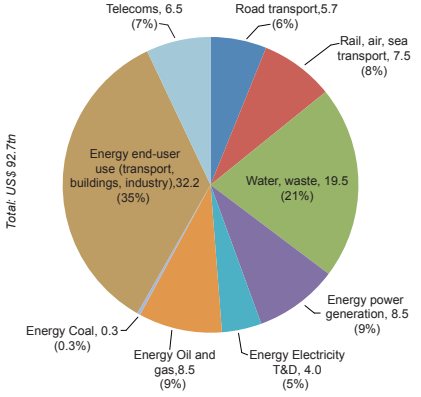
Climate finance is the financial flow needed to respond to the climate change challenge. The structural shift to achieve the goals of the Paris Agreement has massive economic, social and environmental implications, and impact upon the goals of the 2030 Agenda.

Box 5.1

Estimates of global financing needs to meet Paris Agreement Goals

The long-run temperature goal of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels' contained in the Paris Agreement (PA) requires net zero emissions or full global decarbonisation before 2100.[40] There are many conceivable pathways to achieve this, but full decarbonisation of electricity generation by mid-century lies at the core of the agenda. Further, fuel shifting in transport, heating and industries, implementing energy efficiency measures in all sectors (building, transport, agriculture) and preserving or increasing natural carbon sinks will play a major role.[41]

Approximate cumulative infrastructure investment for low-carbon scenario across sectors (in 2010 US$tn)



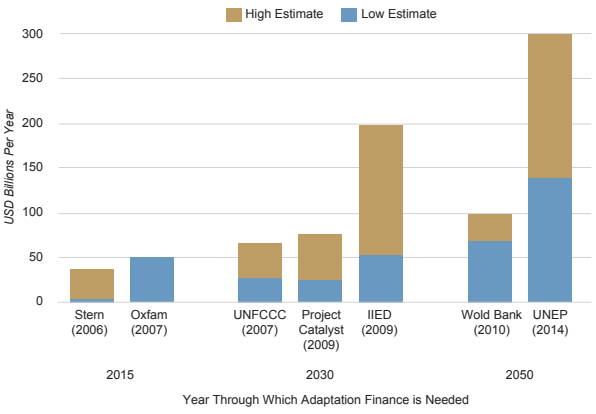
Source: Global Commission on the Economy and Climate (2014a).

The Global Commission on the Economy and Climate provides a comprehensive estimate of the global investment required between 2015 and 2030 to make the transition to a low-carbon economy. Based on a broad definition of infrastructure, the cumulative low-carbon investment needed, relative to base case, for that period is estimated at US$93tn. This would be an increment of US$4.1tn or 4.5 per cent of the total, or an average annual increment of US$273bn (excluding operating costs).

Furthermore, as climate change progresses and extreme weather events become more frequent and more severe, the needs assessments for adaptation finance of developing countries also continue to grow. The chart shows that at current estimates, adaptation finance needs of developing countries are anywhere between US$140bn and US$300bn per annum, on top of the decarbonisation estimates given above.

Box 5.1 Continued

Therefore, mobilizing US$100bn annually by 2020 from public and private sources to support climate action in developing countries is only a start. This target, embedded in the 2030 Agenda as SDG13.a, will not meet the climate investment challenge by itself. This goal is currently the primary political benchmark for assessing progress on climate finance.



Source: WRi (2012).

Financing needs and trends in Asia-Pacific

Much of the estimated global incremental investment of US$4.1tn to decarbonize will be geared to the Asia-Pacific region, where annual average emissions have been growing at a rate of over 4 per cent between 1990 and 2012, faster than any other region in the world. Incremental investment from 2015 to 2050 to decarbonize the Asian energy sector alone are estimated at a net US$21tr or US$600bn per annum. Compared to annual GDP, these amounts are relatively modest, ranging from 0.1 per cent today to 4 per cent by 2050, because of the benefits of decarbonization that include much higher energy efficiency, lower fuel costs and lower operating expenditures.

Climate finance is already flowing in the Asia-Pacific region but significant scale-up is needed, taking into account the growth dynamics of the region. A study[42] has identified a total of US$391bn in public and private climate finance flows for 2014, of which around 40-45 per cent (US$156 – 176bn) flowed to/in the Asia-Pacific region. Public international climate funds provided US$5.1bn to the Asia-Pacific region over the 2013-14 period, which represents a share of one-third of the global total for the group of funds covered. Climate finance channeled through multilateral and bilateral development banks, based on the OECD creditor reporting system database, for the same period amounted to a further US$40.2bn (Figure 9). Adaptation funding was still limited to approximately one-quarter of the total. Region-specific figures for climate-related lending from national development banks were not available but global data suggest that this is a very important channel for climate finance, especially for adaptation.

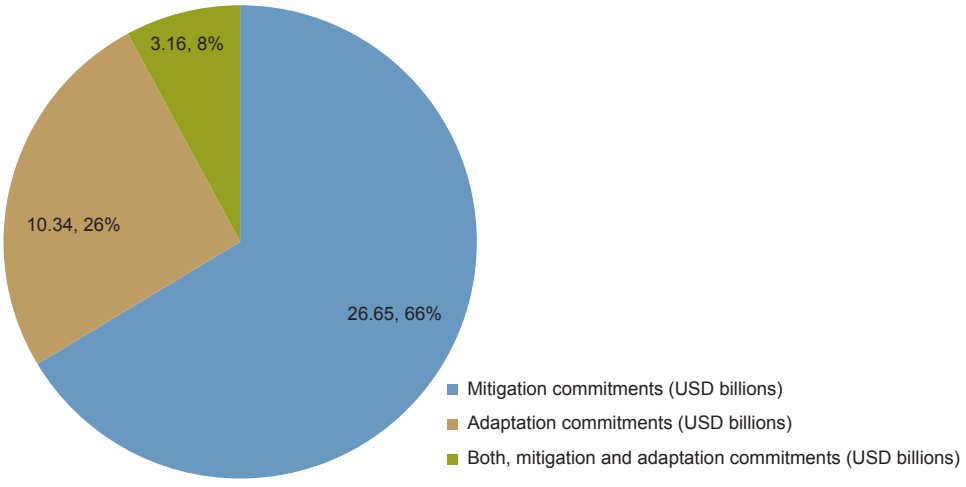
Turning to private sector flows, the data is more limited. New investments in renewable energy encompassing both corporate R&D and government flows in Asia-Pacific reached US$161bn in 2015 or 56 per cent of the global total, of which US$103bn in China, US$10bn in India and US$48bn in the rest of Asia, mainly Japan (US$36bn). In India, financing for utility-scale solar power increase by 75 per cent mainly as a result of the new policy framework on renewable energy. Thailand was the only other country in Asia to reach US$1bn in asset finance for renewables. In 2015, commercial banks provided most of the project-level debt for utility-scale renewable energy projects in China and India.

Scaling up finance

Scaling up climate finance in the region entails identifying and dismantling the key barriers to increase financial flows, creating a conducive policy environment and catalysing private sector investment. This will require a differentiated approach across countries, depending on their income level. There are significant and immediate opportunities to scale-up through a mix of innovative financial instruments, greater use of national development banks and concessional debt, and, for low-income countries, increased development capital flows. But, policy intervention to allow more finance to flow to low-carbon investments must help to address the high cost of financing and the lack of access to long-term funding that are barriers to scale up in the Asia-Pacific region.

Low-carbon investment in middle-income countries is constrained by a high cost of capital. Economic growth creates competing investment needs, resulting in higher interest rates. This is compounded by poorly developed financial and insurance markets that reduce the pool of low-cost capital available for infrastructure investment. Many low-carbon investments are characterized by relatively high up-front capital costs

Figure 9 Climate-related finance commitments in Asia-Pacific region 2013-2014 (in US$ bn)



Source: OECD.

but lower operating costs throughout the lifetime of an investment. Long-term financing is often difficult or even impossible to obtain in many least-developed countries (LDCs), which may be in part due to lack of capital markets or regulatory restrictions on long-term bank lending.

China provides an example of how national development banks and state-owned enterprises (SOEs) have successfully provided subsidized low-cost debt in order to finance LCCR investments at scale. The China Development Bank provided US$80bn of low-cost debt to renewable energy projects alone, while over two-thirds of solar and over five-sixths of wind projects as of mid-2012 were built and owned by SOEs and their subsidiaries. This subsidy, combined with SOE equity funded by retained earnings, and secure power purchasing agreements in the administered market, has greatly reduced the cost disadvantage of low-carbon infrastructure.

On the other hand, lower middle-income countries, like India, without access to low-cost debt through national development banks, may require different solutions for low-carbon investments. For example, for the energy sector, initiatives that replace the subsidies with financial mechanisms such as feed-in-tariffs or power purchase agreements, in order to reduce the other cost to the government, have been successfully applied in India.

Concessional debt from multilateral development banks' climate portfolios will also play an increasingly important role especially for low-income countries. For example, the Asian Development Bank has set a climate change portfolio target of 50 per cent for its operations. MDBs are uniquely positioned to mobilise additional financing, drawing on their ability to leverage money from the global capital markets, as well as through blending and co-financing activities. MDBs also provide risk management instruments that should be scaled-up. Credit guarantees, political risk insurance, and contingency recovery grants can play a critical role in enabling private investments in the context of political uncertainty, or to back private equity and debt financing in countries with more challenging investment environments. Guarantees are particularly well-suited to the lower-middle income and lower-income countries.

National budgets are another instrument to increase climate investments. In the region, the share of climate investment in national budgets ranged from 0 to 15 per cent, or 7.5 per cent of total national capital formation, with the bulk of these investments directed toward adaptation projects, suggesting plenty of room for scale-up. For this to occur, governments must develop a clear policy framework LCCR growth, including emissions reduction or energy intensity targets, and ensure that these are fully mainstreamed into national planning and budgeting process. This entails setting criteria for prioritizing LCCR investments and adopting methodologies to assess co-benefits of these investments.

Providing long-term policy signals across the sectors through solid policy frameworks helps to attract investment. India's recent target of 175 GW of new renewable energy capacity by 2022, and other ambitious targets for rail development, water infrastructure and smart cities, are already attracting increased climate

financing flows and there are many more examples in the region.

Private sector finance can be deterred by a lack of information about the investment opportunities and about relevant markets, or by high perceived investment risks, especially in the area of adaptation financing where investments typically have a long horizon and banks might be unwilling or unable to provide such loans. Such investment risks or information constraints faced by the private sector can be mitigated by policy, e.g. through guarantees, subsidies, tax incentives or even public private partnerships. The private sector is also sensitive to the investment climate in general, and to sector-specific regulatory risk and the policy environment, all risks that can be remedied by policy. The small scale of green projects can create significant problems in obtaining private financing in LDCs. Many larger financial institutions are unwilling to consider small projects because of the high cost stemming from economies of scale in due diligence. For example, typical costs for due diligence of larger projects can be in the range of $0.5m and $1m. International commercial banks are generally not interested in projects below $10m, while even projects up to $20m will find it difficult to obtain interest.

Financial regulation can also be geared to support climate finance. For example, in 2012, the Fiji Reserve Bank imposed a financial regulatory requirement on its six commercial banks to lend 2 per cent of their portfolio to renewable energy projects and, by 2016, commercial banks had surpassed this requirement and were dedicating 3.3 per cent of their loan portfolios to renewable energy. Another example comes from China: the green credit balance of 21 major Chinese banks amounted to 7.26 trillion yuan ($1.1trn), accounting for 9 per cent of their total loans.

The use of green bonds – debt instruments targeted to green investments – as an alternative to conventional bank project finance has taken off in the region. With US$246bn issued, China was by far the global leader in driving growth in the green bond market, accounting for over one-third of the global cumulative total of climate-aligned bonds issued, followed by South Korea (US$20bn) and India (US$17bn). In total, the Asia-Pacific region made up around US$308bn of climate-aligned bonds, or 44 per cent of the global total. Considering their rapid growth and diffusion in the region, they are expected to play a crucial role in scaling up finance as their potential to tap into the wealth of institutional investments is significant. This growth needs to be supported by providing high-quality guarantees to issuers to ensure investor confidence to unlock cross-border flows. Additionally, domestic capital can be mobilized through demonstration issuance of domestic green bonds by public sector entities and banks, and regulatory reform to reduce restrictions that limit green bond investments.

In financial markets, increased disclosure of firms' carbon footprints, clearer verification standards for innovative financial instruments, a method to help integrate climate-related issues into the definition of fiduciary duty, and appropriate stress testing for climate risks should be first priorities for regulatory authorities to identify climate change risks for the financial sector.

Other policy challenges

While the region has attracted significant amounts of public international climate finance already, it is more difficult to ascertain whether it is being used in the most effective way and whether it is reaching the vulnerable countries with low capacity to access finance.

First, it is important that grant finance is targeted to catalyze private investment, especially for adaptation. The color of money is different across different financial instruments. A dollar of grant finance or equity finance is not the same as a dollar of concessional loan. One dollar of grant or equity finance can be more valuable dollar invested through mezzanine or debt finance.
Second, the most vulnerable countries should be given special consideration when allocating the available finance since climate change can drastically reverse their development gains, as was shown for example by the 2004 tsunami in the Maldives which imposed an economic cost equivalent to 70 per cent of GDP. The Green Climate Fund has committed to providing at least half of its adaptation funding (which will make up half of its overall portfolio in the medium-term) particularly to vulnerable countries. Specific criteria for funding allocations should be developed that take into account vulnerability of countries.

The array of climate financial instruments is complex and expanding, with new and innovative instruments continuously being piloted and rolled out and it is difficult for policymakers to keep up. Through the GCF alone, there are six types of instruments that can be requested for co-financing. Given the large choice of different instruments, policymakers often find themselves at odds with which instrument to apply for each priority policy intervention versus what has worked in practice in other countries. A highly tailored approach is required which considers the characteristics of a project, including the technology in question, the development stage of the technology,

the project lifetime, the transaction volume and the sectoral policy environment. As the examples above have shown, in many cases, an appropriate mix of instruments is also required.

Project preparation costs are large and the requirements very onerous. While it is important to ensure good environmental and social safeguards, and that gender considerations are taken into account, small countries with low capacities have repeatedly articulated their difficulties in gathering the required data for project preparation. For example, Fiji's first successful GCF project of around US$40m cost the ADB one million dollars in staff time simply for project preparation. More can be done to streamline requirements and cut sunk costs.

Moving forward, in order to achieve decarbonization in the region, substantial investment is needed. However, there are also many benefits associated with low-carbon, climate resilient investment that reduce costs relative to business as usual. Scale up of climate finance across the Asia Pacific is the largest challenge. This will require identifying and addressing the barriers to investment and access to finance, as well as creating a policy environment that supports transition. These include a high cost of capital and low availability of long-term finance. Many good examples from the region point to ways to blend different financing sources, and put in place successful policy frameworks. Adequate carbon pricing and the integration of long-term policy frameworks for the low-carbon transition into national planning and budgeting will be important elements to support green investment. Financial regulation will also play an important role in easing the risks for private investors thereby unlocking private finance, as will green bonds. Grant finance should be used increasingly to catalyze other sources of financing towards blended solutions rather than as standalone project finance and vulnerable countries require additional help to ensure that they are able to access available sources of grant financing.

CONCLUSIONS

The Asia-Pacific region faces complex choices in its approach to managing climate change. The region's diversity with countries at all stages of development produces different challenges with no "one size fits all" solutions. Many countries in the region such as small island states, least developing countries and landlocked developing countries face severe challenges to address inclusive development, poverty and infrastructure needs. Climate change will compound many of these challenges and create new ones.

The region's impressive economic growth to date has lifted millions out of poverty and transformed the region. However, it has been carbon intensive, and has not accounted for future costs from climate change. Adopting the same carbon-intensive approach to drive the region's future growth brings an unacceptable risk of dangerous and irreversible climate change. The Paris Agreement has converted the global climate aspirations into a universally agreed agenda with defined goals. Yet despite this progress, the anticipated costs of reducing emissions, along with the complexity and risks of enacting long term policies to incentivize shifts towards low-carbon development, remain daunting for many countries. This is underscored by the emissions gap between the current climate pledges and those needed to achieve the Paris target. It is estimated that Asia-Pacific countries will need to double their current levels of abatement ambition up to 2030 to close this gap.

This report has identified some fundamental economic priorities for countries in the region to address as part of the first steps towards a low carbon future. Across the Asia-Pacific, it is clear that economic levers are among the most powerful policy tools to develop low carbon economies. The analysis undertaken has yielded several insights into opportunities and challenges ahead.

Investment in adaptation and resilience is critical given that a level of climate change is already locked in. Government investment in long term adaptation efforts form a key public good such as supporting agricultural resilience for the rural poor, ensuring the resilience of cities to climate change and disaster risk reduction.

Implementing carbon pricing of various forms at a national level can deliver an economically efficient way of reducing emissions as well as promoting long term structural shifts in the economy to reduce emissions intensity. Expanding the size of carbon markets across the region through linking will offer greater potential for cost-effective mitigation. Fossil fuel subsidies in many countries of the region are highly regressive and undermine efforts to increase the use of clean alternatives and energy efficiency.

Linked to this, the further use of renewables and application of energy efficiency in economies of the Asia-Pacific are increasingly cost-effective or cost-negative options and will play a major role in decarbonisation, with effective support policies.

Lastly climate finance needs to be scaled up to meet the growing mitigation and adaptation efforts of developing countries in the region. The scale up of

climate finance by the Green Climate Fund is opening up sectoral and multi-country approaches to financing that will rely on greater regional collaboration. Regional development banks have an important role to play in scaling up climate finance and mainstreaming climate change into their investment lending portfolios. These development banks have adopted a more harmonized approach to mainstreaming climate change into their decision-making, using different tools to screen projects and investment opportunities, to assess the impact of projects on emissions as well as resilience, and to assess the exposure of projects to physical and climate policy-related risks.

The Asia-Pacific has the capacity to respond with progressive policies, incentives and regulations to rewire our economies for low-carbon growth. Regional cooperation is a key tool to link global, national and sub-national climate actions. ESCAP has the capabilities to support its member States to develop these policy frameworks through a range of regional cooperation efforts – regional integration, better data, strengthened regional science, technology and innovation (STI) capacities, cooperation on shared vulnerabilities, implementation of multi-hazard early warning system harmonisation and integration of carbon markets, green finance and private sector initiatives, subnational networks, and the sharing of regional knowledge and best practices. ESCAP's intergovernmental platform, norm setting and multi-sectoral approach can help provide support for its countries as they build low carbon and resilient economies, ensuring continued success in a carbon-constrained world.

Endnotes

[1] World Bank (2015).

[2] Stern, N. (2006).

[3] World Bank (2013).

[4] IPCC (2014b).

[5] IPCC (2012).

[6] IDMC (2015).

[7] Myers, N. (2002).

[8] IDMC (2015).

[9] Carney, M. (2016).

[10] See ADB (2016), Ahmed, M. & S. Suphachalasai (2014), ADB (2014), ADB (2013), ADB (2009), Westphal, M. et al. (2013), and World Bank (2013).

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[12] Carney (2016).

[13] ADB (2016).

[14] Global Commission on the Economy and Climate (2014b), Chapter 1.

[15] ADB (2016).

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[18] See Stern, N. (2006).

[19] World Bank (2010a).

[20] World Bank (2010b).

[21] World Bank (2010b).

[22] Carbon Tracker and Grantham Research Institute (2013).

[23] See Koplow, D. (2009).

[24] See IMF (2013a), Energy Subsidy Reform: Lessons and Implications. This paper calculates pre- and post-tax energy subsidies for 176 countries for the period 2000-2011.

[25] For regional aggregation, the Asian region is taken to be the 'Emerging and Developing Asia' and the 'Commonwealth of Independent States', classifications used by Coady et al. (2015) and IMF (2013). However, this omits Afghanistan, Iran, Iraq and Pakistan contained in their 'Middle East, North Africa and Pakistan' group, so represents an underestimate.

[26] Husar, J. & F. Kitt (2016).

[27] See Coady et al. (2015).

[28] As defined above, estimates based on Coady et al. (2015).

[29] See IMF (2013b).

[30] IEA (2016).

[31] See FS-UNEP (2016).

[32] Levelised Cost of Electricity (LCOE) estimates capture electricity generation costs only, and thus do not represent the total cost of electricity supply such as grid connection or balancing costs for integration of volatile and intermittent RE sources (wind, solar PV).

[33] See WEC (2013).

[34] See IRENA (2016).

[35] See IRENA and CEM (2014).

[36] These were China, India, Indonesia, Japan and Russia.

[37] See IEA and WB (2016).

[38] See OECD and World Bank (2015).

[39] See Albrizio et al. (2014).

[40] Intergovernmental Panel on Climate Change (2014).

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The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional development arm of the United Nations for the Asia-Pacific region. Made up of 53 Member States and 9 Associate Members, with a geographical scope that stretches from Turkey in the west to the Pacific island nation of Kiribati in the east, and from the Russian Federation in the north to New Zealand in the south, the region is home to 4.1 billion people, or two thirds of the world's population. This makes ESCAP the most comprehensive of the United Nations five regional commissions, and the largest United Nations body serving the Asia-Pacific region with over 600 staff.

16-01086