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Recent Policies and Measures for a Worldwide Green Transition

A Research Paper for the Task Force on Evaluation of the Green Transition in China under the China Council for International Cooperation on Environment and Development (CCICED)

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Cover photo: Qinghai landscape/Yishui_20

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3R Reduce, Reuse and Recycle
ANSIPMA Agency of Industrial Safety and Environmental Protection in the Oil and Gas Sector
AUD Australian Dollar
BC British Columbia
BRT Bus Rapid Transit System
CAD Canadian dollar
CCICED China Council for International Cooperation on Environment and Development
CEC Clear Energy Certificate
CFC Chlorofluorocarbon
CIC Creation of an industrial city
CIE Curitiba in English
CO Carbon monoxide
CO_2 Carbon dioxide
CO_2e CO_2 equivalent
COE Certificate of Entitlement
COMEC Coordenação da Região Metropolitana de Curitiba (Brasil)
DECC Australian Department of Environment and Climate Change
DWA South Africa's Department of Water Affairs
EDF Electricité de France
EDF Environmental Defense Fund
EEA European Environment Agency
EEG 2012 German Act on Granting Priority to Renewable Energy Sources 2012
EPA Environment Protection Authority
EPR Extended Producer Responsibility
ETS Emission trading scheme
EU European Union
EUR Euro
FAO Food and Agriculture Organization
FCSAP Canada's Federal Contaminated Sites Action Plan
FDI Foreign Direct Investment
FY Fiscal Year
GDP Gross Domestic Product
GGGI Global Green Growth Institute
GGKP Green Growth Knowledge Platform
GHG Greenhouse gas
IAP Invasive Alien Plant
IBGE Instituto Brasileiro de Geografia e Estatistica (Brazilian Institute of Geography and Statistics)
ICCT International Council on Clean Transportation
IEA International Energy Agency
IETA International Emissions Trading Association
ILO International Labour Organization
INECC Istituto Nacional de Ecología y Cambio Climatico (Mexico)
IPCC Intergovernmental Panel on Climate Change
IPPUC Institute for Research and Urban Planning of Curitiba
ITDP Institute for Transportation and Development Policy
LBL Load-based Licensing
LRA Load reduction agreement
LSE London Schools of Economics and Political Science
MDB Murray-Darling Basin (Australia)
MDG United Nations Millennium Development Goals
MOT Ministry of Transport
NABU Naturschutzbund Deutschland (Nature and Biodiversity Conservation Union)
NH3 Ammonia
NMHC Non-methane hydrocarbons
NMVOC Non-methane volatile organic compounds
NO_x Nitrogen oxides
NSW New South Wales (Australia)
NWC Australian National Water Commission
OECD Organization of Economic Co-operation and Development
PM Particulate Matter
R & D Research and Development
ROK Republic of Korea
SO_2 Sulfur dioxide
SO_x Sulfur oxide
THC Total hydrocarbon
TJ TeraJoule
TMS Target Management System
UK United Kingdom
UN United Nations
UNEP United Nations Environment Programme
UNESCO United Nations Education, Scientific and Cultural Organization
UNU United Nations University
US United States of America
VQS Vehicle Quota System
WEEE Waste electrical and electronic equipment
WHO World Health Organization

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Aha resevoir in Guiyang. Photo by Tianhong Huang.

1 Introduction

This paper is one of several research products mandated by the 2013 China Council for International Cooperation on Environment and Development (CCICED) Task Force on the Evaluation of Green Transition in China. The overall research - led by the National Economic Research Institute of the China Reform Foundation – consists of: 1) a policy review of China's green development and data collection; 2) an international comparison of green transformation; 3) the establishment of a quantitative model and other analytical frameworks; 4) an evaluation of China's green transition; 5) a scenario analysis of China's green transition; and 6) a strategic framework for China's green transition. This paper contributes to item number 2 above. It has two sub-components. The first is a review of historical factors and government policies promoting green transition in a few developed countries such as Germany, Japan and US. The second is a review - in a case study format - and discussion of more recent policies and practices for green transition in the world. This paper contributes to the latter sub-component.

According to a report of the Task Force dated 13-15 November 2013, the policies of particular relevance to China include: 1) those that deal with broader issues on the environment and ecological protection such as particulate matter (PM) 2.5 and water and soil pollution; 2) economic policies or development strategies that reduce pollution and alter economic structures without compromising income and jobs through the use of instruments such as pricing, taxation and trade policy; and 3) policies and measurement systems being adopted by various countries worldwide, which contribute to green transformation. The research on recent policy developments together with the research on historical factors is expected to enable China to learn from other countries' experiences in green transformation, covering major policy instruments, key issues of concern and pitfalls to avoid.

To capture the international experiences in these areas while taking into account China's particular interest, this paper is structured around five environmental themes: 1) climate change; 2) water security; 3) air pollution; 4) waste management; and 5) urban development. Within each theme, the paper reviews the current global status and discusses policy instruments implemented in select countries in response to related environmental concerns. In addition, the paper discusses indicators to measure green transition. The paper highlights fifteen countries, of which seven (South Africa, Brazil, Israel, Korea, Mauritius, Mexico and Slovenia) have similar social and environmental conditions to China. The other eight are industrialized nations (Australia, Canada, Denmark, France, Germany, Japan, Singapore and the U.S.) that have established strategies and policy measures to address and manage some of the environmental concerns. In the end of the paper, there is a section that highlights a number of major lessons learned from the country examples.

2 Climate Change

2.1 Update on climate change

Over the past decades, a strong scientific consensus has emerged that the global warming that is currently taking place is mainly the result of human activities, with greenhouse gas (GHG) emissions being the main driver. According to the IPCC, a substantial number of climatic changes that have occurred since the 1950s are unprecedented (IPCC, 2013a). The period between 2001 and 2010 was the warmest since the beginning of modern temperature measurement and the effects of climate change are already occurring on all continents and across the oceans.

Figure 1 highlights observed impacts attributed to climate change on physical, biological, human and managed systems, as recently identified in the Fifth Assessment Report of the IPCC. Higher average temperatures have resulted in changes to ecosystems and biological systems, such as changed annual life cycles of animals and shifts in habitat ranges as well as earlier greening and flowering of plants (IPCC, 2014a). Negative impacts of climate change on crop yields have become more common, while climate change has had negative outcomes on livelihoods around the globe, exacerbating existing levels of poverty (IPCC, 2014b).

The existing effects of climate change are already causing severe problems and they present serious risks to the future living conditions of the human race as well as to ecosystems. Examples are an increase in food insecurity, water scarcity, the extinction of species and increased spread of disease and parasites. The most severe impact will be on vulnerable populations in developing countries. The possibility of surpassing thresholds that lead to major changes in earth systems and induce irreversible change, rises in conjunction with the increase in global temperature, even though the tipping points cannot be projected with certainty (IPCC, 2014a).

According to the most recent IPCC Fifth Assessment report (IPCC, 2014b), mitigation to limit the increase in temperature to two degrees Celsius above pre-industrial levels is still possible. This will require substantial institutional and technological change, coupled with global action. It especially requires integrating the issue into national agendas. As progress slows towards a post-Kyoto Protocol agreement in 2015, immediate action by national governments is critical. Some examples of country specific climate change policies are presented in the following case studies.

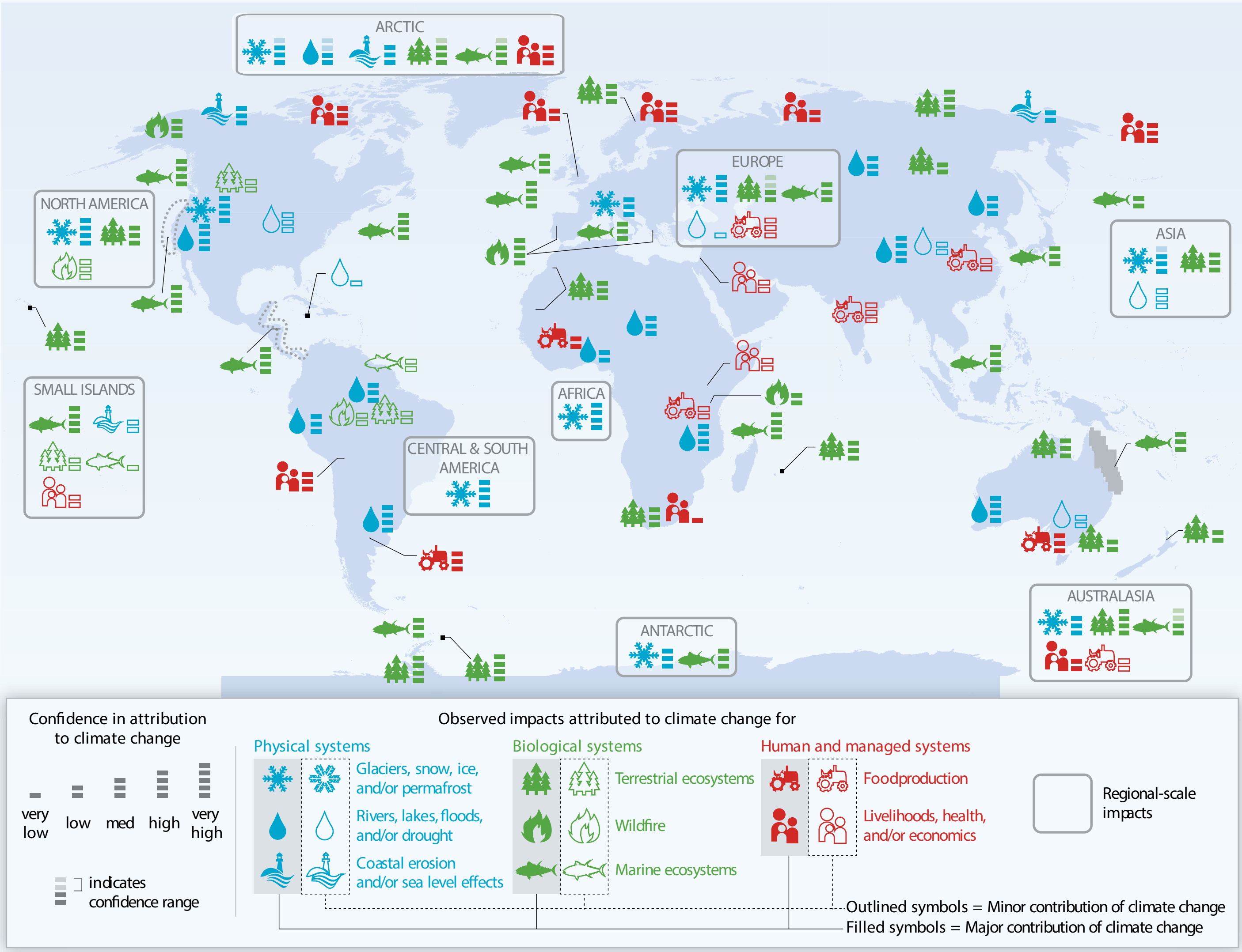
2.2 Country examples

2.2.1 Mexico Climate legislation and energy reform

In June 2012, Mexico introduced the General Law on Climate Change (Ley General de Cambio Climático). After the United Kingdom, Mexico is the second country to establish a legal foundation for addressing the challenges of climate change. The Mexican framework addresses climate change through a multi-sectorial and multi-stakeholder approach, mainstreaming climate change considerations across the federal, state and municipal policy and programme levels.

Mexico's General Law on Climate Change builds upon the country's efforts to advance mitigation and adaptation to climate change in the past decade, as follows: 1) the Inter-secretarial Commission of Climate Change set up in 2005; 2) the National Strategy on Climate Change in 2007 (updated in 2013); 3) the Special Programmes on Climate Change in 2009); and 4) the State Action Plans against Climate Change, which, aligned with the National Development Plan of Mexico, supports the national adaptation and mitigation efforts in the 31 States and the capital, Mexico City. The overall aim is to reduce GHG emissions by 30

Figure 1: Global patterns of impacts in recent decades attributed to climate change, based on studies since the Fourth Assessment Report (AR4).



Source: IPCC(2014b), Fifth Assessment Report - Working Group II: Climate Change 2014. Impacts, Adaptation and Vulnerability. Summary for Policy Makers.

per cent by 2020 and by 50 per cent by 2050 (using 2000 as the baseline year) (Federal Government of Mexico, 2013).

The General Law on Climate Change declares climate change to be a long-term priority for the Mexican State. It introduces an emission trading system and creates the National Institute of Ecology and Climate Change (INECC) to meet mitigation and adaptation challenges. An important part of these efforts is the Energy Reform.

The Energy Reform was signed into law in December 2013. It paves the way for new investments (including Foreign Direct Investment - FDI) in the country's energy sector. Although the energy sector has been in state hands for approximately 75 years, the Energy Reform opens the sector to the participation of private companies in exploration, extraction and power generation and will grant permits for refining, processing, transportation and storage activities (Semarnat, 2014; Federal Government of Mexico, 2013). The government will introduce public bids for contracts and production licenses to be given to the firm offering the best return with a preferential treatment of domestic companies as opposed to foreign firms in case of equal offers. Furthermore, the tax burden of the state oil company Pemex will be reduced. Mexico also plans to ensure a minimum of 25 per cent national labour and nationally produced materials in energy projects. This local content requirement quota will be gradually introduced in 2015. (ABCNews, 2014; Reuters, 2014).

The Energy Reform further intends to increase the share of renewable energy in Mexico's electricity production to 35 per cent by 2024.

In August 2014, secondary (or implementing) laws were enacted. This legislation establishes guidelines for the implementation and regulation of the Energy Reform and the overhaul of Mexico's energy sector in greater detail. With the entry of foreign companies, the 21 new and amended laws provide comprehensive elements of the new fiscal regime and the contractual framework for investor participation. It seeks to increase measures of transparency when it comes to regulation by redesigning existing institutions and creating autonomous, independently funded ones for licensing, safety and environmental protection in the energy sector (Lajou, 2014). Among these is the establishment of the Agency of Industrial Safety and Environmental Protection in the Oil and Gas Sector (ANSIPMA), which will be responsible for policing the sector, particularly in deep water exploration and production in the Gulf of Mexico (Valenzuela & Wood, 2014). An increase in investors and more intensive exploration of energy resources necessitates more effective environmental controls.

The secondary laws also seek to expand the clean energy industry by creating conditions that encourage private investment in solar and wind energy. They introduce rules regarding energy efficiency, cleaner technologies and exploitation of geothermal resources (Federal Government of Mexico, 2013). The laws not only make it easier for clean energy producers to access the Mexican power market, through the introduction of the Clean Energy Certificate (CEC) system, but also create demand for clean power (Miller, 2014).

The Mexican government expects the Energy Reform to induce 1 per cent of additional GDP growth and create 1.8 million jobs by 2018 and further anticipates 2 per cent of additional GDP growth and 1.5 million new jobs created by 2025. It also anticipates lower electricity and gasoline prices (Villiers Negroponte, 2013).

Mexico's long-term climate legislation is an important component of the strategy to address climate change. By integrating climate change into laws at the federal, state and municipal levels, the country shows its commitment to mainstreaming climate change when it comes to decision-making. To ensure the success of climate mitigation, however, financing and capacity building are also vital. It is equally important to ensure that the Energy Reform is consistent with established policy priorities.

The reform is already facing some opposition. In July 2014, thousands of farmers and indigenous communities demonstrated because of the perceived risk that national land may be "indefinitely occupied" by foreign investors reaping the benefits of the sector while only sharing revenues at the national level (Telesur, 2014). On 11 August 2014, the day before the secondary laws were signed, community police from four indigenous villages in southern Mexico held a protest march for similar reasons (Los Angeles Press, 2014). In addition, environmental concerns, such as the intensive use of water by the extraction industry, is a concern of the protesters. Local communities have requested financial support for affected sectors, such as agriculture, but the government has yet to provide a satisfactory response.

One of the challenges that could occur in Mexico is exposure to new foreign direct investors. Although privatizing the market is likely to improve price signals, the Energy Reform may perpetuate climate change by generating greater demand for extraction and exploitation. Furthermore, meeting the goals of reducing GHG emissions requires removing fossil fuel subsidies. Although as of 2013 the government had raised fuel prices by 11 cents, implicit subsidies are still high (OECD, 2014d).

2.2.2 Republic of Korea (ROK) Sector strategies and emission trading

In 2009, the Korean Presidential Committee on Green Growth proposed reducing GHG emissions by 30 per cent or 233 million tonnes of CO_2 equivalent by 2020 compared to a "business as usual" scenario. This target is the highest GHG reduction level recommended by the IPCC for developing countries (UNEP, 2010). ROK made this voluntary commitment despite the fact that under the Kyoto Protocol it is a non-Annex 1 country. The target was subsequently endorsed by the Cabinet and passed into law through the Framework Act on Low Carbon, Green Growth.

Since the target was set, the government has expanded sector-specific strategies to reduce GHG emissions. In 2011, ROK launched the GHG and Energy Target Management System (TMS) to expedite the implementation of the target following over 100 consultations with the companies likely to be affected by the system (Narae, 2013). Under this approach, companies provide emissions and energy consumption data to the government every year if they emit over 20kt CO_2e per year or consume over 90TJ per year of energy (Bloomberg Finance L.P., 2013). The companies concerned are those dealing in power generation, manufacturing, construction, waste management and transport. The government negotiates emissions reduction targets and sets a customized target the subsequent year. Penalties are handed out for failing to meet specified targets. Over 450 companies are involved in the TMS. In 2011 alone, about 76 per cent of emissions under the TMS came from 10 entities, including the state electric utility KEPCO, Samsung, Hyundai and other major enterprises (Bloomberg Finance L.P., 2013).An assessment of 434 companies, undertaken by ROK's Ministry of Environment in 2012, found that 392 firms (90.3 per cent) achieved the GHG reduction target and of these, 372 companies exceeded the target by around 30 million tonnes. The petrochemical industry scored the highest reduction (6.9 million tonnes), followed by the steel industry (5.73 million tonnes). The reduction target will restrict emissions of facilities that emit more than 25,000 tonnes a year and of companies where all facilities cumulatively emit more than 125,000 tonnes a year (EDF & IETA, 2013). Companies that fail to comply risk a fine of US$88 per tonne

(Narae, 2013). In January of 2014, the Ministry of Environment made further efforts by announcing the National GHG Emissions Reduction Roadmap 2020 with targets for seven sectors (See Figure 2) (Ministry of Environment, 2014).

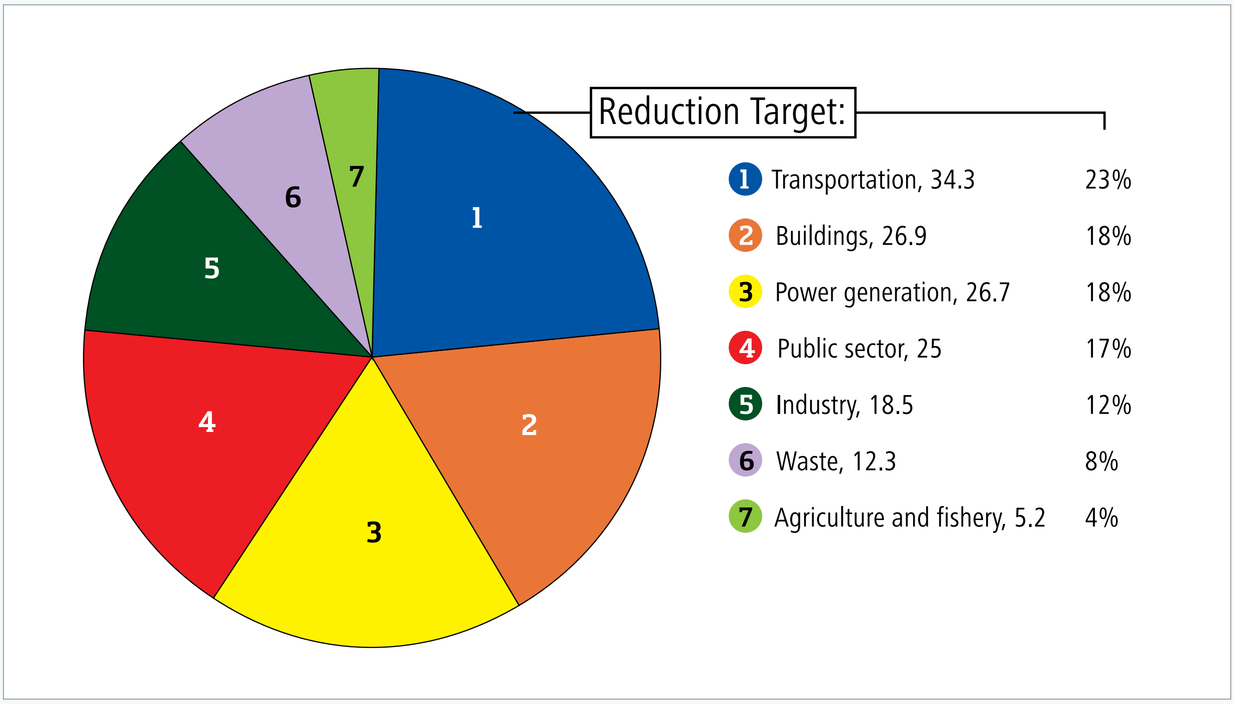
After Korea's National Assembly announced the bill in May 2012, the ROK became the first Asian country to adopt a national emission trading scheme (ETS). It was scheduled to begin on 1 January 2015. The scheme is set to cover roughly 60 percent of the country's emissions generated by approximately 490 of the country's largest emitters.

An Emission Allowances Allocation Committee was established to design the South Korean National Allocation Plan. The Plan will establish specific standards for each phase, industry and sector, with the percentage of auctioned allowances increasing over time. For example, during the first phase (2015-2017), 100 per cent of allowance will be freely allocated, i.e. companies will receive their allowances free of charge, but will not be allowed unlimited emissions. The free allocation for phase II (2018-2020) will be 97 per cent and for phase III (2021-2026), it will be 90 per cent. In phase II, 3 per cent of the allowance will be auctioned and in phase III, 10 per cent of the allowance will be auctioned (EDF & IETA, 2013). The Korean Exchange, the nation's only securities exchange, will host the emissions trading scheme.

A mock trading pilot project was initiated between 2010 and 2012 under the aegis of the Korea Power Exchange for companies with high GHG emissions (Narae, 2013). The pilot project has allowed companies to experience exposure to real trading. As a result of these efforts, in 2012, the GHG emissions growth rate was lower than the GDP growth rate for the first time since 2007 (Ministry of Environment, 2014).

Furthermore, appropriate design of the ETS has been taken into account. The Enforcement Decree of Allocation and Trading of GHG Emissions Allowances Act was enacted in 2012 to develop rules and the governance structure for the ETS. The Ministry of the Environment has acquired leadership over the scheme, with various departments involved in design and implementation. Penalties and compliance mechanisms remain important. For

Figure 2: South Korea's Emissions Reduction Targets (%)



Source: Ministry of Environment, ROK: 28 January 2014. http://eng.me.go.kr/eng/web/board/read.do?menuId=21&boardMasterId=522&boardId=339283

example, failure to submit sufficient allowances will result in penalty surcharges (Bloomberg Finance L.P., 2013).

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2.2.3 Germany Feed-in-tariffs

Germany is the biggest GHG emitter in the European Union and it has consequently set more ambitious goals for itself than other EU members. By 2020, Germany plans to cut emissions by 40 per cent compared to 1990 levels. The fast development of renewable energy production as well as the increase of energy and resource efficiency are two of the most important strategies to meet its reduction target.

Feed-in tariffs constitute one of Germany's most important instruments when it comes to enhancing the development of

BOX 1. MARKET PREMIUM PAYMENTS AND FLEXIBILITY PREMIUM

Power generator using landfil gas. Source: World Bank Photo Collection

Market premium payments. The Act on Granting Priority to Renewable Energy Sources 2012 (the EEG 2012) encourages the direct sale of renewable electricity on the spot market through the introduction of a market premium. The market premiums are intended to increase the participation of new and existing renewable energy generators in the wholesale market and to begin a transition away from fixed price incentives. In addition to the electricity market price, generators also receive the "market premium" payment. The amount of this market premium is calculated on a monthly basis and is equal to the difference between the feed-in tariff and a "reference price", which is calculated at the end of each month.

Flexibility premium. Under the market premium option, there is an additional provision specifically for biogas generators that enables both new and existing biogas plants that sell power to the wholesale electricity markets to claim a *flexibility* premium if the power can be configured to be deliverable during periods of peak demand (e.g. by adding storage). The flexibility premium, which is calculated annually based on the capacity of the system, is additive to the market premium and is paid for a ten-year period.

Source: DB Research (2012). The German Feed-in Tariff: Recent Policy Changes.

renewable energies. The initial versions of these tariffs were implemented in 1991. Feed-in tariffs give renewable energy producers guaranteed access to the electricity grid. The tariffs extend for 20 years and are gradually reduced at a specified rate over that period. Up to 2010, the rate of reduction was calculated according to a formula that was fixed from the beginning of the producer's operation. Although tariffs are revised regularly, the changes only apply to plants commissioned after the revision of the respective tariff. The tariffs are thus dependent on the time a renewable energy plant is commissioned and furthermore on the types of renewable energy produced. The first reform in 2000 led to a boom of renewables.

These measures are intended to increase the security of investors' financial return on investment, thus enabling more market entries through a long-term, predictable price. The success of the German system of feed-in tariffs comes from its longevity and its credibility, owing to the fact that the feed-in tariffs are financed by charges on the consumers rather than by government budgets. The guaranteed tariff makes investment in renewable energies attractive.

The down side is that this cross-financing strategy can lead to unexpectedly higher consumer costs for electricity, resulting in reduced public support for the system. For example, declining costs in photovoltaic technology led to an increase in solar installations in 2009. The costs of the guaranteed tariffs were then passed onto consumers which resulted in increased consumer charges for electricity. This was one reason for reform measures in 2010. The feed-in tariff rates on new photovoltaic installations were adjusted to make them dependent on the volume of new commissions made in the previous year. Nevertheless, this change only applies to new commissions and still guarantees a fixed tariff for 20 years.

The feed-in tariffs were further revised in 2012, advancing dynamic digression for photovoltaic installations and introducing a market premium and a flexibility premium (See Box 1) for biogas to make the whole system more market-based. The revision also implemented new incentives to the grid integration of renewables. For example, when the connection of offshore wind plants to the electricity grid is delayed, the operators receive 90 per cent of the feed-in tariffs they would receive if the plant were connected (DB Research, 2012).

Despite all the changes, consumer prices for electricity, especially for private consumers, are continuing to rise. The prices for private consumers have been further increased by reduced surcharges related to the feed-in tariffs for a huge number of enterprises and by exemptions from the surcharges for companies producing their own electricity. A commonly heard criticism is that private consumers are being forced to bear the burden of Germany's transition to renewable energy (Energiewende), while large companies are exempted. Additionally, although Germany's feed-in tariff compares favourably to other OECD countries, costs are on the rise and were expected to reach 0.8 per cent of GDP, owing to the gap between market prices and guaranteed feed-in prices (OECD, 2014b).

Despite various concerns, feed-in tariffs have been a successful instrument in enhancing the production of renewable energies. By 2010 the renewable share in German electricity reached approximately 17 per cent. When it came to heat generation, it amounted to about 9.5 per cent, up from 7 per cent and 3 per cent in 2000, respectively. Renewable energy also helped Germany to surpass its goals in GHG reduction (OECD, 2012d). Furthermore, the renewable energies sector is expected to create 600 000 jobs by 2030, as compared to about 382 000 jobs (about 1 per cent of the German labour force) in 2012. (Reuters, 2012). It is estimated that the net employment effect of renewable energies is 250,000 newly created jobs by 2030 (Duell, Vetter, 2013). One of the enabling conditions and success factors of the feed-in tariffs is business security for investors, which moves the sector forward, generating spill-over effects on employment.

2.2.4 Denmark Clean Energy

Among the industrialized countries, Denmark has been a pioneer in the transition to clean energy from fossil fuels. It has been a producer of indigenous oil and gas since the mid-1990s and will continue to use these reserves in the short- to medium-term. The government has steadily decreased the share of fossil fuels in the national energy mix and has set a goal of reducing carbon emissions by 40 per cent by 2020 compared to 1990 levels. The government intends to wean all electric power and heat production from fossil fuels by 2035. Moreover, the city of Copenhagen plans to be the world's first carbon neutral city by 2025. Fossil fuel heating has been banned and the government has encouraged the development of cogeneration in which power plants produce both electricity and heating.

Approximately 60 per cent of Danish consumers receive their heating from a district heating system or a cogeneration power plant (Danish Energy Agency). Wind power has also been promoted as a crucial part of Denmark's green energy sector. Today 28 per cent of the electricity system is based on wind power (Danish Wind Industry Association). The government is also interested in replacing coal with biomass as the primary fuel for the country's cogeneration power plants.

While the growth of wind power in Denmark has been significant, progress has been comparatively low in developing low-carbon transport systems. To address this, the government intends to develop electric cars that can use reserve energy stored from wind power that is fed into the grid when the grid capacity is low. The government allocates 3.1 per cent of GDP to research and development, one of the highest rates in OECD countries and a key driver of innovation (The London School of Economics and Political Science, 2014). R&D encourages the creation of Danish energy efficient technologies, district heating systems powered by renewable energy and other tools and equipment that can be used to generate clean energy.

To reduce emissions in the transport sector, two other planned approaches include investment in cycling infrastructure and the creation of incentives for electric vehicle use (LSE Cities, 2014). Also, under the Climate Plan 2025, which was adopted by the Copenhagen City Council to reduce the city's carbon intensity, 50 per cent of commuting to work or school will be made by bicycle or on foot in Copenhagen by 2050. To facilitate the attainment of this goal, the city council plans to build bicycle and pedestrian bridges over the harbour and to construct a network of bicycle superhighways (Copenhagenize Design Co., 2013).

2.2.5 Canada British Columbia's Carbon Tax Reform

British Columbia (BC)'s climate change strategy, which calls for decreasing GHG emissions 33 per cent below 2007 levels by 2020, initiated a new carbon tax on almost all fossil fuel consumption in 2008. This makes BC the first jurisdiction in North America to have its entire public sector become carbon neutral. The carbon tax was introduced at an initial rate of CAD 10 per tonne of CO_2 eq and it was set to increase annually by CAD 5 per tonne CO_2 eq over four years until it reached CAD 30 per tonne CO_2 eq in 2012. BC's carbon tax system is revenue neutral as well. The revenue generated by the carbon tax is offset by cuts on income and corporate taxes.

The tax targets 77 per cent of BC's GHG emissions from residential, commercial and industrial sources, but does not cover emissions from non-fuel sources (such as non-energy agricultural uses, non-combustion industrial process emissions and net deforestation) (British Columbia, Ministry of Finance, 2013). The tax is included in fuel prices and the CAD 30 per tonne of CO_2 eq is translated into different tax rates for each type of fuel according to the amount of GHG gases released when burnt. As a result, the tax is charged to the consumer at the point of final sale and passed back through the retailer to the wholesaler, who then conveys it to the government (Harrison, 2013). The tax is integrated with previous taxes on fuels, making the implementation process fairly easy and inexpensive.

The introduction of the tax received a fairly positive response from the private sector. This initial acceptance has declined slightly in recent years. Other North American jurisdictions have not committed as strongly to carbon pricing as BC and concerns have been raised about decreased competitiveness, particularly in energy-intensive sectors. However, as of 2010/11, corporate income tax cuts captured 54 per cent of carbon tax revenues compared to 32 per cent in 2008/09 and the ratio is expected to rise to 67 per cent in 2012/13 (Lee, 2011).

Since the adoption of the tax, fossil fuel consumption per capita has declined by 17.4 per cent over the four-year period from 2008 to 2012. This is compared to the rest of Canada, which saw an increase of 1.5 per cent over the same period. To put this into perspective, from 2000 to 2008, the annual decrease in fuel consumption per capita was 0.1 per cent, less than the rest of Canada. However, from 2008 to 2012, it went down by 5 per cent per year, more than the rest of Canada (Elgie & McClay, 2013). This difference is significant and it very likely indicates that the carbon tax has an impact on reducing fuel use.

With regards to GHG emissions, BC's per capita GHG emissions associated with carbon taxed fuels fell by 10 per cent in the period 2008 to 2011. In the rest of Canada, the decrease was only 1.1 per cent (Elgie & McClay, 2013). Furthermore, BC is experiencing an increase in green investment and green technologies with twice the Canadian average in adoption of hybrid vehicles and a 48 per cent increase in clean technology industry sales (British Columbia, 2012).

The concern expressed by many opponents to the tax as well as some analysts was that BC's competitiveness would suffer since it was the only jurisdiction in North America to impose the tax. However, trends in GDP per capita show that the carbon tax may not have had any significant effect on the province's economic growth. Between 2008 and 2011, BC's GDP per capita declined by only 0.15 percent compared to an average decline of 0.23 per cent for the rest of Canada (Elgie & McClay, 2013). Despite the tax, BC still managed to perform better than the national average over the period. Given that this was during the global financial crisis, it is hard to tell how much of the decrease in growth could be attributed to the carbon tax alone. Nevertheless, the provincial government reports that the carbon tax has had and will continue to have, a small negative impact on GDP , especially in industries with high emissions intensities such as cement production and gas extraction (British Columbia, 2013).

Due to the revenue-neutrality of the system, Canadians in British Columbia now have the lowest personal income tax rate in Canada, with low-income and rural residents further benefitting from additional cuts. In fact, reports indicate that the tax is revenue negative, meaning that the cuts in property taxes are higher than the revenue raised from the pollution taxes (The Guardian, 2014). In addition, BC also has among the lowest corporate tax rates in North America, a fact that promotes investment and the creation of jobs (The Globe and Mail, 2014).

Overall, British Columbia's carbon tax appears to have been a success, especially when it comes to its main goal in reducing GHG emissions and utilisation of fossil fuels. BC's GDP growth is keeping pace with the rest of Canada and has even performed slightly better since the adoption of the tax. The province is also decoupling its economic growth from fuel consumption and GHG emissions faster than the rest of Canada, thereby building a low carbon economy that will lead to long-term advantages especially if there are future increases in fuel prices (Elgie & McClay, 2013). This puts BC in a unique global position. It demonstrates that a tax reform can mutually support both growth and innovation.

Despite this initial success, however, there is some concern that the current tax rate of CAD 30 per tonne may still be too low to effectively decrease GHG emissions to the necessary level. The Pembina Institute proposes that the tax should be increased to at least CAD 75 by 2020 in order to decrease GHGs to 1990 levels (Horne, 2008). Some studies also suggest that while BC's carbon tax was initially progressive, it is gradually becoming regressive as the rate increases. In 2010, the bottom 10 per cent of households were obliged to pay 1.3 per cent of their income into the carbon tax, while the top 10 per cent paid only 0.3 per cent and the top 1 per cent paid only 0.2 per cent (Lee, 2011). The BC government needed to further increase the protection extended to low-income households in order to mitigate this effect. An analysis by the Canadian Centre for Policy Alternatives suggests that the most equitable redistributive model would be to increase the low-income tax credit to at least a third of carbon tax revenues and at best to half of the revenues (Lee, 2011). This would make the tax more effective and it would benefit households at all income levels.

3 Water Security

3.1 The status of global water governance

The challenges of water management figure prominently on the international development agenda. “Agenda 21” is a UN action plan that emphasizes the need for holistic management of water within the framework of national economic and social policy. The Agenda calls for “the application of an integrated approach to the development, management and use of water resource.” In July 2010, the United Nations General Assembly specifically recognized access to water as a human right, calling on states and international organisations to support this realization. The UN Millennium Development Goals (MDG) aims at facilitating this right, by halving the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015.

At the 2012 United Nations Conference on Sustainable Development (Rio+20), water was highlighted as one of the seven priority areas. The UN recognizes “that water is at the core of sustainable development” and also stresses “the need to adopt measures to significantly reduce water pollution and increase water quality, improve wastewater treatment and water efficiency and reduce water losses” (UN, 2012). Given its importance, water is also a thematic area in the UN Post-2015 Development Agenda.

Although progress has been made over the years, major challenges remain. According to the 2011 UN-Water survey, 65 per cent of more than 130 UN member states have developed integrated water resource management plans, 34 per cent report an advanced stage of implementation (UNEP 2012b) and 67 per cent of countries have included water issues in national/federal development planning documents. Despite this, 2 billion people still lack access to safe water, 2.6 billion have no access to improved sanitation services and 1.4 million children under five die every year as a result of lack of access to clean water and adequate sanitation services (UN 2013, UNEP 2011). Of the 30 environmental goals examined by the 5th UNEP Environmental Outlook in relation to water, only one goal – that of increasing access to clean drinking water – shows significant progress.

Water issues are not only environmentally and socially challenging, but they also exact a significant economic cost. Globally, withdrawals of water tripled over the last 50 years (WWAP, 2009) and demand is expected to continue to increase, accompanied by simultaneous population and consumption growth. US$9-11 billion must be spent annually on additional infrastructure, in order to provide sufficient quantities of water, especially for developing countries, by 2030 (UNEP, 2012a). This expense, however, will justify itself. Eliminating water pollution, for example, could result in health benefits amounting to the equivalent of US$100 million in large OECD economies alone (UNEP, 2012a).

The term “water security” is commonly used in water management. Grey and Sadoff (2007) defined the term as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies” and also believe that water security is a prerequisite to growth and development. OECD further analysed it in the context of the sustainable growth and believes that achieving water security means maintaining acceptable levels of four types of water risks, risk of shortage, risk of inadequate quality, risk of excess and risk of undermining the resilience of freshwater systems (OECD, 2013a). Examples in the following section will illustrate how countries are managing these risks using different instruments.

3.2 Country examples

3.2.1 Israel Creating economic incentives to improve efficient water use

Water scarcity is a major concern for Israel and the government has been fighting against drought for decades. In 2013, however, the Water Authority announced that the country's water crisis had been overcome (The Times of Israel, 2013). The government designed a pricing mechanism to encourage reduced consumption and increased recycling in the domestic, agricultural and industrial sectors. Alternative water sources for agricultural and industrial use have also contributed to a large part of the success. Additionally, active policies supporting innovation, such as the promotion of water technology programmes and innovations in irrigation and smart technologies for water management support greater efficiency (OECD, 2011a).

Water consumption in the domestic sector accounts for one third of the country's water use. The main measures used to reduce household water consumption are water tariffs and water-saving devices. The tariff system for domestic users is a two-block, progressive pricing system. If the rate of usage is below 3.5 m^3/person/month, the charge is US$2.5/$m^3$. If the rate is above 3.5 m^3/person/month, the charge is US$4/$m^3$ (OECD, 2011b).

A third block, or drought tax, was introduced after five consecutive years of drought and it applies to large consumers who are charged at the rate of US$6.95/$m^3$. However, after five months of controversial implementation, the government ended the tax in November 2009. The reasoning was that the tax had little to no impact on water use by low to middle income households. To make up for the drought tax, the government raised water prices throughout the country, with a 25 per cent increase in January. followed by another 15 per cent increase in June 2010 and then a further increase in 2011 (Jewish Journal, 2009).

In the agriculture sector, the government uses three incentives to encourage farmers to switch to alternative water sources. The first is a price incentive - if farmers use treated domestic wastewater, the price is only one third the cost of potable water. Under this measure, approximately 85 per cent of effluent is currently used in the agriculture sector, accounting for 40 per cent of the irrigation water used in 2011, compared to a 60 per cent target for 2050. The second incentive is an arrangement that allows farmers to exchange part of their annual potable water quota in return for a 20 per cent greater volume of reused or brackish water that is free of charge. Because of the drought, however, the quota allocated to farmers decreased in 2001. and further reductions are expected. The third incentive is to subsidize 60 per cent of the effluent pipe infrastructure. The government will gradually charge famers for the social costs of water while taking into account the sector's capacity to further increase its already high efficiency. Similar incentives have also been applied to the industrial sector to promote the usage of alternatives to potable water, although not as effectively as in the agriculture sector (OECD, 2011b).

3.2.2 Australia Water trading and Load-based Licensing

As a dry continent, Australia has been forced to develop strategies to effectively manage its water resources. To this end, the government has developed comprehensive water trading market systems to help better allocate water use. It has also been using a charging system and load-based licensing to manage pollution.

There are two main types of water related property rights - water access entitlement and water allocation – both are traded in the Australian water market. In a water allocation trade or seasonal trade, a person sells part of his/her water allocation for a single year but retains the water access entitlement. In an entitlement trade or permanent trade, a person sells his/her water access entitlement. Compared to conventional trade, such as commodity trading, water trading is much more complicated as the object of the trade is the underlying "rights" to the resource. Therefore, government plays an important role in providing the appropriate legal and institutional support to ensure that the property rights are transferable and that the total number of rights is not over allocated.

Australia does not have a single water market. Instead, there are many separate markets defined by water system boundaries such as surface water system, groundwater system and in some regions various connected water systems. The entitlement trading market turnover in 2012-2013 was AUD 1.1billion and AUD 287 million for the allocation market (NWC, 2013). The Murray-Darling Basin (MDB) market, which covers much of south-eastern Australia, is the country's most important water trading market and in 2012-2013 it accounted for 78 per cent of Australia's water entitlement trading and 98 per cent of Australia's allocation trading (NWC, 2013).

Water trading is an effective mechanism for encouraging water conservation since it allows scarce water resources to be transferred to their most productive uses and it allows access to water resources to be reallocated over time. However, when there is no water constraint, water trading is not an effective tool. Also, the beneficiaries are the parties that participate directly in the trading. This does not always include indigenous people who are dependent on the environment and may be exposed to environmental risks (Varghese, 2013).

The second mechanism Australia has adopted is Load-based Licensing. To deal with pollution control, New South Wales operates a Load-based Licensing (LBL) system to create incentives for polluters to reduce pollution. The LBL focuses on the total amount of pollution emitted each year, not on the level of concentration. A single license controls all aspects of pollution - air, water, noise and waste management. This makes it possible to reduce the potential for exchanging one type of pollution for another, for example from air to water or land. It makes it possible to better control the total pollution incurred by society. Inherently, all businesses that require a license need to pay an administration fee based on the type and size of their activity as well as a pollutant load fee based on the potential environmental impact of pollutants: the lower the impact, the lower the fee. The rate also differs according to the location of the pollution, as some places might be more sensitive to certain pollutants.

The government has set up an emission threshold for each industry type and pollutant that can be reasonably achieved with modern technology. The fee is doubled if operators exceed the threshold. Each license has an annual load limit for each type of pollutant. If the limit is exceeded, a fine is imposed by the Courts with AUD 250,000 for corporations and AUD 120,000 for individuals (NSW EPA, 2001). The LBL also provides rewards. For example, if an operator reduces the amount of pollution released or the environmental impact of the pollution released, it pays lower fees.

Load reduction agreements (LRAs) are an important component of the LBL. They are voluntary agreements that provide immediate fee reduction for licensees willing to commit to future reductions of assessable pollutant loads. The fee is calculated based on the agreed load rather than the current actual load. LRAs last for a maximum of four years, so licensees have three years to upgrade operations and a final year to show they have permanently reduced pollutant loads to the agreed lower level (DECC, 2009).

3.2.3 South Africa Basic right to water and the "Working for Water" programme

South Africa has a highly centralized water management structure. The Department of Water Affairs (DWA), which is under the Ministry of Water and Environment, is the custodian of all water resources and has the power to authorize the state to determine the use rights and allocation mechanism. As South Africa is a water scarce country, the management of water scarcity and wastewater is a priority for the government. The country's recently proposed National Water Resource Strategy (2012) has shaped the way forward in achieving equitable access and sustainable management.

Water pricing has been adopted by the government, taking into account the basic need for water, especially by low-income households. South Africa is one of the few countries in the world that has included the right to water and basic sanitation service into the country's constitution. The government grants every citizen 25 litres per day free of charge and price is only applicable to the amount that exceeds the basic allotment. Since 1994, the number of people with access to basic water services has risen from 23 million (59 per cent) to 46.3 million (93 per cent) and access to sanitation has increased from 18.5 million (48 per cent) to 39.4 million (79 per cent) (DWA, 2010).

Free water initiatives in South Africa did not come without challenges. Free water blocks took time and substantial investment to implement. Some municipalities are unable to meet the free water requirements. Often, the volume of water is not enough and low-income households experience steep price increases on their water bills, perpetuating inequality and poverty (Our Water Commons, 2014). The challenge when it comes to pricing is to set rates that accurately reflect the real cost, while ensuring all actors are able to receive appropriate shares.

Apart from water rights and pricing, South Africa has a "Working for Water" program that was founded in 1995 to clear Invasive Alien Plants (IAPs) while providing social services and rural employment. IAPs tend to be heavy water users in South Africa's arid climate and can divert enormous amounts of water from more productive uses. For example, the water hyacinth negatively affects agriculture, fisheries, transport, recreation and water supply (FAO, 2005). The "Working for Water" program, led by the Department of Water Affairs and Forestry, Environmental Affairs and Tourism and Agriculture, supports a variety of labour-intensive projects to eradicate IAPs using mechanical methods, chemicals and biological control. The main objectives of the program include enhancing water security and supporting marginalized communities through job creation and capacity building (FAO, 2005).

"Working for Water" has received funding and support from partners and sponsors in the private sector and internationally. The combination of intergovernmental, cross-sector and international support has allowed "Working for Water" to develop into a program with more than 300 sites across the country and in all the provinces. By 2009 it had cleared more than one million hectares of IAPs, created more than 40,000 jobs, educated and trained unskilled labours of whom 52 per cent are women and supported community development programs (Green Economy Coalition, 2014).

4 Air Pollution

4.1 Update on global atmospheric pollution

Although atmospheric issues often dominate the global discussion on climate change, global atmospheric pollution remains a significant challenge. Recently, the World Health Organization (WHO) reported that only 12 per cent of the cities reporting on air quality meet WHO air quality guideline levels, with about half of those monitored exposed to air pollution 2.5 times higher than recommended levels, causing concern for long-term health problems (WHO, 2014 News Release).

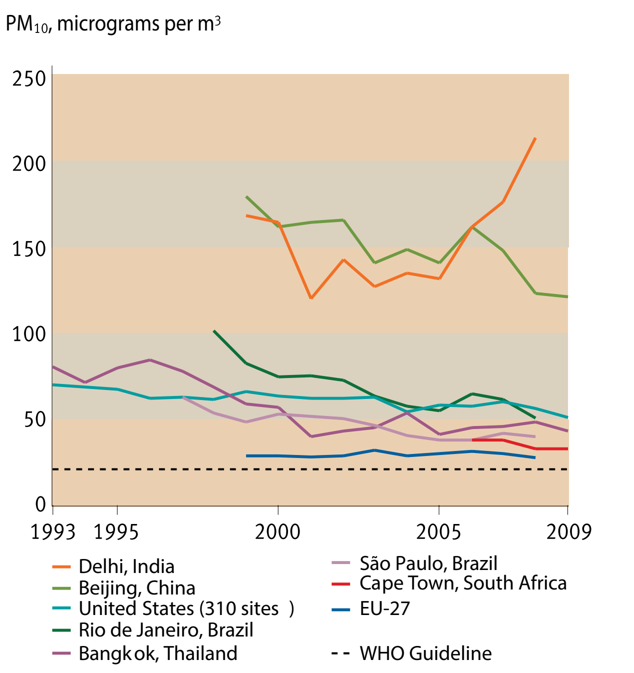
As a result, issues concerning critical air pollution warrant serious attention. Despite some international cooperation to mitigate pollution, overall momentum in achieving environmental goals for particulate matter (PM) and tropospheric ozone is mixed. Despite the high levels of concern about the impacts of PM, solutions are often complex and costly. Although much of the developed world has successfully reduced concentrations of indoor and outdoor PM to levels close to WHO guidelines, levels of PM still exceed such guidelines in many cities in Africa, Asia and Latin America (UNEP, 2012a) where any efficiencies are likely to be offset by increased consumption and levels of activity (see Figure 3).

Similarly, although peak concentrations of tropospheric ozone have decreased in Europe and North America, background concentrations[1] have increased. In rapidly industrializing regions, both background and peak concentrations have been rising steadily (Royal Society, 2008). This is related to the problem of surface ozone, which tends to be associated with regions experiencing high levels of uncontrolled emissions from industrial and urban centres. Surface ozone damages human health and its impact is considered second only to particulate matter (UNEP, 2012a). It is also the most consequential air pollutant causing damage to vegetation, diminishing crop yields and forest productivity, as well as altering net primary productivity.

Global ammonia emissions, largely from the agricultural sector,

[1] Background concentrations are those pollutants arising from local natural processes together with those transported into an airshed from afar, whereas peak concentration refers to the highest level attained during a certain time period.

Figure 3: Urban PM_{10} trends in selected regions and cities, 1993-2009



Note: Air quality data c ome from a variable number of monitoring sites.

Source:UNEP(2012), Global Environment Outlook 5. (page 48) have increased fivefold since the middle of the last century and are projected to continue to climb in all regions with the possible exception of Europe, where they have decreased slightly and may stabilize (EEA, 2009). Nitrogen-based air pollution from agriculture, industry and traffic in urban areas contributes significantly to PM2.5 concentrations as secondary nitrate and ammonium particles. In the same vein, sulphur dioxide emissions are expected to increase in some rapidly developing countries in Asia.

In some regions, particularly in South Asia, atmospheric brown clouds are increasingly common. These are regional-scale plumes of air pollutants consisting mainly of aerosol particles such as black carbon and precursor gases[2] that produce aerosols and ozone. They manifest as widespread layers of brownish haze and they can significantly affect the regional climate, the hydrological cycle and glacial melting (UNEP, 2012a).

4.2 Managing the global atmospheric commons

There is no one-size-fits-all solution for atmospheric problems (Levy et al, 1993). Emissions trading schemes that work well for the reduction of sulphur dioxide in some developed countries may need to be complemented by other measures in developing countries in order to have maximum effect. For example, the scheme's success in the U.S. was aided by the Environmental Protection Agency's capabilities and its federal reach, which may be lacking in developing countries with more decentralized structures and less funding for environmental agencies.

As some air pollutants are also greenhouse gases, cutting down on these types of air pollutants will have climate-related effects. For example, reducing consumption of ozone depleting substances also reduces their impact on climate. There will be a growing need for decision-making frameworks and enabling environments that explicitly recognize the integrated nature of the atmosphere.

There is also a need for multilateral efforts in tackling air pollution because the problem is not limited by national boundaries. There have been notable successes in addressing some problems, such as the elimination of substances that harm the ozone layer. Governments agreed to the Vienna Convention, setting in motion an international negotiation process that culminated in the Montreal Protocol in 1987. The protocol became the model for other international agreements calling for a series of targets and timetables to eliminate ozone-depleting substances in the developed world and for the creation of a multilateral fund to finance replacement technologies for developing countries beginning to manufacture CFCs (Benedick, 1998).

With other pollutants, progress has been uneven. For example, existing technology, affordable abatement costs and growing understanding have made the issue of sulphur dioxide, increasingly manageable in much of the developed world. However, although target setting and the installation of flue-gas desulphurization have become common, growth in the number of coal-fired pow er plants has overwhelmed efforts to reduce emissions. Consequently, levels of acid deposits in East Asia remain high. The health implications of PM make its control an important priority, but alleviation measures can be costly and complex due to a multiplicity of industrial, transport, energy, commercial, domestic and natural sources, especially in developing countries.

[2] Black carbon is the most strongly light-absorbing component of particulate matter and is formed by the incomplete combustion of fossil fuels, biofuels and biomass. Precursor gases of tropospheric ozone include compounds such as carbon monoxide, nitrogen oxides, non-methane volatile organic compounds and methane.

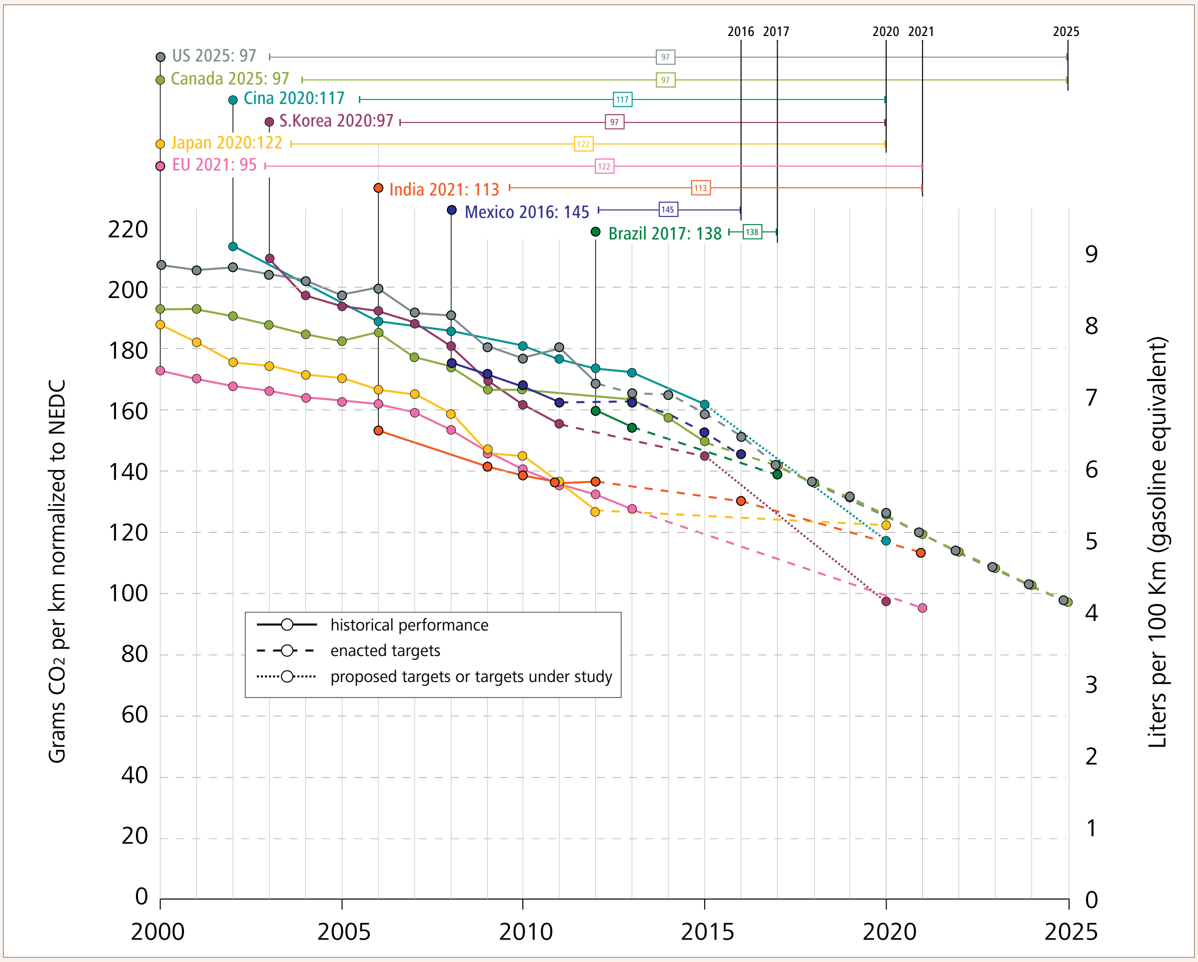
The OECD has calculated the health impacts of air pollution in economic terms. The results suggest that in OECD countries, the cost is US$1.7 trillion per year, whereas China and India have an estimated cost of US$3.5 trillion per annum. Specifically in the transport sector, 50 per cent of the costs from air pollution (in OECD countries) can be attributed to road transport, signifying the sector's importance in rectifying air pollution issues (OECD, 2014c). Although improvements in energy efficiency, cleaner fuels and the use of particulate filters have helped to reduce PM in some areas, the application of such cleaner technologies have not been sustained in rapidly growing cities where high demands for motorization, energy and industrial products have increased aggregate emissions. High costs of inaction, as described above, can be mitigated through the use of specific policies and economic instruments, as exemplified in various countries.

4.3 Country examples

4.3.1 The EU Standard setting

The vehicle emissions standards imposed by the European Union are among the most stringent in the world. This includes limits on emissions of carbon dioxide (CO_2), nitrogen oxides (NOx), total hydrocarbon (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO) and particulate matter (PM) for cars, lorries, trains, tractors and similar machinery as well as barges. Compliance is determined by running the engine through a standardized test cycle. Non-compliant vehicles cannot be sold in the EU, although the new standards do not apply to vehicles already on the roads. Figure 4 compares EU regulation on CO_2 emissions with other major countries.

Figure 4: Comparison of vehicle emissions standards across countries for passenger cars



Source: ICCT (2014), available at: http://theicct.org/info-tools/global-passenger-vehicle-standards

The current Euro V standard, which came into force in 2009, limits emissions from petrol use as follows: CO_2 to 130 g/km, CO to 1.0 g/km, THC to 0.10 g/km, NMHC to 0.068 g/km and NOx to 0.060 g/km. The Euro V standard is the first Euro standard to introduce curbs on PM from petrol use. The Euro VI standard to be implemented in September 2014 will feature tighter standards on emissions as well as lower cap on carbon dioxide emissions.

4.3.2 United States Trading SO_2 emissions

The United States has had a system of trading allowances for sulphur dioxide emissions since the 1990s. The system was created because of growing concerns that acid precipitation was damaging forests and aquatic ecosystems. The initial target was to reduce total annual sulphur dioxide emissions by 10 million tonnes relative to 1980. When the policy was enacted, no credible estimates of economic benefits of alternative target levels were available, so the target was selected largely based on what was believed to be the "elbow" of the abatement cost curve – the level of abatement that was possible at relatively low costs and above which the marginal costs of reducing emissions would climb dramatically (Schmalensee and Stavins, 2013).

The government set "allowances" for power plants covered by the law. If annual emissions exceeded the allowances allocated to that facility, the owner could buy extra allowances or reduce emissions, whether by installing pollution controls, changing the mix of fuels used to operate the facility, or scaling back operations. If emissions were reduced below its allowance allocation, the facility owner could sell the extra allowances or, since damages were understood to reflect cumulative emissions over time rather than annual emissions, bank them for future use.

Overall, the system performed exceptionally well in its first decade from 1995-2005. The costs of achieving the stated environmental objectives with cap-and-trade were significantly less than they would have been with a command-and-control regulatory approach. Cost savings were at least 15 percent and perhaps as much as 90 percent, compared with counterfactual policies that specified the means of regulation in various ways and for various portions of the system's regulatory period. However, the biggest benefit of the system did not come from reducing acid precipitation – as was initially intended – but from the unexpectedly significant improvements in health due to better air quality (Schmalensee and Stavins, 2013).

The United States government has recently launched an initiative, Data.Gov, which provides data and information on global warming in order to inform its citizens and prepare them for the effects of the phenomenon. A website, which can be accessed at http://www.data.gov/climate/, was launched in March 2014 as part of the Climate Action Plan, the United States' strategy for reducing its greenhouse gas emissions by 17 per cent by 2020 compared to 2005 levels. The website is currently in a pilot phase and includes data on coastal flooding, sea level rise and their impacts. In subsequent phases, the government will add more data and tools relevant to the effects of climate-change on infrastructure and health (Reuters, 2014).

4.3.3 Singapore Taxing car usage

In Singapore, the authorities use a Vehicle Quota System (VQS) and vehicle ownership tax to moderate the growth rate of the vehicle fleet to one that can be supported by the domestic road network. Given the country's small size, it is thought that building more roads alone will not be sufficient to ensure smooth flowing roads and the government prefers a market-based mechanism as a means of keeping the vehicle fleet at levels supportable by road infrastructure. The VQS is complemented by planned developments in public transport and traffic management systems.

Under the VQS, anyone who wishes to register a new vehicle in Singapore must first obtain a Certificate of Entitlement (COE), which represents the right to own a vehicle for 10 years and the number of COEs released onto the market at any time is based on the VQS allocation for that period. COEs are awarded after competitive bidding in a closed auction. In addition, a number of taxes such as excise duties and additional registration fees add a significant percentage to the cost of the vehicle.

The VQS has been effective in managing the vehicle population at a sustainable level (at a compounded annual growth rate of about 3 per cent since its implementation) since it was first introduced. An additional driver is the pace of road expansion, which has been slowing down by half, contributing to the reduction of the annual vehicle population growth rate from 3 per cent to 1.5 per cent p.a. since May 2009 for 3 years. The vehicle growth rate was reviewed in 2011 and it will be further reduced to 0.5 per cent p.a. from February 2013 to January 2015 (Singapore MOT, 2014).

4.3.4 Slovenia Linking motor taxes to pollutants

Driven by the need to meet its obligations under the Kyoto Protocol of reducing average annual GHG emissions and by EU regulations, Slovenia has successfully reduced its emissions of virtually all traditional air pollutants, including SOx, NOx, NMVOCs, CO and NH_3, as well as those of particulate matter and heavy metals, though the rate of reductions were uneven. For example, SOx emissions decreased by 86 per cent between 2000 and 2009 while those of NOx were only reduced by 4 per cent over the same period.

In this context, Slovenia has extensive experience with the use of market-based instruments to combat air pollution, including the CO_2 tax on energy carriers, motor vehicle registration fees linked to CO_2 and Euro emission standards and an energy efficiency tax. These instruments have been used mainly to raise revenue, though there is potential to expand their use to internalize the cost of pollution.

In 2010, a reform of the motor vehicle tax linked the tax rate to vehicles' CO_2 emissions rather than to the sale price, as had been the case between 2000 and 2009 (OECD, 2012b). The CO_2 tax applies to the pre-tax price of vehicles, starting at emissions of 110 g CO_2 /km. It ranges from 0.5 per cent to 28 per cent for petrol vehicles with the highest rate applied to those emitting over 250 g CO_2/km and from 1 per cent to 31 per cent for diesel vehicles. Hybrid and all-electric vehicles are subject to the same rates as petrol powered ones, placing them at the bottom of tax rate scale. The highest CO_2 tax rate is applied to any vehicle on which CO_2 data is lacking. The reform also addresses other environmental criteria according to European emission standards.

Although Slovenia's example focuses on CO_2 emissions, the vehicle tax could similarly be linked to other forms of emissions such as nitrogen oxides or carbon monoxide to discourage their use and encourage car owners to shift towards cleaner car models.

4.3.5 France New Measures to Fight Air Pollution

Air pollution is a serious environmental and health problem in France. Indoor air pollution costs the country 19 billion euros a year. Diesel has been subsidized since the 1950s and as a result, two out of three vehicles run on diesel (The Independent UK, 2014), which is very polluting and has contributed to high levels of air pollution. The latest illustration of this was in March 2014 when smog levels in Paris exceeded the normal health limit for five consecutive days. The government responded by making public transport free in order to encourage commuters to reduce their use of cars. The government also increased the number of trains, reduced the speed limit and alternated between allowing only even or odd-numbered licensed cars in Paris and its surrounding neighbourhoods (The Economist, 2014). Although these measures had some effect, the government recognizes that a significant shift in transport and energy use is needed to avoid similar crises in the future. The government is moving ahead with an Urgent Plan for Air Quality (*Plan d'Urgence pour la Qualité de l'Air*), introduced in late 2013, which includes measures to promote car-sharing, electric vehicles and public transportation.[3] For example, the plan called for installing 16,000 electric recharge stations by the end 2014 and an additional 16,000 by 2018.[4]

Another important measure is the Law on Energy Transition for Green Growth (*Le Projet de Loi sur la Transition Energétique pour la Croissance Verte*), which was passed by the Lower House of the French National Assembly on 14 October 2014 and will be presented to the Senate for a final vote in spring 2015. The law aims to transform France's energy sector to one that is low-carbon, consistent with sustainable development principles.[5] Some of the objectives of the law include: reducing greenhouse gas emissions by 40 per cent by 2030 compared to their 1990 levels; decreasing the share of nuclear in electricity generation from 75 per cent to 50 per cent by 2025; cutting energy consumption by half between 2012 and 2050; and increasing the share of renewable energy from 23 per cent in 2020 to 32 per cent in 2030. To meet these objectives, the law includes measures such as simplifying administrative measures for renewable energy producers; banning plastic bags from 2016 and plastic kitchenware from 2020; providing "energy cheques" for households of modest means to help them pay for energy saving renovations in their homes; offering tax credits to defray the cost of insulating public buildings; and cash refund for abandoning diesel-fuelled cars in order to purchase hybrid or electric vehicles (French Ministry of Ecology, Sustainable Development and Energy, 2014). The government estimates that the law could generate 100,000 jobs.[6]

The government is also considering measures to help households of modest means to replace their older and more polluting vehicles with more environmentally friendly vehicles (Cossardeaux, 2014). Other proposals include liberalizing electricity market prices, which are currently set at preferential rates for the national electricity utility, Electricité de France (EDF). The government also plans to create mixed private-public hydroelectric companies (currently only EDF and Gaz de France hold concessions) in order to increase competition in electricity generation and sales.[7]

[3] Details of the Action Plan are available on the website of the French Ministry of Ecology, Sustainable Development and Energy, Actions du plan d'urgence pour la qualité de l'air, 15 September 2014: http://www.developpement-durable.gouv.fr/Favoriser-le-developpement-de.html (accessed 19 October 2014)

[4] Un nouveau bonus en faveur des véhicules propres, Le Figaro, 2 October 2014, http://www.lefigaro.fr/conjoncture/2014/10/02/20002-20141002ARTFIG00040-le-gouvernement-cree-un-superbonus-pour-les-vehicules-propres.php

[5] For the full text of the law, please visit: http://www.developpement-durable.gouv.fr/Le-texte-du-projet-de-loi.html

[6] http://www.developpement-durable.gouv.fr/Creation-d-emplois,40883.html (accessed 17 October 2014)

[7] Le Figaro, Le Deputés Adoptent Largement le Projet de la Loi sur la Transition Energétique, 14 October 2014, http://www.lefigaro.fr/conjoncture/2014/10/14/20002-20141014ARTFIG00301-les-deputes-adoptent-largement-le-projet-de-loi-sur-la-transition-energetique.php

5 Waste Management

5.1 Update on the global waste situation

Waste generation is the direct result of population and income growth. Ten years ago, there were 2.9 billion urban residents in the world who generated about 0.64 kg of municipal solid wate per person per day (0.68 billion tonnes per year). Today, this has increased to about 3 billion residents generating 1.2 kg per person per day (1.3 billion tonnes per year) and it is estimated that the growth rate of waste volumes are higher than the rate of urbanization and GDP growth (World Bank, 2012).

Along with industrial growth, many developing countries face challenges related to industrial waste from all sectors of society including a dramatically increased amount of e-waste. For example, every year, around 50 million tonnes of e-waste are dumped in China and Ghana. It is estimated that annual global e-waste will reach 65 million tonnes by 2017. Only around 13 per cent of the e-waste generated each year is recycled. By 2020, it is estimated that e-waste in China will grow to 137 million tonnes (Li Chunsheng, 2011). Figures from the U.S. Environmental Protection Agency suggests that recycling one million mobile phones could recover 50 pounds of gold, 550 pounds of silver, 20 pounds of palladium and more than 20,000 pounds of copper (The Guardian, 2014). While a huge number of electronic devices have been discarded, rare earth metals, used to make crucial components of many tech products, are increasingly scarce.

The environmental and social impacts of waste are significant. The disposal and treatment of waste in general can produce emissions of several GHGs and contribute to 5 per cent of total anthropogenic emissions (UNEP, 2010). Uncollected waste contributes to flooding and air pollution and improperly treated waste can lead to serious health problems such as skin and eye infections, respiratory problems, vector-borne diseases like diarrhoea, dysentery, typhoid, hepatities, cholera, malaria and yellow fever. According to the ILO, e-waste poses a particularly significant threat as it it exposes workers in developing countries to health risks, imposes long term effects on human health and the environment and engages child labour at e-waste recycling sites (ILO, 2012). A global survey also shows that e-waste contains dangerous toxins and has significant impact on child health, such as chemical burns, cancer and developmental disabilities (UNU & WHO, 2013).

At the same time, the waste management sector, especially recycling, is often one of the biggest employers, in both the fomal and informal economies. It is estimated that up to 15 million people are engaged in waste collection in developing countries (Medina, 2008). In the EU, core environmental industries in the field of pollution management and control, waste collection and treatment, renewable energy and recycling have a combined turnover of over EUR 300 billion, provide nearly 3.5 million jobs and have impressive global market shares of 30-40 per cent (OECD, 2012c).

At the international level, more agreements and strategies on waste control and management are beginning to surface. Examples include the Basel Convention and the Montreal Protocol. Another example is that in June, 2014 the Global Forum on Environment in Japan sought to build a harmonized approach tom waste management by discussing and comparing recent experiences in the design and implementation of the Extended Produceer Responsibility scheme. Waste management is increasingly becoming an international issue and will require collaboration between countries. Actions across countries, therefore, remain fundamental. Some sound practices at the national level can be found below.

5.2 Country examples

5.2.1 Germany Making Polluters Pay and Extended Producer Responsibility

Germany has been one of the most innovative countries in waste management. Its system, introduced decades ago, has been continually updated, with the latest innovations implemented in 2005. The German system for waste management consists of both market-based and regulatory elements.

An important part of Germany's waste management are its waste charging systems, which are based on the "Polluter-Pays Principle" and normally used at the municipal level. Although there are slight differences between municipalities, most of them apply fixed fees for consumers. They aim at giving an incentive to citizens to reduce their waste generation. About 65 per cent of municipal waste management services are provided by the private sector. There are also deposit-refund systems for many types of beverage containers, e.g. cans, bottles made of glass and many kinds of plastic bottles, with the aim of achieving higher recycling rates for cans and bottles (OECD 2012d).

The principle of Extended Producer Responsibility (EPR) has become increasingly important over the last two decades, with Germany being one of the first countries to include this principal in its waste management system. EPR is different from the polluter-pays principal in that it places a financial and/or physical responsibility for the treatment or disposal of post-consumer products on producers and relieves local governments of the burden. In Germany, legal provisions were made for different kinds of waste: packaging (1991), end-of-life vehicles (1997), batteries (1998), waste oil (2002) and waste electrical and electronic equipment(WEEE) (2005). In most cases, producers are obliged to take back and to recycle the waste, usually in combination with a target quota. The revenues from selling secondary products are used to cover the costs of collection and treatment.

There are often restrictions on specific noxious substances as well as regulations on product design to increase recyclability. These provisions have helped to increase the amount of waste collected and treated. For example, regarding waste electrical and electronic equipment the rate is estimated to be at 40 per cent to 50 per cent of the amount produced in the three years after the introduction of producer responsibility concept in 2005 (NABU, 2012; Umweltbundesamt, 2013).

Recycling has been a very important principle in Germany's waste management system and Germany was one of the first countries to introduce the concept of closed cycle material management. Its municipal recycling rate (including composting) at 63 per cent is among the highest within the EU and it has one of the highest rates for the recovery of industrial and commercial waste (80 per cent) and demolition waste (90 per cent). This contributes significantly to Germany's resource efficiency.

To complement these efforts, in 2005, a landfill ban for untreated municipal waste was introduced. Thanks to this ban, the disposal of municipal waste in landfills decreased sharply. The high recycling rates and the ban of landfilling contributed to a sharp reduction of GHG emissions in the waste management sector, totalling 13 Mt CO_2 eq or 1.4 per cent of Germany's emissions in 2010, representing a reduction by 70 per cent since 1990 and by 52 per cent since 2000 (European Environment Agency, 2013, OECD, 2012d).

In Germany, the waste management sector has an annual turnover of EUR 50 billion and strong growth is predicted for the future. The sector also accounts for 25 per cent of the world market for closed-cycle management technologies (OECD, 2012d).

5.2.2 Japan Public-Private cooperation in Industrial Waste Management

Japan has been a leader in waste management for decades and the country has successfully managed to involve the private sector in the management of industrial waste. The Japanese system is a mix of legislation and voluntary initiatives.

In 1971, long before the well-known 3R (Reduce, Reuse and Recycle) initiative, which was launched in 2000, the Japanese Waste Management Law was established and categorised waste into municipal solid waste and industrial waste. The rationale behind this division was that compared to municipal waste, industrial waste streams are large in volume and relatively homogeneous in terms of source and therefore, could be more efficiently dealt with on their own. The law states that industrial waste generators are financially responsible for the handling of waste. They can either treat the waste appropriately on their own or outsource to businesses specializing in industrial waste treatment. Businesses that are in the waste treatment sector are obligated to obtain a license from the relevant authority and each industry has its own treatment standard. Although in the past, waste treatment was the responsibility of the public sector, this was the first time in Japanese history that the private sector could provide their services through the market.

To better regulate and monitor the market, the government provided courses on legislation, industrial waste treatment technologies and standards for businesses to get the licenses. However, in the early stages, the quality of the treatment varied because minimizing costs was the primary goal of both waste generators and waste treatment businesses. Over time and after government intervention, quality became a significant component of the country's (and the private sector's) strategy. The government revised the law in 1997, making an environmental impact assessment compulsory and allowing the involvement of other stakeholders. The conditions for obtaining a license also became stricter and quality of treatment became an important focus.

Furthermore, after realizing that the illegal dumping of waste was becoming costly, local governments started to enforce laws and regulations more rigorously. At the same time, waste generators began to prioritize their waste treatment contractors' quality of service. Subsequently, a framework was established to facilitate competition among private waste treatment companies. The law became the driving force for promoting the recycling of waste in general and recycling became a social trend. Challenges, however, remain and illegal dumping still exists even though it has significantly decreased.

Apart from the national law of waste management, Japan also has a voluntary Industry Action Plan for the environment. The Japan business federation, Keidanren, is an organization with a membership of 1,300 leading Japanese companies, 121 national associations of manufacturing industries, service industries and other major industries and 47 regional economic organizations (as of July 2013). Besides serving as an economic coalition, Keidanren also works on environmental issues. A voluntary environment plan was established in 1994 with a section on waste disposal measures (subsequently renamed "the Establishment of a Sound Material-Cycle Society"), involving 35 of the 41 industrial participants. Waste reduction targets for industries were set in 1999. The 2010 update aims to reduce by FY2015 the amount of landfilled industrial waste by about 65 per cent compared with the FY 2000 level (UNEP, 2013b). In 2011, the amount of landfilled industrial waste was about 5.92

million tonnes compared to 58.41 tonnes in 1990 (Keidanren, 2013).

There are also initiatives on waste management at the municipal level. For example, the Kawasaki "eco-town" aims to better utilize the existing industries and assets in the local community to build a recycling-orientated society while local government facilitates business in the process. One characteristic of the eco-town is that it can connect the potential materials and recycled resources directly to the related companies. This strategy increases the potential for regions to become more resilient and self-sufficient. For example, companies whose core business is steelmaking and engineering operate facilities to turn waste materials into raw materials for blast furnaces and to produce concrete frame panels from waste plastics. Also, on the recycling of used paper, the government collects and supplies used paper to companies for use as inputs for toilet paper production. Furthermore, many of the facilities to recycle waste were constructed with government subsidies to help share the cost with private operators (UNEP, 2013b).

5.2.3 Brazil National solid waste law and business models in e-waste treatment

Brazil has a solid legal framework to manage waste - especially e-waste - at the federal, state and municipal levels. In addition to legal enforcement, businesses also take the initiative to explore various models to get involved and make profits from e-waste management.

Brazil's federal solid waste law requires the sharing of responsibilities for waste management throughout the value chain in the product life cycle. Among the responsible parties for managing e-waste are manufacturers, distributers, importers and retailers. The 2010 Decree 7404 states that responsibilities should also be shared by consumers and municipal authorities. Under the Decree, an inter-ministerial committee was established, involving twelve federal agencies, such as Ministry of Cities, Health, Mine & Energy and Treasury. The Ministry of Environment coordinated the committee (World Bank, 2012).

The laws' implementation instruments are mainly sector agreements, rules of the federal government and the terms of commitment. The government expects to eliminate all open landfill deposits by 2014. There are also regulations at the state and municipal levels to make sure the law is enforced effectively. For instance, in São Paulo, the state government requires electronic product companies to display warnings against discarding e-waste in regular trash, guidance on collection points for e-waste and warnings about heavy metal or toxic substances on the packaging or labelling of their products. The government will enforce these strategies through the use of fees and penalties, which can then be reintegrated into the waste programs and other public services.

Companies in Brazil have been quite active in exploring various business models in managing e-waste. For example, ITAUTEC, a national company manufacturing computers and hardware for bank and commerce automation, disassembes used ATMs in their plant. They then reassemble the used parts in new ATMs. What remains of the old ATMs follows the e-waste treatment process. The annual recycling volume is about 120 tonnes. ITAUTEC has a balanced cost recovery model since most of their income comes from the selling of refurbished ATMs and they only deal with large users rather than individuals.

The multinational corporation, Philips Brazil, on the other hand, covers two-thirds of its recycling costs on its own. Part of Philips Brazil also follows the reverse logistics recycling process, which focuses on the backward flow of materials from customer to supplier to maximize the value from the returned items, assuring its proper disposal. They have established a call centre, a chat centre, a dedicated website, 40 collection points and an optional service to collect waste directly from consumers' homes. In terms of voluntary initiatives, the total amount of collected and recycled electronic devices in 2010 was 92 tonnes, with potential for expansion. Transportation is the major e-waste processing cost. In order to make Philips Brazil's system financially sustainable, a new model is necessary to maximize volume while minimizing transport costs.

Another example is Reciclo Ambiental, a company which helps brand owners manage their used products to prevent them from being sold on the secondary market. The company manages the whole e-waste process on behalf of their clients, including consultations, electronic disassembly and processing the components and even exporting elements to Belgium for refining and extraction of valuable materials. At the end, the company provides their clients with a Certificate of Destination to provide assurance that the e-waste has been dealt with in an environmentally sound way. The company also has partnerships with not-for-profit organizations to provide training and participate in awareness raising events. This consulting company model can be profitable if logistics are well managed (World Bank, 2012).

5.2.4 Canada Restoration of contaminated sites

Although Canada had already started to deal with federal contaminated sites in 1989, the 2002 Report of the Environment and Sustainable Development criticised the government for the lack of information on the number of sites and the failure to produce an action plan to deal with high-risk sites in a timely manner. It pointed to the need for stable, long-term funding to manage the problem (Government of Canada, 2013b).

In response, a legal framework was established between 2000 and 2002 to regulate the management of federal contaminated sites, provide best practices and guidance for those institutions responsible for the management of these sites (which are federal departments, agencies and consolidated Crown corporations). The Federal Contaminated Sites Inventory was publicly released at the same time (Government of Canada, 2012). This list contains about 22,000 sites including confirmed contaminated sites (about 6,800), suspected contaminated sites (about 5,600) and sites where restoration was either completed or not necessary (about 8,900). The current list was compiled through the assessments made under the Federal Contaminated Sites Action Plan (FCSAP) (Government of Canada, 2013a).

The FCSAP was established by the government in 2005. It is a 15-year program with CAD 3.5 billion funding from the Canadian government. The funds are provided to the institutions responsible for the management of the sites for assessment, remediation/risk management and program management. The plan's goal is to reduce the risks to the environment and human health and the federal financial liabilities associated to the sites. Its first phase was completed in 2011 and involved the complete remediation of 650 sites, conducted remediation activities at 1,400 sites and assessment activities at 9,400 sites in total (Government of Canada, 2014). The number of sites on the Federal Contaminated Sites Inventory increased from about 4,000 to about 22,000. In phase one, CAD1.6 billion was spent (Government of Canada, 2013c) and additional funding of CAD 80.5 million was made available between 2009 and 2011 under the Canadian Economic Action Plan (Government of Canada, 2013a). During the first phase the adjusted liability from federal contaminated sites increased by CAD 544 million due to the identification of new sites and more accurate estimates of the liabilities from existing sites (Government of Canada, 2013c). In the second phase, from 2011 to 2016, this work continues, with a focus on the clean-up of the highest priority sites (Government of Canada, 2013a).

The restoration of contaminated soil provides important economic opportunities. Before the completion of the first phase, Industry Canada estimated that brownfield redevelopment could contribute CAD 50 to CAD 200 million to GDP per year. It was further estimated that the activities under the FCSAP could create 5,200 jobs between 2006 and 2009, accounting for 1, 275 positions annually. As many of the contaminated sites are in the North and in rural areas this was seen as an opportunity to boost employment within these communities (ECO Canada, 2007). Northern and northern aboriginal people profit from getting jobs as welders, heavy-duty mechanics, electricians and millwrights and the remediation industry benefits from innovations and dispersion of new technologies through the program (Government of Canada, 2013c). Over the period 2009-2011, the government estimated that FSCAP created 8.4 jobs for every million dollars spent on the programme (Government of Canada, 2013c).

6 Urban development

6.1 Update on global urbanization situation

Today, 52 per cent (3.6 billion) of the global population lives in urban areas. It is projected that the number will reach 6.3 billion by 2050 and urban areas are expected to absorb all of the population growth over the next four decades (UN Population Division, 2011). This scale of urbanization results in significant challenges, especially for developing countries. The growth of cities has often subjected the landscapes and the surrounding ecosystems to increasing pressure. Densely populated areas often have less healthy environments with lower qualities of air, water and biodiversity, which in turn directly impact the health, well-being and productive capacity of urban populations.

Cities are responsible for 67 per cent of global energy consumption and 71 per cent of global energy-related CO_2 emissions. At the same time they are also responsible for a significant share of economic growth and infrastructure investment (OECD, 2013b). Therefore, the urban area is a crucial component for both economic development and environmental protection. Sustainable urban development aims to improve the well-being of urban populations by minimizing the environmental impact of cities. Urban regions are indispensable actors in the green transition.

UNEP's Green Economy Report (2011) identifies several strategies to achieve sustainable urban development across sectors such as transport, buildings, energy, water and waste. For example, planning cities in a compact way (rather than "urban sprawl") is preferred as it makes urban transport, energy, water, waste and sewage systems less expensive, which in turn facilitates investments in public transportation, biking infrastructure, energy efficiency and waste collection. Encouraging the use of public transport and active commuting (walking or biking) not only increases air quality and human health, but also leads to economic benefits since less productivity is lost to traffic congestion. Maintaining green spaces close to residential areas is beneficial to human health and well-being and the preservation of natural ecosystems within cities can contribute to the purification of air and water. Furthermore, green urban development includes careful planning to determine at which locations within the city industrial development should take place and what kind of industries should be encouraged. All of these strategies can be achieved through the strengthening of local governance, the development of sustainable urban planning tools and the use of financial incentives. Given the multiple dimensions of sustainable urban development and the limit on the length of this paper, we focus on only one case study: Brazilian city of Curitiba.

6.2 Brazil The Curitiba Case Study

Over the past century, Brazil has experienced rapid urbanization. This has led to problems of pollution, traffic congestion, a decrease in public and green spaces, informal housing settlements and socio-economic ruptures (Rabinovitch & Leitman 2004). An example of an urban policy that counters these developments is the sustainable urban development programme that began in Curitiba in the 1960s. Curitiba, the capital of Paraná state, has 1.8 million inhabitants (metropolitan region: 3.2 million inhabitants; IBGE 2010), which makes it the eighth largest urban centre of the country in terms of population. Curitiba's sustainable urban development policies have been widely praised; for example, the World Bank's Eco Cities Report[2] concludes that the city managed to successfully integrate policies to spur socio-economic development, environment protection and improvements in the quality of life.

Sustainable urban development in Curitiba started in 1965, the year in which the Institute for Research and Urban Planning of Curitiba (IPPUC) was created as an independent public authority. In the subsequent decades, this Institute has coordinated the development of a series of integrated policies to be executed by the municipal authorities, including:

- The relocation of employment to areas outside the city centre (through, for example, the creation of an "industrial city" (CIC) in a concentrated area west of Curitiba where industries are bound by strict environmental regulations);
- The development of a system of roads with exclusive bus ways at their centre (Bus Rapid Transit System – BRT);
- The rationalisation of the integrated transport system;
- Improved land use legislation, providing clear incentives for commercial developments to be located as closely as possible to one of the public transport axis and outside the city centre (see Figure 5);
- The development of green areas across the city, some of them in former slum areas;
- Improvement, either through relocation or not, of the quality of life in slum areas, from the point of view of public transport access, garbage collection and flood prevention (Puri, Gainza-Carmenates & Lobach 2014; Rabinovitch 1992; Rabinovitch & Leitman 2004).

Impacts of the initiative

The Sustainable Urban Development initiative in Curitiba has had a positive effect on income and job creation. The Industrial City, which was created in order to attract investments, boost employment and reduce poverty, hosts today 700 non-polluting companies, creating 200,000 jobs (of which 50,000 directly) and producing 20 per cent of Paraná's export.

Figure 5: Trinary Road in Curitiba - Linha Verde BRT Curitiba, Est Marechal Floriano. Density of urban development. A legal framework was adopted that made the density of urban development dependent on distance to a public transport axis, in order to decrease average commuting time.

Source:Flickr/Creative Commons/mariordo59

While the city increased three-fold from 1970 to 2008 (a growth rate that might have been expected to have a negative impact on health), the average green area per person increased over the same period, from 1 m^2 to 50 m^2. This has had a positive impact on child health (Bueno et al. 2012). Air pollution, one of the main health burdens in other urban centres in Brazil, has decreased significantly as a result of green areas in the city, but also as a result of the use of public transport in the city: 45 per cent of all trips (including walking and biking) in the city are made by public transport (and only 22 per cent by car) (World Bank 2011; UNEP 2011). The design of Curitiba's public transport system has been an inspiration for several other cities, including Rio de Janeiro (Brazil), Bogotá (Colombia), Lima (Peru) and Guangzhou (China), among many others (ITDP, 2013).

A rise in active commuting (walking to and from bus stops or using the city's 120 km bike network) is another health advantage resulting from Curitiba's urban planning strategy. The creation of parks and natural areas in riverbeds that used to house slum areas has fostered effective ecosystem regulation of water supplies. This has significantly decreased the risk of flooding, thereby reducing the spread of diseases such as dengue fever. Finally, a programme has been implemented to cut garbage collection costs. The programme consists of paying people to collect the garbage in their area and to hand it in to the municipality. This market-based system has lowered unregulated waste dumping and improved hygiene in slum areas while creating alternative income sources for the poorest segments of society (Puri et al. 2014).

Importantly, Curitiba has made an effort to ensure that the relocation of slum areas – which has often been necessary to achieve the overall outcome of sustainable urban planning – would not come at the expense of the inhabitants. In addition to the construction of appropriate housing for relocated slum inhabitants, the city has implemented a policy of designating specific areas for unofficial occupancy, exercising a certain degree of control over informal housing construction, ensuring that the newly designed green areas do not turn into slums again. The areas for unofficial occupancy have been included in city planning so as to ensure the social inclusion of their inhabitants. Although the number of people living in slums is much lower in Curitiba than in other Brazilian cities. Slum inhabitants still form 9.3 per cent of the city population (IBGE 2010), which is far from being a negligible amount.

In order to promote social equity, the city has decentralised city services to various neighbourhoods, always in close proximity to bus terminals. The buses themselves are priced at a flat rate "social fare", which is another way of enhancing social equity as it allows people from all city areas to participate in the economy in the same way. Currently, the city is looking into ways to further expand the bicycle network, allowing more people to use it in their daily commuting rather than only for leisure activities and for building underground rail lines along the main transport axes (COMEC, 2012; CIE, 2014).

One of the most important considerations in sustainable urban planning is financing. Policies for spatially reorganizing Curitiba have been financed by a set of taxes and public funds. For example, special property taxes for new neighbourhoods close to green areas partially finance the construction of such green areas and the improvements in living conditions in slums. In addition, the municipality sells construction and forest exploitation rights, which partially finance slum improvements and historic building preservation. The Institute for Research and Urban Planning regulates and monitors the transfer of development rights among interested parties (Puri et al. 2014).

Some of the enabling factors for the success of Sustainable Urban Development in Curitiba are: 1) the continuity and consistency of the policies of the IPPUC; 2) the holistic vision of this institution, which allowed the design of policies accounting for the economic, the social and the environmental aspects of urban planning, 3) the harmonization between urban development and the legal framework on construction and environment; 4) the availability of specific funding for the project; 5) the ease at which the city was able to purchase the land for transport, residential and industrial use; and 6) the hydrological features of the area which facilitated the creation of green areas across the city (Puri et al. 2014; De Oliveira 2001).

However, in recent years the achievements made in Curitiba have been partially offset by the initiative's lack of regional integration. Smaller municipalities in the metropolitan region have not implemented the same policies regarding transportation, and the result has been urban sprawl across the Curitiba's city limits. This is causing a rise in the number of cars entering the city on a daily basis. The economic development of the surrounding area (e.g. the construction of large shopping malls), unconnected to Curitiba's public transportation system, also favours the use of cars and partially offsetts Curitiba's achievements (World Bank, 2011). Furthermore, polluting industries have been allowed to settle in surrounding municipalities where the water supplies that Curitiba depends on are located (Lubow, 2007). This shows the importance of implementing sustainable urban planning at the supra-municipal level, involving all municipalities of which a metropolitan urban area is composed.

7 Measuring Green Transition

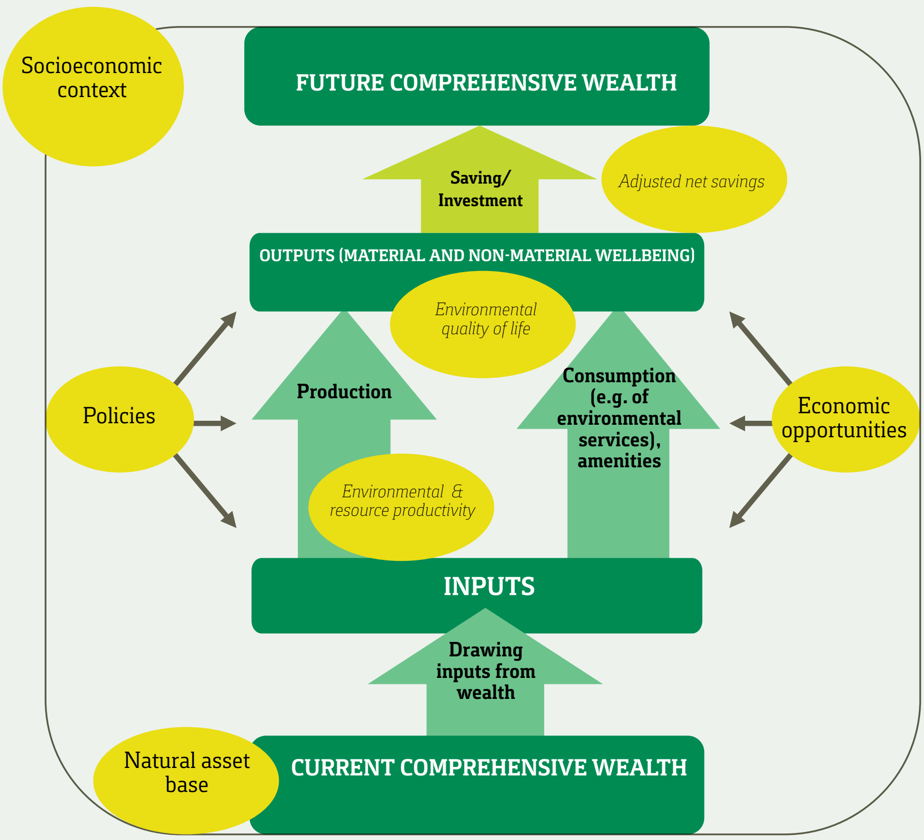
7.1 Major frameworks

Indicators are needed to show progress in the transition to a greener economy. The role of indicators in measuring progress was also recognized by the heads of state and governments as well as other high-level representatives at the Rio+20 Conference on Sustainable Development (UN, 2012). The conference outcome document acknowledged that different national circumstances, capacities and levels of development also need to be taken into account while using indicators,. Even though there is no commonly accepted definition of green economy/ green growth indicators, many international organizations and research institutes have been working on developing indicator frameworks to capture the nexus between social, economic, environmental aspects of an inclusive green economy.

To coordinate international efforts, Green Growth Knowledge Platform (GGKP) synthesized the existing relevant indicators work of the Global Green Growth Institute (GGGI), the Organization for Economic Co-operation and Development (OECD), the United Nations Environment Programme (UNEP) and the World Bank and developed a common approach (see Figure 6) to green growth indicators (GGKP, 2013).

The approach captures the common characteristics of existing frameworks. In general, there are four types of indicator frameworks: 1) an indicator set; 2) headline indicators; 3) wealth accounting; and 4) indicators organized to match the major stages of policymaking (GGKP, 2013). The OECD indicators framework is a typical indicator set and it has been applied by several OECD member countries, such as the Netherlands, South

Figure 6: The production framework for Green Growth/ Green Economy indicators and wealth accounting



Source: GGKP (2013), Moving towards a Common Approach on Green Growth Indicators.

Korea and Germany. The idea of headline indicators is to prioritize a few key indicators for more effective communication to high level policy makers and the public in general. Wealth accounting, as represented by the World Banks's Adjusted Net Savings and Wealth Accounting and Valuation of Ecosystem Services, as well as UNEP's Inclusive Wealth Report, calculates the real wealth of a nation, taking into consideration not only physical capital, but natural and social capital. The emphasis by UNEP and GGGI emphasize the importance of connecting existing indicators to problem solving when using indicators as a policy making tool.

The section below covers two country examples, the Netherlands (using the OECD framework) and Mauritius (using the UNEP framework), to illustrate the use of indicators in green economy policy development.

7.2 Country examples

7.2.1 The Netherlands OECD Green Growth Indicators

In 2011, The Netherlands launched its National Green Growth Indicators Report 2011, based on OECD's framework. Produced by a working group of representatives from seven Ministries, including the Ministry of Finance, Economic Affairs and the Netherlands Environmental Assessment Agency, the report presents an overview of the country's green growth status.

OECD's green growth indicators framework covers four aspects of green growth: the environmental and resource productivity of the economy, the natural asset base, the environmental quality of life and economic opportunities and policy responses. The whole framework is based on the socio-economic context and characteristics of growth (see Figure 7).

Figure 7: OECD Indicators framework

	THE ENVIRONMENTAL AND RESOURCE PRODUCTIVITY OF THE ECONOMY	– Carbon and energy productivity – Resource productivity: materials, nutrients, water – Multi-factor productivity
1	THE NATURAL ASSET BASE	– Renewable stocks: water, forest, fish resources – Non-renewable stocks: mineral resources – Biodiversity and ecosystems
2	THE ENVIRONMENTAL DIMENSION OF QUALITY OF LIFE	– Environmental health and risks – Environmental services and amenities
3 4	ECONOMIC OPPORTUNITIES AND POLICY RESPONSES	– Technology and innovation – Environmental goods & services – International financial flows – Prices and transfers – Skills and training – Regulations and management approaches
5	SOCIO-ECONOMIC CONTEXT AND CHARACTERISTICS OF GROWTH	– Economic growth and structure – Productivity and trade – Labour markets, education and income – Socio-demographic patterns

Source: ICCT (2014), available at: http://theicct.org/info-tools/global-passenger-vehicle-standards

The above figure contains around 30 indicators and is intended to demonstrate the possible choices. Actually, this set contains many more indicators and countries have the flexibility to design and select indicators that best suit their circumstances.

a. Environmental and Resource Productivity

One of the key aims of green growth is to improve the efficiency of resource use. The Netherlands used the indicators in Table 1 to reflect the country's environmental efficiency status. For example, the Netherlands' intensity of greenhouse gas production fell by 31 per cent between 1990 and 2009 and during the same period, the economic growth rate (53 per cent) was considerably higher than the increase in greenhouse gas emissions (5 per cent) (Statistics Netherlands, 2011). Therefore, it is fair to say that relative decoupling has been achieved and the country is set to realize its Kyoto target. Table 1 shows that environmental efficiency in the Netherlands is improving in general, although only relative decoupling occurred in most cases. The efficiency improvement is partly due to the substitution of imports for domestic production.

Table 1: Environmental Efficiency

INDICATOR	TIME SERIES	TREND	POLICY TARGET
Production-based greenhouse gas intensity	1990-2009	Relative decoupling	Likely to be met
Consumption-based greenhouse gas emissions	1996-2009	Relative decoupling	-
Energy efficiency	1990-2009	Relative decoupling	-
Renewable energy	1990-2009	Improvement	Unlikely to be met
Nutrient surpluses	1990-2009	Absolute decoupling	Possible to meet (with additional effort)
Material intensity	1996-2008	Relative decoupling	-
Water use intensity	1990-2009	Absolute decoupling	-
Waste treatment	1985-2008	Improvement	Likely to be met

Source: Statistics Netherlands (2011), Green growth in the Netherlands.
"-" not possible to score, no policy target identified or inconclusive trend

b. Natural Asset Base

Natural asset base indicators measure the flow of environmental goods and services in order to monitor the potential risks to human well-being and economic growth. Indicators under this category are meant to show the physical reserve of natural assets, not the monetary value. For example, Table 2 shows that stocks of timber increased by 27 per cent between 1990 and 2005, due largely to the increase in forest area (Statistics Netherlands, 2011). But most of the country's timber consumption comes from imports, meaning that the country shifted the environmental pressure abroad. Therefore, the data cannot be interpreted to show a reduced dependency on timber stock.

Table 2: Natural Asset Base

INDICATOR	TIME SERIES	TREND	POLICY TARGET
Stocks of timber	1990-2005	Improvement	Unlikely to be met
Fish inputs	1996-2008	Deterioration	-
Natural gas reserves	1990-2010	Deterioration	-
Land conversion into built-up land	1900-2006	-	-
Threats to biodiversity	1994-2005	Deterioration	Unlikely to be met

Source: Statistics Netherlands (2011), Green growth in the Netherlands.
"-" not possible to score, no policy target identified or inconclusive trend

c. Environmental Quality of Life

Indicators of environmental quality of life measure the interaction between environmental conditions and people's well-being. Pollution, for example, is an obvious factor that can influence people's quality of life and was used by the Netherlands in the report (Table 3). The pollution measured here is mainly air pollution (PM10), but other types of pollution, such as water and soil, as well as access to environmental services could also be used as indicators in this category. Additionally, to better capture the attention of the public and the government, some economic indicators, such as the economic cost of pollution-caused risks, could be used.

Table 3: Environmental Quality of Life

Indicator	Time Series	Trend	Policy target
Pollution-induced health problems	1980-2000	Improvement	-

Source: Statistics Netherlands (2011), Green growth in the Netherlands.
"-" not possible to score, no policy target identified or inconclusive trend

d. Economic Opportunities and Policy Response

Governments play a crucial role in promoting green growth through investment, consumption and trade policies, as well as fiscal instruments and industrial policies. Indicators in this category can capture the trend of policy instruments and measure the economic opportunities related to green growth. For example, the indicator of green taxes used by the Netherlands (see Table 4) shows an increasing trend, as the share of these taxes in total tax revenue went up from 9.4 per cent in 1990 to 14 per cent in 2009, with motor fuels excise and energy tax contributing the most (Statistics Netherlands, 2011). The increase of green tax share, however, does not necessarily mean that the country is moving towards green growth; it only shows the government's commitment and response to the transition.

Table 4: Economic Opportunities and Policy Response

Indicator	Time Series	Trend	Policy target
Green patents	2000-2006	Increase	-
Share of green taxes	1990-2009	Increase	-
Energy prices	1990-2009	-	-
Carbon emission trading	2005-2009	-	-
Environmental investments	1990-2007	Stable	-
Green jobs	1995-2008	Increase	-

Source: Statistics Netherlands (2011), Green growth in the Netherlands.
"-" not possible to score, no policy target identified or inconclusive trend

7.2.2 Mauritius UNEP's Indicator framework for policymaking

Although Mauritius does not have a national report on green economy indicators, the country requested that UNEP use indicators based on the country's particular situation to support them in their green economy policymaking process.

UNEP organizes its indicators framework around a standardized policymaking process (see Figure 8). The framework includes four segments: issue identification, policy formulation, policy assessment and policy monitoring and evaluation (UNEP, 2014). In this framework, decision-making refers to a particular point in time in the policy making process, whereas policy implementation is closely connected to Monitoring and Evaluation and is ongoing. Therefore, no separate categories of indicators are proposed for these two stages. In addition, the difference between policy assessment on the one side and monitoring and evaluation on the other is one of *ex ante* and *ex post*; their underlying sets of indicators are similar.

UNEP's framework is also applicable to non-environmental issues and it could easily have a set of indicators for each sector and policy. For example, UNEP applied indicators in seven sectors (agriculture, tourism, energy, waste, manufacturing, transport and water) to address different green economy issues in Mauritius. In the case of the agriculture sector, indicators are suggested below:

a. Issue identification

The conversion of agricultural lands to other uses, such as real estate development, is a worrying trend for the agriculture sector in Mauritius. The area under agriculture decreased by around 15 per cent and the area under sugar cane decreased by around 25 per cent over the period of 2000 to 2012 (UNEP, upcoming). The loss of agricultural lands will lead to significant social and economic problems that could be more costly compared to the profit from real estate development. For example, local citizens' employment, income and living conditions as well as social stability and natural resource stocks will be affected. In particular, during the period of 2000 to 2012, the production of sugarcane dropped by about 20 per cent (UNEP, upcoming), which is creating more pressure for the country since Mauritius is highly dependent on food imports. In fact, with the fallout in the international market, sugarcane lands are actually becoming more profitable for residential, real estate and commercial purposes.

To better monitor early trends to avoid the above situation, indicators below are suggested to the government based on stakeholder consultation:

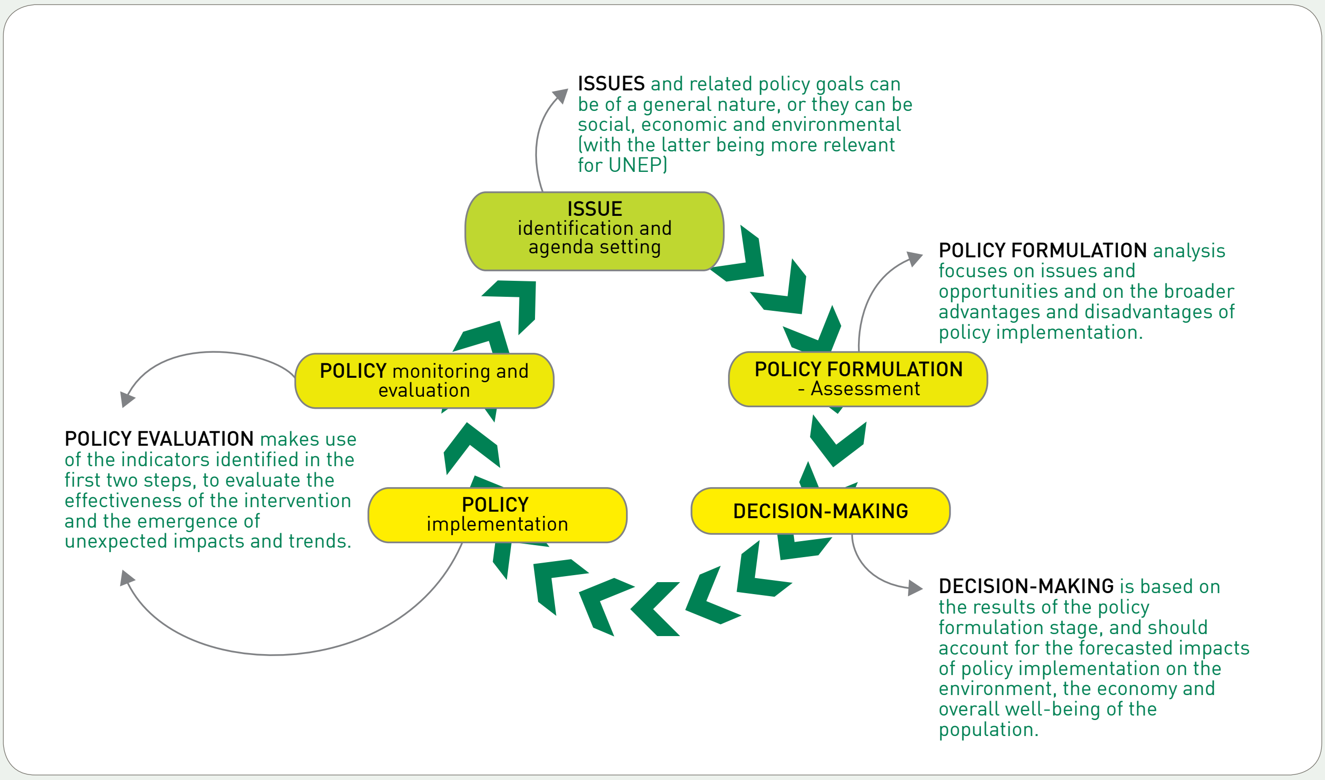
- the area of land under agriculture (sugarcane and food crops);
- volume of agricultural production;
- the number of sugarcane growers and food crop growers;
- the average age of farmers; and
- the average price of land for real estate development.

b. Policy Formulation

Policy needs to be formulated to address the issue identified in the first step. In this case, the desired policy outcome will be to increase food security by increasing crop production as an import-substitution strategy, thereby reducing the food import bill and thus retaining foreign exchange earnings. Therefore, policy indicators could include:

- food security targets for strategic commodities (per cent);
- incentives/subsides for re-directing investment into agriculture (crop and livestock production); and
- taxes on land conversion.

Figure 8: Overview of the integrated policymaking process



Source: Source: UNEP(2014), A Guidance Manual for Green Economy Indicators.

c. Policy Assessment

Once targets are defined and appropriate policy interventions are identified, a policy assessment needs to be carried out to estimate the impact the policy is likely to have once it is implemented. In this stage, since the policy has not been implemented yet, the assessment is based only on analysis and estimates. There has been no real impact yet.

In the Mauritius case, agriculture has a great potential to affect the environment, economy and society positively. Accordingly, indicators used for policy assessment should capture the impacts in these dimensions. Broader well-being indicators should also be covered at this stage.

– volume of agricultural production (tonnes/year)
– food security for strategic commodities (per cent)
– share of agriculture in GDP (per cent)
– area of land under sugar cane (ha)
– area of land under food crops (ha)
– area of forest land (ha)
– employment in the agricultural sector (jobs/year)

d. Policy Monitoring and Evaluation

Policymaking requires continuous monitoring and evaluation of its impacts to make sure it is effective and efficient. Indicators used in this stage may be the same as in the policy assessment, the difference being the timing of the data. In policy assessment, impacts are estimated to predict potential influence, while in evaluation, impact data from the implementation will be used to evaluate the real impact. At the same time, monitoring and evaluation indicators may also be used to anticipate patterns and trends in policy impacts through the analysis of emerging and unexpected events.

8 Lessons Learned

This paper has presented a number of country examples to show a range of policy tools used for addressing major issues of particular concern to China: climate change, water security, air pollution, waste management, urban development and measuring green transition. From these examples, we highlight the following key lessons.

First, tool selection should be issue-driven. Although this paper was mandated to focus on the use of economic instruments, the examples show that most countries use a combination of tools to address an issue or different aspects of the same issue. Learning from the EU, South Korea has both stringent emission reduction targets for enterprises and an experimental emissions trading market. Australia has a water trading regime to deal with water use while issuing licences to deal with water pollution. In Germany, waste charges are levied on household waste but for producers, the government imposed the Extended Producer Responsibility system to deal with post-consumer products, which has the benefit of reducing the fiscal burden on the government. In Slovenia, the basis for vehicle taxes has been changed from sale prices to emission levels in order to achieve targeted effects on pollution.

Second, market-based reform is not always consistent with environmental and social objectives. In Mexico, energy reform, which does include the development of renewable energy is a major part of the country's climate change strategy. Opening up the energy market for competition is conducive to correcting the price distortion of energy products. Without prioritizing investment in renewable energy and energy efficiency, however, the energy reform could lead to the scaling up of fossil fuel extraction, production and consumption, outweighing the effects renewable energy development and energy efficiency improvement. In addition, without consulting with the communities potentially affected by explorative activities, energy reform could ignite protracted social conflicts.

Third, the cost of green transition should be equitably shared. In Germany, the feed-in-tariff has played a pivotal role in switching the country's energy supply towards renewables and has inspired other countries to do the same. But a salient issue is the higher electricity prices paid by German consumers as compared to large businesses. A contrary example is found in one of the components of Israel's water price reform (drought tax) targeted at large water users but with little effect on low and middle income households (whose basic needs are already addressed through a two-block pricing system). The tax had to be replaced by a price increase (in response to drought) that applies across the board.

Fourth, innovative measures can come from the consumer side. Denmark encourages cycling and non-motorised commuting – in particular in the capital city of Copenhagen with the ambition to be carbon neutral - by supporting the construction of a network of bicycle superhighways. Singapore is known for its Vehicle Quota System to control the vehicle population. In the Brazilian city of Curitiba, people get paid for taking the garbage to collection centres. Although this may appear as contradicting the "polluters pay" principle, it is economically more efficient than building collection centre everywhere. It also has the benefit of generating an income stream for the poor. In Paris, the government focused on providing an enabling infrastructure to encourage behaviour change, by reserving parking space for shared vehicles and by increasing the number of charging stations for electric cars near offices and homes. Israel uses varying prices to encourage the use of water with different quality (e.g. treated water for agriculture).

Fifth, some tools can contribute to multiple objectives. In Canada's British Columbia, the revenue neutral carbon tax – raising tax on carbon but reducing tax on income – has been effective in not only reducing carbon emissions, but also in improving the livelihoods of low income households. In South Africa, the Working for Water programme designed to deal with Invasive Alien Plants has successfully integrated the objectives of biodiversity conservation, water conservation and job creation. The most significant benefit from SO_2 trading in the U.S. has turned to be improved public health compared to reduced acid rain and deforestation. In Germany, recycling plus a land fill ban has not only reduced waste and GHG emissions, but also secured 25 per cent of the global market for close-cycle management technology. In Japan, the law on industrial waste has spurred the growth of industrial waste treatment businesses. In Canada, restoration and redevelopment of contaminated sites – with funding from the government - has contributed to the growth of GDP and jobs. In Brazil's Curitiba, integrated city planning, including the concentration of industrial area, development of public transport, increasing green space and improving the situations of slums, has contributed to poverty reduction and improved public health.

Sixth, strong institutional capacity and arrangements are indispensable. In South Korea, the government sets stringent emission targets after negotiations with the business sector. This requires a good knowledge of the business operations in relation to carbon emissions as well as the capacity to induce cooperation from the business sector. The mock trading pilot hosted by the Korean Power Exchange is also a prudent arrangement for building up the capacity to operationalise this new type of trading. In Brazil, the legislation on solid waste promotes shared responsibility along the value chain. It also relies on inter-ministerial cooperation and sectoral agreements. In the city of Curitiba, the key to sustainable urban planning is the establishment of IPPUC, which has both the technical competence and regulatory authority to design the location of industry, transform the slums, designate green space and plan for the development of public transport.

Seventh, measurement of green transition should consider not only environmental conditions, but also economic and social aspects. The Netherlands has piloted an application of the OECD green growth indicators framework, which covers environmental issues, health issues as well as economic policies and opportunities such as green jobs. Mauritius has tried UNEP's green economy indicators framework for its agriculture sector. The UNEP framework focuses on using existing indicators – including the major categories in the OECD framework - at the major stages of making green economy policies: issue identification, policy formulation, ex ante policy assessment and ex post policy evaluation. In UNEP's framework, although the initial issues triggering a green transition may well be environmental, policy interventions focus on economic instruments especially at the macroeconomic and sectoral levels in conjunction with other polices. And at the stage of policy assessment and evaluation, a broader spectrum than environmental issues is used for judging the strengths and weaknesses of different policy options.

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