



# GREENING MARKETS

## MARKET-BASED APPROACHES FOR ENVIRONMENTAL MANAGEMENT IN ASIA

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JULY 2021

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# Foreword

Asia has seen widespread transformation and growth, which has brought many economic benefits to the region, but at the cost of its natural environment. Countries are experiencing large-scale degradation of its air and water quality and generating massive amounts of waste, while becoming vulnerable to climate change impacts. While governments are responding in various ways, traditional regulations, such as standards, bans, and penalties, are limited in their ability to stimulate actions that effectively address the region's urgent environmental problems.

Alternative policy and economic approaches may be one solution to curb business-as-usual activities and impacts on the environment. There is a growing body of evidence suggesting that market-based approaches for environmental management can induce businesses, households, and individuals to reduce pollution and use resources efficiently through incentives, behavior changes, innovation, and raised public awareness of corporate environmental performance.

In the wake of the coronavirus disease (COVID-19) pandemic, we will need smart and sustainable strategies to drive action that will address the current crisis and build resilience to future shocks. While public funding and development assistance are prioritized for health care and social protection in the immediate term, the use of market-based mechanisms can generate domestic revenues and mobilize private sector investment toward a green and resilient recovery in the long term. We have an opportunity to build back better and invest in nature, not only to manage the causes of diseases like COVID-19, but also in our planet's health and wealth.

This report, *Greening Markets: Market-Based Approaches for Environmental Management in Asia*, looks at global and regional trends in air quality, water, and waste management and identifies opportunities where introducing and scaling up market-based policy instruments may help achieve environmental goals.

The report recommends governments to work closely with the private sector and civil society and take on a long-term, well-coordinated, flexible, and iterative approach to planning, designing, and adapting market-based policy reforms. As there is no one-size-fits-all instrument or policy mix that will apply across the region, governments will need to account for their specific environmental, social, and regulatory contexts, as well as design and implement effective economic instruments that are tailored to local needs.

The Asian Development Bank (ADB), through Strategy 2030, is taking action to enhance environmental sustainability through its investments and technical assistance to its developing member countries (DMCs). In particular, ADB is supporting DMCs to strengthen environmental governance by promoting the use of market-based instruments. Building a strong knowledge base is the first step toward achieving these goals. To this end, ADB recently launched a regional hub to promote knowledge-sharing and cooperation on domestic resource mobilization and international tax cooperation, which provides a prime opportunity to promote environmental taxes and other economic instruments.

I am pleased to introduce this report to governments, development partners, the private sector, and civil society in ADB DMCs. I sincerely hope that the knowledge, experiences, lessons learned, and recommendations presented here can inspire innovative thinking and collaboration to create green economies and achieve a more environmentally sustainable Asia and the Pacific.



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# Abbreviations

ADB	-	Asian Development Bank
ASEAN	-	Association of Southeast Asian Nations
BMHR	-	Batteries (Management and Handling) Rules
BOD	-	biochemical oxygen demand
CAC	-	command-and-control
CBD	-	central business district
CDM	-	Clean Development Mechanism
CNY	-	Chinese yuan
COD	-	chemical oxygen demand
DMC	-	developing member country
DRS	-	Deposit-Refund Scheme
EEA	-	European Environment Agency
EPR	-	Extended Producer Responsibility
ERP	-	Electronic Road Pricing
ETS	-	emissions trading system
FAO	-	Food and Agriculture Organization of the United Nations
FIT	-	feed-in tariff
GDP	-	gross domestic product
ICS	-	improved cookstove
IEA	-	International Energy Agency
IPO	-	initial public offering
Lao PDR	-	Lao People's Democratic Republic
LPG	-	liquefied petroleum gas
MBI	-	market-based instrument
MSW	-	municipal solid waste
NEV	-	new energy vehicles
NGO	-	nongovernment organization
NO <sub>2</sub>	-	nitrogen dioxide
NO <sub>x</sub>	-	nitrous oxide
OECD	-	Organisation for Economic Co-operation and Development
PAYT	-	pay-as-you-throw

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PES	-	payments for ecosystem services
PRC	-	People's Republic of China
PROPER	-	Program for Pollution Control Evaluation and Rating
SDG	-	Sustainable Development Goal
SO <sub>2</sub>	-	sulfur dioxide
UNEP	-	United Nations Environment Programme
WEEE	-	Waste Electrical and Electronic Equipment
WHO	-	World Health Organization

# Executive Summary

This report reviews past and ongoing applications of market-based instruments (MBIs) to address air quality, water, and waste management in Asia and provides recommendations for the use of MBIs for more efficient and effective environmental management.

Over the past 60 years, Asia has experienced rapid urbanization and industrialization, changing demographics, and increasing consumption and demand for resources. As a result, environmental quality in the region has been significantly degraded. Ambient air pollution is now widely recognized as a serious public health issue throughout the region. Increasing water scarcity and water pollution are threatening the safety and availability of water resources. A lack of sanitation and waste infrastructure poses health hazards and pollutes waterways. Inadequate solid waste collection and disposal threaten the region's freshwater and ecosystems.

The challenge faced by governments in the region is in identifying and implementing policies that are effective at improving environmental quality while sustaining development gains. Given the dynamic setting and changing economic conditions, such policies need to allow for flexibility, creating incentives for firms and individuals to make decisions that are beneficial for both environment and society.

Governments often respond with state investment and command and control (CAC) regulations that set specific standards for polluters or resource users, such as technology and performance standards, bans, and penalties for noncompliance. However, traditional regulatory approaches generally do not create incentives for changes in behavior or for finding innovative ways to reduce pollution. Thus, such policy interventions may not do enough to improve environmental impact or resource use.

MBIs are policy interventions that provide incentives for producers and consumers to change behavior, more efficiently use resources, and reduce their negative environmental impacts. MBIs seek to address the market failure of environmental externalities by internalizing the external cost of production or consumption activities on processes or products. MBIs also facilitate the creation of property rights and proxy markets for the use of environmental services.

MBIs have several appealing characteristics. They promote flexibility in finding solutions to improve resource use and environmental quality, as well as create incentives to minimize the costs of achieving environmental goals. MBIs also cultivate innovation, creating dynamic pressures that make implementing improvements for environmental sustainability cheaper over time. If properly designed and implemented, MBIs allow any amount of pollution reduction at the lowest cost to society, with the potential to facilitate even greater reductions in emissions compared to standards set by CAC regulations. Environmental taxes and tradable permit markets also create opportunities to raise government revenues. MBIs can improve decision-making by disclosing information about markets and raising people's awareness of the environmental impacts of their actions.

This report reviews opportunities in key sectors to scale up the use of MBIs to more efficiently address environmental impacts. These include MBIs to address (i) air pollution in the energy production, industrial, and transportation sectors as well as at the household level; (ii) water resources management and water quality, particularly in the agriculture sector; and (iii) waste management across the waste stream.

While not a comprehensive list, this report covers the following types of MBIs to address the aforementioned sectoral issues. Each of these examples relies on prices and incentives to change behaviors, improve cost efficiency, and better allocate and conserve scarce natural resources.

- **Pollution taxes, fees, and charges.** These place a per-unit monetary charge on emissions or waste to reduce the quantity generated and put polluters responsible for bearing the cost of their activities. They create incentives to reduce emissions and discharges from production, as well as from unsustainable consumption.
- **Water pricing.** Water pricing applies monetary charges associated with use of water services or resources, which creates incentives to reduce excessive water consumption. Water tariffs are commonly used to manage water use and demand, address equity concerns, and recover costs for the water utility when the long-run marginal cost exceeds the average total cost.
- **Tradable permits.** These are allocated to firms by a central authority to emit specific quantities of a pollutant within a given time period. A firm must have permits to cover all its emissions, and the total number of permits across all emitters is the “cap.” For a firm to increase its emissions, it must purchase additional permits from other firms, which must decrease its own emissions accordingly. This creates a market for pollution permits, or “cap-and-trade,” which creates flexibility for how and where pollution is reduced and ensures that emissions reduction can be done at the lowest possible cost.
- **Environmental subsidies.** These are financial support from governments for environment-friendly activities, such as pollution abatement and development and adoption of green technologies. Subsidies are also implemented to decrease consumer prices or support trade-exposed sectors by lowering costs for firms or households.
- **Removal of harmful subsidies.** The removal of harmful subsidies such as those for fossil fuels, is considered a stand-alone policy instrument to promote more environment-friendly actions or technologies.
- **Payments for ecosystem services.** Payments for ecosystem services (PES) capture the economic value of ecosystem services and create incentives for producers and consumers to pay for environmental conservation.
- **Information provision, labels, and voluntary agreements.** These are mechanisms to disclose information to consumers about the environmental performance, hazards, or risks of firms or products. Information is necessary for MBIs to function successfully and can mitigate transaction costs related to developing environmental markets.
- **Hybrid instruments.** These combine different types of MBIs to accomplish multiple objectives while sharing or lowering costs, such as shifting the burden of monitoring and administrative costs from regulators to polluters. Examples of hybrid policies include deposit-refund schemes (DRS), which applies a charge on the purchase of a product and provides a subsidy for its return (encouraging recycling and reducing waste), and combining an environmental tax with a rebate.

The success or failure of MBIs depends on a number of factors, including (i) the specific context and details of its implementation; (ii) political acceptance, including public understanding of the policy and perception of a policy’s fairness; (iii) distribution of a policy’s costs and benefits across groups, particularly on poor and vulnerable

populations; and (iv) impact on competitiveness and unemployment, particularly pollution-intensive, trade-exposed firms.

A few Asian economies have been leaders in the use of some types of MBIs, but there is ample room for broader application and upscaling. The People's Republic of China has perhaps the most wide-ranging use of MBIs for environmental management, employing taxes to control air pollution and subsidies to promote its renewable energy sector, while other countries have had more limited experience with implementing MBIs. Pollution taxes and subsidies have been used for air, water, and waste in more countries, while the use of hybrid instruments has been limited and only for waste management. The use of information provision, labels, and voluntary agreements are also not as widespread in Asia, though there are a few noteworthy examples. While most policy instruments have been implemented, monitored, and enforced by regulatory bodies, there are some cases where MBIs have been implemented by non-regulatory groups, such as nongovernment organizations.

There have been valuable experiences with MBIs in Asia that other countries can learn from and adapt to fit their particular circumstances. While there is no universal recipe for successfully implementing MBIs to address environmental problems, there are lessons from previous experiences that can help inform further deployment or upscaling.

- **The performance of market-based instruments has been affected by policy and regulatory frameworks favoring economic development over environmental protection.** Many developing member countries lack policy frameworks and institutional resources that would ensure compliance with environmental goals and requirements. As a result, the stringency and effectiveness of many MBIs for environmental management has been low. In most cases, environmental taxes have been set too low to incentivize polluters to make major reductions in emissions or have not been used widely for industrial establishments due to concerns over competitiveness.
- **Monitoring and enforcement are critical to the successful implementation of market-based instruments.** Prioritizing economic growth has also led to inadequate monitoring and enforcement of environmental requirements, stemming from capacity gaps, resource constraints, overlooking the aggregate environmental performance of small and medium-sized enterprises, lack of coordination between sectoral agencies, low engagement with the public on environmental compliance, and leniency toward polluters. Experience in some developing member countries suggests that monitoring and enforcement capabilities can be maximized and administrative costs minimized by targeting a limited group of polluters responsible for the largest share of pollution.
- **Pricing strategies need to be set high enough to incentivize behavior changes.** Many countries in Asia have seen more success improving air quality through pollution charges than they have addressing water pollution, due to the relatively higher taxes on fuel consumption compared to those to improve surface water quality.
- **The political system can affect the choice and performance of market-based instruments.** Governance and the multi-jurisdictional nature of environmental problems can affect enforcement of environmental regulations. Corruption and lack of coordination between national and local regulatory bodies can lead to lax enforcement of environmental regulations. Establishing strong institutions and coherent procedures for enforcement is needed to achieve the desired effectiveness of MBIs.
- **The nature of pollution sources and local economic structure plays a critical role in effective implementation.** The formality of economic sectors and the type of polluters can also affect the performance of MBIs. There is great potential for engaging small and medium-sized enterprises, which often operate informally and are collectively responsible for large amounts of industrial pollution and energy consumption, in environmental improvement.

There is no single MBI or combinations of MBIs that can be universally recommended for use throughout Asia. The application of MBIs differs greatly across sectors and countries. Specific environmental problems must inform and match the characteristics, institutional capacity, and political feasibility of proposed policy instruments. The study shows that efficient design and successful deployment of MBIs requires gradual learning through application; adaptation to local contexts; policy dialogue; long-term political commitment by governments; multi-sectoral coordination; and the use of multiple, complementary policy instruments.

There are a number of potential options for upscaling MBIs for air quality, water, and waste management. While MBIs may not be appropriate in every setting, there are many examples of “low-hanging fruit” where MBIs could complement and improve on existing regulations.

## Market-Based Approaches to Air Quality Management in Asia

Asia’s cities report some of the worst air pollution in the world, causing massive impacts to health and the environment. The sources of the region’s air pollution are primarily coal combustion for industry, energy, and residential heating, as well as household biomass burning, much of which fuel polluting and inefficient technologies. Due to population and economic growth, pollutant emissions have increased with rapid growth in energy demand to make up the majority of all particulate matter, exacerbated by the lack of stringent regulations on fuel quality, energy efficiency, and post-combustion treatment technologies. Furthermore, with growing urban populations, air pollution from transport is also rising in conjunction with increasing vehicle use, which includes older and more inefficient diesel-powered vehicles, and traffic congestion.

In response, while many governments in Asia have adopted CAC regulations, an increasing number have also begun adopting MBIs starting in the 1980s. The review puts forth the following findings:

- **Removing harmful subsidies and imposing targeted taxes have great potential for upscaling in Asia.** In many developing countries in the region, removing subsidies and applying taxes in a few concentrated points in the production chain and subsidy removal can influence fuel consumption and pollution throughout the economy, such as switching to cleaner energy sources, fuel-efficient vehicles, and cleaner cookstoves. Fuel taxes can be collected with little additional administrative burden, and revenues can compensate vulnerable populations. Removing subsidies must be done gradually and communicated clearly to be politically feasible. At the same time, viable alternatives, such as affordable clean energy, mass transit options, and cleaner heating and cooking technologies, must be available, in order to allow consumers and firms options for substitution away from fossil fuels.
- **Subsidies for clean energy and clean production are more politically feasible to implement and can incentivize shifts away from polluting energy sources.** Subsidies, for renewable energy and cleaner industrial production have been implemented successfully in several Asian economies and have attracted private investments. Policy makers need to develop a well-designed strategy for adopting subsidies, so as to phase them out when specific goals are achieved and avoid overcapacity, encourage electricity conservation, and redirect funds.
- **Getting the prices right is essential to achieving environmental goals.** Political opposition from interest groups and the public can lead to prices that are too low, making it difficult to successfully implement taxes, fees, and charges and to reduce pollution.
- **Compensation and information can increase application and tax rates.** Appropriate usage of revenues can make applying MBIs more politically feasible. Information on the use of revenues should be

shared with stakeholders to reduce resistance and convince them of its fairness. Hybrid instruments such as emissions tax refunds can help to increase taxes' stringency and strengthen incentives to innovate.

- **Lessons from experiences in Europe and the United States implementing market-based instruments for air pollution can be applied in Asia.** Asian experiences with MBIs compare well with early experiences in Europe and the United States, encountering similar challenges related to design and implementation of MBIs. Developing member countries can apply lessons learned from these global experiences, and attention should be given to facilitate learning among countries in the region.
- **Cap-and-trade schemes have potential but require strict caps and strong institutions.** Experience shows that tradable permit schemes leave the price of pollution control to the market, leading policy makers to set loose caps and thereby reducing the schemes' effectiveness. An aggressive cap is necessary to achieve a significant emissions reduction. To avoid low and volatile allowance prices in the long term, studies suggest either combining the emission cap with upper and lower limits on allowance prices or adjusting the emission cap over time in line with changes in technologies or political circumstances. If it is politically unfeasible to set appropriately stringent caps, pollution charges can be used.

The review yields the following recommendations for future applications of MBIs on air pollution:

- expanding emissions trading schemes, particularly learning from experiences in the People's Republic of China;
- adopting and gradually phasing out subsidies for renewable energy to reflect progress in mainstreaming cleaner energy options (including lower costs) and to free up public budgets for other competing needs;
- employing procurement auctions to identify least-cost clean energy suppliers and drive down energy prices closer to production costs, ensuring the availability of low-cost renewable energy, while also introducing policy instruments to encourage research and development as well as investments in transmission and storage;
- strengthening enforcement of existing environmental policies through clearer incentives for implementing bodies to participate and improve monitoring and enforcement efforts; and
- implementing fuel taxes and phasing out fossil fuel subsidies while shifting to subsidies for environment-friendly alternatives.

## Market-Based Approaches to Water Management in Asia

Rapid urbanization, economic growth, industrialization, and extensive agricultural development are placing pressures on Asia's water resources, quality, and infrastructure, which has increased water shortages and degraded water quality. High water withdrawals (especially groundwater exploitation), large scale irrigation, poor surface water quality, transferring water allocation across sectors, and ecosystem degradation are among the key challenges to water management in Asia.

The review puts forth the following findings, particularly around inefficient use of irrigation water, poor intersectoral allocation of water, poor surface water quality, and failure to protect and value ecosystems:

- **Water pricing may be effective though politically challenging.** Findings suggest that volumetric water pricing can lead to increases in efficiency and/or shifts to high-value or less water-intensive crops. Agricultural water pumping is energy-intensive, so pricing strategies could target energy as well as water use. However, the burden on lower income communities and subsequent impacts on food sufficiency and resource use make this approach more challenging to implement.

- **Functional markets and strong regulatory frameworks are needed for intersectoral water allocations.** For intersectoral and inter-regional water allocations to succeed property rights need to be well-defined, quantifiable, transferable, and accounting for water flows.
- **Effluent taxes can put a price on polluting discharges.** Effluent charges have been used successfully in a number of Asian countries to address and curb water pollution.
- **Nutrient taxes can address nonpoint source pollution of water from agriculture.** Because nonpoint pollution such as agricultural runoff is difficult to monitor, nutrient taxes may be a useful instrument to curb the use of polluting inputs, such as artificial fertilizers.
- **Tradable discharge permits require a strong regulatory framework to be effective.** While tradable permits for discharges may have higher political feasibility compared to environmental taxes due to its high market value, environmental effectiveness, and social benefits, they require strong monitoring and enforcement of environmental regulations to be effective in pollution abatement. Information asymmetries between regulators and market participants also make compliance difficult.
- **Incentives are needed to promote use of green infrastructure to reduce runoff, water pollution, and flooding.** Development, financial, and tax schemes can motivate developers, investors, and property owners to install green infrastructure, such as green roofs, rainwater harvesting facilities, and nature-based solutions for flood risk management.
- **Behavioral nudges can complement market-based instruments to influence decision-making on water use.** Psychological interventions to influence water users' behavior and decision-making can complement the use of MBIs. These can include social comparison messages, social norms, information provision on water quality, and education campaigns, among others. These may be most effective for either short-term use or where user households are connected to adequate sanitation infrastructure.
- **Creating and defining property rights is necessary for successful implementation of market-based instruments.** Rights need to be clearly defined to ensure that water is available for the environment and for downstream users. These rights can then be traded to be able to use water at market-determined prices. Water markets are beginning to be explored and piloted in Asia, based on the success of past experiences globally. However, they require sophisticated institutional arrangements to be successful.
- **A hybrid policy of information provision and effluent charges may achieve pollution reduction goals.** While taxes and charges may be perceived as politically unfeasible, experience suggests that a policy mix of effluent charges and information provision may be the way forward. Effluent charges incentivize innovation, while information provision can help correct information asymmetries with the public and make noncompliance costlier for polluters.
- **Scaling up payments for ecosystem services shows promise.** Payments for ecosystem services programs in Asia have shown promising results for environmental improvement, but they need the right conditions, including tenure rights, financing, and proper education and information dissemination, to also meet social equity and livelihood goals.

The review provides the following recommendations for future applications of MBIs to improve water management and reduce water pollution:

- employing behavioral nudges by using information to induce low-cost behavior changes in water use;
- designing and implementing hybrid policy instruments to address both water use and waste discharge, including both an effluent charge and an information provision policy, which can mitigate costs in policy implementation and create incentives for adopting environment-friendly technology and innovation; and
- expanding payments for ecosystem services schemes under the right enabling conditions, including political and financial support, strong institutional setup, and transparency and communication.

## Market-Based Approaches to Waste Management in Asia

Growing populations and consumption levels, unsustainable production processes, and inadequate management of solid waste from households and firms are contributing to negative impacts on human health and the environment. The amount of waste generated, particularly mismanaged plastic and electronic waste (e-waste), is growing fastest in Asia and entering the region's rivers and the world's oceans. Improving solid waste management is of crucial importance for the environmental and social welfare of the region and the global community. There has been increasing interest in using MBIs to lower regulatory burdens on municipalities and enable private sector support in waste management efforts; however, there are barriers stemming from a lack of enabling policies incorporating private sector actors and a range of waste streams. Informal and illegal solid waste disposal also pose a lost opportunity to extract value from waste.

Most Asian countries make use of some MBIs for waste management at some stage of the waste stream; many of these instruments address waste collection and processing, while fewer support upstream waste reduction. The review puts forth the following findings:

- **Well-designed waste management policies need to be integrated and cover the full waste stream.** Asian countries have employed both CAC regulations and MBIs, and waste management strategies may consider a mix of complementary economic instruments suited for particular contexts.
- **There is a critical need for better data and monitoring of waste levels, performance of policy tools, and environmental health in Asia.** This will help determine the efficacy of particular policies on a system-wide level and foster transparency and accountability.
- **Voluntary agreements and information-related campaigns are underutilized instruments for solid waste management in the region.** Transparency on firms' production processes can enable consumers to make informed purchasing decisions and help reduce waste.
- **Extended producer responsibility schemes are also underutilized in Asia.** Rising domestic consumption and waste generation in most Asian countries can be an opportunity for governments to hold producers accountable for wasteful production processes, provided there are complementary policies to incentivize producers to use recycled materials in products and employ more resource-efficient design and production processes.
- **The use of taxes, fees, and charges for waste collection can facilitate cost recovery for utilities as well as reduction of waste generation.** The design and implementation of these types of instruments may depend on the particular context. There is evidence to show that consumers are often willing to pay more for efficient waste management and the use of certain MBIs, such as pay-as-you-throw schemes, has led to an increase in waste sorting.
- **There is high potential for economic benefits from various sectors in the waste stream.** Technological improvements to increase resource efficiency can positively impact productivity and stimulate growth in other sectors. Waste beneficiation should be seen as a source of employment and value creation.
- **Integrating the informal sector into waste management frameworks may bring economic benefits and help achieve environmental and social goals.** More enterprises can benefit from policy incentives, reduce environmentally harmful waste extraction methods, and enjoy livelihood opportunities. There is also potential for implementing user charges as well as promoting recycling and composting, which can reduce costs for managing waste.

- **Deposit-refund schemes and information campaigns are important instruments for collecting and processing hazardous waste.** With the growing amount of e-waste, there are significant environmental risks posed by hazardous waste, which raises the need for well-designed DRS and public awareness to increase recycling.

The review provides the following recommendations for future applications of MBIs for waste management:

- introducing initiatives and policies such as pay-as-you-throw schemes and information campaigns that promote separation of waste at-source and enable markets for downstream waste beneficiation, while ensuring integration of public and private sector waste management programs;
- setting up micro-waste depots and creating incentives for informal sector waste pickers to collect general waste and deposit them in safer designated areas;
- scaling up complementary CAC regulations in critical waste streams to encourage faster consumer and producer behavior change;
- ensuring a suitable legal and regulatory framework for encouraging public-private partnerships, to facilitate the transition to using MBIs for waste;
- setting aspirational goals (such as zero-waste policies and transitioning to a circular economy) to help introduce and implement MBIs, which can catalyze action in both public and private sectors in the waste generation and beneficiation industries; and
- employing MBIs such as extended producer responsibility schemes and DRS to facilitate a transition to a circular economy, enabling more efficient use of resources and less waste generation.

## Next Steps for Policy Makers and Development Partners

As next steps, policy makers in Asia can create an environment that can enable successful implementation of MBIs by

- integrating environmental regulations into national plans, policies, and programs with clear performance indicators;
- establishing or strengthening institutions and developing standard procedures to improve monitoring and enforcement of environmental regulations; and
- working together with development partners, the private sector, nongovernment organizations, industry associations, and civil society to leverage resources, expertise, and capacity to strengthen regulatory systems for environmental management.

To this end, development partners are positioned to promote broader market-based approaches to environmental management in the region by:

- building the knowledge base on designing and implementing MBIs by supporting high-quality evaluations and providing platforms for knowledge sharing;
- supporting policy and regulatory reforms and institutional capacity building; and
- supporting assessments and piloting programs and technologies to scale up and strengthen implementation of MBIs.



# 1

# Introduction

## KEY MESSAGES

- The report assesses the suitability of selected market-based instruments (MBIs) to address environmental problems and offers recommendations for promoting their use, opportunities for scaling up application, and where new MBIs offer the greatest promise.
- Policies to protect and improve environmental quality are needed in much of developing Asia.
- Heightened levels of air pollution threaten urban and rural populations, water resources are increasingly stressed, water pollution threatens the drinking water of millions, and the waste stream created by increases in consumption is causing tremendous challenges.
- Command and control regulations have traditionally been employed to set specific standards for users, which do not typically create incentives to change behavior or developing innovative solutions to reduce pollution.
- MBIs are policies that use prices and incentives to achieve environmental goals at a lower cost than traditional regulations.
- MBIs can be cost-effective and flexible approaches to environmental protection. MBIs are also dynamic and create incentives to innovate to achieve the least cost for abatement.
- MBIs covered in this report include (i) taxes, fees, and charges; (ii) water pricing; (iii) tradable permits; (iv) environmental subsidies and removal of harmful subsidies; (v) payments for ecosystem services; (vi) disclosures, labels, and voluntary agreements; and (vii) hybrid policies.
- The success of an MBI hinges on its design, implementation, monitoring, and enforcement. It also depends on public perception and understanding, and distribution of costs and benefits (especially on vulnerable groups).

## Background

### **Market-based instruments provide incentives and flexibility to achieve environmental goals at a lower cost.**

The need for innovative and aggressive environmental policies in much of Asia is clear. Amid rapid urbanization, a changing population structure, and increased demand for resources, goods, and services, environmental quality has been significantly degraded. Furthermore, the energy and water intensity of manufacturing production in developing Asia—the amounts of water and energy used for a given amount of production—are double the world

average (BP 2019). The accelerating environmental degradation in Asia indicates the need for more interventions and the utilization of better policies (Gunatilake and De Guzman 2008). Although there has been increasing policy intervention in Asia, the implementation of environmental policies has often been ineffective and lacking a scientific basis (United Nations Environment Programme [UNEP] 2016).

Given the dynamic setting and changing economic conditions, there is a need for environmental policies that allow for flexibility, creating incentives for individuals and firms to make decisions that would be better for the environment and society as a whole. Previous experience suggests that relying too heavily on direct regulations is not optimal in some sectors, as firms cannot make use of technological and management opportunities to reduce pollution at a lower cost. Market-based approaches can provide producers with more flexibility to find least-cost methods to reduce pollution and use resources more efficiently, which can promote technological innovation. This flexibility also implies that the largest pollution reductions can be achieved by firms with the lowest costs (Gunatilake and De Guzman 2008).

Ideally, market-based policies would create incentives for more efficient use of natural resources, induce innovation, and internalize the costs of using natural resources. Compared to regulations controlling emissions, technologies, or production decisions directly, market-based instruments (MBIs) rely on markets and prices to steer decisions toward more efficient outcomes. Past experience indicates that successful application of MBIs is affected by (i) the characteristics of the policy instrument, (ii) the characteristics of the environmental problem, and (iii) local context, including technical requirements, and the economic, social, and political environment. As such, the suitability of MBIs is likely to vary with a country's characteristics.

### **This report focuses on MBIs for air pollution, water resources, and waste.**

There are many examples of MBIs, and the application of MBIs could take place in a variety of sectors and settings, including reducing airborne emissions, promoting renewable energy investments, combatting congestion in urban areas, or better allocating scarce natural resources (including forests, fisheries, or water). The report focuses on three key areas—air pollution, managing water resources, and waste management—but the general themes developed in this report could easily be extended to other sectors or environmental problems.

## **Air Quality**

Air pollution is a leading cause of illness and death in Asia's growing cities and rural areas. Ambient air pollution results from electricity generation, industrial production, motorized transport, and agricultural practices such as straw burning. Indoor pollution is associated with burning solid fuels such as dung, charcoal, and wood for cooking and heating (Health Effects Institute 2018). Air pollution is a significant concern throughout much of developing Asia, and it will remain a challenge as rapid urbanization and economic growth will increase the demand for energy and motor vehicle ownership. Moreover, while this report focuses on airborne pollutants directly harmful to human health (e.g., particulate matter), air pollution and climate change are closely linked, since major sources of carbon dioxide emissions and air pollutants are the same.

## **Water Resources**

Asia's freshwater resources are being degraded by excessive groundwater extraction and surface water use as well as pollution from waste generated by households and industry. Increasing water use in the agriculture, industry, and urban sectors will place greater pressure on limited water supply. The term "water management" covers a broad spectrum of water-related issues including degradation of water resources through pollution or overuse, efficiency of water use, allocation between competing uses, and failure to protect and value ecosystems.

## Waste Management

Increased waste generation has been driven by rapidly rising urbanization and economic development. Uncontrolled dumping into waterways, unsustainable landfilling, and open burning of waste are still common disposal methods. Facilities are inadequate for complex waste streams, including electronic, food, construction and demolition, disaster, and plastic waste and litter. Levels of recycling and reuse are low and, like air pollution and water resources, waste generation will continue to be a challenge moving forward.

## Objective and Methodologies

The objective of this report is to assess the suitability of various selected market-based policy instruments to address environmental problems in the areas of air quality, water, and waste in Asia. The report also examines how MBIs can be improved, draws lessons based on global and Asian experiences, and makes recommendations for the future, to increase the efficiency of environmental policies in the face of economic growth and increasing pressure on natural resources.

The report is based on an analytical framework intended to synthesize and organize previous studies to provide insights to policy makers and help support choices when applying market-based approaches for environmental management. To enable a systematic analysis, a particular structure has been applied in the information gathering based on (i) the characteristics of the policy instrument, (ii) the characteristics of the environmental problem (polluting activity), and (iii) the context of the implementation in terms of technical and political requirements and conditions.

## Regional Stocktaking

The study focuses on MBIs implemented in selected countries in three regions: East Asia, South Asia, and Southeast Asia. The study picks up from and expands on previous studies led by the Asian Development Bank (ADB), which focuses on countries in these three regions. While there are documented experiences of the use of economic instruments for environmental management in other regions, countries in Central and West Asia as well as the Pacific were not included in the scope of this study.

As a first step, reports were compiled by experts covering the three focus regions and summarized efforts regarding the use of economic policy instruments to solve environmental problems related to air, water, and waste. The geographical delineation of the stocktaking reports was as follows:

- in East Asia, Mongolia and the People's Republic of China;
- in South Asia, Bangladesh, India, Nepal, and Sri Lanka; and
- in Southeast Asia, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Thailand, and Viet Nam.

For these countries, a careful review of the published scientific and gray literature was done to identify lessons learned from both successes and failures of the use of MBIs in the region.

## Scope

This report focuses mainly on state-led MBIs that require the steering of local governments. This is necessary for instruments that rely on existing markets, such as taxes, subsidies, and the provision of information. In other cases, the use of MBIs may require local governments to define or create property rights and markets; such policies include creating tradable credits for emissions control or resource management. As such, the report will not cover instruments implemented mainly by private initiatives without government intervention. Furthermore, the report focuses primarily on addressing pollution control and abatement and does not include discussion on instruments for managing natural capital, with the exception of payments for ecosystem services programs for water management.

## Systematic Reviews

A systematic approach was applied to identify and screen relevant peer-reviewed publications. Systematic reviews provide a basis for evidence-informed decision-making through a transparent, unbiased, and replicable process of searching for and synthesizing evidence in the literature (Bilotta, Milner, and Boyd 2014; Mallett et al. 2012; and Mulrow 1994). For this report, systematic reviews were applied on relevant policy and impact evaluations in the areas of air, water, and waste and related environmental impacts. More details on the methodology and results of the systematic reviews can be found in the Appendix.

## Case Studies

To provide concrete examples of experiences with MBIs, case studies were selected from the findings in the stocktaking reports and systematic reviews, which are presented as text boxes throughout the report. These case studies were chosen to illustrate some of the key concepts in each chapter.

# Overview of Policy Instruments for Environmental Management

Policy makers have two broad types of policy instruments for natural resource management and pollution control. They can use conventional regulatory approaches, or *command and control* (CAC), which set specific standards for polluters or resource-users. They can also use MBIs, which rely on market forces to incentivize changes in producer and consumer behavior and bring environmental improvements. The various kinds of policy instruments included in each category are listed in Table 1 and discussed briefly in this introduction. In the following sections, selected MBIs will be analyzed with respect to country-specific air quality, water, and waste policies.

**Table 1: A Simplified Taxonomy of Policy Instruments**

Type	Policy Instrument
<b>Command and Control</b>	Bans, technology standards, performance standards, and penalties for noncompliance
<b>Market-Based Instruments</b>	Pollution taxes, fees, or charges Water pricing Subsidies or subsidy reduction Tradable permits Hybrid policies such as deposit-refund schemes Payments for ecosystem services

Source: T. Sterner and J. Coria. 2012. *Policy Instruments for Environmental and Natural Resource Management*. New York: RFF Press.

## Command and Control Regulations

The two most common CAC regulations are technology standards (which require specific pollution control technologies or production processes) and performance standards that impose a limit to emissions or resource use.

Technology standards mandate the adoption of some technology, which is often sector-specific. Although a technology standard may reflect the best available technology at the time it is mandated, there could be advances in the control technology over time, and a technological standard would need to be updated to reflect these changes regularly. As such, it is possible to achieve the target level of pollution control or resource use through technology regulations, but this is unlikely to be achieved at the least cost. In addition, technological standards do not incentivize the development of new, more efficient technologies.

A performance standard regulates the quantities of pollution produced or resources used, but it gives firms flexibility in the choice of how the standard is achieved. For example, a performance standard may dictate the maximum energy intensity of production for a given sector. Performance standards may be appropriate when there is uncertainty about the costs or availability of alternative technologies, when monitoring costs are low, and when regulators want to achieve an environmental goal quickly and with certainty.

## Market-Based Instruments

In contrast to standards set out in the CAC regulations, MBIs allow for varied responses by different firms or households. The following section reviews the features, benefits, and drawbacks of some of the most commonly used MBIs.

### Cost-Effectiveness

MBIs can be cost-effective approaches to environmental protection and management, meaning that they are designed to achieve an environmental target at the lowest cost. In the case of pollution abatement, firms are granted flexibility to find the least-cost way to reduce pollution. To illustrate this point, it is useful to contrast MBIs and traditional regulations. For example, suppose two neighboring firms produce similar amounts of pollution. They may employ different technologies in the production process, which means that the cost of achieving a pollution reduction for one firm could be significantly higher than the other firm. A CAC emissions regulation may require each firm to reduce its pollution by an identical amount. This overall pollution reduction, as dictated, does not come at the least possible cost. On the other hand, an MBI could be designed to achieve the same overall pollution level. An MBI is designed to encourage firms with lower pollution reduction costs to reduce pollution more than firms with higher costs. Rather than applying the same pollution discharges among all firms, MBIs are typically designed to equalize the incremental amount that firms spend to reduce pollution (their marginal cost). However, this does not imply that the costs of the policy fall disproportionately on the firm with lower pollution reduction costs.

The flexibility of MBIs is critical, because the appropriate technology in one situation may be inappropriate in another if one wants to minimize the total costs of meeting an environmental target. The structure and variation in the firms' pollution reduction costs is, hence, an important determinant of the effectiveness of MBIs. In general, the more variation in technologies and costs among firms, the greater the gains from MBIs relative to traditional CAC regulations. In short, MBIs are more efficient because they rely on incentives rather than mandates.

### Dynamic Efficiency

MBIs rely on prices and markets to create incentives to achieve an environmental goal. As a result, MBIs create incentives for producers to incorporate pollution reduction into their supply chains and to innovate and continually find the least costly method of abatement. One criticism of CAC regulations is that firms are only

required to either reduce emissions to the regulated level or adopt a mandated technology (which can quickly become outdated). With market incentives, a firm reduces emissions as long as it is financially beneficial to do so.

### **Efficacy in Reaching Environmental Target**

If properly designed and implemented, MBIs can enable any desired level of pollution reduction to be achieved at the lowest possible overall cost to society. This is achieved through the creation of incentives for firms to reduce pollution. In addition, by giving polluters an incentive to go further and reduce pollution by more than what is mandated by environmental authorities, MBIs may lead to larger reductions of pollution compared to CAC regulations. However, the success of an MBI hinges on its design, implementation, monitoring, and enforcement.

## **Types of Market-Based Instruments**

This section describes the categories of MBIs considered in this report. For each category a brief discussion of “successful” attributes is provided. In the subsequent chapters, a more thorough review of MBIs is provided in the context of each environmental issue (air, water, and waste).

### **Pollution Taxes, Fees, and Charges**

Pollution is generated as a by-product of some other valuable economic activity, such as producing goods or services or through the consumption of some good or service. Examples include airborne pollution from smokestacks, vehicle exhaust, runoff from agricultural fields, or consumer waste. Pollution taxes change the “price” of pollution directly. In the absence of a policy intervention, the market price of a good or service may not reflect the true social cost of consuming that good or service. That is, there is a gap between the price a consumer pays and the marginal social cost of the consumption of that good or service—this gap is the marginal “external cost.” An ideal pollution tax is set so that the market price (inclusive of the tax) reflects the social cost of consuming that good or service.

Pollution taxes, fees, and charges place a per-unit monetary charge on emissions or waste to reduce the overall quantity generated. These are designed following the “polluter pays principle,” which loosely states that polluters should bear the cost of their activities. Examples include emissions taxes, wastewater discharge fees, and solid waste disposal fees. Although the names are often used interchangeably, there could be differences in how the revenues are collected and spent. Taxes are usually politically determined, and revenues from taxes go to a central treasury; charges are typically administrative and may be levied by sectoral agencies. In either case, the impact on incentives is the same.

Environmental taxes are meant to create an incentive to reduce the production and consumption of polluting inputs or products. An efficient tax would be set such that the marginal damage from pollution (the incremental harm caused by a unit of pollution) equals the marginal cost of reducing pollution (the incremental cost of preventing a unit of emission) (Organisation for Economic Co-operation and Development [OECD] 2010). The increased cost, equal to the level of the tax, creates an incentive to reduce the production and consumption of polluting inputs or products.

Emissions taxes have the advantage that the per-unit cost is predictable, and the policy does not introduce volatility in the per-unit cost of emissions reductions. For example, a quota on coal imports or production would drive up prices in possibly volatile and unpredictable ways, while a tax on emissions would not. The main drawback is that taxes cannot guarantee that a target reduction is achieved, because the reduction varies with the tax level.

Input or output taxes can act as an alternative to emissions taxes. In general, an MBI will be more efficient if applied closest to the point of environmental damage. However, when emissions monitoring is impossible, difficult, or costly, taxes may be levied on some input or output that is more easily monitored and a good indicator of (or proxy for) the pollution to be regulated.

Taxes on inputs or outputs are sometimes referred to as “presumptive taxes” because, in the absence of direct monitoring, a firm that uses a certain input or produces a certain output is presumed to be polluting (e.g., fuel taxes or taxes on pesticides). Because monitoring individual emissions is often impossible, particularly in developing countries, a presumptive tax could be used in place of a direct tax on pollution.

In practice, it can be difficult to identify precisely how large the tax rate should be. The informational requirements may be daunting (e.g., abatement costs, the environmental damage from pollution, geographical and time-varying conditions, the (ir)reversibility of the environmental challenge, and economic conditions of the society (OECD 2010). As such, the tax rate will rarely be set at the optimal level, yet it may still provide incentives to achieve the desired pollution reduction (European Environment Agency [EEA] 2000). Considerations of political feasibility and revenue raising also become critical when determining the tax rate (OECD 2010). In many cases, however, environmental taxes are not set high enough due to political or distributional concerns.

### **Water Pricing**

Water tariffs are monetary charges associated with the use of municipal water services or water resources. Similar in spirit to the emissions tax, these charges create an incentive to reduce excessive water consumption. Water tariffs are commonly used to achieve objectives such as cost recovery and water demand management, in addition to addressing equity concerns (Cornish et al. 2004 and Nauges and Whittington 2017). The design of water tariffs for municipal and irrigation use affects a large number of important issues, including inadequate municipal water and sewerage services, inefficient use of irrigation water, and an inefficient allocation of water resources across sectors. Challenging aspects of water pricing include (i) measuring water use and collecting payment, (ii) selecting appropriate price level and tariff structure that balances trade-offs between policy objectives, and (iii) finding the political will to increase water prices.

### **Tradable Permits**

Under a system of tradable permits, a central authority allocates a limited number of permits to discharge specific quantities of a pollutant in a given amount of time (e.g., one calendar year). A firm must have emissions permits to cover all of its emissions, and so the total permits across all emitters equals the “cap” set by the regulatory authority. To increase its emissions, a firm needs to purchase additional permits from another firm, which, in turn, must decrease its own emissions accordingly. By allowing firms to buy and sell permits, a market for pollution permits is created.

This type of emissions trading is commonly referred to as “cap-and-trade,” where a cap on total emissions is set and the total number of emissions permits is set equal to the cap. An emitting firm needs to hold one permit for every unit of pollution it emits. Allowing trade in these permits creates flexibility as to how and where pollution is reduced and can ensure that the desired amount of emissions reduction happens at the lowest possible cost. The market also puts a price on pollution (the cost of emitting one unit of the regulated pollutant is the market price of the permit).

The cost-effectiveness of tradable permits arises when producers have different costs of reducing emissions. It is the difference in costs that drives the incentive to buy and sell permits. A firm with high costs of reducing emissions has an incentive to purchase permits, and a low-cost firm has an incentive to make large pollution reductions and sell some of its permits.

The costs of reducing pollution are likely unknown to the regulator. Therefore, pollution taxes add a known quantity to the price of emissions while leaving the total amount of emission reduction uncertain. In contrast, a tradable permit system caps the total amount of emissions while leaving the costs of achieving that outcome uncertain.

There are some drawbacks to a cap-and-trade policy. The costs of the policy are unknown in advance. Transaction costs (e.g., the costs of facilitating trades) can also reduce the efficiency of a tradable permit system. This can be mitigated by facilitating trades through an online marketplace where buyers and sellers can exchange permits and learn about the market price of a permit. If emissions cause local damage (in contrast to global damage, such as the emissions of greenhouse gases), cap-and-trade could lead to areas with concentrated emissions.

The informational requirements of tradable emission permits involve the information needed for determining the appropriate quantity of permits in an emissions trading system and are similar to the informational requirements for setting an “optimal” pollution tax. The total emissions under an emissions trading system equals the total number of permits. The market permit price is inversely related to the number of permits; as more permits are available, the market value of a permit decreases.

### **Establishing Tradable Water Rights**

Tradable permits for water rights are an example of an MBI that requires creating and defining property rights. Water rights are intended to be traded and there require strong institutional frameworks. Secure rights are required for owners to invest in water rights and related infrastructure. Most water rights confer an entitlement that depends on the amount of water available or stored upstream. Water rights must also be clearly verifiable, such as through the installation of meters to measure water use, so as to ensure that water is available for downstream users and ecosystems.

### **Environmental Subsidies**

Subsidies are forms of government-supported financing for an activity. In the case of subsidizing actions or technologies, the payments are meant to incentivize environmentally friendly activities. For example, rather than charging a polluter for emissions, a subsidy may reward a polluter for reducing emissions. However, subsidies are relatively expensive, especially in emerging economies where public funds are allocated and prioritized for other urgent needs. There could also be unintended efficiency impacts; for example, a subsidy for an emissions reduction could encourage the entry (or delay the exit) of firms, which could lead to an inefficiently large number of polluting firms.

Compared to taxes, subsidies are generally more politically feasible to implement since they can be used as a means for politicians to support certain industries, regions, or households. Well-designed subsidies for pollution abatement can provide the same incentives as environmental taxes.

### **Reduction of Harmful Subsidies**

Subsidies are implemented to decrease consumer prices or support trade-exposed sectors by lowering the costs for firms or households. However, many subsidies may have unintended environmental consequences. Fossil fuel subsidies, for example, are widespread and have devastating impacts on ambient air pollution as well as climate change. As a result, subsidy reduction is often classified as a separate environmental policy instrument.

In the case of existing environmentally harmful subsidies, removal of the subsidy may have distributional effects that may need to be compensated for by the government, which can affect the regulatory burden. For instance, if energy prices rise due to an energy subsidy removal, the price of other goods and services may also rise due to

increased production costs caused by the higher energy prices. Poor and vulnerable groups may likely be affected more than other groups; therefore, governments need to consider some kind of compensation or monetary redistribution among groups (Flochel and Gooptu 2017).

Removal of subsidies may, however, be complicated and less politically feasible, even if motivated by a number of reasons, such as being environmentally harmful, inefficient, expensive, and socially inequitable (OECD 2005).

### **Payments for Ecosystem Services**

In the absence of an intervention, many environmental goods such as ecosystem services will be underprovided. To incentivize individuals and firms to take on costly conservation activities, consumers, producers, investors, and donors in some cases pay individuals or groups to protect ecosystems for a well-defined environmental service (Wunder 2007). Payments for ecosystem services allow the economic value of ecosystem services to be captured and to create incentives for conservation. Payments for ecosystem services schemes can be seen as an additional tool to protect water sources and used in conjunction with other measures such as pollution taxes (Defrance and Delvaux 2013).

### **Information Provision, Labels, and Voluntary Agreements**

In many cases, consumers and producers lack information on the costs of different actions or the relative contributions of individual firms to environmental problems. Firms have little incentive to disclose this information unless legally required, and taking voluntary action to improve environmental outcomes is costly and may put a firm at a competitive disadvantage.

Furthermore, all MBIs discussed in this chapter require information to function properly. One of the primary challenges of developing an environmental market, for example, is overcoming the problem of transaction costs. Providing information to market participants is the simplest and most effective way to do so.

Information disclosures provide individuals with information about the environmental performance of firms or information about environmental hazards or risks. Three common types are labeling, public disclosure, and rating or certification.

Another instrument that builds heavily on information disclosure is referred to as a voluntary agreement between environmental regulators and producers. Under a voluntary agreement, a firm agrees to invest or clean up according to a particular environmental standard. In exchange, the firm may receive benefits, such as subsidies, positive publicity, a good relationship with the environmental protection agency, or an expedited review for compliance with other environmental regulations.

Although some voluntary approaches may include mechanisms designed to stimulate diffusion of existing technologies, they generally provide weak incentives for innovation, particularly compared to the financial incentives created by a tax or a tradable emission permit scheme (OECD 2003). Furthermore, the efficacy of information provision, labels, and voluntary agreements depends on the responsiveness of consumers to information; if consumers do not place a high value on “greener” production practices, labeling may be ineffective at generating a pollution reduction.

There are different types of information instruments and depending on the type of instrument and its goal, there are different informational requirements. For instance, voluntary agreements and information disclosure by polluters do not require a high level of informational requirements for the regulator, as it is mainly the polluters that provide the information. However, if policy makers implement green labeling or certifications, they may need information to decide which products should be included in the labeling or certification (Government of the United States, Environmental Protection Agency 2004).

## Hybrid Policies

Some policy instruments are combinations of the other types of instruments, including combinations of CAC regulations and MBIs. An example is the deposit–refund system, which involves both a charge on a particular good and a subsidy for its return. The polluters end up paying a charge for not returning the good, while those who do return the good collect a refund and thus end up paying a lower cost or nothing. This instrument can be used to develop a recycling system. Deposit–refund schemes for beverage cans and bottles are classic examples.

A second example is a pollution tax paired with revenue redistribution. A pollution tax creates an incentive to decrease emissions but also generates revenues for the government. The revenues can be used in a variety of ways, including offsetting distributional impacts of the pollution tax through targeted redistribution, granting subsidies to promote investment in cleaner technologies, or funding investments in public transportation. Providing the public with information of how the pollution tax revenues are being spent is key for generating support by stakeholders.

The policy instruments discussed in this chapter can be combined in numerous ways to tackle an environmental problem. There are numerous issues involved in how instrument choices are made to construct “policy tool mixes” and how they evolve over time. Policies often have complex interaction effects, many of which are difficult to anticipate. The MBIs discussed here are typically not implemented in isolation. If there are pre-existing regulations or multiple objectives, multiple policies may be in place simultaneously.

Table 2 summarizes scenarios under which the use of different MBIs might or might not be the preferred approach.

**Table 2: The Use of Market-Based Instruments Under Alternative Scenarios**

Market-Based Instrument	May Be Preferred When...	May Not Be Advisable When...
<b>Emissions Taxes</b>	<ul style="list-style-type: none"> <li>Polluters have different costs of reducing emissions and there are several emissions-reducing technologies available</li> </ul>	<ul style="list-style-type: none"> <li>Regulators want to achieve a specific emissions reduction</li> <li>Polluters respond little to prices</li> <li>Monitoring emissions is expensive</li> </ul>
<b>Taxes on inputs and/or outputs</b>	<ul style="list-style-type: none"> <li>Monitoring of emissions is impossible, difficult, or costly</li> <li>Inputs and/or outputs are easily monitored and will serve as a proxy for emissions</li> </ul>	<ul style="list-style-type: none"> <li>Regulators want a certain reduction in emissions</li> <li>Use of inputs and/or outputs is a poor proxy for emissions</li> <li>Polluters respond little to prices of inputs and/or outputs</li> </ul>
<b>Water Pricing</b>	<ul style="list-style-type: none"> <li>It is possible to find the political will to set water prices that reflect the full cost of water supply</li> </ul>	<ul style="list-style-type: none"> <li>Property rights are not well-defined</li> <li>It is not costly or impractical to measure water use or to collect payments</li> <li>Demand does not respond to changes in water prices</li> </ul>
<b>Subsidies</b>	<ul style="list-style-type: none"> <li>Firms or individuals require additional financial support to achieve the desired outcome</li> <li>There is a concern about foreign competition from regions or countries with weaker regulation</li> </ul>	<ul style="list-style-type: none"> <li>The subsidy might encourage inefficient firms to stay in the industry</li> <li>There are better alternative uses of the public funds</li> <li>The cost of financing the subsidy is high</li> </ul>

*continued on next page*

Table 2 *continued*

Market-Based Instrument	May Be Preferred When...	May Not Be Advisable When...
<b>Tradable Emission Permits</b>	<ul style="list-style-type: none"> <li>When the policy makers want a certain reduction in emissions</li> </ul>	<ul style="list-style-type: none"> <li>The legal framework is not consistent with allocation of property rights</li> <li>Monitoring of emissions is expensive</li> <li>There is poor regulatory enforcement</li> <li>Markets are not competitive</li> </ul>
<b>Hybrid Policies</b> <b>Refunded emission taxes</b> <b>Deposit refunds</b>	<ul style="list-style-type: none"> <li>Refunding tax revenues could increase the political feasibility of taxes</li> <li>Waste disposal is difficult to monitor</li> <li>Clean-up costs for waste that ends in the environment are high</li> </ul>	<ul style="list-style-type: none"> <li>There are few polluters that can influence the size of the refund</li> <li>Because returning of objects for which the refund is paid is voluntary, the policy is not suitable for addressing very serious environmental hazards</li> </ul>
<b>Payments for ecosystem services</b>	<ul style="list-style-type: none"> <li>There is a good understanding of the processes and outcomes related to the supply and consumption of ecosystem services at a local level</li> </ul>	<ul style="list-style-type: none"> <li>Voluntary enrollment does not ensure sufficient levels of environmental protection</li> <li>Monitoring must be feasible since payments must be contingent upon continuous provision of the service</li> </ul>
<b>Information provision, labels, and voluntary agreements</b>	<ul style="list-style-type: none"> <li>Difficult to implement mandatory regulations because of negotiation costs and implementation lags.</li> </ul>	<ul style="list-style-type: none"> <li>Regulators want a certain reduction in emissions</li> <li>Firms' stakeholders do not react to information about the environmental performance of firms.</li> </ul>

Source: Asian Development Bank.

## Factors that Influence the Success or Failure of Market-Based Instruments

The success or failure of any given policy depends on the context as well as the details of its implementation. The following section describes the technical and political requirements that affect the choice of approach and their success, as well as the expected outcomes from their implementation (Table 3 offers an overview by type).

The public's perception of a policy's fairness, including its effect on income distribution, is also critically important to its political acceptance. Consider a policy that increases the price of fossil fuels. The stakeholders range from those with powerful interests such as oil producers to taxi drivers and poor rural households, each of whom will be impacted differently. While oil producers may benefit from such a policy, households will face (i) the direct cost of the fuel price increase if they buy fuel for household purposes or small business, (ii) the indirect costs or price increases of other goods (e.g., due to increases in transportation costs), (iii) potential benefits from the use of tax revenues, and (iv) benefits of environmental improvements (OECD 2006).

The distribution of costs and benefits across groups is a critical consideration for an MBI to be successful. Studies evaluating the distributional effects of taxes in developing countries have often found that the direct effect tends to be income progressive, meaning that the direct burden of environmental policies tend to fall most heavily (as a percentage of income) on higher-income groups. However, the overall distributional impact of a tax also depends on the use of government revenue.

**Table 3: Requirements and Strengths of Market-Based Instruments**

Market-Based Instrument	Requirements to Establish and Implement the Instrument	Strengths
<b>Pollution taxes, fees, or charges</b>	<ul style="list-style-type: none"> <li>Accurate monitoring data on pollution levels</li> <li>State capacity to enforce compliance</li> <li>Political acceptance of costs and distributional impacts</li> </ul>	<ul style="list-style-type: none"> <li>Can encourage the internalization of environmental costs leading to adoption of cleaner technologies</li> <li>Cost-recovery for utilities and government</li> </ul>
<b>Water pricing</b>	<ul style="list-style-type: none"> <li>Mechanisms to monitor water use and payments</li> <li>Accurate understanding of demand elasticities and distributional impacts to set tariffs</li> </ul>	<ul style="list-style-type: none"> <li>Increases the efficiency of the use of water resources</li> <li>Can send a signal to customers to use water wisely</li> </ul>
<b>Subsidies</b>	<ul style="list-style-type: none"> <li>Accurate monitoring data on pollution levels</li> <li>Information to facilitate efficient targeting</li> </ul>	<ul style="list-style-type: none"> <li>Political acceptability</li> <li>Can be effective in facilitating rapid transitions if well-targeted</li> </ul>
<b>Tradable permits</b>	<ul style="list-style-type: none"> <li>Data for initial allocations</li> <li>Accurate monitoring data on pollution levels</li> <li>Tracking system to record transactions</li> <li>Consistent legal frameworks</li> <li>State capacity to enforce compliance</li> </ul>	<ul style="list-style-type: none"> <li>Can encourage the internalization of environmental costs leading to adoption of cleaner technologies</li> <li>Can control over total level of pollution</li> </ul>
<b>Hybrid policies</b>	<ul style="list-style-type: none"> <li>Accurate understanding of demand elasticities to set front-end charges (deposit) and refunds payable when quantities are turned in for recycling</li> <li>Payment system to facilitate deposit-returns</li> </ul>	<ul style="list-style-type: none"> <li>Little need for monitoring when voluntary</li> <li>Low legal, institutional, and political barriers</li> </ul>
<b>Payments for ecosystem services</b>	<ul style="list-style-type: none"> <li>Identification of baseline pollution levels to assess additionality</li> <li>Monitoring provision of service</li> </ul>	<ul style="list-style-type: none"> <li>Flexibility of application</li> <li>Potential for poverty alleviation</li> </ul>
<b>Information provision, labels, and voluntary agreements</b>	<ul style="list-style-type: none"> <li>Reliable and current data on compliance with market-based instruments made available to the public</li> </ul>	<ul style="list-style-type: none"> <li>Enhance compliance with market-based instruments</li> <li>Low legal, institutional, and political barriers</li> </ul>

Source: Asian Development Bank.

Environmental benefits are often pro-poor in developing countries, because poor rural households depend heavily on natural resources, and poor urban households are greatly affected by pollution. However, while the costs of MBIs may be felt immediately, the environmental benefits may only begin to appear gradually over time.

An additional concern for successful policy implementation involves competitiveness and unemployment (EEA 2016). For instance, environmental taxes are often thought to increase domestic production costs, which would consequently decrease the competitiveness of exports and make imports more competitive. However, empirical evidence has shown that implementing ambitious environmental policies often has little impact on competitiveness, trade, and employment (e.g., Dechezleprêtre and Sato 2017).

Political acceptance is also stronger when there is a wider public understanding of environmental problems and their impacts. This could be achieved through information campaigns and a gradual implementation of taxes (OECD 2006). Environmental taxes also encourage consumers to adopt less environmentally damaging behaviors or use eco-friendly options, which, in turn, encourage firms to shift toward cleaner production technologies (OECD 2001).

For an MBI to be politically tractable, policy makers must consider the impact of MBIs on vulnerable groups, such as low-income households, as well as on pollution-intensive, trade-exposed firms. Lower tax rates or exemptions can be implemented to minimize impacts on such groups. Alternatively, the revenues from an environmental tax could be used to help those who are most adversely affected. For instance, environmental tax revenues could be used to reduce other taxes or subsidize public goods and services, such as mass transit. Shifting the tax burden from labor to environmental objectives may also contribute to higher employment, further investment, and a more efficient economy. This could also offset competitiveness and equity issues (EEA 2000). Revenues could also be redistributed to the poorest households through unconditional direct cash transfers, which could more than offset the adverse impact of the policy change for poor households and help generate political support among the population.

In the following chapters, the use and opportunities for effectively applying MBIs in Asia to address problems related to air quality, water resources management, and waste management will be reviewed in detail.

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# 2

## Market-Based Approaches to Air Pollution in Asia

### KEY MESSAGES

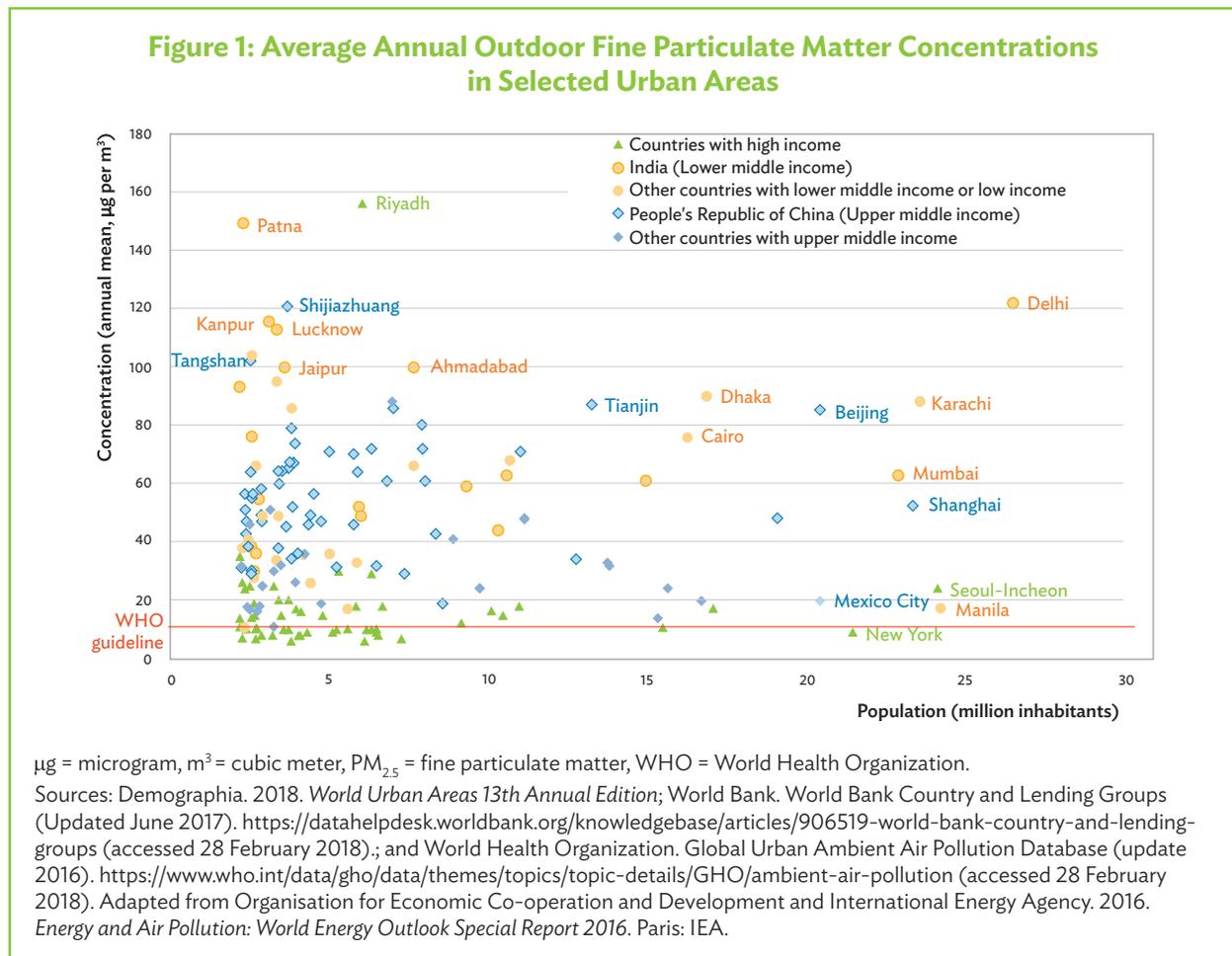
- Each year, around 4 million people in Asia die prematurely from illnesses caused by breathing polluted air, primarily from energy production, industry, and transport.
- Indoor air pollution from cooking and heating fuel is also a major concern, particularly among poor households.
- Many countries in Asia have adopted both command and control (CAC) regulations and market-based instruments (MBIs) to combat air pollution.
- Four common types of MBIs to address air pollution are (i) taxes, fees, or charges; (ii) green subsidies, and reform of harmful subsidies; (iii) tradable permits; and (iv) information provision and voluntary agreements.
- Taxes and charges on pollution can deliver an environmental outcome at a lower cost than CAC regulations and can be an effective alternative in areas where pollution monitoring and enforcement capacity are weak.
- Taxes are most efficient if targeting pollution itself, but targeting a proxy (such as polluting input) is also effective.
- The “right” tax level is critical to the policy’s effectiveness.
- To mitigate the overuse of private vehicles, setting prices wherein motorists perceive the marginal social costs of their transport decisions is essential.
- Subsidies can be effective at inducing technological adoption but must only be planned and used in the short run to induce large behavior changes and minimize incentives for corruption.
- Removing fossil fuel subsidies can free up revenue to compensate those affected by higher fuel prices and have also seen success through gradual phaseouts.
- Tradable permit schemes for carbon and other pollutants (“cap and trade”) put a limit on the total amount of emissions and allow firms to trade the “right” to emit but require advanced institutions to be properly implemented.
- Information, transparent and appropriate use of revenues, and complementary and hybrid instruments can make the use of MBIs feasible.

## Sources of Air Pollution in Asia

### Air pollution comes from energy production, industry, transport, and household fuel use.

Each year, 4 million people in Asia die prematurely from illnesses caused by breathing polluted air, and fine particulate matter (PM<sub>2.5</sub>) is considered the greatest threat to human health (Lelieveld et al. 2015; United Nations Environment Programme [UNEP] 2018; and Yang et al. 2013). The causes and sources of air pollution vary by location and season. In the People's Republic of China (PRC), for example, coal-burning for energy, industry, residential heating is the largest contributor to air pollution and made up 40% of PM<sub>2.5</sub> concentrations in 2013, while solid fuel combustion of both coal and biomass in households is responsible for 19% of the mortality attributable to ambient PM<sub>2.5</sub>. In India, residential biomass burning accounted for about 25% of PM<sub>2.5</sub>-attributable deaths in 2015 and is the largest individual contributor to air pollution, while coal combustion from industrial sources and thermal power plants is responsible for 15.5% (Global Burden of Disease-Major Air Pollution Sources Working Group 2018). Biomass burning from deforestation and slash-and-burn land clearing is responsible for widespread PM<sub>2.5</sub> emissions in Southeast Asia and is the second-biggest contributor to greenhouse gas emissions after carbon dioxide (Jacobson 2001; Karthik et al. 2017; and Wentzel et al. 2003).

India and the PRC are home to some of the most polluted cities in the world (Figure 1). The average annual exposure to fine particulate matter in cities like New Delhi, Patna, and Ahmadabad in India and Shijiazhuang and Tangshan in the PRC are more than 10 times higher than the World Health Organization (WHO) guideline of an annual mean of 10 micrograms per cubic meter (µg/m<sup>3</sup>).



While average annual exposure to fine particulates is lower in Southeast Asia than in East Asia and South Asia, enforcement of regulations is still limited, and concentration limits are higher than WHO guidelines. Average fine particulate concentrations in Southeast Asia are shown in Table 4, where it can be seen that Cambodia, the Lao People's Democratic Republic (Lao PDR), and Viet Nam had the highest levels of PM<sub>2.5</sub>.

**Table 4: Environmental Indicators in Asian Countries**

Country	Indicator				
	Access to Clean Fuels or Technologies for Cooking (% population)	Electricity Production from Coal Sources (% total)	CO <sub>2</sub> emissions (metric tons per capita 2014)	PM <sub>2.5</sub> mean annual exposure (µg/m <sup>3</sup> in 2015)	% Population exposed to levels exceeding WHO PM <sub>2.5</sub> guideline
<b>East Asia</b>					
Mongolia	32.0	92.0	7.1	42.5	92
PRC	57.0	73.0	7.5	59.1	100
<b>Southeast Asia</b>					
Cambodia	13.0	28.0	0.4	29.0	100
Indonesia	57.0	53.0	1.8	15.0	89
Lao PDR	4.6	...	0.3	33.0	100
Malaysia	100.0	38.0	8.0	16.0	87
Philippines	45.0	43.0	1.1	23.0	100
Thailand	76.0	22.0	4.6	26.0	100
Viet Nam	51.0	24.0	1.8	28.0	100
<b>South Asia</b>					
Bangladesh	10.0	2.0	0.5	89.0	100
Bhutan	68.0	...	1.3	56.0	100
India	34.0	75.0	1.7	74.0	100
Nepal	26.0	0.0	0.3	75.0	100
Pakistan	45.0	0.2	0.9	65.0	100
Sri Lanka	19.0	26.0	0.9	30.0	100
<b>Developed Countries</b>					
OECD	98.0	32.0	9.5	15.0	66

... = no data available, CO<sub>2</sub> = carbon dioxide, Lao PDR = Lao People's Democratic Republic, m<sup>3</sup> = cubic meter, mg = milligram, OECD = Organisation for Economic Co-operation and Development, PM<sub>2.5</sub> = fine particulate matter, PRC = People's Republic of China, WHO = World Health Organization.

Source: World Bank. World Development Indicators. <https://databank.worldbank.org/source/world-development-indicators> (accessed 28 February 2018).

Indoor air pollution is a killer in poor households, both in rural areas and in urban slums. Particulate matter is released due to cooking with biomass (wood, charcoal, and dung), heating with biomass and coal, and kerosene lighting. In Southeast Asia, for instance, more than 45% of the population has no access to clean cookstoves (Organisation for Economic Co-operation and Development [OECD] and International Energy Agency [IEA] 2016). In 2016, 43% of India's population and 30% of the PRC's population were exposed to household air pollution from solid fuel burning (Health Effects Institute 2018). In urban and wealthier areas, the use of cleaner fuels such as liquefied petroleum gas (LPG) is more common. However, poor households generally cannot afford cleaner fuels, even in urban areas where these are more readily available.

Pollutant emissions have increased alongside growth in energy demand. While partly due to population and economic growth, it can also be attributed to the lack of stringent regulations related to fuel quality, energy efficiency, and post-combustion treatment technologies. Indeed, the energy sector accounts for a very high proportion of some key pollutants: sulfur dioxide (SO<sub>2</sub>) and nitrous oxide (NO<sub>x</sub>) emissions are almost entirely attributable to energy production and use, as well as make up around 85% of particulate matter (OECD and IEA 2016).

### **Pollution is affected by technology and fuel choices.**

India is expected to become the most dynamic country affecting global energy demand. India is the third most energy-consuming country globally. With continued economic growth forecasted for the country, the scope for rapid expansion in India's energy consumption is clear. Furthermore, given the importance of coal (with a total energy demand of 44%), oil (25%), and biomass (13%) in India's current energy mix, there is a risk that the country's air quality may worsen (IEA 2021).

Power systems differ across Southeast Asia, but the region's power demand is projected to triple by 2040. Moreover, despite declines in global coal demand and shifts to clean and renewable energy sources, Southeast Asian economies like Indonesia, the Philippines, and Viet Nam have depended on coal-fired power plants to meet energy demand (IEA 2019). Even with major financiers reducing their coal investments, some coal plants already in the pipeline or under construction in the region are poised to proceed (Brock 2020 and Coca 2020).

In terms of industry, brick kilns across South Asia are major contributors to air pollution. Most of the bricks are fired in artisanal kilns that pump pollutants into the atmosphere, threatening the health of brick workers, nearby communities, and the wider population. As brick production expands alongside population growth, negative health impacts are likely rising throughout Asia. In 2013, the PRC was the top producer with an estimated annual output of 700 million to 800 million bricks. However, modern technologies with lower emissions rates are becoming more common across manufacturing in the PRC.

### **As urban populations grow, vehicle use increases.**

Internationally, transport accounts for the largest share of energy-related emissions of NO<sub>x</sub> (50%), followed by industry (26%), and power generation (14%), with the exception of the PRC, where industry accounts for the largest source of NO<sub>x</sub> (OECD and IEA 2016). This trend is reversing, though. The rapid growth in road transport emissions caused a 60% increase in total NO<sub>x</sub> emissions in the PRC from 2005, with car ownership increasing from 15 cars per 1,000 inhabitants in 2005 to nearly 100 cars per 1,000 inhabitants in 2016 (OECD and IEA 2016).

Air pollution from transport is rising with growing vehicle use, even with efforts to produce cleaner fuels and vehicles. Many in low- and middle-income Asian economies continue to use inefficient diesel-powered vehicles and two-stroke engines, while many areas lack adequate public transport networks. Asia also has the largest motorcycle fleet in the world, utilized by the expanding working class. Regular traffic congestion contributes to urban air pollution, since slower-moving traffic results in higher emissions per kilometer.

### **Indoor air pollution is caused by burning coal, charcoal, wood, dung, and kerosene.**

Over half of the global energy-related particulate matter emissions come from households, with Asia (India and the PRC, in particular) accounting for 80% of the global total. Residential particulate matter emissions primarily result from incomplete fuel combustion, particularly for cooking (bioenergy), heating (bioenergy and coal), and lighting (kerosene). In India, residential biomass burning is the largest individual contributor to ambient air pollution, responsible for around 25% of PM<sub>2.5</sub>-attributable deaths in 2015. In the PRC, it is the next greatest contributor to ambient PM<sub>2.5</sub>, with 19% of the mortality attributable to ambient PM<sub>2.5</sub> in 2013 (Global Burden of Disease-Major Air Pollution Sources Working Group 2018).

It is estimated that in 2013, exposure to ambient and indoor air pollution cost the world's economy around \$5.11 trillion in welfare losses caused by fatal illnesses. In terms of magnitude, welfare losses in South Asia caused mainly by indoor air pollution from cooking with solid fuels made up 7.4% of the regional gross domestic product (World Bank and Institute for Health Metrics and Evaluation 2016). In East Asia, welfare losses largely due to ambient air pollution from fine particulate matter were equivalent to 7.5% of the regional gross domestic product (World Bank and Institute for Health Metrics and Evaluation 2016).

## Review of Market-Based Instruments Addressing Air Pollution in Asia

This section provides an overview on the use of MBIs to address air pollution caused by energy production, industry, transport, and household fuel use in Asia. While deforestation is also known as a major cause of air pollution, this was beyond the scope of the study. A review of relevant MBIs to address transboundary haze, such as those for forestry management, is worth undertaking in future studies.

Many governments in Asia have adopted CAC regulations to address air pollution. Beginning in the 1980s, a growing number of economies in Asia started adopting and improving MBIs, as shown in Table 5. The next section will review the application of MBIs on three main sources of air pollution: energy production and industries, transport, and household heating and cooking. The four types of market-based instruments used to address these sectors in Asian economies include (i) taxes, fees, or charges; (ii) subsidies and subsidy reduction; (iii) tradable permits; and (iv) information provision, labels, and voluntary agreements.

**Table 5: Overview of Current Use of Market-Based Instruments for Air Pollution in Asia**

Market-Based Instrument	Energy Production and Industrial Pollution	Transport	Household Cooking and Heating
<b>Taxes, Fees, or Charges</b>	Philippines, PRC	Bangladesh, India, Lao PDR, Malaysia, Nepal, Philippines, PRC, Thailand, Viet Nam	
<b>Subsidies</b>	Bangladesh, India, Indonesia, Malaysia, Philippines, PRC, Thailand, Viet Nam	Malaysia, PRC, Thailand	Bangladesh, Cambodia, Indonesia, Lao PDR, Mongolia, Nepal, Viet Nam
<b>Tradable Permits</b>	India, PRC, Republic of Korea		
<b>Information Provision, Labels, and Voluntary Agreements</b>	India, Indonesia, Malaysia, Philippines, PRC, Thailand		

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Source: Asian Development Bank.

## Market-Based Instruments for Pollution from Energy Production and Industry

### **Market-based instruments can reduce pollution from point sources.**

MBIs are likely to work well at reducing pollution from large-scale sources such as energy plants and large industries. These are “point source” polluters, meaning that there are only a few large sources of pollution that are relatively easily monitored. For electricity production, sources of energy can be taxed to discourage its use (e.g., taxing coal) or subsidized to encourage its use (solar) according to their social cost. Energy and industrial production tend to be heterogeneous (varied) in their production methods, so some firms can reduce pollution more cheaply. This means there are likely efficiency gains from MBIs relative to CAC regulations.

### **Taxes, fees, and charges put a price on polluting activities.**

Taxes and subsidies are two ways of directly altering the market price of activities with environmental externalities: taxes increase the price of an activity and subsidies reduce the price. Reducing taxes for cleaner goods (such as less-polluting cars) and reducing subsidies for polluting goods (such as gasoline) are commonly used MBIs. Tax and subsidy levels need to be continuously adjusted to reflect changing and often conflicting goals. For example, policy makers may wish to create incentives for fewer and less-polluting vehicles in cities, while ensuring mobility for growing urban populations.

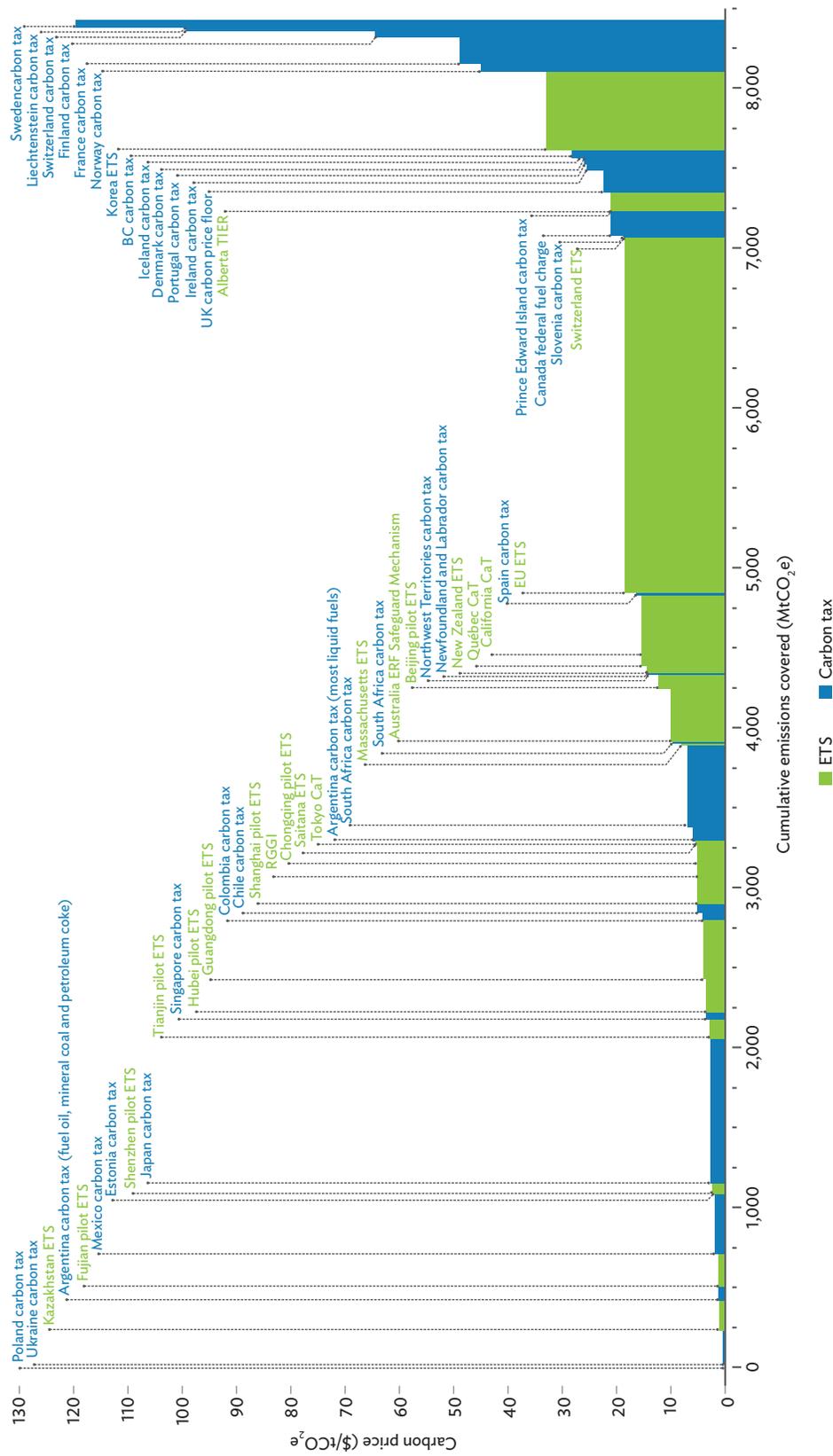
Taxes, charges, and reducing fossil fuel subsidies can deliver greater environmental outcomes than CAC regulations. The use of tax instruments has been more widely used in OECD countries than in developing countries in Asia. In Sweden, for instance, a tax on NO<sub>x</sub> significantly increased the adoption of abatement technology (OECD 2013). Similarly, carbon taxation (levied mainly on large industries) has led to significant reductions of emissions in several countries in Europe (European Environment Agency [EEA] 2000). Figure 2 shows the carbon prices and emissions coverage in 2020, and it demonstrates the high potential for carbon pricing in Asia.

### **Taxes have the potential to incentivize enforcement.**

In many developing countries, environmental regulations may be weakly or selectively enforced due to offsetting behavior by vested interests. For example, the enforcement of environmental regulations could deplete the tax base of local governments if the profitability of the regulated industry is affected by the regulation. Prior to 2018, when local environmental bureaus in the PRC were still responsible for collecting pollution charges, those charges reduced the taxable revenues of local industries, which reduced the tax base available for local governments. In response, local leaders often sheltered corporations from pollution charges (Ge et al. 2017). Under the pollution charge policy, revenues from the environmental tax are meant to go entirely to local governments, which creates an incentive for local enforcement. To safeguard the enforcement, this process has been accompanied by the centralization of emissions data management (which is now controlled and verified by upper level agencies) and by mandatory local implementation of national control policies (Jin, Andersson, and Zhang 2016).

In contexts with weak pollution monitoring and enforcement capacity, taxes on inputs or outputs can be an effective alternative to reduce pollution. One attractive feature of fuel taxes is that they can be collected with little additional administrative burden. Fuel taxes can also have a significant impact on emissions, especially when combustion of the fuel is highly correlated with the pollutant of interest.

Figure 2: Carbon Price and Emissions Coverage of Implemented Carbon Pricing Initiatives



CAR = Clean Air Rule, CaT = cap-and-trade, ETS = Emissions Trading System, GGIRCA = Greenhouse Gas Industrial Reporting and Control Act, GHG = greenhouse gas, MtCO<sub>2</sub>e = Megaton of carbon dioxide equivalent, OBPS = Output-Based Pricing System, PSS = Performance Standards System, RGGI = Regional Greenhouse Gas Initiative, TIER = Technology Innovation and Emissions Reduction, UK = United Kingdom.

Note: The British GGIRCA, Canada federal OBPS, Kazakhstan ETS, Nova Scotia CaT, Newfoundland and Labrador PSS, Saskatchewan OBPS, and Washington CAR are not shown in this graph as price information is not available for those initiatives. The carbon tax rate applied in Argentina, Finland, Ireland, Mexico and Norway varies with the fossil fuel type and use. The carbon tax rate applied in Denmark and Iceland varies with the GHG type. The graph shows the average carbon tax rate weighted by the amount of emissions covered at the different tax rates in those jurisdictions.

Source: World Bank. 2020. *State and Trends of Carbon Pricing*. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/33809>.

**Getting the price right can be a long process.**

In 1979, pilot provinces in the PRC began imposing pollution charges on all emissions exceeding a regulatory standard. Since 2003, emissions charges have been levied on all emissions. However, the charges for SO<sub>2</sub> and NO<sub>x</sub> were much lower than the operational cost of reducing these pollutants, so companies found it cheaper to simply pay the charge (Zhu 2015). Pollution charge rates were increased from 2000 to 2015, but not enough to reduce emissions substantially.

Take the power industry in Shanghai as an example. In 2014, the pollution charge rate was CNY1.26 per kilogram (kg) for SO<sub>2</sub> and NO<sub>x</sub>, but the cost of these pollutants amounted to CNY8/kg for SO<sub>2</sub> and CNY9/kg for NO<sub>x</sub>. As a result, the industry's NO<sub>x</sub> emissions kept rising despite the increases in the pollution charge rate (Chen and Li 2017). Therefore, in 2014, the base charge was doubled, and the charge was significantly higher than if standards were exceeded. After the PRC began implementation of the Environmental Protection Tax Law in 2018, the pollution charge rates in Shanghai came closer to typical emissions reduction costs at CNY6.65/kg for SO<sub>2</sub> and CNY7.6/kg for NO<sub>x</sub> (Hu et al 2020).

**Pollution tax revenues can compensate vulnerable parts of society.**

Tax revenues can be directed to ensure that vulnerable populations are not overly burdened by the environmental policy. For example, a hybrid tax-subsidy could be used, or revenues could be used for directed investments. A two-part policy can be implemented, where taxes are placed on emissions, which creates an incentive to reduce pollution. The revenues are then refunded back to polluters, which can increase the political feasibility of the policy while still achieving the desired level of abatement. This may seem counterintuitive, but the tax creates an incentive to reduce emissions, while the subsidy (when distributed evenly) ensures that the regulated industry still maintains some level of profitability.

Hybrid policies to control air pollution are common in OECD countries but are not yet widely implemented in Asia. In OECD countries, about one-third of the environmental taxes have revenues that are earmarked for particular purposes such as improved infrastructure, recycling systems, or environmental purposes (OECD 2006). For example, in Sweden, the charge on NO<sub>x</sub> emissions from large combustion plants was first levied in 1992. The system sets a tax for every kilogram of NO<sub>x</sub> emitted from stationary combustion plants, and revenues from the charges are repaid to the taxpayers in proportion to the amount of useful energy they produce. As a result, the system incentivizes firms to reduce NO<sub>x</sub> emissions per unit of energy produced, with firms with low emissions benefiting the most, while those with high emissions pay the highest amount in taxes. This scheme has been very effective in reducing NO<sub>x</sub> emissions per unit of energy produced, with an estimated reduction of more than 50% between 1992 and 2010 (OECD 2013).

**Subsidies are common: they are generally more politically feasible to implement since they can be used as means to support certain industries.**

Subsidies for renewable energy and cleaner industrial production have been implemented in several Asian countries. Similarly, preferential tax rates operate similarly; like subsidies, they can reduce the price of cleaner energy sources. In many respects, subsidies to promote cleaner production have been very successful. For instance, costs of solar and wind power have fallen dramatically (International Renewable Energy Agency [IRENA] 2018). Another role for subsidies is to provide financing for small-scale electricity generation at the household or local level. For instance, subsidies for solar home systems offer the added benefit of providing rural electrification.

Phasing out subsidies for electricity consumption can send both households and business price signals to encourage conservation. Reducing or removing subsidies works best when done gradually, with communication and transparency, including clear messages about fairness in how the revenue saved will be used.

### **Subsidies can encourage generation of electricity from renewable sources.**

Subsidies for renewable electricity sources (including preferential tax rates) can provide incentives to shift away from dirty electricity generation. Since utilities are typically either publicly owned or heavily regulated, there is scope for governments to procure energy from a desired energy source. Procurement of renewable energy has been pursued in many countries, including in Asia, to reduce pollution in the energy sector by wholesale substitution of polluting energy sources. Procurement policies can take two basic forms: (i) a fixed price, such as a feed-in tariffs (FIT) or (ii) fixed quantities, which allow prices to be market determined. A classic fixed quantity policy is a reverse auction, where sellers bid below each other to provide electricity.

### **Feed-in tariffs have been common but reverse auctions are even more efficient.**

A fixed-rate FIT guarantees a predetermined uniform price that all energy suppliers receive for electricity generated, with no price competition. Setting the right subsidy rates can be challenging, as the actual cost of electricity production by clean energy sources is usually not disclosed by producers (IRENA 2017).

In contrast, reverse auctions (in which sellers bid for the prices at which they are willing to sell) introduce competition and push prices down toward production costs (Azuela et al. 2014, and IRENA 2018). In India, for example, the National Solar Mission implemented reverse auctions for 25-year fixed price contracts beginning in 2010. This has proved remarkably successful, with capacity growing from 30 megawatts (MW) in March 2011 (Government of India, Ministry of Power, Central Electricity Authority 2017) to 24,000 MW in June 2018, and prices are now at the lower end of the global range (Prateek 2018).

FIT schemes and other subsidies to renewable energy sources have been implemented in India, Indonesia, Malaysia, Nepal, the Philippines, the PRC, Sri Lanka, Thailand, and Viet Nam. For instance, the Government of India has set up FIT for wind, solar photovoltaic, solar thermal, wind, biogas, small-scale hydropower, and biomass energy, starting in 2013. Box 1 shows a brief case study on India's FIT schemes and reverse auctions for solar power. Table 6 discusses some other FIT experiences in Asia.

### **Subsidies, require plans for future phaseout.**

In 2017, the cost range of solar power generation in India and the PRC was within that of fossil fuel-fired electricity generation (IRENA 2018). However, the rapid decline in costs is confined to power generation, not storage or transmission. This results in the problem of curtailment, where a renewable energy plant does not produce at full capacity or produces power that is wasted. This occurs for several reasons. Wind and solar are intermittent sources, and storage technology is underdeveloped. Similarly, the spatial distribution of generation matters; while one region may have abundant sunshine or wind, it can be too expensive to transmit electricity to distant consumers. Therefore, incentives should be increasingly directed to research and development activities and infrastructure investments for storage and transmission (IRENA 2018).

### Box 1: Case Study on Feed-in Tariffs and Reverse Auctions for Solar Power in India

**Context and description of the problem and application.** India has a significant ability to use solar power for electricity generation but is still heavily dependent on non-renewable fuels, particularly coal. Under the Jawaharlal Nehru National Solar Mission launched in 2010, 100 gigawatts of electricity was to be produced using solar power by 2022. A nationwide feed-in tariff rule was designed to accelerate investment in renewable energy technologies. The tariff rate unleashed investment in solar rooftop plants in urban India, and eventually, renewable energy production reached the capacity limit (20%) set by the government (for example, in the state of Gujarat). However, rapid developments in solar technology and hence reduction in costs of production led to significant increases in the supply of power that the grid was not capable of handling. Against this backdrop, the government introduced an “auction” system under which renewable energy prosumers (producer and consumer) offer their bid to fix the tariff rate to sell their electricity. The system resulted in nearly a 50% drop in the tariff rate compared to that under the feed-in tariff system. Expansion of solar power has curbed air emissions, increased the supply of clean energy, and reduced the cost of electricity for consumers.

**Description of the policy instrument.** Two methods have been used to stimulate solar-based electricity generation: feed-in tariffs and auctions. Feed-in tariffs are payments by distribution companies to suppliers of solar power that are decided on by a regulatory body. The price is fixed, and suppliers decide the quantity they wish to supply. Under auctions, the government agency fixes the quantity of electricity to be bought and firms submit bids representing the price at which they are willing to supply solar-based power to the grid.

**Main findings related to criteria.** Both instruments involve a high level of knowledge. Tariffs require the regulator to calculate financial and operating costs, capacity utilization factors, and the duration of the tariff; auction design must contend with establishing a ceiling price, the total quantity to be auctioned, the number of suppliers, and the process of selecting suppliers. The regulatory burden under the auction is comparably lighter at the contract award stage, while higher at the contract execution stage, as suppliers may not build what they committed. Politically, the push toward renewables is gaining strength, but resistance from coal mining-dependent regions should be expected.

Experience has shown that auctions are much more cost-effective in the short run, resulting in prices that are roughly half of those under the tariff. Dynamically, however, auctions could be problematic; bidders may be too optimistic or aggressive in their bidding behavior, which may affect the ability of the suppliers to honor their commitments. In addition, the total capacity auctioned is often less than the capacity put up for sale. Tariffs are also unlikely to be efficient dynamically, as they require regulators to estimate not just the level of prices, but also the change in the level over time. Auctions are gaining in popularity across India, while tariffs have only worked in one state, thus suggesting auctions are better able to reach the environmental target. Possibly the biggest hurdle appears to be the financial health of the state distribution companies.

**Generalizable findings.** Auctions appear better than a regulator-designed tariff in discovering prices, subject to the caveat that a winner’s curse may operate. Dynamically, auctions avoid the lag induced by periodic tariff revisions under a regulator-designed tariff. Auctions almost certainly imply a lower informational burden on the regulators’ part. However, the burden shifts over to auction design and follow up after the auction is carried out, rather than carrying out periodic tariff revisions.

Politically, auctions are increasingly popular worldwide, as they are viewed to be relatively free from corruption or nepotism. Economically, solar is competitive with coal and natural gas. These factors will help auctions scale. The only hurdle politically appears to be how entrenched the suppliers of traditional fuels are in the political system.

Sources: Government of India, Ministry of Power, Central Electricity Authority. 2017. *Executive Summary: Power Sector (April 2017)*; International Renewable Energy Agency. 2013. *Renewable Energy Auctions in Developing Countries*. International Renewable Energy Agency. <https://www.irena.org/publications/2013/Jun/Renewable-Energy-Auctions-in-Developing-Countries>; and G. Shrimali et al. 2015. *Reaching India’s Renewable Energy Targets: Effective Project Allocation Mechanisms*. Climate Policy Initiative Report. <https://www.climatepolicyinitiative.org/publication/reaching-indias-renewable-energy-targets-effective-project-allocation-mechanisms/>.

**Table 6: Feed-in Tariffs—Selected Examples**

Country	Scheme Description	Findings
<b>Mongolia</b>	The 100,000 solar homes' program in 2004–2008 targeted nomadic households. Under a 2011 pilot, 21 urban households received 70% subsidies to install solar panels. Night-time electricity tariffs are reduced by 50% for households using renewable energy systems.	Previously, the nomadic households had no access to electricity. With the subsidy from the urban pilot, what would have taken 8–10 years to recover the cost (MNT7.5 million or \$5,350) was covered by energy savings.
<b>Nepal</b>	A FIT was offered to small hydropower plants and, in 2016, small solar plants. Hydro, solar, and bioenergy suppliers are exempt from corporate tax in the first 10 years, and the tax rate is halved in the subsequent 5 years. There is also assistance with capital costs.	The emphasis on small-scale renewable sources ties in with rural development, by providing lighting to increase work and study hours.
<b>PRC</b>	The first FIT for solar was introduced in 2011 and revised in 2013 to set different rates for three zones based on solar availability. Starting in 2013, wind and bioenergy was also subsidized. In 2016, a price floor was set for all three zones, then reduced in 2017 to a level lower than the 2011 rate and again differentiated by zone. Local governments are encouraged to develop their own subsidies and tax reductions.	The PRC became the world's largest producer of solar and wind power in 2015, but the subsidies took money from education and health. While the cost of producing solar dropped by 90% from 2009 to 2016, the subsidy was reduced by only 30%. Much of the power was "curtailed" (i.e., didn't reach consumers), because utilities prefer more predictable sources, storage technology and transmission infrastructure are undeveloped, and solar, and wind-poor provinces prefer building their own economies than importing from their neighbors. There are "ghost plants" and a black market for permits to build solar plants.
<b>Thailand</b>	The "adder" is a premium for renewable energy. It is available for 10 years for wind or solar and 7 years for other renewables. It is paid for as part of a fuel price volatility adjustment charged to consumers. As one of the oldest FIT schemes in Asia (introduced in 2006), it has been modified several times to address various challenges.	Favorable rates and a streamlined process led to infeasible and speculative applications (i.e., intended for resale). In response, a bid bond was required. Even so, solar applications exceeded targets. The premium to solar producers was reduced and a feasibility assessment process introduced. However, the assessment process has been criticized for subjectivity, delay, and lack of transparency.
<b>Viet Nam</b>	Incentives for renewable energy include (i) loan guarantees and loans below market rates; (ii) 15-year reduction in corporate income taxes and import duties exemption; (iii) FIT market price support and regulation; and (iv) other subsidies such as preferential access to public land.	Despite the introduction of the FIT in 2011, there were only four wind power plants in operation by 2017, which only accounted for about 0.4% of the country's total installed power capacity in 2015. The chief barrier is expensive upfront investment and limited financing channels, including high interest rates.

FIT = feed-in tariff, PRC = People's Republic of China.

Sources: Danish Energy Agency. 2017. *Viet Nam Energy Outlook Report 2017*. Danish Energy Agency. [https://ens.dk/sites/ens.dk/files/Globalcooperation/Official\\_docs/Vietnam/vietnam-energy-outlook-report-2017-eng.pdf](https://ens.dk/sites/ens.dk/files/Globalcooperation/Official_docs/Vietnam/vietnam-energy-outlook-report-2017-eng.pdf); N. Duc Luong. 2015. A Critical Review on Potential and Current Status of Wind Energy in Viet Nam. *Renewable and Sustainable Energy Reviews*. 43 (2015). pp. 440–448; O. Gippner et al. 2013. Microhydro Electrification and Climate Change Adaptation in Nepal: Socioeconomic Lessons from the Rural Energy Development Program (REDP). *Mitigation and Adaptation Strategies for Global Change*. 18(4); S. Tongsopit and C. Greacen. 2013. An Assessment of Thailand's Feed-In Tariff Program. *Renewable Energy*. 60. pp. 439–445; B. Tsevegjav. 2013. *Assessment of Urban Air Pollution Abatement Policy Implementation Vis-a-Vis the Role of Household Energy Use in Ger Areas of Mongolia*. University of Twente. <https://essay.utwente.nl/65055/>; W. Wang et al. 2016. The Key Elements Analysis of Guangdong & Shenzhen ETS & Tips for China National ETS Construction. *Chinese Journal of Population Resources and Environment*. 14 (4). pp. 282–291; and Winston & Strawn. 2014. *Feed-In Tariff Handbook for Asian Renewable Energy Systems*. <https://www.winston.com/images/content/9/1/v2/91697/Feed-In-Tariff-Handbook-for-Asian-Renewable-Energy-Systems.pdf>.

In most countries, establishing dedicated agencies to coordinate installations and roll out FITs has led to rapid growth in investments in corresponding technologies. However, differences in the design of FITs explain different rates of success. Concerns about the long-term political stability can create uncertainties for potential investors. In addition, other uncertainties or lack of information (about rates, periods of payment, and the digression rate—lowering the tariff over time) may all deter private investment.

### **Feed-in tariffs have led to new investments in renewable energy.**

FITs in Asia have been set high enough to attract private investment in diverse clean energy technologies. Nevertheless, existing programs could be improved. In addition to design improvements (which would enhance efficiency), FIT schemes targeted to households tend to mainly benefit higher income individuals, highlighting distributional concerns.

### **Other forms of subsidies can be used toward technology improvement.**

Other policy reforms and subsidies can be used to direct technological adaptation. Import duties can be reduced to promote the use of equipment to reduce pollution or to produce renewable energy. Low-cost loans can be made available to finance renewable energy projects. Microloans to rural households can make small-scale renewable energy feasible.

### **An effective tradable permits program requires a strict cap for total emissions, strong institutions, and a sufficient number of producers to create a “thick” market for permits.**

In Asia, only India, the PRC, and the Republic of Korea have implemented tradable permit schemes (Table 7). Box 2 gives an overview of the experience from piloting seven carbon trading schemes in the PRC. Lessons from tradable permits suggest that the following characteristics are important for success:

- An effective tradable permits program requires local enforcement.
- There could be efficiency gains from broadening the scope (either geographically or by adding sectors) of the regulated firms (Chen and Xu 2018).
- International evidence shows that permit markets operate most effectively when transactions costs are kept low (EEA 2005).
- Participants should understand the rules with certainty so that they can plan accordingly (Schmalensee and Stavins 2017).

Table 7: Tradable Permits

Country	Permit Scheme	Findings
<b>India</b>	<p>In several cities, central and state agencies set caps for NO<sub>x</sub>, SO<sub>x</sub>, and particulate matter, and allowed industries to self-regulate so that pollution does not exceed cap. Firms that emit excess can buy permits from firms that exceed targets.</p> <p>Under the Renewable Energy Certification program (introduced in 2011), energy providers are subject to renewable energy obligations, which can be traded through the energy exchange</p> <p>The Perform, Achieve and Trade (introduced in 2012) program was intended to enhance energy efficiency in energy-intensive industries. High energy users are identified and then can either reduce energy, buy tradable certificates, or pay a fine.</p>	<p>After implementation of the Renewable Energy Certification Program, trading from 2011 to 2012 indicated that industry confidence had built up. However, with limited players, low transaction volume, and infrequent trading, it resulted in a shallow market and hence the lack of an optimal price.</p> <p>Under the Perform, Achieve, and Trade program, the targets were not strict enough to create additional energy savings beyond those that would be expected due to rising energy prices. The fines may have been too low. On the positive side, the program helped raise awareness around energy efficiency. It is expected to build the required ecosystem for future success, provided the targets become more stringent with time and penalties are set high enough to incentivize producers to trade and implement energy conservation measures.</p>
<b>PRC</b>	<p>In 1994, local air pollutant emissions trading was started in six cities, targeting SO<sub>2</sub> and particulates. In 2002, SO<sub>2</sub> trading was expanded to more jurisdictions. In 2006, NO<sub>x</sub> trading and more regional programs were introduced. In 2011, the PRC started carbon cap and trade pilots, with plans to launch a national emissions trading program during the period from 2021 to 2025.</p>	<p>In the 1990s, isolated trades were done to meet local environmental regulations.</p> <p>During the period from 2001 to 2005, the total trading volume accounted for 1% of the planned emission reduction target. Overall, it was found that there is no mature market to set prices, and trading is thin. There is a lack of reliable data on actual emissions reduction. Where the cap is less restrictive, permits are less valuable. In provinces where permits are auctioned, the authorities keep the auction revenue and therefore have an incentive to set restrictive emission caps. Trading across provinces and expanding the participants could strengthen the markets.</p>
<b>Republic of Korea</b>	<p>The National Emissions Trading Scheme, introduced in 2015, is a cap-and-trade scheme to fulfill the country's carbon reduction pledge. The first phase enrolled over 500 firms, accounting for 68% of total emissions.</p>	<p>The ceiling seems to be above the total emissions of participating firms in 2014, although this may not take into account industrial growth in 2015. By 2016, 290 firms held surplus permits, and most of them banked their surplus permits. Other firms borrowed permits from the next year. The participating firms' total emissions in 2015 amounted to a level below the emissions cap.</p>

NO<sub>x</sub> = nitrous oxide, PRC = People's Republic of China, SO<sub>2</sub> = sulfur dioxide, SO<sub>x</sub> = sulfur oxide.

Sources: D. Bhandari and G. Shrimali. 2017. The Perform, Achieve and Trade Scheme in India: An Effectiveness Analysis. *Renewable and Sustainable Energy Reviews*. 81 (1). pp. 1286–1295.; International Carbon Action Partnership. 2018. *Korea Emissions Trading Scheme*. [https://icapcarbonaction.com/en/?option=com\\_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47](https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47); R. Kumar and A. Agarwala. 2013. A Sustainable Energy Efficiency Solution in Power Plant by Implementation of Perform, Achieve and Trade (PAT) Mechanism. *Open Journal of Energy Efficiency*. 2 (04). p. 154; Y. Liu. 2009. *SO2 Emission Trading System Construction in China* [in Chinese]. Sun Yat-sen University; S. Suk, S. Lee, and Y. S. Jeong. 2017. The Korean Emissions Trading Scheme: Business Perspectives on the Early Years of Operations. *Climate Policy*. 18 (6). pp. 715–728.; J. Tao J. and D. N.-Y. Mah. 2009. Between Market and State: Dilemmas of Environmental Governance in China's Sulphur Dioxide Emission Trading System. *Environment and Planning C: Government and Policy*. 27 (1). pp. 175–188.; and J. Wang et al. 2014. Payment for Initial Emission Allowance in China: Practice and Perspective [in Chinese]. *Environmental Protection*. 42 (14). pp. 22–25.

## Box 2. Case Study of the Seven Pilot Carbon Emissions Trading Schemes in the People's Republic of China

**Context and description of the problem and application.** At the United Nations Framework Convention on Climate Change 15th Conference of Parties in Copenhagen in 2009, the People's Republic of China (PRC) committed to reduce the country's carbon emissions per unit of gross domestic product by 40% to 45% by 2020 relative to 2005 levels. This climate target, together with other ambitious targets for energy conservation and pollution abatement, were incorporated into the PRC's Five-Year Plans and became domestically binding. These developments have likely provoked a power contest among government departments in the form of adopting innovative policy instruments. In this context, carbon emissions trading pilots were launched by the National Development and Reform Commission, which oversees the formulation and execution of national economic policies, including those concerning climate change.

**Description of policy instrument.** These carbon emission trading pilots can be characterized as a tradable performance standard scheme. Firms whose carbon emissions per unit of output are higher than a predetermined standard would be required to purchase additional emissions permits, while firms that emit at a lower rate than the standard would be eligible to generate and sell surplus emissions permits. These pilots were launched in 2013 in five major cities and two provinces. A number of carbon-intensive sectors were covered, such as electricity and heating, iron and steel, and cement making. Affected firms were jointly responsible for 36%–60% of the pilot regions' total carbon emissions.

**Evaluation.** The seven pilot markets in the PRC had different emissions reduction achievements. While the reductions in three provinces added up to 100 million tons in 2015, the Tianjin market did not show a significant reduction of carbon emissions. These pilot carbon markets are thin, featuring limited trading volume and transactions. The allowed volume of carbon emissions is probably too high, which has likely undermined the scarcity of emissions permits and is thus unable to induce adequate transactions and market prices. Further, the pilots perform better in provinces where emissions permits are allowed to be auctioned by authorities. Auction revenues may have incentivized local authorities to develop restrictive emissions caps and functional carbon markets.

**Lessons.** Restrictive emissions caps are vitally important for the performance and efficacy of emissions trading. This could be better achieved by allowing local government bodies to benefit from a functional emissions market, such as allowing them to auction off emissions permits and obtain the revenues.

Sources: China Carbon Trading Network. China Carbon Trading Network. <http://k.tanjiaoyi.com/> (accessed 30 June 2017); and Government of the People's Republic of China, National Development and Reform Commission. 2011. *Notice on Launching Pilots for Emissions Trading System*. Beijing.

Past experience in Asia suggests that the price signal in many cap-and-trade schemes has been low and volatile, (Borghesi and Montini 2016 and Narassimhan et al. 2017). This is largely due to caps that are not stringent enough, which induces a low permit price. This is not a design failure of tradable permits, but instead a lack of an ambitious environmental goal.

In addition, allowance price volatility and the absence of clear market price signals may induce firms to postpone investments in emissions-reducing technologies due to uncertainties on the expected returns (Borghesi and Montini 2016). To avoid low and volatile allowance prices in the future, research suggests pairing the emission cap with a price collar providing upper and lower limits on allowance prices (Borenstein et al. 2015). Another solution is to adjust the cap over time according to changes in technology or political circumstances (Hepburn 2006).

Other issues include the administrative costs, which tend to be higher for cap-and-trade than a tax (Narassimhan et al. 2017), and the institutional capabilities to create an operational market.

**Information provision, labels, and voluntary agreements have encouraged energy savings, but it is hard to separate their effects from other policies.**

Information provision, labels, and voluntary agreements are common types of instruments to control air pollution. Eco-labeling and information disclosure programs for air quality have been employed in India, the PRC, and Thailand, among others. However, there are few robust empirical studies that have isolated and identified the effects of these programs. Table 8 highlights a few programs.

**Table 8: Information Provision, Labeling, and Voluntary Agreements in the Energy and Industry Sectors**

Country	Program	Findings
India	The Eco-Mark program, established in 1991, encompasses voluntary labeling of products based on environmental criteria, using a cradle-to-grave approach (i.e., from raw material extraction to manufacturing to disposal).	Since 1991, many initiatives promoting energy conservation and energy efficiency have been implemented. India has made substantial progress in improving energy efficiency, as seen through reductions in energy intensity of GDP (energy used per unit of production).
	Another program includes labeling of consumer appliances for energy efficiency, along with minimum standards by the Bureau of Energy Efficiency.	Labeling of appliances results in significant reductions in energy use, although this does not account for rebound effects (increased use due to lower cost).
PRC	The Green Watch Program, started in 1999, rates firms' environmental performance, especially regarding discharge of SO <sub>2</sub> , NO <sub>x</sub> , and particulate matter, as well as recycling and pollution accidents.	The firms covered by the Green Watch Program demonstrated more improvement in their environmental performance than non-participating firms.
	The Green Securities Policy, introduced in 2008, requires listed companies in highly polluting industries to disclose notable environmental issues which may have significant impacts on stock prices. The policy includes a "Green IPO" requirement of environmental inspection before IPO or refinancing.	The Green Securities Policy relies on self-reporting. As a result, the quality and consistency of firms' disclosures vary greatly.

GDP = gross domestic product, IPO = initial public offering, NO<sub>x</sub> = nitrous oxide, PRC = People's Republic of China, SO<sub>2</sub> = sulfur dioxide.

Sources: P. Balachandra, D. Ravindranath, and N. H. Ravindranath. 2010. Energy Efficiency in India: Assessing the Policy Regimes and Their Impacts. *Energy Policy*. 38 (11). pp. 6428–6438; Y. Jin, H. Wang, and D. Wheeler. 2010. Environmental Performance Rating and Disclosure: An Empirical Investigation of China's Green Watch Program. *Policy Research Working Paper*. No. WPS 5420. World Bank Group. <http://documents.worldbank.org/curated/en/497841468011137982/pdf/WPS5420.pdf>; and H. Wang and D. Bernell. 2013. Environmental Disclosure in China's: An Examination of the Green Securities Policy. *The Journal of Environment & Development*. 22 (4). pp. 339–369.

## Market-Based Instrument Applications to Transportation

**Subsidies for fuel-efficient vehicles and mass transit should be used in place of fuel subsidies to meet urban transportation needs and address air pollution.**

Reducing or removing fuel subsidies is one of the most environmentally sound but politically sensitive MBIs. As the opposite of a fuel tax (which incorporates at least some environmental costs into the price of fuel), subsidies for petrol or diesel create an even wider gap between the price that a consumer faces and the social costs

of using fuel. Fuel subsidies also impose substantial burdens on public finances. Subsidy removal is generally progressive (that is, higher-income households benefit from the subsidy more than lower-income households). Subsidy reforms can free up revenue to compensate those affected by higher fuel prices, but it is essential to communicate plans for fair redistribution of the revenue that is saved. Phaseout plans have generally been more successful than the abrupt elimination of subsidies (Stern 2011).

### **Growing urban populations need both mass transit and fuel-efficient vehicles.**

The relative costs of driving and transit shape commuters' decisions. Drivers' choices are shaped by fuel taxes, tax exemptions and subsidies for cleaner vehicles and fuel, international fuel prices, and local resource endowments. In Beijing, for instance, parking fees have been increased, and congestion pricing has been introduced (United Nations Economic and Social Commission for Asia and the Pacific 2012). However, to induce substitution to mass transit, investment in that sector needs to match the increase in demand as people rely less on private vehicles.

### **Taxes, fees, and charges can influence both vehicle stock and congestion.**

Bangladesh's recent experience in the transport sector illustrates how prices can change behavior. The government has been trying to introduce the use of compressed natural gas in vehicles in Dhaka city since the 1980s. The country is petroleum-poor, but natural gas-rich. Despite being cheaper than imported petroleum, natural gas was not widely used by vehicles as it requires a more expensive type of engine. In 2006, the Government of Bangladesh, under pressure from the global fuel price hike, was forced to nearly double the retail price of imported petroleum overnight. This event led to a substantial increase in the adoption of compressed natural gas technology on existing vehicles in Dhaka, Chittagong, and Sylhet, where natural gas was readily available. In response, concentration levels of particulate matters in Dhaka peaked in 2006 and dropped in 2007 (Clean Air Initiative for Asian Cities 2008). Similarly, the country also experienced a surge in the use of electricity to run vehicles in Dhaka. The surge of electric vehicles forced the government to ban the use and import of electric bikes so that cities could cope with their shortages in electricity. Higher prices in fuel also led to a surge in import of gas generators for factories and for homes. The demand contributed to a crisis in gas supplies because the gas distribution system was not designed for such an increase. As such, in recent times, the government has been forced to ration the use of compressed natural gas in vehicles by raising prices. The government also stopped the import of gas generators to reduce pressure on its gas distribution systems.

### **Gradually increased taxes can upgrade vehicle fleets and affect demand in the long run.**

Registration taxes, circulation taxes, road use taxes, and congestion charges are common among OECD member states (EEA 2016). Taxation of motor vehicles and motor vehicle fuels are used in all OECD member states. Evaluations of the effects of fuel taxes in OECD countries show that the demand for energy, on average, is not very responsive to price increases in the short run but quite responsive in the long run. Over time, commuters respond to higher fuel prices by making different travel choices, buying more fuel-efficient cars, and so on. Thus, taxes on fuels and vehicles significantly reduce demand for energy and petrol, but not immediately (OECD 2006). Therefore, vehicle and fuel taxes should be implemented with a long-term perspective and with a gradual increase of the tax rates over time.

### **A tax on registration of new vehicles discourages car ownership—and newer cars.**

As Table 9 shows, vehicle purchases in the PRC have varied with the level of the registration tax. However, a new vehicle registration tax also encourages drivers to keep older vehicles, which emit more, making the net environmental effect is unclear.

**Table 9: Charges Related to Transport**

Country	Description	Findings
<b>India</b>	Certain state governments have imposed taxes on older vehicles, which are more polluting.	The tax rates are too small to have a noticeable impact on air pollution. In addition, no major city in India, except New Delhi, has invested much in public transit.
<b>Lao People's Democratic Republic</b>	Since 2002, user fees and charges have been imposed, including fuel surcharge, road and bridge tolls, international freight transit charges, fines, and penalties for excess loads.	Due to limitations in monitoring the use of revenues and the lack of an air quality monitoring system, the impacts of this type of instrument remain ambiguous.
<b>People's Republic of China (PRC)</b>	A passenger vehicle purchase tax was introduced in 1993. The tax rate has been periodically adjusted, and sales of passenger vehicles have tended to be higher when the tax rate was lower. The rate is lower for engines with small cylinder capacity, which are less polluting. The tax has been as low as 1% for engines with less than 1 liter capacity and as high as 40% for engines with more than 4 liter capacity.	In 2016, among all taxable automobiles in the PRC, 92% were vehicles with a cylinder capacity of less than 2 liters, accounting for 69% of this type of tax revenue.
<b>Philippines</b>	Taxes were imposed on leaded gasoline to improve air quality. The Government of the Philippines imposed a charge for the use of motor vehicles to reduce transport emissions. As part of its clean air control action plan, 7.5% of motor vehicle users' charges are allocated to a dedicated pollution control fund.	Leaded gasoline was phased out in Metro Manila by 2000 and nationwide by 2001.
<b>Thailand</b>	To phase out the two-stroke engine motorcycle, a higher excise tax was set for two-stroke in 2001.	Combined with more stringent motorcycle standards, differentiation in the excise tax may have been a factor in the phase out of two-stroke engine motorcycles since 2007.
<b>Viet Nam</b>	Environmental taxes on gasoline and oil have been imposed and gradually increased since 2012.	Implementation of environmental taxes has endured challenges, as a result of ambiguous guidelines and coordination issues.

Sources: V. V. Abrera. 2011. *The Use of Economic Instruments in Natural Resource Management in the Philippines*. Paper presented at the Forum-Workshop on Economic Instruments Applied in Environmental and Natural Resource Management in Southeast Asia. Bali, Indonesia. 26–28 September; BankBazaar. Rules & Regulations to Road Tax in India. <https://www.bankbazaar.com/driving-licence/rules-regulations-of-road-tax-india.html>; Government of the People's Republic of China (PRC), State Administration of Taxation. 2017. *Tax Reduction for Energy-Saving Vehicles Has Reached 1 Billion Yuan in the Past 5 Years* [in Chinese]. [http://www.gov.cn/xinwen/2017-07/26/content\\_5213377.htm](http://www.gov.cn/xinwen/2017-07/26/content_5213377.htm); Government of the PRC, State Council. 2000. *Interim Regulation of the People's Republic of China on vehicle purchase taxes* [in Chinese]; Government of the PRC, State Council. 1993. *Provisional Regulations on Consumption Taxes of the People's Republic of China 1993* [in Chinese]. <http://www.chinatax.gov.cn/chinatax/n360/c4423/content.html>; Government of the PRC, State Council. 2008. *Provisional Regulations on Consumption Taxes of the People's Republic of China 2009* [in Chinese]. [http://www.gov.cn/zwgk/2008-11/14/content\\_1149528.htm](http://www.gov.cn/zwgk/2008-11/14/content_1149528.htm); K. Khammounheuang. 2011. *The Use of Economic Instruments in Environmental Management in Lao PDR*. Paper presented at the Forum-Workshop on Economic Instruments Applied in Environmental and Natural Resource Management in Southeast Asia. Bali, Indonesia, 26–28 September.; and T. N. Nguyen. 2017. Using Economic Instruments for Urban Environment Management in Vietnam: Issues and Challenges. *China Report*. 53 (3). pp. 386–399; and P. Tularak. 2011. *The Use of Economic Instruments in Natural Resource Management in Thailand*. Paper presented at the Forum-Workshop on Economic Instruments Applied in Environmental and Natural Resource Management in Southeast Asia. Bali, Indonesia. 26–28 September.

### **Differentiated vehicle registration taxes contribute to a more efficient vehicle fleet.**

An alternative is a differentiated vehicle registration tax, with lower taxes for low-polluting vehicles. India, the PRC, and Thailand have used variations on this approach for both cars and motorcycles. The Government of Israel introduced a Green Tax scheme in 2009, which aimed to reduce all polluting vehicle emissions by adjusting the vehicle purchase tax according to car models' relative impacts from five pollutants (carbon monoxide, nitrogen oxides, hydrocarbons, particulate matter, and carbon dioxide). The tax reform successfully shifted demand toward less polluting vehicles. By 2014, around 83% of all car sales were in the lowest pollution grades, compared to 19% in 2009 (OECD 2016).

Hybrid policies could be used to encourage scrapping of older cars that are emitting more pollutants. Nevertheless, the effects of these policies depend heavily on the availability of alternative transportation methods and the tax rates.

### **Social values around motorcycle and car ownership affect implementation of MBIs.**

One historical challenge affecting implementation of MBIs to control emissions from road transportation in Asia is that motorcycle and car ownership are seen as desirable. In addition, there is a common view that automobile and motorcycle manufacturing are positive signs for a country's economic development (Asian Development Bank [ADB] 2012). For these reasons, past policies have artificially lowered the cost of vehicle ownership through very low registration taxes. Sales taxes for vehicles have been low compared to other goods, and policies have not required strict levels of vehicle maintenance or emissions standards. Such policies have led to high demand for private vehicle ownership, with consequent external impacts and eroding the viability of public transport. Setting prices that enable motorists to perceive the marginal social costs of their transport behaviors and decisions is thus essential to mitigate private vehicle use. However, this is often not viewed as politically viable.

### **Lack of political support has prevented implementation of comprehensive pricing to manage transport demand.**

Congestion fees for entering downtown areas in Europe have been proven to curb congestion and vehicle emissions and to spread out traffic volumes by encouraging vehicles to travel more during unpriced times and on unpriced roads (e.g., Foreman 2016 and Gibson and Carnovale 2015). So far, pricing schemes have been proposed and applied in many cities worldwide, such as in London, Milan, and Stockholm. Empirical evaluations of these experiences indicate that there are significant environmental effects (Coria et al. 2015).

The use of road pricing to reduce vehicle usage in Asia has been rare. A notable exception is Singapore, which is discussed in Box 3.

When the congestion pricing schemes in London, Singapore, and Stockholm were being planned, onboard satellite-based navigation systems such as global positioning system and Galileo were either non-existent or a luxury. They are now inexpensive and ubiquitous, and, therefore, offer a simpler, much less capital-intensive way of implementing far more comprehensive and sophisticated road pricing, since it is possible to price all roads and times differentially. Singapore will again be the global pioneer in this regard, with implementation scheduled in 2020 (Wilson 2016). The reduced capital requirement from new technology means that congestion pricing may become more feasible for developing Asia. The major barrier will be political. Aside from concerns about privacy, it will be necessary to use revenues in ways that are seen to be fair and equitable.

### Box 3: Case Study of the Singapore Congestion Charge

**Context and description of the problem and application.** Singapore is one of the most densely populated countries in the world and with an increasing number of vehicles, severe traffic congestion problems have emerged. With the aim of reducing traffic congestion in the Central Business District (CBD), Singapore implemented the Area Licensing Scheme in 1975, which was the first of its kind in the world. By requiring motorists to purchase a license to enter the CBD during peak hours, the Area Licensing Scheme substantially reduced congestion. However, the scheme became too cumbersome and was therefore updated to a fully automated Electronic Road Pricing (ERP) scheme in 1998. The main differences between the two schemes are that the ERP monitors motorists electronically and charges motorists per trip rather than per day. This makes the scheme less labor-intensive and more flexible in terms of differentiating the charges based on congestion levels.

**Description of policy instrument.** Congestion imposes external costs on all drivers, such as delayed travel times and air pollution. In the absence of efficient road pricing, road use will be underpriced and cause excessive demand. The ERP scheme is an economic instrument that directly affects the cost of using roads by charging motorists that enter the CBD. For this purpose, Singapore has installed electronic gantries encircling the CBD and vehicles have been fitted with dashboard-mounted devices from which charges are deducted as their vehicles pass the gantries. The ERP charges vary by location of the gantry, time of day, and vehicle type.

**Main findings related to criteria.** The ERP scheme in Singapore has a low regulatory burden due to almost non-existent billing errors and low labor-intensity. When designing an ERP, important aspects to consider are the geographical placement of the gantries and the decision of the charge rate. Information about traffic patterns, the geography of the city, and the elasticities of demand for road use are therefore essential. Singapore has been able to ensure political and public acceptance by, for example, gradually implementing the policies, developing a long-term transportation strategy, and substantially improving public transportation. The ERP charges are adjusted on a quarterly basis and vary by location, time, and vehicle type, which make it possible to relate the charge to the actual congestion level and, hence, increase the efficiency of the scheme. In terms of achieving its purpose, the ERP has reduced congestion in Singapore and traffic has become more spread out during the day. Singapore is planning to replace the current ERP scheme with a new Global Navigation Satellite System-based ERP scheme in 2020. This will allow more flexibility in managing traffic congestion and reduce the costs for maintaining the gantries.

**Generalizable findings.** A number of features of Singapore's road pricing scheme have contributed to its success and can be important lessons for future congestion charging schemes. To ensure public acceptance, it is important to address potential privacy concerns, improve public transportation, and ensure that the system is easy to use. Since vehicles do not have to slow down to pay the charge for entering the restricted zone, traffic can flow more smoothly and not cause congestion at the payment points. Cameras installed at the gantries provide objective proof of violations, which reduces disputes.

Sources: G. B. Christiansen. 2006. Road Pricing in Singapore after 30 Years. *Cato Journal*. 26 (1). pp. 71–88; Energy Foundation. 2014. *International Best Practices for Congestion Charge and Low Emissions Zone*. <https://www.efchina.org/Attachments/Report/reports-20140812-en/reports-20140812-en>; M. Goh. 2002. Congestion Management and Electronic Road Pricing in Singapore. *Journal of Transport Geography*. 10 (1). pp. 29–38; D. H. Lee and S. Palliyani. 2017. Sustainable Transport Policy: An Evaluation of Singapore's Past, Present and Future. *Journal of Infrastructure Policy and Development*. 1 (1). pp. 112–128.; E. Pike. 2010. *Congestion Charging: Challenges and Opportunities*. <https://theicct.org/publications/congestion-charging-challenges-and-opportunities>; and D. Van Amelsfort. 2015. *Introduction to Congestion Charging: A Guide for Practitioners in Developing Cities*. Manila and Bonn und Eschborn: Asian Development Bank / Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). <https://www.adb.org/publications/introduction-congestion-charging-guide-practitioners-developing-cities>.

**Subsidies, including R&D, can promote (domestic) electric vehicles.**

The PRC has initiated several programs to promote the development of New Energy Vehicles (NEVs). A research and development program for electric vehicle technology was launched in 2001. In 2005, targets were set for the proportion of electric cars purchased to reach 50% of car sales in 2030. Both taxes and subsidies were used to create incentives for the production and purchase of electric cars. Pilot cities were subsidized to use NEVs in public transit; subsidies and preferential tax rates were made available to purchasers; and Beijing's license plate quota (a CAC regulation that sought to reduce car purchases) was lifted for NEVs (Li and Zhan 2017).

**Reducing or removing subsidies for petrol and diesel can be politically acceptable if done gradually and with fair distribution of the revenue.**

Energy affordability was a major goal of fuel subsidies, but these subsidies tend to benefit higher-income households (Rentschler and Bazilian 2017 and UNEP 2003). In fact, subsidies divert public revenues from other human needs that are important to poor people. The revenue saved by removing fuel subsidies can be redirected to help poor households. In Indonesia, for example, the government started to remove the subsidy on gasoline in 2014. The reform was progressive; the impact on households through increased cost of living is larger for the richer households (Yusuf et al. 2018). ADB recommends transferring subsidy savings to mitigate negative impacts from the removal of subsidies and to use savings for poverty reduction and social programs (ADB 2015).

Gradual subsidy removal can increase political feasibility and limit economic disruptions. In India, diesel accounted for 44% of petroleum consumption from 2012 to 2013. The highest of all fuel subsidy expenditures was for diesel, which was increasing each year due to the growing population. However, high-income households benefited the most from the diesel subsidy. Several attempts to remove the subsidy failed due to political opposition. Finally, in 2013, India adopted a gradual strategy, with a significant price increase for bulk consumers (mainly state-owned railways) and small monthly price increases for all other consumers until the subsidy was eliminated. This strategy worked; the subsidy was removed for all consumers within 2 years (Acharya and Sadath 2017 and Clarke 2015).

**Lessons Learned Regarding Market-Based Instruments for Transport**

Experimentation with MBIs to reduce emissions from transportation would be advisable. Consumers respond by changing their driving behavior as well as their vehicle choice, but there must also be viable alternative options (e.g., mass transit) to driving. Since motor vehicles are a major cause of air pollution in many Asian cities, there is an urgent need to clean up the transport sector, and properly designed and implemented incentives will be required.

Finally, although information provision has not been a major tool in reducing provision from transport, it has been used effectively in combination with other policies. When lower registration fees for cleaner vehicles were combined with consumer information and awareness, there was a dramatic increase in the proportion of less-polluting vehicles (EEA 2000).

## Market-Based Instruments to Reduce Pollution from Heating and Cooking

Air pollution from household heating and cooking has mainly been addressed through the use of information and subsidies, such as for energy-efficient stoves or improved insulation to reduce heat loss. The goal is to reduce household air pollution through incentives to encourage fuel switching and improve combustion technology. However, more research is needed to evaluate the effects of such subsidies.

### Subsidies are common to increase use of improved cookstoves.

Many developing countries have worked with nongovernment organizations to provide subsidies for cleaner cooking and heating devices and to insulate homes. Table 10 provides several examples.

**Table 10: Subsidies for Improved Cookstoves, Insulation, Biogas, and Liquefied Petroleum Gas**

Country	Description	Comment
<b>Bangladesh</b>	The Government of Bangladesh, with the help of several nongovernment organizations, has promoted biogas plants in rural households.	Despite initial success, there are unsold and unused biogas plants. There is a need for a systematic review to understand the bottlenecks. Recently, the government used the Infrastructure Development Company Limited to promote biogas using capital subsidy.
<b>Cambodia</b>	The Government of Cambodia has provided subsidies for and information on ICSs.	3.6 million ICSs have been distributed to households.
<b>India</b>	LPG cylinder refills for cooking have been subsidized for decades but high connection costs limited access. Pradhan Mantri Ujjwala Yojana (Rural Cooking Gas Connection), launched in 2016, provides subsidies for women living below the poverty line to obtain LPG connections. The subsidy rate is 50% of the full price, or Rs1,600 (\$23) per connection.	There was an initial budget of Rs800 billion (\$12 billion) from 2016 to 2018, initially aiming to distribute 50 million LPG connections and eventually expanding its goal to 80 million. By December 2018, 58 million connections had been distributed.
<b>Indonesia</b>	A national program from 2007 to 2012 converted kerosene users to LPG. The program offered free stoves, LPG cylinders, and first consignment of LPG. It also provided LPG as a main cooking fuel to 27 million households in 2010, which was five times more than in 2007.  The Indonesia Domestic Biogas Program was launched in 2009 and built 11,250 biogas digesters by 2013. The program offered a flat subsidy of \$220, while households paid 60% to 80%.	The program is limited in terms of potential for scale-up; 40% of households still rely on biomass fuel for cooking, yet the program targeted kerosene users, with little spillover to biomass users. Moreover, LPG remains unaffordable for many households.  Less firewood is used, and biogas users report better air quality in the kitchen. Improved health could not be documented in the short term.
<b>Lao PDR</b>	The Government of the Lao People's Democratic Republic provided subsidies for and information on ICSs.	ICSs were distributed to 100,000 households.

*continued on next page*

Table 10 continued

Country	Description	Comment
<b>Mongolia</b>	<p>A subsidy of MNT5 million (\$3,500) was provided to households by the Building Energy Efficiency Project to build energy-efficient dwellings. The construction cost ranged from \$15,000 to \$24,100. Long-term mortgage loan requires a down payment of \$4,700 to \$7,500.</p> <p>Gers (yurts) traditionally are heated with coal and wood. “Ger stoves,” which use less fuel and produce fewer emissions, are sold at a 90% subsidy.</p> <p>20,000 blanket-like insulation layers for gers were designed by the UNDP, produced locally in Mongolia, and sold at subsidized prices.</p>	<p>The subsidized price of the stoves, which was about \$20, is affordable for many households.</p> <p>Insulation blankets resulted in 50% reduction in fuel consumption.</p>
<b>Viet Nam</b>	<p>The government-subsidized program and internationally supported projects provided 45,000 ICSs. Viet Nam joined the Global Alliance for Clean Cookstoves in 2012 to promote public-private sector cooperation for production and distribution.</p> <p>Under the 2003 Viet Nam Biogas Program, 158,500 domestic biogas digesters provided cooking fuel for 790,000 rural households.</p>	<p>The Renewable Energy Development Strategy set goals for the number of households using advanced cookstoves and encourages the development of a cookstove industry.</p> <p>The health impacts from switching from fuelwood or charcoal to biogas have not been assessed.</p>

ICS = improved cookstove, Lao PDR = Lao People’s Democratic Republic, LPG = liquefied petroleum gas, MNT = Mongolian togrog, UNDP = United Nations Development Programme.

Sources: S. Aggarwal, S. Kumar, and M. K. Tiwari. 2018. Decision Support System for Pradhan Mantri Ujjwala Yojana. *Energy Policy*. 118 (July). pp. 455–461.; A. Bedi, R. Sparrow, and L. Tasciotti. 2013. *Impact Evaluation of Netherlands Supported Programmes in the Area of Energy and Development Cooperation in Indonesia*. Rotterdam: Government of the Netherlands, Policy and Operations Evaluation Department.; S. Edsel, B. Resurreccion, and S. Rakshit. 2014. *Bio-innovation and Poverty Alleviation: Case Studies from Asia*. New Delhi: SAGE Publications; N. Hanh and S. Von Eije. 2016. *Market Study: Biomass Advanced Cookstove in Vietnam*. SNV.; M. E. Khan and A. R. Martin. 2016. Review of Biogas Digester Technology in Rural Bangladesh. *Renewable & Sustainable Energy Reviews*. 62. pp. 247–259; Partnership for Action on Green Economy. 2014. *Mongolia’s Transition to A Green Economy: A Stocktaking Report*. [https://www.un-page.org/files/public/mongolia\\_green\\_economy\\_eg\\_full\\_nov16\\_web.pdf](https://www.un-page.org/files/public/mongolia_green_economy_eg_full_nov16_web.pdf); SNV (Netherlands Development Organisation). 2015. *Annual Report 2015*. [http://www.snv.org/public/cms/sites/default/files/explore/download/snv\\_corporate\\_annual\\_report\\_2015\\_0.pdf](http://www.snv.org/public/cms/sites/default/files/explore/download/snv_corporate_annual_report_2015_0.pdf); B. Tsevegjav. 2013. *Assessment of Urban Air Pollution Abatement Policy Implementation Vis-a-Vis the Role of Household Energy Use in Ger Areas of Mongolia*. University of Twente. <https://essay.utwente.nl/65055/>; and World Bank. 2012. *Health Impacts of Indoor Air Pollution. EAP Clean Stove Initiative Knowledge Exchange Series 70100*. Washington, D.C.: World Bank.

Subsidies for improved cookstoves (ICSs) have been promoted globally by nongovernment organizations and in developing countries, but it is increasingly apparent that those that simply attempt to burn traditional solid fuels more completely are often ineffective in reducing air pollution substantially (Sambandam et al. 2014 and Thomas et al. 2015).

Biogas digesters are a renewable source of cooking fuel. Biogas is a by-product of livestock. Bangladesh, Indonesia, and Viet Nam have programs to promote subsidized biogas digesters. LPG has been promoted as a substitute for kerosene and firewood in India.

### **Climate finance is used for improved cookstoves.**

In Cambodia, the Lao PDR, and Viet Nam, subsidies were used mainly for design, training, awareness-raising campaigns, and demonstration. Because there are global benefits when households reduce their collection and burning of wood and charcoal—including reduced deforestation and reduced greenhouse gas emissions—these countries are exploring international carbon finance mechanisms to help pay for these programs.

**Adoption of improved cookstoves can be limited due to reduced heating and costly fuels.**

Many improved cooking stoves are not designed to provide the heating required in the house during the winter in places such as Mongolia; in fact, the fuel efficiency of an ICS can reduce the amount of heat emitted into the home. Mongolia faces the challenge that relatively clean fossil fuels (such as improved sawdust briquettes, semi-coking coal briquettes, and semi-coking coal lumps) cost twice as much as raw coal. To close the price gap, the Clean Air Foundation provided discount vouchers to *ger* (traditional yurt) households in a pilot zone, which enabled *ger*-dwellers to buy the cleaner alternatives at subsidized prices.

The level and volatility in fuel prices across countries also need to be considered. For instance, if electricity prices are high, consumers may be reluctant to switch and stop using solid fuels, as the costs for cooking and heating may also rise. Furthermore, in areas with poor and unreliable electricity access, shifting from wood or coal burning to electricity may not even be feasible (Barría 2016).

There are also potential fairness concerns that need to be considered to ensure public acceptance. If a subsidy is not large enough, the poorest households may not be able to afford fuel switching or improvement of their combustion appliance, as was the case of the domestic biogas plant subsidy in Nepal (Bhattarai, Somanathan, and Nepal 2018). Hence, the subsidy may only be useful for middle- and high-income households. Furthermore, even if policies for fuel switching are designed to ensure that the poorest households benefit from the subsidies, there is a possibility that the appliance is not used and sold instead (Troncoso and Da Silva 2017). This experience highlights the importance of good design in subsidy programs.

**It is difficult to separate the effect of information campaigns from other policies.**

Information campaigns and labeling are relatively inexpensive, but few studies that have assessed the effectiveness of information aimed to decrease indoor air pollution (Chafe et al. 2015). One example is a study that assessed an intervention in Tasmania, Australia, which combined the replacement of wood stoves with electricity, educational campaigns, and enforcement of environmental regulations. The proportion of households using wood as heating decreased from 66% to 30% during the 13-year-long study. Furthermore, the particulate matter 10 emissions decreased by 39% and the improved air quality resulted in significant reductions in annual mortality (Chafe et al. 2015). As in Tasmania, information campaigns can work well as part of a hybrid policy – in this case, enforcement of regulations. In fact, subsidies for cleaner technology inevitably include an educational component, as households learn the benefits of a new stove or decide whether or not to borrow money to pay for the unsubsidized portion of a purchase.

## Conclusions and Lessons Learned

**MBIs have great potential – in particular for reducing subsidies and taxing fossil fuels.**

Asian governments can benefit from the flexibility that MBIs offer compared to CAC regulations, in particular when taxes can be levied at a few strategic and concentrated points in the production chain (such as petroleum refineries or coal mines) and still make an impact on fuel consumption and pollution throughout the economy. In many developing Asian economies with weak regulatory capacity, taxes can help mitigate pollution that would otherwise go unchecked. This is especially true of reducing subsidies for polluting fuels, since the quantity response tends to be greater when prices are low.

**Getting the price right is difficult but important.**

A major obstacle to the use of taxes and other MBIs is that the transparency of the policy can easily evoke opposition from industry interest groups and the public. This political opposition likely leads to prices that are too low, which, in turn leads to too much pollution. When taxes are too low, they do not achieve the environmental goal of reducing pollution.

**Compensation and information can increase application and tax rates.**

To reduce resistance to MBIs, the use of revenues should be clear, and it should be seen as fair and equitable. Hybrid instruments and appropriate use of revenues can make the use of MBIs more feasible. Refunding emissions taxes could also help increase the relative stringency of existing taxes as well as the extent to which the incentives can innovate.

**Cap-and-trade schemes show potential but require strict caps and strong institutional capacity.**

Cap-and-trade programs to address carbon emissions, with benefits to air quality, have been implemented successfully in the past. A major challenge is that, while tradable permits provide certainty about the quantity of pollution produced, they leave the price of pollution control to the market. When policy makers are unwilling to risk the high costs of pollution control, they tend to set loose caps, thus reducing the policy's environmental effect. Moreover, price volatility in the permit market can cause a delay in investment in emission-reducing technologies.

**Make use of the fact that MBI experiences in Asia are similar to those of Europe and the US.**

The experiences with MBIs in Asia compare quite well with early MBI experiences in Europe and the United States. Both developed and developing countries encountered similar flaws and challenges related to design and implementation of the instruments, such as over-allocation and inadequate markets for trading emission permits, tax rates that are too low, and poorly designed and generous subsidies for clean energy technologies proven to be financially unsustainable. There is no need for developing countries in Asia to make the same mistakes. Increased attention should be given to learning between countries in the region and beyond.

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# 3

## Market-Based Approaches to Water Management in Asia

### KEY MESSAGES

- Water resources are facing increasing demand and withdrawal, leading to water stress and threatening ecosystem health, water availability, and water quality.
- Allocating scarce water resources is a challenge across Asia.
- Market-based instruments (MBIs) to address water problems include (i) creating tradable use rights; (ii) taxes, fees or charges; (iii) subsidies; (iv) payments for ecosystem services; and (v) information provision.
- Volumetric pricing may help allocate water more efficiently if prices are set correctly.
- Agricultural water pumping is energy-intensive, so pricing strategies could target energy as well as water use.
- Reallocating water across regions and sectors is difficult, but the value under alternative uses could be much higher; therefore, there are large potential efficiency gains from reallocation.
- Surface water pollution can be addressed using discharge taxes, but that is only possible where there is capacity for monitoring.
- Taxes on polluting inputs (such as nutrients) can be implemented in settings where discharge is not easily observed.
- Tradable discharge permits have proven to be successful in some settings, but these policies require observable discharge, good institutions, and the creation of markets.
- Incentives such as subsidy or permitting schemes can facilitate uptake of green infrastructure to reduce runoff.
- Payments for ecosystem services schemes have been implemented successfully in some contexts and have potential for upscaling with enabling political and economic support, information sharing, and strong social benefits.
- Information provision is a low-cost complement to other MBIs.

## Challenges to Water Management in Asia

Rapid urbanization, economic growth, industrialization, and extensive agricultural development in Asia are placing pressure on the region's water resources, quality, and infrastructure (United Nations Department of Economic and Social Affairs 2014). Industrial and agricultural intensification creates further challenges in water resources and water quality management. As a result, water shortages have increased in many areas, while water quality has also deteriorated.

Increased demand for water for household, industrial, municipal, or agricultural use has led to increasing concerns about how water is used and the quality of water resources (Food and Agriculture Organization of the United Nations [FAO] 2008 and Moriarty, Butterworth, and Batchelor 2004). This chapter highlights four water-related problems in Asia: (i) inefficient use of irrigation water, (ii) poor intersectoral water allocation, (iii) surface water pollution, and (iv) failure to protect and value ecosystems.

### High water withdrawal is leading to water stress in many Asian countries.

Assessing water use often begins with an understanding of per capita water withdrawals and freshwater withdrawal with respect to total renewable water resources. Table 11 presents water use statistics by country: water withdrawals by sector (agriculture, industry, municipal), total water withdrawals, per capita water withdrawals, and freshwater withdrawals as a percentage of total renewable water resources. Among countries in the area of study, Pakistan, the Philippines, Thailand, and Viet Nam have the highest total per capita water withdrawals, with per capita withdrawals ranging from 850 to 1,050 cubic meters per year ( $m^3/year$ ). Bangladesh, Cambodia, and Mongolia have the lowest, with per capita withdrawals ranging from 150 to 250  $m^3/year$ . Cambodia, the Lao People's Democratic Republic (Lao PDR), Pakistan, Nepal, and Viet Nam have the highest percentage of water withdrawals devoted to agriculture (over 90%). Over 40% of water withdrawals in Malaysia and Mongolia are for industrial uses, while the proportion for industrial use in Indonesia and the People's Republic of China (PRC) is closer to 20%. India at 9% and the PRC at 19% have the highest water allocation for municipal use.

One measure of water stress is freshwater withdrawals as a percentage of total renewable water resources. By that measure, Pakistan is by far the most water stressed country in the region, with water withdrawals at 74% of total renewable water resources. This is followed by India (34%), the PRC (21%), and Sri Lanka (25%). India, Mongolia, Pakistan, the Philippines, and Sri Lanka are under high or extremely high stress as measured by the World Resource Institute's index (Gassert et al. 2015). Northern PRC, India, and the Indus River systems are experiencing moderate to extremely exploited water conditions (Fant et al. 2016).

Groundwater is among the most exploited resources. It serves over a third of the world's irrigated areas, of which 70% is in Asia, and provides 25%–40% of the world's drinking water (Asian Development Bank [ADB] 2016 and National Groundwater Association 2010). Of the 15 biggest abstractors of groundwater, 7 are in Asia and the Pacific; around 50% of all groundwater use globally is in South Asia alone (ADB 2016 and Margat and van der Gun 2013). The total energy used for lifting groundwater in Bangladesh, India, Nepal, and Pakistan is estimated to be 68.6 billion kilowatt hours per year, which costs \$3.78 billion (ADB 2016). It is projected that by 2050, groundwater use will increase by 30% in India, Pakistan, and the PRC, accounting for 86% of total groundwater abstraction in Asia (International Institute for Applied Systems Analysis 2016). Expanding groundwater use will lead to declining water tables, growing demand for energy, and increasing costs to the energy sector, as well as affecting water availability for household security and urban security (ADB 2016).

**Table 11: Water Use Statistics in Asia**

Country	Year(s) of data	Agricultural water withdrawal (10 <sup>9</sup> m <sup>3</sup> /year)	Industrial water withdrawal (10 <sup>9</sup> m <sup>3</sup> /year)	Municipal water withdrawal (10 <sup>9</sup> m <sup>3</sup> /year)	Total water withdrawal (10 <sup>9</sup> m <sup>3</sup> /year)	Total water withdrawal per capita (m <sup>3</sup> /year)	Freshwater withdrawal as % of total renewable water resources (%)
Bangladesh	2008	31.50	0.77	3.60	35.90	231.0	2.9
Cambodia	2006	2.05	0.03	0.10	2.20	159.1	0.5
India	2010	688.00	17.00	56.00	761.00	602.3	33.9
Indonesia	2000 and 2005	92.76	24.65	13.99	113.30	521.2	5.6
Lao PDR	2003/2005	3.19	0.17	0.13	3.50	588.0	1.0
Malaysia	2005	2.51	4.79	3.90	11.20	419.0	1.9
Mongolia	2009	0.24	0.24	0.07	0.60	196.2	1.6
Nepal	2005 and 2006	9.32	0.03	0.15	9.50	364.4	4.5
Pakistan	2008	172.40	1.40	9.65	183.50	1,034.0	74.4
Philippines	2009	67.07	8.25	6.24	81.60	849.4	17.0
PRC	2015	385.20	133.50	79.40	598.10	425.0	20.9
Sri Lanka	2005	11.31	0.83	0.81	13.00	653.6	24.5
Thailand	2007	51.79	2.78	2.74	57.30	863.7	13.1
Viet Nam	2005	77.75	3.07	1.21	82.03	956.4	9.3

Lao PDR = Lao People's Democratic Republic, m<sup>3</sup> = cubic meter, PRC = People's Republic of China.

Source: Food and Agriculture Organization of the United Nations. AQUASTAT Main Database. <http://www.fao.org/aquastat/en/> (accessed 28 February 2018).

### Large-scale irrigation threatens ecosystems, water availability, and water quality.

While total cultivated land in the world has only increased by 12% between 1961 and 2009, the proportion of cultivated land that is irrigated doubled from 10% to 20% (Food and Agriculture Organization of the United Nations [FAO] 2011). Additionally, groundwater use in irrigation is rising and almost 40% of the irrigated area is reliant upon groundwater. Asia has the highest percentages of irrigated land—40% compared to 8% in Europe, 12% in the Americas, and 5% in Africa. Of the world's irrigated area, 70% is in Asia, with India and the PRC alone accounting for 40% (FAO 2011). Much of this irrigation is large-scale and primarily for paddy rice production.

Irrigation increases farm production and incomes, but it also generates negative externalities, such as decreases in downstream access to water and a reduction of wetland habitats. In India and the PRC, agricultural production tripled between 1964 and 1997, due to investments in irrigation and other technologies to enhance land and water productivity (FAO 2011). However, current patterns of agricultural groundwater use are not sustainable and will result in permanent damage to both the quantity and quality of groundwater resources (Siebert et al. 2010). This is especially a problem in India's Punjab region and the North China Plain. In heavily populated basins in India and the PRC, rivers no longer discharge to the sea and saltwater intrudes upstream with losses of coastal habitats (FAO 2011). Additionally, with the intensification of agriculture, excess nutrients and pesticides are released into surface, ground, and coastal waters.

**Intersectoral water allocation may be necessary but is politically sensitive.**

Rising water demand from agriculture and other sectors is leading to competition for water resources (FAO 2011). As most of the water withdrawals are due to agriculture (82% in Asian countries of interest) and the estimated economic value of water in agricultural production is low relative to household and industrial uses, policy makers often look to shift water from irrigation to municipal and industrial uses (Meinzen-Dick and Appasamy 2002). However, the timing and location of the water resources and demands may not coincide, and transfers need to be exercised carefully, either through markets or through regulatory measures. Direct expropriation of agricultural water to meet other sectoral demands can cause political unrest, as in the case of the Bhavani Basin in India and the Angat Basin in the Philippines (Meinzen-Dick and Appasamy 2002).

**Poor surface water quality has become a serious environmental and public health issue.**

Increasing water pollution from household, industrial, and agricultural activities is a major issue for nearly all developing Asian countries. Irrigation and high levels of agrochemical consumption, as well as high sediment loads, are significant sources of nonpoint source water pollution (Chakraborty and Mukhopadhyay 2014 and Evans et al. 2012; and FAO 2011). Inadequate treatment and management of wastewater from both households and industrial users are also significant problems. This is due largely to the lack of treatment facilities, financial resources, and well-defined policies (Sato et al. 2013).

Wastewater treatment and disposal is becoming an increasingly serious environmental and public health issue. Household and industrial waste are contaminating surface water and groundwater sources in urban areas and high levels of wastewater treatment are required to safely convert to potable water (Chakraborty and Mukhopadhyay 2014). Of the 144 cubic kilometers of wastewater generated annually in Asia, 37% is generated in the PRC, 27% in South Asia, 20% in Japan, and 6% in Southeast Asia (Chakraborty and Mukhopadhyay 2014; Evans et al. 2012; and FAO 2011). Only about a third of all wastewater in Asia is treated, with the lowest treatment rates in South Asia (7%) and Southeast Asia (14%), according to FAO AQUASTAT. Table 12 reports wastewater generation and treatment of countries in Asia.<sup>1</sup> India, Indonesia, and the PRC are the largest producers of municipal wastewater. At 18% for Mongolia and 20% for the PRC, they have the highest rates of treatment while Indonesia has very little wastewater treatment (0%) (Malik et al. 2015).

Biochemical oxygen demand (BOD) is one measure of water pollution from organic pollutants from household, industrial (e.g., paper and pulp mills, sugar mills), and agricultural sources (fertilizers). Water becomes polluted when BOD levels are high because the oxygen available in the water is being consumed by bacteria. Table 13 presents an overview of the level of BOD among countries in Asia, where available. The PRC has the highest levels of reported BOD emissions, at 8.82 million kilograms per day (kg/day). Indonesia, Thailand, and Viet Nam have combined total BOD emissions of 1.96 million kg/day. While most of the countries reported significant growth in BOD emissions accompanying their economic growth, BOD emissions growth far surpassed GDP growth in countries such as Thailand and Viet Nam. From 1998 and 2006, BOD emissions in Thailand grew by 87% and by 255% in Viet Nam; in comparison, their GDP growth rates were 48% (Thailand) and 74% (Viet Nam) (Chakraborty and Mukhopadhyay 2014).

With respect to water quality management, proactive policies are in their infancy. Countries such as India, the Philippines, the PRC, and Thailand are beginning to implement large programs to rehabilitate degraded water resources through legislative or statutory authorities. In the Philippines, Manila's local government has been given more autonomy and greater access to financial resources (Evans et al. 2012). However, enforcing water quality

<sup>1</sup> There are inconsistencies and errors within the FAO reported numbers for wastewater treatment. For example, the calculated treatment levels using reported numbers for the PRC are very high (~100%), compared to reports from other sources (Sato et al. 2013, Malik et al. 2015, and Chakraborty and Mukhopadhyay 2014). For the percentage treated, this study used Malik et al.'s (2015) EPI figures, which tend to be more conservative than both the FAO and Sato et al.'s (2013) estimates. Sato et al. (2013) have acknowledged the dearth of recent, consistent, and complete information about wastewater production, treatment, and use.

regulations is challenging in many developing countries. Institutional capacities are not able to keep up with rapid industrialization. Economic instruments, such as taxes and subsidy removal, clash with development goals (Evans et al. 2012 and Kathuria and Sterner 2006). Monitoring is inadequate and costly and, as a result, compliance is typically poor.

### Poor water management is a driver of ecosystem degradation and declining environmental services.

Poorly implemented water management practices have led to contamination and exploitation of water resources and overall decline of river, lake, and wetland ecosystems, affecting the quality of environmental services. From 1997 to 2011, it is estimated that between \$4.3 trillion to \$20.2 trillion worth of ecosystem services were lost per year, as a result of land use changes (Costanza et al. 2014). Pollution and overexploitation of natural capital, such as wastewater and agricultural discharges or logging for timber, can affect ecosystems' capacity to provide fresh water and other resources and to regulate processes such as water quality and water table levels. Climate change also has severe impacts on rainfall and the hydrological cycle, affecting water availability (Döll et al. 2018; Masson-Delmotte et al. 2018; Saeed et al. 2018; and Schewe et al. 2014). In East Asia, changes in seasonal precipitation are already occurring, while in Southeast Asia, the frequency of droughts and flooding is projected to increase (ADB 2016). Poorly designed infrastructure and fragmented basin management approaches exacerbate these impacts (Grooten and Almond 2018 and United Nations World Water Assessment Programme 2015).

The goal in this chapter is to identify cases in which market-based policy instruments have worked in the water sector despite the difficult institutional and economic contexts.

**Table 12: Wastewater Generation and Treatment in Asia**

Country	Reporting Year	Produced Municipal Wastewater (10 <sup>9</sup> m <sup>3</sup> / year)	Reporting Year	Treated Municipal Wastewater (10 <sup>9</sup> m <sup>3</sup> / year)	Wastewater that Receives Treatment (%)
Bangladesh	2000	0.73	...	...	0
Cambodia	2000	1.18	1994	0.00	0
India	2011	15.45	2011	4.42	29
Indonesia	2012	14.29	...	...	0
Lao PDR	2008	0.08	1995	...	0
Malaysia	2009	4.22	2009	2.60	62
Mongolia	2012	0.15	2006	0.12	20
Nepal	2006	0.14	2006	0.01	4
Pakistan	2011	3.06	2002	0.03	4
Philippines	2011	1.26	...	...	1
PRC	2013	48.51	2014	49.31	18
Sri Lanka	2009	0.12	...	...	0
Thailand	2012	5.11	2012	1.17	23
Viet Nam	2012	1.97	2012	0.20	10

... = no data available, Lao PDR = Lao People's Democratic Republic, m<sup>3</sup> = cubic meter, PRC = People's Republic of China.

Sources: Environmental Performance Index. EPI2016 Raw data. <https://sedac.ciesin.columbia.edu/data/set/epi-environmental-performance-index-2016/data-download> (accessed 28 February 2018); A. E. V. Evans et al. 2012. Water Quality: Assessment of the Current Situation in Asia. *International Journal of Water Resource Development*. 28 (2). pp. 195–216.; Food and Agriculture Organization of the United Nations (FAO). AQUASTAT - FAO's Global Information System on Water and Agriculture. <http://www.fao.org/aquastat/en/> (accessed 28 February 2018); and O. A. Malik et al. 2015. A Global Indicator of Wastewater Treatment to Inform the Sustainable Development Goals (SDGs). *Environmental Science & Policy*. 48. pp. 172–185.

**Table 13: Biochemical Oxygen Demand Emissions in Asia**  
(kg/day)

	1998	2003	2006
Bangladesh	303,022	...	...
Indonesia	721,774	731,009	882,985
Lao PDR	506	...	...
Malaysia	...	181,715	208,312
Nepal	...	26,808	...
Pakistan	...	...	153,680
Philippines	179,901	143,262	...
PRC	...	7,066,070	8,823,750
Sri Lanka	...	...	266,109
Thailand	311,822	...	581,425
Viet Nam	141,036	399,522	500,482

... = no data available, kg = kilogram, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Sources: D. Chakraborty and K. Mukhopadhyay. 2014. Water Pollution and Abatement Policy in India: A Study From an Economic Perspective. In A. Dinar et al., eds. *Global Issues in Water Policy*. 10. New York: Springer.; and World Bank. World Development Indicators [WDI] Database Archives. <https://databank.worldbank.org/reports.aspx?source=1277&series=EE.BOD.WRKR.KG> (accessed 28 February 2018).

## Review of Market-Based Instruments for Water

The rest of this chapter is organized around the use of MBIs to address four different water issues:

- inefficient use of irrigation water,
- a poor intersectoral allocation of water,
- poor surface water quality, and
- failure to protect and value ecosystems.

For each policy instrument, a review of experiences in East Asia, South Asia, and Southeast Asia allows for a comparison of experiences. Where possible, empirical evidence is used to support technical and political requirements and expected outcomes such as efficiency and efficacy. Finally, the chapter concludes with a discussion of lessons learned and recommendations for the future use and evaluation of MBIs.

### Market-Based Instruments Commonly Used to Address Water Problems

There are five categories of MBIs used in addressing water problems: markets for trading water use and pollution rights; taxes, fees, and charges; subsidies; payments for ecosystem services; and information provision (Table 14). For each policy issue, the key MBIs used in Asian countries are discussed and evaluated.

**Table 14: Overview of Market-Based Instruments for Water Management in Asia**

Market-Based Policy Instrument	Inefficient Use of Irrigation Water	Poor Intersectoral Water Allocation	Surface Water Pollution	Failure to Protect and Value Ecosystems
<b>Water markets, tradable discharge markets</b>	Bangladesh, India, PRC	India; PRC; Taipei, China	PRC	Philippines, PRC
<b>Taxes, fees, or charges</b>	Bangladesh, Cambodia, India, Lao PDR, Nepal, Pakistan, Philippines, PRC	Sri Lanka	Malaysia, Philippines, PRC, Thailand, Viet Nam	Bangladesh, Indonesia, PRC
<b>Subsidies</b>	Bangladesh, India, Pakistan, Viet Nam		India, Indonesia, PRC, Sri Lanka	
<b>Payments for ecosystem services</b>				India, Indonesia, Philippines, PRC, Thailand, Viet Nam
<b>Information provision, labels, and voluntary agreements</b>			Indonesia, India, Philippines, PRC, Viet Nam	

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China

Source: Asian Development Bank.

## Market-Based Instruments to Tackle Inefficient Use of Irrigation Water

Water prices faced by farmers in Asia are extremely low, and reforms to reduce water use have set prices too low to induce behavior change, given the existing estimates of how responsive producers are to changes in the price of water (i.e., the “price elasticity of demand”) (Aregay, Zhao, and Bhutta 2013 and Moore 2014). Most public irrigation schemes in Asia are heavily subsidized. Irrigation management reform has aimed to reduce these subsidies by transferring operation and maintenance responsibility to water users.

Volumetric pricing as an MBI can be used to tackle inefficient use of irrigation water by charging farmers for the amount of irrigation water consumed or delivered. However, the measurement of the volume of water used by each consumer requires an extensive network of water meters (or flow gages), which require installation, routine maintenance, and meter readings. Furthermore, implementation costs are relatively high, and a central water authority is needed to set the price, monitor use, and collect fees.

The efficient use of water would require that the price be set equal to the marginal cost of providing the water, including the external costs associated with its use. While this type of pricing would encourage users to limit their water use, cost recovery may be difficult to achieve if marginal costs are lower than average costs or average costs are decreasing (Easter and Liu 2005). Additionally, as the operational costs are relatively stable, revenues from uncertain sales—which may be magnified by uncertain prices—provide limited financial security to an operating agency (Cornish et al. 2004).

There have been studies on the effect of price increases in volumetric pricing, but there is little known about the effect of switching from non-volumetric to volumetric prices.<sup>2</sup> As with any tax, the responsiveness of consumers depends on chosen tax level, so policy makers need to consider the price change required to induce a behavior response.

<sup>2</sup> In Zhangye, People's Republic of China, one study found that, even though farmers paid a water fee per area, they were aware of the connection between the water price and the volume of water used (Dong et al. 2001). However, it is unclear to what extent farmers were incentivized to save water due to this measure (Loeve 2007).

Some evidence of the effect of pricing comes from pilot programs in the PRC (Wang, Zhang, and Huang 2016).<sup>3</sup> The pilot reform project used two instruments. First, there was a real increase in electricity fees associated with irrigation pumping (20% in 2009 and 15% in 2012) to reduce groundwater use. Second, reform subsidies added to the collected irrigation fees that were allocated to farmers at the end of each year to offset “potential negative impacts on their income” (Wang, Zhang, and Huang 2016). They found that farmers in the pilot reform villages used 21% less groundwater for wheat and cotton, but not for maize (possibly because it is grown in the rainy season). The subsidy successfully mitigated farmer income losses.<sup>4</sup> While the pilot reform demonstrated success, it has not been applied widely in the PRC due to the unique conditions present at the study site (e.g., dominant groundwater use, and deep, costly tube wells managed by village committees instead of farmers).

Similarly, a study of the Heihe River Basin found that farmers do not really respond to small water price changes, since they were far below the value to farmers in most irrigation zones. Reducing agricultural water demand could occur only with a significant increase in the water price and, therefore, “a quantitative control measure (would be) more effective at reducing water use” (Shi et al. 2014).

### **Water pricing could be effective but challenging in practice.**

In principle, volumetric water pricing would lead to an efficient allocation of water if prices are set correctly. In practice, however, pricing has largely been ineffective at current levels, and increasing the price enough to have an impact on use has been politically difficult.

Studies in both India and the PRC have found that volumetric water fees (or associated marginal costs for electricity use) lead to increases in efficiency and/or shifts to high-value or less water-intensive crops (Kumar, Scott, and Singh 2011; Mukherji 2007; Shiferaw, Reddy, and Wani 2008; and Wang et al. 2010). Research also shows that an increase in electricity fees reduces groundwater use (Kumar 2005 and Kumar, Scott, and Singh 2011) and when paired with subsidies, it mitigated farmer income losses (Wang, Zhang, and Huang 2016).

Beyond efficiency gains from pricing, there are important practical considerations. For example, the costs of implementation need to be considered. To address this, in Bangladesh, the Barind Multipurpose Development Authority pioneered a volumetric irrigation fee and pre-paid metering system in deep tube wells for groundwater-based irrigation system, which resulted in substantial cost recovery of irrigation water supply (Gain, Mondal, and Rahman 2017).

Finally, there are also equity concerns that affect the political feasibility of the policy instrument. Though a few studies examine heterogeneity of effects across different subgroups (Kumar 2005 and Kumar, Scott, and Singh 2011), addressing adverse distributional impacts could be critical to gaining the political will to develop effective pricing policies.

Surface water pricing can also clash with government policies aimed at reducing the disparity between rural and urban incomes and achieving national food self-sufficiency (Liao, Giordano, and de Fraiture 2007). When volumetric pricing is introduced (or if prices are increased) for irrigation from surface water, farmers substitute from surface water to groundwater usage. Thus, pricing the use of surface water can lead to an increase in the exploitation of groundwater resources.

<sup>3</sup> Wang, Zhang, and Huang (2016) visited 10 reform villages and 10 control villages in 2009 and 2012; the reforms were established from 2005 through 2008 in these villages.

<sup>4</sup> Without the subsidy, about half of the farmers would have lost money and half would have earned more, rewarding those who use less water for irrigation. With the subsidy, only 11% of wheat farmers lost money in 2009 and just 5% in 2012.

### **Agricultural water pumping is energy-intensive, so a hybrid MBI could target electricity as well as water pricing.**

In addition to water resources, the use of irrigation can involve significant energy use due to pumping. Some estimates suggest that agricultural water pumping accounts for over a quarter of total power consumption in India (Centre for Monitoring Indian Economy 2002 and Kumar 2005), which has led to studies of the impact of electricity prices on irrigation practices (Kumar 2005; Kumar, Scott, and Singh 2011; Mukherji 2007; and Shah et al. 2008). The lack of pricing groundwater has stressed India's aquifers (Poddar, Qureshi, and Shi 2014 and Shah, Giordano, and Mukherji 2012), but despite groundwater depletion, prices remain inefficiently low—indeed most of the time zero—and in the current price range farmers are unresponsive to small changes in prices (Shiferaw, Reddy, and Wani 2008 and Singh 2007). The strong link between irrigation and both energy use and water depletion suggests that a pricing mechanism could be applied to electricity as well as water (Kumar, Scott, and Singh 2011; Mukherji 2007; and Shah et al. 2008).

### **Market-Based Instruments to Tackle Poor Intersectoral Water Allocation**

Though the intersectoral transfer of water between agriculture and other users is infrequent (Organisation for Economic Co-operation and Development 2010), agriculture is often not the highest value use of water at the margin. With quickly growing urban populations and urban water scarcity, in many cases, urban water supply can be augmented through transfers of water from agriculture (Molle and Berkoff 2006). The conventional conceptual framework presents a “straightforward case that water is misallocated” and that this failure calls for pricing and market mechanisms as an alternative solution (ADB 2003; Anderson and Snyder 1997; Dinar 1998; Holden and Thobani 1996; Molle and Berkoff 2006; and Rosegrant and Cline 2002).

#### **Water markets can transfer rights to higher value uses.**

Of the transfer mechanisms, market-based instruments include (i) trading formal rights in a regulated market with positive experiences confined to economies with a strong legal, institutional, and regulatory background, such as the California Water Bank or other markets in Australia, Chile, and the United States and (ii) purchasing water from tankers in a free market (e.g., Chennai) or from neighbors in “spot markets,” such as *warabandi* in India and Pakistan (Molle and Berkoff 2006).

Water can be transferred across sectors as a permanent change or as a temporary reallocation. Temporary transfers often occur during a drought. Chennai has bought water from surrounding wells in times of shortage, while Manila has reallocated water stored in reservoirs to municipal use. There are also cases of water purchases from wells and reservoirs in Chennai, Kathmandu, Seville, and the PRC, but they are made through formal administrative decisions with negotiation and due compensation similar to transactions in informal rights and regulated markets (Molle and Berkoff 2006).

Gradual permanent transfers occur when a source is increasingly diverted to supply a city (Molle and Berkoff 2006). Examples in Asia of large gradual transfers include the Zhanghe Reservoir in the PRC and the Chao Phraya River in Thailand; smaller transfers in percentage terms can be seen in the case of Chiang Mai in Thailand and Hyderabad India.

Outright permanent transfers represent a reallocation of water from one sector to another. Two prominent examples of intersectoral water transfers in the PRC include transfers from agriculture to industrial, municipal, and hydropower use in Hubei's Zhanghe Reservoir, and transfers of water-usage rights by the government in Ningxia (Moore 2015; Zhang 2012; and Zhang et al. 2016).

In the case of the Zhanghe Reservoir, a transfer from irrigation to higher value uses such as for industrial, municipal, and hydropower utilization was allowed from the 1960s to the early 2000s. The transfer of rights was successful, with relatively little loss in rice production (Hong et al. 2001), which may be due introducing volumetric pricing at the village level in the late 1982, coupled with increased rice yields due to improved varieties and increased fertilizer use (Loeve et al. 2007).

In Ningxia, there was a pilot project in 2003 to transfer 144 million cubic meters (m<sup>3</sup>) of water entitlements from irrigation districts to two new hydropower plants for 25 years. Prices for water rights were primarily determined by the engineering costs of water-saving irrigation projects, and other price components, such as the scarcity rent of water resources, risk compensation for irrigation water shortages, and ecological compensation for affected parties, had not been considered in the transfer price (Chen et al. 2009 and Zhang et al. 2018). Part of the success here may likely be attributed to the large scope for canal lining investments to transfer usage rights to industry; moreover, water use in Ningxia's urban centers was 80% above the natural rate of replenishment (Moore 2015).

In Taipei, China, there is no formal mechanism for water rights trading. However, there are allowances for water transfers following negotiation and appropriate compensation (Huang et al. 2007). Two types of water transfers have occurred: (i) between water rights holders and (ii) emergency transfers. Both involve the transfer of agricultural water: to industrial users in the transfer between water rights holders, as well as to household users in the emergency transfer case. In the regular water transfer case, the negotiations between the water providers (Changhwa and Yunlin Irrigation Associations) and the recipient (a Taipei, China-based petrochemical corporation) took 4 years to complete, with arbitration from the Central Region Water Resource Agency.

Studies of the demand responsiveness to price changes in different settings can shed light on water's value in different settings. For example, prices tend to increase in periods of drought, and the responsiveness varies by sector (Huang and Chiueh 2010). Similarly, a study of Colombo, Sri Lanka found that industrial demand is more responsive to price changes than residential or commercial demand. In this setting, increasing the water price by 10% reduces the amount of water demanded in the industry sector by over 13%, while the same increase would reduce water demand in the residential sector by only 1.8% (Hussain, Thrikawala, and Barker 2002).

### **Water markets can transfer rights to higher-value regions.**

Inter-regional water market transfers have not been used in Asia, except in the PRC. In the PRC, there is one relatively well-documented example of inter-jurisdictional transfer between Dongyang and Yiwu. Beginning in 1998, the municipal government of Yiwu (in Zhejiang Province) provided Dongyang, a neighboring city, \$24 million in construction funds in exchange for a permanent right to 50 cubic millimeters of water from one of its reservoirs (Molle and Berkoff 2006). Yiwu invested CNY3.1 million to upgrade the reservoir by increasing the height of the dam and a further CNY35.7 million in water conservation projects to save a total of 23,000 m<sup>3</sup> of water (Liu, Savenjie, and Zu 2003 and Moore 2015). The investment not only saved Yiwu from building its own reservoir, but it also increased water supply capacity for both cities (Moore 2015; Wang 2013; and Yi 2010). Moore (2015) cautioned that this case may not be replicable because of the unusually close relationship between the two cities, which see themselves "as a single integrated market and view cooperation from a strategic perspective" (Wang 2013).

Intersectoral and inter-regional water transfers, though infrequent, can occur through formal administrative decisions with negotiation and compensation, or through water markets. State, or public, allocation of water resources usually occurs under circumstances involving large scale systems; the resulting allocation often depends on the political clout of various stakeholders. User-based allocation through water markets tends to be more flexible, but there are high transaction costs associated with organizing users to develop systems (Dinar, Rosegrant, and Meinzen-Dick 1997).

In the PRC, beginning in 2001, the Ministry of Water Resources (MWR) established a plan for a system based on initial allocation of usage rights to both regions and enterprises and allowed property holders to sell excess, unused water rights (Moore 2015). Subsequent legislation in 2002, 2005, and 2007 refined implementation by establishing basic criteria for the initial water rights allocation (Moore 2015 and Zhang and Jia 2012). As a result, pilot water markets have emerged in the last decade in the groundwater market in Hebei Province (Mi et al. 2008; Xu et al. 2016; and Zhang, Wang, and Huang 2008) and the surface water market in Gansu Province (Xu et al. 2016 and Zhongjing, Hang, and Xuefeng 2009). In 2014, the MWR began to create a national exchange for water rights and regional water markets in four provinces: Gansu, Guangdong, Henan, and Inner Mongolia (Xu et al. 2016).

Two additional examples from the PRC provide a contrast of surface water and groundwater quotas. In the Heihe River Basin, in 2002, the MWR initiated the PRC's first experimental project establishing a water usage rights system with tradable water quotas (Zhang 2007). However, the system was difficult to implement, and trading was not popular. Zhang and Zhang (2008) reported that total water use was 29% greater than the total water quota. Although the surface water quotas were more closely followed, groundwater use greatly surpassed the established quotas. Since property rights were well-defined for both surface water and groundwater systems, the differences in quota system performance can be attributed to enforcement through mutual monitoring. When groundwater pumping capacity is higher than water demand, users have little incentive to monitor others' water use. When groundwater pumping capacity is less than water demand, the goals of the municipal local governments need to be aligned for groundwater quotas to be met (Zhang and Zhang 2008).

While the Government of the PRC was laying the groundwork for water markets, (surface) water trading organically emerged in 2008 in the Xiying irrigation district (in the Shiyang River Basin, Gansu Province). There was no supervision or support from local governments in the beginning, but as more villages became involved, regulation increased (with price caps and authorities checking each trade). Existing conditions in this area allowed for easier establishment of the water market, including an initial water rights allocation system; an annual usage cap for each water user association; the participation of established water user associations; and the presence of "effective water supply and monitoring infrastructures" (Xu et al. 2016). While markets became more active from 2008 to 2014, only 1% to 3% of annual total water rights were traded during this period. The researchers found that the level of market activity in Xiying was much lower than those in developed countries, such as in Australia (Wei et al. 2011 and Xu et al. 2016). As a result, further market development was constrained by lack of incentives for water saving and trading, high transaction costs, and other barriers (Xu et al. 2016).

In a second pilot of water markets in Xiying, Shiyang Basin, Gansu, the water rights trading system consisted of three elements: (i) initial allocation of water rights to individual water users; (ii) an online platform to record trades and increase participation and monitoring capacity; and (iii) investment in smart meters to monitor water abstraction (Gao 2007; Moore 2014; and Zhang 2012). Although the Shiyang Basin project incorporates many of the internationally established best practices (e.g., individual water rights allocation and popular participation), the project also illustrated important impediments to the development of water markets in the PRC (Moore 2014). Researchers have attributed the limited number of market transactions to unclear legal foundations (entitlements referring to abstraction or actual consumption and duration of water rights), high transaction costs (with authorities checking each trade), insufficient incentives for water saving and trading (i.e., non-existent enforcement of water abstraction permits and quotas), and corruption (Moore 2014; Xu et al. 2016; and Zhang 2012).

Water markets are also global in scale, and there is a growing trade of "virtual water" between countries to meet agricultural, industrial, and other freshwater needs. From 1996 to 2005, 76% of virtual water flows was related to international trade in crops and derived crop products, while trade in animal and industrial products accounted for 12% each (Hoekstra and Mekonnen 2012). India, Indonesia, and the PRC are among the top major gross virtual water exporters in Asia, while Japan and the PRC are major gross virtual water importers. The study also notes that rapid growth and growing water stress in some countries may lead to increasing reliance on external

water resources. For example, the PRC and the Republic of Korea have acquired land abroad, extending as far as Africa, following water shortages in key agricultural areas like the North China Plain (The Economist 2009). As water scarcity worsens, there is a need to develop policies to ensure sustainable global trade of water-intensive commodities, alongside domestic consumption and water resources management.

### **Well-defined property rights and water flows are needed for functional markets for intersectoral water allocations.**

The complex institutional conditions required for functional water markets for intersectoral and inter-regional water allocations are similar to those of water markets for irrigation water, as discussed in the last section. First, there must exist well-defined, quantifiable, and transferable property rights (Dinar, Rosegrant, and Meinzen-Dick 1997). Establishing these conditions has been identified as a key challenge in the PRC. The legal foundations of water resources trading are presently unclear, as many areas have been unable to clearly define annual water use entitlements (Moore 2014). Often, the duration of granted water rights is uncertain and it is unclear whether rights holders can maintain or must re-apply to keep existing water allocations (Gao 2007 and Moore 2014).

Furthermore, in defining property rights, there may need to be unbundling or an accounting for hydrological realities such as return flows (Young 2014). The lessons learned from water markets in Australia showed the importance of allocating water rights for ecosystem purposes (Young 2015). However, in the PRC, though there are mandates to conserve enough water for use by ecosystems and for minimum stream flows, it is unclear who is responsible for designating and protecting these entitlements (Liu 2005 and Moore 2014).

Water markets also have equity implications for smallholders and others who may be unable to compete in the market. Though tradable water property rights may ease the intersectoral reallocation process through compensation (Dinar, Rosegrant, and Meinzen-Dick 1997), researchers have found that the water market reforms have had negative distributive impacts (Romano and Leporati 2002).

While inter-basin water rights trading has not occurred, there have been documented cases of compensated water transfers between industries and jurisdictions. In the PRC, the inter-jurisdictional transfer between Dongyang and Yiwu, two neighboring cities, led to benefits for both—an avoidance of building a new reservoir and increased water supply capacity for both cities. In Taipei, China there have been negotiated transfers, but in one case, the negotiations were difficult and took 4 years, requiring arbitration from a government agency.

## **Market-Based Instruments to Address Surface Water Pollution**

There are many market-based instruments used globally to tackle the problem of poor surface water quality. Water pollution is a classic environmental issue, and there is a rich body of work in both the global and Asian contexts. The policy instruments to be discussed include taxes, tradable permits, incentives for green infrastructure, and information disclosure.

### **Effluent taxes put a price on pollution discharge.**

Effluent charges are used to control water pollution in Malaysia (World Bank 1997), the Philippines (World Bank 1997), the PRC (Wang and Wheeler 1996 and Wang and Wheeler 1999), and Thailand (Simachaya 2009). Pollution fees and enforcement in the PRC have been found to be effective; however, fees are frequently set lower than the marginal cost of abatement and enforcement is often poor. In one study, it was found that, for every 1% increase in the water pollution levy, the intensity of organic water pollution decreased by 0.8% (Wang and Wheeler 1996). When applied to the paper industry, pollution charges reduced industrial pollution and promoted technological innovations (Xu, Hyde, and Amacher 2003).

However, it is likely that pollution charges could be much more effective because there is poor enforcement of the PRC's environmental laws, and pollution charges are commonly underpaid (Hu and Luan 2004 and Xu and Luan 2004). Only about 50% of the assessed pollution charges are actually collected (Li, Li, and Sui 2009). Other studies showed that the enforcement of the PRC's pollution charges was typically affected by local governmental bodies, polluters, and other local stakeholders (Dasgupta, Huq, and Wheeler 1997; Lin 2013; and Wang et al. 2003). Chen (2013) also found evidence of local protectionism. For instance, enterprises owned or closely affiliated with local governments were more likely to be sheltered from environmental charges compared to other enterprises. The local economy's reliance on enterprise revenues was found to be negatively correlated with the stringency of the enforcement of pollution charges, which was itself negatively correlated with chemical oxygen demand (COD).

Malaysia introduced effluent fees, paired with licensing, to control pollution from the palm oil and rubber industries in 1978; notably, it was one of the first market-based instruments in the world (Hojat and Rahim 2012; Rahim 2005; Stavins 2001; and World Bank 1997). The Environmental Quality (Prescribed Premises) Regulations required that crude palm oil mills apply for an operating license every year and stipulated discharge standards for biochemical oxygen demand (BOD) and seven other pollutants. The annual license fee depended on the facility's projected BOD load: RM10<sup>5</sup> per ton of BOD up to 5,000 milligrams per liter (mg/l) and an additional RM100 per ton exceeding the standard. Over time, the effluent standards became more stringent. The standard for BOD was gradually reduced on a yearly basis, reaching 100 mg/l by 1984. A year after the imposition of discharge standards, in 1978, the pollution load in Malaysia fell by more than half (Catelo, Francisco, and Darvin 2016). Over a span of 2 decades the organic pollution load decreased by about 90%. Firms that owned crude palm oil and rubber mills also invested in wastewater treatment technology innovation. For example, some firms developed commercial by-products (i.e., animal feed, fertilizers, and biogas) from the effluent, thus avoiding the cost of treatment, as well as the pollution charges.

Discharge fees used in Laguna Lake, Philippines, which were introduced in 1997, led to an 88% decrease in BOD discharges between 1997 and 1999 (Stavins 2001 and Wheeler et al. 2000). Within 10 years of the introduction of the environmental user fee system, the industry sector's contribution to lake pollution was reduced from 40% in 1997 to only 11% in 2006. In addition, this system also led to the following actions that brought about reduction in wastewater discharge to the lake: (i) increased wastewater treatment efforts among the regulated sources by building new or improving existing treatment facilities; (ii) wastewater recycling activities; (iii) waste minimization; and (iv) voluntary closure or plant relocation (Catelo, Francisco, and Darvin 2016).

### **Nutrient taxes can address nonpoint source pollution of water from agriculture.**

Nonpoint source pollution, such as agricultural runoff, poses a different set of challenges. Unlike point source pollution, nonpoint source pollution is difficult to observe or monitor, so taxing discharge is not possible. Surface water and groundwater pollution of nutrients causes eutrophication, algal blooms, and harmful effects to human health. However, agricultural sources of nutrients are dispersed and difficult to identify, therefore raising a complex policy issue (Pearce and Koundouri 2003). Nutrient taxes are an input-based policy instrument used to reduce pollution. There are three types of nutrient taxes: (i) the mineral fertilizer tax targets artificial fertilizers, (ii) the nutrient input tax targets animal fodder nutrients (i.e., organic fertilizers), and (iii) the nutrient loss tax targets application residuals, which is ex-post loss from the root zone (Andersen 2013). There are also output-based policies encouraging farmers to substitute to less fertilizer-intensive crops through either taxes or subsidies (Sun, Delgado, and Sesmero 2016).<sup>6</sup>

<sup>5</sup> \$1 = RM3.9 in early 2018.

<sup>6</sup> In theory, output subsidies create similar effects as input subsidies in terms of encouraging excessive application of nutrient.

However, rather than taxing fertilizer to address runoff, many developing countries subsidize fertilizer prices to keep costs down for farmers. In an effort to increase agricultural productivity, farmers are charged less than the market price for fertilizer. This is the case for Chile, India, Indonesia, Malawi, the PRC, and Sri Lanka (Andersen 2013). In other cases, there are incentive payments to encourage land use change; these incentives also encourage destructive behavior rather than discourage it. In these countries, a reduction of perverse incentives would be an important first step in addressing pollution from agricultural sources.

### **Tradable discharge permits systems require a strong regulatory framework and monitoring infrastructure to be effective.**

In a system of tradable discharge permits, the water management authority sets the maximum amount of emissions for a particular ecosystem. Then, the total amount of emissions is divided into a fixed number of permits. After the initial allocations (through auctions or past levels of discharge), the holders can be allowed trade their permits in a secondary market (Borghesi 2014). Through this system, pollution abatement can be allocated to firms that have the most efficient production and abatement technologies. In practical applications, tradable permits have often been found to outperform taxes and voluntary best management practices in terms of welfare and environmental effectiveness (Borghesi 2014; Johansson and Moledina 2005; and Young and Karkoski 2000). The political feasibility of a tradable permits program is also often higher than for an environmental tax because the initial allocation of rights to legally discharge emissions has a high market value (Borghesi 2014). As one example, the tradable permits system for the Hunter River in Australia was successful in inducing 11 coal mines and two electrical centers to reduce the introduction of saline water into the river. This was due to strong institutional capacity to regulate the market and reduce the uncertainty for trading agents (Borghesi 2014).

The success experienced through the trading scheme on the Hunter River encouraged other countries, such as the PRC, to follow (Borghesi 2014). There is a large potential gain from introducing transferability. For example, on the Nanpan River in the PRC, a non-tradable water pollution permit system was established for point sources in 1992. The potential cost savings of switching from a non-trading system to a trading system were estimated to be around 20% (Tao et al. 2000).

There are, however, design and implementation challenges. There are often information asymmetries between the regulator and market participants. For example, the regulator needs to establish the proper number of permits. There are also regulation and monitoring challenges, where the regulator must establish ecological objectives, issue sanctions, and continuously monitor the market's competitiveness (Borghesi 2014). Obviously, tradable discharge permits are only effective if total discharges are strictly regulated. However, in many locations in Asia, this prerequisite is not yet met.

For example, since 2008, the PRC's Ministry of Ecology and Environment and Ministry of Finance have selected seven provinces to pilot water pollution trading programs, though trades have not yet occurred (Government of the PRC, Ministry of Ecology and Environment 2008 and Zhang, Zhang, and Bi 2012). Of the seven locales, Lake Tai is one of the most prominent.<sup>7</sup> In 2008, COD emissions trading was planned to be piloted in the Taihu River Basin, which would have given rise to the largest market for emission permits in the PRC at that time. Both existing and new enterprises were required to purchase emission permits. During 2009–2010, permits for 84,600 tons of COD emissions were traded in transactions worth over CNY100 million in total. However, it has been difficult to expand the pilot to a national scheme due to the lack of a legal basis at the national level and the

<sup>7</sup> The Tai River Basin was one of the most economically advanced, industrialized, urbanized, and populated in the PRC. The area was subject to severe pollution and limited environmental capacity. The clash between economic development and protection of water quality was particularly evident. The Taihu Lake and its water system continued to deteriorate. The water body was moderately eutrophicated and the water quality was rated the lowest by the PRC's water quality rating system. At the end of May 2007, an extraordinarily large bloom of blue-green algae in Taihu heavily contaminated its waters and triggered a drinking water crisis for nearly one million residents in Wuxi.

absence of reliable monitoring of pollutant emissions. Direct transactions among polluters have been infrequent and the market liquidity was low early in the pilot program.

As a result, water emissions trading has not spread in the PRC (or the rest of Asia). In one study on the implementation of a pilot water pollution trading scheme in the Tai Lake Basin in the PRC, this was attributed to policy conflict around the “Energy saving and emissions reduction” mechanism, which is a pollution reduction quota inducing local governments to push new pollution reduction projects, such as producer requirements to procure new equipment or higher emissions discharge standards. Given the uncertainty surrounding future energy saving and emissions reduction, such a policy conflict undermines firms’ incentives to engage in trading of water pollution permits; they may be more likely to store their allowances instead of selling (Zhang, Zhang, and Bi 2012). While the uses of policy mix have become widespread in dealing with environmental problems, the conflicts among different policy instruments need to be taken into consideration in policy formulation and implementation. Information requirements and regulatory complexity can thus discourage governments and firms from establishing tradable discharge permit markets for water pollution.

### **Incentives are needed to stimulate investments in green infrastructure for reducing runoff.**

In Asia’s rapidly growing cities, surface runoff of rainwater has become a major source of water pollution and flooding, resulting from inadequate drainage infrastructure, impervious pavement surfaces, and increasing extreme weather events linked to climate change. The use of green infrastructure approaches, such as rainwater collection systems, green roofs, permeable pavements, and nature-based solutions for drainage (like constructed wetlands), are effective solutions for managing runoff as an alternative or complement to traditional flood protection infrastructure. These can also bring other benefits to cities, including carbon emissions reduction, water security, mitigating urban heat island effect, and improved mental and physical health among residents from having more green spaces. One key example is the “sponge cities” model piloted in Pingxiang in the PRC, which employs a range of green infrastructure measures, such as retention ponds, sunken parks, and stormwater wetlands, to absorb, store, and release rainwater (ADB 2017). Policy instruments can facilitate the uptake of green infrastructure projects. A range of development, financing, and tax incentives have been put in place to encourage investments and installation of green infrastructure for residential and non-residential users. For example, Singapore has a Skyrise Greenery Incentive Scheme, which funds up to 50% of the cost of installing rooftop and vertical greenery (Government of Singapore, National Parks 2020). In the Philippines, the Rainwater Harvesting Facility Act requires all new developments of at least 1,500 square meters to maintain at least 3% of its total area as a rainwater harvesting facility before securing a building permit (Government of the Philippines, House of Representatives 2019). Information must be made available to urban developers, property owners, and investors to understand the risk profile of investing in green infrastructure.

### **Information disclosure instruments may create incentives for adopting environmentally responsible practices.**

Public disclosure of firm pollution may correct information asymmetries and increase polluters’ costs of non-compliance (García, Sterner, and Afsah 2007). In Asia, information disclosure schemes have been used in India (Powers et al. 2011), Indonesia (Afsah, Laplante, and Wheeler 1997; Dasgupta, Wheeler, and Wang 2007; and García, Sterner, and Afsah 2007), the Philippines, the PRC (Wang et al. 2004), and Viet Nam (Dasgupta, Wheeler, and Wang 2007). The Program for Pollution Control Evaluation and Rating (PROPER) case study (Box 4) offers a useful illustration of a successful information disclosure campaign in Indonesia.

Other examples include India’s Green Rating Project (Powers et al. 2011), which targeted the environmental performance of the largest pulp and paper plants using detailed plant-level data. Green Watch in the PRC is a program that rates and publicly discloses firms’ environmental performance. Overall performance improved during both of the two Green Watch pilot programs, with compliance rates increasing 10% in Zhenjiang and 39% in Hohhot (Wang et al. 2004).

### Box 4: Case Study on the Information Disclosure for Waste Reduction Program in Indonesia

**Context and description of the problem and application.** In the 1980s, water pollution was severe in Indonesia due to rapid industrialization, fast population growth, and urbanization. Despite efforts to reduce pollution levels using command and control regulations, water quality remained severely degraded.

**Description of policy instrument.** In 1995, the Program for Pollution Control Evaluation and Rating (PROPER), a public disclosure program, was launched. PROPER selected companies that were deemed major contributors of river pollution, and they were rated according to a five-color performance scheme: gold, green, blue, red, and black. These colors corresponded to the pollution control, with gold and green ratings representing clean technology adoption. Companies with high ratings received public praise, which increased demand for their products. Companies with blue, red or black ratings were placed under stricter regulatory oversight and enforcement.

PROPER's operation had three main steps: data collection and verification from participating factories, data analysis, and assigning ratings followed by public disclosure.

**Main findings related to criteria.** PROPER had yielded quick and positive responses in raising the level of environmental compliance among industrial firms and the positive impacts remained in the succeeding months. PROPER's information accuracy was considered trustworthy since the program not only utilized data from prior programs but also collected both self-assessment data provided by the companies as well as primary field data from environmental inspectors. In addition, PROPER gained high political feasibility and was well-received by the public.

PROPER induced firms to reduce their pollution level but also created an incentive to adopt greener production practices. PROPER was successful in achieving the environmental target at a relatively low cost.

**Generalizable findings.** PROPER success demonstrates that the public at large, when empowered, can incentivize firms to control pollution. Providing information on firms' environmental performance can be a low-cost intervention and provides the necessary monitoring for increased regulatory oversight.

PROPER faced challenges related to its credibility, an uncertain public reaction, and selection of participants.

A public information disclosure program could reach greater scopes and larger impacts when there is participation by all stakeholders, i.e., government, nongovernment organizations, investors, suppliers, consumers, employees, the public at large, and the regulated entries. A critical component of the success of the program was the transparency of the rating system and data collection efforts.

Sources: S. Afsah and J. R. Vincent. 1997. *Putting Pressure on Polluters: Indonesia's PROPER Program*. Harvard Institute for International Development. <https://www.performeks.com/media/downloads/vincent.pdf>; J. H. García, S. Afsah, and T. Sterner. 2009. Which Firms Are More Sensitive to Public Disclosure Schemes for Pollution Control? Evidence from Indonesia's PROPER Program. *Environmental and Resource Economics*. 42 (2). pp. 151–168.; P. Kanungo and M. M. Torres. 2003. *Indonesia's Program for Pollution Control, Evaluation, and Rating (PROPER)*. <https://pdf4pro.com/view/indonesia-s-program-for-pollution-555ba.html>.; and S. Reliantoro. 2012. *The Gold For Green: How the Gold PROPER Award Drives Five Major Companies Achieve Innovation, Value Creation and Environmental Excellence*. <https://proper.menlhk.go.id/propercms/uploads/magazine/docs/buku/buku-proper.pdf>.

## Market-Based Instruments to Tackle Failure to Protect and Value Ecosystems

Healthy ecosystems are essential for maintaining water supply, water quality, and other environmental services. Evidence shows that long-term measures and investments to protect ecosystems are more cost-effective than spending for ecosystem rehabilitation. However, due to lack of knowledge and capacity, many policy makers have failed to recognize the economic value of healthy ecosystems and build on basin-wide and cross-sectoral synergies needed for improved water management (United Nations World Water Assessment Programme 2015). In response, there are a number of Asian countries that have used market-based approaches to improve ecosystem conservation.

### **Scaling up payments for ecosystem services schemes shows promise.**

There have been increasing efforts to implement and invest in payments for ecosystem services (PES) schemes in developing countries, addressing a range of environmental needs, including watershed protection and biodiversity conservation. PES schemes have been implemented in a number of countries in Asia, with varying levels of success. Programs employing similar instruments, designed specifically for local and national contexts, have also been rolled out. For example, ecological compensation programs in the PRC encompass a broad range of approaches that account for the costs of environmental goods and services, reward ecosystem protection, compensate for environmental damage, and impose polluter charges (Lopez and Bennett 2017).

Experiences in the region have demonstrated promising results for environmental performance (Adhikari and Agrawal 2013). For example, in the PRC, the Sloping Land Conversion Program (SLCP), which is considered the country's first national PES program, aims to convert farmland on slopes to forest or grassland, to reduce soil erosion and sedimentation from slopes down into waterways. Participating farmers are compensated with an annual grain subsidy, a cash subsidy, and upfront provision of tree seedlings. The program scaled up from an initial pilot phase covering three provinces in 2001 to 25 provinces in 2006, increasing the rate of land conversion more than six times over the same period (Bennett 2008; Kolinjivadi and Sunderland 2012; and Xu et al. 2010). In Nepal, the government initiated a conservation program for the Kulekhani watershed. The program aimed to reduce sedimentation and increase the reservoir's lifespan as well as improve land use management through community forestry, fruit planting, terrace improvement, and conservation education. As a result, the program was able to reduce siltation, increase dry season water flow, and expand additional water availability due to forest conservation in the upstream watershed (Adhikari 2009 and Upadhaya 2005).

However, some studies suggest that while PES schemes in Asia have shown positive environmental impacts, there are still gaps in terms of social gains. Studies reviewing PES schemes implemented in six Asian countries found that while they delivered higher levels of impact on environmental sustainability, they did not perform as well in supporting equity, participation, and livelihoods. This is complicated by insecure property and tenure rights to land and forest resources, high transaction costs from implementation, and lack of information dissemination and public awareness about the PES scheme (Adhikari 2009 and Adhikari and Agrawal 2013). For instance, weak property rights and lack of social capital development have affected the long-term sustainability of the PRC's SLCP (Adhikari and Agrawal 2013; Grosjean and Kontoleon 2009; and Tu et al. 2011).

The success of PES schemes also depends on well-informed valuation studies. Ecosystem valuation quantifies the price or value that consumers would be willing to pay or apply to protect ecosystem services, which can be incorporated into national income accounts as well as used to inform country planning and decision-making (Boelee 2011 and Costanza et al. 2014). Ecosystem valuation captures the benefits of ecosystem services in economic terms, which are shown to exceed the costs of water-related investments in ecosystem conservation (Costanza et al. 2014). Valuation methods, coupled with information on how resources are used by involved communities, can help design markets for ecosystem services (Adhikari 2009).

While there are many factors necessary for the successful implementation of PES programs, there are emerging examples where environmental and social benefits are achieved. One successful case study in Viet Nam deals with a PES program to protect watersheds that had been overexploited. After a period of piloting, the PES program was implemented at the national level in 2011. The program helped to reduce the government's financial burden for forest conservation and protection, as well as improved economic conditions and created sustainable livelihoods for communities protecting and managing the forests. As of mid-2016, \$257 million was collected for the protection of 5.6 million hectares of forest, while more than 500,000 households, made up of mainly ethnic minorities and poor households living in the forested area, received money from the scheme (Vietnam Forest Protection and Development Fund [VNFF] 2016). One key feature is that Viet Nam devolved forestland use rights from the state directly to households. This type of reform is distinct from other countries that devolved rights from state to community in the form of community-based forest management. While the individual household contracts for service providers imply high transaction costs, the program demonstrated the high administrative capacity of intermediary agencies to ensure well-defined terms to each contract, an efficient payment scheme, and effective monitoring and evaluation. With community contracts to lower transaction costs, coupled with government capacity, such payment schemes could be even more attainable for other countries and contexts.

## Conclusions and Lessons Learned

When properly designed and implemented, MBIs can be cost-effective tools to promote efficient water use and reduce water pollution. MBIs allocate water resources to maximize net benefits to society, and they can reduce water pollution to specified targets at the least cost. However, in practice, MBIs in the water sector in ADB developing member countries have often suffered from poor design, implementation, and monitoring and enforcement. Careful consideration of the choice of MBIs and the use of multiple policy instruments is needed.

### **Behavioral nudges can complement MBIs to influence decision-making on water use.**

New directions for the application of MBIs and flexible policy instruments to address water challenges in Asia may include behavioral nudges that use psychological interventions or changes in choice structure to influence the behavior and decision making of the water user (Russell and Fielding 2010). This is an emerging approach that could complement the use of MBIs. Tools such as social comparison messages (Ferraro and Price 2013 and Torres, Marcela, and Carlsson 2016), information provision on water quality (Brown et al. 2017), a combination of technical information, moral persuasion, and social comparison (Bernedo, Ferraro, and Price 2014), social norms (Datta 2005), and education campaigns (Szabó and Ujhelyi 2015) have been experimented in the water sector around the world. Nudges must be clearly distinguished from marketing, where the former directs users to perform specific actions that benefit people, while the latter appeals to consumers to purchase specific products or services that benefit businesses and profits (Mont, Lehner, and Heiskanen 2014). However, most of these experiments found only small effects of the nudges in reducing water consumption or non-payment. They are likely to be most attractive for short-term use during droughts and in middle-income countries where households already have sewer connections and where wastewater treatment is already provided.

### **Creating and defining property rights is necessary for successful implementation of MBIs for water pollution.**

MBIs to address water pollution require creating and defining property rights, which can be challenging for a number of reasons. First, property rights must be defined simply and clearly enough to be easily traded, while also sufficiently reflecting the reality and complexity of the underlying ecosystem service. Second, property rights

must also align with existing institutional and legal frameworks. Third, the nature of the property right will depend on the characteristics of the good or service and the proposed market structure. For example, water rights require a strong institutional framework, as they are intended to be traded among landholders, requiring certainty for individuals to invest in water rights and related infrastructure. Fourth, property rights must also account for the variable nature of water availability. Hence, most water rights confer an entitlement that depends directly or indirectly on the amount of water stored upstream.

The policy goal of ensuring that water is available for the environment and downstream users requires that rights are clearly verifiable. For instance, by installing meters, water markets and water users (companies or individuals) can trade rights or entitlements to use water at the market equilibrium price (Easter and Liu 2005; Gómez, Delacámara, and Pérez-Blanco 2013; Hanak et al. 2011; Rey, Calatrava, and Garrido 2011; and Young 2010). Water markets depend on supply and demand forces to determine the price for irrigation water. They are also more flexible than centrally controlled allocation mechanisms (Johansson et al. 2002 and Mariño and Kemper 1999). Water markets allocate water to the highest value use by allowing farmers to sell their water-use rights to the highest bidders (Cornish et al. 2004). The economics of water markets parallel those of tradable emission permits (i.e., cap-and-trade programs); however, instead of capping emissions, the quantity of water used or extracted is capped. Often, overall constraints on water abstraction are set and converted into a property right to use water (Gómez, Delacámara, and Pérez-Blanco 2013 and Howe 2000). Common policy objectives of water markets include curbing water scarcity, reducing drought exposure, increasing resilience through reallocating risks, creating opportunities to save and conserve water, and improving water allocation efficiency (Gómez, Delacámara, and Pérez-Blanco 2013).

Water markets are becoming more common, with successful global experiences showing that substantial economic gains and increased optimization of water resources use are possible. However, there have been experiences in the global context that have revealed design flaws, but these have led to proposed solutions and guiding frameworks. As water markets require sophisticated institutional arrangements, this policy instrument has only recently been explored in Asia, with pilot water markets emerging in the PRC in the last decade. The pilot projects in the PRC experienced challenges with implementation. In the Heihe River Basin, the system was difficult to implement, and trading was not popular. Additionally, both groundwater and surface water use surpassed the quotas.

### **A hybrid policy of information provision and effluent charges may achieve pollution reduction goals.**

Effluent charges and pollution taxes for industrial pollution in Asia in general have been set too low and enforcement has been weak. There are often political concerns that taxes and charges might hinder economic growth. Moreover, investment in regulatory enforcement has not been sufficient. On the other hand, information provision and labeling instrument for point source water pollution has proved to be successful in several countries such as Indonesia, Malaysia, the Philippines, and the PRC.

Previous experience suggests that a policy mix consisting of both information provision and effluent charges is the best way forward in most locations. Effluent charges provide polluters a continuous incentive to innovate and to find the least-cost pollution abatement options. Information provision can eliminate information asymmetries between polluters and the public, as well as increase the political pressure on industries to abate.

**Expanding PES schemes shows promise, under the right conditions.**

While challenging to design and implement, experiences in Asia show promise and provide useful lessons for expanding PES programs in the region. Studies show that there are a number of enabling conditions required to scale up successfully, including political support, sustainable financing, lean institutional setup (including cross-sectoral coordination across government agencies), effective tools and systems, clearly demonstrated impact, and flexibility to adapt to different conditions across target ecosystems and communities. Social benefits can also facilitate political will and resources to drive and expand PES programs and environmental investments (Porras 2015; Porras 2018; and Porras, Steele, and Mohammed 2016).

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# 4

## Market-Based Approaches to Waste Management in Asia

### KEY MESSAGES

- Urbanization and rising production and consumption are driving large amounts of waste generation in Asia, much of which is mismanaged and leaks into the world's oceans.
- Effective waste management strategies must have an integrated approach and facilitate value creation to reduce waste and efficiently use materials and products.
- There are three key points for managing waste: upstream waste reduction, household and industrial waste collection, and waste processing.
- Broader application of market-based instruments (MBIs) for solid waste management will require legislation to define both property rights and responsibilities related to waste.
- Property rights and incentives created by MBIs are central to reduce waste and enable waste beneficiation.
- Policy interventions should be directed toward the waste hierarchy; upstream waste reductions should be prioritized.
- Waste management policy needs to be cognizant of different waste streams, and policies aimed at waste beneficiation should target specific waste streams.
- Taxes, fees, and charges benefit from their simple design, facilitate cost recovery, and are often effective in reducing upstream waste generation, but require monitoring and enforcement.
- Extended producer responsibility schemes can ensure that waste generation costs associated with production are internalized by producers, but they require complementary policies that necessitate the use of recycled components in product design and other innovative solutions to be effective.
- Hybrid policies such as deposit-refund schemes can support waste collection and sorting at the source.
- Scope exists to extend the use of information provision and voluntary agreements to encourage more responsible production.
- Integrating the informal waste sector into solid waste management systems can help with waste collection and materials recovery, while also creating jobs and addressing poverty.

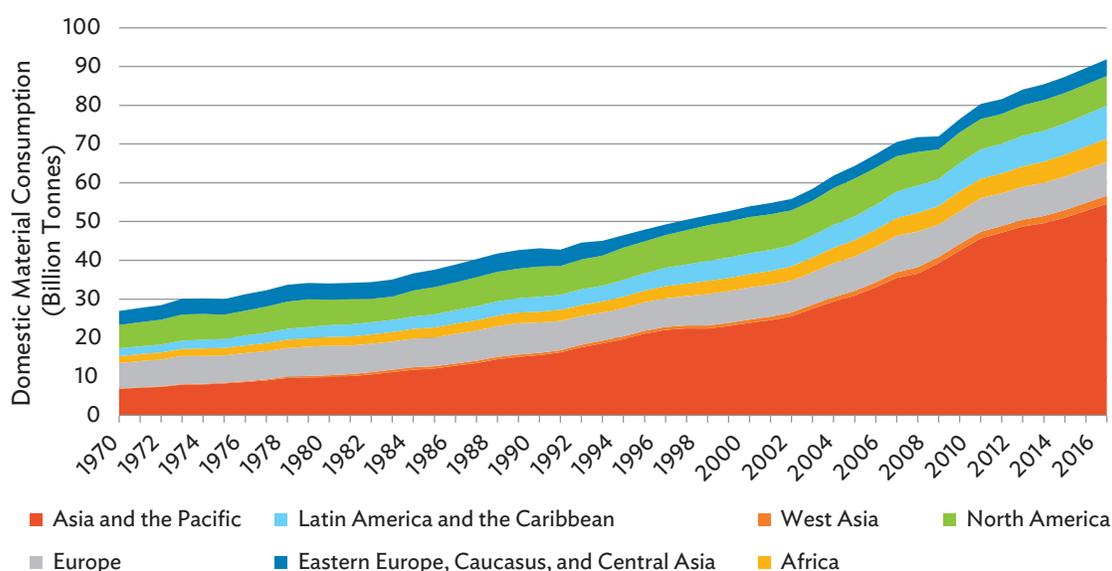
## Resource Use and Consumption in Asia

### Urbanization, rising domestic consumption, and export-oriented production are driving waste generation in Asia.

With a population of 4.5 billion people and rapidly rising incomes, Asia is seeing an unprecedented increase in consumption levels. Asian urban populations are growing at an average of 1.5% per year, faster than any other major region in the world (United Nations [UN] 2014). This rapidly growing group of urban residents with disposable incomes and access to markets will present a key challenge to Asian cities that have to manage municipal solid waste (MSW) in the next few decades. Medium-sized cities and cities with fewer than one million inhabitants are growing the fastest, and ensuring that these cities have the capacity to cope with the challenge of waste management will be a key to establishing a sustainable trajectory.

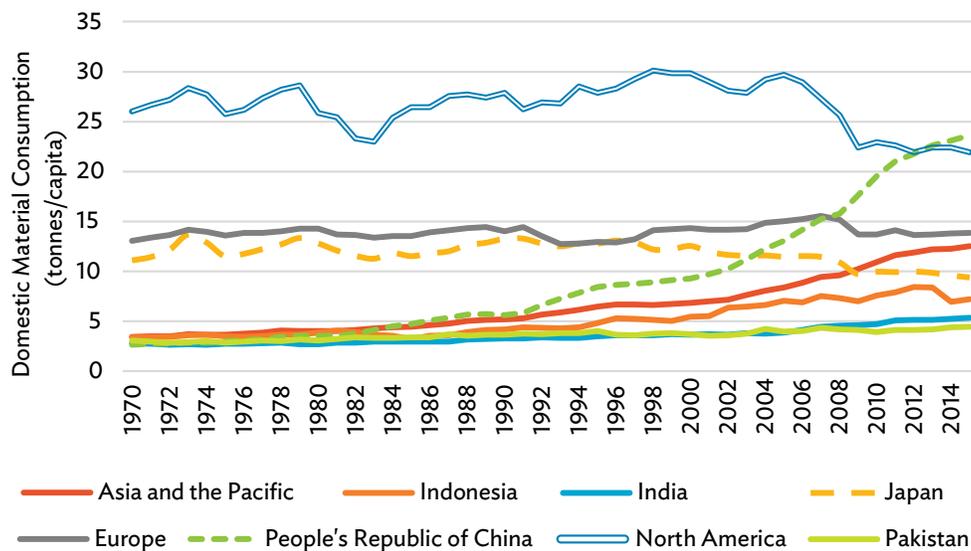
Figure 3 and Figure 4 illustrate the immense growth in domestic material consumption in Asia and the Pacific over the past 4 decades, reflecting the rise in both production and consumption. Domestic material consumption is defined as direct, gross physical domestic extraction of materials from the environment within a nation's territory, plus direct physical imports minus direct physical exports of materials (UN Environment Programme [UNEP] International Resource Panel 2017). While domestic material consumption does not translate into an equal amount of waste generated, the continued trend of significant growth in domestic material consumption will likely translate into the generation of significantly more waste in Asia. The People's Republic of China (PRC), in particular, has been an important driver of this growth and is now close to North America in per capita terms of domestic material consumption. It is also important to note that Asia is a diversified continent with an average waste produced per household per day varying from as low as 0.22 kilograms in Mongolia to 0.94 kilograms in Singapore.

**Figure 3: Domestic Material Consumption**



Note: Domestic material consumption is defined as direct, gross physical domestic extraction of materials from the environment within a nation's territory, plus direct physical imports minus direct physical exports of materials.

Source: United Nations Environment Programme, International Resource Panel. Global Material Flows Database (accessed 28 February 2018). <https://www.resourcepanel.org/global-material-flows-database>.

**Figure 4: Per Capita Domestic Material Consumption**

Note: Domestic material consumption is defined as direct, gross physical domestic extraction of materials from the environment within a nation's territory, plus direct physical imports minus direct physical exports of materials.

Source: United Nations Environment Program International Resource Panel, Global Material Flows Database. <https://www.resourcepanel.org/global-material-flows-database> (accessed 28 February 2018).

In addition, almost half of the world's manufacturing production takes place in Asia and the Pacific (United Nations Industrial Development Organization [UNIDO] 2018), and a mixture of inadequate legislation and enforcement, as well as externalized costs of waste from production, have led to the development of unsustainable production processes. This poses an acute threat to human and environmental health with global implications.

This unprecedented increase in production and consumption in Asia, associated with the increase in the material burden of the economy, calls for a need for increased resource efficiency. This requires more efficient, less material-intensive, and more environmentally friendly production processes as well as the reduction and recycling of waste.

## Solid Waste: Definitions, Statistics, Trends

### Policies aimed at waste beneficiation should target specific waste streams.

Solid waste emanates from different stages of production and consumption. Different countries have their own definitions for particular categories of waste (Kawai and Tasaki 2016). Understanding these distinctions is important for crafting effective policies. Policy instruments that may be suitable for a particular type of waste or targeted at a particular stage of the waste-creation process may be unsuitable for others. Table 15 provides examples of waste streams.

Table 15: Waste Streams

Agricultural waste	Hazardous waste	Nuclear waste (see: Radioactive waste)
Animal by-products	Heat waste	Packaging waste
Biodegradable waste	Household waste	Post-consumer waste
Biomedical waste	• Household hazardous waste	Radioactive waste
Bulky waste	Human waste	• Low-level waste
Business waste		• High-level waste
Chemical waste	Industrial waste	• Mixed waste (radioactive or hazardous)
Clinical waste	• Slag	• Spent nuclear fuel
Coffee wastewater	• Fly ash	Recyclable waste
Commercial waste	• Sludge	Residual waste
Composite waste	Inert waste	Retail hazardous waste
Construction and demolition waste	Inorganic waste	Sewage
Consumable waste	Kitchen waste	Sharps waste
Controlled waste	Litter	Ship disposal
Demolition waste	Liquid waste	Slaughterhouse waste
Domestic animal waste	Marine debris	Special waste (see: Hazardous waste)
Electronic waste (e-waste)	Medical waste	Toxic waste
Food waste	Metabolic waste	Uncontrolled waste
Gaseous waste	Mineral waste	Waste heat
Green waste	Mixed waste	Wastewater
Gray water	Municipal solid waste	Winery wastewater

Source: Asian Development Bank.

### Levels of solid waste in Asia are growing rapidly.

Projections suggest that solid waste generated by the world's cities will increase to 2.2 billion tonnes by 2025, with growth in waste quantities being fastest in Asia (Bhada-Tata and Hoornweg 2012). Waste production in East Asia, the Pacific, and South Asia, are expected to more than double by 2025 from their 2012 levels. In contrast, total waste production in the 34 Organisation for Economic Co-operation and Development (OECD) countries, while starting from a high base, are likely to remain relatively constant, if not to decline in the future, as a result of increasingly stringent regulation, slowing population growth, and changing consumer attitudes (Kawai and Tasaki 2016). In Asia, the combination of waste from unsustainable production and consumption means that improved waste management is now an issue of fundamental importance for the ecological and social welfare of the region. It is also a global issue.

MSW is one of the largest components by weight of total solid waste in urban areas, but rates vary significantly across countries, with agricultural, industrial, and construction and demolition waste being the other major components of solid waste. High-income countries still produce roughly 46% of all MSW (Bhada-Tata and Hoornweg 2012). However, high collection rates and modern processing techniques in the majority of rich countries contribute to lower levels of environmental and social harm. Waste collection rates are around 73% in East Asia and the Pacific and 64% in South Asia, compared to a collection rate of 98% in the OECD member states (Bhada-Tata and Hoornweg 2012).

## Eight of the top 10 economies with the most mismanaged plastic waste are in Asia.

When ranked according to the mass of mismanaged plastic waste, 8 of the top 10 countries in the world are situated in Asia (Jambeck et al. 2015).<sup>8</sup> Much of this plastic ends up in the world's oceans via rivers, and a recent study found that 10 rivers contribute to around 90% of the plastic in the world's oceans. Of the 10, 8 of these are also in Asia, including the Yangtze, Indus, Yellow, Hai He, Ganges, Pearl, Amur, and Mekong rivers (Schmidt, Krauth, and Wagner 2018). Asia produces 41% of the world's e-waste, and only 15% of this is documented to be collected and recycled (Baldé et al. 2017).

These statistics point to an urgent need for action and better tools to meet the growing quantity of waste being generated in Asia. In the absence of well-designed, effective waste management schemes, including the effective use of economic tools available to policy makers, unmanaged waste is likely to have severe environmental and social consequences in the coming decades, especially in rapidly growing cities.

Solid waste management is also a critical component of meeting the Sustainable Development Goals (SDGs), as outlined in Box 5.

### Box 5: Solid Waste Management and the Sustainable Development Goals

Waste management is an integral part of the Sustainable Development Goals (SDGs). It is directly linked to at least seven of them:



**Goal 12: Responsible Consumption and Production.** Numerous production practices are still inefficient, and rates of consumption result in an immense material burden on the world. Action is needed to reduce upstream waste from production processes, improve the collection of waste, and improve processing, reuse, and recycling of waste to make both production and consumption sustainable.



**Goal 3: Good Health and Well-Being.** Hazardous waste and inadequate waste management processes pose a direct threat to human health.



**Goal 6: Clean Water and Sanitation.** Inadequate waste management poses a risk to water pollution as hazardous materials leach into ground and surface water sources.



**Goal 11: Sustainable Cities and Communities.** An integral part of ensuring that cities are healthy and sustainable living spaces lies in the reduction and efficient management of waste. Utilities need to be equipped to collect and process waste, but smart policies are also needed to reduce waste production upstream in the production process.



**Goal 13: Climate Action.** At present, a large proportion of waste in Asian countries is either uncollected or ends up in landfills. Landfills produce significant amounts of methane and other greenhouse gases, and methane from landfills is responsible for 12% of total global methane emissions.



**Goal 7: Affordable and Clean Energy.** The potential energy that is lost when waste is taken to landfills presents a lost opportunity to produce energy. The incineration of waste has been used successfully in many countries to produce a clean and renewable source of energy.



**Goal 17: Partnerships for the Goals.** Waste management is a problem that has both national and international implications. Waste streams often cross national boundaries, and the management of waste presents an opportunity for mutually beneficial regional partnerships and collaboration.

Sources: Government of the United States, Environmental Protection Agency. 2006. *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. and International Solid Waste Association. 2017. *Waste Management and the Sustainable Development Goals*. <https://marinelitter.iswa.org/media/news/detail/waste-management-and-the-sustainable-development-goals>.

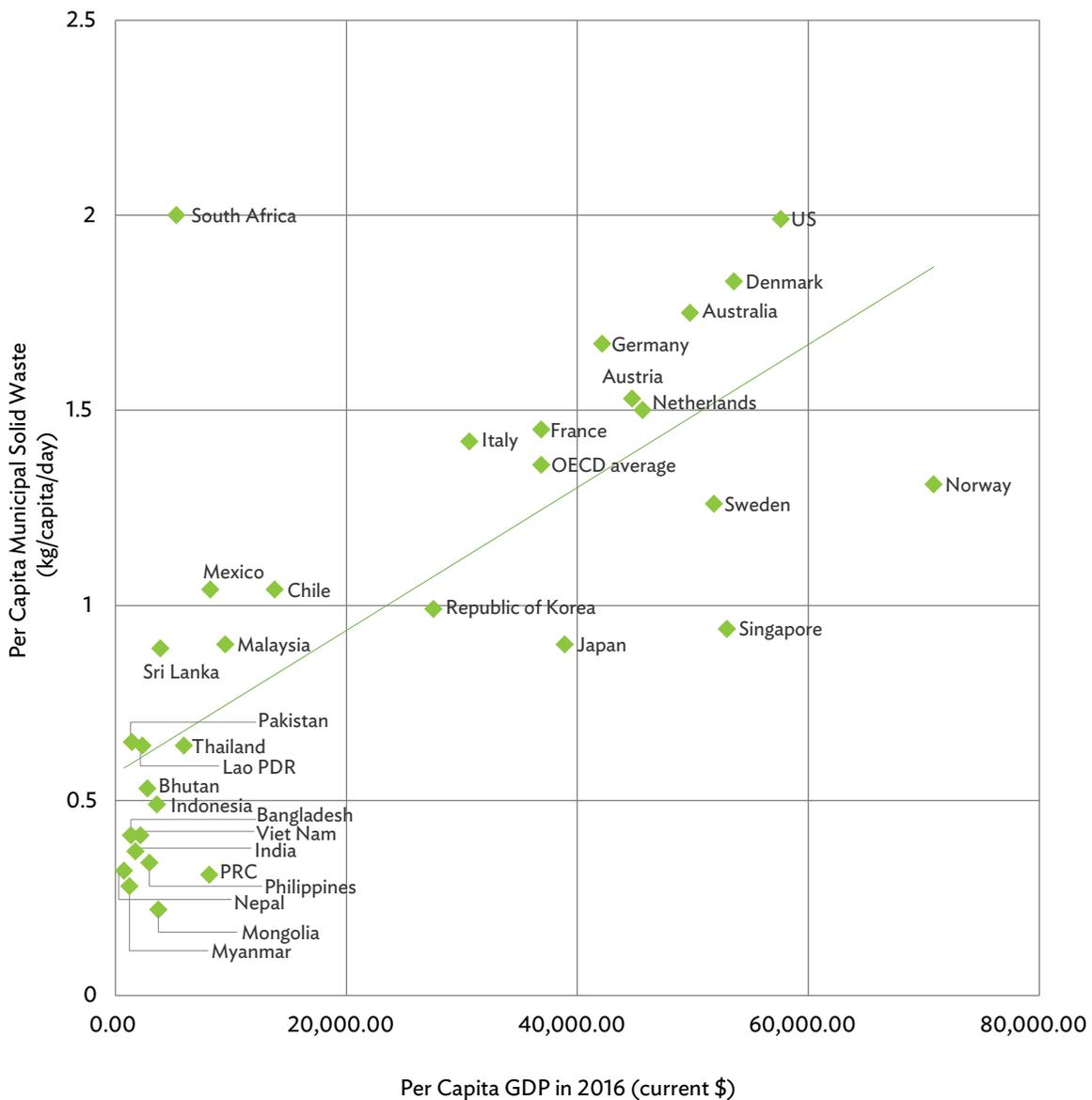
<sup>8</sup> The countries listed in order of percentage of total mismanaged waste are the PRC, Indonesia, the Philippines, Viet Nam, Sri Lanka, Thailand, Malaysia, and Bangladesh.

### Resource decoupling highlights the challenge of raising living standards while minimizing waste.

As incomes increase, people tend to consume more and generate more solid waste. Figure 5 shows the positive relationship between per capita levels of MSW generation and per capita gross domestic product (GDP).

However, the experience of countries like Japan, Norway, and Singapore suggests that it is possible to maintain high living standards while producing much less waste than, for example, Australia, Denmark, and the United

**Figure 5: Municipal Solid Waste Generation and Gross Domestic Product Per Capita**



GDP = gross domestic product, kg = kilogram, Lao PDR = Lao People's Democratic Republic, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China, US = United States.

Sources: K. Kawai, and T. Tasaki. 2016. Revisiting Estimates of Municipal Solid Waste Generation Per Capita and Their Reliability. *Journal Mater Cycles Waste Management*. 18. pp. 1–13. <https://doi.org/10.1007/s10163-015-0355-1>; and World Bank. GDP per capita (current US\$) <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD> (accessed 28 February 2018).

States. Per capita levels of MSW generation in Japan are roughly the same as those in Malaysia, Mexico, and Sri Lanka, even though Japan's level of GDP per capita is more than twice that of these countries. This illustrates that while the overall trend is for MSW generation to increase with higher living standards, this is not inevitable, with proper waste management systems in place. As Asian economies continue to grow, the dual challenge will lie in (i) breaking the trend of increased MSW with higher GDP and (ii) improving waste collection and processing to deal with the rising amount of total waste generation.

The challenge for emerging economies lies in decoupling economic growth and social well-being from excessive resource use and waste generation. This concept, known as “resource decoupling” and illustrated in Figure 7, is intimately linked to the efficiency with which natural resources are converted into economic outputs in the production chain (UNEP 2011). The related concept of “impact decoupling” relates to reducing the environmental impact of economic activity. The success of both of these goals will be important in fostering better waste management. To achieve this resource decoupling and to meet the SDGs, increased resource efficiency will be needed. Moreover, individual country experiences, as well as technological improvements, are showing that resource efficiency is often both practically attainable and a source of opportunity that can contribute to economic growth and job creation in itself. Resources can be used more efficiently in production processes. Approaches include extended producer responsibility, in which a producer is responsible for the entire life cycle of its product (as opposed to only its production) (Lindhqvist 2000); sustainable consumption and production; life cycle-based management; life cycle thinking; integrated solid waste management; the 3Rs (Reduce, Reuse, and Recycle); and the circular economy as well as resource efficiency.

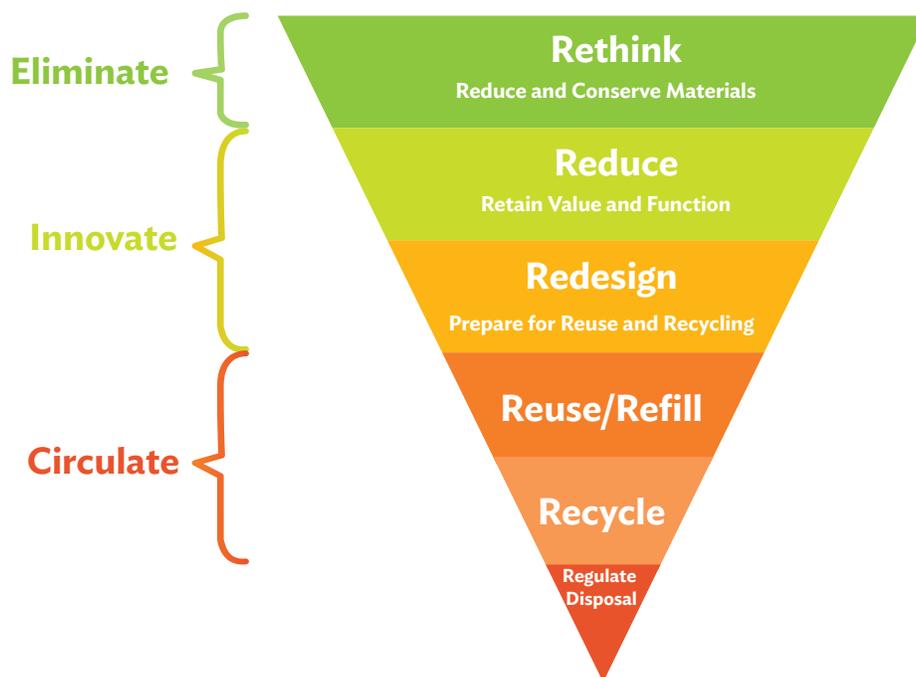
### **Value extraction is a key strategy to keep materials in circulation and reduce waste.**

Ideally, the quantity of solid waste produced should be reduced through innovative business models, greener production methods, and consumer choices. Figure 6 shows the hierarchy of waste management policies from most desirable (prevention) to least desirable (disposal).

Solid waste can be illegally burned or informally dumped in streets or rivers or on the edges of settlements, formally collected at homes or businesses and disposed of in landfills, or bought and sold in formal and informal markets. These processes not only have negative impacts on human health and the environment, but they also constitute a lost opportunity to extract value from waste. To extract value from waste, it can be separated at the source (e.g., household recycling bins), picked out of dumps and landfills and then separated by impoverished and unregulated entrepreneurs, or burned under controlled conditions to produce energy. Certain materials or products are also targeted by recyclers due to their high recyclability and value in the market, such as polyethylene terephthalate waste, which can be recycled to produce new bottles and packaging. Enabling institutional, policy, and regulatory frameworks, as well as supporting infrastructure, must be in place to facilitate value creation and improve how waste is managed.

An effective waste management strategy requires an integrated approach, often encapsulated by the 3Rs and emanating from the G8 Action Plan on Science and Technology for Sustainable Development adopted in 2004 (UNEP 2017). This means that waste management can be improved at various stages: (i) upstream waste production can be reduced, (ii) waste collection can be made more comprehensive and efficient, and (iii) waste processing can allow for reuse and recycling of disposed waste. Coherent and integrated policies for waste management develop specific goals for each stage of the waste hierarchy so that, over time, policies such as zero waste can be achieved.

**Figure 6: Action Hierarchy in the Circular Economy**



Sources: Adapted from European Commission [EC]. Waste Framework Directive. [https://ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-directive\\_en](https://ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-directive_en); and M. Goorhuis and A. Bartl. 2011. International Solid Waste Association Key Issue Paper on Waste Prevention, Waste Minimization and Resource Management. [https://www.iswa.org/index.php?eID=tx\\_iswaknowledgebase\\_download&documentUid=2359](https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=2359).

## Systematic Review of Market-Based Instruments for Waste Management in Asia

The analysis in this chapter is based on a systematic review of the academic literature on waste management in Asia. A total of 80 contemporary peer-reviewed journal articles concerning market-based tools for waste management were identified using a set and replicable protocol and classified by type of analysis, focus, and conclusions (Appendix has more details).

### **Legislation is required to define both property rights and responsibilities related to waste.**

It has been difficult to implement alternatives to dumping and landfilling in lower-income countries in Asia because of the lack of enabling legislation that incorporates private actors and all types of waste. Waste management has historically been the responsibility of municipal (local), provincial (state), or national (federal) levels, or some combination of all three tiers of government. Consequently, the traditional policy instruments for waste management are command and control-based. Their major feature is that regulatory bodies evaluate each instance of waste and then decide on the treatment.

Historically, non-hazardous waste was mainly disposed of in landfills. However, this practice has been internationally recognized to be harmful to the environment (El-Fadel, Findikakis, and Leckie 1997 and Lisk 1991). Consequently, alternative waste management options, including zero waste-to-landfill policies,

are now prominent features in many European countries (Bartl 2014 and Curran and Williams 2012). However, in developing countries, this objective is much more challenging because of the lack of enabling legislation that deals with all waste streams and incorporates the private sector. Consequently, there is increasing interest in MBIs for waste management that has seen the state look to the private sector to assist with waste management efforts.

Although entrepreneurs manage many kinds of waste in developing countries, these activities are often carried out by informal micro-enterprises (Medina 2008). Formal waste markets can be developed through overarching waste management legislation that is generic enough to provide flexibility for private actors to process all kinds of waste.

To enable the market to do its job effectively, property rights for waste must be clearly defined. Depending on the waste stream, different instruments will be applicable. But each waste stream has to deal with the same set of issues pertaining to the upstream and downstream, demand- and supply-side aspects of the waste value-chain, including waste collection, storage, treatment, prevention, recycling, reuse, and (increasingly) export. Entrepreneurs in one country will often purchase waste from other countries; this means that the transboundary movement of waste must also be incorporated into domestic waste management policies. The public must also be engaged to raise awareness of how much waste they are producing. In that way, both the production and the consumption of waste can be targeted.

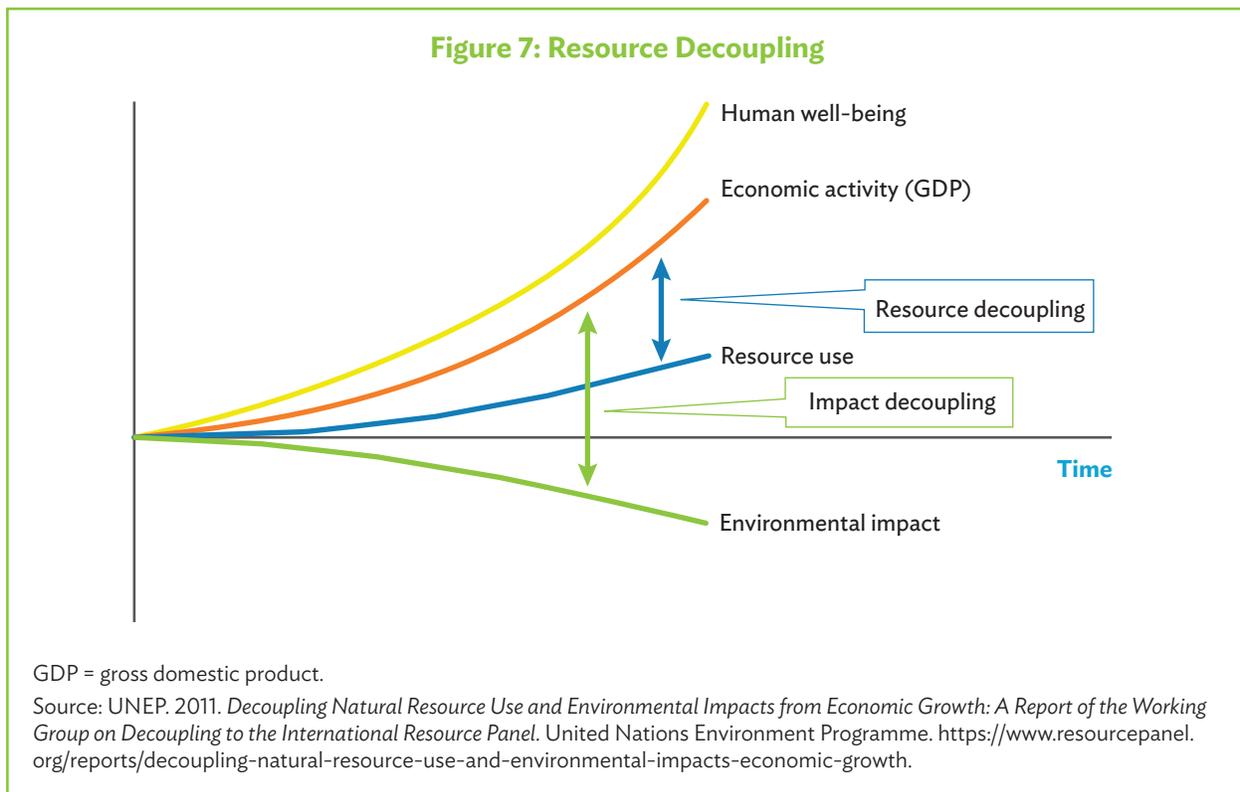
### **Incentives and institutional strengthening are central to reduce waste and enable waste beneficiation.**

When formulating policy for waste management, it is often useful to define the end goal. Increasingly, global best-practice is directed to a policy of “zero waste,” which looks to encourage not only zero waste to landfill (and increasingly, zero waste to incineration), but better waste management practices on the production and consumption sides of the market. For example, products must be redesigned to take explicit account of their end-of-life uses, reuse, and/or decomposition. This means that entrepreneurs have to be incentivized by policy to (re)design the products they manufacture in a more sustainable way. In this way, a more holistic approach can be taken to waste management (Singh and Ordoñez 2016 and Stahel 2016).

Each waste stream can be viewed similarly to an industry sector. Just as governments encourage industrial development using industrial policy, there should be a policy for each waste stream to encourage waste beneficiation activities. Depending on the waste stream, different commercial opportunities will exist. Creating the correct enabling environment to unlock the enormous value in these waste streams also requires creating appropriate oversight institutions to monitor the management of the fiscal, prudential, and market conduct issues that inevitably arise once waste streams are operationalized. In developing countries, this also means engaging with the informal sector and considering how best to incorporate informal activities into mainstream waste management efforts.

### **Policy interventions should be directed toward the waste hierarchy: upstream waste reductions should be prioritized.**

A common framework for developing policy interventions is to utilize the waste hierarchy shown in Figure 7 and consider where current initiatives focus and where possible policy gaps may exist for waste management. The succeeding section evaluates how Asian economies have used MBIs for different parts of the waste hierarchy. It is often the case that when countries have very underdeveloped property rights regimes with no enabling legislation, they will only focus on waste disposal. As the overall policy goals become more advanced, different policies are created for every part of the waste hierarchy, and both markets and government regulations are crucial institutions required to move up the waste hierarchy over time. This discussion focuses on the challenges of Asian economies in realizing the economic and environmental potential of better waste management opportunities.



### There are three key points for managing waste: upstream waste reduction, household and industrial waste collection, and waste processing.

The economic policies to affect the waste management stream can be applied at three points: (i) upstream waste reduction; (ii) household and industrial waste collection; and (iii) waste processing. Upstream waste reduction refers to production and distribution processes and consumer choices that affect the quantity of waste. Waste collection refers to the methods for collecting waste, which range from formal pick-up at households and businesses (sometimes with separation of recyclables at the source) to sites where recyclables and other waste can be deposited, to no formal collection at all. Waste processing refers to the ultimate disposition of waste, ranging from putting it in a landfill with no further extraction of value (or extraction of value by garbage pickers in the informal economy) to reuse, recycling, or energy production.

This section discusses the Asian experience in using market-based waste management policies for these three applications. For each application, there are various economic tools that can be of use to policy makers. In particular, five market-based instruments are highlighted: (i) tradable permits; (ii) taxes, fees, and charges; (iii) subsidies; (iv) hybrid policies or policy mixes; and (v) information provision. The efficacy and constraints of each of these economic tools are also evaluated in relation to country experiences.

**Inadequate coverage, improper design, and a lack of implementation limit the effectiveness of existing waste management instruments.**

In most Asian countries, MSW management has emerged as an issue of growing public concern. In recent years, policy and legislative measures to deal with solid waste have been introduced at a faster pace as the magnitude and risks associated with this problem are becoming clearer.

One advantage of MBIs is that well-functioning waste markets could involve less of an information and enforcement burden, compared to conventional attempts to directly regulate waste. Real-time measures of waste generation, which are needed to monitor and enforce regulations, are lacking in many Asian countries, and state capacity to implement policies may be strained as well. However, a knowledge of incentive structures, the organization of industries, and the implications of various costs can allow policy makers to craft policies that place lower regulatory burdens on municipalities while achieving waste management targets. Taxes, fees, and charges levied on inputs or products can incentivize producers to transition to less waste-generating production or to reuse materials. Well-designed collection subsidies or deposit-refund schemes (DRS) can improve waste collection rates. Information provision can help change consumer attitudes toward waste and encourage producers to transform their own practices to meet these.

In addition to the missing market problem, another reason so much waste is generated—and often ends up in landfills—is that there are few costs or penalties associated with waste generation and disposal and, at the same time, high costs associated with processing and recycling. MBIs can impose an explicit cost on waste and disposal. By creating incentives for markets for waste, MBIs also help raise revenues to offset processing and recycling costs.

Most Asian countries have introduced MBIs for waste management at some stage of the waste stream. One key challenge lies in the implementation of existing policies and the enforcement of existing legislation. Waste management policies dependent on a well-functioning public sector have not yielded the desired results, especially in countries where the informal sector is a significant part of waste management and where formal systems lack adequate capacity. An integrated approach to solid waste management (SWM) with workable goals is central to well-functioning outcome-oriented policies. It is of limited value if a given policy improves the collection of waste without a commensurate oversight to guide the safe and effective processing thereof nor adequate development in disposal and recycling systems.

Table 17 provides an overview of the use of MBIs for waste management by instrument, application, and economy. This shows that the uptake of particular economic instruments differs for the three applications to waste management. Not all instruments are suitable for a specific waste application, and not all available and even viable economic instruments have been used to address a specific waste-related problem. While many Asian countries have introduced policies to address waste collection and processing, there is a relative dearth of the use of economic tools when it comes to upstream waste reduction. In this regard, the EPR policies have not been used in Asia as extensively as they have been in Europe and North America. Tradable permits have hardly been used in the management of waste in Asia. The overall picture emerging from Table 16, however, is that economic instruments are being used extensively in the waste sector in Asia and that there is large scope for learning from these experiences to make future applications even more efficient.

**Table 16: Overview of the Current Use of Market-Based Instruments for Solid Waste Management in Asia**

Market-Based Instrument	Upstream Waste Reduction	Household and Industrial Waste Collection	Waste Processing
<b>Tradable Permits</b>			Carbon trading using animal feed wastes: PRC Clean Development Mechanism (CDM) projects: Bangladesh, India
<b>Taxes, Fees, or Charges</b>	User Charge/ Collection Fee: Bangladesh, Cambodia, Indonesia, Lao PDR, Thailand, Viet Nam Treatment Fee by weight/PAYT: PRC Pollution Charge/Tax: Mongolia, PRC Environmental Tax: PRC Environment Fund: Thailand Penalties for noncompliance: PRC	Property and trade service tax: Malaysia Differential collection fee and segregation: PRC User charge for construction and demolition waste: PRC Tax on Electronic and Electrical Producers and Importers: Thailand User charge: Macau, China Bag-based collection charge: Taipei,China	Recycling fee: India; Malaysia; Taipei,China Recycling fee on electrical and electronic products: PRC; Taipei,China User charge on emptying fecal waste: Bangladesh
<b>Subsidies</b>	Tax rebate: PRC Tax exemptions for storage and treatment of hazardous wastes: Malaysia	Subsidy to cooking oil recycling: PRC Payment for accepting agricultural waste: PRC Subsidy on e-waste and WEEE: India Subsidy on MSW collection: Mongolia, Viet Nam Write-off provision on investment in environment protection: Malaysia	Subsidy to develop organic fertilizer markets: Bangladesh, India Subsidy on biogas plants: Bangladesh, PRC Waste treatment subsidy: PRC Subsidy on recycling: Malaysia, Philippines, PRC, Thailand VAT refund for waste treatment plants: PRC Income Tax Exemption for waste recycling and treatment: Malaysia Subsidy on composting: Taipei,China

*continued on next page*

Table 16 continued

Market-Based Instrument	Upstream Waste Reduction	Household and Industrial Waste Collection	Waste Processing
<b>Hybrid Policies</b>	Subsidy for recyclers and tax on construction: PRC  Public awareness, financial incentives, zero-waste policy: Taipei,China	Recycling fee and subsidy to recyclers: Taipei,China  Sharing of tax on CDM: PRC  Recycling fee and development of second-hand product market: PRC  Deposit-refund scheme for batteries: Bangladesh, India  Deposit-refund scheme on ELV: PRC  Deposit-refund scheme on WEEE: India; PRC; Taipei,China  Deposit-refund scheme for automobile tires: Taipei,China  Deposit-refund scheme and waste exchange program: Philippines	Subsidy for recycling and deposit-refund on batteries: PRC  Waste collection tax and development of infrastructure for MSW management: Mongolia  Recycling tax import facilitation and recycling park for steel recycling: PRC
<b>Information Provision, Labels, and Voluntary Agreements</b>	Information disclosure on pollution control: PRC  Mandatory awareness-raising by local government: Mongolia	Developing formal recycling market: PRC  Industrial waste exchange program: Philippines	Public participation, regulation on waste processing and source separation: India  Enforcement rules and conflict in governance: Nepal  Technical assistance and financial incentives: Taipei,China

ELV = end-of-life vehicle, Lao PDR = Lao People's Democratic Republic, MSW = municipal solid waste, PAYT = pay-as-you-throw, PRC = People's Republic of China, VAT = value-added tax, WEEE = waste electrical and electronic equipment.

Source: Asian Development Bank.

## Market-Based Instruments Can Be Applied at the Upstream, Disposal and Collection, and Processing Phases of Waste Management

The following section analyzes the effectiveness of the instruments by application, based on the findings in the literature review.

### Upstream Waste Reduction

To reduce upstream waste at the source, the instrument used most by countries in Asia is in the class of taxes, fees, and charges. This is partly because the current set of local government institutions is mandated to deal with wastes from households. When there are similar living standards in a given neighborhood and low levels of average waste generation per capita, user fees or charges are the easiest means of collecting fees. Many jurisdictions find it easy to collect these taxes by charging them as a part of property tax; in one case (in Mongolia), it was a fixed percent of electricity bills.

However, as cities have grown, many have found it difficult to deal with large volumes of MSW. Particularly in light of rising standards of living, household waste has become more heterogeneous, which has led cities to experiment with the practices that exist in developed countries. As a result, pay-as-you-throw (PAYT) collection fees were introduced. However, for household waste, such a fee is difficult to levy because it requires weight measurement while being collected as well as strict monitoring and enforcement. To deal with measurement requirements, Taipei, China used a fee-per-bag, though the success of such schemes is dependent on citizens' participation. Experiences like in the United Kingdom show that imposing fees or taxes on waste collection, disposal, and even recycling can lead to illegal dumping, which can be addressed by public reporting mechanisms, monitoring technology, and strong enforcement capacity. Studies suggest that PAYT fees are easier to implement for commercial or industrial waste, although the experience of implementing pollution charges for solid waste discharge in the PRC revealed the importance of charging an appropriate charge rate/tax rate to ensure its effectiveness. Studies also found that while there is a general level of acceptance among people in many of the countries to pay for collection, many countries have privatized the collection jobs to local businesses or nongovernment organizations where waste collectors are paid directly by homeowners for their job.

### Taxes, fees, and charges require monitoring and enforcement.

Almost all Asian economies have implemented taxes, fees, and charges for managing MSW, as shown in Table 17. Taxes, fees, and charges, though applied on collection or for ensuring proper recycling, benefit from their simple design, facilitate cost recovery, and are often effective in reducing upstream waste generation. These policies create a disincentive for producers and consumers to generate waste and encourage the adoption of more resource-efficient processes. Such charges or taxes have the double benefit of generating income for waste utilities as well as reducing waste generation. However, in most countries, the charges are very low and only cover a portion of the cost of managing the waste. In other cases, inadequate enforcement means that these taxes and charges are avoided.

**Table 17: Selected Examples of Pricing for Upstream Waste Reduction**

Country	Description	Findings
<b>Bangladesh</b>	In some urban areas, household waste is now collected by nongovernment organizations or local communities and clubs (a model developed by the Kalabagan Housing Society in Dhaka in the 1980s). Households pay a monthly collection charge for this service.	Its success has made the system grow. City councils remain liable for transporting waste from secondary collection points instead of daily collection from house-to-house, which has reduced the financial burden on the city councils.
<b>India</b>	Several municipalities have used user charges on waste collection from households and then transferred part of the fund to the recycling industry established under public-private partnership to recover and process recyclable materials.	User charges are the highest revenue generator compared to the sale of recyclable waste and compost from 2012 to 2015. Other studies have found that some households are willing to pay more for efficient waste collection.
<b>Mongolia</b>	Mongolia introduced a waste service fee in the form of a tax by the district taxation office in January 2013. In 2014, the proportion of households that paid the waste service tax was 81% in apartment areas and 57% in <i>ger</i> areas (forms of peri-urban residential districts in Mongolia). Businesses and other organizations had contractual agreements with the waste service providers and 90% of them paid the waste service tax. The price is higher in <i>ger</i> areas than in apartment areas due to higher costs.	In <i>ger</i> areas, waste service fees were formerly collected by waste service providers. However, starting in July 2011, they have been paid together with electricity bills through electricity distribution companies, which draw a transaction fee of 23% of the waste service fees collected.  After the introduction of the new payment channel, the proportion of households that paid for waste collection services increased from 28% in July 2011 to 57% in 2014.

Sources: B. K. Bala. 2012. Modeling of Solid Waste Management Systems. In M. A. Uqaili and K. Harijan, eds. *Energy, Environment and Sustainable Development*. Vienna: Springer. pp. 265–289. [https://doi.org/10.1007/978-3-7091-0109-4\\_27](https://doi.org/10.1007/978-3-7091-0109-4_27); B. Byamba and M. Ishikawa. 2017. Municipal Solid Waste Management in Ulaanbaatar, Mongolia: Systems Analysis. *Sustainability*. 9(6). 896; G. Mohan, U. K. Sinha, and M. Lal. 2016. Managing of Solid Waste Through Public Private Partnership Model. *Procedia Environmental Sciences, Waste Management for Resource Utilisation*. 35. pp. 158–168. <https://doi.org/10.1016/j.proenv.2016.07.066>; and T. Hazra, S. Goel, and B. Maitra. 2015. Willingness-to-Pay and Preference Heterogeneity for Service Attributes of Solid Waste Management: An Experience in Kolkata, India. *Global NEST Journal*. 17. pp. 82–92.

## Household and Industrial Waste Collection

Success in segregated waste collection is dependent on several factors: (i) acceptance and willingness of households and industries to separate different kinds of waste and to deliver their waste to recycling collection points, (ii) efficiency of the waste collectors to take the waste to processing and recycling stations, and (iii) level of awareness of local communities of regulations related to waste collection. While incentives are provided to segregate waste at the source, the system will not be effectively implemented if a system does not exist to collect the materials separately. Therefore, it is imperative to ensure that a system of waste collection exists to ensure that recyclable wastes are recycled formally.

Historically, collection of waste was thought to be the job of the local municipalities, and so, in many cities, citizens used to pay little attention to this. As the standard of living has become higher, there is also a growing demand among communities to make the collection system work better and, hence, it has become costly. User charges in the form of flat fees for the collection of household waste have been the most popular in Asia, as they are easier to implement, though they do not provide incentives for reducing waste. In countries like India and Bangladesh, such charges are usually collected by agencies providing door-to-door collection of waste. These charges are generally low and do not include the costs of transportation or processing incurred by the municipality. Market-based incentives can be an efficient strategy to introduce efficient collection systems and, thus, reduce threats to the environment.

### **Hybrid policies such as deposit-refund schemes can support waste collection and sorting at the source.**

The appropriate policy often depends on the type of waste. For example, a hybrid policy such as reducing the price of a product nearing expiry date could help reduce food waste (Aramyan, Valeeva, and Vittuari 2016). This type of policy requires flexibility in regulation as well as buy-in from producers and retailers. Examples are shown in Table 18.

Many Asian economies have introduced DRS to induce households to sort through their garbage and return certain kinds of waste to the designated collection points. This instrument has been successfully used for collection of electronic and electrical wastes; expired and used batteries of mobiles, laptops, toys, etc.; and automobile and similar parts. However, the biggest challenge to the collection of these wastes comes from informal scrap markets. Studies have shown that unauthorized recyclers can afford to collect materials from consumers' doorsteps because of their low-cost recycling processes that are harmful to the environment. As such, some countries used income from the recycling fee to develop authorized collection centers for recyclable items to combat unauthorized trade of recyclable materials. This is a major regulatory challenge because unauthorized collection of these wastes ends up being processed without adequate care for compliance with environmental quality standards. Several studies have focused on increasing the level of awareness among consumers about the importance of returning wastes to designated collection points, and on subsidizing collection centers. The strategy of formalizing the informal markets of waste recycling is emphasized in most of the research results from Asia.

**Table 18: Hybrid Policies and Deposit-Refund Schemes—Selected Examples**

Economy	Description	Findings
<b>India</b>	In the city of Alappuzha, the “Clean Home, Clean City” campaign was implemented as a means to efficiently manage waste generation. The interventions combined door-to-door and school-based awareness campaigns with plastic waste collection in return for coupons. This provided a subsidy of 75% to 90% for the installation of aerobic pipe compost or biogas plants in households, providing infrastructure, monitoring dumping, and imposing a penalty on illegal dumping.	As a result of the program, consumption of liquefied petroleum gas (LPG) cylinders went down in 2013–2014 and 2014–2015.
<b>People’s Republic of China</b>	The Government of the People’s Republic of China (PRC) introduced a subsidy and deposit–refund scheme for end-of-life vehicles to promote authorized recycling of vehicles at the end of their life. The deposit is refunded along with the residual value of the car once it is returned to the collection center, and the owner receives a certificate of cancellation of registration of the vehicle. The subsidy is provided to authorized recyclers to protect them against illegal recyclers and to develop the recycling market. The PRC also introduced a subsidy and tax together to make the recycling industry viable.	
<b>Republic of Korea</b>	In the Republic of Korea, the Waste Management Law, which was introduced in 1986 and renewed in 1991, required that deposit–refund systems on a range of items be implemented. Both manufacturers and importers were required to pay deposits that could be claimed back on proof of proper disposal.	The costs of disposing wastes were higher than the deposits and, thus, recapture rates were low.
<b>Taipei, China</b>	Taipei, China introduced a mixture of command and control and economic instruments to improve garbage collection and recycling. A “Keep Trash Off the Ground” policy entails a change in garbage collection practices, the simultaneous collection of waste and recycling, and mandatory garbage sorting coupled with a per-bag trash collection fee. This became known as the “Four-in-One Recycling Plan.”	The Keep Trash Off the Ground program increased the amount of recyclable materials collected compared to three other policies implemented. Citizens’ participation in the program is a key factor for its success.

Sources: Z. Chen et al. 2015. Policies on End-of-Life Passenger Cars in China: Dynamic Modeling and Cost-Benefit Analysis. *Journal of Cleaner Production*. 108 (A). pp. 1140–1148.; S. Hong. 1999. The Effects of Unit Pricing System Upon Household Solid Waste Management: The Korean Experience. *Journal of Environmental Management*. 57. pp. 1–10. <https://doi.org/10.1006/jema.1999.0286>; B. E. Paul. 2017. Paradise Regained: How Alappuzha in Kerala Is Setting an Example to the World. *The New Indian Express*. 10 December. <http://www.newindianexpress.com/states/kerala/2017/dec/10/paradise-regained-how-alappuzha-in-kerala-is-setting-an-example-to-the-world-1723251.html>; L. Wang and M. Chen. 2013. Policies and Perspective on End-of-Life Vehicles in China. *Journal of Cleaner Production*. 44. pp. 168–176. <https://doi.org/10.1016/j.jclepro.2012.11.036>; C. Yu-Long 2008. *Waste Management*. 28 (5). pp. 859–869.; and W. Zhao, R. B. Leeftink, and S. Rotter. 2008. Construction and Demolition Waste Management in China: Analysis of Economic Instruments for Solving a Growing Problem. In M. Zamorano et al, eds. *Waste Management and the Environment IV*. Southampton, UK: WIT Press. pp. 471–480.

### **Informal waste collectors and processors pose both a challenge and an opportunity for rethinking waste management policy.**

The large informal sector involved in waste collection and processing in many parts of Asia, and particularly in South Asia, poses both a challenge for centrally designed policies, as well as an opportunity to incorporate it. The case study in Box 6 illustrates one such example in the case of lead-acid batteries in India.

### Box 6: Case Study on the Deposit-Refund Scheme for Lead-Acid Batteries in India

**Context and description of the problem.** The battery industry in India consumes 74% of lead produced in the country. As of 2016, the market size of lead-acid batteries in India stood at \$4.47 billion and is expected to grow at a compound annual growth rate of 8.36% over 2017–2022. The Basel Convention characterizes lead-acid batteries as hazardous waste. Lead is a highly toxic metal and exposure to it can cause hypertension, developmental defects, renal dysfunction anemia, impaired learning, irreversible mental impairment, and even death. On the other hand, the identical quality of recycled and primary lead makes lead one of the most recyclable metals. Recycling lead under controlled conditions not only reduces environmental damages, but recovery of lead from used batteries is 39% less energy-intensive than producing lead from primary sources. However, there are both formal and informal battery recycling markets in India, and informal recycling has been found to be damaging to the environment.

**Description of policy instrument.** To facilitate recycling of lead batteries in a safe and environmentally friendly manner, India's Ministry of Environment and Forests formulated the Batteries Management and Handling Rules, 2001 (BMHR). The BMHR instituted a deposit-refund scheme to ensure collection of used batteries. Under this scheme, consumers do not make a deposit upfront but instead receive a discount on the purchase of a new battery upon return of the used battery.

**Main findings related to criteria.** In spite of the BMHR and a high awareness among consumers regarding the scheme, it has only been partially successful due to the existence of the informal sector. The informal sector siphons off batteries at both the collection level and the recycling level.

**Collection level.** The informal sector is able to pay a higher price for used batteries, as they do not incur the costs associated with complying with the BMHR. Informal recyclers make frequent visits to retailers, which make this arrangement convenient as well as lucrative for retailers.

**Recycling level.** The minimal investment required to set up informal units makes it extremely hard to keep account of the units and penalize noncompliance. In addition, the existence of markets for local brands of informal battery manufacturers, lack of effective monitoring, and registered smelters running at less than 100% capacity further ensures that the informal sector thrives in the country, in spite of the deposit-refund scheme.

**Generalizable findings.** It is necessary to ensure that the buy-back price that the retailer receives from the manufacturer is higher than the price paid by the informal sector and should be inclusive of the storage costs borne by the retailer and the taxes paid.

Sources: D. Carrington. 2016. Backyard Battery Recycling Is Biggest Chemical Polluter for Poorer Nations. *The Guardian*. 25 October. <https://www.theguardian.com/environment/2016/oct/25/backyard-battery-recycling-is-biggest-chemical-polluter-for-poorer-nations>; K. Chechi. 2017. Indian Lead Acid Battery Market: Leading from the Front. *IPF Online*. 1 September. <http://www.ipfonline.com/news/detailnews/indian-lead-acid-battery-market-leading-from-the-front/Technical%20Articles/8509/9369>; Y. Gupta. 2012. Is the Deposit Refund System for Lead Acid Batteries in Delhi and National Capital Region Effective? *South Asian Network for Development and Environmental Economics Working Paper*. No. 68-12. Kathmandu: South Asian Network for Development and Environmental Economics. [http://www.sandeeonline.org/uploads/documents/publication/968\\_PUB\\_Working\\_Paper\\_68-12.pdf](http://www.sandeeonline.org/uploads/documents/publication/968_PUB_Working_Paper_68-12.pdf); T. S. Krishnan and S. K. Gouda. 2018. Impact of Policy on Closed-Loop Chains of Lead-Acid Batteries. In A. Chakraborty, S. K. Gouda, and M. S. Gajanand, eds. *Sustainable Operations in India (Managing the Asian Century)*. Singapore: Springer.; Metalworld. 2016. Lead Recycling in India: A Need More Than a Challenge. August. <http://metalworld.co.in/Newsletter/2016/aug16/enews0816.html>; H. Needleman et al. 1999. Health Effects of Lead on Children and Adults. In A. M. George, ed. *Proceedings of the International Conference on Lead Poisoning, Prevention and Treatment*. Bangalore, India. 8-10 February; and Toxic Links. 2011. Lead Acid Battery Recycling. [http://toxicslink.org/docs/06011\\_Lead\\_Acid\\_Battery\\_Recycling.pdf](http://toxicslink.org/docs/06011_Lead_Acid_Battery_Recycling.pdf).

**Success in solid waste management is critically dependent on the quality of waste processing.**

Waste collection is not efficient if the waste is not processed effectively after collection. Despite this, many Asian countries have yet to develop functional sanitary landfill sites for household wastes, waste-to-compost, waste-to-energy, or waste-to-product concepts. Experiences from Asia suggest a need for (i) a capital subsidy for establishing waste processing units, (ii) a concept of waste separation at the source, and (iii) waste collection centers. In many Asian countries, the informal recycling sector does not adhere with environmentally friendly standards for recycling. Therefore, the system must also use incentives to increase formal recycling, while at the same time integrating the informal sector into waste management systems for livelihood development. In addition, waste processing is not enough. The manufacturing sector must also be incentivized to use recycled resources as input in their production process.

Some governments introduced a “recycling fee” for manufacturers and importers of electrical and electronic products to generate additional resources. A few countries gave access to these resources to the manufacturer to design eco-friendly products. It therefore suggests that a hybrid set of policies is required to promote waste processing that includes incentives for recycling for consumers, recyclers, and manufacturers. However, again, the policies require monitoring to ensure that incentives are not misallocated.

Finally, to promote recycling, reuse, and recovery from waste, studies also revealed that there is a need to make collection centers available in local communities to make the recycling market competitive with regular products. At the same time, to encourage investment in recycling, which is often costlier than regular investment for similar products, there is genuine need for a subsidy plan covering initial investment. Such subsidies can also be effective in reducing unauthorized and harmful recycling. Tradable permits can be linked directly to emission reductions, but such a system has greater information requirements in terms of emission reductions achieved and therefore requires the development of independent institutions. The market for carbon using the Clean Development Mechanism (CDM) has been used to some extent, by Bangladesh to trade carbon dioxide emissions. This is a good example of how carbon markets could be used to reduce waste generation.

**Subsidies can play an important role in supporting nascent waste collection and beneficiation industries.**

Subsidies that incentivize producers to adopt technologies for limiting waste generation during production have the potential to increase resource efficiency. Subsidies can have an important role directly in waste collection and recycling. To maintain collection of waste from households in urban areas, many municipalities in Asia used to receive a state subsidy, as shown in Table 19. The need for subsidies is largely due to the failure to develop the necessary institutional mechanism to make the cities accountable in terms of collection of urban taxes. However, in a large majority of cities, the waste collection system has been separated into several stages and the primary waste collection (door-to-door) is without any subsidy.

**Table 19: Subsidies for Waste Collection and Processing—Selected Examples**

Country	Program	Findings
India	A market development assistance subsidy was provided to support marketing composted organic components of municipal solid waste to farmers.	Farmers were found to be unwilling to purchase compost as no direct subsidy or incentive was being provided. There was also a need to create awareness among farmers for use of compost.
Malaysia	The Malaysia Industrial Development Authority offered companies: (i) an annual allowance to write off an initial investment, if they adopted the use of environmental protection equipment, established facilities to store, treat, or dispose of their own wastes, or reduced energy consumption within 3 years; and (ii) a deduction from their income tax for all donations made to environmental protection or conservation organizations.	Many of the agro-industries on rubber and palm oil production used this opportunity and invested in environmentally friendly technologies to treat their effluent.
People's Republic of China	A subsidy (including exemption from profit taxes) was provided for waste-incineration power generation.	Waste incineration causes high carbon emissions per ton of waste. If waste is not fully burnt, it results in particulate matter emissions. Generous subsidies may also harm the industries' competitiveness and sustainable development. Subsidies should be conditional on the harmless treatment of waste, required monitoring of waste incineration performance data by an independent third-party rating agency, and the availability of an open-access information system by local governments.
	The People's Republic of China introduced a subsidy for recycling waste of electrical and electronic equipment and of end-of-life vehicle parts. The draft rule for recycling of waste of electrical and electronic equipment was introduced in 2004, which was prompted by the European Union rules on Huawei Electronics to comply with the green market chain and eco-design of equipment sold in European Union markets.	From 2010 to 2013, recycling increased from 24% to 34% due to this program. While large firms have the ability to recycle their wastes, small firms cannot do it alone. As such, the policy introduced a sharing principle to divide the cost of recycling between municipalities, manufacturers, and retailers, as well as launched a green market chain program.

Sources: P. Chen. 2005. *The WEEE Challenge to China*. 2005 4th International Symposium on Environmentally Conscious Design and Inverse Manufacturing; Government of India, Ministry of Environment, Forest, and Climate Change. 2016. *E-Waste Management Rules*. <http://moef.gov.in/wp-content/uploads/2017/07/EWM-Rules-2016-english-23.03.2016.pdf>; L. Liu et al. 2017. A Review of Waste Prevention Through 3R Under the Concept of Circular Economy in China. *Journal of Material Cycles and Waste Management*. 19. pp. 1314–1323. <https://doi.org/10.1007/s10163-017-0606-4>; Z. A. Rahman. 2011. *The Use of Economic Instruments in Environmental Management in Malaysia*. Paper presented at the Forum-Workshop on Economic Instruments Applied in Environmental and Natural Resource Management in Southeast Asia. Bali, Indonesia. 26–28 September; L. Wang and M. Chen. 2013. Policies and Perspective on End-of-Life Vehicles In China. *Journal of Cleaner Production*. 44. pp. 168–176. <https://doi.org/10.1016/j.jclepro.2012.11.036>; and X. Zhao et al. 2016. Technology, Cost, a Performance of Waste-to-Energy Incineration Industry in China. *Renewable and Sustainable Energy Reviews*. 55. pp. 115–130.

## Market-Based Instruments for Converting Complex Waste Streams into Value

This section will discuss the international and Asian regional experiences of market-based instruments to tackle waste management. In addition, it will discuss some of the factors associated with successful policies.

The traditional strategy to let local government units manage waste is seriously challenged, since most municipalities find it financially difficult to cope with rising waste volumes in light of rapid urbanization and rising incomes in Asia. This has resulted in the use of a range of market-based instruments in Asia to deal with rising volumes of increasingly complex wastes coming from households, industry, and commercial units. Unlike many developed countries, many countries in Asia also have a large number of informal waste recyclers who fulfill an important role in waste management but are also at times causing significant harm to the environment by not processing waste in accordance with the rules. These informal recycling industries are well-established and use various market channels to secure their supplies.

### Global Experiences

#### **Taxes, fees, and charges are a useful tool to facilitate waste sorting at source.**

PAYT schemes, tax levies, user charges, and DRS internalize environmental costs associated with waste generation into polluters' decisions. Studies found that the introduction of PAYT schemes, in general, led to an increase in the sorting of waste (Bartelings and Sterner 1999 and Bucciol, Montinari, and Piovesan 2011). However, the impact on reduction of waste at the source is mixed. Bartelings and Sterner (1999) found a reduction in waste collected after the introduction of a weight-based billing system, while Bucciol, Montinari, and Piovesan (2011) found no such evidence. The introduction of PAYT schemes in Virginia led to a reduction of waste generated, but researchers also found evidence of illegal dumping. Jenkins et al. (2003) found that the price of disposal is not a significant determinant of household recycling. In addition to unit pricings simply signaling an incentive to reduce trash, the finding indicated the importance of setting a price of disposal high enough to create a response.

#### **Information campaigns and deposit-refund schemes improve the collection of hazardous wastes.**

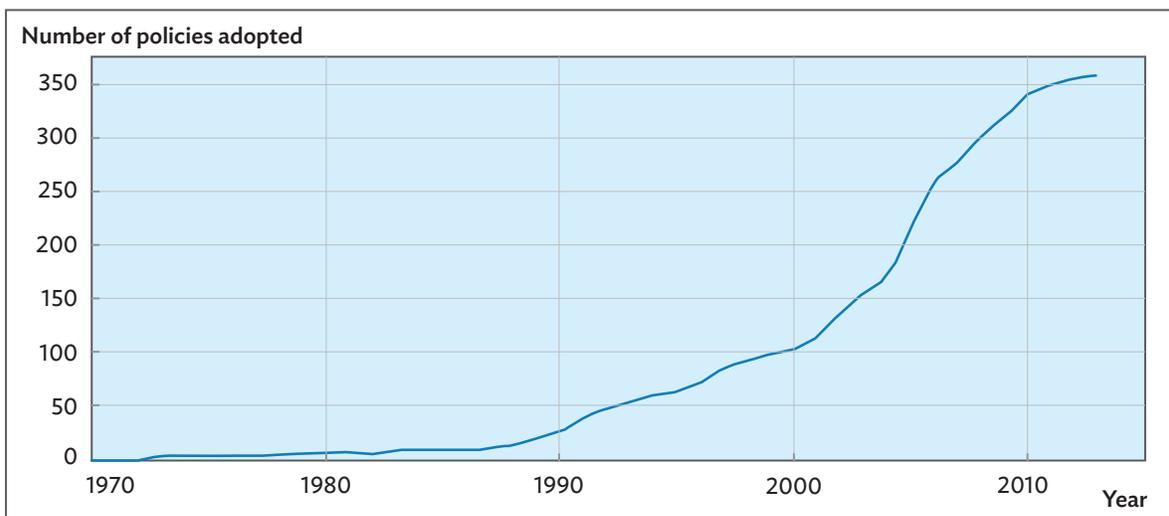
Increasing public awareness was successful in increasing the amount of hazardous waste collected and in increasing recycling behavior (Lim-Wavde, Kauffman, and Dawson 2017 and Rhodes et al. 2014). A study done in Abadan, Iran, showed that in addition to the awareness campaigns, the provision of infrastructure is also necessary to promote recycling (Babaei et al. 2015).

DRS have been successfully implemented in many developed countries to take back used goods for recycling. One such scheme applied in Germany resulted in consumers returning 98% of refillable bottles. Similarly, after introducing a DRS in Sweden in 1984, recovery rates reached 86% for cans and 77% for plastic bottles. Norway also has a recovery rate of 75% to 90% for its deposit scheme for containers, implemented in 1999.

### Extended producer responsibility schemes are widely used internationally but underutilized in Asia.

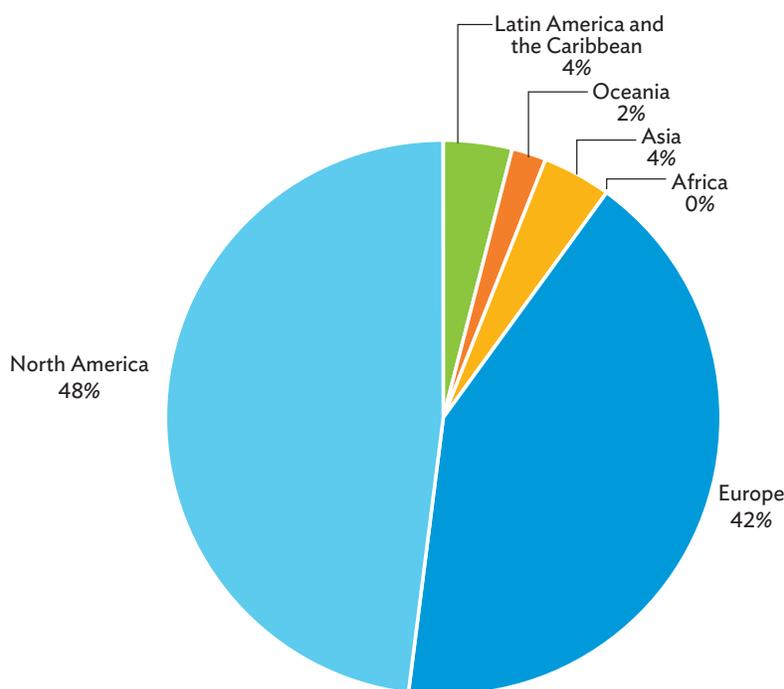
As illustrated in Figure 8, the past 3 decades have seen the emergence and recent proliferation of extended producer responsibility (EPR) policies across the globe. These policies have proven to be key in ensuring that the waste generation costs associated with production are internalized by producers. In particular, this internalization of the waste-related costs of production has resulted in targeted products being designed with their entire life cycle in mind, as well as improving the collection of used products. Of these EPR policies, take-back requirements have emerged as the most commonly used, comprising 72% of global EPR policies in 2013 (Kaffine and O'Reilly 2013). These take-back requirements ensure that producers or retailers are responsible for the end-of-life management of their products.

**Figure 8: Cumulative Extended Producer Responsibility Policies Adoption Globally, 1970–2015**



Source: D. Kaffine and P. O'Reilly. 2013. What Have We Learned About Extended Producer Responsibility in the Past Decade? A Survey of the Recent EPR Economic Literature. [Organisation for Economic Co-operation and Development] OECD Working Party on Resource Productivity and Waste. 45.

Figure 9 shows that the vast majority of EPR efforts had been undertaken in Europe and North America, while only 4% had been undertaken in Asia in 2013. Box 7 describes one such program undertaken in the PRC. This shortfall is particularly glaring in light of the large manufacturing industries in a growing number of Asian countries and the fact that Asia is producing so much of the electronics and textiles consumed worldwide. However, global experiences suggest that EPR schemes require strong complementary policy frameworks to be effective. In Europe, EPR has been effective at stimulating waste collection without influencing upstream actions such as prevention and redesign for recycling, and producers are not compelled to reuse or recycle their collected waste. In addition to EPR, policies to incentivize innovation and require the use of recycled components in product design are needed for producers to create products or use materials with high recyclability.

**Figure 9: Regional Distribution of Extended Producer Responsibility Policies**

Source: D. Kaffine and P. O'Reilly, 2013. What Have We Learned About Extended Producer Responsibility in the Past Decade? A Survey of the Recent EPR Economic Literature. *OECD Working Party on Resource Productivity and Waste*. 45.

### Box 7: Case Study on the Recycling Waste of Electrical and Electronic Equipment in the People's Republic of China

**Context and description of the problem or application.** Households and workplaces in the People's Republic of China (PRC) generate a large amount of waste electrical and electronic equipment (WEEE). Valuable resources can be recycled from WEEE, such as metals and plastics. However, WEEE recycling businesses in the PRC were only competitive when operated under harmfully low environmental standards, which considerably reduces their production costs and causes soil, air, and water pollution.

**Description of policy instrument.** The Extended Producer Responsibility (EPR) scheme seeks to incentivize producers to enhance their environmental performance by holding them responsible for the environmental impacts of their products over a full life cycle. Subsidies are provided to manufacturers of electrical products and electronics who collect and dispose of their products by themselves or outsource the work to other parties. In either case, disposal procedures are required to meet high environmental standards. Alternatively, the obligation can be fulfilled by contributing to a national fund that subsidizes environmentally friendly recyclers.

*continued on next page*

Box 7 continued

**Main findings related to criteria.** The study found corroborating evidence for the efficacy of the EPR scheme in steering the PRC's WEEE recycling industry toward a more environmentally friendly direction. The EPR scheme has, on the one hand, promoted the proliferation of standardized disposal and recycling procedures that mitigate environmental impacts and, on the other, urged manufacturers to adopt environmentally friendly design features that help reduce disposal costs. Through both avenues, the EPR system delivers a broad range of environmental benefits such as the reduction of heavy metal emissions and other forms of pollution. In particular, the study found sizable reductions of refrigerant emissions from the dismantling of discarded refrigerators and air conditioners, which curbs an important source of greenhouse gases and contributes to the mitigation of climate change.

**Generalizable findings.** The necessity and viability of the financial incentives provided by the scheme are particularly justifiable in developing regions where WEEE recycling is profitable due to cheap labor and loosely enforced environmental regulations. In that case, electricals and electronics users have the motivation to sell their WEEE to informal recyclers, and environmentally friendly recyclers, if unsubsidized, are bound to be taken over by recyclers with low environmental standards, which have more competitive production costs.

Source: J. Cao et al. 2013. Incentive Mechanism Between Government and Manufacturers Based on EPR System [in Chinese]. *Systems Engineering - Theory & Practice*. 33 (3). pp. 610–621.; Y. Gu et al. 2017. To Realize Better Extended Producer Responsibility: Redesign of WEEE Fund Mode in China. *Journal of Cleaner Production*. 164. pp. 347–356; NetEase. 2009. Largest Village Buried in E-waste: Guiyu, Guangdong Province [in Chinese]. <http://discovery.163.com/09/0412/09/56MIHS4J000125LI.html>; Y. Zhao, C. Wu, and Z. Fu. 2008. Review on Research Progress and Implications of Selecting Responsible Main Part for EPR Based on Circular Economy Development [in Chinese]. *Science Research Management*. 72(2). pp. 111–118.; and S. Zou and L. J. T. Wu. 2009. Research on Reverse Logistics Mode of Private WEEE in City [in Chinese]. *Technoeconomics & Management Research*. (4). pp. 102–105.

### Asian economies have used both regulations and MBIs to address waste.

In Southeast Asia, many countries have already established national strategies and regulatory frameworks to address challenges related to waste management. Countries such as Malaysia, the Philippines, and Thailand have attracted investment in waste management by giving incentives such as income tax exemptions or investment tax allowances. Malaysia has significantly improved its environmental quality thanks to the combination of economic and command and control (CAC) approaches. In the Philippines, the Industrial Waste Exchange Program is considered a successful model (Abrera 2011). Likewise, recycling of lead-acid batteries in Thailand increased in the presence of excise tax reduction; however, it is not certain that the tax reduction is responsible for the increase in recycling in the informal sector (Tularak 2011).

In most of the countries, environmental charges for municipal solid waste have not been implemented; only fees for waste collection have been implemented, and these have been subsidized. The use of such instruments is considered inadequate and needs to be improved in these countries (UNEP 2017).

DRS for e-waste and lead-acid batteries have been developed in several countries to promote recycling of hazardous wastes, but their effectiveness has yet to be determined. Khandker et al. (2014), in their studies on a solar home system, found that lead-acid batteries are often not returned to the vendors. Gupt (2012) found that DRS for lead-acid batteries in India have been successful in ensuring batteries being returned to the retailers; however, they do not ensure that these are being recycled in an environmentally friendly manner.

In terms of waste processing, there are informal markets for recycling many solid wastes like paper, metals, glasses, and plastic products in South Asia. These items are often sold by the households to the vendors (*kabadiwala*) for onward processing through the markets. This shows that the market for recyclable and reusable products has potential and can be developed to reduce wastes at the dump sites and reduce health risks for people who collect garbage from dump sites. The PRC and Taipei, China have used a variety of instruments to deal with solid wastes.

Of the five classes of MBIs—(i) tradable permits; (ii) taxes, fees, or charges; (iii) subsidies; (iv) hybrid policies; and (v) information provision, labels, and voluntary agreements—the least-used class of MBIs to address waste in Asia is the tradable permits. These have been used only as a part of the CDM under the Kyoto Protocol for waste processing to trap methane to reduce carbon emissions. None of the Asian economies have used the CDM to deal with waste processing, despite most of them suffering from acute shortages of land for the landfilling of household wastes.

In the case of taxes, fees, and/or charges, the most common instrument used in Asia is user charges for the collection and disposal of waste. However, flat charges used in many of the countries do not contribute toward reducing the volume, and most of the countries used it as a part of property taxes. Treatment fees by weight or PAYT principles have been quite effective in reducing waste thrown away by households and firms. However, there is also a need to create incentives in the households to return their recyclable wastes. The success of such schemes also requires regular data collection, strict monitoring, and enforcement.

To ensure the recycling of materials through designated centers, the tax collected as a recycling tax or charge should be used to promote formal recycling. Formal recycling requires abiding by environmental quality standards, whereas informal recycling causes more harm to the environment. Hence, channeling the income collected through a recycling fee or tax to make formal recycling competitive is an important requirement for managing recyclable wastes. The review also reveals that while awareness is an important first step to reduce the volume of solid wastes, it is also important to develop collection centers to help households deposit conveniently. With the rise in use of domestic materials in Asia, introducing recycling fees on products containing recyclable materials both from manufacturers and importers will generate revenue for the government. The fee can be combined with the DRS to let the consumers return the products after use with a cash-back benefit, and the fee can be used to promote the development of collection points and make recycling competitive.

It is also possible to develop a subsidy policy for manufacturers to claim a part of the recycling fee if they improve their use of recycled parts during the manufacturing period. Production processes using recyclable products are costlier compared to products made of natural materials, and hence the recycling fee can also be channeled to promote production using recyclable products and reduce waste generated at the waste disposal centers. A possible solution could be to tax products made from virgin materials.

With Asia pursuing construction-led economic growth due to rapid urbanization and improved standards of living, there is also a need to deal with construction wastes. However, the review also finds that such measures would cause a relatively greater increase in construction costs for small construction companies compared to large companies, and hence it is less affordable for small firms.

### **Scope exists to extend the use of information provision and voluntary agreements to encourage more responsible production.**

While not widely used at present, there is scope for information provision to play a large role in upstream waste reduction. Labeling products that are produced in ways that minimize waste generation is one way of changing consumer attitudes toward waste as well as encouraging producers to move away from wasteful production processes (Aramyan, Valeeva, and Vittuari 2016). Similarly, more transparency on the amount of waste generated

in the production of a particular product can serve as a mechanism for producers to internalize the costs of waste if consumers change their buying decisions based on this information. Information campaigns encouraging source separation are also likely to lead to more efficient waste processing, which is presently lacking in the countries. Many of the efficiency advantages associated with markets are premised on perfect information. At present, both in Asia and across the world, there is still little incentive for producers to provide consumers with full information on the origin and waste generated in the production of the goods they purchase. The provision of this type of information would assist consumers in making more informed decisions.

### **Tradable permits have potential but are underutilized because of the difficulty of defining waste generation rights.**

Because of the heterogeneous nature of waste and the lack of tools that allow for a comparability of the toxicity, difficulty of recycling, or harmfulness of various waste types, no country has implemented policies to cap-and-trade waste generation rights. In effect, this is because a market of this nature would require much clearer information on how different types of waste compare. In addition, cap-and-trade policies would place large informational requirements on regulatory authorities, which can be costly in itself.

Tradable permits also have the potential for use in waste processing activities. Their potential for use in promoting recycling was accidentally discovered through the United Kingdom regulation on packaging of products. The regulation required users to comply with a proportion of waste recovery during production. As a result, firms began trading waste recovery certificates to ensure their compliance. In Asia, this has not been used yet, but has potential in the future.

### **The informal sector is an important aspect of Asian waste management.**

The waste management literature brings to light the role of the informal sector in effectively managing waste. Many countries in Asia, such as Bangladesh, India, and the PRC, have a prominent informal sector that plays a significant role in waste collection and recycling.

While the existence of the informal sector improves recycling rates and leads to savings for city authorities by reducing the cost of waste collection and disposal (Wilson et al. 2012), the sector does not adhere to the prescribed environmental regulations. Given the nature of informal sector businesses, authorities often find it difficult to keep track of their activities. Countries such as India have introduced DRS to provide monetary incentives to stem the flow of waste. However, by avoiding regulation, the informal sector can provide convenient (door-to-door) and frequent collection. Therefore, the success of many formal policies has been limited.

The informal sector, including waste collection, is an important source of livelihood for a large population in Asia. As such, incorporating the informal sector into waste management frameworks has the potential to serve additional goals, such as job creation and poverty alleviation. The political economy aspects of waste management will also center around the impact of policies on the livelihoods of various constituencies. Policies that do not recognize the importance of vested interests can be rejected on political grounds, despite having positive environmental effects. For example, the distributional consequences (such as job losses for informal battery recyclers) associated with a policy banning retailers from selling used batteries to informal recyclers can politically outweigh the broader societal gains that may be more difficult to perceive (such as reductions in groundwater pollution as a result of better recycling protocols).

Given the wide network and greater efficiency of the informal waste collection sector, and the collection inefficiency of many municipalities and authorities, it is essential to institutionalize the role of the informal sector. Despite the health and social issues associated with the informal sector, retaining the informal sector has economic benefits (Wilson, Velis, and Cheeseman 2006). Entrepreneurs involved in the informal recovery process can be trained and integrated into the formal resource recovery system to reduce the amount disposed and recover valuable products (Qdais 2007). With the progressive formalization of the informal sector, more enterprises will benefit from policy incentives (Matter et al. 2015). Formalization will help provide safe working conditions and also help reduce environmental pollution by informal sector recyclers. To ensure formalization, tax incentives will have to be provided and maintained and land and energy supplied at subsidized rates to the formal sector. A study in Bangladesh suggested registering the informal e-waste recycling plants to formally recognize and track the sector (Alam and Bahauddin 2015).

## Conclusions and Lessons Learned

Economic tools have gained increasing traction in the waste management sector in Asia over the past 2 decades. While evidence of the effectiveness of economic instruments as a whole are mixed, there are important areas where they have proven successful in improving the efficiency of waste management, meeting environmental targets, and facilitating cost recovery for waste utilities to keep them financially sustainable. MBIs are applicable to specific aspects of waste management, such as the facilitation of collection or processing of waste. However, waste management policies need to take the full waste stream—from production to waste processing—into account in an integrated fashion. As several cases have shown, while certain economic tools may work well in achieving particular goals, in the absence of a functioning integrated solid waste management plan, they might not be effective in serving the broader goal of improved waste management.

### **There is a need for better data and monitoring of waste levels, performance of policy tools, and environmental health in Asia.**

This is the surest way to determine whether and which policies are working on a system-wide level and fosters transparency and accountability. The growth in e-waste, in particular, has emerged as a concern, especially in light of a rapidly growing middle class in Asia. Keeping detailed inventories of e-waste is a credible way of monitoring the efficacy of policies in reaching their goals.

### **Voluntary agreements, information-related campaigns, and extended producer responsibility schemes are underutilized policy tools in the solid waste sphere in Asia.**

Fostering transparency in production processes—and in this way enabling consumers to make informed purchasing decisions—is an important avenue through which the currently externalized costs of wasteful production can be internalized. Information-related campaigns to reduce waste have proved successful in Europe, as well as in programs like the Program for Pollution Control, Evaluation and Rating in Indonesia (Box 4), but on the whole, they remain underexplored in other parts of Asia.

EPR schemes are also underutilized in Asia compared to many countries in Europe and North America. Until now, most manufactured goods in Asia have been exported, but as domestic consumption in most Asian is increasing rapidly, there is even more policy space for governments in Asia to hold producers accountable for wasteful production processes. Complementary policies with the end-of-life management of products in mind will encourage a transition to more resource-efficient design and production. This will be important for sustainable production and consumption both in Asia and the rest of the world that imports products from the region.

**Policy instruments can support cost recovery for waste collection and promote waste reduction.**

A serious problem in many urban centers in Asia is the risk that utilities are not able to keep up with growing levels of municipal solid waste generation driven by rapid rural–urban migration and rising living standards. Many waste utilities lack the physical capacity, financial resources, or management capability necessary to collect and safely process this growing volume of waste. A key factor that will influence the success of waste management is the financial sustainability of utilities. The use of taxes, fees, and charges for waste collection can facilitate cost recovery as well as encourage a reduction of waste generation. The framework through which these costs are recovered, whether through PAYT schemes or as part of property and environmental taxes or monthly utility bills, will depend on the particular context. Studies have shown that residents are often willing to pay for more efficient waste management and the current lack of efficient waste management is likely to be imposing significant coping costs on residents. In addition to the mounting risks to human and environmental well-being, this provides a strong motivation for the use of economic policy tools.

**There is potential for economic benefits from waste.**

A growing body of evidence also highlights the potential for economic benefits to emanate from various sectors in the waste stream and improved waste management as a whole. The technological improvements necessary for increased resource efficiency can lead to positive spillovers in technological capability that have the potential to improve productivity and stimulate growth in other sectors as well (Ekins et al. 2016). The inefficient resource use associated with current production implies that valuable resources can be extracted from waste, including through “landfill mining” (Krook, Svensson, and Eklund 2012).

**Support for the informal sector will help improve waste management.**

Another factor that has been highlighted by the literature is the presence of a large and important informal sector involved in waste management, particularly in South Asia. At the moment, informal waste collectors and recyclers fulfill an important social function. However, in many cases, the methods used to extract valuable products from waste are, in themselves, dangerous and polluting. There exists the potential for synergies between government aims and the interests of this sector, and this should be explored. If governments can support the informal traders in formalizing their business, there is a potential for increasing recycling of products in South Asia, and this will reduce the cost of managing solid wastes. City councils in several cities in Asia have used user charges and have been managing the door–to–door collection of solid wastes using a third party (often NGOs), and have been successful in reducing their financial burden. It is possible to go a little further to develop incentives to promote composting, which would reduce the cost of solid waste management.

**Deposit–refund schemes will be crucial to managing hazardous waste.**

Hazardous wastes, particularly in used and discarded electrical and electronic products, have also emerged as a factor of growing concern. In particular, batteries constitute a major environmental risk if they are not properly disposed of. DRS to facilitate the collection of hazardous wastes have not fully worked so far. This is possibly due to the transaction cost of returning the batteries being higher than that of the deposit amount set by the government. Given the major environmental risk posed by chemical compounds in batteries and other hazardous wastes, DRS are an important policy tool to facilitate the collection and processing of these wastes.

Further experimentation with market-based policy tools for waste management should allow for the accurate monitoring of their effectiveness as well as focus on the linkages between various sections of the waste management stream. The goal of SWM involves the reduction of waste generation through improved resource efficiency and higher rates of waste collection, as well as reusing and recycling of waste in the processing stage. The linkages between these different stages should be explored and policy tools should take them into account.

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# 5

## Comparative Analyses of Market-Based Approaches for Environmental Management in Asia

### KEY MESSAGES

- While market-based instruments (MBIs) are already being used in many parts of Asia, there is significant scope to further deploy MBIs to address issues in air quality, water, and waste management.
- The stringency and effectiveness of MBIs depend on existing policy and regulatory frameworks, design, implementation, and local context.
- Monitoring and enforcement capabilities are critical to success.
- Pollution taxes and volumetric pricing can be used to change behavior, but prices need to be set sufficiently high to be effective.
- The political system can affect the choice and the performance of MBI.
- The nature of pollution sources and local economic structure plays a critical role.

### Market-Based Instruments Used in a Variety of Contexts in Asia

While MBIs have been used in a variety of contexts in Asia, there remains significant scope for the further deployment of MBIs. This chapter evaluates the application of MBIs to address environmental problems involving air, water, and waste to identify patterns of failure and success. Particular emphasis is given to the factors affecting the overall performance of instruments as well as the factors affecting the performance of specific MBIs.

An overview of the use of MBIs to address problems related to air, water, and waste is shown in Table 20. All MBIs discussed in the introductory chapter have been implemented by countries covered in this study, but prior experience with MBIs is more concentrated in some countries and for some environmental problems than for others. The People's Republic of China (PRC) has perhaps the most wide-ranging use of MBIs, covering each MBI category and addressing problems in air, water, and waste (Appendix). Other countries have had more limited experience with the implementation of MBIs.

Taxes and subsidies have been used in more countries in the study than other MBIs. The use of hybrid policies has been limited and only to address waste. Few countries have implemented tradable permits to reduce

emissions from energy production and industrial sources, and transferable water rights have been used in several cases to more efficiently allocate water across and within sectors.

Pollution taxes and subsidies have been used across all three categories (air, water, and waste) in several countries, and a comparison of the design features is shown in Table 21. As discussed in Chapter 1, pollution taxes are more efficient if applied closest to the point of environmental damage (i.e., emissions). However, when emissions monitoring is impossible, difficult, or costly, taxes may be levied on some input or output that is more easily monitored and a good indicator of (or proxy for) the pollution to be regulated. As shown in Table 21, the majority of taxes found in this study correspond to taxes on inputs and/or outputs. There are few exceptions in the case of air and water, where countries such as the Philippines, the PRC, and Thailand use emission taxes to control emissions of some urban pollutants. Similarly, Malaysia, the Philippines, and the PRC have imposed various effluent charges to control water pollution.

The use of subsidies tends to target inputs. Subsidies to address air pollution tend to promote renewable energy technologies, cleaner fuels, or energy efficient technologies. Water-related subsidies have been used to incentivize substitution toward less fertilizer-intensive agricultural practices and the use of electricity by irrigation technologies. Waste-related subsidies have been used to promote recycling and waste treatment infrastructure.

The use of information provision, labels, and voluntary agreements are not as widespread in Asia, although there are some interesting examples worth highlighting. There are informational instruments aimed at increasing information about air pollution, both locally and globally. Households have been informed about contaminated drinking water leading to switching to safer water sources and reductions in the risk of diarrhea and dysentery, and similar program are used to increase public awareness about issues such as hazardous waste.

While most policy instruments have been implemented, monitored, and enforced by the regulatory sector (e.g., national and local government, municipalities, or other authorities), in some cases MBI have been implemented by non-regulatory groups such as nongovernment organizations (NGOs). To address indoor air pollution, subsidies have been used to increase the use of cookstoves in Cambodia, the Lao People's Democratic Republic (Lao PDR), and Viet Nam. Similarly, the promotion of biogas plants in rural households in Bangladesh have been subsidized with assistance from NGOs. To address issues with waste, the construction of sanitary landfill sites was partially funded by the Japan International Cooperation Agency, and the development of a medical waste facility in Mongolia was supported by the Asian Development Bank (ADB).

**Table 20: Overview of Current Use of Market-Based Instruments Across Sectors in Asia**

MBI	Air	Water	Waste
<b>Tradable permits</b>	India, PRC, Republic of Korea	Bangladesh; India; PRC; Taipei,China	
<b>Pollution taxes, fees, or charges</b>	Bangladesh, India, Lao PDR, Malaysia, Nepal, Philippines, PRC, Thailand, Viet Nam	Cambodia, Lao PDR, Malaysia, Philippines, PRC, Viet Nam	Bangladesh; Cambodia; Lao PDR; Indonesia; Macau, China; Malaysia; Mongolia; PRC; Taipei,China; Thailand; Viet Nam
<b>Water Pricing</b>		Bangladesh, Cambodia, India, Indonesia, Lao PDR, Mongolia, Nepal, Philippines, PRC, Sri Lanka, Thailand, Viet Nam	

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Table 20 continued

MBI	Air	Water	Waste
<b>Subsidies</b>	Bangladesh, Cambodia, India, Indonesia, Lao PDR, Malaysia, Mongolia, Nepal, Philippines, PRC, Thailand, Viet Nam	Bangladesh, India, Indonesia, PRC, Sri Lanka, Viet Nam	Bangladesh, India, Malaysia, Mongolia, PRC, Taipei,China
<b>Hybrid policies</b>			Bangladesh; India; Mongolia; Philippines; PRC; Taipei,China
<b>Payments for Ecosystem Services</b>		India, Indonesia, Philippines, PRC, Thailand, Viet Nam	
<b>Information provision, labels, and voluntary agreements</b>	India, Indonesia, Malaysia, Philippines, PRC, Thailand	Bangladesh, Cambodia, India, Indonesia, Malaysia, Mongolia, Nepal, Philippines, PRC, Viet Nam	India; Mongolia; Nepal; Philippines; PRC; Taipei,China

Lao PDR = Lao People's Democratic Republic, MBI = market-based instrument, PRC = People's Republic of China.

Source: Asian Development Bank.

Table 21: Design Features of Some Market-Based Instruments in Asia

MBI		Air	Water	Waste
<b>Taxes, fees, or charges</b>	On pollution	Philippines, PRC, Thailand	Malaysia, Philippines, PRC, Viet Nam	
	On inputs/outputs	Bangladesh, India, Lao PDR, Philippines, PRC, Thailand, Viet Nam	Cambodia, Lao PDR, Malaysia, Philippines, PRC	Bangladesh; Cambodia; India; Indonesia; Macau, China; Malaysia; Mongolia; Lao PDR; PRC; Taipei,China; Thailand; Viet Nam
	On point sources	Philippines, PRC, Thailand	Malaysia, Philippines, PRC, Viet Nam	
	On non-point sources	Bangladesh, India, Lao PDR, Malaysia, Nepal, Philippines, PRC, Thailand, Viet Nam		
	Formal Regulations	Philippines, PRC, Thailand	Cambodia, Lao PDR, Malaysia, Philippines, PRC	Cambodia; India; Malaysia; Mongolia; PRC; Taipei,China; Thailand; Viet Nam
	Informal Regulations			Bangladesh, Lao PDR

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Table 21 continued

MBI		Air	Water	Waste
<b>Subsidies</b>	On pollution			
	On inputs/outputs	Bangladesh, Cambodia, India, Indonesia, Lao PDR, Malaysia, Mongolia, Philippines, PRC, Thailand, Viet Nam	India, Malaysia, Philippines, PRC, Viet Nam	Bangladesh; India; Malaysia; Mongolia; Philippines; PRC; Taipei,China; Thailand
	On point sources	Bangladesh, Cambodia, India, Indonesia, Lao PDR, Malaysia, Mongolia, Philippines, PRC, Thailand, Viet Nam		
	On non-point sources	Malaysia, PRC, Thailand		
	Formal Regulations	Bangladesh, India, Indonesia, Malaysia, Mongolia, Philippines, PRC, Thailand, Viet Nam	India, Malaysia, Philippines, PRC, Viet Nam	Bangladesh; India; Malaysia; Philippines; PRC; Taipei,China; Thailand
	Informal Regulations	Bangladesh, Cambodia, Lao PDR, Viet Nam		Mongolia
<b>Information provision, labels, and voluntary agreements</b>	On pollution	PRC	Bangladesh, India, Indonesia, Philippines	PRC
	On inputs/outputs	India, PRC, Thailand	Bangladesh, Cambodia, India, Indonesia, Mongolia, Nepal	India; Mongolia; Nepal; PRC; Taipei,China; Philippines
	On point sources	PRC	Indonesia, Philippines	
	On nonpoint sources	India, Indonesia, Malaysia, Philippines, PRC, Thailand	Bangladesh, India	
	Formal Regulations	India, PRC, Thailand	Indonesia, Philippines	PRC; Taipei,China
	Informal Regulations		Bangladesh, Cambodia, India, Indonesia, Mongolia, Nepal	Bangladesh, India, PRC

Lao PDR = Lao People's Democratic Republic, MBI = market-based instrument, PRC = People's Republic of China.

Source: Asian Development Bank.

## Key Factors Affecting the Success of Market-Based Instruments in Asia

There is no universal recipe for the successful implementation of an MBI to address an environmental problem, but there are some lessons from previous experience that can help inform the further deployment of MBIs or the upscaling of existing policies. It is important to consider the environmental problem and its source as well as institutional characteristics and social and economic considerations.

### **The stringency and effectiveness of MBIs have been affected by policy and regulatory frameworks favoring economic development over environmental protection.**

Asia is diverse in terms of political systems and levels of economic development. This implies different capacities and abilities of institutions in implementing, monitoring, and enforcing MBIs. In particular, the institutional capabilities have not been able to keep up with rapid industrialization, and the implementation and level of stringency of market-based instruments for environmental management clashes with short-term development goals.

A key goal of any government is sustaining economic growth for its citizens, but some policies to promote growth may have negative environmental consequences. In an attempt to combat environmental degradation, ADB developing member countries (DMCs) have established legal systems and institutions to oversee environmental protection and management. However, reviews of environmental performance in the region reveal that many DMCs lack policy frameworks and institutional resources and capacity that would help achieve stated environmental goals. The evidence of MBIs' performance to date is consistent with such a diagnosis, as the stringency and enforcement of most policies in place is generally low. Furthermore, environmental taxes are often high enough to raise governments' revenues but too low to lead to significant behavior responses. The level of charges or taxes has been often decided without due regard to environmental goals. In many instances, these charges and taxes were not annually adjusted for inflation, making them even less stringent in real terms over time (Cotelo, Francisco, and Darvin 2016).

Experiences in the PRC provide examples of the low level of stringency of environmental policies. Pollution charges are generally priced lower than the cost of an incremental pollution reduction, even with rate increases. In many cases, the actual charge paid by a producer is a result of bargaining with agencies. Furthermore, the collection rate is low, estimated on average to be less than 50% of imposed charges (between 10% in western provinces and 80% in coastal areas), diminishing their incentive effect (Organisation for Economic Co-operation and Development [OECD] 2006).

Economic development concerns have also constrained the broad and effective application of pollution charges across Asia. For instance, in Southeast Asia, taxes, fees, and charges have not been used widely for industrial establishments. Economic development considerations have played a role since concerns over the impacts of environmental taxes and charges on the competitiveness of industries have discouraged their comprehensive application (OECD 2012). A similar problem occurred in the case of air pollution control, which is strongly connected to energy and industrial activity.

In the case of water, increasing block tariffs and taxing wastewater discharge have been mainly used by municipal water utilities in most of Southeast Asia. In contrast, the application of taxes and charges for controlling poor surface water quality from industrial and agricultural production is much more limited (specific cases have been observed such as effluent charges for crude palm oil and rubber mills or environmental user fee for Laguna Lake in the Philippines). In the waste sector, household waste discharge fees are widely used in most countries. License and fees have been applied for industrial solid waste but are not widely used.

**Monitoring and enforcement are critical to successful implementation of market-based instruments.**

Inadequate monitoring and enforcement were identified as a key factor in growing environmental degradation in DMCs such as the PRC (OECD 2006). The general policy framework favoring economic growth over the environment influences the work of enforcement bodies at the subnational level, leading to widespread noncompliance with environmental requirements. These issues are exacerbated by the slow progress in engaging sectoral agencies and the public to address environmental problems. In many cases, pollution control equipment is put in operation only when expecting inspection, as producers may be more concerned with saving on operation costs or, in the case of wastewater, communities cannot afford to operate sewage treatment plants. Despite several types of noncompliance sanctions, a wide gap exists between what environmental regulators are authorized to apply and what they actually do when producers violate environmental laws.

However, even where environmental officials may have identified pollution sources, local governments may demonstrate leniency toward these producers for political reasons. Thus, reducing the implementation gap, particularly at the subnational level, is one of the major challenges in improving environmental performance in the PRC. Much improvement is needed to increase the stringency of enforcement of environmental regulations and sanctions, as well as greater engagement of the public in promoting compliance with environmental laws.

Similar challenges are documented for Indonesia and Malaysia, where the existing environmental regulations are not properly implemented and noncompliance with environmental regulations is widespread (e.g., Indonesian Council of Environmental Law 2008 and Mohammad 2011). For instance, in Indonesia, the 2006 Program for Pollution Control, Evaluation, and Rating (PROPER) report, which evaluated compliance with air pollution control regulations by 254 companies, indicated that only 103 companies (40.5%) were assessed as compliant, 147 companies (57.9%) were assessed as noncompliant, and 4 companies (1.6%) did not generate any emissions from their activities. An explanation for the high rate of noncompliance is that environmental agencies do not have the authority to impose significant administrative sanctions or conduct remedial and emergency actions. Moreover, authority over environmental law enforcement is shared by several institutions, requiring improved coordination. Insufficient human resources to support effective compliance and enforcement is also a common concern (Garcia, Sterner, and Afsah 2007).

Alternatively, it could be more efficient and effective to target a limited number of polluters that account for the largest share of pollution to minimize enforcement costs. For instance, Cotel, Francisco, and Darvin (2016) found that in Thailand, wastewater discharge mainly came from a few provinces that locate approximately 1,000 out of 68,000 factories of Thailand. These 1,000 factories produced 60% of biochemical oxygen demand and 68% of total suspended solids that the whole industry produces in a year. Administrative resources devoted to monitoring and enforcement could be minimized if regulations were to target this small group of high-polluting facilities.

**Pricing strategies such as pollution taxes or volumetric pricing need to be sufficiently high to incentivize behavior changes.**

Pollution charges have generally seen more success in combatting air pollution than water pollution. One of the reasons why pollution charges to reduce air pollution have performed better in terms of accomplishing environmental targets is that many countries in Asia have imposed relatively higher taxes on fuel consumption than on water pollution. In contrast, the environmental taxes aimed to improve poor surface water quality are generally too low to achieve a sizable reduction of pollution (Cotel, Francisco, and Darvin 2016).

Moreover, enforcement and monitoring capabilities are very different for air and water. Taxes on fuel are indirect instruments that apply to the product—they are targeted to reduce fuel use or improve fuel quality rather than

controlling air pollution directly. Imposing a tax on fuel is much easier than monitoring and enforcing a tax on discharge to control wastewater. For a water discharge tax to be imposed, high-quality monitoring data must be readily available, and that is typically not the case.

### **The political system can affect the choice and the performance of the market-based instrument.**

In countries with strong central governments, such as the PRC, the monitoring and enforcement of these direct regulations are usually at the discretion of government officials, which could create opportunities for rent-seeking. Environmental protection may reduce an industry's profits in the short run, which is a significant concern to local government officials. Since these profits provide a tax base, polluting firms and government bodies often jointly benefit from relaxed enforcement of environmental regulations. Polluters may attempt to bribe local government officials in exchange for lax enforcement of environmental regulations, as long as the inducements are cheaper than the compliance costs.

The governance and multijurisdictional nature of environmental problems have also affected the performance of MBIs. If standards are set federally but enforced locally, local officials may attempt to attract investment and industry by providing lax enforcement of regulation (Dasgupta 2000). For example, even if there are national guidelines regarding the frequency of visits for inspections, individual states may not regard the guidelines as binding. Thus, the establishment of institutions and coherent procedures for enforcement need to be addressed to achieve the desired effectiveness of environmental instruments in general and MBIs, in particular.

### **The nature of pollution sources and the local economic structure play a critical role.**

The formality of economic sectors and the type of polluters also affects the performance of MBIs. A significant proportion of small and medium-sized enterprises (SMEs) are not inspected by environmental authorities, due to capacity gaps and limitations stemming from “pragmatic” enforcement, which pushes environmental regulators to focus on “low-hanging fruit” by targeting big polluters, even though SMEs' aggregated pollution volume can be substantial. For example, the industry sector in India is characterized by many SMEs that operate without any permits. They utilize limited pollution control solutions and were responsible for an estimated 70% of the total industrial pollution load and about 20% of total industrial energy consumption nationwide in 2006 (OECD 2006). However, until now, most efforts to reduce pollution have been concentrated in large-scale enterprises.

In this case, there is a great potential for environmental improvements by regulating SMEs. However, enforcement costs for many small, informal firms could be substantial, and monitoring could be a significant challenge.

## **Context Matters for the Implementation and Success of Market-Based Instruments**

### **Southeast Asia**

Information provision and labeling has been a successful example of an MBI in the Southeast Asia region. The instrument has been used in all sectors i.e., air, water, and waste management (e.g., carbon disclosure projects in Indonesia, Malaysia, the Philippines, and Thailand; PROPER for water in Indonesia, water efficient product labeling scheme in Malaysia, EcoWatch in the Philippines; and the Industrial Waste Exchange program in the Philippines). A common characteristic of the use of this instrument in different countries is that it is applied to medium-sized and

large industrial establishments concerned about their public images and perhaps equity valuations. A good position in the ranking system or a green labeling could positively affect consumer behavior or investor decisions.

Another lesson from the experience with MBIs in Southeast Asia is that in using environmental taxes and charges, most countries have adopted simple levies rather than more complex charges that could lead to uneven requirements and conditions for businesses or households. The simple levies system reflected the way these countries dealt with the problems of informational requirements and regulatory burdens in implementing an MBI. Facing weak institutional capacity for monitoring and evaluating the taxes, as well as lack of human, financial, and technical capacity, governments in Southeast Asia have chosen a simple levy system that has not necessarily helped to improve the efficacy of reaching environmental targets, but has reduced the regulatory burden.

Removing fuel subsidies could be considered a successful case for Southeast Asia, particularly since political barriers have been challenging. Countries like Indonesia, Malaysia, Thailand, and Viet Nam, where fuel subsidies amounted to a significant share of government expenditure (e.g., 13% in Indonesia and Malaysia), removed fuel subsidies to finance poverty alleviation policies.

Tradable permits have not been used in Southeast Asia. The main reason for this is the regulatory burden; this instrument requires a tracking system to record transactions and more importantly, a consistent legal framework that has not been available in Southeast Asia (OECD 2012). Furthermore, the implementation of tradable permits has been considered premature when there is still a lack of evaluation of other market-based instruments in place. Taking air pollution management as an example, Indonesia and Malaysia had recently decided to remove high levels of fuel subsidies. Removing fuel subsidies was the first priority in the air pollution management agenda, not the use of tradable permits.

## East Asia

For air-related environmental management, Mongolia has launched a wide set of MBIs to curb air pollution stemming from household heating and cooking. The PRC has been focusing more effort on its industrial, energy and transport sectors. This difference closely relates to the relative contributions of these sectors to air pollution in Mongolia and the PRC. For instance, in Ulaanbaatar, emissions from household heating and cooking account for about 50% of the city's air pollution, while smog in Beijing is largely attributable to fossil fuel combustion in the manufacturing, power generation, and transport sectors.

In both Mongolia and the PRC, the MBIs are mostly intended to impose additional costs on actors responsible for adverse environmental outcomes (e.g., excessive pollution and overexploitation of natural resources), and to provide financial incentives to finance environmentally friendly actions (e.g., renewable energy supply). One rare exception is that the PRC's agricultural production is exempt from paying water use fees, which can be regarded as a substantial subsidy for agricultural water use in light of the considerable water use fees imposed on other sectors. There is thus considerable scope for water savings in the PRC's agriculture sector.

For sulfur dioxide, the PRC employs both a cap-and-trade scheme and a pollution tax. This use of a policy mix is somewhat unusual. In theory, the two MBIs are able to achieve equivalent outcomes under certain circumstances (when the total supply of tradable permits is set at such a level that the market prices of permits converge to the same rate of the pollution tax). One explanation is that the two MBIs have different advocates inside the government because they add to the power and income of different government departments. For example, the finance department collects environmental taxes, while the environment department is responsible for the initial allocation of tradable permits (which can be chargeable). It would be advisable to discern and address such conflicts of interest to achieve socially optimal policy making.

In East Asia, there is a body of empirical literature that has reported on the considerable achievements of MBIs. For instance, the PRC's pollution charges have been quite efficient in reducing industrial firms' water and air pollution (Chen 2013). Of the PRC's seven pilot carbon markets, large trading volume tends to be closely associated with a greater degree of carbon emission reduction (Chen and Xu 2018). There also exists evidence showing that a hypothesized increase in the PRC's gasoline tax rate would help mitigate air pollution via reducing driving (Qin, Zheng, and Wang 2013) and enhancing the preference for fuel efficient vehicles (Sun, Xu, and Yin 2016).

In addition, by 2015, generous state subsidies have enabled the PRC to establish the world's largest renewable energy sector. Extensive numbers of households in Mongolia have switched to energy efficient dwellings and stoves, improved insulation, renewable energy, and clean fossil fuels, which could not have been affordable at unsubsidized prices. Further, both countries' waste collection and disposal services mostly rely on public subsidies to operate.

A widely acknowledged strength of MBIs is their cost-effectiveness. However, an additional, under-explored merit of MBIs is their potential to incentivize enforcement actions when environmental regulations can only be weakly or selectively enforced, which also provide financial benefits to government bodies. This helps explain the uneven performance of environmentally related MBIs in the PRC. For example, the PRC's pilot carbon markets functioned better in Hubei province, where emissions permits were allowed to be auctioned by authorities (Chen and Xu 2018). Moreover, the piloted pollution taxes (which were expanded later to the entire country) outperformed pollution charges (Zheng 2016). In the PRC's pollution charge system, local environment bureaus were responsible for collecting and spending pollution charges. This depleted the tax base (which depended on industrial profits) available for more powerful authorities such as local government leaders and treasuries, who might have overridden environment bureaus and tolerated shortfalls in pollution charge payments. A pollution tax would be able to rectify this drawback, because the revenues from the pollution tax would now be reaped by these more powerful authorities, which would incentivize their enforcement actions.

## South Asia

South Asia has had several experiences using MBIs to protect its environment and conserve resources. In the subregion, India has the largest economy and has used a number of such instruments to deal with its environmental problems. Many of them have not been fully implemented due to difficulty in terms of regulatory requirements. For example, privately operated central effluent treatment plants are intended to provide a central location to which firms can send their effluent for processing and disposal. These facilities were unable to deliver, so the National Green Tribunal ruled the pollution control board and the Madhya Pradesh State Industrial Development Corporation to pay Rs9.6 million for the cleanup of the Ulash river. It was recommended that central effluent treatment plants be delinked from owners and managed instead by an independent agency (Chatterjee 2017). Despite such implementation gaps, there are some success stories. One strong example is India's feed-in tariff and auctions for renewable energy producers to supply electricity to the power grid (Box 1).

Private informal water markets have also appeared in many parts of South Asia (Anshika et al. 2017 and Venkatachalam 2016). India and Bangladesh share similarities in the management of their respective water sectors. Bangladesh has been heavily dependent on groundwater for irrigating its agricultural land, and this is also true in many states in India. Public investment in irrigation infrastructure and subsidized provision of water (combined with a reduced price of electricity for water pumping) has led to a decline in both surface water supplies and groundwater tables (Rahman et al. 2011 and Sidhu 2010), leading to implementation of innovative pricing mechanisms, such as the use of prepaid meters for irrigation in the Baring tract in Bangladesh (Asaduzzaman 2013; Pandey et al 2020; and Sharma and Prathapar 2013)).

**MBIs offer the opportunity for real environmental improvements and can transform the economic landscape if properly implemented.**

The introduction of any new policy instrument needs careful consideration of the available options, the local social and economic context, and an understanding of the institutions required for successful implementation. However, MBIs have proven to be successful in addressing environmental and resource problems in a variety of contexts.

The next chapter provides specific recommendations for the piloting of new MBIs, the upscaling of existing MBIs, and where evidence suggests that some MBIs can be implemented in the near term (so-called “low-hanging fruit”).

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# 6

## Recommendations

### KEY MESSAGES

- Market-based instruments (MBIs) offer promise for Asia to balance economic and environmental objectives and attain their commitments to the Sustainable Development Goals.
- Effective design and implementation of MBIs require gradual learning, adaptation, policy dialogue, and the use of multiple, complementary policy instruments.
- Successful implementation of MBIs also requires long-term commitment and adapting to changing conditions.
- Some MBIs, such as removing fossil fuel subsidies, taxing emissions, pricing water resources, and procurement auctions for electricity offer significant promise to be transformative.
- MBIs have the potential to be deployed in new areas, particularly through information provision, reforming subsidies, taxing emissions, and pricing scarce resources such as water.
- MBIs with potential for “scaling up” include additional emissions trading programs, deployment of feed-in tariffs and procurement auctions, expanding payments for ecosystem services, and expanding extended producer responsibility and deposit–refund schemes.
- Policy makers need to create an enabling policy and regulatory framework, strengthen institutions, and cooperate with development partners to successfully implement MBIs.
- Development partners can promote MBIs by building the knowledge base, providing technical assistance for reforms and institutional capacity building, and supporting assessments and pilots to scale up and strengthen design and implementation.

## The Role of Market-Based Approaches to Environmental Management for Growth and Sustainability

The use of market-based approaches to environmental management offers an opportunity for developing countries in Asia to address environmental problems and achieve the Sustainable Development Goals (SDGs) through prices and incentives rather than top-down mandates. As economic growth is still a priority for Asian Development Bank (ADB) developing member countries (DMCs), MBIs should be considered as a critical policy option that can complement or replace traditional command and control (CAC) regulations.

There is a need for transformative environmental policy, as the region is facing critical environmental and resource challenges. Some of the world's most polluted air is found in cities in Asia. Water scarcity is a growing concern, and water pollution threatens the fresh water that serves a growing population. The increase in waste that is being generated across Asia is an urgent problem facing policy makers. This report documents the use of MBIs in addressing challenges in the areas of air pollution, water resources, and waste and summarizes the characteristics of successful MBIs for different settings and contexts.

By using MBIs, environmental goals can be reached more efficiently than through traditional approaches such as mandates or directed state investment. MBIs ensure that pollution reductions are achieved in a more cost-effective manner, and they rely on market mechanisms such as prices to efficiently allocate scarce natural resources. MBIs incentivize the efficient use of resources, discourage pollution, and encourage innovation in new products, processes, and technologies. As such, MBIs offer flexibility to businesses in how environmental goals are achieved, which lowers the costs to firms and incentivizes innovation.

MBIs are also consistent with goals of more sustainable production and consumption, addressing climate change, and promoting inclusive green growth, as outlined by the SDGs, the Paris Agreement, and ADB's Strategy 2030. For these commitments to be achieved, natural resources must be utilized as efficiently as possible, and all firms and consumers must realize the environmental and social costs of their choices. MBIs are designed to provide price and market signals to firms and consumers to achieve the desired environmental outcomes.

This report provides concrete examples of the complexities of efficient environmental policy design. The characteristics of environmental problems need to be matched with the characteristics of the policy instruments as well as the capacity of governments and institutions and the political feasibility of the proposed instruments. In practice, this means that there is no ideal policy instrument that would be appropriate in all settings. Instead, this review has revealed that efficient design and implementation of MBIs is characterized by gradual learning, adaptation, policy dialogue, and in many cases, the use of multiple policy instruments.

The successful deployment of MBIs has required years of work and a long-term political commitment by governments. For example, in the 1990s, the People's Republic of China (PRC) experimented with the public-private partnerships in the municipal water supply sector. Many of these contracts were terminated early and at the time were widely considered failures. But the PRC learned from its experiences with foreign contractors and gained valuable expertise. The government persisted in its efforts to utilize the expertise of private firms, shifting its focus from engaging foreign private contractors to domestic private contractors. As a result, private sector partners have increased capital investments in the sector and improved production efficiency (Wu, House, and Peri 2016). After over 20 years of experimentation and learning, the private sector arguably plays a larger role in the municipal water sector in the PRC than anywhere else in Asia. This has been achieved as a result of the government's long-term strategy and commitment.

Similarly, the success of Manila's water privatization has not been easy. In the initial privatization plan, the city was divided into zones, each to be run by a different concessionaire. The goal was for the regulator to benchmark each concessionaire's performance against the other. The East Zone, run by Manila Water, was deemed a success, but the West Zone concession initially failed and had to be re-bid. Meanwhile, the East Zone continuously revised its tariffs with considerable controversy. There was no master plan for how to deal with such difficulties. Rather it was a process of trial and error that eventually led to progress in both the East and West concessions.

Likewise, despite a slow start, there is evidence of the efficacy of the PRC's pollution charges in reducing industrial firms' water and air pollution. The PRC's carbon emissions trading pilots yielded large trading volumes and prices. Successful implementation of MBIs requires a willingness to experiment and adapt programs to changing conditions. Policy makers in Asia who are considering the use of one or more MBIs need to appreciate the challenges of implementation, and they will need the support and guidance from those who have successfully implemented MBIs.

In the waste management sector, the successful use of MBIs requires coordination across various levels of the waste-stream (upstream waste-reduction, household and industrial waste collection, and waste processing). For example, the use of deposit–refund schemes to improve the collection rates of used batteries in India proved successful in increasing customer–returns of used batteries. However, retailers preferred to sell the returned batteries to the informal sector that could collect more frequently than manufacturers and were able to pay higher prices, as they did not have to adhere to environmental standards (Dholakia and Jain 2015).

This report demonstrates that the application of MBIs differs greatly between sectors and across countries. This mirrors the experience from Organisation for Economic Co-operation and Development countries, where the deployment of MBIs has been very gradual and where certain combinations of policy instruments and application are much more common than others. The next section outlines stages of what could be considered a deployment strategy for new MBIs.

## Where are the New Opportunities for the Use of MBIs?

### Designing a Deployment Strategy

For countries with little experience in the application of MBIs for environmental policy, this section provides recommendations for implementing new MBIs. There are a number of policies that are well established as “no-regret options.” These are the obvious candidates for the deployment of new MBIs.

### No-Regret Options

#### Building Momentum with Information

A first step toward the deployment of MBIs is creating awareness of environmental problems. There is an understandable reluctance by governments to implement new regulations and create new markets unless the problem to be addressed is considered to be a high priority. Similarly, people would be reluctant to accept higher environmental taxes, fees, charges and restrictions if they do not perceive the benefits to be corresponding or the cost of inaction too high. Information can thus pave the way for reform and represent a policy instrument in its own right. In practice, this means that the collection and regular publication of accurate data on environmental quality indicators is an important aspect in driving public awareness and enabling evidence-based policy making.

A striking example of the power of information is the case of the air-quality monitor on the United States Embassy in Beijing that was installed in 2008. At the time, Beijing’s poor air quality was common knowledge, but the new information provided by continuous monitoring led to a widespread discussion of the problem, leading to changes in environmental policy, advances in air quality science, and similar efforts in neighboring countries (Roberts 2015).

#### Subsidy Reform

Reforming perverse subsidies would have numerous environmental and fiscal benefits. In Chapter 2, there are a number of examples of how previous energy, and in particular fossil fuel, subsidies have been reformed. Such subsidies typically have negative environmental consequences and have direct costs to the government budget. Subsidies that support consumption of fossil fuels encourage excess energy consumption, promote energy-

intensive industries, reduce incentives for investments in renewable energy, and accelerate the depletion of natural resources (Clements et al. 2013). The International Energy Agency estimates the value of global fossil fuel consumption subsidies in 2019 to around \$318 billion, with vast differences by country. The cost of subsidies varies depending on the methodology and whether externalities are included, but estimated that energy subsidies would cost a total of \$5.2 trillion in 2017, or 6.5% of global gross domestic product, with the PRC providing the largest subsidies at \$1.4 trillion in 2015 (Coady et al. 2019).

### **Pollution Taxes and Resource Pricing**

When goods or services cost less than the true social cost to society, there is an externality generated by their production or consumption. Such externalities lead to inefficiencies throughout the economy, which reduces the well-being of the society.

A critical first step is to identify such negative environmental externalities, estimate the negative welfare implication each externality has, and then impose a tax so that the producers and consumers fully internalize the cost. Such taxes can be placed on greenhouse gas emissions, local pollutants, or waste generation.

Emissions taxes raise revenue while at the same time reducing the negative environmental impact. Environmental tax revenues can be used for green infrastructure spending or to offset reductions in other taxes. Throughout this report it has also been noted that while taxes, charges, and fees are common policy instruments, the levels need to be high enough to incentivize behavior changes.

Similarly, without proper pricing, scarce resources such as water will be overused and misallocated throughout the economy.

### **Where there has been successful experience with similar instruments in other settings, an MBI should be considered.**

An MBI could be implemented with a high probability of success if previous experience has demonstrated its feasibility, and if the local context suggests that it is practical. Specifically, if a similar instrument has been successfully used in a country of similar socioeconomic status and institutional capacity, that instrument should be promoted.

## **Opportunities and Potential for Upscaling of Market-Based Instruments for Air, Water, and Waste**

This report reviewed the experiences of applications of MBIs in Asia. The further deployment of MBIs should be considered in settings and countries with similar institutional capacities. In terms of potential for upscaling of MBIs for air, water, and waste, a number of “low hanging fruit” recommendations are described in this section.

MBIs in DMCs have often suffered from a low level of stringency as well as poor monitoring and enforcement. Careful consideration of the choice of MBI and the use of multiple policy instruments may be needed. This section discusses opportunities for innovating policies and/or modifying existing MBIs that can deliver substantial economic and environmental benefits at a relatively low cost.

## Upscaling Market-Based Instruments to Reduce Air Pollution

A wide array of market-based policy reforms for air pollution mitigation have been implemented, and many have been intended to improve or update existing regulations. This does not necessarily mean that such policy reforms are exempted from political resistance or are universally successful. However, they may be more likely to deliver the expected improvements as they emerge as remedies to observed imperfections in existing policies. In contrast, developing new policies from scratch may be more controversial or uncertain than reforming existing policies. Moreover, imperfections in existing policies may necessitate these policy remedies anyway and hence render them more pressing than opening another front.

### **Subsidies for renewable energy should be reduced to reflect technological progress.**

As discussed in Chapter 2, renewable energy policies have considerable scope for improvements in light of the rapid decline in production costs owing to technological innovations. In 2017, the cost range of solar power generation in India and the PRC was within that of fossil fuel-fired electricity generation. This implies that, even in the absence of subsidies, solar power may soon become competitive as fossil fuel-fired electricity in terms of generation costs. Therefore, public subsidies for solar power generation could be reduced at the same pace, as is the case in India and the PRC, or even fully abolished if and when subsidies for fossil fueled power have been removed and policy instruments to internalize the damage from fossil fuel energy are fully implemented. In the meantime, more efficient approaches can be employed to ensure low-cost renewable energy investments. A procurement auction requires solar energy suppliers to specify the prices they wish to receive, and the grid would then purchase energy from the least-cost suppliers. Solar energy suppliers in competition with each other would be willing to accept lower prices as long as they can make a profit, which can then drive prices down to closer to production costs. This mechanism thus creates dynamic prices for solar energy that are more adaptable to changes in production costs. A review of renewable energy auctions in India suggests that, when designed appropriately to manage risks, renewable energy capacity can be deployed in a cost-effective and fair manner, with savings of up to 58% from the baseline feed-in tariff as well as fair allocation of projects (Shrimali, Konda, and Farooque 2016).

### **Infrastructure investments are necessary to accommodate renewable energy expansion.**

Problems in the transmission process have increasingly emerged alongside the scale-up of renewable power, especially where renewable energy endowments are geographically uneven and centralized renewable power needs to be transmitted over long distances. Advanced power grids and storage systems are required to better accommodate the intermittent nature of many types of renewable power (such as solar and wind) at a larger scale. In addition, some localities may be reluctant to import renewables from wind- and solar-rich areas to protect local fossil fuel-fired power suppliers. Policy instruments should be increasingly directed to research and development activities and infrastructure investments for the transmission and storage of renewable power, and to overcoming the institutional hurdles of cross-province transmission. Otherwise, renewable energy would be prone to a high risk of curtailment.

At the same time, some countries are also encouraging distributed renewable energy generation, such as rooftop solar energy for residential and commercial purposes. In the PRC, distributed solar photovoltaic systems make up over 27% of its total solar PV installed capacity. Unstable power supply from centralized grids, affordability and scalability of decentralized technology, and limited land availability have contributed to growth in distributed renewable energy markets. Policies and incentives are needed to stimulate investment in distributed renewable energy and make progress toward achieving grid parity, or driving the cost to equal or less than the cost of power from the electricity grid. This can also generate revenues to support grid infrastructure upgrades, promote energy security and job creation, and bring the environmental and climate benefits.

**Governments must strengthen the enforcement of existing environmental policies by better incentivizing implementing bodies.**

Previous experience with the PRC's pollution charges were found to be able to reduce pollution when rigorously enforced. The main problem was that pollution charges were often weakly or selectively enforced due to a conflict of interest among implementing bodies. Previously, local environmental bureaus were responsible for collecting and spending pollution charges. This would reduce the tax base available for more powerful stakeholders, such as local governmental leaders and treasuries. Replacing pollution charges with environmental taxes, as the PRC did with the Environmental Protection Tax Law, would overcome this hurdle because environmental tax revenues now accrue to local governments and mandate their enforcement actions. It is important to ensure that pollution charges are directly utilized to bring about cleaner production and consumption actions, so that stakeholders can see the impact of the charges. To enable this, environmental agencies need to move beyond a CAC role to a more technology facilitation and behavior change role.

**Fossil fuel subsidies must be phased out.**

Many policies with environmentally harmful impacts can be reformed to achieve similar social and economic outcomes at a lower cost to the environment. Coal, gas, and diesel subsidies are still widespread, despite overwhelming evidence of fossil fuels' detrimental impact on human health and its contribution to climate change. For example, the agriculture sector often lobbies for a diesel subsidy by arguing for its contributions to food security and poverty alleviation, as agricultural machinery is often powered by diesel. However, output-based subsidies, such as price premiums for agricultural products or subsidies for agricultural machinery powered by renewable energy, and incentives and support to incorporate solar energy to replace diesel can achieve the same objectives. Switching to such policy alternatives would considerably reduce political resistance toward the phaseout of environmentally harmful subsidies. For instance, India attempted to launch a fossil fuel reform intended to curb the incentives for the use of diesel. This agenda provoked strong resistance from the public and was eventually reduced to a gradual rise in diesel prices instead of the outright removal of diesel subsidies. This problem may be smoothed over by replacing diesel subsidies with environmentally friendly (or neutral) subsidies that target the same interest groups, as well as support for improved technology adoption and pricing alternatives that address variable needs of small and marginal farmers and diesel fuel users.

**Emission trading schemes have potential for expansion with appropriately stringent caps.**

To address carbon emissions, seven pilot carbon emissions trading schemes implemented in the PRC from 2013 to 2017 (Chen and Xu 2018) show that there is some promise for upscaling. Cap-and-trade programs to address carbon emissions and air pollution have been successfully implemented in both Europe and the United States in the past. The pilot Emissions Trading Schemes in the PRC show both the promise and challenge of wider implementation of such schemes (Box 2). Some of the challenges are that it is hard to set an appropriate level of ambition, and cap-and-trade instruments require more institutional capacity than some alternatives. For this reason, some observers argue that price-based instruments such as taxes and fees are more promising. Even more experience will be gathered as the program is now implemented at the national level, and other countries and sectors could learn from this as they design their own programs.

## Upscaling Market-Based Instruments for Water Management and Reducing Water Pollution

### **Behavioral nudges can induce a low-cost behavior change.**

Behavioral “nudges” use psychological interventions to influence the behavior and decision-making of water users to complement the use of MBIs. Tools such as social comparison messages; information provision on water quality; a combination of technical information, moral persuasion, and social comparison; social norms; and education campaign have been effective in changing behavior in other contexts. To be effective and sustainable, nudges can be employed as part of short-term campaigns for conservation during water shortages and targeting communities with adequate wastewater treatment and sanitation infrastructure.

### **A mixed policy instrument to address water use and waste discharge is recommended.**

One possible instrument would include an effluent charge and an information provision policy. Such an application of information provision has been successful in Asia, while effluent charges have shown mixed results (due to monitoring challenges). Examples of information provision to address water resources management issues include the Program for Pollution Control, Evaluation and Rating for water management in Indonesia; a water-efficient product labeling scheme in Malaysia; the Eco-Watch program in the Philippines and the PRC; and the Industrial Waste Exchange program in the Philippines. In Malaysia and the Philippines, applications of effluent charges resulted in large and significant decreases in biochemical oxygen demand discharges.

### **A mixed policy of information instruments and effluent charges can create incentives for adopting environment-friendly technology and innovation.**

Separately, each instrument has demonstrated some efficacy in reaching environmental targets, but a mixed policy has the potential to significantly improve environmental outcomes. These can also provide benefits in terms of mitigating corporate risk perception, which can help attract investment in water resources management.

Utilization of the supporting system of one instrument for the other one would help mitigate costs of the policy. For example, the information requirements for a successful implementation of the information provision instrument also cover the information requirements for the implementation of effluent charges. Information on firm-level activities and discharge, such as self-assessment data and primary field data, should be collected and submitted to authorities, and that information would be used for both the information instrument and the effluent charge. In addition, information on available abatement technologies and environmental damage from discharge is required to set the charge at a level that provides enough incentives to achieve a desired pollution reduction. A policy mix could be applied for medium-sized and large firms in the early stage of the implementation process to reduce transaction costs in collecting and processing information.

### **Development, financing, and tax incentives are needed to scale up green infrastructure.**

A range of green infrastructure approaches will need to be mainstreamed and upscaled to address water pollution and flooding in Asia’s cities. There are emerging examples on the use of incentive schemes such as subsidies and tax breaks for green roofs and permitting requirements for stormwater management facilities in the region. Knowledge of the benefits of nature-based solutions and other greening measures for reducing water pollution and flood risks needs to be further mainstreamed.

### **Payments for ecosystem services schemes show promise for upscaling.**

Regional examples of successful payments for ecosystem services (PES) schemes show that there are a number of enabling conditions required to scale up, including political support, sustainable financing, lean institutional setup (including cross-sectoral coordination across government agencies), effective tools and systems, clearly demonstrated impact, and the flexibility to adapt to different conditions across target ecosystems and communities. Social benefits can also facilitate political will and resources to drive and expand PES programs and environmental investments. Innovative financing mechanisms, such as water funds, can also provide necessary support to program sustainability. Studies and investment are required to clarify the property rights and control of ecosystem services as a basis of PES schemes. Experiences in Nepal, the PRC, and Viet Nam show promise and provide useful lessons for implementing larger scale PES programs.

## **Upscaling Market-Based Instruments for Waste Management**

### **Initiatives and policies to separate waste at the source can enable markets for downstream waste beneficiation.**

Policies, bolstered by incentives such as pay-as-you-throw schemes and information campaigns, should require households and producers to segregate their waste at-source and ensure their proper treatment. The first step is for households to separate their waste into organic and inorganic components, which must be collected separately. Commercial waste can be separated into organic waste, dry recyclables (for recycling), hazardous waste (for special treatment), and residual waste. The goal of both households and firms separating waste is to enable waste beneficiation activities in the private sector by generating the volume of high-quality waste needed to catalyze investments in integrated solid waste management systems and waste treatment technologies. At the municipal level, this must be coordinated to ensure the harmonious integration of public and private sector waste management activities.

### **Micro-waste depots in informal settlements can create incentives for informal sector waste pickers.**

Informal waste pickers can collect general waste and deposit it in safer designated areas, rather than disposing of waste in waterways and other areas. Micro collectors could be incentivized to participate by providing payments per kilogram of waste collected (via electronic payment). Waste could then be separated and, if practical, private sector transport providers could be incentivized to transport that waste to recyclers and other waste beneficiation companies. Setting up cooperatives of micro-collectors is one way to formalize these initiatives, which must be explored. The waste value chain needs to be addressed as a system so that informal collectors can be integrated in the solid waste management system and derive better value from recyclers and the processing industry.

### **Useful command and control regulations can be scaled up in identified critical waste streams.**

For example, rather than an outright ban on plastic bags, information campaigns could be used in conjunction with bag fees to encourage business and consumers to substitute to multi-use alternatives. Similarly, performance standards on the production of plastic bags across Asia can be implemented to make the bags easier to reuse and recycle.

**Countries must ensure there is a suitable legal and regulatory framework for encouraging public-private partnerships.**

Public-private partnerships are key enabling mechanisms to facilitate the transition to more market-based waste management instruments and stimulate innovation. To be truly effective, such partnerships require conducive legislative and regulatory environments as well as oversight mechanisms.

**Setting aspirational goals can help support introduction and implementation of MBIs.**

This will act as a catalyst to both the public and private sectors in the waste generation and beneficiation industries and identify clear objectives that can be monitored over time. Supporting policies to transition to more market-engaging approaches to environmental management can then be identified, such as encouraging public-private partnerships in the waste collection, storage, transportation, and beneficiation industries.

**An ambitious but aspirational goal would be to enact zero-waste policies.**

This clear goal focuses attention on the necessary first steps that must be taken to get to zero waste and clearly defines the policy goal and discourse. It is easy to communicate and is a necessary first step in building a coordinated approach to improved waste management practices in the region. The following issues would be necessary to consider:

- an assessment of the clarity of property rights assignment for each waste stream or group of related waste streams (e.g., organic waste, dry recyclable materials, residual waste, hazardous waste);
- identification of policies that can be implemented to assign clear property rights where they are lacking;
- recommendations for how public-private partnerships can be further encouraged to enable the transition over time from CAC to a broader use of MBIs for waste management;
- identification of strategies to deal with legacy waste, which should also involve the informal sector and provide recommendations for pathways out of informality using waste management as the tool to achieve this;
- development of industrial support policies for each waste stream or group of related waste streams aimed at different parts of the waste hierarchy; and
- an assessment of the market- and nonmarket-based barriers to entry for private sector involvement in waste management value chains.

**Market-based instruments can facilitate the transition to circular economy models.**

Beyond achieving zero waste, countries can consider a holistic and comprehensive approach to resource use, production, consumption, and waste management that designs out waste and enables efficient and continual use of resources. A circular economy would reuse products and recycle waste as materials in other production processes. MBIs such as carefully designed extended producer responsibility and deposit-refund schemes would contribute to a circular system. This is starting to gain traction in Asia. In Indonesia, the National Plastic Action Partnership Action Plan aims to reduce marine plastic pollution leakage by 70% by 2025 and achieve zero plastic pollution through adoption of a circular economy (Global Plastic Action Partnership, 2020). The Action Plan highlights the use of incentives for plastic waste recovery and integrating the informal sector.

## Recommendations for Next Steps for Policy Makers

### **Governments need to integrate environmental regulatory frameworks into national plans and programs.**

Regulatory frameworks in many Asian countries are still unprepared to introduce MBIs. Existing regulations for standards, emissions caps, or property rights are weak and unable to create the right enabling environment to establish MBIs. Furthermore, many of the required conditions, particularly adequate institutional capacity to monitor and enforce environmental regulations, are not strong enough to successfully implement MBIs. Governments will need to strengthen national environmental regulatory frameworks, with clear performance indicators that are linked to national development plans, policies, and programs. These can also be tied to targets in international agreements and treaties, such as the SDGs and the Paris Agreement for climate change.

### **Governments can establish or strengthen dedicated institutions and develop procedures to improve enforcement of environmental regulations.**

Enforcement of environmental regulations often requires coordination between different agencies, including environmental agencies and law enforcement authorities, as well as national, regional, municipal, and local-level governments. There need to be clear guidelines and procedures for cooperation. In some cases, independent task forces, committees, or other institutional arrangements can be established to enforce specific regulations. For example, the Philippine Center for Environmental Protection and Sustainable Development, Inc. was established to serve as administrator of the country's National Ecolabeling Programme, Green Choice Philippines, under the auspices of the Department of Environment and Natural Resources and the Department of Trade and Industry. Existing regulations must also be harmonized between environmental and other agencies and authorities to reduce redundancies and streamline responsibilities and resources.

### **Government and nongovernment actors can work together to strengthen regulatory systems.**

Where governments lack in resources, expertise, and capacity, they may leverage relationships with partners in other sectors, who may be able to compensate and provide complementary support to strengthen environmental regulatory systems. Nongovernment organizations (NGOs), the private sector, industry associations, research and academic institutions, and other stakeholders have knowledge and technical expertise that can help inform the design of policies and economic instruments, as well as to monitor and enforce environmental standards. Many NGOs, such as the Forest Stewardship Council and World Wide Fund for Nature, have also led the development and enforcement of environmental codes and sector-specific certification schemes in collaboration with the private sector. These experiences can meet regulatory gaps, and best practices can be shared with governments. NGOs and civil society can also support the government in disseminating information, raising public awareness of environmental management, and campaigning for behavior changes that result in environmental improvement.

## Recommendations for Development Partners

Development partners, including international organizations, donor agencies, the private sector, and civil society organizations, are positioned to support countries in achieving the SDGs through greater use of MBIs. For instance, ADB's operational priorities under Strategy 2030 support the application of market-based approaches to help enhance environmental sustainability in its DMCs. These organizations should promote the use of MBIs when appropriate and provide assistance in the design of new MBIs, as well as upscaling and promoting the innovative use of MBIs to address the critical environmental challenges facing the region.

**Development partners can build the knowledge base on designing and implementing MBIs by supporting high-quality evaluations and providing platforms for knowledge-sharing.**

Partners can support countries in building a regional and global knowledge base for best practices and lessons on experiences with designing and implementing MBIs. There is a lack of empirical evidence for the effectiveness of many MBIs implemented in developing Asia. The lack of well-designed, quantitative evaluations of MBIs in many Asian economies points to the importance of supporting research initiatives investigating the effects of existing MBIs as well as cross-country comparisons of the performance of MBIs. More in-depth knowledge is needed on the actual short- and long-term impacts of implementing MBIs on environmental protection, revenues, distributional implications, and political economy, which will be necessary to correct and improve their design, including their stringency. This could be supported by targeted pilot programs and careful data gathering for impact evaluation. For instruments without sufficient experience, development partners could support experimenting through technical assistance, alongside strategic knowledge-sharing programs and platforms to highlight best practices and lessons from the region and globally. Academic and research institutions can provide technical expertise and advisory support on the design, evaluation, and redesign of MBIs.

**Development partners can support policy and regulatory reforms and institutional capacity building to create the right enabling environment.**

Development partners are well-placed to provide expertise and support institutional capacity development for policy and regulatory reforms, to introduce and ensure the efficacy and sustainability of MBIs. International organizations can support governments in aligning national policies and plans with global agreements such as the SDGs, Convention on Biodiversity, or Convention on International Trade in Endangered Species of Wild Fauna and Flora. They can also facilitate and coordinate actions to address environmental degradation and climate change through regional cooperation bodies such as the Coordinating Body on the Seas of East Asia and the Greater Mekong Subregion Core Environment Program. Partners may also have a role in assisting governments to develop proper measuring systems, performance indicators, or incentive structures to stimulate greater responsiveness and integration of environmental issues. Technical assistance may also be needed to improve coordination across regulatory bodies and capacity to enforce environmental regulations.

**Development partners can support assessments and piloting programs and technologies to scale up and strengthen implementation of MBIs.**

To meet knowledge and capacity gaps and enable learning and experimentation, countries may need support to assess opportunities and practical actions for countries to scale up and strengthen MBIs. Road map studies and market assessments are some of the approaches that can be supported by partner organizations and agencies. These can help identify opportunities for further assistance and investment programming. Development partners can also support roll-out of programs and technologies that can strengthen and scale up implementation of MBIs in the region. Projects can support the deployment of cutting-edge technologies and other innovative approaches to improve emissions monitoring and data collection that can better inform design, implementation, and enforcement of MBIs. Partners can also consider piloting new instruments in selected countries and conducting evaluations that can inform future design and implementation.

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# Appendix: Systematic Review of Market-Based Instruments for Environmental Management in Asia

## Introduction

For the review of experiences of market-based instruments (MBIs) for environmental management, a specific method—a systematic review—was used to identify and screen the current knowledge base. Systematic reviews provide a basis for “evidence-based practice” or “evidence-informed decision making” through a transparent, unbiased, and replicable process of searching for and synthesizing evidence in the literature (Bilotta et al. 2014; Mallett et al. 2012; and Mulrow 1994). While there are many variations of systematic reviews, these commonly require clear and precise protocols for searching literature in a replicable way, screen studies using quality specific inclusion and exclusion criteria, and apply consistent coding to extract, summarize, and analyze results.

Systematic reviews were applied on what was defined to be relevant policy or impact evaluations in the areas of air, water, and waste and related environmental impacts, and searches were constructed with a specific search protocol for each of these three thematic areas. The inclusion criteria of the search protocols can be divided into five categories, and only papers that contain at least one aspect of each category will be accepted for the next step of the process:

- (i) the paper relates to either air, water, or waste management;
- (ii) the paper includes at least one of the relevant pre-defined policy instruments for that topic;
- (iii) the paper utilizes some kind of quantitative method of analysis;
- (iv) the paper addresses the environmental impacts of the policy; and
- (v) the paper addresses MBIs implemented in one of the economies relevant for the review (or contributes to global best practice).

The search was executed in three databases of peer reviewed articles: Web of Science, SCOPUS, and EconLit. These were chosen since they together cover the majority of peer-reviewed journals and articles and have highly customizable search options. Once the initial search was completed, two additional iterations of screening the results were conducted, one by one, to identify the papers that fulfill all the criteria. These papers were used for the meta-analysis and contribute to the findings in the report.

The next section presents the structure of the search protocols, along with an overview of the main results of the systematic review across sectors, applications and MBIs.

# Overview of Systematic Review of Market-Based Instruments for Environmental Management in Asia

## Search protocols

There are five categories under each area (air, waste, and water) for keywords:

- (i) specific words under each area “air”, “waste”, or “water;”
- (ii) keywords related to “market-based policy instruments;”
- (iii) keywords toward “impact”, “analysis”, or “evaluation;”
- (iv) keywords for “environment”, “health”, or “climate change;”
- (v) keywords for “region”

Note:

1. Between each word in a column, there is an “OR” command, and between each “column”, there is an AND command. The results contain at least one keyword from each of the 5 columns.
2. Also, NEAR/x operator is to find articles where the terms joined by the operator are within a specified number of words of each other, where x is a number.
3. \* symbol is used to retrieve words with variant zero to many characters [Example: disease\* will include diseases, diseased, diseasing, diseasedness, etc.]
4. The words with bold mark are added after going through the articles.

## Organization of Article Sources

The articles are listed and organized based on which of the following categories that the article considers:

- The main economy discussed and/or examined in the article
- The year the article was published
- The main type of instrument discussed and/or examined in the article
  - Air
    - Tradable permits
    - Taxes, fees, and charges
    - Subsidies
    - Hybrid policies
    - Information disclosure
    - Voluntary agreements
  - Water
    - Water markets, tradable discharge markets
    - Taxes, fees, and charges
    - Subsidies
    - Privatization
    - Payments for ecosystem services

- Information provision, labels, voluntary agreements
    - General
  - Waste
    - Tradable permits
    - Taxes, fees, and charges
    - Subsidies
    - Hybrid policies
    - Information provision, labels, and voluntary agreements
- The evaluation criteria mentioned in the article
  - Informational requirements
  - Regulatory burden
  - Political feasibility
  - Static efficiency
  - Dynamic efficiency
  - Efficacy in reaching environmental target
- Which specific applications the article considers
  - Air
    - Point source (energy production)
    - Nonpoint source (transport)
    - Domestic cooking and heating
  - Water
    - Inadequate municipal water and sewerage services
    - Poor intra-sectoral water allocation
    - Poor surface water quality
    - Failure to protect and value ecosystems
  - Waste
    - Upstream waste reduction
    - Waste collection (domestic and industrial)
    - Waste processing

## Results and Analysis of Systematic Review

In total, 673 articles were yielded by the systematic review process: 313 centered on market-based policies for the problem of air pollution, 282 centered on market-based policies dealing with water management, and 78 centered on market-based policies for the problem of solid waste management.<sup>1</sup> Table A1 provides an overview of the number of articles identified and tagged by the search-criteria, across sectors, applications, and MBIs.

From this overview, some broad trends can be identified. For air quality management, most of the studies identified have centered around energy production and industrial pollution, of which the majority have focused on the use of tradable permits, while taxes, fees, and charges are also extensively explored in the literature. Relatively few studies in Asia have focused on the use of hybrid policies and information provision and other voluntary agreements in reducing air pollution. In the water sector, the majority of studies focused on the

<sup>1</sup> The total number of articles is not the same as the sum of totals in table 1 because any particular article can be centered on multiple sectors, applications or instruments.

problem of poor intra-sectoral water allocation, and across applications, the use of taxes, fees, and charges as an MBI has been the most extensively explored in the literature. In the waste sector, the majority of studies identified focused on waste processing, where once more, taxes, fees, and charges feature regularly in the literature. One possible reason for this may be due to a smaller set of policies having implemented these types of interventions.

Furthermore, there is a dearth of studies of the information provision and voluntary agreements as a policy tool for environmental management, despite the success of these types of interventions, for instance in the case of the Program for Pollution Control Evaluation and Rating in Indonesia, or Green Watch in the People's Republic of China (PRC). Hybrid schemes are also generally under-explored in the literature. Given a growing recognition that governments should try to adopt the correct policy mix, more attention should be paid to the potential synergies and linkages between different MBIs that can be used together—to achieve the same goal. In the case of waste management, for example, the various stages of the waste stream all need to be addressed for effective waste management—likely requiring different tools, but with a common goal.

Additionally, the literature on the use of economic tools for environmental management is largely dominated by studies focused on the PRC. While there are likely to be important reasons for this, it points to the importance of supporting research initiatives on this subject in other Asian economies.

Table A1: Overview of Results of Systematic Review, by Sector, Application, and Market-Based Instrument

	Applications										
	AIR			WATER					WASTE		
	Energy production and Industrial Pollution	Air pollution from Transport	Domestic heating/cooking	Inadequate municipal water and sewerage services	Poor intra-sectoral water allocation	Poor surface water quality	Failure to protect and value ecosystems	Upstream waste reduction	Waste collection	Waste processing	
Tradable permits	139	11	4	5	65	22	7	0	0	0	0
Taxes, fees and charges	99	21	1	46	78	23	4	6	11	21	
Subsidies	31	15	9	9	11	9	1	3	4	11	
Hybrid policies	3	1	0					4	6	9	
Information provision, labels, and voluntary agreements	8	0	0	3	6	2	0	3	1	8	
Privatization				16	18	17	1				
Payments for environmental services (PES)				1	0	0	4				
<b>Total by application</b>	<b>280</b>	<b>48</b>	<b>14</b>	<b>80</b>	<b>178</b>	<b>73</b>	<b>17</b>	<b>16</b>	<b>22</b>	<b>49</b>	
<b>Total by sector</b>		<b>343</b>			<b>348</b>				<b>87</b>		

Note: The table shows the number of peer-reviewed journal articles identified by each of the three systematic reviews conducted, organized by application and instrument. The tagging procedure is not mutually exclusive as some articles may involve multiple applications of instruments.

Source: Asian Development Bank.

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## **Greening Markets**

### *Market-Based Approaches for Environmental Management in Asia*

Asia has experienced massive economic growth, characterized by rapid urbanization and industrialization, changing demographics, and increasing consumption and demand for resources. This has contributed to significant environmental degradation. The challenge faced by governments in the region is in identifying and implementing innovative and dynamic policy approaches that are effective at improving environmental quality while sustaining development gains. This report reviews past and ongoing applications of market-based instruments (MBIs) to address air quality, water, and waste management in Asia and provides recommendations for the use of MBIs for more efficient and effective environmental management.

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ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members—49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.



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