
# SUSTAINABLE INDUSTRIAL DEVELOPMENT

## in Punjab, Pakistan

WORLD BANK GROUP

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Korea Green Growth Trust Fund

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The Korea Green Growth Trust Fund is a partnership between the World Bank Group and the Republic of Korea, established in 2011 to support client countries as they shift to a green development path. Both partners share a common goal to reduce poverty and promote shared economic prosperity in an environmentally responsible and socially inclusive way. The Trust Fund finances on-the-ground programs, as well as knowledge exchange activities, and to date has funded 132 programs worldwide. Based on strong performance, as well as increasing demand for collaborative development implementation programs, the fund was replenished at the end of 2015, growing from US$40 million to US$88 million to fund programs through 2021. For more information about the KGGTF please visit www.wbgkggtf.org

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# Abbreviations and Acronyms

| | |
|---|---|
| **ADEME** | French Agency for the Environment and Energy Efficiency |
| **BAT** | Best Available Technique |
| **BC** | Black Carbon |
| **BCI** | Better Cotton Initiative |
| **BOD** | Biochemical Oxygen Demand |
| **CAGR** | Compound Annual Growth Rate |
| **CE** | Circular Economy |
| **CETP** | Common Effluent Treatment Plant |
| **COD** | Chemical Oxygen Demand |
| **CPC** | Cleaner Production Center |
| **CPEC** | China-Pakistan Economic Corridor |
| **CPI** | Cleaner Production Institute |
| **CSSB** | Cement Stabilized Soil Block |
| **DALY** | Disability-adjusted Life Year |
| **DDK** | Clamp/Down Draught Kiln |
| **DE** | Domestic Extraction |
| **DETDZ** | Dalian Economic and Technological Development Zone |
| **DMI** | Direct Material Input |
| **EIA** | Environmental Impact Assessment |
| **EID** | Environmental Information Disclosure |
| **EIP** | Eco-industrial Park |
| **EMP** | Environmental Management Plan |
| **EMS** | Environmental Management System |
| **EnMS** | Energy Management System |
| **EPA** | Environment Protection Agency |
| **EPD** | Environment Protection Department |
| **EPO** | Environmental Protection Order |
| **EPR** | Extended Producer Responsibility |
| **EPRD** | Environmental Performance Rating and Disclosure |
| **EPT** | Environmental Protection Tax |
| **ESCO** | Energy Saving Company |
| **ESSA** | Environmental and Social Systems Assessment |
| **ETP** | Effluent Treatment Plant |

| | |
|---|---|
| **EU** | European Union |
| **FaL-G** | Fly Ash-Lime-Gypsum |
| **FCK** | Fixed-chimney Kiln |
| **FDI** | Foreign Direct Investment |
| **FIEDMC** | Faisalabad Industrial Estates Development and Management Company |
| **GDP** | Gross Domestic Product |
| **GHG** | Greenhouse Gas |
| **GIZ** | German Agency for International Cooperation |
| **GoPunjab** | Government of Punjab |
| **GPP** | Green Public Procurement |
| **GreenCo** | Green Company Rating System |
| **GSP+** | Generalized Systems of Preferences |
| **HHK** | Hybrid Hoffman Kiln |
| **IBI** | Information-based Instrument |
| **ICID** | Industries, Commerce, and Investment Department |
| **ICIMOD** | International Centre for Integrated Mountain Development |
| **IE** | Industrial Estate |
| **IEE** | Initial Environmental Examination |
| **IFC** | International Finance Corporation |
| **IS** | Industrial Symbiosis |
| **ISO** | International Organization for Standardization |
| **J&C** | Jobs & Competitiveness |
| **JICA** | Japan International Cooperation Agency |
| **KEA** | Korea Energy Agency |
| **KEITI** | Korea Environmental Industry & Technology Institute |
| **KGGTF** | Korean Green Growth Trust Fund |
| **KNCPC** | Korea National Cleaner Production Center |
| **LED** | Light Emitting Diode |
| **LSM** | Large-scale Manufacturing |
| **LWG** | Leather Working Group |
| **MF** | Material Footprint |
| **MFA** | Material Flow Analysis |
| **MI** | Material Intensity |
| **MOTIE** | Korean Ministry of Trade, Industry and Energy |
| **MSMEs** | Micro, Small, and Medium Enterprises |
| **NAP-SCP** | National Action Plan on Sustainable Consumption and Production |
| **NCPC** | National Cleaner Production Center |
| **NEECA** | National Energy Efficiency and Conservation Authority |
| **NEQS** | National Environmental Quality Standards |
| **NGO** | Nongovernmental Organization |
| **NISP** | National Industrial Symbiosis Programme |
| **NPO** | National Productivity Organization |
| **NSDS** | National Sustainable Development Strategy |

| | |
|---|---|
| **OECD** | Organisation for Economic Co-operation and Development |
| **PBIT** | Punjab Board of Investment and Trade |
| **PEECA** | Punjab Energy Efficiency and Conservation Agency |
| **PEQS** | Punjab Environmental Quality Standards |
| **PIEDMC** | Punjab Industrial Estates Development and Management Company |
| **PM** | Particulate Matter |
| **PPD** | Public-Private Dialogue |
| **PPP** | Public-Private Partnership |
| **PROPER** | Program for Pollution Control, Evaluation, and Rating |
| **PRTR** | Pollutant Release and Transfer Register |
| **PSIC** | Punjab Small Industries Corporation |
| **REACH** | Registration, Evaluation, Authorisation, and Restriction of Chemicals |
| **RECP** | Resource-efficient and Cleaner Production |
| **REDA** | Rizhao Economic and Technological Development Area |
| **RMC** | Raw Material Consumption |
| **RME** | Raw Material Equivalent |
| **S&L** | Standard and Labeling |
| **SBP** | State Bank of Pakistan |
| **SDC** | Swiss Agency for Development and Cooperation |
| **SEPA** | State Environmental Protection Administration |
| **SMART** | Self-monitoring and Reporting Tool |
| **SMEDA** | Small and Medium Enterprises Development Authority |
| **SMEs** | Small and Medium Enterprises |
| **SPM** | Suspended Particulate Matter |
| **SSM** | Small-scale Manufacturing |
| **STAGL** | Sialkot Tannery Association (Guarantee) Ltd. |
| **STZ** | Sialkot Tannery Zone |
| **SWM** | Solid Waste Management |
| **TBNA** | Tianjin Binhai New Area |
| **TDS** | Total Dissolved Solids |
| **TEDA** | Tianjin Economic-Technological Development Area |
| **TK** | Tunnel Kiln |
| **TOE** | Tons of Oil Equivalent |
| **TSS** | Total Suspended Solids |
| **UNIDO** | United Nations Industrial Development Organization |
| **VA** | Voluntary Agreement |
| **VSBK** | Vertical Shaft Brick Kiln |
| **WASCO** | Water Saving Company |
| **WF** | Water Footprint |
| **ZED** | Zero Defect—Zero Effect |
| **ZZK** | Zigzag Kiln |

# Executive Summary

## Background

**Greening Pakistan's industry has become an imperative to minimize its adverse impacts on the environment and society, but also to sustain the sector's growth.** Despite substantial growth in recent decades, the industrial sector is yet to make its full contribution to Pakistan's development. Limited consideration of the growing resource use, waste, and pollution that have accompanied industrialization has imposed mounting economic, environmental, and social costs. This is particularly true in large urban centers around which industries agglomerate, such as Lahore and Karachi. At the same time, poor environmental management has become a liability for Pakistan's industries, which notably undermines the competitiveness of export-oriented manufacturing sectors. The challenges posed by industries' lack of environmental sustainability jeopardize Pakistan's development and are expected to worsen under a business-as-usual scenario.

## Main Messages

**There is substantial scope to generate economic, social and environmental gains in Pakistan by promoting a more sustainable industrial development pathway.** This report focuses on the industrial province of Punjab that is home to over half of the country's population. It argues that there are significant unexploited opportunities to reduce industries' footprint, while improving their competitiveness, notably through firm-level investments in resource-efficient and cleaner production (RECP), green investments in industrial estates, and the promotion of industrial symbiosis and resource circularity. Despite increased awareness, firms still often lack the incentives and capacity to improve their environmental performances. Government support will therefore be required to tackle the various capacity constraints and market failures that have prevented this evolution from occurring on its own.

**A more comprehensive approach to industrial resource use and pollution management is needed in Punjab.** The focus of national and provincial authorities has traditionally been on industry compliance with environmental regulations, which remains low. This reactive 'end-of-pipe' approach focuses on managing downstream releases of already-formed contaminants in the air, water, solid waste, and soil. While this is needed and should be strengthened, it is not enough. Complementary efforts to promote preventive approaches and to leverage industrial sustainability as a source of competitiveness also have a major role to play, which is currently underexploited. Such approaches include firm-level interventions to foster RECP, interindustry solutions such as eco-industrial parks and the promotion of the circular economy more broadly. Despite several studies and promising pilot initiatives over the last two decades in Pakistan, and in Punjab in particular, little has been done so far to foster a systemic change to that effect.

**The Government of Punjab (GoPunjab) should put sustainable industrialization at the center of its growth strategy and should modernize its policy toolkit for this purpose.** Punjab's Growth Strategy 2018 envisioned that growth must be private sector-led, investment-driven, export-oriented, environmentally sound, and employment-intensive. Developing an ambitious and integrated policy to green

industries would be a strategic way to jointly achieve these objectives, and in so doing, Punjab could become a lighthouse for the rest of Pakistan. This would require both strengthening environmental policy (stick) and developing elements of a green industrial policy looking at investment, innovation, and trade (carrot). Importantly, policy objectives should go beyond the current focus on pollution control and compliance, to include preventive and circular approaches at the firm and industry levels that could yield environmental and productivity/competitiveness gains. The time has come to integrate these approaches in strategies and regulations, and to institutionalize and mainstream them across relevant government agencies.

# Recommendations

**To break the status quo, GoPunjab should identify priority actions that could pave the way for the greening of the industrial sector.** Many different policy instruments have been used by countries over the world to green their industries. While some may be difficult to implement in the short term for legal, technical, financial, or political economy reasons, other could be introduced to break the status quo and build constituencies for change, including by establishing a more cooperative framework with industries (also including multinational companies sourcing products in Pakistan), and by engaging citizens in industrial pollution issues. GoPunjab, which recently adopted a broad five-year Green Development Program to promote green growth in the province, could prioritize actions on the industry side based on needs, capacity, and impact:

- **Strategy.** GoPunjab would benefit from developing and implementing an integrated medium-term strategy on sustainable industrial development involving all key departments. This strategy should include targets for decoupling growth from resource use, pollution, and waste, as well as an action plan with timeline, institutional responsibility, and budget. Preparing a solid strategy with a sound analytical basis, strong government and industry ownership, and sufficient resource allocated would take some time. However, the following could be undertaken in the short term, focusing on a small number of priority resource-intensive and polluting sectors:
    - Conduct **analytical work** assessing the scope for greening these sectors, including through RECP, industrial symbiosis, and circularity. This would look at economic, environmental and social impacts, both positive and negative, and would benchmark Punjab's industries with good international industry practices. This should also include stepped up efforts to **fill data gaps** on selected industries' resource use, pollutant emissions and waste, for instance, by developing standard operating procedures for firm audits, training auditors (e.g., young graduates), and requiring industrial firms to undergo such audit periodically at subsidized rates. Finally, a planned inventory of industrial waste and pollution streams should be carried out.
    - Establish a platform for **public-private dialogue** on industrial sustainability and competitiveness. This could be a committee under the Punjab Environmental Protection Council, with representatives of key departments, industries, academia, and environmental NGOs, and working groups for priority sectors. This would facilitate the identification of reforms, policies, and targets; build ownership and a collaborative mindset among stakeholders; and enable feedback loops to adjust policies.
- **Environmental regulations.** Stronger regulatory pressure is necessary to push industries to better control pollution and invest in RECP. This requires an updated regulatory framework, including industry-specific emission standards and regulations for industrial resource consumption benchmarks, waste, and resource circularity. Priority actions for key sectors could include the following:

- **Promote RECP through existing regulatory instruments and adopting implementation regulations** for the 2016 National Energy Efficiency and Conservation Act.
- Organize **consultations on environmental standards** with industry representatives to discuss needed reforms, considering domestic circumstances and international good practices.
- Agree with industrial sector associations and their member industries on a **road map for environmental compliance,** which could include time-bound intermediary pollution reduction targets, commitments by firms to invest in pollution control equipment and RECP, proposed modalities of government support, role of the association as guarantor for individual members, and so on.
- Consider the opportunity to develop a **law and/or regulations on RECP, industrial symbiosis, and circularity.**

- **Other environmental policy instruments.** There are opportunities to complement environmental regulations with market- and information-based instruments, especially those likely to foster preventive solutions for the greening of industries. Environmental taxes and fiscal incentives could be introduced to incentivize RECP and resource circularity, beyond compliance with existing standards. Eco-labeling and certification schemes for firms and products could be developed. Finally, more information about resource-intensive, polluting, and waste-generating firms' compliance could be disclosed to generate public pressure and enable firms to benchmark their performance. Short-term actions could include the following:
  - Update and implement the existing **pollution charge system for industries,** focusing initially on large polluting units and industrial estates, and **consider new environmental taxes** on industries, which could be made revenue-neutral to increase their acceptability.
  - Continue efforts initiated on the **standards and labeling** of appliances and promote **voluntary international standards** and certification schemes (e.g., ISO 14001).
  - Improve the **transparency and accessibility of existing information** on industries' environmental performance and compliance for citizens, the media, and NGOs, and develop a **pilot environmental performance rating and disclosure scheme,** starting with large polluting firms.
- **Institutional capacity.** GoPunjab's capacity to regulate and engage with industries on sustainability issues, including preventive environmental approaches, should be gradually strengthened. In addition to strengthening the Environment Protection Department (EPD)'s capacity (e.g., strategy, policy and regulatory, monitoring, inspection), which is an absolute priority, this could also include the establishment of a provincial Cleaner Production Center/ Environmental Technology Center. In the shorter term, institutional reforms and training efforts could focus on the following:
  - Strengthen environmental monitoring (both ambient and point-source) and enforcement capacity, including through **increased medium-term budget allocation for the EPD,** additional hiring and training, and investments in facilities and equipment.
  - Establish at the EPD an **Environmental Technology Center** with adequate staffing and equipment to identify and pilot promising environmental and RECP technologies for priority sectors, and the **Environmental Policy Center** with notably a mandate to carry out policy analysis on RECP, industrial symbiosis, and circular economy.
  - Establish **sustainability departments at the Industry Department and the public corporations in charge of industrial estate development (PIEDMC and FIEDMC),** and ensure all

estates have governance bodies and/or dedicated cells in charge of environmental issue, RECP, and circularity.

- **Develop the capacity of the Punjab Energy Efficiency and Conservation Agency (PEECA)** to promote industrial energy efficiency, working with its national-level counterpart NEECA.

- **Support to firms.** In parallel with efforts to strengthen and modernize the environmental policy framework, GoPunjab should start developing programs to support the adoption by polluting small and medium enterprises (SMEs) of greener technologies and practices, focusing on priority sectors. These programs should be owned by the implementing departments and avoid merely relying on donor support. They could include information dissemination and the direct provision of technical and financial assistance, and should involve industry associations, academic experts, and financial institutions. To ensure sustainability and increase scale, a related objective should be to develop the private market for RECP technologies and services, including by facilitating access to foreign expertise while the domestic supply is built.

  - Run large **communication and training campaigns** directed at SMEs in priority sectors to raise awareness about RECP (especially no- or low-cost options) and circular economy and to share success stories. Publish industry-specific **guidelines and benchmarks** on resource efficiency, pollution, and waste.

  - Work with industry associations to **identify, pilot, and demonstrate promising RECP technologies** in a few priority sectors.

  - Establish a **dedicated financing facility for RECP** for SMEs addressing credit and risk constraints, and leveraging commercial finance to the extent possible.

- **Industry-level programs.** While many firm-level initiatives have been implemented in Punjab, there has so far been virtually no program to foster broader solutions, for instance, on EIPs or industrial symbiosis. GoPunjab could aim to replicate and adapt the successful experiences of other countries, starting for instance by the following actions:

  - Developing a **pilot EIP program** for a major zone, such as Sundar Industrial Estate, covering institutional/regulatory reforms and investments for both end-of-pipe infrastructure (e.g., common effluent treatment plant, sanitary landfill), and preventive/RECP approaches.

  - Commission studies to **research the potential for industrial symbiosis and circular economy** in Punjab and develop a **virtual information exchange platform on industrial waste.**

# 1 Introduction

**Despite substantial growth in recent decades, the industrial sector is yet to make its full contribution to Pakistan's development.** On average, industrial value added has grown at almost 5 percent annually in real terms between 1998 and 2018, although its share in gross domestic product (GDP) is roughly equal in 2017 to what it was 50 years earlier, at about 18 percent.[1] To date, the structural transformation of Pakistan's economy away from agriculture has mostly benefited the services sector, which has been the main contributor to GDP growth in recent years. Several factors have undermined industrial productivity and growth, preventing the sector from reaching its full potential in terms of growth and job creation. These notably include constraints related to the macroeconomic framework, business environment, infrastructure, firm capacity, and skills, as well as environmental management (Sánchez-Triana et al. 2014a).

**Greening Pakistan's industry has become an imperative to minimize its adverse impacts on the environment and society, but also to sustain the sector's growth.** As recently emphasized in the report 'Pakistan @ 100: Shaping the Future' (World Bank 2018a), growth in Pakistan is now jeopardized by the major environmental degradation it has contributed to. In particular, industrialization with limited consideration of the parallel growth of resource use, waste, and pollution have imposed mounting environmental and social costs. This is particularly true in large urban centers around which industries agglomerate, such as Lahore and Karachi. Industrial pollution has been one of the main causes of degrading water and air quality (Azizullah et al. 2011; Sánchez-Triana et al. 2014b). These issues have been neglected for a long time, but there has been a renewed sense of urgency over the last few years, notably after the severe smog episodes that have affected major cities. Under growing pressure from citizens, the media, and courts to curb pollution, the Government of Punjab (GoPunjab), the most affected province, has reaffirmed its commitment to do so and has adopted ambitious reform and investment plans. At the same time, poor environmental management has become a liability for Pakistan's industries, which notably undermines the competitiveness of export-oriented manufacturing sectors. Despite increased awareness, firms still often lack the incentives and capacity to improve their environmental performances.

**A more comprehensive approach to industrial resource use and pollution management is needed in Pakistan.** The focus of national and provincial authorities has traditionally been on industry compliance with reactive environmental regulations. This 'end-of-pipe' approach focuses on managing downstream releases of already-formed contaminants in the air, water, solid waste, and soil. While this is needed and should be strengthened, it is not enough. Complementary efforts to promote preventive approaches and to leverage industrial sustainability as a source of competitiveness also have a major role to play, which is currently underexploited. Such approaches include resource-efficient and cleaner production (RECP) at the firm level; interindustry solutions, such as industrial symbiosis (IS) and eco-industrial parks (EIPs); and the circular economy (CE) more broadly (Box 1). Despite several studies and promising pilot initiatives over the last two decades in Pakistan, and in Punjab in

1 World Development Indicators, World Bank.

particular, little has been done so far to foster a systemic change to that effect. Focusing on Punjab and building on the recommendations of 'Pakistan @ 100' for clean growth, this report explores the opportunities and constraints to promote sustainable industrial development, notably by mainstreaming preventive environmental approaches.

## BOX 1. DEFINING RECP, EIPs, AND CE

- **RECP,** sometimes labeled eco-efficiency, is commonly defined as the "continuous application of an integrated preventive environmental strategy to processes, products, and services to increase efficiency and reduce risks to humans and the environment." This implies the adoption by firms of improved technologies and practices that enhance resource efficiency (less material, water, and energy per unit of output), ensure cleaner production (less waste and pollution per unit of output) and protect human health (lower occupational health and safety risks). It considers impacts for the whole life cycle of products, from resource extraction to end of use. RECP can be pursued by resorting to several strategies, such as good housekeeping (e.g., preventing leaks and spills), input substitution (e.g., using less toxic and renewable inputs), better process control (e.g., modifying operational procedures and monitoring to ensure efficiency), equipment modification, technology change, on-site recovery/reuse, production of a useful by-product, and product modification.

- An **EIP** is "a dedicated area for industrial use at a suitable site that ensures sustainability through the integration of social, economic, and environmental quality aspects into its siting, planning, management and operations." EIPs are often thought of as one of the main ways to apply industrial ecology principles by fostering exchanges of waste material, waste energy, and wastewater between tenants ("industrial symbiosis"), as well as with surrounding urban areas. Other ways for EIPs to reduce their environmental impacts and improve operational efficiency include (a) investing in common pollution and waste management facilities and services, (b) promoting RECP investments by each tenant company, (c) promoting resource circularity (e.g., remanufacturing, reuse and recycling), (d) adopting green building and other environmental standards (e.g., ISO 14001 of the International Organization for Standardization [ISO]), (e) increasing access to renewable energy sources, (f) ensuring strategic recruitment of tenants, and (g) investing in green infrastructure and services (e.g., tree cover in the estate, public transportation).

- The **circular economy** is a broad conceptual framework aiming to go beyond the traditional linear industrial model ('take, make, and dispose'), by gradually decoupling economic activity from the consumption of finite resources, and by designing waste and pollution out of the system. The model distinguishes between separate biological and technical cycles, with the former organized to regenerate biodegradable materials through processes such as composting, and the latter recovering and restoring products, components, and materials for further use. The CE includes several strategies related to changes in business models and the way goods and services are produced and consumed. These include eco-design of products and services, industrial ecology/symbiosis, product-as-a-service and the sharing economy, reuse, repair, remanufacture, and recycling.

*Source:* UNIDO and UN Environment (2010); World Bank, UNIDO and GIZ (2017); Ellen MacArthur Foundation (2016) (https://www.ellenmacarthurfoundation.org).

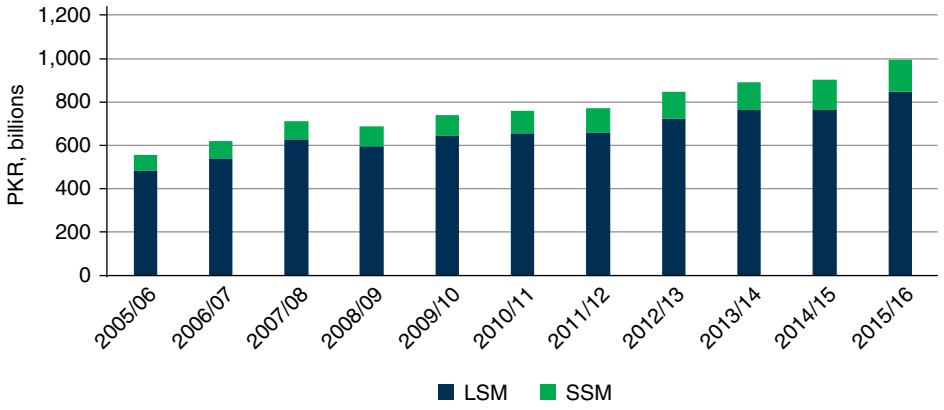
2

# Industrial Resource Use and Pollution in Punjab

## 2.1. Background on Punjab's Industrial Sector

**Punjab is Pakistan's most industrialized province and has ambitious plans to boost industrial output.** Punjab represented nearly 60 percent of national industrial value added in 2015/16, up from 50 percent a decade earlier (PERI 2017). Its industry is dominated by manufacturing, which accounted for 76 percent of its value added in 2015/16, with major sectors including textile, leather, sugar, cement, pulp and paper, steel, automotive, agribusiness, pharmaceuticals, chemicals and fertilizers, bricks, machinery and equipment, surgical instruments, sport goods, and so on. A large majority (around 80 percent) of manufacturing value added comes from large-scale manufacturing (LSM). Small-scale manufacturing (SSM) has nonetheless been a dynamic source of growth over the last decade and makes up the vast majority of firms in Punjab. Moreover, official statistics are likely to underestimate the contribution of large numbers of informal small and medium enterprises (SMEs) in various sectors. Industrial value added in Punjab has grown rapidly over the last decade (Figure 1), owing to good performances in sectors such as automobiles, fertilizer, chemicals, iron and steel, pharmaceuticals, and leather. Private sector-led growth has been a key pillar of the Punjab Growth Strategy 2018, which included ambitious objectives in terms of private investment and exports (Government of Punjab 2015a). In application of this strategy, the Punjab Industries Sector Plan 2018 presented policies, reforms and projects aiming at boosting industrial investments and growth (Government of Punjab 2015b). GoPunjab notably intends to foster a stronger and more stable contribution of the manufacturing sector to the province's economy.

**FIGURE 1.** Evolution of Manufacturing Gross Value Added in Punjab (constant 2005/06 prices)




*Source:* PERI 2017.

**Punjab's industry remains spatially concentrated, and its environmental impacts particularly affect cities.** The LSM sector is mostly located in a small number of urban districts in the northeastern part of Punjab, including Lahore, Kasur, Sialkot, and Faisalabad, although the SSM sector is spread out more evenly across the province (PERI 2017). The spatial concentration of industry has not changed noticeably in Punjab over the last two decades, and no new center of industrial production has emerged during this period.[2] This concentration is expected to continue in the future, in parallel with the rapid growth of major urban population centers (Sánchez-Triana et al. 2014a). Throughout the province, 34 industrial estates (IEs), including large ones, such as Sundar IE, Multan IE, and Quaid-e-Azam IE, concentrate large numbers of units. Moreover, many manufacturing units are found within residential urban areas, for instance with over 2,100 units in Lahore in diverse sectors, including textile weaving and spinning, chemicals, pharmaceutical products, and steel rerolling (ICID 2013), and dozens of small and medium leather tanneries in Sialkot. Likewise, the province's estimated 10,000 brick kilns are for the most part located near urban areas. This geographical concentration and inadequate land-use planning compound local pressure on natural resources, especially water, and adverse impacts from industries on the urban population.

## 2.2. Industrial Resource Use

**Industries contribute significantly to the consumption of materials, energy, and water in Punjab.** This should be put in the context of relatively low, but rapidly growing, resource consumption at the national level (see Box 2).

### BOX 2. PAKISTAN'S RESOURCE CONSUMPTION

**At the national level, natural resource consumption remains low per capita, but it has rapidly grown in absolute terms with industrialization and should keep growing in the future.** Material flow analysis (MFA) data suggest that Pakistan's material and energy inputs have increased rapidly since the 1970s.[3] Although this is not only due to industries, it implies increasing pressure on resource stocks and the environment. This is reflected in the quintupling of direct material input (DMI)[4] across all major material categories between 1970 and 2017, with domestic extraction and imports, respectively, accounting for 92 percent and 8 percent of DMI at the end of the period (Figure 2). Pakistan's material footprint (MF)[5] has also grown rapidly, at 2.6 percent per year on average since 1990,

*continued* ▶

2 By contrast, in countries such as India, Bangladesh and Sri Lanka, several of the largest industrial districts by employment have changed between the 1990s and 2000s (Lopez-Acevedo, Medvedev and Palmade 2017).

3 MFA is the study of physical flows of natural resources and materials into, through, and out of a given system (usually the economy). Material flow indicators can provide critical insights to guide policies on resource use and waste, provided they are interpreted taking context into account (e.g., resource endowment, geography, demography, technology). For more details, see notably OECD (2008) and UN Environment (2016).

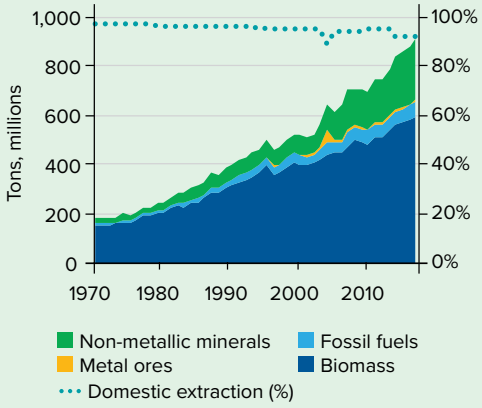
4 DMI measures the direct input of materials for use in an economy, that is, all materials which are of economic value and are used in production and consumption activities. This includes biomass, metal ores, nonmetallic minerals, and fossil fuels, but excludes water and air. It can be calculated as domestic extraction (DE) plus imports (see https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Material_flow_indicators).

5 MF, also called raw material consumption (RMC), measures the total amount of raw materials required to produce the goods used by the economy. It is calculated as DE plus net exports in raw material equivalent (RME, that is, the amounts of raw materials required to provide the respective traded goods).

with manufacturing being its primary component at 44 percent (West, Schandl and Hosking 2016). Like China and India, Pakistan has seen increased material import dependency while being a net exporter of material when adjusting trade flows for upstream and downstream indirect material flows associated with trade, that is, looking at the raw material equivalents of trade (UN Environment 2016).

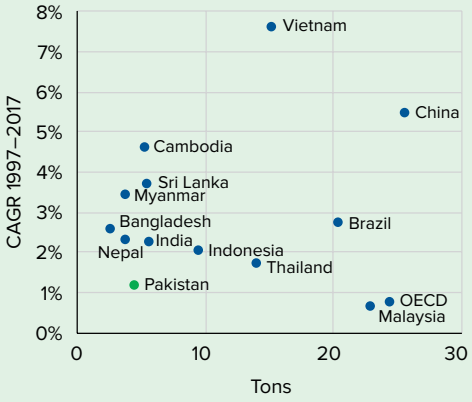
**Given the pace of population growth, Pakistan's MF has remained low on a per capita basis.** DMI and MF per capita have grown more slowly than in most other Asian countries over the last two decades, and in 2017 reached less than five tons and just over three tons, respectively, both well below the Asian averages (Figure 3). Similar trends are observed for energy inputs as for materials (West, Schandl and Hosking 2016). The demand for material and energy inputs is thus likely to increase significantly, in both absolute and relative terms, as Pakistan continues industrializing and urbanizing. This could have negative consequences in terms of environmental impact, pollution, waste and access to critical material, increasing the rationale to proactively improve resource efficiency.

## **FIGURE 2.** Evolution of Pakistan's DMI




*Source:* UN Environment 2018.
*Note:* CAGR = Compound annual growth rate.

## **FIGURE 3.** Pakistan's DMI per Capita in Comparison



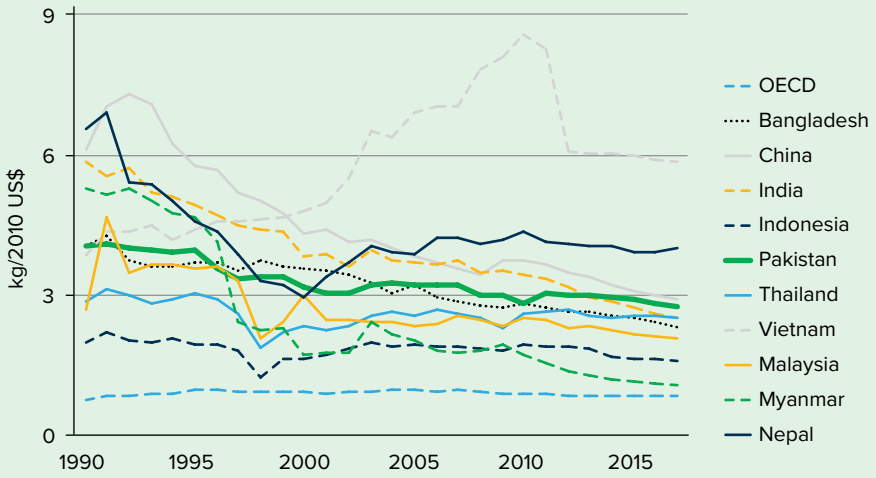

*Source:* UN Environment 2018.

**A relative decoupling of economic growth and material consumption has been observed in Pakistan.** Following a global trend, Pakistan has become more efficient at converting materials into GDP since the 1990s, but other countries, such as China, India, and Bangladesh, have made faster progress. Despite a 32 percent decrease in its adjusted material intensity (MI)[6] between 1990 and 2017, Pakistan remains a relatively material-intensive economy today compared to several Asian countries and to the Organisation for Economic Co-operation and Development [OECD] (Figure 4). Likewise, energy intensity (the amount of energy used per unit of GDP) was much lower than the rest of Asia in the 1970s but has decreased slower than in other countries in the region, resulting in a convergence with the average (West, Schandl and Hosking 2016). Like most other countries, Pakistan has not achieved absolute decoupling so far, meaning that meeting the Federal

*continued* ▶

6 MI is the ratio of material used to generate a unit of GDP and is thus a measure of the efficiency of resource use. MI uses DMI as numerator, while adjusted MI uses MF.

**FIGURE 4.** Evolution of Pakistan's Adjusted MI in Comparison




*Source:* UN Environment 2018.

Government's ambitious growth and development objectives will result in significantly increased resource and energy use.

**Water stress is high in Pakistan, and there is scope to improve the efficiency of water use.** The available evidence suggests that Pakistan's water withdrawals are much higher than its water footprint (WF),[7] which implies that its exports embody large volumes of water (West, Schandl and Hosking 2016). On a per capita basis, water withdrawals have been declining since the 1970s, but not as fast as the WF, meaning that Pakistan's tendency to export virtual water has increased over time. In 2013, Pakistan's WF per capita was less than three-quarters the average for developing Asia, but its water withdrawals per capita were almost twice the regional average. This is likely unsustainable as Pakistan is, and is expected to remain in the future, one of the world's most water-stressed countries (WRI 2015). Although Pakistan's water intensity, that is, the amount of water extracted per unit of GDP, has declined dramatically over the last four decades, in 2013, it remained five times higher than the developing Asia average on a territorial basis (twice higher on a WF basis) (West, Schandl and Hosking 2016). This confirms that water efficiency should remain a priority topic for policy makers.

7 A country's WF is defined as the total volume of freshwater that is consumed and/or polluted, both directly and indirectly (through 'virtual water' embedded in imports), to produce the goods and services consumed by consumers and producers in this country. WF is composed of three parts, green water (from rainfall), blue water (extracted from surface or groundwater sources), and grey water (freshwater required to assimilate pollutants discharged in surface water and meet applicable ambient water quality standards). See WWF (2015) and http://waterfootprint.org/en/water-footprint/what-is-water-footprint.

**The available evidence suggests that several key manufacturing sectors currently operate at low resource efficiency levels.** Studies for Punjab, Pakistan, and South Asia have shown that firms in resource-intensive and polluting sectors, especially SMEs, tend to use materials, energy, and water inefficiently.[8] For instance, a recent report found that investments in more efficient technology and equipment could reduce the energy consumption of Pakistan's textile mills by 22 percent (2.4 million MWh) and save them over US$60 million (IFC 2016). The same study also found significant energy/water- and cost-saving opportunities in the sugar, pulp and paper, and leather sectors. Firms in the textile and leather sectors, two of Pakistan's largest export industries, rarely use technologies to recover toxic chemicals and minimize their use. Dozens of small and medium steel foundries and rerolling mills operate near Punjab's cities with poorly designed furnaces, resulting in inefficient use of energy and raw materials (steel scraps from the shipbreaking and construction sectors). Punjab's large and mostly informal brickmaking sector is entirely made up of about 10,000 small-scale units. Despite the existence of cleaner alternatives, virtually all of these are fixed-chimney kilns (FCKs), one of the least energy-efficient technologies, and only produce clay bricks which require large quantities of agricultural topsoil as raw material.

**Punjab's industries are major water users, indirectly through the use of agricultural inputs, as well as directly through uncontrolled operational processes.** Although this report focuses on direct resource use by industries, agricultural and industrial water efficiency are linked, since water-thirsty crops, such as sugarcane and cotton, are inputs for the agribusiness and textile industries.[9] On-site pumping of groundwater is the main channel for direct consumption in the sugar (61 percent), textile processing (90 percent), and pulp and paper (98 percent) sectors (IFC 2016). There can be wide within-sector variations in consumption; for instance, medium-size textile mills processing export-quality fabric tend to use more water per unit of output than large firms (which have better equipment and optimized processes) and small units (which produce lower-quality fabric) (CPI 2018).

**In several industries, high water consumption also leads to the generation of effluents that tend to remain untreated and to contaminate Punjab's water systems.** A recent study of the water footprint of key industries in Punjab—sugar, textile, leather tanning, and paper—estimates that they account annually for around 29,000 million cubic meters ($Mm^3$) of blue water (mostly from domestic agricultural inputs) and 17,500 $Mm^3$ of grey water, an indication of pollution from industrial effluents (WWF 2015). These are large figures relative to the availability of water in the Indus river basin, where these sectors and their supply chains are concentrated, and the 53,000 $Mm^3$ annual flow of the Indus.

**There is scope for much-needed improvements in water management practices in Punjab industries.** Overall, firms in water-intensive industries such as textile tend not to measure, control, and benchmark their water use in the absence of incentives to do so, leading in turn to increased use of energy and chemicals (CPI 2018). Poor maintenance of machines and water pipes also contributes to wastage. Contributing to better water management practices, by pushing for water efficiency and reuse along supply chains and in own operations, is important for industries to mitigate the water-related operational, regulatory, and reputational risks likely to grow with water scarcity. In particular, industries' direct operational water use and effluent discharges, though small in relative volumetric

8 See notably IIP (2014), IFC (2016), World Bank (2018c), and CPI (2018).

9 A primary cause of Pakistan's water intensity is low water productivity in agriculture, a sector responsible for over 90 percent of domestic withdrawals (World Bank 2018a). Fertilizers and pesticides loads in agricultural runoffs also contribute to the pollution of surface water and groundwater. Efforts under the Better Cotton Initiative (BCI) to make the production of cotton more sustainable in Pakistan have shown the strong scope for efficiency gains; in 2013, 37,000 participating farmers achieved sizable reductions in their use of water (−21 percent), fertilizers (−22 percent) and pesticides (−37 percent), while increasing their gross margin (+29 percent) (WWF and IKEA 2014). By the 2016/17 growing season, the number of BCI-licensed farmers in Pakistan had increased to 90,000, who produced 316,000 tons of cotton on 359,000 hectares of land (https://2017.bciannualreport.org).

terms, are critical for business operation and can be the source of the most acute and short-term water risk for an individual business (WWF 2015). They can also put pressure on local water systems in cities where firms in water-intensive industries agglomerate, such as the leather cluster in Sialkot.

## 2.3. Industrial Pollution and Waste

**Industries are a major source of air, water, and soil pollution in Punjab, and in many cases exceed applicable provincial environmental standards and good international industry practices.** A classification of Punjab's industrial sectors based on the average unit's pollution load and number of units in the province shows that a dozen sectors can be considered as having highly adverse environmental impacts (Table 1).[10]

### **TABLE 1.** Classification of Punjab Industries by Environmental Impact

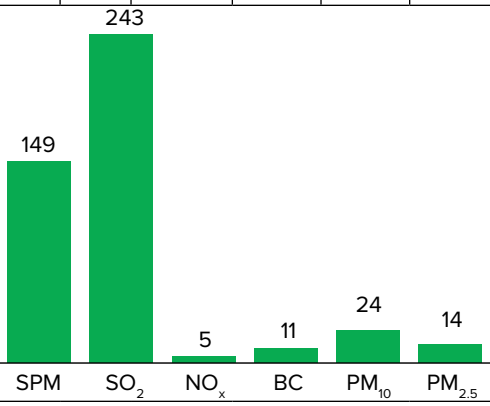
| | | Approximate units | Pollution level | | | Density | Environmental impact |
|---|---|---|---|---|---|---|---|
| | | | Water | Air | Hazardous waste | | |
| Large size | Sugar | 46 | H | M | M | H | H |
| | Cement | 13 | L | H | L | M | H |
| | Fertilizer | 6 | H | M | M | L | M |
| | Industrial chemicals | 7 | H | M | M | L | M |
| | Automobiles | 4 | M | M | M | L | L |
| | Petroleum refinery | 2 | L | M | M | L | L |
| Small and medium size | Dairy | 91 | H | M | L | H | H |
| | Oil and ghee | 54 | H | M | M | M | H |
| | Textile processing | 400 | H | M | L | M | H |
| | Beverages | 30 | H | L | L | M | H |
| | Tanning | 200 | H | L | M | M | H |
| | Steel melting | 182 | L | H | L | H | H |
| | Marble cutting | >300 | L | H | L | H | H |
| | Brick kilns | >10,000 | L | H | L | H | H |
| | Stone crushing | >650 | L | H | L | H | H |
| | Pulp and paper | 28 | H | M | M | L | M |
| | Paint | 26 | H | L | M | L | M |
| | Pesticide | 10 | L | L | H | L | M |
| | Pharmaceuticals | 93 | M | L | M | H | L |
| | Fruit/vegetable processing | | L | L | L | L | L |

*Source:* CPI (2018).
*Note:* L = Low; M = Medium; H = High.

10 Other sectors also have significant environmental impacts, and could benefit in various ways from improved resource efficiency and environmental performances.

- **Air.** Industries are major sources of emissions of air pollutants, such as particulate matter (PM), and of greenhouse gases (GHGs). Air quality is degraded by large-scale cement, fertilizer, sugar, steel, and power plants—many of which use furnace oil that is high in sulfur content—as well as by large numbers of SMEs in diverse sectors (e.g., brick, steel rerolling and recycling, plastic molding) that use low-grade coal and 'waste' fuels, including old tires, paper, wood, and textile waste (Sánchez-Triana et al. 2014a). Some large-scale units, such as cement plants, have installed equipment to control point-source emission, but such equipment is generally inadequate or absent in smaller and informal units in the brick, marble cutting, and stone crushing sectors (CPI 2018). In particular, the thousands of brick kilns around Punjab's cities represent a major emission source of air pollutants, including PM (e.g., black carbon from incomplete fuel combustion), sulfur oxides (SOx), nitrogen dioxide, carbon monoxide, carbon dioxide ($CO_2$), and heavy metals. Although no detailed data exist on pollution from this and other informal sectors for Punjab, back-of-the-envelope estimates suggest that considerable volumes of local air pollutants are emitted each year in the province (Table 2). Moreover, fugitive emissions (e.g., from hauling materials) are largely uncontrolled in all types of facilities, and the widespread use of inefficient and poorly maintained diesel generators and boilers further exacerbate industrial emissions. Finally, a recent GHG inventory estimated that manufacturing industries directly emitted about 60 teragrams (Tg) of $CO_2$ equivalent in 2012, about 16.4 percent of Pakistan's total emissions (Mir, Purohit and Mehmood 2017). This includes fuel combustion (37.9 Tg), mainly from energy-intensive sectors such as cement, brick,

## **TABLE 2.** Estimated Annual Local Air Pollution from Brickmaking in Punjab

| | | | | | | |
|---|---|---|---|---|---|---|
| Number of kilns in Pakistan *[a]* | 20 thousand | | | | | |
| Number of kilns in Punjab *[b]* | 10 thousand | | | | | |
| Pakistan's annual brick production *[c]* | 45 billion | | | | | |
| Punjab's annual brick production *[d = c*b/a]* | 22.5 billion | | | | | |
| Weight of one brick *[e]* | 3 kg | | | | | |
| Weight of Punjab's production *[f = d*e/1,000]* | 67.5 million tons | | | | | |
| Emission factors (kg/ton of fired brick with FCK technology) *[g]* | *SPM* | *$SO_2$* | *$NO_x$* | *BC* | *$PM_{10}$* | *$PM_{2.5}$* |
| | 2.2 | 3.6 | 0.069 | 0.17 | 0.36 | 0.21 |
| Air pollution (thousand tons/year) *[h = f*g/1,000]* |  | | | | | |

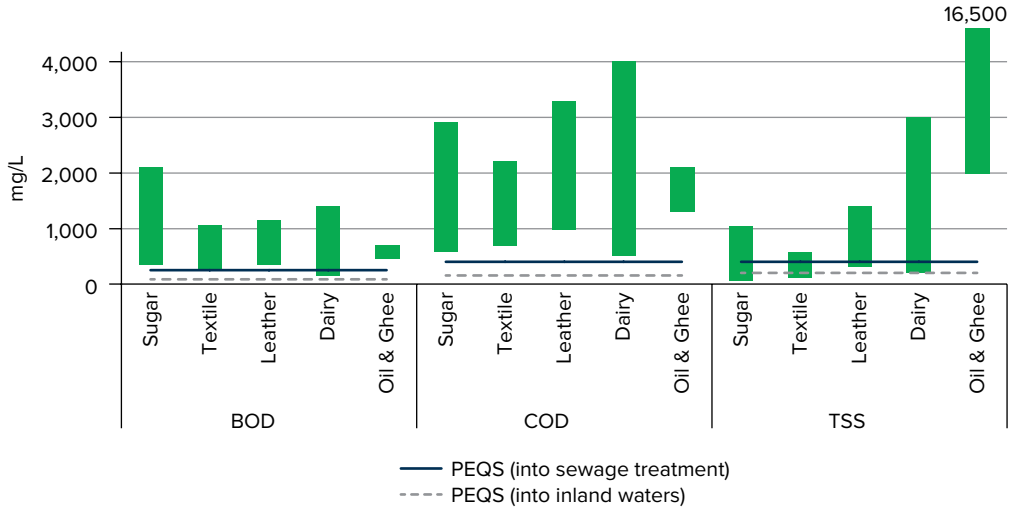


*Source:* Authors' calculations based on World Bank (2018c) and CCAC (2015).
*Note:* BC = Black carbon; SPM = Suspended particulate matter.

and fertilizer,[11] and process emissions (19.4 Tg)[12] but does not account for power sector emissions linked to industrial electricity consumption.

- **Water.** Pollution from several sectors, such as textile, leather, sugar, paper, and chemicals, is due to the release of large quantities of effluents with high levels of biochemical/chemical oxygen demands (BOD/COD) and total dissolved/suspended solids (TDS/TSS).[13] There are large variations in effluent characteristics across and within sectors, but in most cases, pollution loads are well above applicable Punjab Environmental Quality Standards (PEQS), which are not industry-specific (Figure 5). In several cities, IEs are a particularly large source of polluted wastewater (Figure 6). In the absence of effluent treatment plants (ETPs), common effluent treatment plant (CETP), or other specialized installation (e.g., chrome recovery plant for leather tanning), wastewater is generally released untreated in nearby waterways, natural drains, or agricultural fields.[14] This contaminates surface water and groundwater, creating hazards for ecosystems and other uses, such as irrigation, drinking, and sanitation, as some of the pollutants released are highly toxic (e.g., chemicals and heavy metals).

## **FIGURE 5.** Range of Effluent Pollutant Load in Selected Industries in Punjab




*Source:* CPI 2018; EPD 2016.

- **Solid and hazardous waste.** Growing waste generation represents an increasing environmental and public health hazard in Punjab's urban areas, compounded by highly deficient solid waste management (SWM) systems (World Bank 2010).[15] Industries contribute to this growing issue, along with other private sector waste sources (e.g., commercial and construction waste), but no

11 42 percent of these emissions were from coal combustion by different industries, notably cement production.

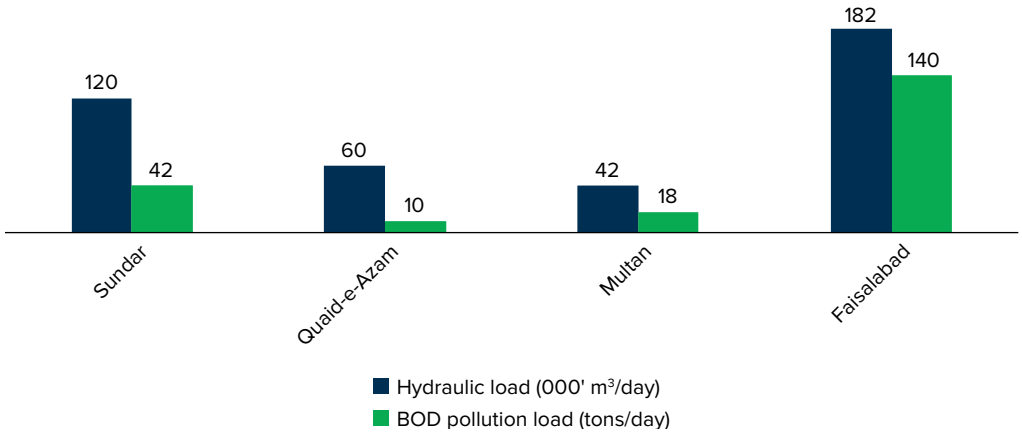
12 Process emissions were estimated to come mainly from cement production (80 percent) and chemicals (17 percent).

13 Additionally, in some sectors, the use of air pollution control technologies, such as wet cutting of marble, produces dust-laden effluents that create another environmental issue when released untreated (CPI 2018).

14 Only two IEs in Pakistan have CETPs: one is owned and operated by the Pakistan Tanners Association at Korangi (Sindh) and the other by the Kasur Tanners Association at the Kasur tanneries cluster (Punjab). Both are operating only partially and do not comply with applicable discharge standards, because of low enforcement, organizational, and financial reasons (World Bank 2016a).

15 However, the resort to a private operator has improved collection performance in Lahore in recent years.

**FIGURE 6.** Estimated Effluent Volume and Pollution Load from Selected IEs in Punjab




*Source:* World Bank 2016.

detailed and reliable data exist about the waste volume they generate throughout the province.[16] One 2010 study for Multan estimated that industries generated about 103 tons of solid waste daily, or 17 percent of the total (World Bank 2010). There is some indication that a portion of valuable agricultural and industrial waste is recycled or reused by other sectors, such as cattle farm waste used as fertilizer or textile waste reused for different purposes (World Bank 2010; Noman, Batool, and Chaudhary 2013). However, there are no formal plans, systems, or facilities to facilitate reuse/recycling, and most of the waste is not collected or is mixed with municipal waste. The facilities and systems in place for SWM in Punjab's IEs are of variable effectiveness and, in some cases, inexistent (Zafar 2012). Improperly discarded waste includes hazardous waste generated by various sectors, such as leather tanning, steel, pulp and paper, oil and ghee, sugar, and chemicals (CPI 2018). No safe disposal or recycling system exists for the large amounts of coal ash from boilers and sludge from wastewater treatment plants. Brick kiln bottom ashes have been shown to have high heavy metal concentration, with high adverse health and ecological risks (Mondal et al. 2017). Industries dispose of some of the most toxic and persistent pollutants, including heavy metals and synthetic organic chemicals, directly on land and into water bodies, without any form of environmental treatment or protection.[17] This indiscriminate disposal of toxic waste by industries is contaminating fresh groundwater and prime arable land, and leaching of heavy metals at dumping sites is a major source of groundwater contamination. Open burning of toxic industrial waste at low temperatures produces air and carcinogenic pollutants.

**Pollution has become a major public health hazard, with both social and economic impacts.** Degrading ambient air and water quality has dire consequences for Punjab's citizens, especially vulnerable population categories (e.g., the poor, children, pregnant women, and the elderly).[18] Pollution is estimated to cause around 340,000 deaths per year in Pakistan, over 70 percent of which are due

16 The Environment Protection Department (EPD) has planned for several years to conduct an inventory of industrial solid and hazardous waste for Punjab, but this has not been carried out yet.

17 A 2012 study identified 25 sites polluted by hazardous wastes in the Province of Punjab (Khwaja, Shaheen, and Yasmeen 2012).

18 Pakistan ranked 177 out of 180 countries for environmental health on Yale's 2018 Environmental Performance Index's (air quality, water and sanitation, and exposure to heavy metals), ahead of only India, Nepal, and Bangladesh.

to air pollution (Landrigan et al. 2017).[19] This represents a quarter of total annual deaths in the country, making Pakistan one of the world's most affected countries. Polluting production processes also cause high occupational health and safety (OH&S) risks for workers, for instance in the brick sector where they are exposed to extremely high SPM and toxic chemical levels, and thus at an increased risk of cancer, acute and chronic respiratory disease, and potentially anemia (World Bank 2018c). Finally, pollution negatively influences current and future labor productivity, as well as labor force participation, by causing diseases and affecting cognitive abilities.[20]

**Poor industrial resource efficiency and pollution/waste management also undermine more directly the productivity and competitiveness of Punjab's industries.** As the textile mills example cited in the previous chapter shows, energy-inefficient production processes unnecessarily increase the production costs of industrial firms in Punjab. In the longer term, low efficiency could also expose some industries to growing costs to access sufficient quantity and quality of fresh water in a context of changing climate and increased water scarcity.[21] Noncompliance with pollution standards creates regulatory uncertainty for firms, as the Punjab government announced its intention to curb pollution and step up enforcement under growing pressure from citizens and the judiciary. It also undermines the competitiveness of export-oriented industries, as firms struggle to meet the environmental and social standards of international buyers and their governments (Sánchez-Triana et al. 2014a). This has notably been identified as one factor behind the declining competitiveness of Pakistan's leather and textile exports.[22] According to Zafar (2012), the lack of CETP and SWM facilities in the Sundar IE made it more difficult to attract export-oriented investors to the estate, who sought to meet foreign clients' expectations.

19 See https://www.pollution.org for country-level data.

20 Studies have estimated that reducing air and water pollution in various contexts increased the hours worked and productivity of local workers by 3–6 percent. Overall, the annual cost to GDP due to productivity losses caused by pollution-related diseases has been estimated at 2 percent in low and middle-income countries (Landrigan et al. 2017).

21 A recent study estimated that the adoption of resource-efficient and cleaner technologies in the Bangladeshi textile and leather industries could reduce long-term investments and operational expenditures needed to ensure a continued supply of water by up to US$9 billion by 2030 (WRG 2015).

22 Major brands, such as Adidas, H&M, IKEA, and Nike, are increasingly seeking to buy products from manufacturers that are compliant with international standards set by the Leather Working Group (LWG), as well as the Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) regulation of the European Union (EU). Also, since 2014, Pakistan has been a beneficiary of the EU's Generalized Systems of Preferences (GSP+), which grant duty-free market access for over 60 percent of EU tariff lines and require ratification of and compliance with 27 international conventions, including eight on the environment.

3

# Opportunities for Greening Punjab's Industries

**Resource efficiency and waste/pollution prevention are key elements of modern industrial environmental management.** Pollution control has historically been focused on the 'end of pipe' and aimed to achieve acceptable pollutant concentration in different media. However, since the 1990s, preventive approaches have gained increasing prominence globally as a needed complement.[23] This shift stemmed from a realization that, while pollution control can effectively reduce pollution, it can be costly,[24] technically challenging, and difficult to implement in the absence of strong monitoring and enforcement capacity. It also emerged as two major concerns came to the fore, namely (a) the growing resource use and waste generation trends in all regions of the world, and (b) the need to curb industrial GHG emissions in the context of climate change mitigation, notably through energy efficiency and renewable energy. Contrary to pollution control, preventive approaches aim at finding opportunities to reduce resource use and minimize pollution/waste at the source, thus improving productive efficiency, reducing end-of-pipe treatment costs, and benefiting the firm's bottom line.

**There is unexploited scope to improve Punjabi and Pakistani industries' environmental, economic, and social performances by promoting preventive strategies to reduce resource use, waste, and pollution.** As discussed in this chapter, such opportunities can be found at the firm level, can be developed between firms in the same or in different industries, and can leverage principles of the circular economy. In all cases, contrarily to end-of-pipe approaches, these require questioning the way goods are produced and industries are organized. This in turn implies bringing environmental and industrial policies closer. Despite several pilot initiatives, little has been done so far to mainstream these approaches in Punjab.

## 3.1. Firm-level RECP

**Firm-level RECP has been the most widely promoted preventive approach in recent decades.**[25] As defined in Box 1, RECP aims at promoting the use of more efficient and greener technologies and practices. This is intended to yield a broad range of benefits, on different dimensions: (a) economic

23 Resource efficiency and preventive approaches have for instance been promoted by countries such as the United States (US Pollution Prevention Act 1990), Korea (Law Promoting the Shift to an Environment-Friendly Industrial Structure 1995) and China (Law on the Promotion of Cleaner Production 2002), and have been championed by international organizations including the United Nations Industrial Development Organization (UNIDO), UN Environment and the World Bank (e.g., World Bank 1998).

24 For instance, the CETP technologies required to meet applicable effluent standards in Punjab are capital-intensive, require large and constant energy supply, and create hazardous sludge that must be disposed of (World Bank 2016a).

25 UNIDO and Environment Program (UN Environment) have played a leading role in promoting RECP in developing countries since the 1990s, notably through the global RECP program and network of National Cleaner Production Centers (NCPCs) (http://www.recpnet.org).

gains for the firm (enhanced productivity,[26] innovation, lower end-of-pipe treatment costs and potential environmental liability, compliance with export market standards), (b) environmental gains (conservation of natural resources, pollution and waste reduction), and (c) social gains (well-being of workers and local communities).

**The international evidence shows that there is generally substantial scope for individual firms in environmentally damaging sectors to improve resource efficiency and reduce pollution/waste.** Central to RECP is the continuous assessment of current production methods to identify the main sources and causes of resource inefficiency/pollution and to generate cost-efficient options to minimize them.[27] Such options can include low-hanging fruits with low capital requirement and short payback time that can easily be implemented even by small companies (e.g., good 'housekeeping', input change, process control), as well as more financially and technically demanding investments (e.g., equipment modification or technology upgrade). Over two decades after the concept was popularized, there is strong evidence from the literature that RECP has proven to be an effective approach, capable of generating the above-mentioned environmental, economic, and social gains in a large diversity of countries and sectors (Marques Matos et al. 2018). The potential for such gains is especially large in resource-intensive and polluting sectors (e.g., leather, textile, pulp and paper) and in developing countries where production is dominated by SMEs with low environmental management capacity. As mentioned, SMEs represent a relatively small share of industrial value added in Punjab but account for the vast majority of firms, with notably large cumulative environmental impacts. However, there is also an increasing focus on technological options to improve energy efficiency and decarbonize in heavy industries, such as cement, steel, and chemicals (IEA 2017; McKinsey 2018).

**RECP has been introduced and promoted in Pakistan since the 1990s, particularly in Punjab.** With support from international donors, a large and increasing number of RECP pilot projects have been implemented in several key industrial different sectors, with a focus on textile and leather (Figure 7). These projects covered the major industrial production centers throughout Punjab. These were generally carried out through the three cleaner production centers (CPCs) located in the province[28] and private consulting firms, partnering with a range of other public and private institutions, such as industries associations, the Industries Department, Chambers of Commerce and Industry, the Punjab Small Industries Corporation (PSIC), and the Small and Medium Enterprises Development Authority (SMEDA). While some also included end-of-pipe solutions (e.g., CETP), these projects have for the most part focused on RECP, conducting sector diagnostic and firm-level assessments, offering training, and financing pilot projects.

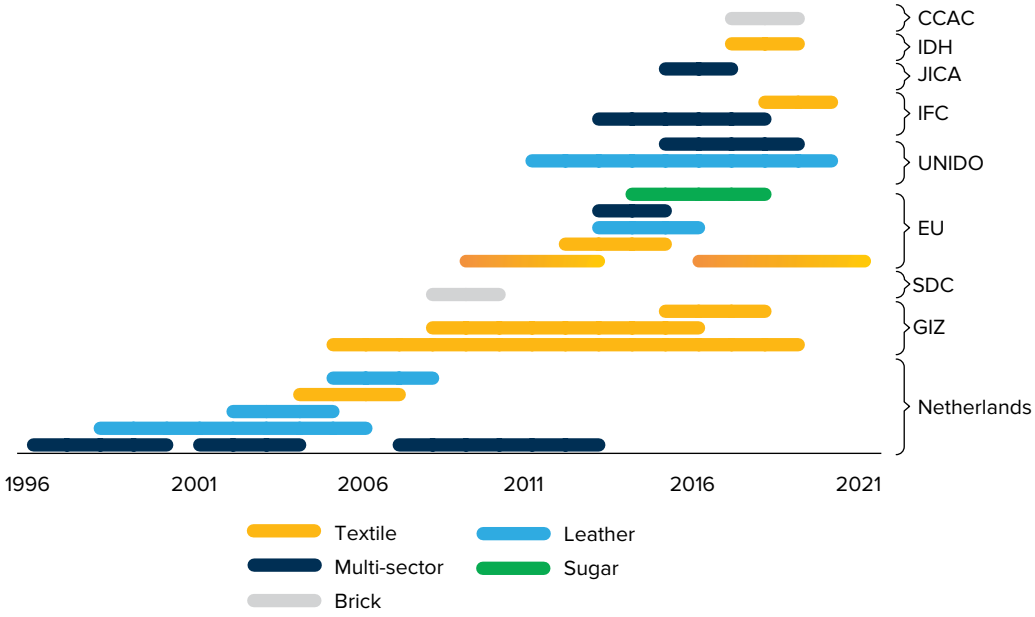
**After more than two decades, RECP has not been mainstreamed in Punjab's different industrial sectors.** Hundreds of SMEs have been directly supported through past projects, and hundreds more were made familiar with RECP through training and engagement with industrial associations. Studies suggest that there is still a large potential for efficiency gains in several resource-intensive and polluting sectors, with profitable investment opportunities and payback periods often ranging from a few

26 Productivity gains come mostly from the reduced input use and lower treatment costs, although there could be broader gains. For instance, research on the impact of adopting energy-efficient light emitting diode (LED) lighting in Indian garment factories suggests that investing firms reap labor productivity co-benefits due to a lower temperature in buildings (Adhvaryu, Kala, and Nyshadham 2017).

27 See for instance the handbook prepared by UNIDO and UN Environment (2010) to conduct firm-level management plans for resource efficiency (water, energy, materials, and chemicals) and waste/pollution minimization.

28 Namely the Cleaner Production Institute (CPI) in Lahore, the NCPC (affiliated to the Attock oil refinery), and the Sialkot CPC for tanneries.

## **FIGURE 7.** Selected RECP Projects Implemented in Punjab




*Source:* CPI 2018.
*Note:* CCAC = Climate and Clean Air Coalition; GIZ = German Agency for International Cooperation; IDH = Initiatief Duurzame Handel (Sustainable Trade Initiative); IFC = International Finance Corporation; JICA = Japan International Cooperation Agency; SDC = Swiss Agency for Development and Cooperation.

months to two–three years.[29] In spite of this potential, in Punjab, like in many other countries, RECP has arguably not passed the pilot stage to achieve sector-wide mainstreaming. As shown in Figure 5, there are wide within-sector variations in industrial units' pollution levels in Punjab. Regarding GHGs, improving energy efficiency, modernizing processes, and enhancing access to renewable energy in energy-intensive industries, starting with large point sources (e.g., thermal power plants, cement plants, fertilizer plants, and steel furnaces), has been identified as a priority to curb national emissions going forward, while improving industrial productivity (Mir, Purohit, Mehmood 2017). Finally, some key resource-intensive and polluting sectors have not been prioritized. In particular, brickmaking still relies on technology that is highly inefficient, polluting, and hazardous for workers. Efforts to introduce more modern technologies have been limited to date, despite the spread of cost-effective RECP options in the rest of South Asia in recent years and the accumulation of experience (Box 3).

**What factors explain that many firms do not adopt efficient and cleaner technologies available in Punjab?** As few as one-fifth of the 230 manufacturers supported with energy efficiency assessments in each of four different sectors had implemented recommended energy-saving techniques in a recent study on Pakistan by IFC (2016). The global experience with RECP shows that multiple constraints can limit firms' capacity to invest in profitable RECP options, including the lack of

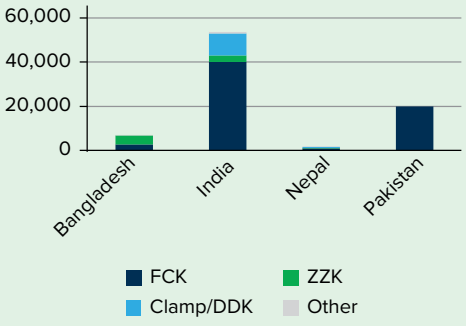
29 For instance, IFC (2016) covers the textile, sugar, pulp and paper, and leather sectors. The study, based on audit data of 230 manufacturers operating in the textile, sugar, paper, and leather industries in Punjab, found that they had implemented energy-saving recommendations that reduce consumption by more than 287,000 MWh annually, but could further reduce their energy consumption by 3.7 million MWh annually and save over US$76 million in energy costs (IFC 2016). Likewise, CPI (2018) extensively covers textile, leather tanning, steel furnaces, brickmaking, dairy, sugar, oil and ghee, beverages, marble cutting, and stone crushing, identifying several technologies to address inefficiencies and increase resource circularity in each sector. Ortolano et al. (2014) covers textile and leather. IIP and IFC (2014) assesses the potential for waste heat recovery in the cement sectors of different countries, including Pakistan. IIP (2014) covers textile, bricks, shipbreaking, and steel rerolling for South Asia.

## BOX 3. EXPERIENCE WITH EFFICIENT AND CLEANER BRICKMAKING TECHNOLOGIES IN SOUTH ASIA

**As one of the primary sources of air pollution, brickmaking imposes large environmental, social, and economic costs on South Asian countries.** India is the second largest brick producer in the world after China, with about 144,000 kilns producing an estimated 250 billion bricks each year. There are about 20,000 kilns in Pakistan (45 billion bricks annually), 7,000 in Bangladesh (27 billion bricks annually), and 1,700 in Nepal (5 billion bricks annually). The brick sector is responsible for up to 91 percent of total PM emissions in some South Asian cities. According to a recent study, in 2015, about 6,100, 55,000, and 600 deaths were caused by pollution of the brick sector in Bangladesh, India, and Nepal, respectively (World Bank 2018c), with associated disability-adjusted life years (DALYs) reaching 49,000, 436,000, and 4,800, respectively. The economic costs on public health of the brick sector are about US$633 million per year in Bangladesh, US$3.6 billion in India, and US$46 million in Nepal.

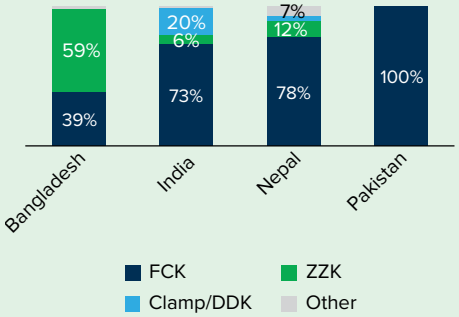
**Traditional polluting technologies still dominate the sector in South Asia, although cleaner and more efficient technologies have started to spread in several countries.** Most kilns in the region are traditional FCKs, followed by Zigzag Kilns (ZZKs) and Clamp/Down Draught Kilns (DDKs) (Figure 8), with FCKs dominating production in all countries except Bangladesh (Figure 9). In Bangladesh, roughly 60 percent of all operating kilns are considered as improved/intermediate technologies (namely ZZK, Hybrid Hoffman Kiln [HHK] and Tunnel kiln [TK]). In Nepal and India, these figures are roughly 17 percent and 3 percent, respectively, while improved kilns are nearly inexistent in Pakistan. All countries have less than 1 percent market penetration of advanced and efficient technologies

**FIGURE 8.** Prevalence of Different Kiln Technologies in South Asia




*Source:* Authors' calculations, World Bank 2018c.

**FIGURE 9.** Annual Production by Kiln Technology in South Asia




*Source:* Authors' calculations, World Bank 2018c.

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(HHK and TK). In addition to kiln technologies, alternative building materials that use less virgin material and energy, and do not rely on firing, have emerged in several countries. For instance, solid/hollow concrete blocks, Fly Ash-Lime-Gypsum (FaL-G) blocks, Cement Stabilized Soil Blocks (CSSBs), and Autoclaved Aerated Concrete (AAC) blocks have successfully penetrated the Indian market.[30]

**Cost-benefit analysis conducted by the World Bank suggests that HHK and TK should be the technologies of choice of all entrepreneurs if they are constructing new kilns.** This finding applies to the financial analysis, reflecting private profit alone, and is even more pronounced in the economic analysis incorporating negative health and climate change externalities, which are substantial and offset all private profit except in the case of the cleanest, most efficient technologies. The most efficient technologies, such as HHK and TK, significantly reduce energy consumption and air pollutant emissions. Because these use the exhaust heat from flue gas to dry green bricks and do not rely on sun drying, they can be operated year-round and provide more stable employment opportunities. The sensitivity analysis suggests that hollow bricks—compatible primarily with modern kilns—and relatively low-interest financing (also indispensable for capital-intensive modern kilns) dramatically enhance the profitability of HHK and TK technologies, both in the absolute sense and relative to low-debt, smaller-scale kiln projects, such as ZZK and FCK.

**The slow adoption of efficient technologies in Bangladesh, India, and Nepal indicates that the barriers to modernization and formalization are substantial.** RECP technologies for fired brick manufacturing appear to be profitable investment opportunities. They have been actively promoted by governments and development partners in some countries. Several barriers can nonetheless explain why many South Asian kilns have not been upgraded, including the brick industry's informality, which can make kiln owners reluctant to seek public support for fear of being regulated and taxed; entrepreneurs' high discount rate; preference for high short-term profits offered by traditional technologies over potentially larger long-term gains with modern ones; lack of information about alternative technologies' profitability and unwillingness to take risks; limited capacity to finance large initial investments to retrofit or build new kilns, and lack of access to credit; low levels of human capital and technical know-how; and difficulty to access required equipment, land type, and energy sources (e.g., exhaust fans, flood-free highland, gas, electricity connection).

**Brickmaking technology in Pakistan is lagging compared to the rest of South Asia.** An early attempt by the SDC to introduce the efficient Vertical Shaft Brick Kiln (VSBK) technology in 2008–10 failed to sustain results, despite promising pilots.[31] More recently, the Punjab EPD has worked since 2017 with the National Energy Efficiency and Conservation Authority (NEECA), the All Bricks Kiln Owners Association of Pakistan and the International Centre for Integrated Mountain Development (ICIMOD) to promote the Induced Draught ZZK. Preliminary evidence suggests that this technology, which has the advantage of being relatively close to the conventional FCK used by local kiln owners, can

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30 Diversification away from traditional solid clay brick, notably by developing waste-using bricks, hollow bricks/blocks and non-fired technology, has also been a key element in the efficiency-improving modernization of China's brick industry since the 1990s, along with mechanization and consolidation (World Bank 2011). This transition was actively encouraged by the government through policy, regulations, economic instruments, and support for new technologies. China has nonetheless found it difficult to upgrade the technology of small producers, which still represent the majority of units even if they account for a declining share of production.

31 "Brick Kiln Project Faces Closure." *Dawn.* November 13, 2011.

work as a more efficient, more profitable, and less polluting alternative in Punjab.[32] This has so far led to the organization of information sessions for kiln owners and to the retrofitting of one kiln, with plans to convert about 20 more as of mid-2018, after a successful pilot in Raiwind, near Lahore.[33]

**GoPunjab's plan to foster the use of cleaner brickmaking technologies is laudable, but the regional experience suggests this should be managed carefully.** GoPunjab forced FCKs to shut down in the fall of 2018 to fight against smog. Based on recent pilots, it also announced its intention to require the conversion of all the province's kilns to ZZK, although no timeline has been set. While this would be an improvement over the current situation, investment decisions should be based on sound economic and financial analysis to ensure that the technologies supported are the ones bringing the most economic, environmental and social benefits. To the extent that conditions in Punjab are similar to those in other South Asian countries, previously mentioned evidence suggests ZZK may not be the most beneficial technology in this regard. Finally, pushing a technology without the appropriate conditions in place may not bring about the desired results: in Bangladesh, a legal push since 2013–15 to convert FCKs to ZZKs without adequate technological support and control has resulted in a large number of kilns being built or converted without conforming to quality standards, raising questions about their efficiency and cleanliness. Furthermore, shifting policy priorities and successive bans of different technologies have created uncertainty and made brick operators wary of adopting newer and expensive technologies.

*Source:* World Bank (2018c).

(a) awareness and information about available technologies, (b) skills and technical capacity to implement them, (c) access to finance, (d) providers of affordable clean technology services and equipment, and (e) needed complementary infrastructure (e.g., electrical connection). As the brick sector shows, sector-specific constraints also exist (Box 3). Such constraints apply differently to firms in different sectors, and to different types of firms within each sector (e.g., small versus large, domestic versus foreign-owned, and formal versus informal). Generally, SMEs tend to face higher informational, technological, and financial obstacles. Moreover, incentives can be misaligned with the objective to achieve higher efficiency and lower pollution, notably if environmental regulations are inadequate and weakly enforced, if investing to increase production is perceived as a more profitable option in fast-growing markets, if uncertainty or low margins make firms reluctant to innovate, if public pressure to limit pollution is limited in a context of scarce data, and so on. One lesson from past RECP projects in Punjab and elsewhere is that communicating a clear and convincing business case for such investments was essential.

**The various initiatives implemented in Punjab to promote RECP have suffered from shortcomings that have limited the scope and sustainability of their impacts.** While government and donor-supported initiatives have generally provided much-needed technical and financial support for RECP to firms in polluting sectors, they have failed to create conditions for sustainable supply and demand

32 A comparative analysis of the performances of this pilot ZZK and a traditional FCK in Punjab found that the former used 22 percent less coal, and that it emitted 42, 38, 8, and 3 times less $PM_{2.5}$, $SO_2$, CO, and $CO_2$, respectively (Shariff and Nasim 2018). Over a 20-year kiln lifespan and with a 10 percent discount rate, the estimated private net benefits for kiln owners is PKR 195 million with ZZK, compared to PKR 85 million with FCK. The present values of social net benefits (private net benefits minus the cost of carbon emissions) of employing ZZKs and BTKs are PKR 171 million and PKR 50 million per kiln, respectively. ZZK owners can recover their initial investment in 1.5 years, while it takes BTK owners 2.4 years.

33 http://ccacoalition.org/en/news/pakistan-moves-toward-environmentally-friendly-and-cost-effective-brick-kilns

for such services (UNIDO and Government of Pakistan 2014). In particular, projects have tended to provide diagnostics and recommendations to firms, rather than building their capacity to conduct such diagnostics and help them structure employee training, incentives, and responsibilities so that a framework for continuous improvement can be established. Likewise, institutional capacity building for government agencies and other key stakeholders, such as industry associations, has been neglected. Few projects have sought to foster the development of private RECP technology and service suppliers, as well as of sustainable financing options. Initiatives have focused on the supply side, overlooking demand-side issues. Moreover, multiple initiatives, including within the same sectors, have generally been implemented simultaneously with little coordination. Finally, most initiatives have focused on pilots for individual firms, missing opportunities to foster industry-level progress.

## 3.2. Industry Level

**Beyond firm-level improvements, cooperation between multiple firms within or across sectors can offer additional opportunities to reduce their environmental footprint, while generating economic gains.** This can notably be done by relocating clusters of polluting industrial units in dedicated estates to jointly manage environmental issues; by strengthening environmental management in industrial estates (IEs) to gradually shift toward an "eco-industrial park" (EIP) model promoted notably by China (Box 4);, and by developing exchanges of waste material, waste energy and wastewater between firms within and/or outside of IEs (industrial symbiosis) (Box 5). Such approaches have been central elements in the strategies of countries that have successfully initiated the greening of their industrial sectors in the recent period, such as China and Korea.

### BOX 4. CHINA'S EXPERIENCE WITH ECO-INDUSTRIAL PARKS

**EIPs are a relatively recent but increasingly influential concept, notably in China.** The last two decades have seen a growing interest for EIPs among academics and policy makers in high-, medium-, and low-income countries alike, as a way to improve industries' environmental, economic, and social performances.[34] While many industrial parks around the world have claimed the 'eco' label, there are still few actual EIPs in operation, especially in developing and emerging economies (UNIDO 2016). In China, improving the sustainability of IEs, which concentrate most of the country's massive industrial production, has become an increasing focus of the authorities since the 1990s, and EIPs have become a priority tool of industrial and environmental policy.

**The systematic management of environmental issues in Chinese IEs was initially fostered through the promotion of estate-wide Environmental Management Systems (EMS).** The State Environmental Protection Administration (SEPA)[35] launched a demonstration program in 1999 for the adoption of EMS and related ISO 14001 certification at the level of

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34 For overviews of EIPs in developing countries, see notably UNIDO (2016), World Bank, UNIDO and GIZ (2017), Chertow and Park (2016), and Shenoy (2016).

35 Now Ministry of Ecology and Environment.

IEs.[36] Several IEs have been certified since then and have promoted the use of EMS among their tenant companies, which has been credited with improved environmental management, as well as diverse social and economic benefits in these estates (including increased attractiveness for foreign investors). For instance, the Dalian Economic and Technological Development Zone (DETDZ) adopted an EMS in the early 2000s, covering notably air emission control, integrated management of water and of solid waste, emergency preparedness, and promotion of cleaner production and ISO 14001 certification among local enterprises through technical assistance and partial subsidization of certification costs.

**China has been a leading promoter of the EIP concept over the last two decades.** In parallel with renewed efforts over the last two decades to strengthen environmental regulations and to ensure industry compliance, an EIP demonstration program was launched in the early 2000s to minimize pollution and waste generation in existing IEs. This has been supported by several laws and regulations adopted since then to promote RECP, circular economy, and so on. China is also one of the few countries that has developed different sets of standards to define EIP requirements and monitor their performances on key dimensions (e.g., economic performances, material efficiency, energy efficiency, renewable energy, resource recovery, pollution, EMS, green infrastructure, information disclosure).[37] Finally, several fiscal and financial instruments have been established to support IEs and their tenants in the transition to the EIP model, especially for infrastructure development.

**There is emerging evidence that Chinese EIPs have recorded a strong improvement in economic and environmental performance.** By 2018, about 240 IEs, out of over 2,500 national and provincial ones in the country, had been certified under one or several of the existing EIP standards. The evidence suggests that Chinese EIPs have generally been effective in improving their environmental performance. For instance, one study estimated that a sample of EIP and CE demonstration parks reduced their energy and water intensity by about a third.

**Tianjin Economic-Technological Development Area (TEDA) offers a good example of EIP which gradually strengthened environmental management.** TEDA is a leading industrial area in China and hosts thousands of companies, mainly in the electronics, automobile and machinery, biotechnology and pharmaceutical, and food and beverage industries. It established an independent environmental regulatory body in 1990 and a tenant environment protection association in 1996. Since then, it has continuously upgraded its environmental management capacity (e.g., environmental impact assessment of investment projects, air and water quality monitoring, pollution discharge levies). TEDA obtained ISO 14001 certification in 2000, in parallel with several tenant companies. In the early 2000s, TEDA formulated

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36 While generally applied at the level of an individual company, EMS and ISO 14001 can also be adopted by larger organizations, such as IEs. This can be done to manage the environmental impact of an estate's own activities and services, which is mostly relevant if the estate management is responsible for major services (e.g., CETP, SWM facilities). Various industrial estates in countries such as Belgium, France, Germany, Japan, Indonesia, the Philippines, Spain, and Thailand have obtained ISO 14001 certification for their activities over the last two decades. A more ambitious version is a Comprehensive EMS (CEMS), in which estate management and tenant companies each establish their own certified EMS and adopt joint policies and activities to address common issues at the estate level. Given the possible reluctance or incapacity of some tenant companies (especially SMEs) to invest in a formal EMS, the intermediate option of an 'environmental quality charter' has been promoted in France by the association Orée, by which estate managers and tenants sign a contractual charter specifying their respective environmental responsibilities and areas of collaboration (http://www.oree.org/gestion-environnementale-ZAE.html).

37 Three separate EIP standards, led by different ministries and agencies and with slightly different focus, have been formulated since 2006 and have been regularly updated since then, namely '"National Demonstration Eco-Industrial Parks' (2006), 'Industrial Parks for Circular Economy Transformation' (2012) and 'Green Industrial Parks' (2016).

an EIP development plan and was recognized as a national demonstration EIP and pilot CE zone. In addition to regulatory requirements and resource scarcity, one of TEDA management's main motivations for transitioning to an EIP model was fierce competition for foreign investment from other leading IPs in China. Over the years, TEDA and its tenant companies have developed a complex system of public infrastructure and symbiotic exchanges between companies to recover materials and improve the management of energy, wastewater, and solid waste. Economic and environmental benefits have been considerable, with a partial assessment for 2006 finding that they included 1.26 $Mm^3$ of reclaimed water purchased by industrial users, and several hundred thousand tons of material and waste recycled or reused.

*Source:* World Bank (2018d).

## BOX 5. FOSTERING INDUSTRIAL SYMBIOSIS WITHIN AND OUTSIDE IEs

**Industrial symbiosis (IS) has been recognized since the 1990s as a potentially powerful way of improving industrial resource efficiency and reducing waste/pollution.** IS designates the process by which by-products or waste (e.g. material, water, heat) from one industry that would otherwise have been discarded become valuable inputs for one or several other industries (replacing virgin material or other energy sources), which benefit all parties involved economically and can generate environmental gains. At the same time, IS involves some risks for businesses that need to be managed (e.g., fluctuating supply of by-product for waste-receiving firms and profitability of the exchange depending on volatile commodity/energy prices). It could also have adverse impacts in case alternative uses for waste reduce incentives for firms to reduce it in the first place.

**IS can be fostered through well-designed policy.** While there is a broad recognition that IS is likely to be successful only when it is a business-driven process, appropriate regulatory and institutional frameworks can nonetheless play an important role to facilitate the emergence of symbiotic exchanges. Indeed, in addition to Korea, several countries have actively sought to promote IS over the last two decades, such as the United Kingdom, Australia, and China. Examples of structured IS initiatives include Kalundborg in Denmark and Ulsan in Korea.

- ***Kalundborg.*** Kalundborg is the world's best-known IS example. Rather than a government-planned estate, it is a business-led IS and utility-sharing network, which has been progressively established since the 1960s. The system is currently made up of 25 different exchanges of water, energy/heat, and materials, with flows emanating from six different industrial firms and three public organizations totaling 5,000 employees. Since 2011, this partnership has been formalized as a private association, Kalundborg Symbiosis,[38] which manages matters involving all partners and explores opportunities for further collaboration. A life cycle assessment based on data for 2015 and comparing production with and without the current IS network showed

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38 http://www.symbiosis.dk/en/

that it generated annual financial savings of over €24 million for all the partners involved, and reduced GHG emissions by 635,000 tons of $CO_2$ equivalent.

- ***Ulsan.*** The metropolitan area of Ulsan, Korea's industrial capital, features two national industrial complexes, as well as several regional ones, which include over a thousand firms in diverse heavy industries. Faced with rapidly growing industrial pollution, the Korean government started to impose stricter environmental quality standards in Ulsan industrial complexes from the late 1980s, pushing resident firms to invest in pollution management and prevention, and to promote RECP from the 1990s onward. Building on synergies previously established by local industrial firms, Ulsan became a pilot site under the national EIP program launched in 2003, which focused on the development of IS. The Ulsan Regional EIP Center, led by an advisory board with representatives from the local government, industry, and academia, was established to collect data; identify potential IS projects; coordinate with the national level for the provision of technical and financial support to individual projects; and monitor economic, social, and environmental impacts. Under the program, 77 projects were funded for research and development and 34 for operations. Investments amounted to US$14.8 million in project research and development from the government and US$245.8 million from industries. Overall, the projects supported have led to US$65 million in new business income from the sale of waste and by-products and US$78 million in energy and material costs savings each year. Between 2005 and 2016, they also saved 279,761 tons of oil equivalent (TOE) in energy use (that is, a reduction of 665,712 tons of $CO_2$ emissions and 4,052 tons of air pollutants, such as $SO_x$ and $NO_x$) and 79,357 tons of water, and enabled the reuse of 40,044 tons of by-products and waste.[39]

**Establishing national/regional IS networks can be a successful approach to foster IS, as exemplified by the U.K.'s National Industrial Symbiosis Programme (NISP).** A regional IS network was first piloted in one region in 2000 and subsequently extended to other regions, with coordination at the national level under NISP since 2004. Activities under the different regional initiatives included convening stakeholders, awareness raising, coordination to address potential barriers to IS, data collection and analysis, support to design and implement symbiotic exchanges, and independent evaluation of impact. The experience has shown that it was essential to identify well-established and capable local institutions and practitioners with a deep knowledge of local industries to animate the network, and to ensure the participation of committed champions from key local companies. Importantly, NISP was facilitated by conducive policies (e.g., resource productivity policy) and tax incentives (e.g., climate change levy, landfill tax, and credit), although some regulations hampered IS (e.g., restrictions on the use of waste). After five years, NISP had over 12,500 member companies (mostly SMEs) and contributed to significant economic and environmental gains, including reducing virgin material use by almost 10 million tons, diverting 7 million tons of waste from landfill, reducing carbon emissions by over 6 million tons, enabling £156 million in cost savings and £176 million in additional sales for participating firms, creating 3,683 jobs and saving 5,087 ones, and so on. NISP has been recognized as best practice by the EU and has been emulated in several other countries, including Brazil, South Africa, and Canada.

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39 Nationwide, Korea's EIP program prompted firms to invest over US$691 million in energy efficiency, industrial symbiosis, waste management, and other ecofriendly investments. To date, this has helped firms save over US$857 million and generate US$1.3 billion in new revenues. Through this program, South Korea was able to reduce 1.7 million TOE energy consumed in the industry sector, 8.54 million tons of carbon dioxide ($CO_2$) emissions, and 6.85 million tons of waste generated from the industrial sector. The EIP initiative also helped to create nearly 1,000 new jobs (World Bank, UNIDO, GIZ and MOTIE 2018).

**In China, IS has been included in the scope of EIP development early on.** Several zones, such as the Rizhao Economic and Technological Development Area (REDA) and TEDA have had some success fostering IS. For instance, TEDA management took steps to this effect since the 1990s, notably with the establishment of a dedicated information platform to facilitate by-product exchanges among tenants. TEDA established a partnership with the U.K.'s NISP in 2010 to develop an IS network in the surrounding Tianjin Binhai New Area (TBNA), as a step toward introducing this approach nationwide. This cooperation initially struggled to generate broad interest from local companies, due notably to a less conducive policy environment compared to the U.K. (e.g., lack of regulatory or fiscal disincentives to landfill). Between 2010 and 2013, the program was nonetheless credited with having facilitated 99 synergies and diverting 1.43 million tons of material from landfill. The Eco-Center established by TEDA management to implement the program was maintained after its completion to continue promoting IS and other environmentally sound business practices in TBNA.

*Sources:* World Bank (2018d); Laybourn and Morrissey (2009); World Bank, UNIDO, GIZ and MOTIE (2018).

**In Punjab, IEs provide opportunities to promote greener industrial development.** As mentioned, a large share of industrial production, and pollution, in the province is concentrated in IEs. The number of IEs has increased from 24 in 2006 to 34 in 2016, including 13 large ones managed by Punjab Industrial Estates Development and Management Company (PIEDMC) and Faisalabad Industrial Estates Development and Management Company (FIEDMC) (PERI 2017). Going forward, GoPunjab plans to develop facilities at existing IEs, including for effluent treatment, and to build several new IEs in different parts of the province (Government of Punjab 2015b). The construction of nine Special Economic Zones is also planned in the framework of the China-Pakistan Economic Corridor (CPEC), including one in Punjab (Faisalabad). This represents a good opportunity to target efforts at improving industrial environmental management in brownfield and greenfield IEs, through both end-of-pipe systems (e.g., CETP, SWM facilities) and preventive/RECP approaches.

**Despite the large potential, little has been done so far to promote sound environmental management in Punjab's IEs.** Most IEs have suffered from lack of essential environmental infrastructure (e.g., CETP, landfill) due to inadequate allocation of responsibilities between GoPunjab, zone developers, and tenants to finance their construction, maintenance, and operations (World Bank 2016a). Beyond infrastructure, IE's policy, institutional and regulatory frameworks do not emphasize environmental management and only consider it under the angle of compliance with environmental standards, which is generally not achieved. Zone developers and managers (PIEDMC, FIEDMC, and PSIC) still have little understanding or concern about how improved resource efficiency and cleaner production within IEs could become a central element of their sustainability and competitiveness (UNIDO and Government of Pakistan 2014).

**Introducing the concept of EIP could help achieve Punjab's industrial and environmental objectives.** As demonstrated by the cases of China and Korea (Box 4 and Box 5), ensuring sound environmental management and promoting RECP in IEs can be a source of broad economic, social, and environmental gains. In Punjab, a generic 'Sustainability Framework' was recently prepared (CPI 2013a) and applied to specific estates, such as Sundar IE (CPI 2013b) and Quaid-e-Azam IE, after

consultations with their respective boards of management.[40] This framework represents a good step toward introducing the EIP model in Punjab's existing and planned IEs, but it does not appear to have been implemented so far. Since then, in 2016 GoPunjab launched the Jobs & Competitiveness Program with support from the World Bank,[41] which includes objectives related to the improvement of environmental management in IEs, notably regarding effluent treatment and promotion of RECP. More recently, GoPunjab expressed its intention to develop an EIP strategy under the new Punjab Green Development Program, also supported by the World Bank. Using the previously developed IE sustainability framework and available international guidance,[42] the time is right for GoPunjab to take concrete steps to develop EIPs in the province. In doing so, the following principles and lessons learned from international experience should be kept in mind:

- Compliance with environmental laws and regulation by IE tenant companies is a prerequisite. EIP, RECP, and IS are intended to bring about additional benefits, although they can also lower end-of-pipe treatment and compliance costs.
- There is no single EIP model, and different EIP elements can be gradually introduced in Punjab's IEs based on local priorities and available resources.
- Top-down EIP programs have a mixed record, showing that strong involvement from IE management and tenant industries is essential. This being said, governments can play an important role by (a) sending signals through the adoption of an EIP strategy/policy and designation of pilot IEs; (b) establishing a conducive regulatory and institutional environment; and (c) facilitating business-driven initiatives through the dissemination of information, provision of technical and financial support, and so on but leave flexibility for local implementation.
- While improving environmental management within the estate would be a priority of EIPs, substantial environmental impacts may occur upstream or downstream from tenants' supply chains, in which case initiatives could aim at involving outside suppliers and clients.
- EIP initiatives can yield significant gains but are no silver bullet or substitute for broader environmental policies.

**GoPunjab could also consider facilitating the emergence of IS networks in the province.** Some exchange of by-products and waste already takes place in Punjab, but these are often not done efficiently and can even generate environmental or health hazards (e.g., protein-rich but chromium-laden tannery waste used to produce poultry feed) (CPI 2013a). In many countries, IS links have successfully been established involving many different industries present in Punjab, such as textile, leather, sugar, and cement. Many more such links could likely be developed within and outside IEs in the province with better awareness and support, for instance, along the lines presented in Box 5. The literature on IS shows that various obstacles and market failures can prevent otherwise mutually beneficial exchanges between industries (e.g., coordination issues and information asymmetries, non-internalized environmental externalities, financing, dependency risk, uncertain benefits), and that

40 This framework was prepared under the Dutch-financed Programme for Industrial Sustainable Development, Phase II (2010–13). It looks at IE-level environmental planning and management, as well as at tenants' individual practices and cooperation for RECP, and covers various EIP dimensions (e.g., by-product, wastewater, and waste heat exchanges; shared pollution/waste management infrastructure; support for RECP; green buildings' renewable energy; and social amenities). It suggests a process to develop, operationalize, and monitor a customized sustainability framework based on a given IE's priority sustainability issues.

41 See https://prmp.punjab.gov.pk/jandc

42 In particular, the World Bank, UNIDO, and GIZ recently published a joint EIP framework, which defines prerequisites and performance indicators for IEs to be considered EIPs regarding park management, environmental, economic, and social performances (World Bank, UNIDO and GIZ 2017). The same organizations and the Korean Ministry of Trade, Industry and Energy (MOTIE) subsequently published a detailed and practical handbook to develop a national EIP program, implement the EIP model at the estate level, and establish industrial symbiosis networks (World Bank, UNIDO, GIZ and MOTIE 2018).

a combination of direct and indirect support and incentives, through regulatory, fiscal, and other policy instruments, can help facilitate IS.[43]

**Finally, in some cases, the relocation of polluting industry clusters, including in dedicated IEs, can be an option to reduce their environmental impacts and improve efficiency.** Much of the manufacturing in Punjab takes place in and around rapidly growing cities, where there is insufficient land formally zoned for industry, although GoPunjab plans to improve industrial zoning (Government of Punjab 2015b). As in other South Asian countries, polluting sectors such as textile and leather tend to be made up of clusters of SMEs operating in similar ways. The scattered location of these SMEs, coupled with their often informal status, makes them difficult to regulate despite the local impact they can have in terms of waste and pollution. Facilitating the relocation of such clusters in appropriate locations can be needed to mitigate adverse environmental and health impacts. For some industries, dedicated IEs could be an appropriate solution, making joint treatment of waste and effluents economical and enabling the consolidation of by-products that can be reused by other industries, composted, and so on. Such a project has been initiated in Sialkot, where the Sialkot Tannery Zone (STZ) is being developed to relocate on a voluntary basis the numerous tanneries currently operating within and around the city, with the hope that it will facilitate pollution control and the adoption of cleaner and more efficient technologies and practices by SMEs.[44] However, Bangladesh's experience with the Savar Leather Industrial Park shows that such projects are difficult to implement and may merely displace the issue if they focus on infrastructure but neglect economic, social, political, and institutional aspects.[45] UNIDO recently prepared a useful review of the global experience with leather industry parks and derived lessons to implement them and maximize economic, environmental, and social benefits (UNIDO 2017).

## 3.3. Circular Economy

**The CE aims to rethink production and consumption systems in ways that are compatible with sustainable development.** The different definitions of the CE that have been proposed all agree on the overarching objective to close resource loops so as to minimize finite resource consumption, waste, and pollution, which are constitutive elements of traditional linear industrial systems. While RECP's focus on incrementally increasing efficiency is a necessary and complementary approach, the CE takes a step further by aiming to 'design out' resource use and pollution/waste wherever possible. Likewise, an improved recycling system is an important part of the framework but is considered a last resort, as it comes at the end of the product life cycle. As defined in Box 1, other more upstream CE

43 See notably Costa, Massard and Agarwal (2010), Jiao and Boons (2014), and European Commission (2018).

44 To address the sector's pollution issues, in 2009, the Sialkot Chamber of Commerce and Industry and tanners formed the Sialkot Tannery Association (Guarantee) Ltd. (STAGL), a nonprofit organization, to develop a dedicated estate with a CETP through a public-private partnership (PPP) arrangement with GoPunjab. STAGL has completed land acquisition and installation of fences and has started building zone infrastructure, such as roads. All Sialkot tanners purchased STZ plots to relocate their production by 2019/20 after the estate is ready. UNIDO has been supporting STZ development since 2015 (for example, training on RECP and pollution control; completion of land-use planning, climate, and social assessment, and waste management planning; technical design of CETP and building of first module, expected to be completed in 2019). The STZ's Environmental Impact Assessment (EIA), including an Environmental Management Plan (EMP), was approved by EPD in 2011. Under the UNIDO project, STAGL reconfirmed its commitment to properly implement the EMP.

45 In 2003, the Government of Bangladesh initiated this project to relocate tanneries from Hazaribagh, a highly polluted part of Dhaka, to a purpose-built estate 20 km outside the city. The project, which was expected to be completed in two years, is not operational yet and has far exceeded its initial budget. While around 200 tanneries were eventually compelled to relocate in Savar in 2017, the CETP, one of the estate's main components, was still not fully effective in 2018, notably because of disagreements regarding its financing between tanners and the government. As a result, tannery effluents continue to be released untreated in waterways. Likewise, planned SWM facilities have not been completed, leading to unsanitary dumping of hazardous solid waste around the estate, and poor transport and energy infrastructure have hampered tanneries' operations. Unimproved environmental performance in the sector has been blamed for the reduced demand for Bangladeshi leather in recent years (see "Savar Leather Estate Rife with Environmental Hazards." *Dhaka Tribune*. August 19, 2018).

elements include product eco-design (to increase their lifespan and make them easier to repair or recycle) and extended producer responsibility (EPR); industrial symbiosis; new business models (e.g., product-as-a-service, sharing economy); and reuse, repair, and remanufacture. The CE approach is also buttressed by a shift to renewable energy sources for production.

**Circularity is still a relatively new concept, but it could offer opportunities to reduce the environmental impact of industrial development while generating economic and social gains.** The CE framework builds on various concepts developed over several decades, but gained increasing traction globally among researchers, policy makers, and business leaders in recent years.[46] To date, most work on the topic has focused on high-income countries. However, some studies have started to be prepared on the CE potential in low- and middle-income ones, as well as the implications for them of future transitions toward more circular economic models in the north.[47] For instance, one report for India looking at three topics (cities and construction, food and agriculture, and mobility and vehicle manufacturing) estimated that a CE path to development could bring India annual benefits of US$624 billion in 2050 compared with the current development path, equivalent to 30 percent of current GDP (Ellen MacArthur Foundation 2016). In South Asia, this transition could build on relevant existing activities, such as the shipbreaking and recycling industries (e.g., batteries) but would have to ensure they are conducted in conditions that minimize health and safety risks for workers, consumers, and the environment. As argued in an earlier study on SWM in Punjab, this could also be an opportunity to leverage and formalize the thriving recycling activity carried out by scavengers in cities (World Bank 2010).

**What could be the main opportunities to improve the economic, environmental, and social performances of Punjab's industries through circular solutions?** The CE framework is broad, covering multiple sectors in addition to industry, such as urban development, agriculture, energy, and transport. It adopts a life cycle approach considering all stages, from resource extraction to production, consumption, and disposal/recycling. Restricting the focus to manufacturing production, analysis is needed to determine how circular principles could be applied in Pakistan to solve major issues linked to industrial resource use and pollution, and also to the consumption and disposal of products.[48] For instance, various technologies exist to reuse water, chemicals, and heavy metals in the leather and textile sectors (e.g., zero-liquid discharge introduced in India and Bangladesh, chrome recovery plants). The business model of 'chemical leasing' promoted notably by UNIDO also offers opportunities for these and other sectors by incentivizing chemical manufacturers to minimize the quantity of chemical used by their clients.[49] In the brick industry, India and China have shown how the use of different types of waste as a raw material and alternative building materials can improve environmental and economic performances (Box 3). Likewise, CE solutions could be found to produce other goods, such as plastics[50] and paper.[51]

46 See, for instance: WEF, Ellen MacArthur Foundation, and McKinsey (2014), Geissdoerfer et al. (2017), and CEPS (2018).

47 See notably: Tearfund (2017), Preston and Lehne (2017), COER (2017), and Gower and Schröder (2016).

48 Given its focus on Punjab's industries, this chapter does not extend on the challenges posed by the increased consumption and disposal of various goods produced outside the province (e.g., electronics, appliances, plastic goods) and the potential circular solutions, such as extended producer/importer responsibility.

49 http://www.chemicalleasing.com

50 WEF and Ellen MacArthur Foundation (2017).

51 WEF (2016)

4

# Policies to Foster Sustainable Industrialization

**Governments have an important role to play to ensure industrialization does not undermine sustainable development, but rather contributes to it.** Over the last 50 years, governments around the world have increasingly sought to minimize adverse environmental and social impacts from industries by adopting stricter environmental policies. Since the 1990s, many have also adopted policies to promote resource efficiency and preventive approaches to industrial pollution and waste, as a less costly way to achieve this objective, which can also strengthen innovation, productivity, and competitiveness.

**A range of complementary policy instruments should be used to minimize industrial resource use, waste, and pollution.** As explained in the previous chapter, several reasons can explain why firms do not always invest in resource efficiency and cleaner production, even when this could increase profits. Adopting and enforcing appropriate environmental standards can create pressure to this effect but may not be sufficient. In fact, countries that have been able to green their industrial sector, such as Korea (Box 6), have tended to combine this traditional regulatory approach with other instruments of environmental policy (e.g., market-based, information-based), as well as with a more proactive 'green industrial policy' to address various obstacles limiting the adoption of RECP, industrial symbiosis, and so on.[52] This need to combine approaches is particularly relevant in developing countries, where industrial sectors are generally made up of numerous small and often informal firms, and where enforcement capacity is low.

## BOX 6. KOREA'S EXPERIENCE GREENING THE INDUSTRIAL SECTOR

**Korea's rapid industrialization from the 1960s led to severe adverse impacts on the environment and public health.** In the 1960s, the government's overarching objective to foster export-led economic growth resulted in a manufacturing boom, especially in polluting heavy industries. There was at that time little consideration for environmental aspects, and efforts to introduce environmental protection measures were initially slow, as they were seen as a hindrance for economic growth and faced resistance from industrialists.

**Korea has gradually strengthened its environmental management framework over time.** Attention to pollution issues grew in the 1970s, as academia and the media

*continued* ▶

52 See for instance UN Environment (2017a) for a comprehensive presentation of the concepts, instruments, and country experiences with green industrial policy, and OECD (2018) for a presentation of policy instruments focusing on greening SMEs.

developed research on the topic, and public pressure built for a cleaner environment. The argument that controlling pollution was necessary to sustain economic growth started to be made. Environmental protection was thus introduced in national economic development plans and the policy, legal, and regulatory framework for environmental protection and pollution/waste management was developed from the late 1970s. Enforcement among industries was enhanced in the 1980s with the strengthening of the Environment Agency's monitoring and inspection capacity. At the same time, public investment in waste and pollution management infrastructure was increased, and environmental management was integrated at all levels of the education system. The policy framework was developed over time to include increasingly strict emission standards and permits, pollution levies, EIAs, environmental dispute resolution systems, and so on. Significant success was achieved to control pollution levels during this period, but industrialization continued to put pressure on the environment and new challenges emerged (e.g., management of chemicals and hazardous industrial waste).

**The focus of Korea's environmental policy has gradually shifted from controlling to preventing waste and pollution.** A law on the saving and recycling of resources was adopted in 1992 to minimize waste. Several charges, volume-based fees, and deposit-refund systems were introduced and updated since then to create incentives for pollution and waste reduction. The ministries of environment and of industries adopted joint guidelines to reduce industrial waste at the source in 1996, with support and incentives for firms. Financial support and tax incentives were granted to the recycling industry, and public procurement was leveraged to foster demand for recycled products. An EPR scheme for waste was adopted in 2002, and product standards and labeling were introduced to facilitate recycling. Since the 1980s, the share of industrial waste landfilled has dropped dramatically in favor of recycling, which now reaches about 80 percent.

**Korea has increasingly complemented environmental policy with active support to green the industrial sector.** The objective of this strategy is to protect the domestic environment and public health, as well as to improve industries' competitiveness by increasing resource productivity, innovation, and compliance with export markets standards. In 1995, a law on the 'Shift to an Environment-Friendly Industrial Structure' was adopted, promoting RECP technology development and dissemination, the adoption by industries of EMS, resource efficiency data and metrics, public-private dialogue (PPD) on industrial environmental issues, and so on. Technical and financial assistance has been provided to industries (especially SMEs) through various programs and agencies[53] since then to support RECP dissemination at the firm level, promote industrial energy efficiency, foster industrial symbiosis,[54] certify green firms and products, and so on. At the same time, the government has also increased support for environmental technology with a dedicated agency for research and development and different funding schemes for environmental industries. Energy and water demand management strategies and policies were adopted in the 2000s to reduce resource use through standards and programs to develop energy/water saving companies (ESCOs/WASCOs). Importantly, such programs have been regularly evaluated and reformed to improve their impact.

*Source:* KEITI (2018).

53 This includes the active Korea National Cleaner Production Center (KNCPC) (https://www.kncpc.or.kr), Korea Energy Agency (KEA) (http://www.energy.or.kr/renew_eng/main/main.aspx), and Korea Environmental Industry & Technology Institute (KEITI) (http://www.keiti.re.kr).

54 See Box 5 on Korea's national EIP program.

**Beyond donor-funded projects, Pakistan and Punjab's approach to address industrial pollution has focused on 'command-and-control' regulations.** As detailed below, the Federal Government, and the provincial one since the 2010 decentralization, has adopted environmental standards and attempted to enforce industries' compliance with them, with limited success. Other environmental policy instruments have not been used extensively in Punjab and, despite multiple pilot RECP projects, preventive approaches have not been translated in policy either. In particular, GoPunjab has made limited efforts to date to complement its regulating role with a facilitating role, working with industries to achieve better environmental performances. This has hampered progress toward greener industrial development, which, as argued in the previous chapter, faces different types of obstacles.[55] This chapter provides an overview of policies that are currently implemented in Punjab and of others that could complement them, based on good international practices.

## 4.1. Strategic and Institutional Framework

### STRATEGIES AND POLICIES

**While several strategies and policies contain relevant elements, Punjab lacks an integrated strategy for sustainable industrial development.** In recent years, strategies dealing with industrial development, energy efficiency, and environmental management have been adopted at both the federal and provincial levels. Overall, limited links are made between these different dimensions, especially in provincial strategies, which seems to indicate a lack of coordination between the departments concerned.

*Federal*

- The 2012 National Sustainable Development Strategy (NSDS) included relevant objectives related to industries' environmental performances but lacked a concrete action plan and implementation framework.[56]
- The 'Vision 2025'[57] adopted in 2014 does not emphasize sustainability issues beyond water scarcity and energy use, and largely fails to connect them with the emphasis put on promoting private sector–led growth and enhancing industrial competitiveness and productivity.
- The 2006 National Energy Conservation Policy included objectives to introduce energy audits in industries and facilitate the implementation of efficiency-improving measures. This was followed by an energy efficiency sector road map (2010–19) and by an act of Parliament in 2011. This act, updated in 2016, provides a good basis to foster industrial energy efficiency.[58]

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55 For instance, manufacturers in Punjab interviewed for a recent study (IFC 2016) emphasized various obstacles to invest in energy and resource efficiency, including the weak enforcement of environmental regulations and absence of efficiency standards, the lack of awareness about technological options and their financial benefits, the lack of financing, the low level of technical skills, the scarcity of companies offering clean technology services and equipment (IFC 2016).

56 'National Sustainable Development Strategy: Pakistan's Pathway to a Sustainable & Resilient Future.' The NSDS includes general objectives regarding the efficient use of energy, water, and other natural resources, as well as reduced pollution and waste from production and consumption. It recognized cleaner production as an opportunity to improve the efficiency of industrial production, and stressed the government's role to promote it by supporting technology upgrading; reforming the legal and regulatory framework and strengthening its enforcement; introducing environmental taxes and subsidies; developing green standards, labeling and certification schemes; and so on. The NSDS also linked sustainable industrial production with trade competitiveness.

57 'Pakistan 2025: One Nation, One Vision.' Ministry of Planning, Development & Reform (https://www.pc.gov.pk/web/vision).

58 The 2016 National Energy Efficiency and Conservation Act notably establishes a national energy efficiency board and authority and lays out the federal and provincial powers to foster efficiency, including setting standards and labeling for equipment and appliances, mandating energy audits and the hiring of energy managers in designated industries, establishing incentives for the use of efficient equipment, creating an energy conservation fund, and so on (see http://www.na.gov.pk/uploads/documents/1472205962_638.pdf).

- The National Action Plan on Sustainable Consumption and Production (NAP-SCP) adopted in 2017 looks at sustainable industrial production, along with several other sectors (e.g., energy, construction, food, transport, ecosystems).[59] It provides a long list of almost 50 measures on industries, which arguably suffers from a certain lack of prioritization and specificity.
- The 2018 National Water Policy[60] recognizes industry as an important water user. It reaffirms the need to enforce the 'polluter pays' principle and to mandate effluent treatment, and also mentions the importance of water recycling, including in IEs. The policy also recommends planning legislation to determine water abstraction licenses and water rates for industrial use.

*Provincial*

- Punjab's Growth Strategy 2018 mentions in passing the relationship between competitiveness and environmental sustainability but does not expand on it.[61] Likewise, the linked Industries Sector Plan does not emphasize resource efficiency, pollution, or waste, only mentioning the need to improve end-of-pipe effluent treatment in IEs by building CETPs.[62]
- GoPunjab recently drafted an extensive Strategic Framework for IE development, which recommends developing CETPs through PPPs and strengthening compliance monitoring/enforcement in IEs but does not consider broader dimensions of environmental performance.[63]
- GoPunjab has also been preparing an industrial policy to improve the soundness of policy making in this area and facilitate coordination between the different institutions involved.
- Punjab lacks a comprehensive environmental policy, although a draft was prepared in 2015. This draft mentions the need for sustainable industrialization, focusing on industrial zoning and end-of-pipe pollution/waste management in IEs.[64]
- Regarding air pollution specifically, a smog policy was adopted by the EPD in 2017. It includes objectives related to shutting down major air polluting units, improving industrial zoning, and supporting polluting industries (especially SMEs) to adopt cleaner technologies.[65]

**An integrated strategy, with a credible action plan to achieve its objectives, would be a useful first step in enabling GoPunjab to foster a more sustainable pathway for industries.** Chile,[66]

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59 'National Action Plan on Sustainable Consumption and Production.' Federal Ministry of Climate Change (http://www.oneplanetnetwork.org/sites/default/files/final_nap_report_aug_2017_pakistan.pdf). The NAP-SCP presents improved sustainability of industries as a source of competitiveness. It emphasizes the need for both strengthened enforcement of environmental regulation and collaboration between industries and with the government for improved environmental performances. It includes objectives and actions related to energy and water efficiency/conservation, RECP, industry's environmental compliance, EIPs, and so on. Responsible institutions identified include federal and provincial authorities in charge of the environment and also of industries, trade, finance, and vocational education.

60 See http://mowr.gov.pk/wp-content/uploads/2018/06/National-Water-policy-2018-2.pdf

61 The Strategy mentions the need for 'technical and regulatory support to assist firms in tapping into export markets and keeping local industry viable in the face of opening trade', which includes 'improvements in quality and certification labs to meet global technical standards' (e.g., energy efficiency, sanitary and phytosanitary standards). It also mentions that 'effluent management, the use of greener technology, and meeting labor standards are not only important to exports, but also important for the protection of human rights and the environment. These are cross-departmental issues that require the building of awareness both at the industry and at the governmental level'. (Government of Punjab 2015b, p. 26).

62 The Industries Sector Plan (Government of Punjab 2015b) includes the objectives to develop an industrial policy and an Industrial Zoning and Land Use Plan for the province, as well as to improve data collection on industries, which would all be needed to improve environmental management.

63 However, the Strategic Framework (Frost and Sullivan 2017) presents Korea's national EIP program (focused on industrial symbiosis) and the case of the Gujarat Eco-Textile Park in India, a textile EIP with both preventive and end-of-pipe environmental infrastructure. It also emphasizes as key insights from China's experience with IEs the importance to 'offer rewards to promote energy-saving and environmental-friendly companies while imposing strict punishments on companies that breach environmental regulations' and to 'incorporate environment standards as early as the planning stage'.

64 Draft Punjab Environment Policy (Government of Punjab 2015c).

65 Policy on Controlling Smog 2017 (Government of Punjab 2017).

66 *'Política de Fomento a la Producción Limpia.'* (1998). Available at: http://www.tecnologiaslimpias.cl/chile/docs/PFPL_1997-2000.pdf

Guatemala,[67] Vietnam,[68] and China (Box 7) are among the countries that have used national strategies to promote cleaner production and the circular economy. In Punjab, such a strategy should provide an integrated assessment of the economic, social, and environmental dimensions of industrial development in the province. Data and indicators could be identified to measure the evolution of key variables (resource efficiency, pollution levels, waste generation, energy and material recovery, and so on), and targets could eventually be set. The strategy should consider a broad range of environmental and industrial policy instruments to promote the different opportunities previously presented, including firm-level RECP, EIPs, and circularity, and ensure coherence with key linked policies (e.g., trade,[69] investment,[70] energy, innovation,[71] urban development, and SWM[72] education). Finally, it would ensure participation and ownership by all key departments and agencies, as well as cooperation with key stakeholders, such as industries, academia, civil society, and so on.

## BOX 7. CHINA'S STRATEGIC AND LEGAL FRAMEWORK FOR A RESOURCE-EFFICIENT AND CIRCULAR ECONOMY

**China has a long experience promoting resource efficiency, cleaner production, and circularity.** Policies on the 'comprehensive utilization of resources' were adopted as early as the 1950s, with the objective to increase industrial output rather than to protect the environment. However, faced with growing environmental degradation from the 1980s, the Chinese government increasingly put emphasis on the need to make fast-pace industrialization more environmentally and socially sustainable. In parallel with stepped up pollution control efforts (e.g., enforcement of stricter environmental standards, relocation, and closing of highly polluting industrial units), the concepts of RECP and EIP were introduced in China in the late 1990s as ways to reduce waste and pollution. Pollution/waste prevention and resource circularity have become key elements of China's development strategy since then. At the strategic level, these themes have occupied a central role in the 11th (2006–10), 12th (2011–15), and 13th (2016–20) five-year plans, with increasingly ambitious targets in terms of resource efficiency, reuse and recycling of industrial waste, and so on. A Circular Economy Development Strategy and Action Plan was also adopted in 2013. Being considered a source of future competitiveness and growth, this agenda has benefited from strong political support at the highest level.

**China's framework to promote a circular economy is the result of over two decades of sustained and incremental policy making efforts.** Many policies, regulations, and programs, including the framework for EIP development previously described (Box 4), were

*continued* ▶

67 *'Política Nacional de Producción más limpia.'* Available at: http://www.marn.gob.gt/Multimedios/385.pdf

68 'Strategy on cleaner industrial production to 2020.' Available at: http://www.chinhphu.vn/portal/page/portal/English/strategies/strategiesdetails?categoryId=30&articleId=10051863

69 This can concern lowering import tariffs on inputs and equipment that can support cleaner production. For instance, India's large leather and textile sectors were affected in the 1990s by German regulations banning chemicals commonly used in their production processes. To help Indian manufacturers face the resulting compliance costs, the Indian government reacted decisively by lowering import duties on higher-quality and costlier chemicals, from 150–200 percent to 20 percent. Additionally, Germany worked with state-sponsored industrial bodies in India to provide technical support for adaptation to firms. Overall, this regulatory shock positively influenced large Indian producers' export revenues, by fostering investment in high-quality imported raw materials and technology. On the other hand, it affected small leather and textile firms which found it more difficult to adapt (Chakraborty 2017).

70 For instance, Morocco has actively promoted foreign direct investment (FDI) to develop renewable energy, in parallel with efforts to support related skills development and the emergence of domestic supplier industries (UN Environment 2017a).

71 On eco-innovation in industries, see notably Dutz and Sharma (2012) and OECD (2010).

72 In Europe, for instance, increasingly strict policies to regulate and tax landfilling have been one driver of industrial symbiosis (Costa, Massard, and Agarwal 2010).

put in place by several agencies of the central and local governments over time. Major laws underpinning this framework include the following:

- *Solid Waste Law* (1995). This law covers the prevention and control of pollution from industrial, municipal, and hazardous waste. This law, which has been amended several times, was under revision in 2018 to reinforce waste prevention and control in line with the objective to establish a CE.
- *Cleaner Production Promotion Law* (2002). This requires national and local governments to include RECP in development plans and to promote it through various means. It also mandates the adoption of a catalogue of outdated polluting and inefficient production technologies to be phased out. The law established mandatory cleaner production audits for certain enterprises that exceed pollution discharge standards, are energy-intensive or use/release toxic and hazardous substances. Under the law, such companies are required to disclose environmental information, carry out and publish audits, implement solutions, and face fines for failing to do so.[73] The law also contains provisions to publicly recognize compliant firms and agree on further reduction of RECP targets.
- *Circular Economy Promotion Law* (2008). This law defines the CE and clarifies the objectives and instruments of its development. It requires new industrial development policies to be consistent with the circularity principles. It defines incentives and sanctions and introduces new concepts such as EPR.

**China's CE agenda has become more complex over time.** China has actively sought knowledge from other countries and international organizations, and has continuously adapted new concepts to the domestic context. Initially looking at end-of-pipe recycling and reuse of industrial waste, it has in recent years focused more on the upstream, the product life cycle, and green innovation (e.g., eco-design, EPR), thus becoming more of a competitiveness agenda.

*Source:* Qi et al. (2016); Zhu et al. (2018).

## INSTITUTIONAL FRAMEWORK

**The institutional framework in Punjab could be made much more conducive to the greening of industries.** As demonstrated by the Chinese and Korean examples, countries that have successfully initiated the greening of their industrial sector have generally (a) involved various key government institutions in this agenda, beyond the ones in charge of environmental protection and (b) gradually strengthened the capacity of the different institutions to adopt and implement conducive policies on environmental issues and to support industries. Punjab's main institutions suffer from shortcomings on both points, with little to no institutionalized capacity to promote the kind of preventive approaches analyzed in this chapter beyond temporary donor-funded projects:[74]

73 The number of enterprises carrying out cleaner production audits has increased from around 2,000 in 2008 to over 10,000 in 2012 and includes major heavily polluting industries. The law and mandatory audit system have been credited as having greatly enhanced the awareness and capacity of different public and private actors (including private cleaner production consulting service providers) in the country in relation to cleaner production. Mandatory audits have led to large and rising investments by firms in cleaner production and have had important impacts in terms of resource conservation and pollution reduction.

74 There are relevant federal institutions as well, which are not covered in detail here. They include the National Productivity Organization (NPO), which has provided technical assistance on energy efficiency in sectors such as textile and steel over the past decade, and SMEDA. The Federal Ministry of Commerce and Textile and All-Pakistan Textile Mills Association have a plan to establish a Sustainable Production Center for the textile industry, with support from GIZ. Finally, the judiciary has played an increasingly important role on environmental and pollution-related issues in recent years in Punjab, with the Punjab Environmental Tribunal and Green Benches in the High Court of Punjab (see World Bank [2016a] for a detailed analysis).

- **EPD.** Since the devolution gave it overall responsibility for environmental management in the province, the EPD and attached Environment Protection Agency (EPA) have suffered from insufficient capacity and resources to carry out their mandate, notably in terms of developing policies and regulations, monitoring pollution, and enforcing environmental regulations.[75] Despite implementing some projects on industrial pollution, the EPD has not complemented EPA's regulatory role with a facilitation function to support the greening of industries. However, GoPunjab has expressed its intention to strengthen the EPD's capacity, including by establishing new departments for environmental monitoring, piloting, and demonstration of cleaner technologies, and policy making.
- **Industries, Commerce and Investment Department (ICID).** The ICID and linked agencies[76] are in charge of industrial development, including through IEs. They have not dedicated substantial focus nor resources to industries' environmental sustainability so far, despite a sharp increase in the department's budget since 2013.[77] The ICID has not established a dedicated unit and its staff generally has little awareness of how industrial sustainability can be fostered through RECP, EIPs, and so on. The top management of PIEDMC and FIEDMC were assessed to be aware of environmental compliance issues, although each only has a small one-person environmental section and capacity to promote environmental sustainability at the estate level is limited (World Bank 2016a).[78] Punjab's Industries Sector Plan advocated a shift from ICID's largely administrative and regulatory role to become a facilitator of industrial development (Government of Punjab 2015b). Given the importance of RECP for the industry's productivity and competitiveness, this new role should cover environmental aspects. The ICID should implement recommendations of the J&C Environmental and Social Systems Assessment (ESSA), collaborate with the EPD, and ensure its staff is trained on environmental issues.
- **Energy Department.** The Energy Department has traditionally focused more on supply than demand-side issues. The establishment of the Punjab Energy Efficiency and Conservation Agency (PEECA) and initial work on standards and labeling of electric appliances are welcome developments, even if the agency still has limited capacity and focuses on the public sector. It could however play an important role in the future to foster industrial energy efficiency, like the KEA has done by subsidizing firm-level audits in Korea, promoting Energy Management Systems (EnMS), and developing the ESCO market.[79]

These institutions could be reformed to better integrate the greening of industries in their mandate and activities. Key topics, such as RECP, EIPs and CE, could be promoted by dedicated units under these departments, or by a new agency. For instance, the two decades of experience with NCPCs in almost 60 countries offer lessons on how to establish and operate such centers (Luken et al. 2016). Other countries, such as Australia and South Africa, offer examples of agencies dedicated to the greening of industries.[80]

**Better intragovernmental coordination and public-private dialogue (PPD) are also essential for green industrial development.** There is currently a damaging lack of coordination between key government departments, especially ICID and EPD. Punjab also lacks an adequate platform for all key public and private stakeholders, including agencies in charge of environmental management and industrial

75 See World Bank (2016a) for an institutional analysis of EPD/EPA.

76 Punjab Board of Investment and Trade (PBIT), PIEDMC, FIEDMC, and PSIC.

77 According to PERI (2017), the ICID's average annual budget allocation between 2014 and 2017 (post-Punjab Growth Strategy) was over six times as high as before 2014.

78 The ESSA prepared for the Jobs & Competitiveness (J&C) Program notably recommended the establishment and staffing of social and labor units in PIEDMC and FIEDMC. Since the program was adopted in 2016, the ICID has been lagging on implementation of these and other measures identified to improve its environmental management capacity.

79 See http://www.energy.or.kr/renew_eng/energy/industry/enms.aspx

80 See https://www.greenindustries.sa.gov.au (Australia) and https://www.green-cape.co.za (South Africa).

development, to discuss and coordinate issues related to industrial resource use, pollution, and waste.[81] For instance, the Smog Commission established in December 2017 to identify the causes of the smog episodes affecting Punjab and to recommend priority actions did not include the ICID, despite industries' recognized contribution to the issue.[82] The Punjab Environment Protection Council already has a mandate to *'coordinate integration of the principles and concerns of sustainable development into Punjab development plans and policies'*.[83] However, it has been dormant in recent years, despite the legal requirement that it meet at least twice yearly and injunctions by the Lahore High Court to resume these meetings. It could be reactivated and a committee on sustainable industrial development could be established under it, co-chaired by the EPD and ICID with representatives of key industry associations, academia, civil society, development partners, and so on. Relevant examples of platforms in South Asia include (a) the India Resource Panel, established in 2016 to examine material and energy efficiency across key sectors (e.g., automobiles, iron, and steel) following a life cycle approach, and (b) Bangladesh's BUILD platform for PPD, which includes a working group on sustainability and green growth.[84]

## 4.2. Environmental Policy

**Punjab's environmental policy framework for industries is lacking in terms of implementation and completeness.** While Punjab has adopted a legal and regulatory framework for environmental management, largely inherited from the federal one, several of its provisions concerning industries have not been implemented meaningfully to date. This framework is focused on 'command-and-control' regulations, which mostly ignore preventive approaches, and complementary instruments are lacking, including market-based, information-based, and voluntary instruments. As a result, the polluter-pays principle has no meaningful application in the province, and industries face little incentive to improve resource efficiency.

### ENVIRONMENTAL REGULATIONS

**GoPunjab's capacity to enforce existing regulations on industrial pollution remains weak.** Several laws and rules regulate industrial pollution.[85] GoPunjab has also adopted several PEQS, including for industrial gaseous emissions and effluents, rules on hazardous waste management (under revision), and requirements for new projects to submit Initial Environmental Examination (IEE) and EIAs.[86] However, as mentioned, EPA's capacity to monitor emissions and enforce compliance with these regulations is weak, especially for the provinces' numerous SMEs. There is no real-time, remote monitoring of air and water pollutant emissions even for large plants, and the existing self-monitoring and reporting tool (SMART) for industries has never been widely used. A legacy of lack of political will to take enforcement action against industry is also an issue. Very few firms in polluting sectors, such as textile and leather, are sanctioned for noncompliance, and the amount of fines collected annually has declined over 2012–17 (WWF 2018). Since 2016, however, the EPA has ordered the closing of excessively polluting units as a

81 For guidance on public-private dialogue, country case studies, and lessons learned, see http://ppd.cipe.org and World Bank (2016c).

82 See https://epd.punjab.gov.pk/system/files/Smog%20commission%20report.pdf

83 This council was established by the Punjab Environment Protection Act as an apex decision-making body on environmental issues, headed by the provincial Chief Minister and made up of representatives of various government departments, the private sector, nongovernmental organizations (NGOs), and so on.

84 See http://www.buildbd.org/index.php/main/work_area/5

85 These include the Punjab Environmental Protection Act (1997), as well as, to a lesser degree, the Factories Act (1934) and Canal and Drainage Act (1873) (CPI 2018). A Boilers and Pressure Vessels Ordinance (2002) is in force but focuses on safety rather than efficiency.

86 See https://epd.punjab.gov.pk/rules_regulations

temporary measure to mitigate the risk of smog.[87] Firms that make efforts for environmental management generally do so due to pressure from foreign buyers much more than from regulators. While most investors submit required IEE/EIAs to obtain EPA's non-objection, the quality of these reports and monitoring of their implementation is often lacking. There have also been debates on the adequacy of current PEQS, with some industry voices calling for less-stringent standards. Standards should be achievable but also ambitious enough to bring polluting industries in line with good international industry practices. Developing industry-specific standards, as GoPunjab currently plans to do, would be a positive step.

**The regulatory framework in Punjab does not foster preventive approaches that improve industrial resource efficiency and reduce pollution and waste.** Regulations focus on the 'end of pipe' and on pollutant concentrations, ignoring resource consumption, cleaner production, waste generation, and resource recovery, which are considered as voluntary actions by industries. However, some general regulations, such as those on IEE/EIA and Environmental Protection Orders (EPOs),[88] could be used to promote RECP solutions and introducing resource consumption benchmarks, while others, such as the boilers and pressure vessels ordinance, could be updated to include a focus on energy efficiency. Punjab could also learn from other countries which have sought to promote RECP, industrial symbiosis, and circularity through regulations on these topics, including the following:

- China has adopted regulations on inefficient and polluting technologies to be phased out and established mandatory cleaner production audits for some polluting or energy-intensive firms.
- In the United States, firms using significant quantities of toxic chemicals must file an annual source reduction and recycling report.
- Under the EU's 2007 Integrated Pollution Prevention and Control Directive, 52,000 covered industrial units are delivered permits considering contextual elements (e.g., geographical location, local environmental conditions) and with evolving standards based on Best Available Techniques (BATs) for pollution prevention.[89] To minimize waste and promote circularity, the EU also adopted a Waste Framework Directive in 2008,[90] and several countries have introduced EPR regulations.[91]
- In India, regulations have been adopted since 1999 to mandate the reuse of fly ash, which currently requires brick manufacturers located within 100 km of a thermal power plant to reuse its fly ash and cities with at least 1 million inhabitants to make the use of fly ash bricks mandatory in building construction (World Bank 2018c).

## MARKET-BASED INSTRUMENTS

**Market-based instruments (MBIs) can play an important role to incentivize the greening of Punjab's industries.** There is large theoretical and empirical evidence supporting the use of MBIs, including different types of environmental levies, taxes, and subsidies, as a complement to

87 Temporary closures during the smog season have targeted steel furnaces and rerolling mills without adequate pollution control technologies since 2016, as well as non-zigzag brick kilns in some parts of Punjab in 2018 (*"55 Furnaces, Re-rolling Mills Sealed for 'Causing Smog.' Dawn.* November 10, 2016; *"Punjab Braces for Smog Control." Dawn.* September 10, 2018). Such measures may provide temporary relief and respond to public and judiciary pressure to tackle smog. However, they do not provide a comprehensive or permanent solution to air pollution, which remains high throughout the year, and have been criticized by plant owners as arbitrary. They also have adverse economic and social impacts, leading in the case of bricks to soaring prices and lost income for workers.

88 When any party is found to be, or about to be, violating the PEQS, EPA, after giving the party an opportunity of being heard, may issue an EPO directing 'to take such measures as the Provincial Agency may consider necessary within such period as may be specified in the order', which may include installation, replacement, or alteration of equipment to eliminate or abate pollution.

89 See http://ec.europa.eu/environment/archives/air/stationary/ippc/index.htm

90 See http://ec.europa.eu/environment/waste/framework/

91 See http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

command-and-control regulations to reduce pollution.[92] Furthermore, such instruments are central in the 'Porter hypothesis', according to which well-designed environmental regulation can trigger innovation and competitiveness gains that can partly or even more than compensate the cost of pollution abatement (Ambec et al. 2013). Research also suggests that factoring in the inverse relationship between pollution and labor productivity/supply significantly increases the measurement of environmental taxes' positive impacts on firm profitability and welfare (Pang 2018; Williams 2002). Taxing the use of nonrenewable resources and reducing taxes on activities such as repair, reuse, and recycling have also been highlighted as keys to promote the circular economy (Webster 2017).

**In Pakistan, MBIs have so far not been used significantly to incentivize environmental compliance and RECP in industries.** At the national level, fossil fuels have traditionally been taxed, but the government recently reduced rates to keep consumer prices from increasing.[93] Moreover, some industrial sectors, such as textile, leather, and fertilizers, were recently granted subsidies to reduce the cost of natural gas.[94] On the other hand, recent discussions of a federal carbon tax have not yet led to a concrete project for such a tax.[95] Punjab does not have environmental taxes for industries either. A pollution charge system was adopted in 2001 to push firms to comply with the National Environmental Quality Standards (NEQS) (not to promote improvements beyond compliance), but it has not been implemented to date.[96] Punjab would benefit from the introduction of environmental taxes or fees designed not only to reduce end-of-pipe pollution, but also resource use (e.g., fossil fuels, water, toxic chemicals) and solid waste. Such taxes could be set at levels sufficient to create incentives for firms, with a credible timeline for escalation. Several developing countries, such as China, Vietnam, and Malaysia (Box 8), have long experiences with environmental tax reform, which Punjab could learn from.[97] On the waste side, landfilling taxes have been one driver of waste reduction and industrial symbiosis in Europe (Costa, Massard and Agarwal 2010). While industries have often resisted environmental taxes (especially on carbon), claiming that they undermine competitiveness, several ways can be found to address such concerns, while preserving taxes' environmental effectiveness (World Bank 2018e).

**Finally, fiscal incentives for energy and resource efficiency could be increased.** In Pakistan, import duties and taxes on solar and wind energy equipment have been removed, and a budget proposal was made in early 2019 to temporarily waive taxes on the domestic manufacturing of such equipment.[98] Such incentives could be considered for a broader range of RECP technologies. Lessons could be learned from the countries that have introduced tax incentives for industries investing in cleaner and more efficient technologies and equipment, such as the United States,[99] the United Kingdom,[100] and South Africa.[101]

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92 For more details, see the guidance note on MBIs in World Bank (2012).

93 *"Finance Minister Asad Umar Announces Rs 2 Decrease in Petrol, Diesel Prices." Dawn.* November 30, 2018.

94 *"Cabinet Approves Rs 25.7 bn Gas Subsidy for Exporters." Dawn.* December 7, 2018.

95 See https://unfccc.int/news/pakistan-explores-carbon-pricing

96 "Pollution Charge for Industry (Calculation and Collection) Rules, 2001"(available at: https://epd.punjab.gov.pk/rules_regulations).

97 On environmental tax reform and industries in developing countries, see also Cottrell et al. (2016) and UN Environment (2017a).

98 *"Taxes on Solar, Wind Power Equipment May Be Waived to Boost Production." Dawn.* January 30, 2019.

99 Several states have adopted such incentives for pollution control equipment (https://www2.deloitte.com/content/dam/Deloitte/us/Documents/Tax/us-tax-pollution-control-tax-credits-and-incentives-may-2017.pdf), energy efficiency (https://aceee.org/topics/industrial-energy-efficiency-programs) and recycling (https://www.bna.com/incentives-watch-states-b57982092980/).

100 The U.K. Government maintains a list of energy-efficient plants and machinery, investment in which is supported through tax credits for businesses (https://www.gov.uk/guidance/energy-technology-list).

101 The 12L Energy Efficiency Tax Credit provides an allowance for businesses to implement energy efficiency savings through waste heat recovery and co-generation (http://www.sanedi.org.za/12L.html).

## BOX 8. CHINA, VIETNAM, AND MALAYSIA'S EXPERIENCE WITH ENVIRONMENTAL TAXES IN INDUSTRIES

**China.** China has implemented since the early 1980s a comprehensive emission levy system. This system has been applied to hundreds of thousands of sources of air, water, solid waste, and noise pollution, with an increasing number of firms participating and growing revenues collected over the years. The resources collected are used to finance environmental institutional development and environmental projects, and to provide subsidies or loans to firm-level pollution control projects. Empirical studies have found that this system has had a significant positive impact on pollution discharge intensity, and that firms' response focused on process modification rather than on end-of-pipe abatement. The levy system was strengthened in 2003 to increase its impact on firm behavior by increasing the number of industrial pollutants covered, changing the levy base from the concentration of pollutant to total mass of pollutant, and increasing the levy price. Further strengthening of environmental taxes applying to industries was announced in 2016.[102]

**Vietnam.** The Environmental Protection Tax (EPT) has been in place since 2012, replacing a range of previous taxes on resource use and pollution, which lacked a coherent legal basis and had failed to modify behaviors due to low rates, too many exemptions, and poor monitoring and enforcement. The EPT introduced taxation on a wide range of tax bases (e.g., fossil fuels, chemicals, plastic bags) with a range of tax rates for each. While the lower end of each tax band was initially implemented, the government can raise those taxes in the future without modifying the law. Environmental tax receipts accounted for around 11 percent of the total budget in 2015/16.

**Malaysia.** In the 1970s, the Malaysian government faced the challenge to address growing water pollution from the country's large palm oil industry without undermining its competitiveness. It used a combination of instruments, including a pollution tax, increasingly stringent effluent standards, and innovation subsidies for mills. The tax was a 'licensing fee' made up of two components, a flat fee and a variable fee based on effluents, and varied depending on several mill characteristics. This system fostered improved environmental performance and innovation in the industry (e.g., use of treated effluent sludge as animal feed). Between 1976 and 1985, BOD load discharge decreased by over 99 percent, while the number of mills increased from 131 to 225, and the industry's output grew from 1.3 million tons to 4.1 million tons.

*Sources:* Wang and Wheeler (2005); Cottrell et al. 2016; Kathuria and Khan (2002).

### INFORMATION-BASED INSTRUMENTS AND INFORMATION DISCLOSURE

**Information-based instruments (IBIs) can help drive greener production and consumption choices.** Such instruments, including company rating and certification schemes and product standard and labeling (S&L) schemes, can help bridge information asymmetries and create pressure for industries to internalize environmental externalities by greening their technologies and practices, allowing markets to function more efficiently. The provision of information about the environmental footprint of firms and products can benefit consumers and reward virtuous producers, through improved

102 *"China to Levy New Taxes in Bid to Strengthen Pollution Fight." Reuters* December 25, 2016.

reputation and reduced liability, product differentiation, capacity to capture the willingness to pay for green or energy-efficient products, improved worker motivation, and so on. Such schemes can provide information on the production or use of a product and can be mandatory or voluntary. Several scheme characteristics, contextual elements, and implementation modalities influence the potential for IBIs to yield positive results.[103] Overall, there is significant evidence that well-designed IBIs can be effective, notably concerning energy efficiency S&L schemes (IEA 2015a). Governments worldwide have adopted a growing number of IBIs as complements to command-and-control or market-based instruments, as they are seen as a cost-effective and politically acceptable way to pursue environmental policy objectives.[104] Many private initiatives have also been developed by multinational companies and NGOs.

**IBIs have not been used extensively in Punjab.** A few voluntary international standards and certification schemes are used by some larger export-oriented textile and leather producers in Pakistan, such as Oeko-Tex's Standard 100 (which focuses on minimum use of toxic chemicals in textile), Higgs Index (which measures sustainability along the apparel supply chain), Better Cotton (which looks at the sustainability of cotton production) and the LWG (which certifies the environmental performance of leather manufacturers). Recently, PEECA has started developing energy efficiency S&L for appliances, starting with electric fans and with plans to cover other appliances. There is scope for a broader use of green and energy efficiency certification, standards, and labeling in Punjab. For instance, the absence of appropriate S&L has been identified as a factor enabling the spread of low-quality imported solar energy equipment at the expense of efficient equipment.[105] IBIs could cover consumer products and also industrial equipment, such as motors and transformers, and could consider the whole life cycle beyond the end-of-pipe impact of production.[106] GoPunjab could draw from other countries' experience in this regard. For instance, green company rating systems include India's Green Company rating system (GreenCo)[107] and the Zero Defect—Zero Effect (ZED) program for micro, small, and medium enterprises (MSMEs).[108] For products, good examples include Korea's Eco-Label program,[109] the United States' Energy Star program,[110] and Egypt's recent effort to develop the market for energy-efficient industrial motors through S&L (Box 9).

**Another information-based approach to foster the greening of industries is the public disclosure of environmental information.** Public access to environmental information is a principle recognized by several multilateral environmental agreements. In parallel with efforts to improve the collection and dissemination of data on ambient air and water quality, which is still lacking in Punjab, disclosing information about resource-intensive, polluting, and waste-generating firms' emissions and compliance could foster the greening of industries by generating public pressure and enabling firms to benchmark their performance. The global experience shows that it is possible to design environmental information disclosure (EID) programs that are effective and manageable for regulators and

103 For more details, see the guidance note on labeling and certification in World Bank (2012).

104 See, for instance, https://globalecolabelling.net for examples of different countries' eco-labelling schemes, and IEA (2014) for a presentation on different energy efficiency S&L schemes.

105 *"Taxes on Solar, Wind Power Equipment May Be Waived to Boost Production." Dawn.* January 30, 2019.

106 See World Bank (2016b) for a presentation of the global experience with S&L scheme for industrial equipment.

107 GreenCo has been implemented by the Confederation of Indian Industry since 2011. It designed to provide a holistic assessment of companies' environmental performance (energy efficiency, water conservation, renewable energy, GHG mitigation, waste management, material use, and so on) using a life cycle approach (product design, inputs, vendor management, manufacturing, packaging, distribution, product use, disposal, and recycling). In 2018, over 200 companies in various sectors have already been certified according to the system's three-tiered ranking, with several hundreds more pursuing certification. SMEs can also be certified with adapted criteria. The program also provides training, disseminates best practices, and so on (see http://www.greenco.in).

108 This program was launched by the Ministry of MSMEs and the Quality Council of India in 2016. It aims at reducing waste and pollution and strengthening completeness in the MSME sector through training, certification, and a five-level rating scale (see https://www.zed.org.in).

109 See http://el.keiti.re.kr/enservice/enindex.do and KEI (2016).

110 See https://www.energystar.gov

businesses.[111] Such programs can include a Pollutant Release and Transfer Register (PRTR),[112] which has been used notably in the United States and the EU and is being developed in Turkey.[113] They also include Environmental Performance Rating and Disclosure (EPRD) initiatives, with notable examples from Indonesia, China and India (Box 10).

## BOX 9. ENERGY EFFICIENCY STANDARDS FOR INDUSTRIAL MOTORS IN EGYPT

**The use of inefficient motors has been a drag on the competitiveness of Egypt industries and has inflated energy consumption.** Motors make up over half of industry's electricity consumption, but most of the motors used in the country are over 10 years old and highly inefficient. Analysis suggests that effective implementation of high-efficiency motor standards could help save industry nearly US$560 million and could help avoid power generation of 1,000 MW by 2030.

**S&L have been used to develop the domestic market for energy-efficient motors.** In a context of growing industrial energy demand, as well as pressure on energy prices due to the decision to phase out electricity subsidies, the Egyptian government has worked to protect industries' competitiveness and facilitate efficiency gains. A project supported by the World Bank Group was launched in 2015, which has included the promotion of energy-efficient industrial motors through an S&L scheme and support for domestic manufacturing of compliant motors. The program involved data collection and analysis to build a business case, knowledge exchange with technical institutes from Korea and Denmark, capacity building on market surveillance and enforcement, extensive public-private dialogue, and so on. Outcomes so far have included the adoption of a standard in line with those used globally, which is planned to become mandatory, and investment in a motor testing laboratory.

## BOX 10. ENVIRONMENTAL PERFORMANCE RATING AND DISCLOSURE INITIATIVES IN ASIA

- **Indonesia.** The Program for Pollution Control, Evaluation, and Rating (PROPER) was introduced in 1995 and was at the time the first major public disclosure program in the developing world. The program targeted major industrial water polluters and used a five-color scale to grade facilities' compliance with or violation of existing regulations. Empirical assessments of PROPER's effectiveness have shown that, with relatively low implementation costs, the scheme pushed firms to reduce their wastewater pollution

*continued* ▶

111 For more details, see the guidance note on environmental information disclosure in World Bank (2012) and Kathuria (2009) on public disclosure initiatives in developing countries.

112 See http://www.oecd.org/chemicalsafety/pollutant-release-transfer-register

113 See https://eprtr.csb.gov.tr

discharge, especially those with poor environmental compliance records which reduced them by about a third on average. However, no impact was found for firms that were already in compliance. Additionally, some firm characteristics, such as being foreign-owned and being located in densely populated regions, were correlated with a stronger response.

- **China.** Green Watch was introduced in 2000 with pilot programs covering 150 factories in two Chinese municipalities. In 2005, 20 municipalities adopted similar programs covering 8,500 factories. Research shows that the Green Watch program has significantly reduced pollution emissions in China, especially among moderately noncompliant firms.
- **India.** The Star Rating program has been implemented since mid-2017 by the Maharashtra Pollution Control Board with support from domestic and international research institutions. It rates several hundreds of large industrial plants in eight polluting sectors based on their PM emission. The ratings are publicly available online with an interactive map and report card for each rated firm. The program also makes available data from approximately 20,000 industrial stack samples over multiple years and organizes awareness events in polluted cities to ensure wider citizen engagement.

*Sources:* García, Sterner, and Afsah (2007); Jin, Wang and Wheeler (2010); http://mpcb.info

## VOLUNTARY APPROACHES

**Voluntary agreements (VAs) negotiated between governments and industries may not be sufficient to promote compliance and RECP, but could play a useful role initially.** Pollution reduction VAs, which provide incentives but do not mandate pollution control, have been used in a growing number of OECD and developing countries since the 1990s. The effectiveness and efficiency of such agreements have been debated, notably regarding their capacity to provide additional improvement in environmental performance beyond a 'business-as-usual' scenario.[114] While, in high-income countries, VAs have mostly been used to foster improved environmental performances beyond regulatory requirements, developing country regulators lacking enforcement capacity have tended to use them to reduce broad noncompliance (Blackman et al. 2010). The evidence from developing countries suggests that VAs may not be sufficient to trigger improved environmental performance in industries in the absence of regulatory pressure. However, they could help establish cooperative relationships between regulators and industries, and to build capacity for broader environmental policy reform (Box 11). This could yield lessons for GoPunjab's efforts to engage with different industrial sectors to promote environmental compliance and RECP. The EPD could learn from this experience and aim to negotiate time-bound and performance-based VAs on these issues with adequate incentives and sanctions, starting with a pilot sector.

**The government can also promote the voluntary adoption by firms of EMS/EnMS to improve resource efficiency and prevent pollution/waste.** Since the 1990s, EMS's have been an increasingly popular tool globally for businesses to manage their environmental footprint while improving

114 For lessons learned based on experience in OECD countries, see notably: http://www.oecd.org/env/tools-evaluation/voluntaryapproachesforenvironmentalpolicy.htm

## BOX 11. LATIN AMERICA'S EXPERIENCE WITH VOLUNTARY AGREEMENTS

- **Mexico.** The Clean Industry Program, introduced in 1992, has sought to promote pollution reduction by creating incentives, such as public recognition and fewer inspections, for firms that correct deficiencies identified by a third-party environmental audit. This process has generated interest from large firms seeking the recognition and has also helped inspections to target hot spots rather than large firms, given that the latter ensure compliance through the program. However, empirical evidence suggests that the program, while it attracted polluting plants already under pressure from regulators, did not have a large, lasting impact on their environmental performance after they graduated from the program.

- **Colombia.** Several dozens of national, sectoral, and regional VAs involving thousands of firms in different polluting sectors have been signed since the 1990s in Colombia. Most them were deemed unsuccessful to significantly improve environmental performances and prevent pollution, although a significant proportion of commitments were met under a few VAs. The evidence suggests that any improvement in environmental performances under the VAs were largely driven by pressure from local communities, foreign markets, and regulation. However, several agreements proved useful to manage the transition toward a more complete regulatory regime by (a) reducing regulatory uncertainty and risks related to widespread noncompliance for firms, (b) facilitating exchanges of information and establishing a cooperative relationship between regulators and industries, and (c) building capacity on both sides.

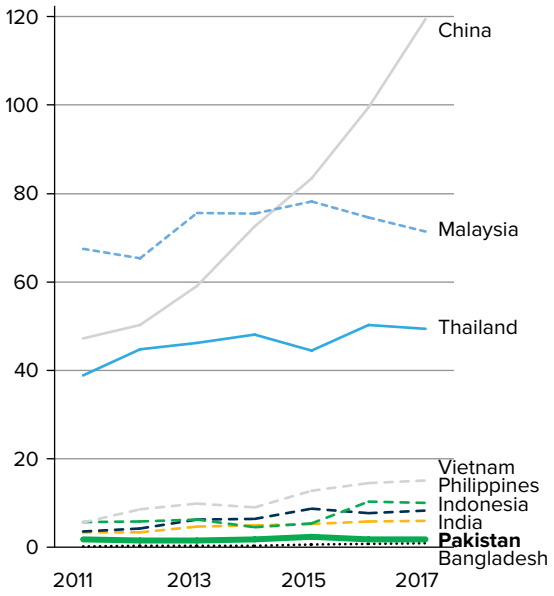
- **Chile.** The Chilean government started negotiating several high-profile VAs, mostly with industry associations made up of SMEs, as one of the main tools to implement its 1998 Cleaner Production Policy. This was facilitated by the government's objective to develop public-private cooperation for cleaner production in parallel with environmental regulatory reforms, and by industries' willingness to accelerate environmental progress to respond to market pressure. These VAs have generally featured several characteristics increasing the likelihood they would achieve some results, including adoption as complement to effective mandatory regulations, inclusion of specific environmental performance targets, clear deadlines, third-party monitoring, sanctions for noncompliance, and pollution abatement subsidies. Moreover, VAs covered both RECP as 'no-regret' options increasing competitiveness and the possibility of compliance normalization through the agreement. The evidence suggests that VAs positively influenced signatory firms' environmental efforts, although improvements were generally incremental rather than radical.

*Sources:* Blackman et al. (2010, 2012); Jiménez (2007).

operating efficiency.[115] While the literature has found mixed evidence that ISO-certified EMS's can drive improvements in environmental performance, there is evidence that they can be effective at least in certain contexts, especially when the regulatory framework offers sufficient incentives and flexibility for firms to become greener (Arimura et al. 2016). One study in Mexico found that the incidence of regulatory fines spurred ISO 14001 certification, which was also higher for exporting and larger firms (Blackman and Guerrero 2012). Other studies for Brazil (de Oliveira et al. 2010) and China (McGuire 2014) suggest that EMSs have helped firms improve compliance, increase resource efficiency, and prevent pollution. EnMSs have emerged more recently and have a similar management system for firms to use energy more efficiently.[116] The empirical evidence on the effectiveness of EnMSs is sparse, especially for developing countries, although research on German manufacturing firms suggests a positive impact (Schulze, Heidenreich, and Spieth 2017).

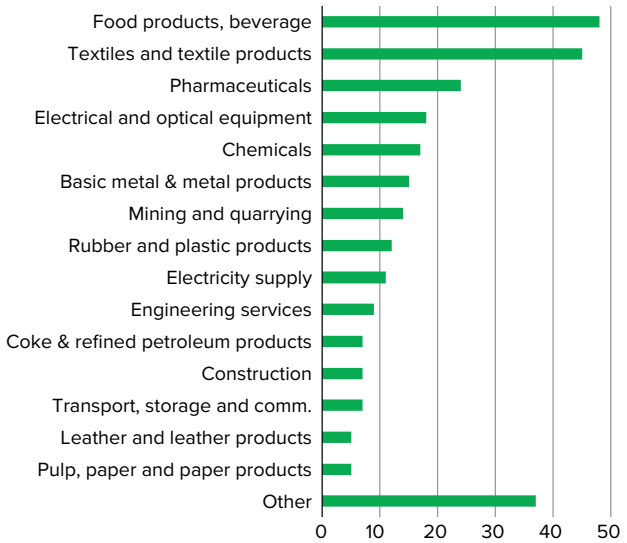
**ISO 14001 certification remains rare in Pakistan, and GoPunjab could promote its dissemination.** While it has slowly increased since the 2000s, the number of firms with certified EMS's only reached 350 in 2017 in Pakistan. This is far below most other large Asian countries in relative terms (Figure 10). A breakdown by sector shows that ISO certification among Pakistani firms are concentrated in some regulated and/or export-oriented sectors (e.g., food products and beverages, textiles, pharmaceuticals), but that certification is very rare or absent in most polluting sectors (Figure 11). For instance, India

**FIGURE 10.** Number of ISO 14001-Certified Firms per Million Inhabitants




*Source:* Author's calculations, based on ISO 2018 and WDI data.

**FIGURE 11.** ISO 14001-Certified Firms by Sector in Pakistan (2017)




*Source:* ISO 2018.

115 An EMS can be defined as a system of organizational objectives, policies, and processes adopted by an organization, with the aim to achieve domestic environmental compliance and also to continuously improve environmental performance and operating efficiency, including for nonregulated issues. The main elements of a sound EMS are defined internationally through the ISO 1400 series of voluntary standards and guidelines, including the ISO 14001 standard (see https://www.iso.org/iso-14001-environmental-management.html).

116 ISO 50001 is the international standard defining the requirements for certified EnMS (see https://www.iso.org/iso-50001-energy-management.html).

and Bangladesh have 31 and 3 certified cement producers, respectively, while Pakistan has none. The ISO 5001 standard is still virtually absent in Pakistan, with 5 certified firms in 2017, while it has spread rapidly in China (1,507 firms) and India (608 firms) over the last few years. GoPunjab could promote and facilitate the development of EMSs and their certification among polluting industries, following the example of countries such as China, which has actively promoted ISO 14001 since the late 1990s (McGuire 2014), and of India, which partially reimburses the cost of acquiring ISO 14001 certification for SMEs.[117]

## 4.3. Green Industrial Policy

**In parallel with reforms to strengthen its environmental policy, GoPunjab could gradually develop a more active green industrial policy.** As previously noted, various obstacles can prevent industries from adopting greener technologies and practices, particularly SMEs. An array of policies and programs could be considered to provide technical and financial support to firms, develop EIPs, facilitate industrial symbiosis, and promote circularity.

### TECHNICAL SUPPORT

**Lack of information and technical capacity has been shown to be a major obstacle to the adoption of RECP among SMEs worldwide.** This justifies public interventions to draw firms' attention to current inefficiencies and the magnitude of potential savings through RECP investments, facilitate the regular monitoring of resource use and efficiency in industries, disseminate information about best-available technologies (e.g., through industry associations, study tours abroad), subsidize firm-level RECP audits,[118] and foster the emergence of specialized service providers. Even if they are convinced that profitable RECP investment opportunities exist, firms may lack the technical capacity to efficiently install and utilize new cleaner technology, as found in the case of brick kilns in Punjab. Support can for instance be provided through training and programs to pilot and demonstrate new technologies, or by helping individual firms prepare feasibility studies and bankable investment projects. For instance, many developing countries on all continents have established NCPCs to provide such services. Some have also actively developed the domestic supply of RECP technology and service providers (e.g., ESCOs) or to facilitate access to international expertise. Others have sought to increase the supply of trained professionals.[119]

**There is a need to develop sources of technical support on RECP in Punjab.** In the past, such support has been provided on an ad hoc basis through various donor-funded projects. As mentioned, the EPD currently has little capacity to promote the piloting and dissemination of environmental and RECP technologies, although it has plans to strengthen it by establishing a dedicated center. Punjab's three CPCs have provided valuable services to promote RECP for the last two decades. They are nonetheless limited in terms of their sectoral coverage and capacity to undertake broad programs to

117 See https://msme.gov.in/technology-upgradation-and-quality-certification

118 For instance, Japan subsidizes energy audits for firms with an annual energy use exceeding 1,500 kiloliters in crude oil equivalent and publishes aggregate data (showing that potential energy savings average 8 percent across sectors) to help convince other firms (IEA 2015b). Likewise, the French Agency for the Environment and Energy Efficiency (ADEME) launched in 2018 a program to foster the adoption of RECP technologies and practices among MSMEs. Under the program, each company works with an expert (trained by the agency) over a 12-month period to identify sources of efficiency gains, agree on a set of actions, and implement and evaluate them. Companies are only charged for the services if a minimum level of savings is identified and agreed upon.

119 For instance, an Energy Efficiency and Demand-side Management Hub was established at the University of Pretoria in 2008 to train specialized master's degree and doctoral students. See https://www.up.ac.za/national-hub-for-postgraduate-programme-in-energy-efficiency-and-demand-side-management-eedsm-hub

support a large number of firms across entire sectors (Sánchez-Triana et al. 2014a). The CPI in Lahore is active but remains a private institution, whose size varies significantly based on the availability of clients and donor-funded projects. The scale of support provided to industries could be expanded through reforms to the financial and governance model of CPCs, possibly the establishment of a provincial CPC by GoPunjab, and increased cooperation with the global network of NCPCs and with sectoral associations, as well as with increased focus on capacity building for local service providers. The scope of technical support could cover firm-level RECP and also industrial symbiosis and circular business models.

## FINANCING

**Access to finance is a common obstacle for SMEs and, given the limits to public subsidies, scaling up the adoption of RECP in polluting industries requires leveraging commercial finance.** While SME financing is generally difficult in itself, financing for investment in RECP is often even more challenging due to banks' lack of familiarity with the concept and the less tangible returns coming from lower production or compliance costs, compared for instance to traditional loans to expend production. Many countries have promoted the commercial financing of RECP through various modalities of grants, credit lines, and guarantees. The experience has shown that green financing projects for SMEs are often undermined by an insufficient pipeline of investment projects, lack of capacity on the part of both potential borrowers and lenders, lack of collateral, and high transaction costs. Interesting examples of initiatives that have sought to address some of these obstacles include the following:

- **Bangladesh.** Bangladesh Bank launched in 2016 a US$200 million Green Transformation Fund to provide low-rate long-term financing for the purchase of more efficient and cleaner machinery and equipment in the export-oriented textile and leather sectors through participating financial institutions.
- **Brazil.** The US$25 million Energy Efficiency Guarantee Mechanism has been implemented since 2009 with support from the Inter-American Development Bank to assist companies in securing commercial bank financing for investments in energy efficiency, by covering performance risk of energy efficiency projects and credit risk of the borrowers.[120]
- **Vietnam.** The World Bank supports the Energy Efficiency for Industrial Enterprises project, which includes a US$100 million line of credit to support investment by industrial firms in energy-saving technologies and a component to build banks' capacity to finance such projects.[121]
- **Vietnam.** The Green Credit Trust Fund was implemented over 2007–17 to facilitate SMEs' access to credit for investment in RECP and to raise awareness about green credit among local banks. The National CPC assessed SMEs' projects from the technical and environmental point of view, while partner banks provided credit on commercial terms based on their financial assessment. The fund provided both (a) a partial credit guarantee (50 percent) for firms with insufficient collateral and (b) a partial grant (up to 25 percent) to subsidize the invested capital, awarded ex post based on verified improvement of the firm's environmental performance and going directly to the lending bank as reimbursement of the credit.[122]

120 See https://www.iadb.org/en/project/BR-L1111

121 See http://projects.worldbank.org/P151086?lang=en

122 See https://vncpc.org/en/project/green-credit-trust-fund-gctf/

**Punjab currently lacks adequate financing sources for the greening of its industries.** Financial sector constraints have traditionally resulted in very low bank lending to SMEs, notably due to high collateral requirements and information asymmetries (Karandaaz 2017). The financing on the basis of balance sheet is notably an issue for sectors which could require project finance, such as ESCOs. Green finance is relatively new to the province, although the Green Banking guidelines adopted by the State Bank of Pakistan (SBP) in 2017 represent an opportunity to develop it.[123] At the federal level, the Ministry of Commerce and Textile and SBP announced in 2016 a Technology Upgradation Fund to subsidize investment in imported machinery by textile manufacturers, including to improve energy efficiency, but this scheme does not seem to have been used in practice.[124] SME financing schemes by GoPunjab, which have focused on interest rate subsidization, have had modest results, suggesting that a new approach is needed. Recently, a subsidized financing package has reportedly been worked out by the SBP, GoPunjab, and commercial banks to upgrade brick kilns.[125] The different stakeholders (e.g., Finance Department, EPD, ICID, SBP, banks, industry representatives) need to work jointly and identify workable financing options for RECP and circular businesses. These could include limited matching grants for the initial piloting and demonstration of technologies, guarantees, or insurance to cover potential losses or lower-than-expected savings after the installation of new equipment,[126] credit lines, and credit risk guarantees, coupled with capacity building for both borrowing firms and banks.

## EIP AND INDUSTRIAL SYMBIOSIS

**Punjab would benefit from proactive efforts to foster green industrial estate development and industrial symbiosis.** The experience of different countries, including China, Korea, and the United Kingdom, shows the potential value of active policies and programs promoting EIPs and IS (Box 4, Box 5). No such initiatives have been undertaken in Punjab so far, despite preliminary analytical work (CPI 2013a, 2013b). As previously argued, a sustainability strategy could be developed under GoPunjab's new Strategic Framework for IE development and a pilot EIP and/or IS program could be developed in an IE, identifying priority institutional/regulatory reforms and investments. The EIP framework and handbook recently published provide useful guidelines and examples to develop a national EIP program, implement the EIP model at the estate-level, and establish IS networks.[127]

## GREEN PUBLIC PROCUREMENT

**Leveraging public procurement is another way that governments have sought to promote the market for green goods and services.** Most OECD countries and a growing number of developing ones have adopted policies and regulations to increase green public procurement (GPP), notably for construction material and buildings, food, vehicles, and energy-using products.[128] The objectives of GPP generally include developing a stable demand for cleaner industrial products, driving green innovation and circularity, and also generating savings for the full life cycle cost of procurement contracts (e.g., LED light bulbs). Countries starting GPP frameworks often face challenges, including a higher

123 See http://www.sbp.org.pk/smefd/circulars/2017/C8-Annex.pdf

124 See http://www.sbp.org.pk/smefd/circulars/2018/C2.htm

125 "Punjab Authorities Are Responding to Help Manage the Smog, but Is It Enough?" *Dawn.* November 1, 2018.

126 For instance, the All-Pakistan Textile Mills Association has in the past offered performance guarantees to members undertaking energy efficiency investments, to reimburse them in case anticipated load reduction and savings did not materialize. According to the association, this guarantee was not called as participating firms managed to obtain the expected results.

127 World Bank, UNIDO and GIZ (2017); World Bank, UNIDO, GIZ and MOTIE (2018).

128 For international experience and best practices, see notably OECD (2017) and UN Environment (2017b).

cost of green products on a purchase basis, lack of staff capacity, and lack of green products in the market. Based on the experience of Japan, Korea, China, and Thailand, success factors include strong government commitment, use of eco-labeling programs as a basis for GPP, adoption of clear rules and guidelines for procurement staff in parallel with capacity building, the adoption of rigorous monitoring and evaluation systems, and active communication and promotion efforts (UN Environment 2017b). For instance, Korea offers an example of a country having adopted an ambitious and successful GPP framework.[129] As another example, California recently adopted a law to set maximum acceptable global warming potential for eligible materials, such as steel and glass.[130]

129 Under a dedicated 2005 law, all central/local governments and public organizations must submit annual GPP plans for eco-labeled products and report on the previous year's performance. Several initiatives were introduced to facilitate implementation, including the development of GPP guidelines, the establishment of a 'Green Products Information Platform' for purchasers, and a nationwide online monitoring system. Total public green expenditure has boomed from KRW 254.9 billion in 2004 to KRW 1,727 billion in 2012, and the system has been instrumental in stimulating the development of eco-labeled products in both quantity and quality.

130 See http://buycleancalifornia.org

# 5 Conclusion and Recommendations

**There is substantial scope to generate economic, social, and environmental gains in Pakistan and in Punjab by promoting a more sustainable industrial development pathway.** The challenges posed by industries' resource use, pollution, and waste currently jeopardize Punjab's development and are expected to worsen under a business-as-usual scenario. As shown in this report, there are significant unexploited opportunities to reduce industries' footprint while improving their competitiveness through firm-level investments in RECP, the development of EIP and industrial symbiosis, and the promotion of resource circularity. However, the various capacity constraints and market failures that have prevented this evolution from occurring imply that government support will be required.

**GoPunjab should put sustainable industrialization at the center of its growth and development strategy, and should modernize its policy toolkit for this purpose.** Punjab's Growth Strategy 2018 envisioned that growth must be private sector–led, investment-driven, export-oriented, environmentally sound, and employment-intensive. Developing an ambitious and integrated policy to green industries would be a strategic way to jointly achieve these objectives, and in so doing, Punjab could become a lighthouse for the rest of Pakistan. This would require both strengthening environmental policy (stick) and developing elements of a green industrial policy looking at investment, innovation, and trade (carrot). Importantly, policy objectives should go beyond the current focus on pollution control and compliance, to include preventive and circular approaches at the firm and industry levels that could yield environmental and productivity/competitiveness gains. As argued in this report, most polluting industries have been exposed to RECP, which has been piloted in Punjab through donor-funded projects for two decades, but have not widely embraced it in the absence of sufficient incentives and support from GoPunjab. The time has come to integrate the concept in strategies and regulations, and to institutionalize and mainstream it across relevant government agencies.

**To break the status quo, GoPunjab should identify priority actions that could pave the way for the greening of the industrial sector.** The 'Pakistan @ 100' report made the case that continued environmental degradation was partly caused by shortcomings in the post-devolution institutional and policy framework, as well as by political economy obstacles (World Bank 2018a). As shown in this report, many different policy instruments have been used by countries over the world to green industries. While some may be difficult to implement in the short term for legal, technical, financial, or political economy reasons, others could be introduced to break the status quo and build constituencies for change, including by establishing a more cooperative framework with industries (also including multinational companies sourcing products in Pakistan) and by engaging citizens in industrial pollution

issues. GoPunjab, which recently adopted a broad five-year Green Development Program to promote green growth in the province, could prioritize actions on the industry side based on needs, capacity and impact:

- **Strategy.** GoPunjab would benefit from developing and implementing an integrated medium-term strategy on sustainable industrial development involving all key departments. This strategy should include targets for decoupling growth from resource use, pollution, and waste, as well as an action plan with timeline, institutional responsibility, and budget. Preparing a solid strategy with a sound analytical basis, strong government and industry ownership and sufficient resource allocated would take some time. However, the following could be undertaken in the short term, focusing on a small number of priority resource-intensive and polluting sectors:
    - Conduct **analytical work** assessing the scope for greening these sectors, including through RECP, industrial symbiosis, and circularity. This would look at economic, environmental and social impacts, both positive and negative, and would benchmark Punjab's industries with good international industry practices. This should also include stepped up efforts to **fill data gaps** on selected industries' resource use, pollutant emissions, and waste, for instance by developing standard operating procedures for firm audits, training auditors (e.g., young graduates) and requiring industrial firms to undergo such audit periodically at subsidized rates. Finally, studies identified in 2016 by the J&C ESSA, including the inventory of industrial waste streams, should be carried out as planned by the ICID and EPD.
    - Establish a platform for **public-private dialogue (PPD)** on industrial sustainability and competitiveness. This could be a committee under the Punjab Environmental Protection Council, with representatives of key departments, industries, academia, and environmental NGOs, and working groups for priority sectors. A PPD framework would facilitate the identification of reforms, policies, and targets; build ownership and a collaborative mindset among stakeholders; and enable feedback loops to adjust policies.
- **Environmental regulations.** Stronger regulatory pressure is necessary to push industries to better control pollution and invest in RECP. This requires an updated regulatory framework, including industry-specific emission standards and regulations for industrial resource consumption benchmarks, waste, and resource circularity. Priority actions for key sectors could include the following:
    - **Promote RECP through existing regulatory instruments,** such as IEE/EIA and EPOs, and **adopting implementation regulations** for the 2016 National Energy Efficiency and Conservation Act.
    - Organize **consultations on environmental standards** with industry representatives to discuss needed reforms, considering domestic circumstances and international good practices.[131]
    - Agree with industrial sector associations and their member industries on a **road map for PEQS compliance,** which could include time-bound intermediary pollution reduction targets, commitments by firms to invest in pollution control equipment and RECP, proposed modalities of government support, role of the association as guarantor for individual members, and so on.
    - Consider the opportunity to develop a **law and/or regulations on RECP, industrial symbiosis and circularity.**

131 This could replicate the Shamslakha committee of experts established in the 1990s to reform the NEQS after extensive consultations (Sánchez-Triana et al. 2014a).

- **Other environmental policy instruments.** GoPunjab should explore opportunities to complement environmental regulations with market- and information-based instruments, especially those likely to foster preventive solutions for the greening of industries. It could notably aim to introduce environmental taxes and fiscal incentives to incentivize RECP and resource circularity, beyond compliance with the PEQS. It could also develop eco-labeling and certification schemes for firms and products. Finally, it should work toward the disclosing of information about resource-intensive, polluting, and waste-generating firms' compliance to generate public pressure and enable firms to benchmark their performance. Short-term actions could include the following:
    - Update and implement the existing **pollution charge system for industries,** focusing initially on large polluting units and IEs, and **consider new environmental taxes** on industries, which could be made revenue-neutral to increase their acceptability.
    - Continue efforts initiated on the **standards and labeling** of appliances and promote **voluntary international standards** (e.g., LWG) and certification schemes (e.g., ISO 14001).
    - Improve the **transparency and accessibility of existing information** on industries' environmental performance and compliance (e.g., IEE/EIA, inspections) for citizens, the media, and NGOs and develop a **pilot environmental performance rating and disclosure scheme,** starting with large polluting firms.
- **Institutional capacity.** GoPunjab's capacity to regulate and engage with industries on sustainability issues, including preventive environmental approaches, should be gradually strengthened. In addition to strengthening the EPD/EPA's capacity, which is an absolute priority (e.g., strategy, policy and regulatory, monitoring, inspection), this could also include the establishment of a Cleaner Production Center/Environmental Technology Center. In the shorter term, institutional reforms and training efforts could focus on the following:
    - Strengthen environmental monitoring (both ambient and point-source) and enforcement capacity, including through **increased medium-term budget allocation for the EPD/EPA,** additional hiring and training and investments in facilities and equipment.[132]
    - Establish at the EPD the proposed **Environmental Technology Center** with adequate staffing and equipment to identify and pilot promising environmental and RECP technologies for priority sectors, and the **Environmental Policy Center** with notably a mandate to carry out policy analysis on RECP, industrial symbiosis, and circular economy.
    - Establish **sustainability departments at the ICID, PIEDMC, and FIEDMC,** and ensure all IEs have governance bodies and/or dedicated cells in charge of environmental issue, RECP, and circularity.
    - **Develop the capacity of PEECA** to promote industrial energy efficiency, working with its national-level counterpart NEECA.
- **Support to firms.** In parallel with efforts to strengthen and modernize the environmental policy framework, GoPunjab should start developing programs to support the adoption by polluting SMEs of greener technologies and practices, focusing on priority sectors. These programs should be owned by the implementing departments and avoid merely relying on donor support. They could include information dissemination and the direct provision of technical and financial assistance, and should involve industry associations, academic experts, and financial institutions.

132 Such recommendations have been made by several reports since at least the early 2000s with little effect (Sánchez-Triana et al. 2014a), although the increased political pressure to address pollution in recent years made it more likely that action will be taken on this agenda.

To ensure sustainability and increase scale, a related objective should be to develop the private market for RECP technologies and services, including by facilitating access to foreign expertise while the domestic supply is built.

- Run large **communication and training campaigns** directed at SMEs in priority sectors to raise awareness about RECP (especially no- or low-cost options) and circular economy and to share success stories. Publish industry-specific **guidelines and benchmarks** on resource efficiency, pollution, and waste.
- Work with industry associations to **identify, pilot, and demonstrate promising RECP technologies** in a few priority sectors.
- Establish a **dedicated financing facility for RECP** for SMEs addressing credit and risk constraints, and leveraging commercial finance to the extent possible.

- **Industry-level programs.** While many firm-level initiatives have been implemented in Punjab, there has so far been virtually no program to foster broader solutions, for instance on EIPs or industrial symbiosis. GoPunjab could aim to replicate and adapt the successful experiences of other countries, starting for instance by the following actions:
  - Develop a **pilot EIP program** for a major zone, such as Sundar IE, covering institutional/regulatory reforms and investments for both end-of-pipe infrastructure (e.g., CETP, sanitary landfill) and preventive/RECP approaches.
  - Commission studies to **research the potential for industrial symbiosis and circular economy** in Punjab and develop a **virtual information exchange platform on industrial waste.**

# References


Adhvaryu, Achyuta, Namrata Kala, and Anant Nyshadham. 2017. "The Light and the Heat: Productivity Co-benefits of Energy-saving Technology." NBER Working Paper No. 24314. Available at: https://www.nber.org/papers/w24314

Alam, Ahmad Rafay. 2018. *Review of Regulatory and Institutional Framework for Resource Efficient Cleaner Production in Pakistan with a Focus on Punjab.* Unpublished background report prepared for the World Bank.

Ambec, Stefan, Mark Cohen, Stewart Elgie, and Paul Lanoie. 2013. "The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?" *Review of Environmental Economics and Policy* 7 (1): 2–22.

Arimura, Toshi, Nicole Darnall, Rama Ganguli, and Hajime Katayama. 2016. "The Effect of ISO 14001 on Environmental Performance: Resolving Equivocal Findings." *Journal of Environmental Management* 166: 556–566.

Azizullah, Azizullah, Muhammad Nasir Khan Khattak, Peter Richter, and Donat-Peter Häder. 2011. Water Pollution in Pakistan and Its Impact on Public Health—A Review. *Environment International,* 37(2): 479–497.

Blackman, Allen, and Santiago Guerrero. 2012. "What Drives Voluntary Eco-certification in Mexico?" *Journal of Comparative Economics* 40 (2): 256–268.

Blackman, Allen, Bidisha Lahiri, William Pizer, Marisol Rivera Planter, and Carlos Muñoz Piña. 2010. "Voluntary Environmental Regulation in Developing Countries: Mexico's Clean Industry Program." *Journal of Environmental Economics and Management* 60 (3): 182–192.

Blackman, Allen, Eduardo Uribe, Bart van Hoof, and Thomas Lyon. 2012. "Voluntary Environmental Agreements in Developing Countries: The Colombian Experience." Working Paper 12-06. Washington, DC: Resources for the Future.

CCAC. 2015. "CCAC Initiative—Mitigating Black Carbon and Other Pollutants from Brick Production." Available at: https://breathelife2030.org/wp-content/uploads/2016/09/Fact-Sheet-5-Bricks-FINAL-Digital-May2015.pdf

CEPS. 2018. "The Role of Business in the Circular Economy Markets, Processes and Enabling Policies." Brussels: Centre for European Policy Studies.

Chakraborty, Pavel. 2017. "Environmental Standards, Trade and Innovation: Evidence from a Natural Experiment." *Environment and Development Economics* 22 (4): 414–446.

Chertow, Marian and Jooyoung Park. 2016. "Scholarship and Practice in Industrial Symbiosis: 1989–2014." In Clift and Druckman (eds.), *Taking Stock of Industrial Ecology*. SpringerOpen.

COER. 2017. "The Circular Economy and Developing Countries: A Data Analysis of the Impact of a Circular Economy on Resource-Dependent Developing Nations." COE-Resources Issue Brief 3.

Costa, Ines, Guillaume Massard, and Abhishek Agarwal. 2010. "Waste Management Policies for Industrial Symbiosis Development: Case Studies in European Countries." *Journal of Cleaner Production* 18 (8): 815–822.

Cottrell, Jacqueline, Kai Schlegelmilch, Matthias Runkel, and Alexander Mahler. 2016. "Environmental Tax Reform in Developing, Emerging, and Transition Economies." Berlin: Deutsches Institut für Entwicklungspolitik.

CPI. 2013a. *Generic Sustainability Framework for Industrial Estates of Pakistan.* Report prepared under the Programme for Industrial Sustainable Development—Phase II. Lahore: Cleaner Production Institute.

———. 2013b. *Development of Sustainability Framework for Sundar Industrial Estate*. Report prepared under the Programme for Industrial Sustainable Development—Phase II.

———. 2018. Baseline *Assessment for Resource Efficient Cleaner Production (RECP) in Punjab, Pakistan*. Report prepared for the World Bank.

De Oliveira, Otávio José, José Roberto Serra, and Manoel Henrique Salgado. 2010. "Does ISO 14001 Work in Brazil?" *Journal of Cleaner Production* 18 (18): 1797–1806.

Dutz, Mark, and Siddharth Sharma. 2012. "Green Growth, Technology and Innovation." Policy Research Working Paper 5932. Washington, DC: The World Bank Group.

Ellen MacArthur Foundation. 2016. *Circular Economy in India: Rethinking Growth for Long-term Prosperity.* Available at: http://www.ellenmacarthurfoundation.org/publications

EPD. 2016. *Punjab Environmental Quality Standards (Notification No. SO(G)/EPD/7-26/2013, August 5, 2016).* Lahore: Environment Protection Department. Available at: https://epd.punjab.gov.pk/system/files/Punjab%20Environmental%20Quality%20Standards%20for%20Muncipal%20And%20Liquid%20Industrial%20Effluents%20final.pdf

European Commission. 2018. "Cooperation Fostering Industrial Symbiosis: Market Potential, Good Practice and Policy Actions." Brussels: European Commission.

Frost and Sullivan. 2017. *Transforming Industrial Policy Recommendations into a Strategic Framework for Industrial Zones Development in Punjab.* Final report prepared for the Government of Punjab.

García, Jorge, Thomas Sterner, and Shakeb Afsah. 2007. "Public Disclosure of Industrial Pollution: The PROPER Approach for Indonesia?" *Environment and Development Economics* 12 (6): 739–756.

Geissdoerfer, Martin, Paulo Savaget, Nancy Bocken and Erik Jan Hultink. 2017. "The Circular Economy—A New Sustainability Paradigm?" *Journal of Cleaner Production* 143: 757–768.

Government of Punjab. 2015a. *Punjab Growth Strategy 2018: Accelerating Economic Growth and Improving Social Outcomes.* Available at: http://www.pndpunjab.gov.pk/system/files/Punjab_Growth_Strategy_2018_0.pdf

———. 2015b. *Punjab Industries Sector Plan 2018: Promoting Industrial Development and Investment.* Available at: http://www.pndpunjab.gov.pk/system/files/Punjab_Industries_Sector_Plan_2018_0.pdf

———. 2015c. *Draft Punjab Environment Policy.* Lahore: Environmental Protection Agency. Available at: https://epd.punjab.gov.pk/system/files/Draft%20Punjab%20Environment%20Policy%202015.pdf

———. 2017. *Policy on Controlling Smog 2017.* Lahore: Environmental Protection. Available at: https://epd.punjab.gov.pk/system/files/Policy%20on%20Controlling%20Smog%20%28Final%29.pdf

Gower, Richard, and Patrick Schröder. 2016. "Virtuous Circle: How the Circular Economy Can Create Jobs and Save Lives in Low and Middle-income Countries." IDS/Tearfund.

ICID. 2013. "Punjab Residential Areas Industries Scenario Threats, Challenges and Proposed Response." Directorate General Industries, Prices, Weights & Measures. Lahore: Department of Industries, Commerce and Investment.

IEA. 2014. "Energy Standards and Labelling Programs Throughout the World in 2013." Paris: International Energy Agency.

———. 2015a. "Achievements of Appliance Energy Efficiency Standards and Labelling Programs: A Global Assessment." Paris: International Energy Agency.

———. 2015b. "Accelerating Energy Efficiency in Small and Medium-sized Enterprises: Powering SMEs to Catalyse Economic Growth." Paris: International Energy Agency.

———. 2017. "Renewable Energy for Industry: From Green Energy to Green Materials and Fuels." Paris: International Energy Agency.

IFC. 2016. "Sustaining Growth: Cleaner Production in Pakistan." International Finance Corporation (IFC), Cleaner Production Institute (CPI) and National Productivity Organization (NPO).

IIP. 2014. "Promoting Resource Efficiency along the Supply Chain of Key Sectors in South Asia." Institute for Industrial Productivity. Available at: http://www.iipnetwork.org/CaseStudy_Compendium.pdf2

IIP and IFC. 2014. "Waste Heat Recovery for the Cement Sector: Market and Supplier Analysis." Available at: http://www.iipnetwork.org/62730%20WRH_Report.pdf2

ISO. 2018. "ISO Survey 2017." Geneva: International Organization for Standardization. Available at: https://www.iso.org/the-iso-survey.html

Jiao, Wenting, and Frank Boons. 2014. "Toward a Research Agenda for Policy Intervention and Facilitation to Enhance Industrial Symbiosis based on a Comprehensive Literature Review." *Journal of Cleaner Production* 67: 14–25.

Jiménez, Orlando. 2007. "Voluntary Agreements in Environmental Policy: An Empirical Evaluation for the Chilean Case." *Journal of Cleaner Production* 15 (7): 620–637.

Jin, Yanhong, Hua Wang, and David Wheeler. 2010. "Environmental Performance Rating and Disclosure: An Empirical Investigation of China's Green Watch Program." Policy Research Working Paper No. 5420. Washington, DC: The World Bank Group.

Karandaaz. 2017. "Nature and Characteristics of SME Financing and NPLs in Pakistan." Islamabad: Karandaaz Pakistan.

Kathuria, Vinish. 2009. "Public Disclosures: Using Information to Reduce Pollution in Developing Countries." *Environment, Development and Sustainability* 11 (5): 955–970.

Kathuria, Vinish, and Nisar Khan. 2002. "Environmental Compliance versus Growth: Lessons from Malaysia's Regulations on Palm Oil Mills." *Economic and Political Weekly* 37 (39): 3993–3999.

KEI. 2016. "Eco-Label Certification System (ECS) in Korea." *Korea Environmental Policy Bulletin* 41. Korea Environment Institute. Available at: http://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Korea%20Environmental%20Policy%20Bulletin%20-%20Eco-label%20Certification%20System%20%28ECS%29%20in%20Korea.pdf

KEITI. 2018. "Development of Environmental Policy in Korea." Korea Environmental Industry and Technology Institute.

Khwaja, Mahmood A., Nazma Shaheen, and Farzana Yasmeen. 2012. "Mapping of Chemically Polluted Sites in Pakistan." Islamabad: Sustainable Development Policy Institute.

Landrigan, Philip et al. 2017. *The Lancet Commission on Pollution and Health*. Published online October 19, 2017. Available at: http://www.thelancet.com/commissions/pollution-and-health

Laybourn, Peter, and Maggie Morrissey. 2009. "National Industrial Symbiosis Programme: The Pathway to a Low Carbon Sustainable Economy." Birmingham: International Synergies Ltd.

Lopez-Acevedo, Gladys, Denis Medvedev, and Vincent Palmade (eds). 2017. "South Asia's Turn: Policies to Boost Competitiveness and Create the Next Export Powerhouse." Washington, DC: The World Bank Group.

Luken, Ralph, René Van Berkel, Heinz Leuenberger, and Petra Schwager. 2016. "A Twenty-Year Retrospective of the National Cleaner Production Centers Programme." *Journal of Cleaner Production* 112(1): 1165–1174.

Marques Matos, Lucas, and coauthors. 2018. "Implementation of Cleaner Production: A Ten-year Retrospective on Benefits and Difficulties Found." *Journal of Cleaner Production* 187: 409–420.

McGuire, William. 2014. "The Effect of ISO 14001 on Environmental Regulatory Compliance in China." *Ecological Economics* 105: 254–264.

McKinsey. 2018. "Decarbonization of Industrial Sectors: The Next Frontier."

Mir, Kaleem Anwar, Pallav Purohit, and Shahbhaz Mehmood. 2017. "Sectoral Assessment of Greenhouse Gas Emissions in Pakistan." *Environmental Science and Pollution Research* 24 (35): 27345–27355.

Mondal, Ananya, Subhasish Das, Rajesh Kumar Sah, Pradip Bhattacharyya, Satya Sundar Bhattacharya. 2017. "Environmental Footprints of Brick Kiln Bottom Ashes: Geostatistical Approach for Assessment of Metal Toxicity." *Science of the Total Environment* 609: 215–224.

Noman, Muhammad, Syeda Adila Batool, and Muhammad Nawaz Chaudhary. 2013. "Economic and Employment Potential in Textile Waste Management of Faisalabad." *Waste Management and Research* 31 (5): 485–493.

OECD. 2008. Measuring Material Flows and Resource Productivity—The OECD Guide. Volume 1. Paris: Organisation for Economic Co-operation and Development.

———. 2010. "Eco-Innovation in Industry: Enabling Green Growth." Paris: Organisation for Economic Co-operation and Development.

———. 2017. "Going Green: Best Practices for Sustainable Procurement." Paris: Organisation for Economic Co-operation and Development.

———. 2018. "Environmental Policy Toolkit for SME Greening in EU Eastern Partnership Countries." Paris: Organisation for Economic Co-operation and Development.

Ortolano, Leonard, Ernesto Sànchez-Triana, Javaid Afzal, Chaudhary Laiq Ali, and Susan A. Rebellón. 2014. "Cleaner Production in Pakistan's Leather and Textile Sectors." *Journal of Cleaner Production* 68: 121–129.

Pang, Yu. 2018. "Profitable Pollution Abatement? A Worker Productivity Perspective." *Resource and Energy Economics* 52: 33–49.

PERI. 2017. *Punjab Economic Report 2017*. Punjab Economic Research Institute, Planning & Development Department, Government of Punjab.

Preston, Felix, and Johanna Lehne. 2017. "A Wider Circle? The Circular Economy in Developing Countries." London: Chatham House.

Qi, Jianguo, Jingxing Zhao, Wenjun Li , Xushu Peng, Bin Wu, Hong Wang, Fengling jia, Tong Yang, and Haiying Qi. 2016. "Development of Circular Economy in China." Springer.

Sànchez-Triana, Ernesto, Dan Biller, Ijaz Nabi, Leonard Ortolano, Ghazal Dezfuli, Javaid Afzal, and Santiago Enriquez. 2014a. "Revitalizing Industrial Growth in Pakistan: Trade, Infrastructure, and Environmental Performance." Washington, DC: The World Bank Group.

Sànchez-Triana, Ernesto, Santiago Enriquez, Javaid Afzal, Akiko Nakgawa, and Asif Shuja Khan. 2014b. "Cleaning Pakistan's Air: Policy Options to Address the Cost of Outdoor Air Pollution." Washington, DC: The World Bank Group.

Schulze, Mike, Sven Heidenreich, and Patrick Spieth. 2017. "The Impact of Energy Management Control Systems on Energy Efficiency in the German Manufacturing Industry." *Journal of Industrial Ecology* 22 (4): 813–826.

Shariff, Faiza, and Sanval Nasim. 2018. "To Adopt or Not to Adopt That is the Question: An Environmental and Economic Case for Zigzag Kilns." Available at: https://cdpr.org.pk/wp-content/uploads/2018/08/Energy-efficient-and-environment-friendly-brick-kilns.pdf

Shenoy, Megha. 2016. "Industrial Ecology in Developing Countries." In Clift and Druckman (eds.), *Taking Stock of Industrial Ecology*. SpringerOpen.

Tearfund. 2017. "How Will Europe's Ecodesign Measures Affect the Circular Economy in Low-Income Countries." Available at: https://www.green-alliance.org.uk/resources/Europe_Ecodesign_Affect_Circular_Economy_Low_Income_Countries.pdf

UN Environment. 2016. "Global Material Flows and Resource Productivity: An Assessment Study of the UNEP International Resource Panel." Paris: United Nations Environment Programme.

———. 2017a. "Green Industrial Policy. Concept, Policies, Country Experiences." Geneva, Bonn: UN Environment; German Development Institute / Deutsches Institut für Entwicklungspolitk (DIE).

———. 2017b. "Comparative Analysis of Green Public Procurement and Ecolabelling Programmes in China, Japan, Thailand and the Republic of Korea: Lessons Learned and Common Success Factors." Paris: United Nations Environment Programme.

———. 2018. "International Resource Panel Global Material Flows Database." Available at: http://www.resourcepanel.org/global-material-flows-database

UNIDO. 2016. "Global Assessment of Eco-Industrial Parks in Developing and Emerging Countries." Vienna: United Nations Industrial Development Organization.

———. 2017. "Leather Industry Park: Planning, Implementation, Benefits, Challenges and Experience." Vienna: United Nations Industrial Development Organization.

UNIDO and Government of Pakistan. 2014. "Resource Efficient Greening of Industry Initiative for Pakistan." Available at: http://www.greenindustryplatform.org/wp-content/uploads/2015/03/Final-REGI-Initiative-for-Pakistan-28.-01.-14a.pdf

UNIDO and UN Environment. 2010. *PRE-SME—Promoting Resource Efficiency in Small & Medium Sized Enterprises Industrial Training Handbook*. Paris: United Nations Environment Programme.

Wang, Hua, and David Wheeler. 2005. "Financial Incentives and Endogenous Enforcement in China's Pollution Levy System." *Journal of Environmental Economics and Management* 49 (1): 174–196.

Webster, Ken. 2017. *The Circular Economy: A Wealth of Flows*. Ellen MacArthur Foundation Publishing.

WEF. 2016. “Design and Management for Circularity—the Case of Paper.” Geneva: World Economic Forum.

WEF and Ellen MacArthur Foundation. 2017. “The New Plastics Economy Catalysing Action.” Geneva: World Economic Forum.

WEF, Ellen MacArthur Foundation, and McKinsey. 2014. “Towards the Circular Economy: Accelerating the Scale-up across Global Supply Chains.” Geneva: World Economic Forum.

West, Jim, Heinz Schandl, and Karin Hosking. 2016. *Green Asia Country Report: Pakistan*. Canberra: Commonwealth Scientific and Industrial Research Organisation. Available at: https://publications.csiro.au/rpr/download?pid=csiro:EP177267&dsid=DS2

Williams, Roberton III. 2002. “Environmental Tax Interactions When Pollution Affects Health or Productivity.” *Journal of Environmental Economics and Management* 44 (2): 261–270.

World Bank. 1998. *Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production*. Washington, DC: The World Bank Group.

———. 2010. *Establishing Integrated Solid Waste Management in the Large Cities of Pakistan (Multan)—Comprehensive Scope Evaluation Report*. Washington, DC: The World Bank Group.

———. 2011. “Introducing Energy-efficient Clean Technologies in the Brick Sector of Bangladesh.” Washington, DC: The World Bank Group.

———. 2012. *Getting to Green: A Sourcebook of Pollution Management Policy Tools for Growth and Competitiveness*. Washington, DC: The World Bank Group.

———. 2016a. *Punjab Jobs and Competitiveness Program for Results—Environmental and Social Systems Assessment (ESSA)*. Washington, DC: The World Bank Group.

———. 2016b. “A Greener Path to Competitiveness; Policies for Climate Action in Industries and Products.” Washington, DC: The World Bank Group.

———. 2016c. “State of Play—Public-Private Dialogue.” Washington, DC: The World Bank Group.

———. 2017. “Pakistan Development Update: Managing Risks for Sustained Growth.” Washington, DC: The World Bank Group.

———. 2018a. “Pakistan@100—Shaping the Future: Environmental Sustainability.” Washington, DC: The World Bank Group.

———. 2018b. “Doing Business 2018: Reforming to Create Jobs—Pakistan.” Washington, DC: The World Bank Group.

———. 2018c. “Dirty Stacks, High Stakes: An Updated Review of the Brick Sector in South Asia.” Washington, DC: The World Bank Group.

———. 2018d. “Enhancing China’s Regulatory Framework for Eco-Industrial Parks: Comparative Analysis of Chinese and International Green Standards.” Washington, DC: The World Bank Group.

———. 2018e. “Fiscal Policies for Development and Climate Action.” Washington, DC: The World Bank Group.

World Bank, UNIDO, and GIZ. 2017. “An International Framework for Eco-Industrial Parks.” Washington, DC: The World Bank Group.

World Bank, UNIDO, GIZ, and MOTIE. 2018. “A Practitioner’s Handbook For Eco-Industrial Parks: Implementing the International EIP Framework.” Washington, DC: The World Bank Group.

WRG. 2015. “An Analysis of Industrial Water Use in Bangladesh with a Focus on the Textile and Leather Industries.” Water Resources Group. Available at: https://www.2030wrg.org/wp-content/uploads/2016/02/WRG-Bangladesh-Report.pdf

WRI. 2015. *Aqueduct Projected Water Stress Country Rankings*. Washington, DC: World Resources Institute.

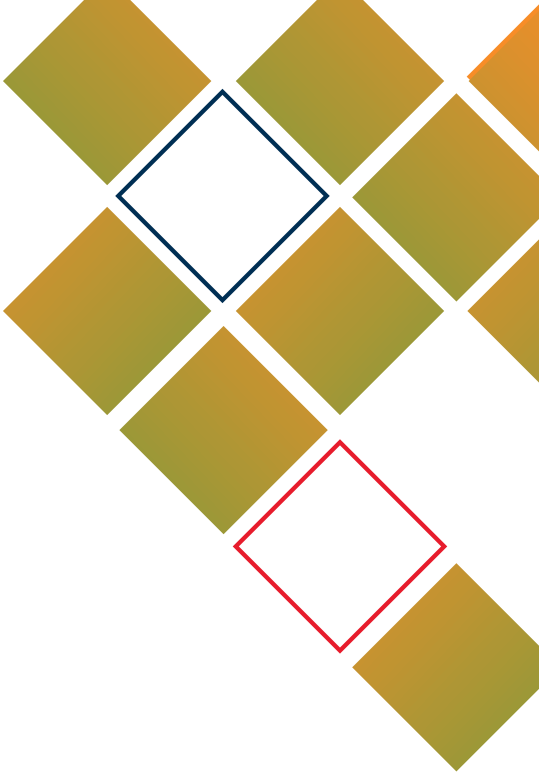
WWF. 2015. “Water Footprint of Key Industrial Sectors in Punjab, Pakistan.” World Wildlife Fund for Nature (WWF), Cleaner Production Institute (CPI) and EU SwitchAsia.

———. 2018. “Economic Impacts and Health Implications of Non-Compliance of the Leather and Textile Industry.” Available at: http://www.wwfpak.org/wwf-projects/images/iles/EconomicImpactReport.pdf

WWF and IKEA. 2014. *WWF and IKEA Project Report 2014—Cotton.* Available at: https://bettercotton.org/wp-content/uploads/2014/07/wwf_ikea_sustainable_cotton_initiative_201404_final_web_1.pdf

Zafar, Hajra. 2012. "Industrial Policy in Punjab: A Case Study of Sundar Industrial Estate." Lahore: Forman Christian College. Available at: http://cppg.fccollege.edu.pk/wp-content/uploads/2014/04/Industrial-Policy-in-Punjab-A-Case-Study-of-Sundar-Industrial-Estate.pdf

Zhu, Junming, Chengming Fan, Haijia Shi, and Lei Shi. 2018. "Efforts for a Circular Economy in China: A Comprehensive Review of Policies." *Journal of Industrial Ecology*.



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