Greenhouse Gas Mitigation Options for Pakistan: Industry Sector

Key Facts

Since its independence in 1947, Pakistan has transformed itself from a largely agrarian economy to a semi-industrialised one. Industry is now an important contributor, representing roughly 25 per cent of gross domestic product (GDP). At the same time, energy use and emissions released during certain industrial processes contributed approximately 18 per cent of GHG emissions in 2012, or 60 $MtCO_2e$. The sector predominantly comprises of large to middle-scale manufacturing, mining and quarrying and construction.

Much industry in Pakistan can be broadly characterised by relatively outdated production processes and equipment, which often leads to high intensities of labour, energy and other inputs. The low observed levels of investment in modernisation can be attributed to a number of factors: unstable policy environment, lack of access to appropriate financing, lack of awareness, comparatively low levels of foreign direct investment and a deficit in critical supporting infrastructure (such as power and energy provision).

Taking action in industry has benefits far beyond GHG reductions. Many industrial energy efficiency options reduce costs and allow for higher levels of production. They can also contribute significantly to improving working conditions and environmental outcomes. The challenge will be to incentivise or push industry to take action on energy efficiency by appropriate policy-making and regulation.

GHG Baseline

Industry emissions are projected to rise by 230 per cent between 2012 and 2030 driven by a growing sector. This represents a growth from approximately 59 $MtCO_2e$ in 2012 to approximately 196 $MtCO_2e$ in 2030.

TABLE 1 PROJECTED GHG EMISSIONS IN INDUSTRY (MT CO_2E)

Major Emission Source Category		2012	2015	2020	2025	2030
Industrial Energy Demand	Cement	10.6	13.3	20.1	29.1	39.3
	Textiles	5.2	6.2	8.2	10.9	14.5
	Other Industries	9.2	11.1	15.9	23.9	34.9
	Brick	4.9	5.9	8.4	12.7	18.5
	Pulp and Paper	2.5	3.0	4.3	6.5	9.5
	Fertilizer	1.9	2.1	2.5	3.0	3.4
	Iron and Steel	1.6	1.9	2.7	4.1	6.0
	Sugar	0.7	0.8	0.9	1.0	1.1
Industrial Processes	Mineral Products	15.7	19.6	29.5	42.8	58.0
	Chemical Industry	6.5	7.2	8.6	10.1	11.4
	Metal Production	2.0	2.4	3.4	5.0	7.3
	ODS Substitutes	2.7	3.3	4.6	6.4	8.2

Mitigation Options

Options were identified from a review of existing policies and strategies, independent studies and key industrial improvements that have demonstrated their success in similar contexts. The methodology for calculating emissions reductions, as well as more detail on assumptions and figures, can be found in the corresponding technical report for the agriculture sector.

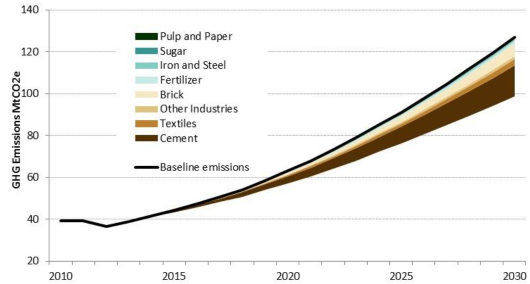
Options were prioritised based on their commercial and technical viability in Pakistan. The final set of priority options for the analysis were:

Industry sector	Abatement option
Cement	- Shifting the production from single-stage dry kilns to high efficiency multi-stage dry kilns - Standardization of fuel for cement industry
Brick	- Converting the existing bull trench kilns (BTK) to modified bull trench kilns (MBTK) with improved combustion - Converting BTKs and clamp kilns to zig-zag kilns (ZZK) - Best available technology (BAT) standard for ZZK - Standardise fuel for brick kilns
Textile	- Combination of various energy efficiency measures - Energy and water audits
Iron and steel	- Introduce BAT for blast-furnace-process for iron production - Conversion of electric arc furnaces to induction furnaces - Efficiency improvements for steel re-rolling process
Fertilizer	- Improved steam reforming and Haber Bosch process
Paper and pulp	- Thermal efficiency improvements
Sugar	- Limited energy saving potential, however, bagasse could be used for increased power production with export - Replace boilers with more efficient and high performance boilers - Ultimately considered in the analysis on 'energy supply'
Other industries	- Thermal efficiency improvements

TABLE 2: EMISSION MITIGATION MEASURES AND IMPACTS

Emissions Mitigation Measure	GHG Emission Reductions in 2030 ($MtCO_2e$)	GHG Emission Reductions from Sector BAU in 2030 (%)
Cement	14.7	7.5%
Brick	3.0	1.5%
Textile	1.4	0.7%
Iron and steel	6.2	3.2%
Fertilizer	1.4	0.7%
Paper and pulp	1.0	0.5%
Other industries	0.7	0.4%
TOTAL INDUSTRY SECTOR	**28.4**	**14%**

Figure 1: potential GHG emissions reductions from BAU levels in Industry sub-sectors



Cement

Cement production is highly energy-intensive and the cement industry is the largest single industrial sector in Pakistan with regards to fuel use, with a significant dependence on coal. Coal accounts for more than 90 per cent of energy consumption in the sector, while oil and gas cover the remaining energy requirements, as well as electricity for grinding raw materials and the finished cement. Emissions in cement production arise from fuel combustion (to heat limestone, clay and sand to roughly 1,450°C) and from the calcination reaction. Fuel emissions can be reduced through improvements in energy efficiency and fuel switching, while process emissions (the calcination reaction) are largely unavoidable and can be mitigated by reducing demand, inter alia through improved material efficiency.

Scenario Definition

In the cement sector, two measures have been considered to improve energy efficiency: 1) introducing BAT standard to all cement plants with dry kilns, and 2) shifting the production from the energy-inefficient single-stage dry kilns to multi-stage dry kilns. Both measures together allow a reduction of coal consumption and associated emissions by 44% in 2030 compared to the baseline. It is assumed that both measures are conducted gradually starting in 2015 and being completed in 2030.

Benefits and Impacts

Fuel cost savings and associated higher competitiveness/profitability create an incentive to equip new cement kilns with more modern energy efficient technology. It can also contribute to the reduction of dust, other harmful emissions and water usage.

Brick manufacture

The clay-brick manufacturing sector in Pakistan is a relatively unregulated and undocumented industry sector. In a typical production process, green bricks made of raw soil need to be heated between 8,500 C to 10,000 C in a kiln, the temperature at which the vitrification of soil takes place. This is responsible for a large part of the energy use and thus emissions. More efficient kiln technologies can therefore reduce emissions. The vast majority of kilns in Pakistan are so-called bull-trench kilns, which have long been phased out in modern production processes.

Scenario Definition

For the brick industry, the first mitigation measure involves converting Pakistan's bull-trench and clamp kilns to modified bull-trench and zig-zig kilns. These share a lot of similarities with regards to kiln layout, and as such converting only requires limited modification. This makes zig-zig kilns well suited for the Pakistani brick industry. As a subsequent energy efficiency improvement, it is assumed that these zig-zig kilns are converted to best available technology levels, which includes adding a fan to increase draught and improving insulation in the firing section of the kiln. These measures can lead to 35 per cent energy savings in 2030.

Benefits and Impacts

Switching to cleaner technology not only reduces fuel costs, but also local air pollution and associated respiratory diseases. Minimising the use of agriculture topsoil for brick making can further improve environmental sustainability. Importantly, modernising production could help improve working conditions in the industry.

Textiles

The textile industry is a vital industrial sub-sector in Pakistan, both for its contributions to employment and trade balance. It contributes approximately 10% of GDP and more than 50 per cent of total exports. It further provides employment to approximately 30% of the work force of the country. In terms of electricity, the textile sector consumes around 38 per cent of electricity in chemical processing, 34 per cent in spinning, 23 per cent in weaving and 5 per cent for miscellaneous purposes. Non-electrical energy demand is largely covered by gas and oil products, and to a limited extent coal; where oil products are generally used as back-up fuel storage to replace gas during shortages. There are considered to be substantial opportunities for equipment and process modernisation that would benefit both emissions and the sector performance more broadly.

Scenario Definition

For the textile industry, it is assumed that the energy efficiency improvements up to 22 per cent of the total baseline natural gas consumption will be gradually deployed by 2030. This maximum relative reduction is derived from previous studies and is achieved through a combination of various single measures; such as such as steam traps and improved boiler maintenance, enhanced process integration and process control.

Benefits and Impacts

The subsector is associated with pollution caused by the discharge of untreated effluents and chemical use, as well as workplace safety. Upgrading inefficient machinery offers the chance to improve resource and waste management, to reduce water consumption and modernise working conditions.

Iron and Steel

The iron and steel industry in Pakistan accounts for 6 per cent (2012) of total fossil fuel demand in the industry sector. This demand is mainly met through natural gas (92 per cent), combined with minor usage of oil products (8 per cent). Looking at the production processes for iron and steel, a distinction between public and private producers can be made. The state-owned Pakistan Steel Mills uses an older blast furnace technology, while newer mills plan to use a direct reduced iron (DRI) process or electric arc furnace technology that reduce energy demand.

Scenario Definition

For the iron and steel industry, we distinguish two energy efficiency improvement measures: 1) For the private sector, which represents one third of total natural gas demand of the iron and steel industry, we estimate energy efficiency improvements associated to the re-rolling process resulting in 10 per cent less fuel consumption by 2030 2) Enhancing the iron and steel making process of public plants to a BAT efficiency standard by 2020 can lead to a reduction of natural gas use by 15 per cent.

Benefits and Impacts

Modernisation of blast furnace technology can reduce environmental impact and local health hazards from air and water pollution while increasing energy efficiency and competitiveness of the sector, which is sorely needed.

Fertiliser

The fertiliser industry in Pakistan consumed 3.7 Mtoe in 2012 and utilises primarily natural gas both as fuel and as feedstock input for ammonia production. Approximately 4.2 million tonnes of urea were produced in 2012, which is a decline of about 15 per cent compared to 2010 production quantity at a rather stable demand 5.5-5.8 Mt of urea. Production of fertilisers in Pakistan covers domestic consumption by approximately 75 per cent, and imports are required to satisfy demand. Due to the strong reliance of Pakistan's agricultural sector on substantial amounts of fertiliser, the sector has comparably stable access to Pakistan's gas supply.

Scenario Definition

For the fertiliser industry, we consider improvements in the production of ammonia from natural gas based on previous assessments by the International Energy Agency of good practice. This includes gradually moving to a high efficiency steam reforming and Haber-Bosch synthesis process over the period to 2030. This can lead to a 25 per cent reduction of gas demand in 2030 compared to the baseline fuel consumption.

Benefits and Impacts

In the fertiliser industry, increased efficiency can lead to higher productivity and higher quality products, generating cost-savings. Similar to other sectors, local environmental pollution can be greatly reduced if harmful waste products are recycled and disposed of correctly. Workers' safety and health in handling fertiliser materials must be taken into consideration when upgrading equipment.

Pulp and paper

The paper and pulp industry accounts for 7 per cent (2012) of industrial final energy consumption in Pakistan. Approximately 94 per cent total fuel use in the paper and pulp industry can be attributed to natural gas, and the remaining 6 per cent to oil-based fuels, which are generally used as back-up. The energy intensive steps of the paper production process can be structured into pulping, bleaching and rolling phases. In the pulping step, wood chips are thermo-mechanically converted into pulp. This step has by far the largest energy intensity of the entire paper production chain.

Scenario Definition

As noted, the pulping step has by far the largest energy intensity, and reducing fuel consumption for this process step is regarded to be particularly effective to reduce GHG emissions. For a combination of various thermal energy efficiency improvements (such as better insulation of pipes and other equipment, increased fuel conversion efficiency in boilers, heat recovery of blow and flash steam, and cogeneration of power and heat) previous studies estimate natural gas demand reductions of 7 per cent at most in Pakistan. This figure is adopted and applied to the baseline projections estimated in this study.

Benefits and Impacts

Alongside improved energy costs, modernisation can offer a chance to treat and reduce wastewater and solid wastes as well as chemical use for production.

Other industry

The category 'other industries' is an aggregate of several industry branches, mainly non-energy intensive industries, not covered by the energy sectors described before. This aggregate includes the chemical (excluding fertiliser), food and beverage, and leather industries, as well as other general small- and medium-sized industries. Approximately 30 per cent (2012) of all industrial energy use can be allocated to other industries, as a power source for automation, process heating, and captive generation. It can be assumed, that the efficiency of energy conversion is very low, particularly in second-hand boilers, which are largely imported, and that emissions reduction potential from boiler improvements exists.

Scenario Definition

For other industries, we estimate an emissions reduction potential for the aggregate 'other industries' as a whole and refer to the energy efficiency improvements estimated previously by the Asian Development Bank. Correspondingly, we assume a maximum 4 per cent reduction of baseline energy consumption due to general thermal energy efficiency improvements. It should be noted that a detailed dedicated bottom-up approach for several industry applications aggregated under 'other industries' might provide a different level of GHG mitigation potentials. This requires, however, detailed sub-sectoral data in order to assess concrete fuel saving potential and hence mitigation options.

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