Greenhouse Gas Mitigation Options for Pakistan: Residential, Commercial and Agriculture Energy Demand

This factsheet provides a summary of the mitigation option analysis in the residential, commercial and agriculture sector, for more details on methodology and source, please refer to the corresponding technical report.

Key Facts

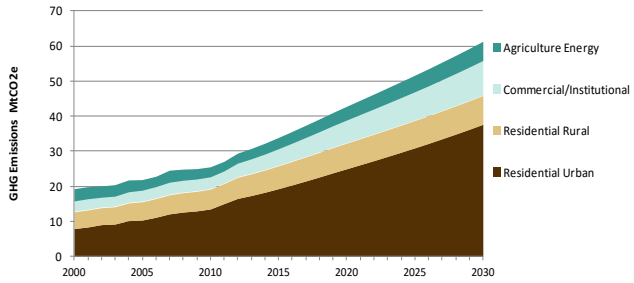
Altogether residential, commercial and agricultural (RCA) energy consumption account for just under 30 per cent of Pakistan's energy demand. Domestic energy consumption is rising consistently compared to industrial energy use, indicating a rise in economic welfare and an increase of electrical appliances. Natural gas still dominates the fuel mix, complemented by biomass and electricity. The RCA sector contributed roughly 9 per cent of national greenhouse gas (GHG) emissions in 2012, with around 70 per cent of the population having access to electricity.

The main challenge is to satisfy increasing energy demand in a sustainable manner in the face of unstable grid infrastructure and energy security risks. Considering that suppressed demand will likely absorb any efficiency gains in the coming decade, energy demand reductions quoted here are rather seen as energy gap reductions.

GHG Baseline

Historical GHG emissions from the sector by source and end use, as well as projected fuel consumption, to the year 2030 are indicated in Figure 1. **Emissions are projected to more than double between 2012 and 2030 and are forecast to grow from approximately 29 $MtCO_2e$ in 2012 to 61 $MtCO_2e$ in 2030.**

FIGURE 1: HISTORICAL AND PROJECTED GHG EMISSIONS IN RCA SECTOR ($MTCO_2E$)



Mitigation Options

Options were identified from a review of existing policies and strategies, independent studies and key RCA sector 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 RCA sector.

Based on extensive review, 12 options were identified to improve energy use in the RCA sector:

- Efficient lighting
- Efficient stoves
- Efficient water heaters
- Efficient space heaters
- Efficient refrigerators
- Efficient air conditioners
- Efficient fans
- Efficient water pumps
- Efficient irrigation
- Improved roof insulation
- Solar thermal water heating
- Increased use of biomass and biogas

The first nine mitigation options were prioritised based on their abatement potential, feasibility, development benefits and cost-effectiveness. All are

examined in detail below in Table 1, with a summary of GHG benefits and cost.

TABLE 1: EMISSION MITIGATION MEASURES AND IMPACTS

Emission Mitigation Measure	Abatement Potential in 2030	GHG Emission savings in 2030 (in MtCO2e)	Invest-ment costs (USD million)	Payback time (years)
Efficient lighting	22% (CFLs) 4% (FTLs)	2.19	763	0.9 (res) 0.2 (com)
Efficient stoves	43%	12.86	275	0.5 (res) 0.2 (com)
Efficient water heaters	30%	2.47	124	1.3 (res) 0.5 (com)
Efficient space heaters	36%	1.10	205	4.8 (res) 1.9 (com)
Efficient refrigerators	23%	0.89	703	1.5 (res) 0.8 (com)
Efficient air conditioners	6%	0.86	361	0.9 (res) 0.5 (com)
Efficient fans	32%	4.59	991	1.2 (res) 0.8 (com)
Efficient water pumps	47%	0.63	1335	10.9 (res)
Efficient irrigation	24% (electric), 31% (diesel)	2.98	828	0.4 (electric) 0.8 (diesel

Efficient Lighting

There are about 46 million incandescent bulbs (IBs), 56 million Compact Fluorescent Lamps (CFLs), and 29 million Fluorescent Tube Lights (FTLs), in Pakistani households and commercial locations. In terms of percentage of electricity consumption, lighting is about 28 per cent in the residential, and 15 per cent in the commercial sector. Lighting has a strong potential for savings that would use widely available technology already introduced to Pakistan.

Scenario Definition

This option consists of replacing incandescent bulbs with CFLs, and replacing magnetic ballasts in FTLs by electronic ones. A typical CFL consumes about a quarter of the energy of an incandescent bulb, for the same light output. As for FTLs, a typical setup with a magnetic ballast would be a 40W lamp with an 11W ballast, which could be replaced by a 40W lamp with a 1W ballast. Investment costs are low and payback times are short

Benefits and Impacts

In general terms, the reduction of energy demand through increased efficiency reduces consumer costs in households and enterprises and increases disposal income. The reduced per-unit cost of energy use increases affordability of energy services for poorer households and can expand energy access. More efficient lighting can reduce energy bills and exposure to fluctuation, relieving stress and increasing disposable income that can be invested in family livelihood. More efficient lighting contributes to an improved living and working atmosphere and replacing bulbs can reduce the use of toxic substances such as mercury (replaced bulbs need to be disposed correctly).

Non-Electric Appliances: Stoves, Water Heaters, and Space Heaters

Efficient stoves, water heaters and space heaters are all devices used to produce heat that use similar types of fuels. While rural households mostly rely on wood and agricultural residues (95 per cent of the energy use), urban households rely mainly on natural gas (69 per cent for cooking, 82 per cent for water, 94 per cent for space heating and some LPG 1.4 per cent for cooking). The commercial sector, meanwhile, uses fossil fuels exclusively (78 per cent natural gas, 22% LPG). These natural gas devices are generally locally manufactured and are inherently inefficient and hazardous. The push towards cheap and inefficient devices is caused by low natural gas prices for households (set by the government), setting few incentives to buy more expensive and efficient devices.

Scenario Definition

This option entails replacing all cooking stoves by more efficient ones with high savings at low cost, making this one of the most cost-effective options. Retrofitting all water heaters and space heaters with more efficient ones involves relatively low costs and payback times.

Benefits and Impacts

The use of more efficient stoves significantly reduces emissions of harmful short-lived climate pollutants (SLCPs) such as black carbon and reduces the risk of burns, benefitting the health of women and children in particular. More efficient stoves free additional time for women and girls responsible for collecting fuel that can be used instead to improve education or pursue an income-generating activity. Stoves can often be manufactured locally, creating employment opportunities. More efficient heating systems improve thermal quality and reduce dampness, mold and gas and particulates emissions, increasing usable living space and benefitting health.

Efficient Refrigerators

The amount of refrigerators is expected to grow very strongly in the coming years, from 12.8 million in 2014 to 18.7 million in 2020, and to 44.3 million in 2030. This means that refrigerators will go from something that only a small proportion of households own, to a relatively common device. This growth is most likely linked to an increase in electrified households. Refrigerators represent a moderate amount of the electricity used in Pakistan (11 per cent in the residential sector, and 7 per cent in the commercial sector). The efficiency of refrigerators has greatly increased worldwide and efficient devices will be available for Pakistan.

Scenario Definition

This option entails replacing 24 per cent of refrigerators with more efficient devices. While the costs per device (about USD 250) are the highest among all devices considered, payback times are moderate and savings significant.

Benefits and Impacts

Reliable, affordable and efficient refrigeration ensures both safe medical supplies and healthy effective food supply chains and can improve the incomes of local producers and retailers. Switching to natural refrigerants eliminates the use of hydrofluorocarbons (HFCs) that have high global warming potential, preserves resources and reduces persistent wastes from noxious refrigerants. It is imperative that replaced devices are disposed of correctly to reduce emissions from released cooling agents and negative environmental impacts.

Efficient Air Conditioners and Fans

Fans are more commonly used for cooling than air conditioners (about 55 versus 2.8 million). The number of air conditioners is expected to grow strongly to 4.0 million in 2020, and 11.1 million in 2030. While a fan uses less energy than an air conditioner, together, they use about 45 per cent of the electricity in the residential, and 25.1 per cent in the commercial sector. The use of different types of motors can bring large efficiency gains.

Scenario Definition

This option entails replacing 29 per cent of air conditioners with devices that are 40 per cent more efficient. The costs per device (about USD 250) are highest among all devices considered, but have short payback times. Fans that use AC induction motors, while inexpensive, are quite inefficient. The aim would be to replace these with much more efficient DC motors that have become quite common and involve low costs per device.

Benefits and Impacts

More efficient air conditioning systems and fans in residential and commercial buildings reduce consumer costs, increase disposal income and can increase affordability of energy services. Efficient cooling and ventilation improves indoor thermal quality, reduce dampness and mould and improve air quality, increasing usable living space and benefitting health. However, these benefits may not be enjoyed by those least able to afford air conditioning, possibly having a negative equity impact and increased use of air conditioning can create heat islands in urban areas.

Efficient Water Pumps and Irrigation

The way Pakistani households have access to drinking water is relatively diverse, with 30 per cent using tap water, 30 per cent use motor pumps, 27 per cent use hand pumps, with the rest using other means such as dug wells. Water pumps represent less than 2 per cent of the electricity use in the residential sector, limiting the potential absolute savings. The majority of rural population depends on groundwater irrigation for their livelihoods. Agriculture uses 94 per cent of Pakistan's water consumption with pumping for irrigation typically performed by tube wells (turbine pumps) that use electricity or diesel (the majority, with 87 per cent). The efficiency of both electric and diesel motors is relatively low in Pakistan due to poor quality of the motors and from suboptimal operation (such as incorrect fitting of transmission belts). Relatively large efficiency gains can hence be expected.

Scenario Definition

The option entails replacing 90 per cent of water pumps with devices that are 50 per cent more efficient. The costs per device are on the higher side and the option involves longer payback times, however. Replacing inefficient motors used to pump water for irrigation with more efficient ones and improving operations (better fitting of transmission belts, for example) can lead to significant savings (38 per cent for electric pumps, and 50 per cent for diesel pumps). Access to capital can be a constraint for farmers, however payback times are relatively short.

Benefits and Impacts

Improving water pumps can reduce water consumption and waste and can help to provide reliable and clean drinking water. Health and social development benefits can be maximised if water pump replacements are made available to all groups of society, improving access to sanitary systems. Energy efficiency measures that contribute directly to health benefits, also indirectly reduce health care expenses. Efficient irrigation systems that combine more

efficient and well-maintained pumps and improved irrigation technology reduce overall energy and water consumption, decrease fertiliser need and labour intensity and can increase yields by up to 100 per cent, leading to higher income that allows the recovery of investment costs. Efficient irrigation can improve soil quality and conserve freshwater and energy resources, helping farmers affected by climate change to adapt to water scarcity and strengthen their resilience.