ENERGY SAVING IN PAKISTAN

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Prepared by HIMA Verte

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RESEARCH & ADVOCACY FOR THE ADVANCEMENT OF ALLIED REFORMS

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Acknowledgements

Ali Hassan Habib: *Lead Consultant*

Noor Ul Hira: *Research Assistant*

Dr. Nasir Mahmood: *Agriculture sector*

Aqrab Ali Rana: *CEO, Green Building Council of Pakistan*

Nudah Hasan: *Marketing Advisor*

Ms. Fatima Abidi: *UK Energy Savings Opportunity Scheme*

Salman Zafar: *LED lights, CEO Sinewave Pvt. Ltd.*

Hashim Akhtar: *Solar water-heating for industrial boilers*

Muhammad Mohsin: *Solar energy*

Muhammad Mansha: *Solar energy*

Afzal Abidi: *Legal aspects of Feed-in-tariff*

Muhammad Tariq: *Market survey of gas water geysers*

List of Acronyms

AEDB	Alternate Energy Development Board
BRESL	Barrier Removal Energy Efficiency Standard Labelling
CDD	Cooling Degree Days
CDPR	Consortium for Development Policy Research
CPEC	China Pakistan Economic Corridor
DPRC	Development Policy Research Centre
EEC	Energy Efficiency Capacity
EER	Energy Efficiency Ratio
ENERCON	National Energy Conservation Centre
ESCO	Energy Service Company
ESOS	Energy Savings Opportunity Scheme
EU	European Union
GBCP	Green Building Council of Pakistan
GHG	Greenhouse gases
IFC	International Finance Corporation
ISO	International Standards Organization
KSE	Karachi Stock Exchange
kVA	kilo Volt Amps
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LESCO	Lahore Electric Supply Company
MAF	Million acre feet
MEP	Minimum Energy Performance Standards
MTOE	Million Tonnes of Oil Equivalent
NAMA	Nationally Adapted Mitigation Action
NEPRA	National Electric Power Regulatory Authority
NUST	National University of Science and Technology
OECD	Organisation for Economic Cooperation and Development
PAYG	Pay-As-You-Go
PSA	Pakistan Solar Association
REEE	Renewable Energy and Energy Efficiency
SDG	Sustainable Development Goals
SECP	Securities and Exchange Commission of Pakistan
SNGPL	Sui Northern Gas Pipelines Limited
T&D	Transmission and Distribution
TOE	Tonnes of Oil Equivalent
UNIDO	United Nations Industrial Development Organization
UPS	Uninterrupted Power Supply
USAID	United States Agency for International Development
WASA	Water and Sanitation Authority
WWF	World Wide Fund for Nature

Executive Summary

Energy in Pakistan: the crisis

According to a research study[1] conducted by the International Finance Corporation (IFC), it is estimated that over 140 million people (22 million households) in Pakistan either have no access to grid electricity (off-grid) or face severe under-electrification (facing over 12 hrs of load shedding per day).

Of these 140 million, 69 million do not have grid connections; thus the lack of electricity has a disproportionately negative impact upon the poor and marginalised population of Pakistan, especially women and girls, who spend more time inside their homes.

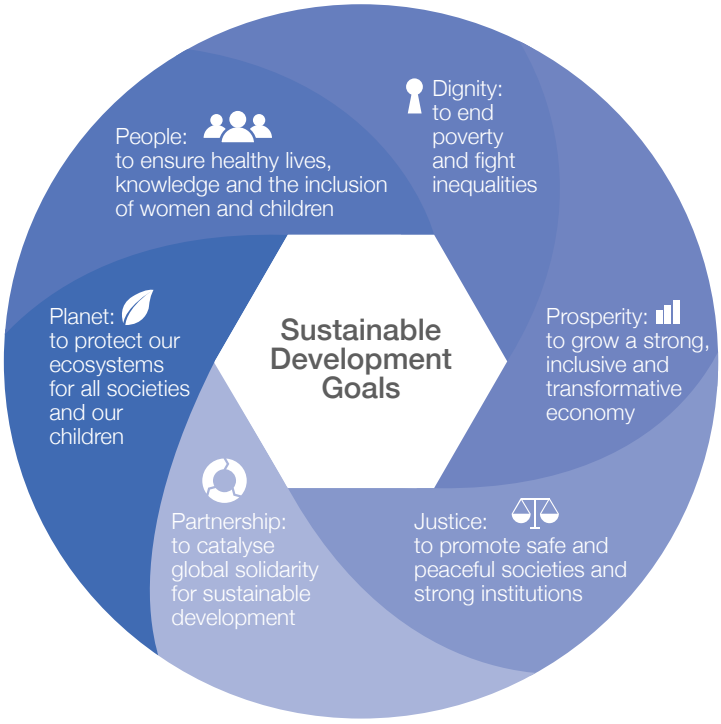
The national cost of load shedding, inclusive of both direct and indirect costs, is estimated as Rs. 1.4 trillion (USD 14 billion) for 2011-12[2].

Energy Conservation: the global landscape

Developments in the selected countries of China, the United Kingdom and Malaysia are given additional attention, with a commentary on the potential relevance for the adoption of energy conservation measures in Pakistan. China carries unique significance due to its recent partnership with Pakistan through the China Pakistan Economic Corridor and the fact that much of the world's renewable energy and efficient lighting products originate from China.

Under the United Nations framework an overarching global agenda for improving the status of people and the planet has been in place, referred to as the Millennium Development Goals, which covered a 15 year period from the year 2000 to 2015. For the next 15 year period (from 2015 to 2030) the same agenda will continue under the title of Sustainable Development Goals (SDGs) launched by the UN within 2015. Energy is covered as goal no. 7 of the 17 goals. This Energy goal is further divided into four segments: Energy Access; Energy Efficiency; Share of Renewables; Reduction in Consumption.

It will thus be beneficial to draft Pakistan's energy plans in such a manner that they benefit from alignment within this UN energy framework[3].



[1] IFC March 2015, Lighting Asia-Pakistan
[2] Beaconhouse National University, Dr. Hafiz A Pasha, 2013, Economic Costs of Power Load-shedding in Pakistan
[3] UN Sustainable Development Goals document: https://sustainabledevelopment.un.org/post2015

Energy Conservation in Pakistan: the opportunity

Potential

In spite of being poorly served by electricity, the energy savings potential in Pakistan from energy conservation and efficiency measures is substantial, at an estimated 17% of total electricity use, according to an IFC report[4]. The Vision 2025 document also gives a similar figure of 11 Million Tonnes of Oil Equivalent (MTOE) of energy saved (16.5%) from energy conservation and demand management. The total primary energy for Pakistan was 66.8 MTOE in 2014.

This severe electricity shortage and inefficient usage also provide a major opportunity for private and public sector investment. The above IFC report estimates that the industrial sector alone can absorb energy efficiency investments of over USD 4 billion with typical 3- to 5-year payback periods.

This report makes a case for energy-saving possibilities in Pakistan, covering opportunities for both energy efficiency and conservation. While efficiency relates mainly to the introduction of energy-efficient appliances, conservation consists mainly of behavioural changes at individual and collective levels to reduce energy consumption. The potential benefits both in terms of financial returns and meeting pressing social needs will be addressed.
The global trends in energy efficiency and conservation, which are mostly integrated with the adoption of renewable energy, are covered, giving some overall global trends.

The main focus of this report is to investigate demand-side opportunities for energy conservation in the domestic and rural sectors. Energy conservation opportunities in the industrial sector are already well researched, mainly by the IFC as mentioned above, and thus this report provides reference to this work where appropriate, but does not cover the sector in detail.

Positive Market/Voluntary Trends in Pakistan

In spite of the serious shortfall of energy and inefficient practices widespread in Pakistan, it is extremely important to “dig out” information about the many excellent examples of energy conservation and renewable energy initiatives in the country, as it is probably within these seeds that the foundations of scaling up and consolidation will take place. This report thus covers a number of important voluntary initiatives such as the Green Building Council of Pakistan, the energy conservation campaign of Karachi-Electric, the Lighting Pakistan programme of IFC and the Green Office energy savings scheme for corporations facilitated by the World Wide Fund for Nature Pakistan (WWF-Pakistan).

Government Policies, Laws and Plans

A number of government policies, laws and activities that support energy conservation exist, and these will be highlighted. Often a number of excellent government initiatives are started as projects, and the challenge becomes to integrate learning and momentum once the project is complete.

The Punjab government seems to be proactive in terms of its commitment and plans for adoption of energy conservation and renewables. In September 2015 the Punjab government allocated Rs. 1.2 billion for a 3-year energy conservation initiative, and a further Rs. 1.2 billion for providing solar energy solutions to the poor. The Khyber-Pakhtunkhwa government is also promoting renewables such as solar water pumping and micro-hydro electricity generating units. The Sindh government is playing an active role in facilitating the establishment of wind energy installations. Wind energy is likely to play a major role in overcoming the gap between demand and supply considering the 120,000 megawatts of potential for wind energy in Pakistan. According to the AEDB, 60,000 megawatts of this wind energy potential lie along a 60 km stretch along Pakistan’s coast. Another area of high potential is western Baluchistan Province.

[4] IFC Nov 2014, Dr. Ambrosini, Sustainable Energy Finance

Energy Conservation in Pakistan: the solutions

Conversion to Energy-Efficient Appliances

Consumers are rapidly shifting to energy-efficient appliances such as LED lights and inverter air conditioners. Fine-tuned government policies and innovation projects can "lubricate" these positive market dynamics, and rules and regulations need to be applied with caution and in a phased manner. This report will focus on lights, fans, refrigeration and air conditioning as appliances with the greatest potential for conversion to greater energy efficiency.

Natural Gas

Energy conservation initiatives of the Sui Northern Gas Pipelines Limited (SNGPL) will be discussed, such as the introduction of cone baffles in gas water heaters, installation of the smartphone-based gas water heater on-off device "Jul Bujh" and introduction of solar water heaters.

Agricultural Irrigation Practices

Pumping groundwater for irrigation is a major cost and consumer of energy in Pakistan, and therefore will be investigated for opportunities to convert to more energy-efficient practices. Of the around 1.2 million irrigation pumps installed in Pakistan, 362,626 are within areas with a groundwater table of 30 ft or less, which make them a "good fit" for conversion to solar pumping.[5]

Scale of Impact and Feasibility of Implementation

Based upon the areas considered for energy conservation within the report, a consolidated set of recommendations and desirable outcomes is proposed. For each desirable outcome an assessment of the existing barriers to its adoption will be discussed, as well as realistic options for overcoming the barriers. Some problems may be obvious, but methods for overcoming them will be difficult. One example is that, while replacing an inefficient fridge will lead to substantial savings at the national level, the upfront cost, including disposal of the old fridge, may be a difficult barrier for the consumer to overcome. On the other hand, replacement of lights with the more energy-efficient LED lights offers a practical option for consumers, businesses and financing institutions.

Some of the key recommendations are given in the table below, showing the priority measures for energy conservation, selected on the basis of their potential scale of positive impact. In addition, the level of feasibility of implementation of each recommendation is given, including the barriers to adoption and possible approaches to overcoming these barriers.

[5] Pakistan Bureau of Statistics, Agriculture Census Organization, Punjab

Energy Conservation Measures of High Impact								
Sr. No.	Energy Efficiency Measures	Potential Impact						
		H=High M=Medium L=Low	Scale of Impact	Quantitative Energy Saving Estimate	Load-shedding reduction (Assuming 4,000 MW shortfall)	H=High M=Medium L=Low	Barriers	Possible Solutions
1	Conversion to Energy Efficient Lighting	H	Pakistan's Electricity Consumption	9.3%	47.0%	H	Upfront cost	Financing
2	Conversion to Energy Efficient Fans	H	Pakistan's Electricity Consumption	7.7%	39.0%	M	1-Technology improvement 2-Fan manufacturers support 3-Buy back of old fans	Work with the fan manufacturers association
3	Conversion of 350,000 low-water table (30ft) irrigation pumps to solar	H	Total irrigation pumps in Pakistan	Fuel Savings for 30% of all pumps in Pakistan		M	1-Technology standard 2-High upfront cost 3-Specialised maintenance	Rural outreach, skills enhancement, farmer finance solutions
4	Conversion of domestic gas water-heaters to solar	H	SNGPL domestic gas demand	9% gas savings		H	Scaling up	SNGPL to access finance
5	National Level Policy/ Regulation	H	National			M		
6	Energy Conservation Donor Coordination Group	M	National			M	Each has own priorities	Donor Coordination Group
7	Sub-National Policies and Targets	M	Provincial/ Department			M		
8	Fridge replacement programme	M	Low income group			L	Upfront cost of new fridge	Fridge buy-back for poor

Energy in Pakistan: The Crisis

1.1.Pakistan's state of energy

World Energy Council Energy Index Ranking

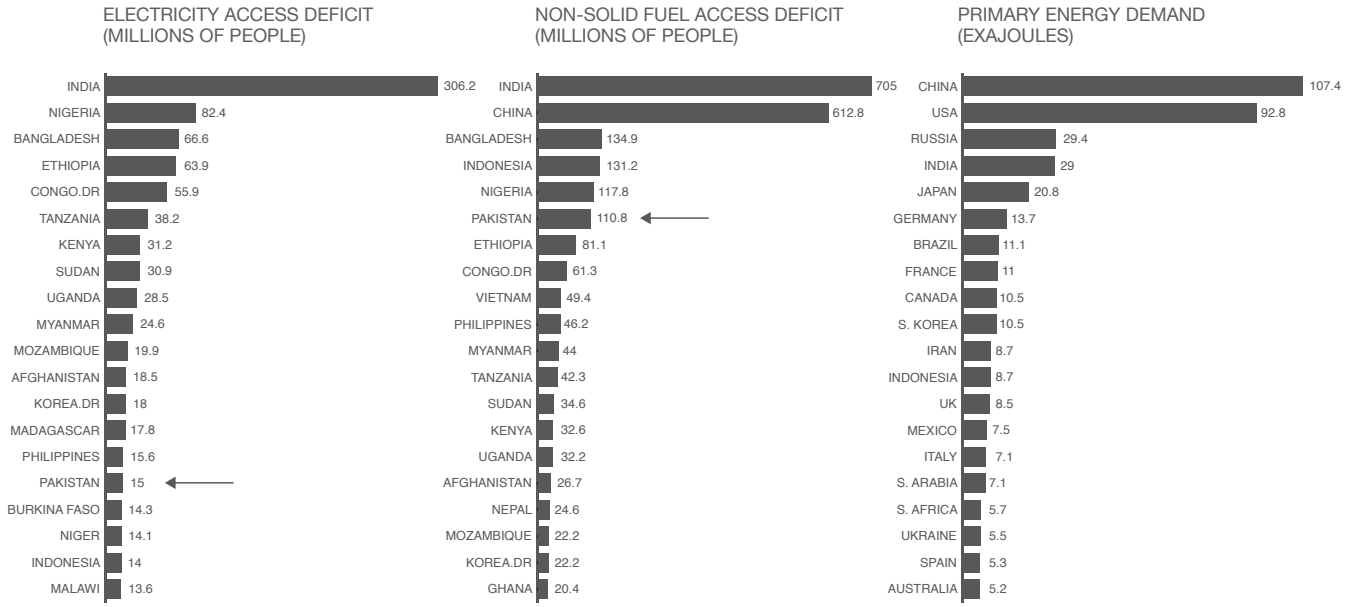
The Energy Index Ranking published by the World Energy Council considers three key competing parameters for energy and how well countries balance them. Pakistan is ranked 118 of 129 countries assessed on the basis of data for the year 2014. Thus Pakistan clearly needs to dramatically improve its energy demand-supply dynamics, although many other developing countries face a very similar challenge. The table below shows Pakistan's state of energy compared with some other selected countries.

Energy Index, Ranking A-Excellent B-Good C-Poor	Energy Security: Extent of import reliance, infrastructure, supply	Energy Equity: Availability across society	Environmental Sustainability: Adoption of renewables, efficiency
Pakistan	B	D	D
India	C	D	D
China	A	C	D
Malaysia	A	B	C
United Kingdom	A	A	A

High Energy Impact Countries: World Bank 2013

This World Bank study lists the top 20 countries of concern with high impact upon the status of energy in the world, covering three criteria: 1-Number of people with access deficit to electricity, 2-Number of people with access deficit to solid fuel and 3-Total energy demand. Pakistan appears in two of these criteria, indicating that the energy deficit problem in Pakistan is of such a large scale that it will impact global figures, as shown in the diagram below:

Figure 1.1 Overview of High Impact Countries, 2010 (Source: World Bank 2013)



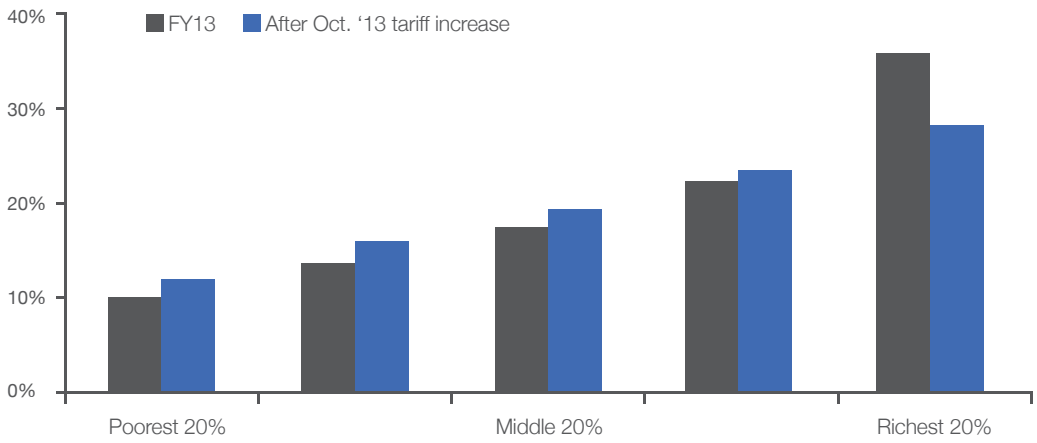
1.2.Impact on poor and marginalised groups

According to the IFC, 69 million people in Pakistan are not connected to the grid[6]. Pakistan Vision 2025 gives a similar figure of only 67% of people with access to electricity, leaving 33% of the total population of 200 million, or 66 million people, without access to electricity.

An electricity backup is considered a luxury, as families in the lower income bracket cannot afford the upfront cost of a UPS/battery system. A research study carried out by the International Finance Corporation of 4,000 households concluded that even large cities such as Lahore and Karachi have many people that experience "off-grid" living due to extensive load shedding as they cannot afford an alternative electricity supply. Of the 69 million people that do not have access to the grid, there are a disproportionate number of poor.

A rather shocking fact is revealed by a 2014 World Bank report[7] about the beneficiaries of the over Rs. 300 billion per year electricity subsidy in Pakistan. The richest 20% of Pakistanis receive a 28% share of this subsidy, while the poorest 20% only receive an 11% share. This is illustrated by the graph below, extracted from the same report.

Figure 1.2 Share of Electricity Subsidies Received by Households, ranked by Expenditure



Source: PSLM Survey, 2010-11

Of the 69 million people who are not connected to the grid, 81% are in rural areas of Punjab[8].

Disaggregated targets, achievement monitoring

Therefore, any energy-efficiency programme should aim to measure achievements in a disaggregated manner to cover data for the poor, and possibly women and children. As evident from the untargeted electricity subsidies, higher resources could be diverted for this purpose.

1.3.Cumulative costs of poor electricity supply

According to research conducted by Beaconhouse National University Lahore, the national cost of load shedding, inclusive of both direct and indirect costs, was estimated at Rs. 1.4 trillion (USD 14 billion) for 2011-12.[9]

It is ironic that such major costs accumulated over the past ten years could have added over 20,000 megawatts to the country's national grid over the same period, overcoming the shortfall of 7,000 megawatts that exists today.

6 IFC, 2015: Lighting Pakistan Consumer Study
7 World Bank, 2014: Reforming Electricity Subsidies in Pakistan; Measures to Protect the Poor
8 IFC, 2012: Off-grid lighting scope
9 Economic Costs of Power Load shedding in Pakistan, Dr. Hafiz A Pasha, Beaconhouse National University, 2013

1.4.Use of back-up electricity supply and its impact on energy use

Consumers in Pakistan have had to adapt to the irregular and low-quality supply of electricity and natural gas by developing their own alternatives to meet their needs.

Battery-based Uninterrupted Power Supply (UPS)

According to an estimate by the Federal Environment Protection Agency, about 60% of Pakistani households have some form of UPS to provide electricity backup for selected appliances, putting the estimated number of UPS at 18 million.[10]

Based on figures from the Pakistan Bureau of Statistics, 36,783 UPS units were imported in 2013-14 at a cost of Rs. 161 million, and 668,585 battery chargers at a cost of Rs. 1.53 billion. Assuming this represents only 5% of the consumers that prefer imported equipment, an annual cost of twenty times this amount, or over Rs. 30 billion (USD 300 million), is being spent on UPS/battery chargers alone. The cost of associated batteries and solar equipment, if any, is not included in these figures. These costs indicate the extent of expenditure and inconvenience experienced by people to compensate for the lack of a reliable electricity supply.

An empirical study conducted by the NED University Karachi (Abdullah Munir, March 2015) using four different types of UPS units concluded that they had widely ranging energy conversion efficiencies, from around 20% to 50%; thus the substitution of higher efficiency UPS units will reduce demand side load, as well as the peak load immediately after the completion of a load shedding cycle, since all UPS batteries within a locality draw maximum current due to their charging needs. In addition to charging loads, inferior UPS units emit harmonics measured as Total Harmonic Distortion, which can harm the distribution transformers of an electricity distribution network.

Voluntary labelling, efficiency standards for a UPS

Since a mandatory labelling and efficiency standard for a UPS device will be almost impossible to implement, it would be better to assist in technical research to help improve the efficiency of the standard local UPS. Through an awareness programme, consumers can be informed of the money they spend on a monthly basis by buying an inefficient backup UPS.

Backup diesel generators

Both domestic and commercial consumers in Pakistan import around USD 1 billion-worth of backup generators. In addition to this capital cost, a very high operating cost is incurred along with the major inconvenience of noise, placement and maintenance.

It is estimated that the total installed capacity of backup generators is well over 20,000 megawatts and thus above the approximately 17,000 megawatts electricity distribution capability of the whole national electricity supply of Pakistan.[11]

A recent newspaper article gave a summary of generator imports over the last three years, and is summarised in the table shown below:

Year	Import Million USD	Megawatts added*
2015	1,329	5,633
2014	1,070	4,537
2013	959	4,064

Dawn, February 22, 2015
*Calculated with conservative estimate of average cost per kilowatt of Rs. 25,000

[10] Dawn, 'UPS and generators heavy on pocket — and health too', printed 04 June 2012, http://www.dawn.com/news/723767/ups-and-generators-heavy-on-pocket-and-health-too-2
[11] Dawn, 22 February 2015

Energy Conservation: The Global Landscape

2.1. Global trends in energy conservation and renewables

A World Energy Council report of 2013 on Energy Efficiency Policies[12] provides details of how energy conservation is receiving support from many sectors of society. One of the main drivers at the national level is to reduce greenhouse gas (GHG) emissions, which are contributing towards the alarming levels of global warming.

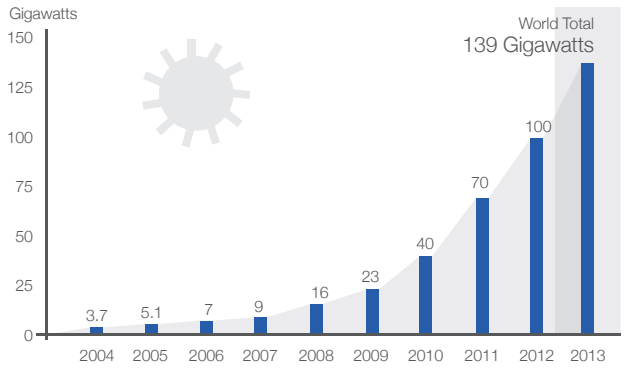
As detailed in the report, which covered 85 countries including Pakistan, it was observed that, while many positive trends in energy efficiency are taking place due to the role of market instruments such as voluntary agreements and economic incentives, legal regulatory frameworks are also essential in areas such as improved building codes and consumer appliance standards.

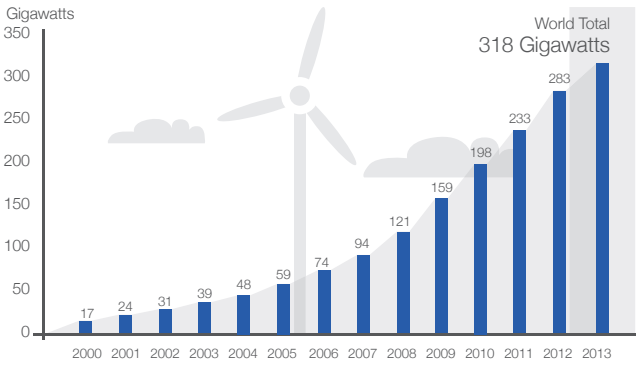
Some key recommendations from this report are:

-Innovative financing tools should be implemented to support consumers' investments.
-The quality of energy-efficient equipment and services should be controlled.
-Behaviour should be addressed as much as technologies, relying on information and communications techniques.
-Monitoring of achievements is necessary to evaluate the real impact of energy efficiency policies.

Almost all OECD countries, and an increasing number of non-OECD countries, are enacting laws to enhance energy conservation/efficiency. One example is the EU Energy Efficiency Directive of 2012[13], which has in turn triggered the requirement for enactment of supporting national laws in all EU Member States. For example, the United Kingdom government issued the Energy Savings Opportunity Scheme (ESOS)[14] regulations in July 2014, which covers mandatory requirements for large organisations as well as offering a template for voluntary initiatives by organisations to enhance their energy conservation measures.

The graphs below show the rapid increase in installed solar and wind energy in the world:





Source: REN21 2014 (1 Gigawatt = 1,000 Megawatt)

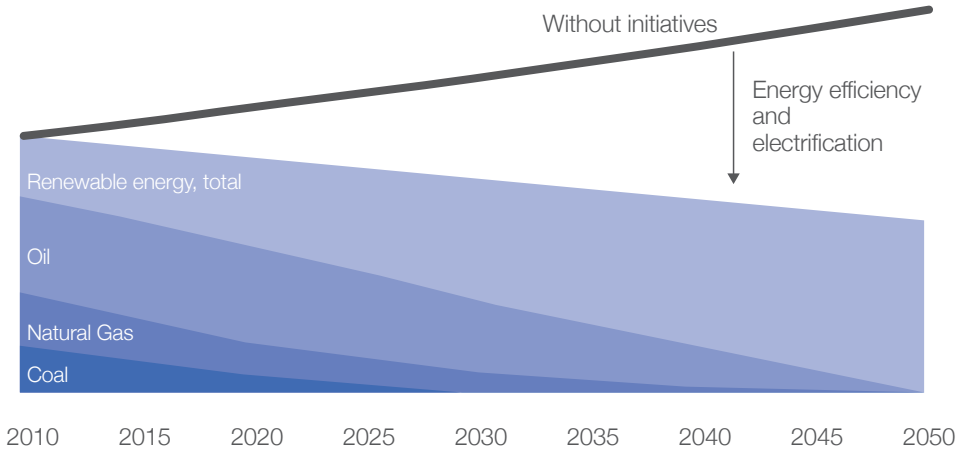
[12] World Energy Council, 2013, Energy Efficiency Policies: What Works and What Does Not
[13] EU Energy Efficiency Directive 2012/27/EU (http://ec.europa.eu/energy/efficiency/eed/eed-en.htm)
[14] ESOS, July 2014 (www.legislation.gov.uk/uksi/2014/1643/made)

2.2.Country case studies

Denmark

The example of Denmark is shown to illustrate the "template" for a desirable future energy plan for any country, and is thus relevant for Pakistan as a reference. Any future graphical representation for Pakistan should also mention expected energy saved due to energy efficiency gains. The prominent role of energy conservation in reducing future demand is illustrated in the diagram below, which sets the future targets of Denmark's 2050 plan[15] to achieve 100% renewables as a source of energy. In 2013 Denmark banned the use of fossil fuels for heating in new buildings.[16]

Figure 2.1 Illustration of energy consumption up to 2050



As shown in the diagram above, energy efficiency gains translate into reducing electricity demand by about 60%, illustrating the substantial potential in even advanced countries such as Denmark.

Malaysia

In the case of a developing country, the Eleventh Malaysia Plan 2011-2015 covered a special section Strategy Paper 17, which put forward ambitious plans for enhancement of renewable energy and demand-side management through energy conservation measures.

A draft National Energy Efficiency Action Plan for Malaysia awaiting legal notification will set into motion a number of policy and support mechanisms.

United Kingdom

In order to comply with the EU Energy Efficiency Directive, the UK government issued the legal instrument referred to as the Energy Savings Opportunity Scheme (ESOS) in 2014. The compliance guidelines were issued in 2015. Compliance is mandatory for large organisations only, defined by the term "Large Undertaking" within this ESOS. The first deadline for sending compliance reports was 5th December 2015.

The ESOS is more of a facilitating law, rather than an enforcing or punitive one. Basically it asks the organisations to develop serious plans for reducing energy consumption within their operations, and monitor how they are performing against those plans. Typical areas to be covered are:

-Transport
-Processes
-Buildings

[15] Danish Government: Our Future Energy
[16] REN21, 2014, Renewables Global Status Report

Organisations that are already certified under ISO 5001, the energy conservation international standard, will be able to submit their ISO compliance reports as satisfying ESOS compliance needs as well.

The UK ESOS may have relevance to Pakistan since it mentions that "…UK registered establishment of an overseas company will also need to take part in ESOS…"

Considering some large UK-based companies are operating in Pakistan, such as Standard Chartered Bank, Bestway Cement, Mott MacDonald, Oxfam and Unilever, there may be an opportunity for these companies to voluntarily apply ESOS schemes in a disaggregated manner for their operations in Pakistan even though UK law may not require them to do so.

Sub-national targets within the UK are an impressive mechanism, whereby regions or cities within the UK are committing to meeting higher standards than requirements of national law. An example is that Scotland commits to transition to 100% renewables by 2020.[17]

Even though the United Kingdom and Pakistan are very different in terms of their economy and legal compliance, this particular ESOS scheme has many lessons for Pakistan to follow in developing strategies and laws for energy efficiency. An important aspect to note is that, even in a highly regulated and legally defined society such as the UK, the ESOS is only mandatory for large organisations, and voluntary for others. In addition, compliance requirements are light, as companies will simply need to share their energy conservation plans with the government, and be open to energy audits once every 4 years. Additional flexibility is shown in the fact that past best practices will be recognised: those organisations that are already certified by the international standard ISO 5001 for energy conservation can comply with the ESOS by simply submitting the audit report as required by ISO 5001.

ESOS compliance within Pakistan can also play a catalytic role in enhancing trade of environmentally friendly products such as energy-efficient fans.

The UK government can encourage all companies listed on the Karachi Stock Exchange with home offices in the UK to follow ESOS in a voluntary manner.

China

2013 was the first year that the addition of new renewable energy capacity was greater than the number of new fossil fuel-based power plants.[18]

China spent USD 56.3 billion in 2013 on renewable energy installations, which is greater than the USD 48.4 billion spent by the whole of Europe in the same year.[19]

China is now a world leader in the total wind and solar installed renewable energy capacity, at about 140,000 megawatts or 140 gigawatts.[20]

China is a world leader in the manufacture of solar panels and energy-efficient appliances such as LED lights.

The recently concluded China Pakistan Economic Corridor (CPEC) undertaking will provide significant opportunity for Pakistan to integrate energy efficiency and enhancement of renewable energy. The addition of 200 megawatts of wind energy and 1,000 megawatts of solar energy are planned projects within the CPEC.

IFC is collaborating with the Chinese company Three Gorges Corporation, which has committed to investing USD 7 billion for energy investments in Pakistan.[21]

17 REN21 Renewables Global Status Report 2014
18 REN21 Renewables Global Status Report 2014
19 REN21 Renewables Global Status Report 2014
20 Renewables course North China Electric Power University June 2015
21 IFC Islamabad press release April 2015

Energy in Pakistan: The Opportunity

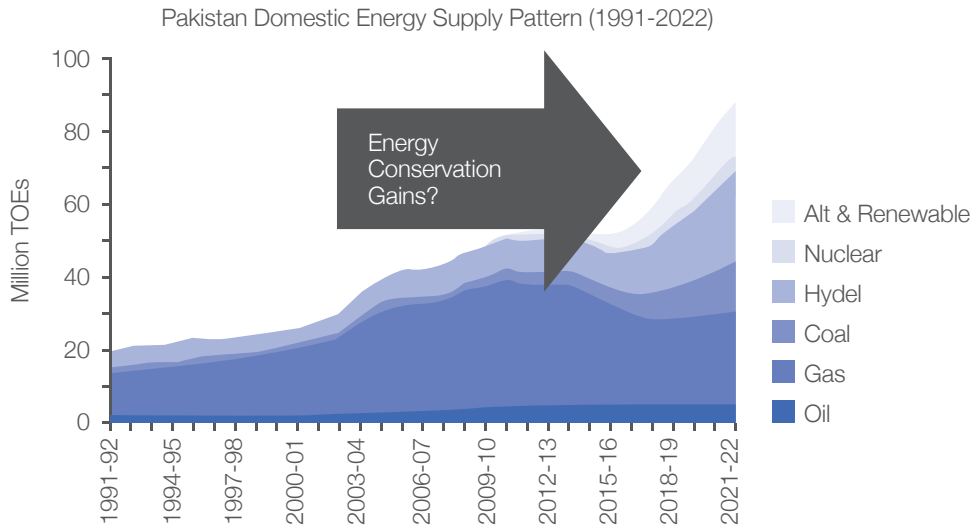
3.1. Potential

Consumers in Pakistan are rapidly increasing their adoption of energy-efficient appliances such as LED lights and inverter-type air conditioners. There is therefore an opportunity to encourage this positive behaviour through government and voluntary initiatives, considering that the gap between energy demand and supply will be partly alleviated through these energy conservation measures.

The adoption of renewables is also experiencing rapid growth, both through market-based purchase and government-sponsored projects such as for wind and solar electricity generation.

While the adoption of energy conservation measures by a substantial part of the population of Pakistan will certainly assist in reducing the demand on energy supply, a major opportunity for convincing residential, commercial and agricultural consumers will be the incentive of financial payback to consumers in lower energy bills.

Energy Conservation policies need emphasis: While it is understandable to prioritise the need to increase capacity for energy generation, policies for energy conservation need to be prioritised at the same level. As an example, the energy supply pattern graph for Pakistan below, extracted from the Pakistan 2009-22 Energy Plan, does not show a trend of energy conservation gains, as shown in the example of Denmark above.



3.2. Positive market/voluntary trends in Pakistan

Trend in uptake of renewables in Pakistan

Solar and wind energy are rapidly growing in Pakistan, and this trend is likely to grow further.

Mandatory solar lighting for billboards: A Presidential directive is in place, which does not allow an electricity connection to billboards in Pakistan. This has led many billboards to be powered with solar energy.

Solar energy for telecom towers: The electricity requirement for telecom towers varies according to the nature of the equipment. Since the energy requirement is large, solar energy for telecom towers becomes feasible mainly for off-grid areas.

Rooftop solar photovoltaics: Recent trends indicate substantial growth in the installation of rooftop solar, probably linked with the extent of load shedding. Lahore has many more installations compared to Karachi. Research carried out in a housing colony[22] shows that generally the potential roof space available to generate solar electricity is ten times that needed inside the house. The recent approval by the State Bank of Pakistan to allow solar installation costs to be included in home loans,[23] as well as NEPRA's

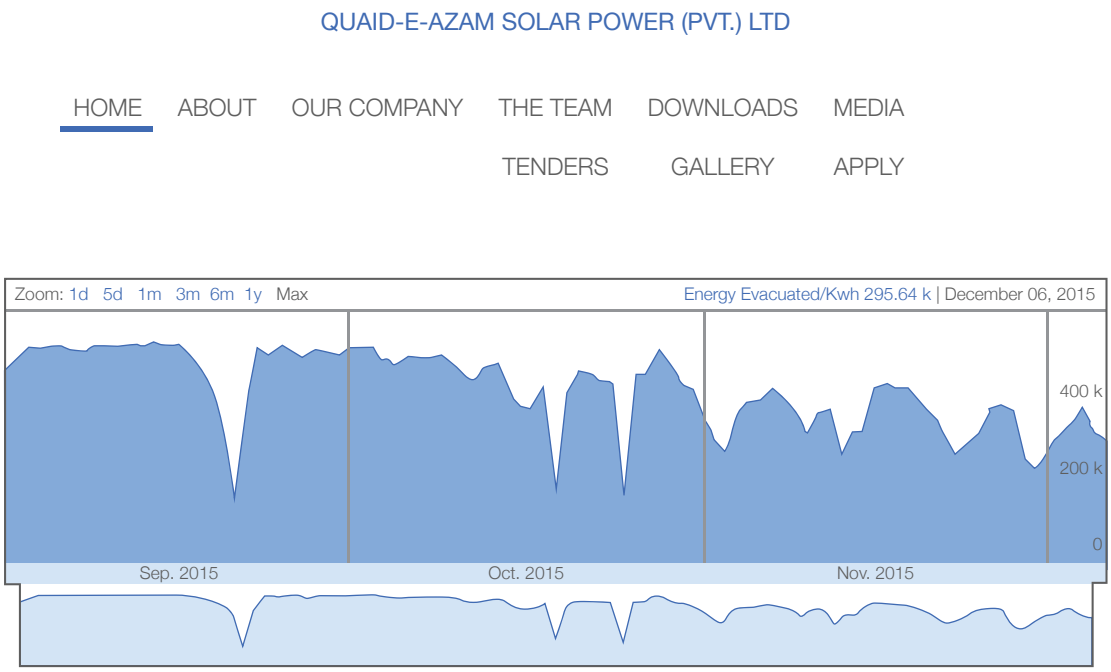
[22] Scientific Research Publishing, May 2015, Muhammad Luqman, Estimation of Solar Energy Potential from Rooftop of Punjab Government Servants Cooperative Housing Society Lahore

[23] State Bank of Pakistan Circular No. 08 of 2015: www.sbp.org.pk/smefd/circulars/2015/C8.html

approval of reverse metering, can provide a market push for greater adoption of rooftop solar. It is expected that the cumulative installed photovoltaic capacity in Pakistan will reach 9,000 megawatts by 2018.[24] At present the estimated installed photovoltaic is 1,000 megawatts.

Wind resources: Sindh itself has a wind energy potential of over 60,000 megawatts.[25] The installed wind energy capacity has increased to around 300 megawatts at present, and plans are in place to enhance this to over 1,000 megawatts in a few years.

Quaid-e-Azam Solar: The planned QA Solar 1,000-megawatt power plant is an important initiative for learning about large-scale solar. Considering the largest solar power plant at present in the world is about 500 megawatts, the government should first learn lessons from the existing 100-megawatt installation before embarking upon other large-scale solar power plants. Unlike wind, solar is often a more appropriate solution as a distributed power source, especially by utilising building rooftops. So far the 100-megawatt installation is producing electrical energy 12% beyond its design capacity committed to NEPRA. These electricity production statistics are being shared on the QA Solar website; a screen-shot is reproduced below:



Pakistan Solar Association (PSA): This nascent organisation assists in conducting training sessions for upgrading skills of solar technicians, facilitates the participation of solar professionals in international training courses, and facilitates trade fairs.

Industrial Passive Solar Heating: Passive solar pre-heating of oil for steam boilers used in gas-fired electric power generation plants has tremendous potential for reducing consumption of oil.

A case study[26] conducted by the National University of Science and Technology produced the following financials:

An investment of Rs. 545 million in a Concentrated Solar Plant will be able to produce 30,000 tons per year of steam through solar energy from within the required 80,000 tons of steam per year for the power plant. An estimated 2 million litres of fuel oil will be saved, translating to a saving of Rs.120 million per year, giving a payback period of between 4-5 years.

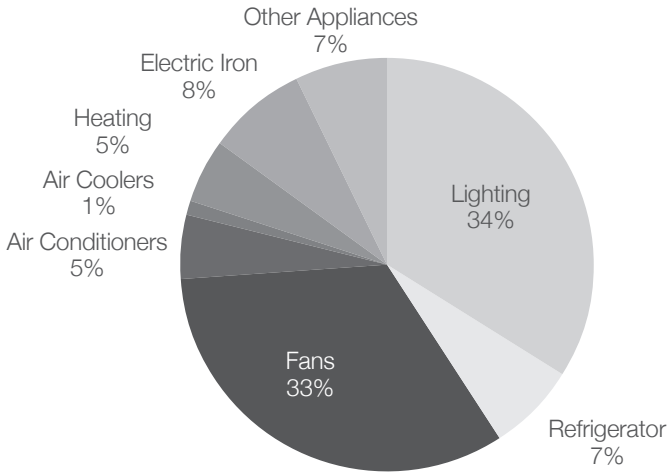
[24] Usman Ahmed, Vice President Pakistan Solar Association
[25] Alternate Energy Development Board website: www.aedb.org
[26] National University of Science and Technology (NUST), 2015, Hashim Akhtar

3.3. Energy efficiency of consumer appliances in Pakistan

Consumers in Pakistan are rapidly increasing their adoption of energy-efficient appliances such as LED lights and inverter-type air conditioners. There is therefore an opportunity to encourage this positive behaviour through government and voluntary initiatives. Adoption of renewables provides a natural complement to adoption of energy-efficient appliances. Often replacement of existing lights with LED lights becomes a necessary step before installation of solar energy solutions. The trends and data of adoption of renewable energy are covered in a dedicated section later.

The domestic/residential sector in Pakistan represents about 47% of the total electricity demand, compared to about 29% for the industrial sector. This is in contrast to the global average, in which the industrial sector in countries generally has a higher percentage of electricity use compared to the residential sector.

As shown in the chart below, 67% of domestic energy consumption is from fans and lights.



Source: IJRET, 2013, Farooq Jan: Energy conservation in residential sector

Based upon market trends and the potential for their future energy conservation impact, the following consumer appliances have been selected for special focus:

- Ceiling Fans
- Lights
- Refrigerators
- Air Conditioners
- Solar water heaters

3.3.1. Ceiling fans

About 10 million new fans are added in Pakistan every year, of which around 7 million are ceiling fans.[28]

Only ten companies based in Gujrat and Gujranwala cover 70% of the Pakistan market[29], and their fans are considered to be of a higher quality than the other remaining manufacturers.

The existing standard ceiling fan consumes about 80 watts of power. Recently the established fan manufacturers have introduced a more energy-efficient ceiling fan, which is also being advertised as the “50 watt” fan.[30]

27 PEECA, 2015-2020 Punjab Energy Efficiency and Conservation Strategy (p. 11)
28 DPRC Lahore University of Management Sciences 2011, Fan Industry in Gujrat and Gujranwala
29 DPRC Lahore University of Management Sciences 2011, Fan Industry in Gujrat and Gujranwala
30 A 50-watt Royal fan was tested at the HIMA'Vert office in August 2015 with an Efergy energy meter and found to take 53 watts, but the air displacement was lower than the standard fan

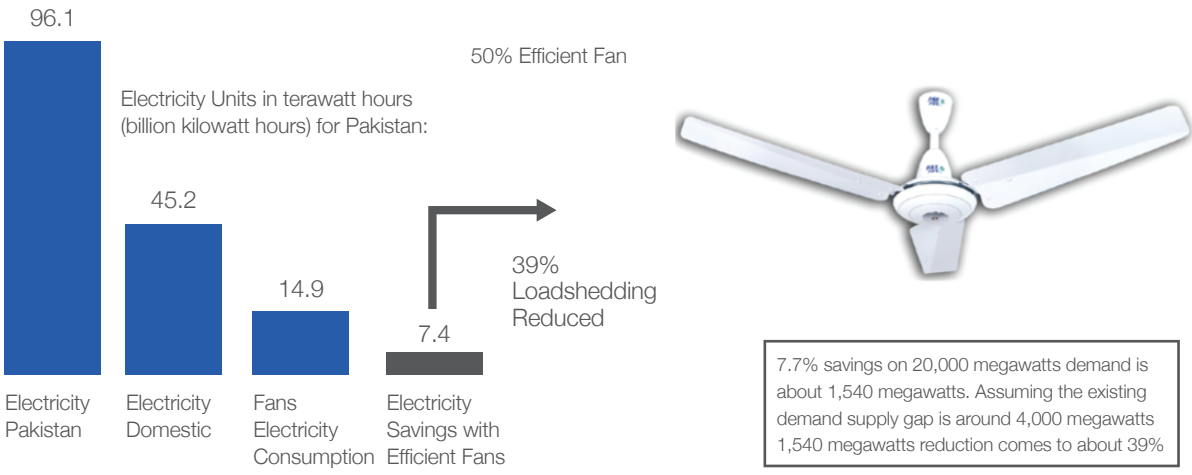
Fan Replacement Programme: Considering only ten fan manufacturing companies have a majority market share, and the sector is organised under the Pakistan Fan Manufacturers Association, there is an opportunity to engage with them to assist them in launching a programme for replacement of existing fans with energy-efficient ones. Through this scheme the manufacturer could buy back their old fan as part of the sale of the new fan. The materials from the old fans can then be recycled within their industry. Such a fan replacement programme could be implemented through the Pakistan Fan Manufacturers Association in collaboration with the relevant government departments and the technical collaboration of international partner organisations such as UNIDO. Since a number of fan manufacturers are now exporting their products, they are likely to become more conscious of their quality and energy efficiency requirements. Fan exports stood at USD 38 million[31] in 2010-11.

A study by Nihar Shah[32] in 2014 concluded that the power consumption of ceiling fans could be cost-effectively improved by at least 50% through known technology.

While it is not realistic to expect that all fans in Pakistan can be replaced with energy-efficient ones, the potential impact of such a measure is substantial, and the opportunity to engage with fan manufacturers to arrive at a feasible plan is certainly worth the effort.

The same study by Nihar Shah states that manufacturing techniques such as improved fan blade design achieve 80%-100% higher efficiencies.

The box below shows the potential energy savings, and utilises data from the International Energy Agency, giving the figure of 96.1 terawatt hours of electricity produced in Pakistan in 2012.



Source: International Energy Agency, 2012 electricity production figures for Pakistan
International Journal of Renewable Energy Technology, 2013, Farooq Jan

3.3.2. Lights

The lighting sector in Pakistan is already experiencing a rapid conversion to more energy-efficient lighting, primarily based upon market dynamics. Even most new government projects incorporate energy-efficient lighting, such as the Rapid Bus Transport projects in Lahore and Islamabad.

An example of sophisticated energy-efficient lighting is demonstrated in the lights installed at the road tunnels commissioned on the Karakoram Highway from Hunza to the Chinese border Khunjerab. The highly efficient LED lights in the tunnels obtain their electricity from solar energy and become bright and dim automatically based upon the presence of traffic movement inside the tunnel.

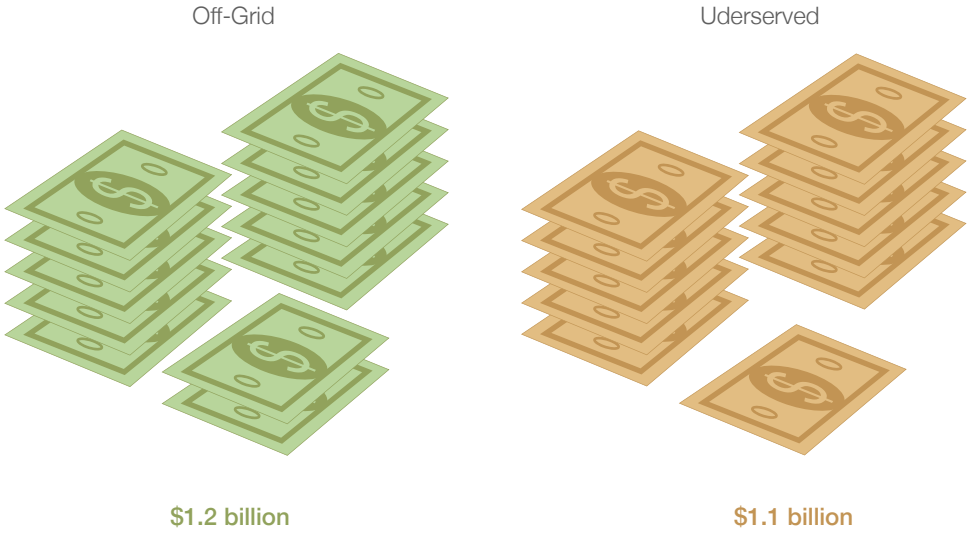
Karakoram Highway, Hunza, Attabad Lake tunnels, 2015

[31] Trade Development Authority of Pakistan
[32] Nihar Shah, 2014, Springer: Efficiency Improvement Opportunities for Ceiling Fans

According to information released by the federal Ministry of Climate Change[33], about 15% of the total electricity in the country is consumed by the lighting sector. In the case that all lighting is converted to more efficient lighting, there is potential to reduce the total lighting load by 35%, and the total electricity load in the country by about 5.5%, resulting in savings of USD 4 billion by 2019. The conversion of lighting in the public, commercial and industrial sector is already well underway, as it has a short payback period.

A total of 144 million Pakistanis are either off-grid (69 million) or under-served (more than 12 hours load shedding), of which a large percentage includes the rural poor.[34] This also presents the country with an opportunity to provide energy-efficient lighting as and when this off-grid population is provided with electricity. The total spend on lighting by families living off-grid is USD 2.3 billion per year, as shown in the diagram below.

Annual Spending on off-Grid Lighting Products in Pakistan



Source: IFC Consumer Perceptions Study Field Research

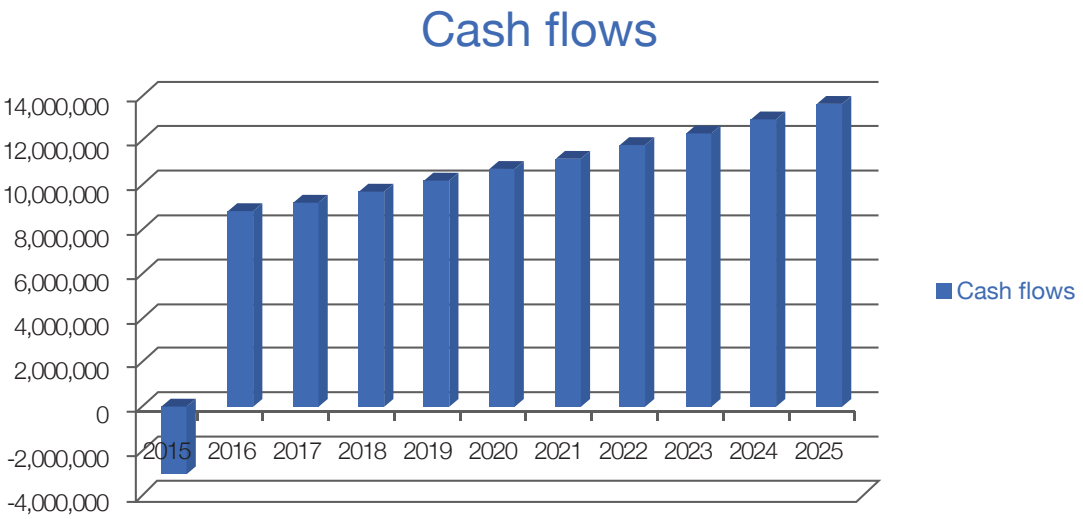
Kerosene lamps and candles are the most widely used methods for meeting lighting needs.

With the assistance of IFC, a major initiative to offer commercially viable off-grid lighting solutions has been launched in Pakistan, and is showing promise, although the challenges of delivering to the “last mile” customer are significant. The quality of products being sold in the Pakistan market is also being improved through an IFC certification programme, which has so far certified five companies in Pakistan that supply high-quality lighting solutions.

Conversion to energy-efficient lighting in the industrial sector is already well underway.

One example is the replacement of 2,000 standard 70-watt tube lights with 18-watt LED light at a textile-weaving mill. With an initial investment of about Rs. 3 million, the payback in terms of savings in electricity costs is about 3 months, with subsequent continued savings over the coming years, as shown in the graph below:

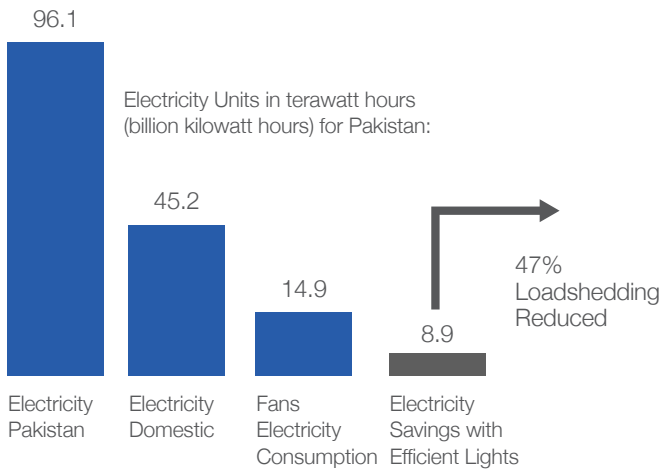
[33] Presentation at a Climate Change summit, Copenhagen, Denmark, May 2013
[34] Lighting Pakistan Consumer Study, March 2015, IFC



Source: Salman Zafar, CEO Sinewave, figures from an actual client, 2015

Lights Replacement Programme: Since lights are likely to be imported into Pakistan, ENERCON can prioritise MEPs' (Minimum Energy Performance standards) labelling. In the first phase, while labelling may be mandatory, a minimum standard can be set voluntarily and adoption can be through consumer choices. Over a few years this can be converted to a mandatory minimum standard, also allowing for the existing rapid technology developments to stabilise.

The Ministry of Climate Change has prepared a project proposal to encourage the conversion of lights in Pakistan to energy-efficient ones[35], estimating a saving of around 2,000 megawatts, or about a 50% reduction in load shedding pressure. With a conservative assessment of 60% savings, this is illustrated in the box below:



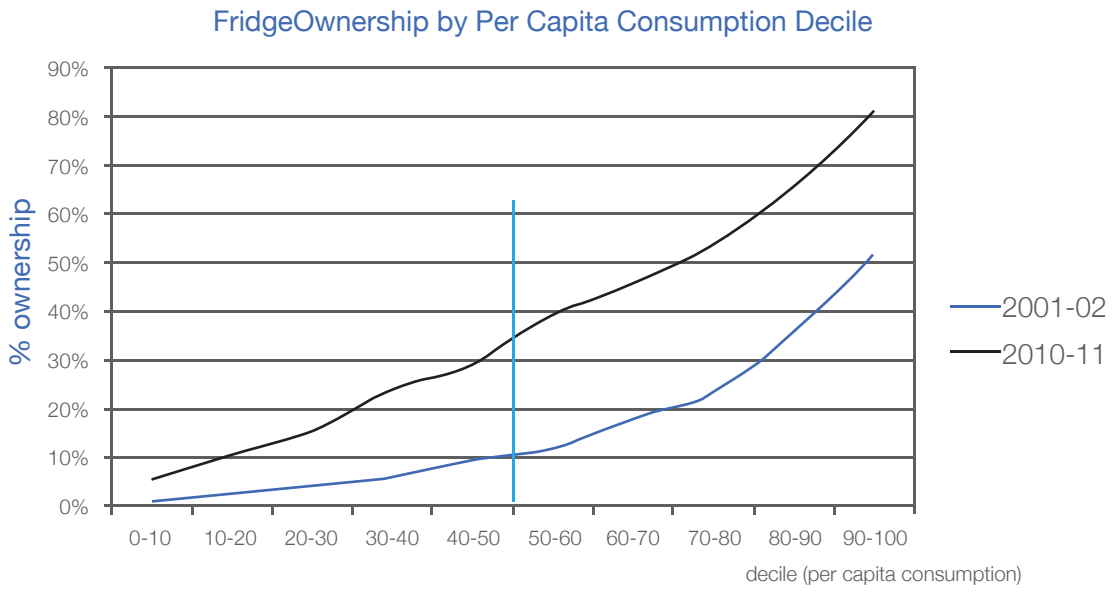
Source: International Energy Agency, 2012 electricity production figures for Pakistan
International Journal of Renewable Energy Technology, 2013, Farooq Jan
Ministry of Climate Change, 2013

60% Efficient Lights

9.3% savings on 20,000 megawatts demand is about 1,860 megawatts. Assuming the existing demand supply gap is around 4,000 megawatts, a 1,860 megawatts reduction comes to about 47%

[35] Ministry of Climate Change, 2013: Energy Efficiency Lighting

3.3.3. Refrigerators



Source: Dr. J. Ghani, IBA The Emerging Middle Class in Pakistan, 2014

As shown in the above diagram, the number of households in the 50% per capita consumption segment increased their fridge ownership from around 12% to 40% of households from 2001-02 to 2010-11.

It is estimated that around 1.3 million refrigerators are sold in Pakistan each year. The top five volume leaders and their energy efficiency criteria are shown in the table below:

Fridge Brand	Estimated No. Sold in 2014	Energy Efficiency disclosure
Dawlance	500,00	Launched the “Energy Saver” series, claiming to use 23% less energy
PEL	320,000	Claim an Energy Efficiency Ratio of 3.1
Haier	250,000	Claim to be “Eco-Friendly, low energy consumption
Orient	150,000	Launched an ”Econotech Series” of energy-efficient models
Waves	100,000	No Upfront mention of energy efficiency

The data above were collected through personal discussions with retailers and manufacturers. While the numbers mentioned above were verified by at least three different sources, none of the sources were willing to be quoted for commercial reasons.

It is important to note that the highest-selling brands are also the ones that advertise and highlight the energy-saving capabilities of their products.

Mandatory labelling: Local fridge manufacturers can follow the 3-star energy efficiency labelling process managed by ENERCON, and imported fridges will need to carry energy efficiency labels from other international certifying agencies, such as the Energy Efficiency Ratio (EER).

3.3.4. Air Conditioners

Air Conditioner Brand	Estimated No. Sold in 2014
Gree	135,000
Haier	100,000
Orient	70,000
Kenwood	65,000
Dawlance	60,000
Others	100,000

Air conditioners only consume 5% of domestic energy in Pakistan,[36] but have a disproportionate impact upon peak load dynamics and the need for greater installed electricity generation capacity in the country. Recent trends in the use of energy-efficient inverter-type air conditioners are expected to become the norm within a few years.

Pakistan is ranked fifth in the world in terms of its future demand for air conditioning, as shown in the chart below. CDD stands for Cooling Degree Days, a measure of the extent of cooling needed within the year.

Country	Population (in millions)	Annual CDDs	Annual GDP per capita (in thousands)
India	1,252	3,120	1.5
China	1,357	1,046	6.8
Indonesia	250	3,545	3.5
Nigeria	174	3,111	3.0
Pakistan	182	2,810	1.3
Bangladesh	157	2,820	1.0
Brazil	200	2,015	11.2
Philippines	98	3,508	2.8
United States	316	882	53.0
Vietnam	90	3,016	1.9
Thailand	67	3,567	5.8
Mexico	122	1,560	10.3

Source: Davis, University of California, Berkeley, March 2015

New air conditioners to be efficient

The air conditioner manufacturers in Pakistan can be encouraged to convert their manufacturing in a phased manner to inverter-type, and similarly the import can be limited to these energy-efficient types. Over a few years the energy efficiency labelling requirement and a minimum standard can be made mandatory.

[36] Diagram on page 18

3.3.5. Solar water heaters

According to Sui Northern Gas Pipelines, it has about 4.7 million customers and about 2 million gas water heaters installed. SNGPL has started a campaign to install cone baffles inside these gas water heaters, which enable reduction in gas consumption of about 25%. This campaign was started in 2009, whereby SNGPL would arrange to provide cone baffles to customers. The market has now adopted these cone baffles, and most new gas water heaters come with a pre-fitted cone baffle, which is also available separately from the market. Thus the cone baffle campaign can be considered as a success, as the market has adopted it as a minimum standard.

SNGPL is now piloting two new energy conservation innovations:

Jul Bujh automatic device

This device is installed as an add-on to the consumer's gas water-heater, and a 24-hour on-off cycle can be set by the customer using a smartphone app called "Jul Bujh". SNGPL estimates that 25% savings in gas can be achieved by the installation of this device.

Solar water heater

SNGPL provides these solar water heaters to its customers and covers the cost through automatic deductions in the monthly gas bill. According to SNGPL, this solar water heater can work for an average 100 of the 150 days that heating of water is needed during the year.

Mandatory solar water heating for new houses

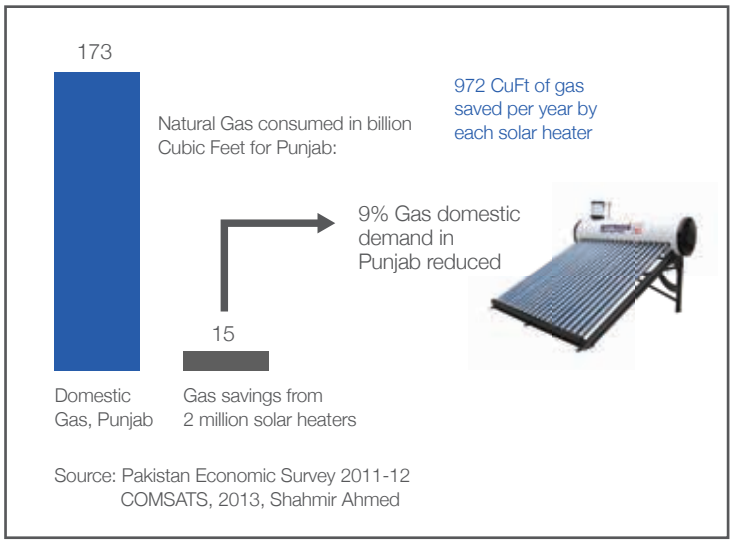
Considering the low cost of solar water heaters, a mandatory law for solar water heating for all new houses in the large cities can be considered. Similarly, a law can be passed that requires anyone obtaining a new natural gas connection to install solar water heaters for at least 50% of their water heating requirement.

A typical solar water heater will save about 7,500 cubic feet of natural gas per year.[37] If all 2 million gas water heaters of SNGPL customers were converted to solar, 15 billion cubic feet of natural gas would be saved. Considering the 173 billion cubic feet[38] of domestic gas consumption in Punjab, this translates to a saving of about 9%.

Based upon the success of the trial phase of these solar water heaters installed at over 200 customers' houses, it is suggested that the SNGPL establish a business division for the supply and installation of these solar water heaters. At present the initiative is being taken by the CSR department of SNGPL. SNGPL offers its customers instalment options of up to 24 months. Financing institutions could collaborate with the SNGPL for higher volume financing to facilitate a larger scale programme for installation of the solar water heaters.

Savings in natural gas use due to the solar water heater will have an estimated financial payback within 5-7 years for the consumer. The existing instalment scheme without interest being offered by SNGPL makes this an easier choice.

The box illustrates the gas savings potential of solar water heaters.



[37] COMSATS, 2013, Shahmir Ahmed, Minimizing Gas Consumption Through Solar Water Heating
[38] HDIP, 2014, Energy Year Book

3.3.6. Home-based energy monitoring devices

Research shows that, on average, households that measure their energy consumption will modify their lifestyles and save energy. For example, in Queensland, Australia, a utility company distributed In-Home-Displays (IHDs) for energy to 340,000 households, which saved on average USD 300 per household per year.[39]

A similar survey conducted in the UK demonstrated that households using IHDs saved on average 18% on their electricity bill.[40]

These devices have remote displays, and can easily be installed when new houses are being constructed.

Energy monitoring devices

Utilities to distribute In-Home-Displays: Utility companies can offer these energy monitoring devices to their consumers on easy instalments based upon automatic deductions from the electricity bills.

3.4. Government policies, laws and plans

Considering the large shortfall between demand and supply of both electricity and natural gas, any reduction in demand from energy conservation measures in Pakistan will alleviate this strain, and in addition provide a number of other benefits such as reduction in consumer expenditure on energy, reducing greenhouse gas emissions and assisting Pakistan in meeting obligations to international conventions such as the UN Climate Change Convention and the UN Sustainable Development Goals 2016-2030, which now include energy as a separate goal.

ENERCON, the federal government agency with the mandate to promote energy conservation in the country, estimates that USD 5 billion per year can be saved through energy conservation measures.[41] The primary energy supply in Pakistan stands at 66.8 million TOE (Tonnes of Oil Equivalent) for 2013, according to the Pakistan Economic Survey 2013-14.

In addition to the mandate of ENERCON, there are a number of approved government policies, laws, rules and regulations that provide the impetus to increase energy conservation in Pakistan. Some of these are:

National Energy Efficiency and Conservation Act 2015: The Pakistan Parliament approved this bill in August 2015. As per the provisions of this legislation, a corresponding Board and Authority with wide-ranging powers to set standards, set up tribunals and enforce compliance will be established. ENERCON will be notified to act as the Authority under this law.

Distributed Generation and Net Metering Regulations 2015: NEPRA published these regulations in September 2015. The years 2015 and 2016 should thus focus on trials for both distributed generation and net metering. The autonomous Sundar Industrial Estate is an excellent facility to test Distributed Generation, and private housing schemes such as Bahria will provide an excellent platform for net metering, encouraging households to install grid-tied rooftop solar solutions.

National Power Policy 2013: Energy conservation is mentioned as one of its nine main goals, with focus upon reduction in demand due to increased efficiency and reducing losses in electricity transmission.

In addition to various federal government policies and plans, a number of provincial government policies and plans now prioritise energy efficiency and conservation needs. A few prominent provincial documents are mentioned:

Punjab Energy Efficiency and Conservation Programme 2015-18: The Punjab government has approved a Rs. 1.2 billion budget for this ambitious energy conservation programme.

[39] Efergy Pvt. Ltd.
[40] Ofgem data
[41] ENERCON website, www.enercon.gov.pk

Punjab Energy Department Annual Plan and Strategy 2012-13: The documents lays out in detail plans for enhancing efforts for energy efficiency and conservation in the province, including various plans for establishing renewable energy generation facilities. Punjab Growth Strategy 2018: Issued in March 2015, the strategy foresees the launch of a comprehensive Rs. 10 billion Energy Efficiency and Conservation Programme, which will last until 2019.

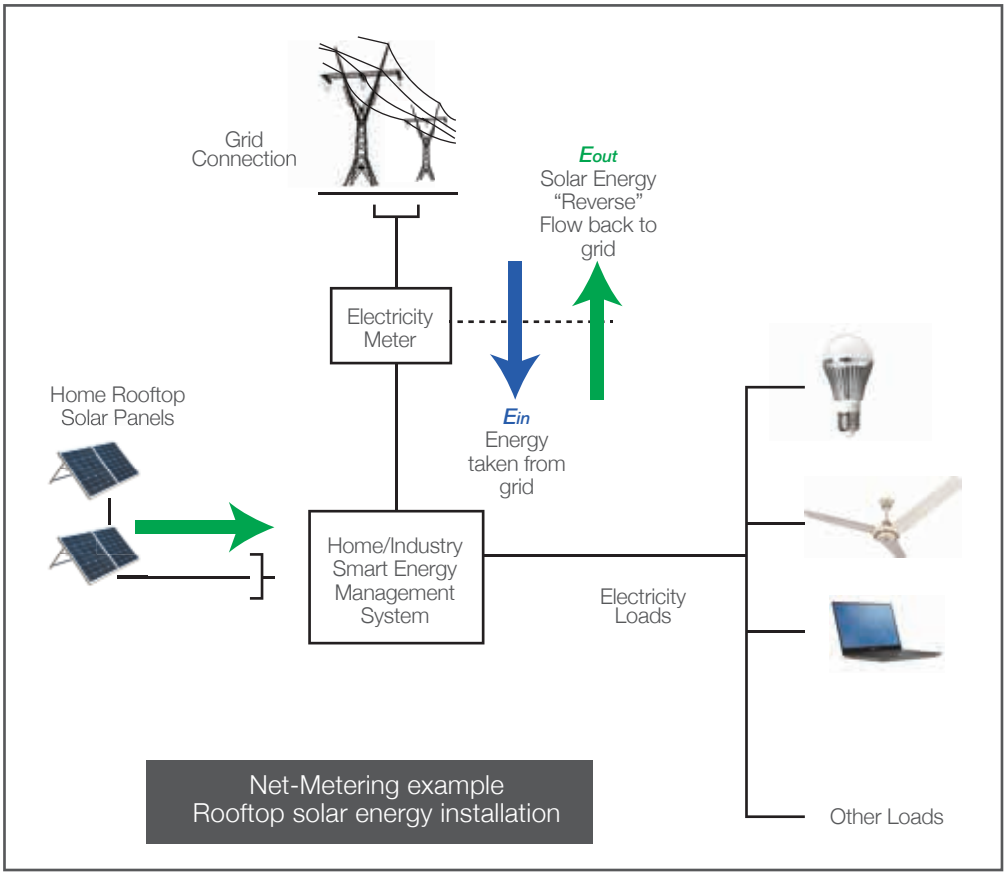
Punjab Power Generation Policy 2009: This comprehensive policy lays out plans for enhancing electricity generation. A main aim of the policy is to deregulate the electricity market to allow greater roles for decentralisation within the province and allow greater roles for the private sector.

Khyber-Pakhtunkhwa White Paper 2014-15: This Ministry of Finance budget support document puts emphasis upon promoting renewable energy, including small-scale hydropower and improving agricultural efficiency.

Since Punjab constitutes nearly 60% of the energy consumption of Pakistan, it carries a greater responsibility to implement energy conservation measures.[42] The dedicated Punjab Energy Department is already taking a number of steps to promote energy conservation.

3.4.1. Net metering

NEPRA passed the "Distributed Generation and Net Metering Regulations 2015" in September 2015, thus opening up opportunities for net metering. Pakistan is one of 98 countries[43] that have policies for net metering.



The diagram above[44] helps illustrate the concepts of net metering, and associated concepts of feed-in tariff and reverse metering.

[42] Institute of Public Policy (Beaconhouse National University) and Government of Punjab (2011)
[43] REN21, 2014 Renewables Global Status Report www.ren21.net
[44] Reproduced with permission from SHAMA Solar

Under common circumstances, electricity flows only in one direction from the grid to the home or consumer. In many countries of the world, governments have allowed homeowners to "feed in" energy produced within the homes, typically from rooftop solar installations back to the grid. This technical innovation requires that the energy flow both from the grid to the home and from the home to the grid are measured separately and the homeowner is billed according to a net tariff, representing the cost of electricity purchased from the grid minus the credit for electricity "sold" back to the grid by the homeowner. Thus net metering represents the "net" bill for electricity taken from the grid. In extreme circumstances, the consumer may "feed in" more energy back to the grid than they take; thus they may get paid accordingly by the distribution company for the net positive electricity they have received from the homeowner.

Thus, in summary:
Net Metering: It is the difference between the separate measurements of electrical energy taken from the grid by the homeowner, shown as Ein in the above diagram, and the energy fed in to the grid by the homeowner, shown as Eout. Depending upon government policies, the tariff for purchase of electricity and sale of electricity to the grid may be different, thus net metering is a term that encompasses both the technical process of measuring the difference between Ein – Eout and catering for the different tariffs applicable to these energy flows.

Feed-in Tariff: The electrical energy flowing back to the grid Eout will be credited to the homeowner according to an agreed tariff set by the distribution company. Many countries have utilised this mechanism successfully to encourage the installation of rooftop solar, whereby this feed-in tariff has been greater than the tariff for electricity purchased from the grid.

Reverse Metering: This concept indicates that the electricity meter that typically takes energy from the grid can run in "reverse" when energy flows back to the grid, in effect reducing the bill of the homeowner. In practical terms, often electricity meters have two separate readings, the first measuring energy consumed from the grid, and the second reading showing the total energy going back into the grid for a given period of time, usually a one-month period.

Considering net metering involves changes to the equipment, operating procedures, laws and billing rates, it may take some time before the recently passed NEPRA Regulations on net metering are actually implemented at the consumer level. In the interim, it is therefore important to test the technical, operational and legal elements in controlled trials. The electricity meters utilised for such applications cost almost the same as the regular meters, and some local manufacturers have already started trial production.

Suggested trials include:
Sundar Industrial Estate: This is a well-functioning autonomous industrial estate in the south of Lahore in Punjab. The industrialists can collectively establish a power generation facility, and individual factory owners can be given the net-metering incentive to install rooftop solar solutions.

Bahria Town housing estate: Considering Bahria Town already has a distribution licence from NEPRA, it can be encouraged to establish net-metering facilities for its homeowners, which will in effect subsidise the installation of rooftop solar solutions by the homeowners. Other housing estates with similar electricity distribution licences, such as Valancia Town in Lahore, may also be keen to undertake these trials.

K-Electric: During meetings with K-Electric senior professionals, they were enthusiastic in conducting net-metering trials, and looked forward to the necessary approvals from NEPRA. While NEPRA is at the moment in conflict with K-Electric on regulatory matters, the roll-out of net metering from K-Electric clients should still be facilitated by NEPRA on merit, as it will add convenience for the public and create a substantial reduction in electricity demand, since it would incentivise homeowners and businesses to install rooftop solar solutions.

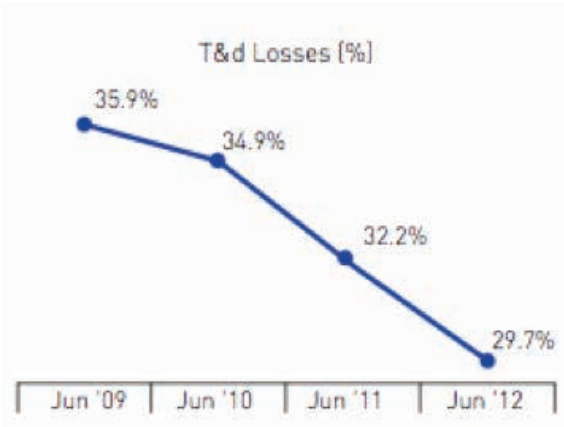
3.4.2. K-Electric, LESCO energy conservation initiatives

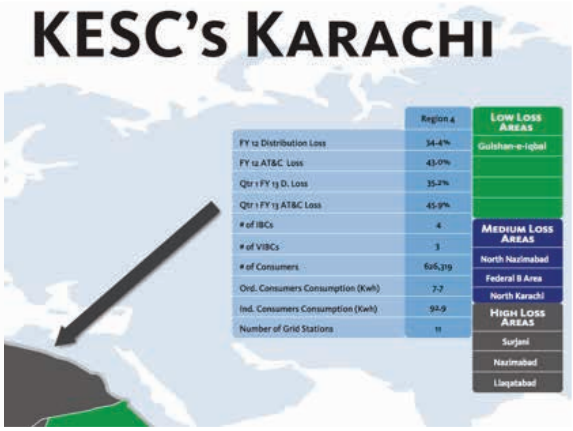
Karachi-Electric is the only private sector distribution company, and has run a comprehensive energy conservation plan.

To encourage consumers to conserve electricity, LESCO bills now show the change in electricity consumption compared to the previous year in their monthly bill.

K-Electric

K-Electric is the only distribution company that has a dedicated department for energy conservation, and it is taking a number of steps to enhance energy conservation. The organisation has a published environment policy, which aims to reduce greenhouse gas emissions. K-Electric monitors the Transmission and Distribution (T&D) losses and, as shown below, this has improved over the past years:





K-Electric recognises that a reduction of 1% in T&D losses translates to savings of Rs. 1 billion, and deploys this slogan in its energy conservation campaigns. A campaign that attracted attention was the link K-Electric made between the reductions in T&D of an area with the number of hours of load shedding. In this manner, reducing load shedding in that particular area rewarded collective good consumer behaviour. In areas with low losses, there is no load shedding.

K-Electric collaborates with universities such as NED University to conduct research on consumer appliances such as lights, fans and UPS. Jointly with Phillips, the company distributed a large number of energy-efficient lights to consumers.
K-Electric is keen to test pre-paid and net metering in selected areas of Karachi, to facilitate energy conservation measures by consumers including feed-in tariff, and reduce the overall electricity demand, which at present stands at around 3,100 megawatts, or more than 15% of the entire country.[45]

LESCO

The Lahore Electric Supply Company has been provided with a sophisticated remote monitoring smart distribution technology through USAID money. This facility enables the load managers to be aware of the electricity consumption of remote distribution areas, and thus control load shedding.

With assistance from the Asian Development Bank, LESCO is planning to conduct trials of smart metering in some locations.[46]

[45] Information gathered from author's discussions with representatives from K-Electric
[46] ADB Website

3.4.3. Non-governmental organisations/bodies

Pakistan Green Building Council
The Pakistan Green Building Council was established in 2012, and is associated with the World Green Building Council. At present the GBCP is facilitating the adoption of energy-efficient buildings by certifying them to standards set by the LEED certification system in the USA.

Over a short period of 3 years, the number of building initiatives that meet some criteria of the GBCP has grown to 16. This is expected to grow rapidly in the coming years. Examples of buildings that have signed up for certification under the stringent LEED USA certification include:

-Pebbles housing project
-Coca-Cola Multan Plant
-Artistic Garment Industry Pvt. Ltd., Karachi
-Mega Corporate Office Tower, Karachi
-British Council Library
-NCC Karachi
-Citiplan Bank, Karachi

In addition to the US LEED certification standards, GBCP is also developing indigenous building energy efficiency standards for encouraging more widespread adoption of these practices.

While the Pakistan Engineering Council has notified provisions for energy under the Pakistan Building Code regulations 2011[47] for buildings of a certain size, there is no clarity of enforcement methods. These energy codes provide a lot of detail, such as the air conditioning temperature is not to be kept below 25 degrees centigrade in the summer and not above 22 degrees centigrade in the winter, to conserve energy.

It seems that voluntary initiatives, such as those carried out through the following organisations, have achieved more in contributing toward the adoption of energy-efficient buildings in Pakistan:

-Institute of Architects of Pakistan
-Pakistan Institute of Interior Designers
-Construction Association of Pakistan
-Institute of Building Performance Standardisation Association
-HVACR Society
-Association of Builders and Developers of Pakistan
-Renewable Energy Association of Pakistan

According to a UN-Habitat and ENERCON research study of 19 different home energy improvement techniques, nine techniques were identified that bring a 7%-11% improvement in inside temperatures.[48]

[47] Pakistan Engineering Council, http://www.pec.org.pk/building_code_pakistan.aspx
[48] UN-Habitat & ENERCON, 2010: Energy Efficient Housing.

The table below lists the nine techniques, and the fourth best is surprisingly a simple lime wash paint on the roof surface, having the lowest cost of Rs. 3 per square foot per year.

Sr. No.	Solution	Temperature			10-yr cost (Rs/sqft)	Special Skills Needed
		3:00 pm	12:00 am	% temperature reduction at 3 pm		
	Outside Temperature (Degrees Centigrade)	41	32			
	Control house (no imrovements) inside temperature	36.2 ↓	36.7 ↓			
1	Paper board false ceiling	32.2	31.7	11.0	22	Y
2	Extruded Polystyrene (Jumbolon)	32.2	32	11.0	76	Y
3	Munawar AC Tiles	33	33.4	8.8	80	N
4	Lime wash	33.1	32.6	8.6	30	N
5	White enamel paint	33.1	32.9	8.6	80	N
6	Black tiles with stabilized mud	33.1	33.9	8.6	39	N
7	Mud with thermo pole	33.6	34.1	7.2	52	N
8	Smart concrete tiles	33.7	32	6.9	70	N
9	Weather shield paint (white)	33.7	32.6	6.9	80	N

Source: UN-Habitat, ENERCON, 2010: Energy Efficient Housing (Improvement of Thermal Performance of RC Slab Roofs)

WWF-Pakistan Green Office Certification

The World Wide Fund for Nature chapter for Pakistan, WWF-Pakistan, encourages offices to develop energy conservation initiatives, on the basis of which those offices can be certified as a “Green Office”. This certification is renewed every year through audits conducted by professionals from WWF-Pakistan.

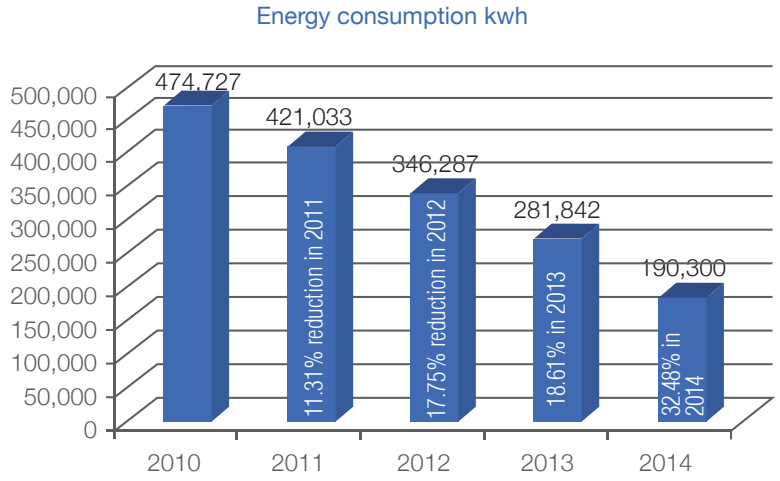
To date, 42 offices of organisations have obtained certification from WWF-Pakistan, and in the process improved their energy efficiency in a number of ways.

The table below shows the nine corporations that are certified Green Offices and have submitted data to WWF-Pakistan for analysis. They collectively saved 2.24 million units (kilowatt hours) of electricity, translating to an estimated saving of Rs. 37.8 million rupees in 2014. The WWF Green Office Certification is for office space only.

Sr. No.	Company Profile	kWhr Usage		kWhr in 2014	% Reduction
1	Engro Fertilizers	2010	474,727	190,300	59.9
2	Unilever	2011	3,688,098	2,185,711	40.7
3	Qarshi	2013	169,439	161,984	4.4
4	Engro Dharki	2012	935,360	934,080	0.1
5	Engro Polymer	2013	126,488	122,241	3.4
6	Engro Foods	2013	630,480	256,925	59.3
7	Engro Powergen	2013	105,324	92,287	12.4
8	Engro Zerkhez	2013	74,304	55,786	24.9
9	Sialkot Dry Port	2013	427,078	391,858	8.3

A dramatic decrease in energy consumption is evident from a mature Green Office corporation, Engro Fertilizers:

The WWF Green Office certified members take a number of initiatives to conserve energy, including both the adoption of energy-efficient technologies and changing the behaviour of their staff in the way they utilise energy.



3.5. Trade and energy savings opportunities

While there are no direct links between trade and energy savings opportunities, examples of a few opportunities linking responsible trade with energy savings are worth mentioning.

3.5.1. EU Directive on Energy

The EU Member States are obliged to issue country-level legislation to promote energy savings measures, and the ESOS of the UK, as mentioned above, is an example. Considering the presence of European-based companies in Pakistan, there is an opportunity to enhance the energy-savings measures of European companies operating in Pakistan.

3.5.2. Energy-efficient appliances and trade

The increased export of fans manufactured in Pakistan complement the potential benefit of developing energy-efficient fans, so that better prices could be negotiated by the country's manufacturers.

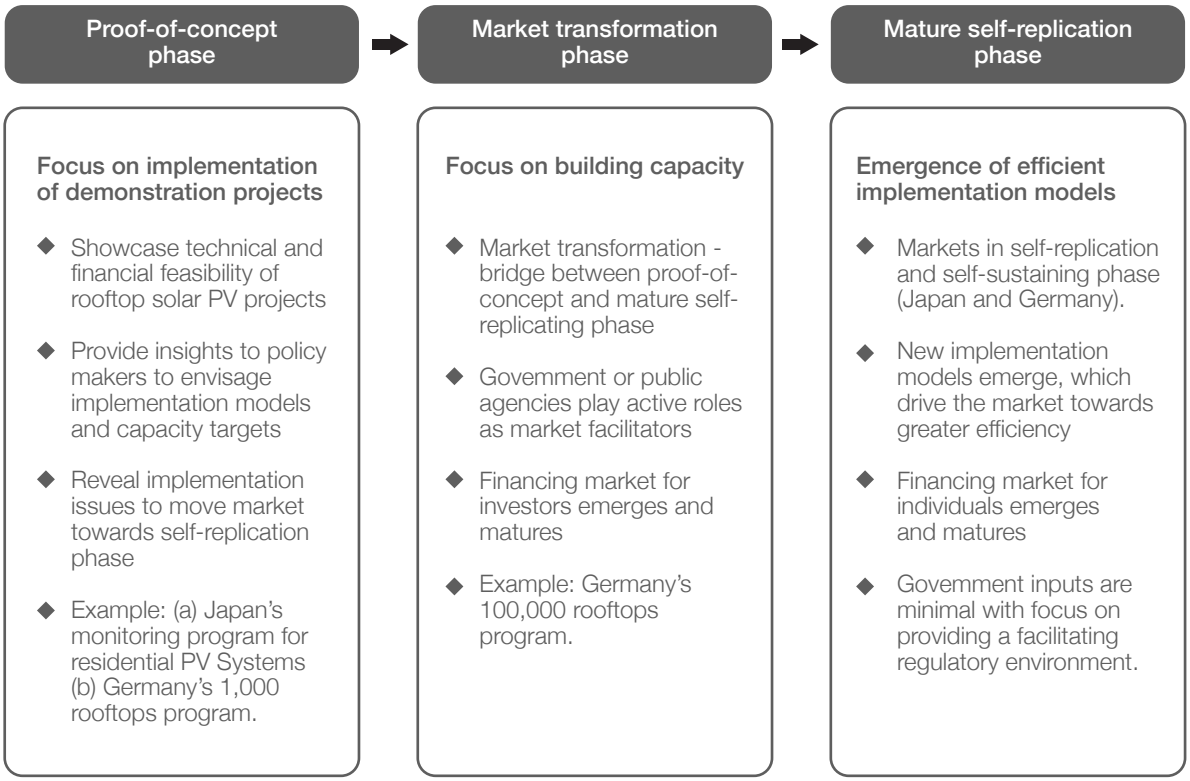
Energy Conservation in Pakistan: The Solutions

4.1.Approach to adoption of energy savings

In order to develop appropriate policies, strategies, laws and regulatory frameworks to enhance energy efficiency in Pakistan, a multitude of approaches will be required, finely tuned to the barriers that need to be overcome – there are no "cookie cutter" approaches. For example, it will be easy to implement mandatory labelling and Minimum Energy Performance standards (MEPs) for air conditioners, but not for backup UPS devices. Therefore, the transition to more efficient air conditioners and to UPS devices will require completely different approaches.

Consideration of energy efficiency gains is a relatively new approach, even in the West, and in most cases adoption of new technologies is involved. Adoption of new technologies can be both easy, such as with LED lights, which for many in Pakistan will be the first light they have ever had in their homes, or very difficult, such as for higher efficiency pump motors for farm irrigation. Thus a deeper understanding of the human nature involved in adoption of new technology will play a critical role in developing future plans to enhance energy efficiency in Pakistan.

The different phases for adoption of new technologies are explained well in an IFC publication for rooftop solar photovoltaic in India,[49] as shown below:



[49] IFC, 2014, Harnessing Energy From the Sun: White Paper on Grid-Connected Rooftop Solar Photovoltaic

Gas geyser cone baffles save 30% on gas: An SNGPL success story

Similar technology adoption phases in market adoption were also visible in the SNGPL introduction of the cone baffles for gas water geysers:

Proof-of-concept phase:
- Beginning 2009, SNGPL conducts own research, develops consistent product and demonstrates results in a number of pilot applications with selected consumers. Analyses technical and financial problems; overcomes them.

Market transformation phase:
- SNGPL introduces the concept to gas geyser manufacturers, and undertakes a mass awareness campaign to inform consumers that they will save natural gas and money when they use cone baffles.

Mature self-replication phase:
- By 2014 almost all gas geyser manufacturers provide the cone baffle as a standard component, and retail stores also sell cone baffles separately. The effort of SNGPL was a success in enabling market forces to introduce this energy-efficient technology.

4.2.National policies and laws for energy conservation

In the year 2015, two very important policy approvals took place:

- Passing of the energy conservation bill that empowers ENERCON to take legal measures to implement energy conservation measures;
- Approval by NEPRA to allow distributed power generation and net metering.

While the two policies mentioned above offer excellent opportunities to enhance energy conservation measures and increase the adoption of renewable energy based upon market dynamics, these will need to be introduced in measured phases. If a prescriptive and punitive process is followed, which is often the case in the introduction of new polices and laws in Pakistan, counter-intuitively there will be reduced success and even the risk that voluntary best practices may be reversed.

4.2.1. ENERCON initiatives

Building upon the contents of the various sections of this report, the following phases for implementing the energy conservation steps by ENERCON are an example of how such an approach might work:

Appliance:	% of total residential load[50]	Phase-1 (1-2 yrs)	Phase-2 (3-5 yrs)	Phase-3 (>5 yrs)
Lights	34	- Convert all gorvernment office lighting to LED - Convert all public street lighting to LED - Demonstrate success, publicise benefits - Mandatory solar lighting for billboards	- Make labelling mandatory for all imported lights to mention the energy efficiency rating - Conduct sample tests from market to verify authenticity of label and efficiency performance specifications	- Set legal Minimum Energy Performance standards, MEPs, for all LED lights - Disallow import of CFL, incandescent lights, except with special permission for special application

[50] Diagram on page 18

Appliance:	% of total residential load[50]	Phase-1 (1-2 yrs)	Phase-2 (3-5 yrs)	Phase-3 (>5 yrs)
Fans	33	- Work with the Pakistan Fan Manufactureres Association to voluntarily introduce energy-efficient fans. (50-watt fans already in the market) - Recognise and give awards to the most efficient fans	- Launch a fan replacement programme, whereby retailers offer to buy back old fans from consumers when they buy the energy-efficient fans. - Make energy efficiency labelling mandatory - Assist the fan industry to establish facilities to utilise and recycle components from the old fans	- Set MEPs for all fans
Refrigerators	7	- Work with local refrigerator manufacturers to develop a future plan to convert to higher efficiency models. - Conduct research to measure annual energy consumption differences between the different types/brands of refrigerators in the market	- Make energy-efficient labelling mandatory - Brand advertising by companies to always carry the message of energy conservation	- Set MEPs for all locally manufactured refrigerators - All imported refrigerators to also be of a minimum MEP, but accept other international labelling standards from other countries
Air Conditioners	5	- Work with local air conditioner manufacturers to develop a future plan to convert to higher efficiency models. - Conduct research to measure annual energy consumption differences between the different types/brands of refrigerators in the market	- Make energy-efficient labelling mandatory - Brand advertising by companies to always carry the message of energy conservation	- Set MEPs for all locally manufactured air conditioners - Only inverter-type to be allowed - All imported refrigerators to also be of a minimum MEP, but accept other international labelling standards

The State Bank of Pakistan can assist in guiding and encouraging the financial institutions to provide creative financing to energy conservation schemes, tailored for the domestic, industrial and agricultural sectors.

4.2.2. Introduction of distributed generation and net metering

Distributed generation and feed-in tariff approval by NEPRA is a welcome development, but it will need to be rolled out in cautious phases and it will need to be accepted that there will be a lot of learning to be done and obstacles to be overcome.
Some suggested early trials for feed-in tariff are:

- Encourage well-functioning autonomous industrial estates such as the Sundar and Hattar industrial estates to both set up their own distributed generation, and encourage feed-in tariff regimes such as through privately owned rooftop solar photovoltaic.

- Encourage private entities that possess electricity distribution licences, such as Bahria Town, and other well-functioning housing societies, such as Defence, to offer schemes of net metering to their homeowners.

4.2.3. Encourage sub-national target setting for energy conservation

All provinces, territories, municipalities and other large organisations should develop a process of target setting for energy efficiency. An example is that WASA sets targets of maximum energy consumption per capita for people within its area of jurisdiction. Districts, Tehsils and even Union Councils will be encouraged to set energy conservation targets.

The provinces of Punjab, Sindh and Khyber-Pakhtunkhwa have both unique opportunities and responsibilities to contribute towards energy conservation measures. Some examples are provided:

Punjab: Already seems to have taken the lead in establishing a dedicated energy department, and introducing a number of solar energy schemes. Considering Punjab has the largest population, including a large percentage without grid connectivity, the province needs to focus on distributed generation, off-grid household renewables and rooftop solar energy solutions. Considering most of Pakistan's irrigation pumps are in Punjab, the province should make a programme to convert to solar energy all 362,626 irrigation pumps that operate in areas of groundwater level 30 ft or below.[51]

The Punjab Urban Unit, an autonomous provincial government department, has a track record of excellent research and professional services. Their expertise in areas such as GIS planning and energy audits can be better integrated into the functioning of all relevant provincial line departments.

Sindh: Much of the country's 120,000 megawatt potential for wind energy is within the territory of Sindh. A number of wind energy projects have been commissioned, and many more are in the pipeline. Facilitating the urgent establishment of private wind energy projects itself offers the possibility to steer Pakistan out of its current energy shortfall within the next five years. Unlike solar, wind energy farms continue to give output during the night. An example of this is shown in the diagram below, showing the average wind speed over a 24-hour period in an area in Sindh for high wind potential:[52]

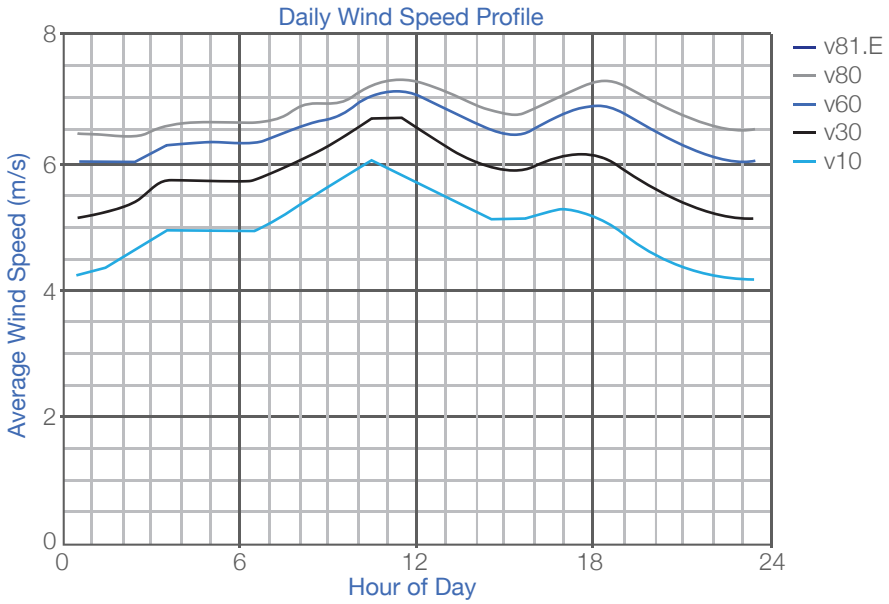


Figure 11: Diurnal Wind Speed profile for Baburband Mast.

Khyber-Pakhtunkhwa: The province can assist in the efficient implementation of the nationally important Dasu and Diamer-Basha hydropower projects. A major opportunity, however, lies in the province developing market dynamics for the implementation of hundreds of micro-hydro electricity generating projects, many of which can be collectively owned by the communities, rather than by private companies.

[51] Agriculture Census Organisation, Punjab, Pakistan
[52] EDB, 2010, Gharo-KetiBundar Wind Corridor

Azad Jammu and Kashmir, Gilgit-Baltistan and Baluchistan: Each province and territory should be facilitated in developing their own plans and aspirations to meet the energy needs of their population, especially from renewable sources.

4.2.4. Develop improved financing mechanisms

Energy-efficiency improvements often have a payback period for the consumer, and these need to be analysed and understood, and financing needs to be accessible, in order to implement the energy-conservation solution.

Financing of larger-scale renewable energy projects has been successful in arranging private and institutional finance, and the greater challenge is financing for the poor and for individuals wanting to adopt energy-efficient technologies and renewable energy solutions.

Some early initiatives have begun, and need to be better understood so that lessons can be learned from their experiences. Some of these are mentioned below:

State Bank allows rooftop solar as part of home loan: The State Bank passed a notification in May 2014 allowing people accessing housing finance to include the costs of solar solutions. This has not yet become a standard product in banks, although Bank Alfalah is an example that offers a number of solar solutions in instalments.

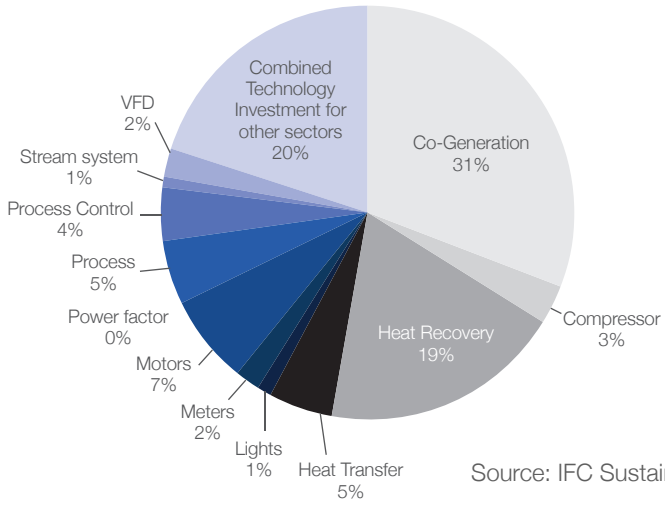
Eco-energy Finance: This company is providing solar energy solutions in instalments in selected areas of Sindh for off-grid solar energy solutions. It employs a device that is connected to the mobile phone network; thus the company can shut off the device from its remote location if the client does not pay the instalment in time. This Pay-As-You-Go (PAG) technology has tremendous potential for scaling up, as has been demonstrated in Africa.

Zarai Taraqiati Bank: This bank offers loans for solar energy-based irrigation pumps, but very few people have been able to benefit from the scheme.

NAMAs: Pakistan has developed a Nationally Adapted Mitigation Action (NAMA) for the conversion to energy-efficient lighting. The NAMA is an instrument to enable countries to access international finance for mitigation measures that reduce greenhouse gas emissions. The lighting and other NAMAs developed or being developed by Pakistan need to be followed up on and assistance given in arranging financing.

An IFC study[53] on sustainable energy finance provides a comprehensive sector-wise assessment of potential energy conservation measures, and estimates potential savings of 17.25% in primary energy use based on calculations for the year 2011-12.

For the industrial sector, based upon typical 3-year payback periods, an estimated Rs. 400 billion can be justified. The breakdown according to the industrial sector is shown in the pie chart below:



Source: IFC Sustainable Energy Finance, 2014

[53] Dr. Ricardo Ambrosini, 2014, Sustainable Energy Finance: The Opportunities in Pakistan

4.2.5. Establish a "Donor Coordination Group" for energy conservation

Considering billions of US dollars are being provided to Pakistan by various donor agency programmes, an improved coordination of these programmes will be of interest to both the donor organisations and to Pakistan. Many donor organisations already conduct activities in a coordinated manner, such as IFC and the German organisation GIZ.

This approach has been successfully followed in the case of donors for the environment, with the title "Environment Donors Coordination Group".

Donor offices could themselves adopt energy-conservation measures, such as improved building insulation and use of energy-efficient appliances such as lights and air conditioning. From amongst the donor offices, the British Council Lahore seems to be the only office listed as obtaining a Green Office certification through the WWF-Pakistan scheme.

Substantial investments in the future are planned for energy efficiency and renewables for Pakistan. A few of these are highlighted below:

GIZ: Is by far the most steady and hands-on donor in renewables and energy efficiency in Pakistan. It represents the German government, and at present employs 60 international and 380 national staff working in Pakistan. It coordinates the programme Renewable Energy and Energy Efficiency (REEE) project, which has passed through many phases, and is expected to continue until 2020. Another project funded through the German development ministry is BMZ, referred to as "ESPIRE", which is helping to develop ESCO (Energy Service Company) capabilities within the private sector by providing commercially viable energy-efficiency solutions for the industrial sector. GIZ is also effective in collaborating with other donor agencies, as it has partnerships with the European Commission, Norway, Australian Aid and IFC.

IFC: Is playing a unique role in facilitating improved market dynamics to meet the lighting needs of the 69 million in Pakistan that live off-grid as part of the "Lighting Pakistan" project. IFC has dedicated professionals that cover the whole spectrum of activities from field research to policy formulation, and actual testing of LED lights to improve quality standards. IFC also provides substantial financial assistance to many renewable energy and energy efficiency projects in the private sector. The recent IFC research published in 2014, "Market Study of Sustainable Energy Finance in Pakistan", provides an excellent overview for potential business investments to improve energy efficiency in all major sectors in Pakistan.

JICA: The Japanese agency is assisting in the replacement of WASA pumps with more energy-efficient ones.

UNDP: Barrier Removal to Energy Efficiency Standards and Labelling (BRESL) project, working closely with ENERCON, which has now concluded.

USAID: Energy Efficiency and Capacity (EEC) project, which has now concluded. USAID projects for energy efficient pumping have generated much data, and would be very useful in sharing with others for scaling up.

Asian Development Bank: The Bank has been providing substantial loans for the energy sector, and is planning a major USD 990 million project under the Multi-Tranche Financing facility for the roll-out of smart metering to improve efficiency of electricity distribution, and influencing energy conservation behaviour amongst consumers.[54]

UK government: While the UK does not have dedicated projects for renewables or energy efficiency, the large financial support of over GBP 300 million per year[55] means that there are many UK-funded projects that can integrate energy efficiency. The UK project "Pakistan Financial Inclusion Programme" is an example, which can help develop financing schemes for off-grid lighting and solar pumping for marginalised communities.

[54] http://www.ead.gov.pk/gop/index.php?q=aHR0cDovLzE5Mi4xNjguNzAuMTM2L2VhZC9mcm1EZXRhaWxzLmFzcHg%2FaWQ9NjMmYW1wO29wdD1uZXdzZXZlbnRz

[55] DFID, Summary of DFID's work in Pakistan 2011-2015

4.3. Agricultural irrigation practices

4.3.1. Potential for improving irrigation pumping efficiency

Pumping for irrigation water consumes substantial energy, mostly in the form of burning of diesel in internal combustion engines, either through diesel pumps or tractors used to drive pumps through belts.

Since about 90% of all tube wells[56] are in Punjab, the greatest responsibility and opportunity lies within Punjab province to improve energy efficiency in agricultural pumping.

The Agriculture Census Organization, Punjab, maintains detailed statistics about all irrigation pumps in Punjab according to each district and the depth of water table where they are installed. Bhakkar and Muzaffargarh districts have the largest number of these tube wells, at about 15,000 each.

Target Programme to convert tube wells at 30ft to solar: Considering the lower energy requirement for installing a solar pumping solution for pumps drawing water from these low water table areas, a targeted programme for these identified areas would have the most attractive payback period for farmers, and provide national energy efficiency gains provided the barrier of capital investment financing is overcome.

Of the 137.5 million acre feet (MAF) of water used for irrigation in Pakistan in 2012-13, 50.2 MAF, or 36.5%, comes from groundwater pumping.[57]

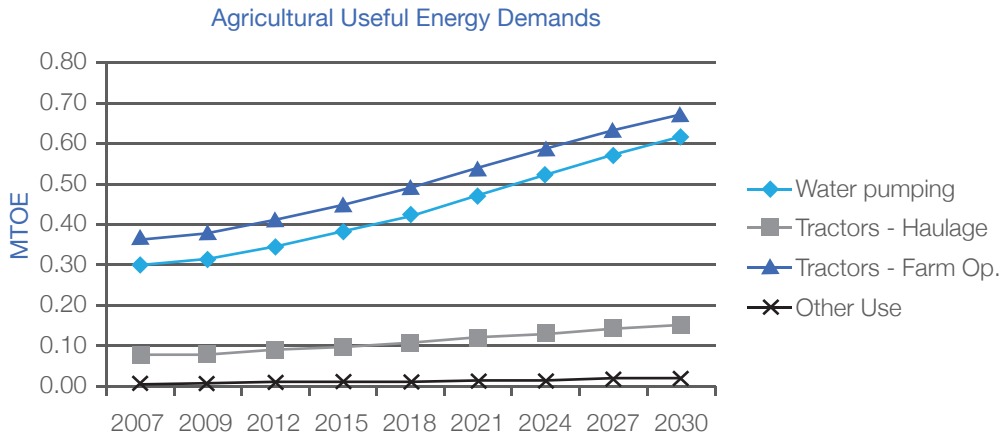
According to the Agriculture Census Organization, Punjab, there are 362,626 irrigation pumps in the province that are installed in areas with a water table of 30 ft or below. These are suited for conversion to solar energy pumping due to the reasonable capital cost involved.

Since there are about 1.2 million irrigation pumps in Pakistan, the above pumps represent about 30% of all irrigation pumps in Pakistan. Since 90% of these pumps use diesel either directly in diesel pumps, or tractor driven, converting the pumps to solar will mean about a 27% saving in diesel fuel consumption for irrigation pumping in Pakistan, which is a significant energy conservation measure.

With an estimated cost of Rs. 1 million for the installation of one solar pumping solution, for the farmer the payback period will on average be three years. With preferential financing on practical terms, this will be financially viable both for the farmer and the financing organisation.

4.3.2. Potential for improving tractor efficiency

There are an estimated one million tractors in operation in Pakistan.[58] The market leader is Millat Tractors, and meetings and discussions were held with senior professionals at Millat for the purposes of this report.



[56] Pakistan Agriculture Machinery Census 2004
[57] Planning Commission Annual Plan 2013-14: Chapter 8-Agriculture and Food Security, p.83
[58] Pakistan Automotive Manufacturers Association, 2015. http://www.pama.org.pk/

As shown in the chart above, tractors are the largest energy consumer. Interestingly, apart from the use of tractors for regular farm duties, over 200,000[59] irrigation pumps in Pakistan are being operated upon with tractors directly through pulleys, rather than pumps running with electricity.

As an example, the three main practices of using tractor implements for rice cultivation are as follows:

Cultivator: To plough the land
Disc Harrow: For mixing the soil and water, often referred to as puddling
Leveller: To level the land before sowing

Millat Tractors now offers a multipurpose set of implements, which are installed on the tractor in such a manner that all three functions are achieved during one driving operation on the land, thus saving about 50% of the fuel consumption, as compared to the existing prevalent farming methods of using the tractor for rice cultivation. The cost of this multipurpose unit is similar to that of the regular implements.

The table below shows the estimated savings for tractor use for rice cultivation by switching to this more energy-efficient method.

Rice Area under cultivation (million acres)	Assume 80% of the total rice area uses tractors for cultivation (million acres)	Tractor diesel fuel consumption per year with existing inefficient practices: 6 litres/acre (million litres)	Total diesel savings potential per year by converting to efficient implements: 50% saving (million litres)	Equivalent savings for farmers per year, in reduced cost of tractor @ diesel cost of Rs. 80/l
5	4	24	12	Rs. 960 million

While the energy and cost savings potential is substantial, the feasibility of implementing such a change in farming practices may be difficult.

4.4. WASA energy conservation potential

A study conducted by the Urban Unit Lahore[60], presented in January 2015, demonstrated the tremendous energy and cost savings that can be realised by efficiency improvements in the 754 pump-motor sets in WASA Lahore with electricity costs of about Rs. 3 billion for 2014. The low power-factor penalty in itself cost WASA Rs. 21 million in 2014. Based upon detailed energy audits conducted by the Urban Unit, Government of Punjab, it is estimated that annual savings after energy efficiency improvements will be over Rs. 400 million per year, and the cost of undertaking these measures was estimated at Rs. 62 million.

The potential energy efficiency savings for the tubewell and disposal stations (TW & DS) for WASA Punjab of Rs. 700 million per year are summarised in the table below.

[59] Directorate of Crop Reporting Services Punjab, June 2014 data
[60] Punjab Cities Governance Improvement Project, January 2015, Engineer Abid Hussainy

4.5. Scale of impact and feasibility of implementation

Although Pakistan continues to face severe energy shortages, it is not difficult to foresee that, within a period of five years with consistent policies, sustained effort and market dynamics, the country will be able to overcome its energy shortage.

The availability of 120,000 megawatts of wind energy potential, if efficiently materialised, itself carries the key to providing long-term renewable energy for Pakistan's growing energy consumers.

The table below summarises the recommended priority measures that will have a high positive impact on energy conservation. The ease or difficulty of implementing these measures will vary significantly, as indicated in the table below.

Energy Conservation Measures of High Impact								
Sr. No.	Energy Efficiency Measures	Potential Impact						
		H=High M=Medium L=Low	Scale of Impact	Quantitative Energy Saving Estimate	Load-shedding reduction (Assuming 4,000 MW shortfall)	H=High M=Medium L=Low	Barriers	Possible Solutions
1	Conversion to Energy Efficient Lighting	H	Pakistan's Electricity Consumption	9.3%	47.0%	H	Upfront cost	Financing
2	Conversion to Energy Efficient Fans	H	Pakistan's Electricity Consumption	7.7%	39.0%	M	1-Technology improvement 2-Fan manufacturers support 3-Buy back of old fans	Work with the fan manufacturers association
3	Conversion of 350,000 low-water table (30ft) irrigation pumps to solar	H	Total irrigation pumps in Pakistan	Fuel Savings for 30% of all pumps in Pakistan		M	1-Technology standard 2-High upfront cost 3-Specialised maintenance	Rural outreach, skills enhancement, farmer finance solutions
4	Conversion of domestic gas water-heaters to solar	H	SNGPL domestic gas demand	9% gas savings		H	Scaling up	SNGPL to access finance
5	National Level Policy/ Regulation	H	National			M		
6	Energy Conservation Donor Coordination Group	M	National			M	Each has own priorities	Donor Coordination Group
7	Sub-National Policies and Targets	M	Provincial/ Department			M		
8	Fridge replacement programme	M	Low income group			L	Upfront cost of new fridge	Fridge buy-back for poor