RENEWABLES
READINESS ASSESSMENT

# PAKISTAN

April 2018

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## About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

## Acknowledgements

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# PAKISTAN

# FOREWORD
## from the Minister of Energy

As a developing country undergoing industrialisation, Pakistan has seen its energy demand increase by over 5% annually in recent years. Yet the country has suffered a succession of severe energy crises because of inadequate development on the supply side, which has crippled economic growth.

Overcoming energy challenges requires dedicated efforts, commitment and resolve by all stakeholders in the power sector. In line with the current government's broad development vision, reliable electricity supply has lately been established to match today's demand. The Power Division at the Ministry of Energy has taken remarkable strides in promoting a coherent strategy for the sector. Support from local and international partners has also contributed greatly to the improved reliability of power supply.

Now, Pakistan is gearing up to utilise other energy potential, including renewables, to meet further increases in power needs. The Government of Pakistan is devising policies, plans and programmes to include clean, affordable and sustainable energy supply based on greater shares of renewables in the energy mix. These energy supply plans form part of Pakistan's sustainable development agenda. Installed capacity of alternative and renewable energy sources in the power sector has already risen from 0.2% in 2013 to 5.2% of total installed capacity in 2018. Ongoing policy reforms, regulatory transformations, infrastructure development and investment incentives aim to ensure clean, cheap and continuous supply that includes a steadily growing share of renewable energy.

A lot more room remains for renewable energy growth. The government is working hard on measures to promote such sources through the National Electricity Plan. This would boost Pakistan's energy self-reliance, as well as contributing to our international commitments to reduce greenhouse gas emissions and help to limit global warming.

The International Renewable Energy Agency (IRENA) has provided valuable policy guidance and technical assistance to determine our best available renewable-based power options. Pakistan's Renewables Readiness Assessment (RRA) represents a much-needed step that can help to shape further policy making, investment opportunities and energy development actions.

The resulting guidance should help to devise effective implementing mechanisms for renewables and simultaneously improve the country's energy security. Greater reliance on indigenous energy resources would provide economic benefits, averting the power shortages that have cost about 2% of gross domestic product in recent years. It would also strengthen environmental protection and mitigate the country's carbon footprint. Finally, it would help us achieve social equity, particularly by driving development in areas that are not connected to the grid.

This report has highlights key initiatives including competitive bidding for new renewable power, net metering to support distributed generation, strategic infrastructure development, and policies to create a conducive environment for deploying renewables. All these are prerequisites for Pakistan's broader pursuit of a sustainable future.

The Government of Pakistan and the Ministry of Energy greatly appreciate the insights arising from the RRA process. The recommendations made in this report are sure to be considered in decisions about any future course of action in the power sector.

**Awais Ahmed Khan Leghari**
**Federal Minister for Energy (Power Division)**
**Government of Pakistan**

# FOREWORD
## from the IRENA Director-General

Pakistan, like other South Asian countries, grapples with the challenges of a large and growing population, combined with rapidly growing energy needs. Heavily dependent on fossil-fuel imports, the country finds itself vulnerable to global oil price volatility. It could also, despite recently stabilising its power supply, potentially face a return to electricity shortfalls in the years ahead.

In response, the federal government has resolved to pursue low-carbon energy options, both to bolster energy security and to spur sustainable economic growth. Pakistan has responded positively to the global call to tackle climate change, ratifying the Paris Agreement in 2016. Renewable energy technologies, in this context, have come to the fore in national planning and policy-making.

Pakistan introduced a comprehensive renewable energy policy in 2006, making private investment in the sector commercially viable. Since 2015, the installed capacity of other renewables has edged above 1 200 megawatts (MW), including nearly 600 MW of wind power, 400 MW of solar photovoltaic, 50 MW of small hydropower, and 160 MW from biomass. Renewable-based projects currently under development will provide another 2 000 MW. Large hydropower dams, which now meet one third of electricity needs, could provide considerably more if sustainability requirements can be met.  Yet, the full possibilities of hydropower, along with tremendous solar, wind and biomass potential, are yet to be exploited. These sources can help put the country on a path to long-term prosperity.

This Renewables Readiness Assessment (RRA), undertaken in co-operation with the Government of Pakistan, examines the energy sector holistically, identifying key actions to accelerate renewable energy deployment. The study puts forward options to strengthen Pakistan's policy, regulatory and institutional framework for renewables. It suggests ways to strengthen renewable energy targets, examines the constraints of existing grid infrastructure, highlights the best mechanisms to reduce costs and ease technical challenges, and underlines the potential for private investment in renewables for off-grid and rural electrification.

Over 30 countries, spanning Africa, the Caribbean, Latin America, the Middle East and the Asia-Pacific region, have undertaken the RRA process since 2011, exchanging knowledge and supporting international co-operation to promote clean, indigenous renewable energy technologies.

I would like to thank the Alternative Energy Development Board and the Federal Ministry of Energy for their support in the preparation of Pakistan's RRA study. Insights from other governmental agencies and a wide range of other stakeholders have further enriched this study. The International Renewable Energy Agency (IRENA) looks forward to working with all of them, as well as with development partners, to translate these recommendations into practical on-the-ground initiatives, promoting renewables as a key element in sustainable, equitable socio-economic development.

I sincerely hope these RRA findings will strengthen Pakistan's pursuit of renewable energy solutions. IRENA stands ready to assist in accelerating the country's transition to a sustainable energy future.

**Adnan Z. Amin**
**Director-General**
**International Renewable Energy Agency**

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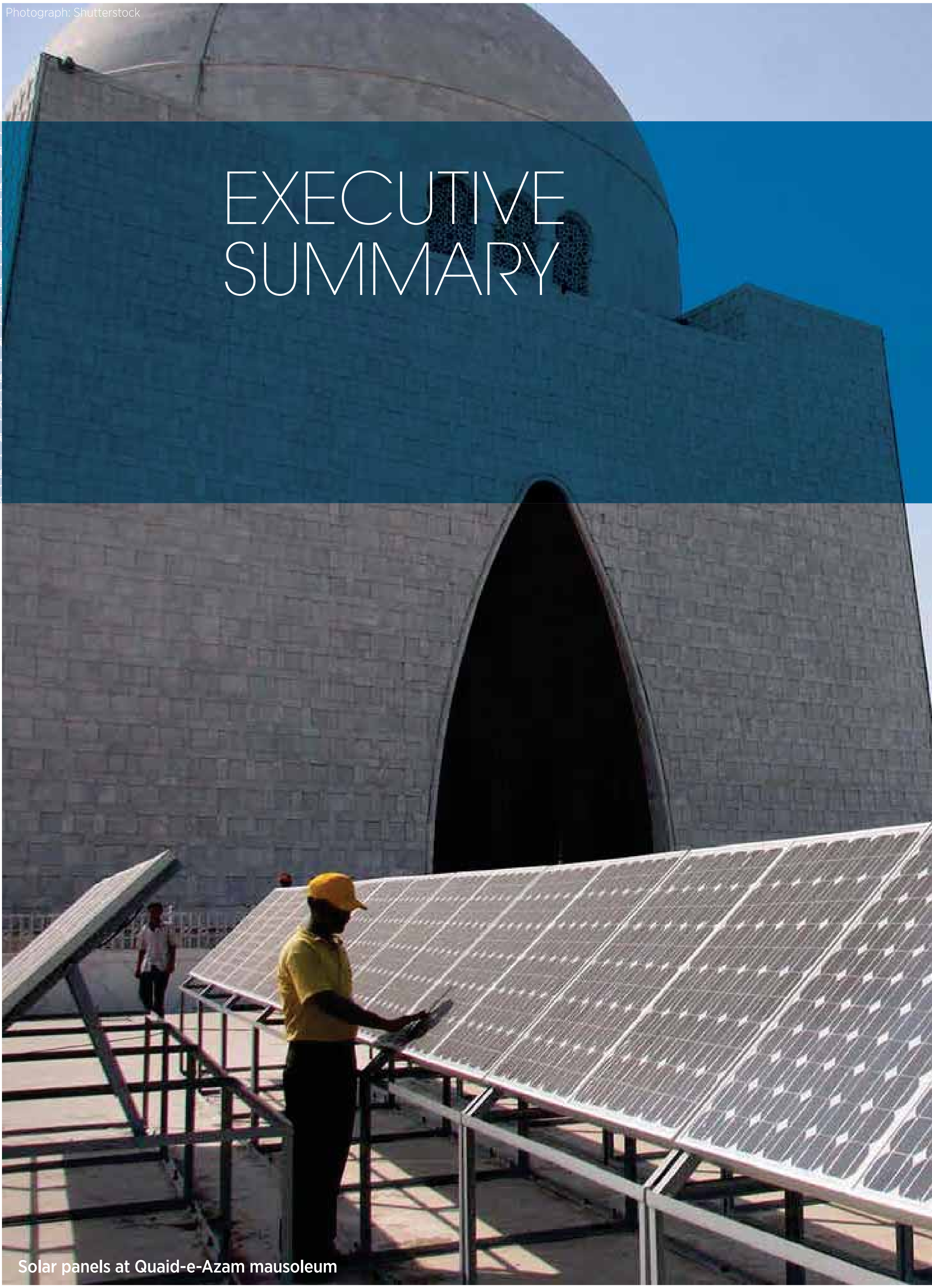
# BOXES

# ABBREVIATIONS

| | |
|---|---|
| **AEDB** | Alternative Energy Development Board |
| **BOOT** | build, own, operate and transfer |
| **COD** | commercial operations date |
| **CPEC** | China-Pakistan Economic Corridor |
| **CPPA** | Central Power Purchasing Agency |
| **CPI** | consumer price index |
| **D/C** | double circuit |
| **DISCO** | distribution company |
| **EPC** | engineering, procurement and construction |
| **ESMAP** | Energy Sector Management Assessment Program |
| **FESCO** | Faisalabad Electric Supply Co. |
| **FF** | foreign financing |
| **FWEL** | Foundation Wind Energy-I Limited |
| **FY** | fiscal year |
| **GEPCO** | Gujranwala Electric Supply Co. |
| **GENCO** | State-owned generation company |
| **GDP** | gross domestic product |
| **HESCO** | Hyderabad Electric Supply Co. |
| **IEA** | International Energy Agency |
| **IOREC** | Off-grid Renewable Energy Conference |
| **IPP** | independent power producer |
| **IRENA** | International Renewable Energy Agency |
| **IRP** | integrated resource plan |
| **KIBOR** | Karachi inter-bank offered rate |
| **LESCO** | Lahore Electric Supply Co. |
| **LF** | local financing |
| **LIBOR** | London inter-bank offered rate |
| **LNG** | liquefied natural gas |
| **LPG** | liquefied petroleum gas |
| **MEPCO** | Multan Electric Power Co. |
| **MW** | megawatt |
| **n/a** | not applicable |
| **NDC** | Nationally Determined Contribution |
| **NEPRA** | National Electric Power Regulatory Authority |
| **NGO** | non-governmental organisation |
| **NTDC** | National Transmission & Dispatch Company |
| **O&M** | operation and maintenance |
| **PAEC** | Pakistan Atomic Energy Commission |
| **PEPCO** | Pakistan Electric Power Company |
| **PESCO** | Peshawar Electric Supply Co. |
| **PPAF** | Pakistan Poverty Alleviation Fund |
| **PPIB** | Private Power and Infrastructure Board |
| **PKR** | Pakistan rupee |
| **PV** | photovoltaic |
| **QESCO** | Quetta Electric Supply Co. |
| **RRA** | Renewables Readiness Assessment |
| **S/C** | single circuit |
| **SCARP** | Salinity Control and Reclamation Programme |
| **SEPCO** | Sindh Electric Power Co. |
| **TESCO** | Tribal Areas Electric Supply Co. |
| **TGF** | Three Gorges First |
| **t/line** | transmission line |
| **ToU** | time of use |
| **TPES** | total primary energy supply |
| **USAID** | United States Agency for International Development |
| **USD** | United States dollar |
| **WAPDA** | Water and Power Development Authority |
| **GW** | gigawatt |
| **km** | kilometre |
| **kV** | kilovolt |
| **kW** | kilowatt |
| **kWh** | kilowatt hour |
| **$m^2$** | square metre |
| **Mtoe** | million tonnes of oil equivalent |
| **MVA** | megavolt ampere |
| **MW** | megawatt |
| **MWp** | megawatt peak |
| **Tscf** | trillion standard cubic feet |
| **V** | volt |

Photograph: Shutterstock

# EXECUTIVE SUMMARY



Solar panels at Quaid-e-Azam mausoleum

Over the past decade Pakistan has been experiencing a widening gap between power demand and generation, with continued growth in energy demand and inadequate investment in generation infrastructure. The shortage reached as much as 7 gigawatts (GW) in 2012, but has generally swung between 4 GW and 6 GW. This has negatively impacted economic and social development in Pakistan and thus the Government of Pakistan has given priority to addressing this challenge.

Pakistan's primary energy mix comprises natural gas, oil, hydropower, coal and nuclear energy. Natural gas accounts for the lion's share of the energy mix. With little capacity to expand domestic gas production due largely to reduced proven reserves, demand has inevitably been met by imports. Pakistan entered into a 15-year agreement with Qatar in February 2016 for the import of up to 3.75 million tonnes annually of liquefied natural gas (LNG), increasing supply while at the same time weakening energy security. The share of oil in total primary energy supply has risen consistently since 2006, representing 36% in 2016. Moreover, nearly one-third of the country's oil demand is met by imports, exposing the country not only to the budgetary burden, but also to the risks presented by the volatility of oil prices on international markets.

With respect to rural energy, more than half of the total population still reside in rural areas and rely on traditional biomass use. Among the rural population, only half have access to electricity. The lack of affordable modern energy carriers and exposure to indoor pollution have been persistent challenges in addressing poverty issues in the country. Several provincial governments introduced rural energy initiatives, with renewable energy as a promising solution, in addition to the Pakistan Poverty Alleviation Fund, a non-government entity supported by bilateral and international donors, prioritising energy provision to rural communities across the country. However, increased and continued efforts are needed.

Pakistan has abundant renewable energy resources that can be utilised for power generation and end-use sectors. Hydropower, with its potential in the northern provinces, has traditionally been the most prominent source of renewable energy in Pakistan. Yet existing installed capacity remains far below the country's economically and technically viable 60 GW potential of all scales and types, including the significant potential for development of small-scale (1-50 megawatt [MW]) run-of-river hydropower. Solar energy resources are mostly in the southern and southwestern parts of the country. With declining photovoltaic (PV) technology costs, the sector is taking off following the completion of 400 MW of solar PV projects in 2015-2016. This has also provided more than 15 500 job opportunities for local people, due to the fact that most of this workforce is involved in small-scale residential and commercial deployment, which tends to be more labour-intensive than utility-scale installations.

Wind potential has been identified in the provinces of Sindh and Baluchistan in southern Pakistan. With an approximate theoretical potential of over 50 GW, the Gharo-Keti Bandar wind corridor in southern Pakistan was prioritised by the government at the very beginning of renewable energy development in the country. At the moment, all the installed wind power in Pakistan is in this corridor. The World Bank-ESMAP Renewable Resource Mapping Project for Pakistan has mapped out the country's biomass resources, with 25 million tonnes per year of biomass feedstocks from industrial and agricultural residue that can be made available for use. In addition, the study indicates that around 26 000 tonnes of municipal waste are produced across the country every day.

However, this Renewables Readiness Assessment (RRA) finds that several key challenges would need to be effectively addressed to further exploit indigenous renewable energy resources and therefore overcome the present energy crisis. To this end, the following recommendations are provided to the Government of Pakistan for consideration in its future policy-making processes.

1. **Co-ordinate development and implementation of an integrated energy plan**

   Given that Pakistan's provinces are empowered under the constitution to devise their own power policies, plans and infrastructure, the need arises for the development of an integrated national energy plan, building on past endeavours and crafting a well-co-ordinated development plan for the renewable energy sector. This could assist policy makers in evaluating the costs and benefits of both demand-side and supply-side interventions under given sets of technological, economic, resource and environmental constraints, including the reduction in greenhouse gas emissions through Pakistan's Nationally Determined Contribution (NDC).

   In addition, the current ownership structure of the various power market sectors, the availability of renewable resources across the provinces and the constitutional powers of provincial governments further accentuate the need for an integrated planning process. Furthermore, an integrated plan would help set priorities for the technology, volume and location of renewable energy projects, which would make the competitive bidding process for renewable energy technologies more effective and sound.

   The process should involve stakeholders from the public and private sectors considering investment in power generation, transmission, distribution and energy efficiency. It needs to be designed and implemented in a collaborative and participatory manner. This would also help ensure its ownership by various stakeholders and levels of government.

2. **Set targets for renewable energy development**

   Pakistan has no clear renewable energy target, despite the political ambition that policy makers have expressed on various occasions. To translate political will into a language that can be understood by investors, a clear target first needs to be set. Specific obligations, such as renewable portfolio standards, tend to be more effective because they ensure measurability and are mandated by law. This assures investors that they are less vulnerable to changes in the political climate. For Pakistan, such targets imply the introduction of an act duly approved by the Parliament and Senate. This would require either a consolidated target or the assignment of renewable portfolio standards to distribution utilities.

3. **Encourage renewable energy zoning and competitive procurement to reduce overall system costs**

   The cost of renewable energy projects has come down significantly in Pakistan. Yet they are still generally higher than thermal energy. The National Electric Power Regulatory Authority (NEPRA) directive to introduce competitive bidding for solar and wind projects by using benchmark tariffs as the ceiling for a reverse auction offers a great opportunity to further decrease the cost.

   Competitive procurement mechanisms, such as auctions, can procure renewable energy at the lowest possible price if there is significant interest from investors and thus a high degree of competition. Policy makers must therefore address any barriers posed by the wider framework to supporting renewable energy. Policy consistency and predictability have significant influence on private-sector investment decisions. Since Pakistan plans to introduce auctions for solar and wind, the commissioning of such projects in designated renewable energy zones should be encouraged whenever possible. To alleviate concerns that renewable energy projects make grid operations difficult, new renewable energy zoning should consider and synchronise with existing government grid development plans.

4. **Involve the private sector in the development of transmission infrastructure to enhance the grid**

   The limited financial resources of the National Transmission & Dispatch Company (NTDC) have created a serious challenge to meeting the need for transmission line development. Some development partners are providing financial assistance for infrastructure development in Jhimpir and Gharo. However, development funding might not suffice for the scale of investment required to satisfy the infrastructure needs. With initial experience gained from the implementation of the dominant Private Power and Infrastructure Board (PPIB) Transmission Line Policy 2015, the country should explore further the possibility of involving private-sector partners in developing transmission lines. This would reduce the government's requirement to mobilise public funds and allow grid expansion and reinforcement, grid code amendments and construction of new substations to take place on time.

5. **Devise a comprehensive distributed power generation plan**

   The existing net-metering regulations provide an opportunity for distributed power generators, particularly those operating small-scale solar PV systems, either household systems at the kilowatt level, or industrial and commercial systems with capacity even reaching the MW level. Given the importance of grid stability and reliability, as well as overall financial viability to the distribution utilities, the technical and financial impacts of distributed power generation on grid operations should be carefully examined. More specifically, a rigorous analysis of distributed power generation potential and its impacts on the economics of the power market is advisable, to be conducted to ensure the fair distribution of anticipated benefits gained through the net-metering schemes. On the basis of this analysis, a comprehensive distributed power generation plan should be devised.

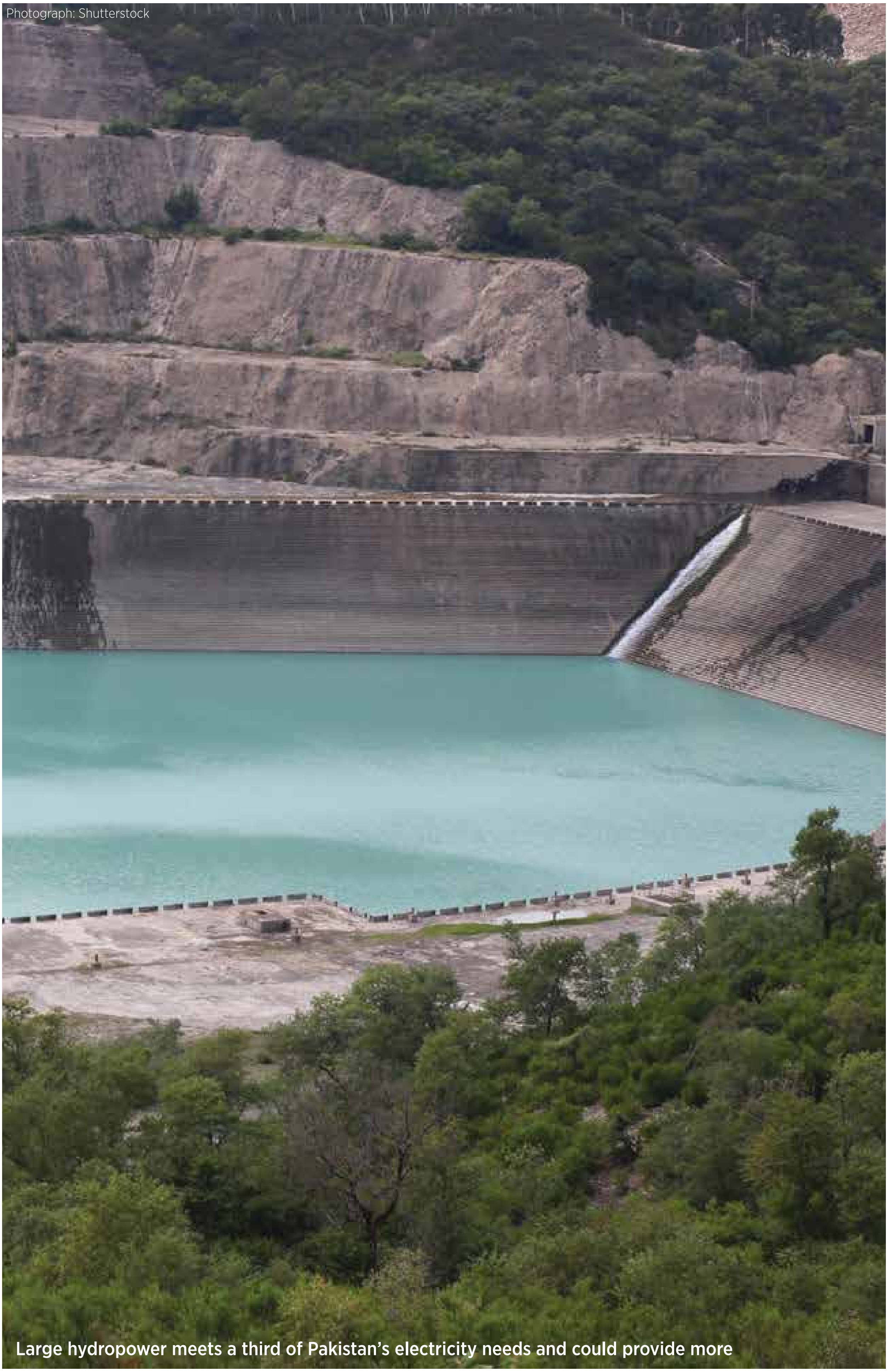
6. **Develop policy and regulatory frameworks and implementation mechanisms facilitating private-sector engagement in rural electrification**

   At the federal government level the focus is primarily on utility-scale projects. Applications promoting stand-alone systems or mini-grids that have proved successful in many developing countries have yet to be applied in Pakistan. Policy, economic and technical barriers remain relatively high, impeding the growth of this particular market segment. The serious lack of technical expertise is also a factor among others limiting the use of micro/mini-grids for rural electrification.

   On the policy side, thus far no federal or provincial agency or department has formulated an effective implementation mechanism for policies addressing the rural electrification issues. In addition to such policy constraint, rural electrification is conventionally perceived as presenting high commercial risk and investment need, facing the challenges of limited knowledge of market potential and lack of financing and government support. Pakistan is not an exception.

In this context, the Government of Pakistan is advised to consider developing policy and regulatory frameworks and implementation mechanisms to facilitate private-sector engagement in rural electrification. Pakistan is particularly advised to take a closer look at the role of micro- or mini-grids powered by renewable energy sources, due to their capability to enable the productive use of electricity. More specifically, a study should be conducted on how such policy and regulatory frameworks and implementation mechanisms could be developed to foster a healthy ecosystem, facilitating private-sector engagement in developing micro- and mini-grids and allowing the public sector to leverage the private sector in addressing the challenge of rural electrification in Pakistan.

In conclusion, Pakistan faces a complex energy challenge. The choice the government makes today to address those challenges will have significant impacts tomorrow. With abundant renewable energy resources in the country and dramatically decreased technology costs, renewable energy presents a promising solution. However, to capitalise on such potential, the right enabling framework needs to be put in place and the identified technical, policy, regulatory and financing barriers have to be overcome.

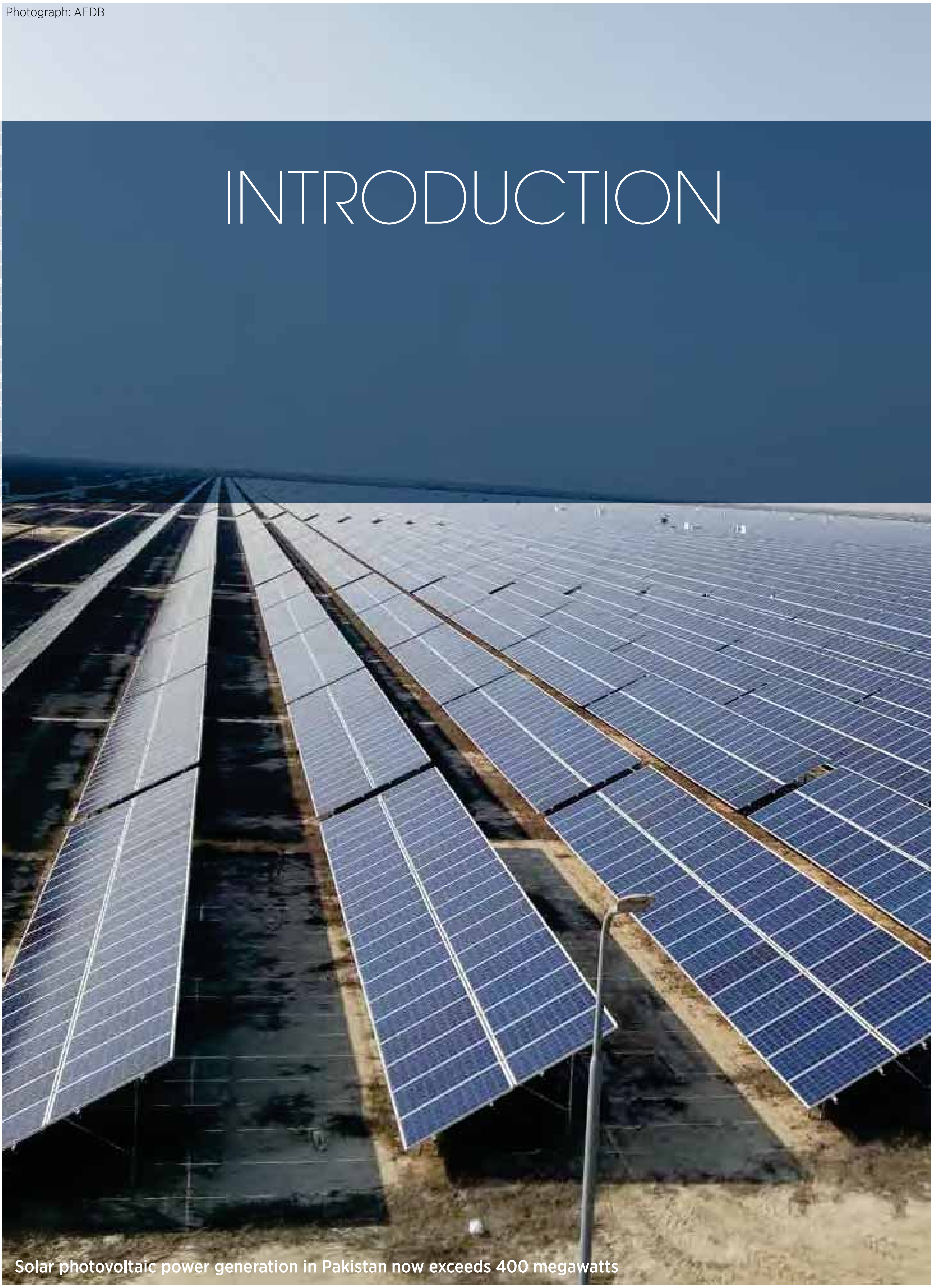


Photograph: Shutterstock

Large hydropower meets a third of Pakistan's electricity needs and could provide more

Photograph: AEDB

# INTRODUCTION



Solar photovoltaic power generation in Pakistan now exceeds 400 megawatts

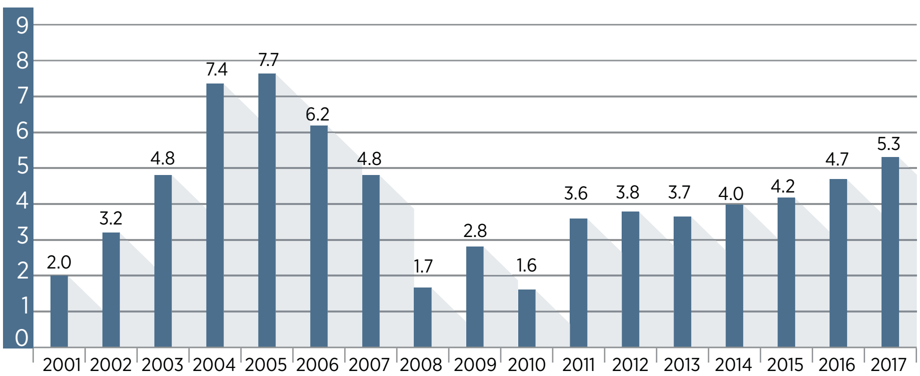
# 01

The Islamic Republic of Pakistan is in the northwestern region of South Asia where the Middle East meets Central Asia. It borders India to the east, Iran and Afghanistan to the west and China to the north. It has a southern coastline along the Arabian Sea. With an estimated population of 195.4 million, it is the sixth most populous country in the world (Ministry of Finance, 2016).

## 1.1 Economy and outlook

In recent years, the country's economy has shown signs of improvement. Gross domestic product (GDP) grew by 5.3% in fiscal year (FY) 2017, the highest growth seen since 2007 (Figure 1) (Ministry of Finance, 2017).[1] This growth can be attributed to several factors, including improved foreign exchange reserves, a reduced budget deficit and better security (Ministry of Finance, 2016). Two other important factors have helped economic stability: a steep decline in international oil prices and growth in foreign remittances.

**Figure 1.** Annual GDP growth rate (FY 2001 to FY 2017)




Based on Ministry of Finance, 2017

[1] Based on: World Bank (2016); Ministry of Finance (2017), *Pakistan Economic Survey 2016-17*

In the government's official statistics, the agriculture sector posted a growth rate of 3.46% in FY 2017 compared to 0.27% in FY 2016 (Ministry of Finance, 2017). In FY 2017, the industrial and service sectors posted growth rates of 5.02% and 5.98% respectively. To further improve macroeconomic stability, the government has placed particular emphasis on fiscal reform and made efforts to standardise monetary management, which improved Pakistan's credit rating. Moody's, for instance, increased its rating from CAA1 with "negative outlook" to B3, implying that the sovereign government's creditworthiness and macroeconomic outlook is stable (Moodys.com, 2017).

The country is experiencing an economic recovery, with the annual GDP growth rate increasing every year since 2013, reaching 5.3% in 2017. Given this recent economic growth, electricity demand grew much faster than the rate at which generation capacity could be added over the same time period. The demand-supply gap widened and led to deteriorating power outages and regular brownouts (Institute of Public Policy, 2012).[2] Power shortages led to an estimated annual loss in GDP value of 1.5% between FY 2010 and FY 2013 (Institute of Public Policy, 2014).

Nonetheless, the mid-term budgetary framework put in place by the Ministry of Finance has set a target to achieve a 7% annual growth rate (Ministry of Finance, 2016). To maintain this rate of growth, the country needs to ensure it has a sustainable energy supply to meet demand. For this purpose, a portfolio of power generation projects using hydropower, coal, liquefied natural gas (LNG), wind, solar and bioenergy are at various stages of development.

## 1.2 Renewables Readiness Assessment

The International Renewable Energy Agency (IRENA) developed the Renewables Readiness Assessment (RRA) as a tool for carrying out a comprehensive evaluation of the conditions for renewable energy deployment in a particular country. The RRA is a country-led and consultative process. It provides a venue for multi-stakeholder dialogue to identify challenges to renewable energy deployment and to come up with solutions to existing barriers. Short- and medium-term recommendations are presented to governments to guide the formation of new policies or the reform of existing policies to open up a more enabling environment for renewable energy. The RRA also consolidates existing efforts and mobilises resources for priority action.

For Pakistan, the RRA process has been led by the Alternative Energy Development Board (AEDB), with technical support from IRENA, and has greatly benefitted from stakeholder input. These stakeholders include, among others, transmission and distribution utilities, the power system regulator, provincial and federal government departments, power project developers, development partners, financial institutions, civil society and academia. The consultative process was initiated at an expert workshop held in Islamabad in November 2015 and based on a background paper describing the challenges and opportunities for renewables development. During this two-day event, experts discussed the state of renewable energy in Pakistan, as well as various challenges and possible solutions. Their insights informed a draft report presented in the follow-up consultative workshop held in February 2016 and jointly organised by AEDB, IRENA and the World Bank. In addition, the analysis benefitted from bilateral interviews with key stakeholders.

The RRA process in Pakistan has thus produced the outputs listed below.

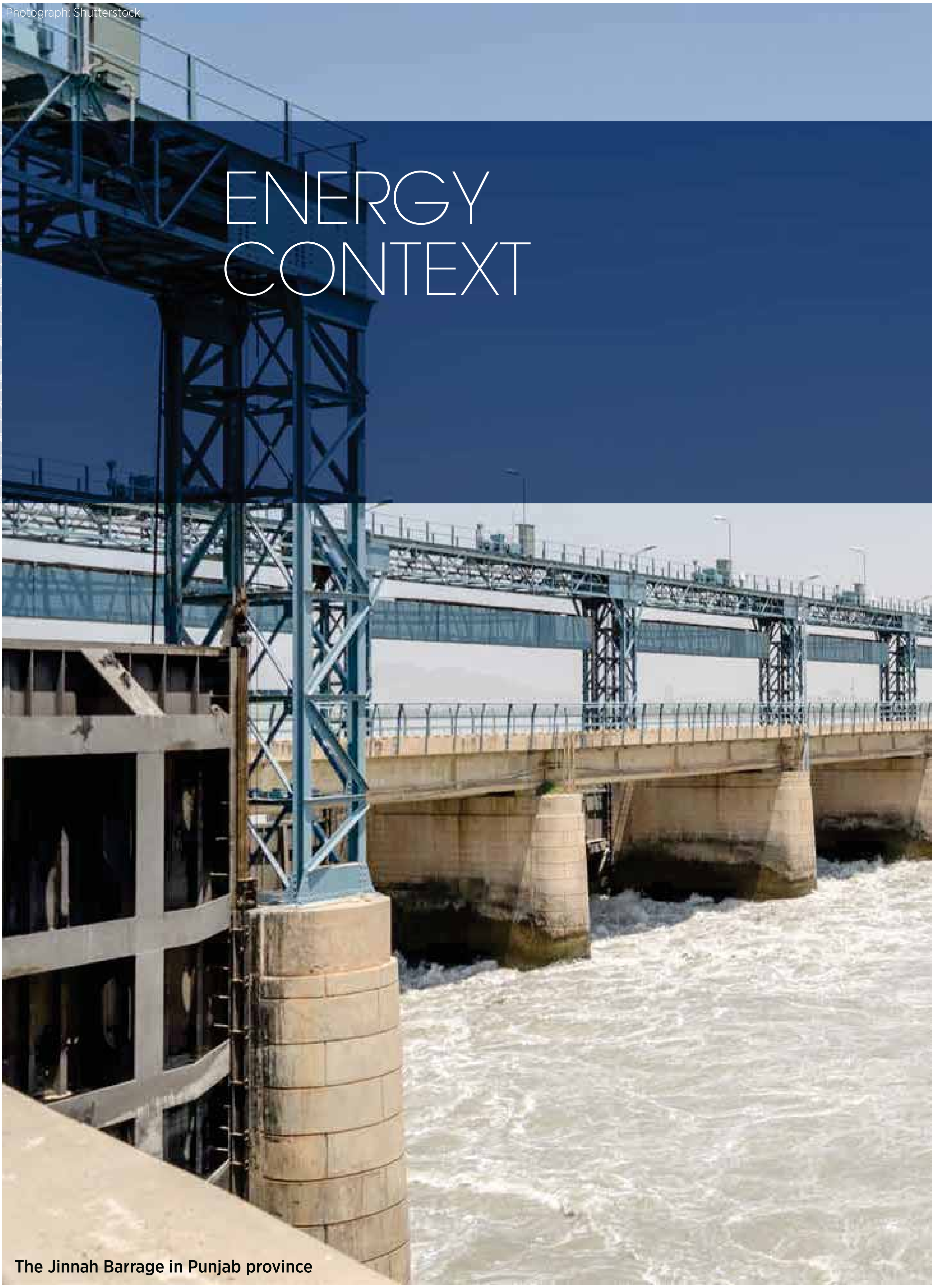
- An analysis of the existing enabling environment and growth of the renewable energy market.
- Identification of the critical and emerging issues associated with and arising from renewable energy resource development.
- A portfolio of initiatives and policy measures for taking advantage of the opportunities revealed by the examination of Pakistan's energy sector and by extensive discussions with numerous stakeholders on converting resource potential into energy supply.

The co-ordinated approach employed to produce this RRA helps set priorities in consultation with bilateral and multilateral co operation agencies, financial institutions and the private sector for implementing the recommended action.

[2] This period coincides with the surge in oil prices that led to prohibitively high costs for thermal power generation. Moreover, the government decided not to increase electricity tariffs.

Photograph: Shutterstock

Wind power can help meet the country's fast-growing energy demand




# ENERGY CONTEXT

The Jinnah Barrage in Punjab province

02

## 2.1 Energy sector overview

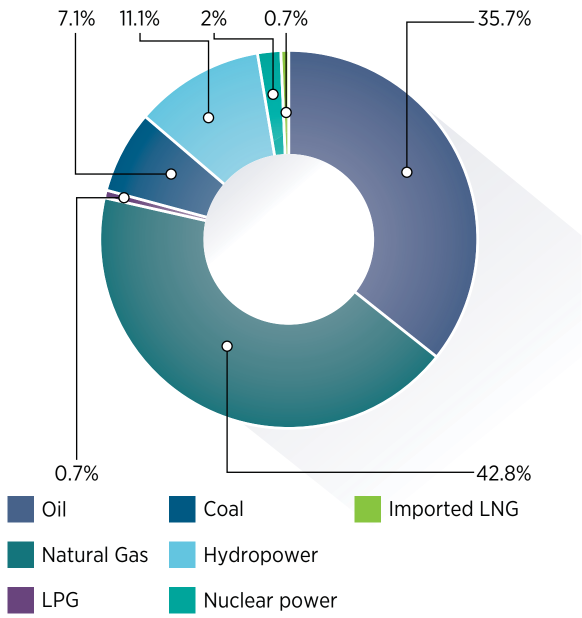
The primary sources of energy in Pakistan include natural gas, oil, hydropower, coal and nuclear energy.[3] These supplies grew from 58.06 million tonnes of oil equivalent (Mtoe) in FY 2006 to 70.27 Mtoe in FY 2015. This excludes traditional biomass use, figures for which are not officially estimated and published by the government.

Natural gas and oil are the two main energy sources, accounting for 43% and 36% of total primary energy supply (TPES) respectively in 2015 (Figure 2). Although natural gas has been playing a key role in meeting overall demand, its production and supply remained stable at 29-32 Mtoe in the ten-year period between FY 2006 and FY 2015 (Figure 3), primarily because there has been no significant increase in domestic production. Although the balance of recoverable reserves of natural gas fell from 31 trillion standard cubic feet (Tscf) in 2009 to 23.64 Tscf in June 2014 (NEPRA, 2016a), the share of natural gas in the energy mix is expected to increase. This is because Pakistan entered into a 15-year agreement with Qatar in February 2016 to import up to 3.75 million tonnes of LNG per annum. With LNG spot prices at lows not seen for many years, this agreement has set the price of the LNG at 13.37% of the preceding three-month average Brent crude oil price (Reuters, 2016).

The share of oil in TPES has risen consistently since 2006. For example, oil constituted 28.27% of TPES in 2006, 32.04% in 2011 and 34.42% in 2015. Over 2006-2015, oil consumption grew by an average of 4.5% each year. A slump in oil prices in 2014 led to a reduction in the import bill. As part of the total import bill, petroleum products and crude oil accounted for 14.77 billion US dollars (USD) in FY 2014, USD 12.167 billion in FY 2015 and USD 7.668 billion in FY 2016 (State Bank of Pakistan, 2016).

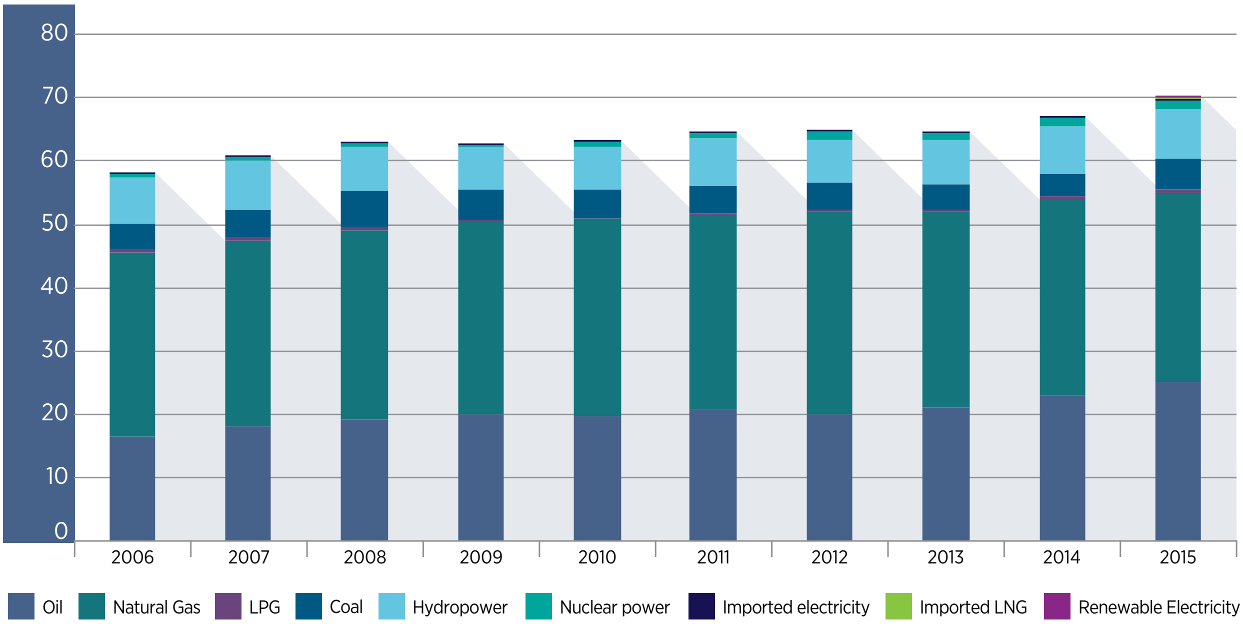
[3] In FY 2015 imported electricity and renewable power contributed 0.11 and 0.19 Mtoe respectively, equivalent to a share of less than 1%, which has not been factored into Figure 2. However, these sources of energy are represented in Figure 3.

**Figure 2.** Primary energy supply by source, 2015




Source: Hydrocarbon Development Instititute of Pakistan (2016)

**Figure 3.** Primary energy supply by source (2006-2015)



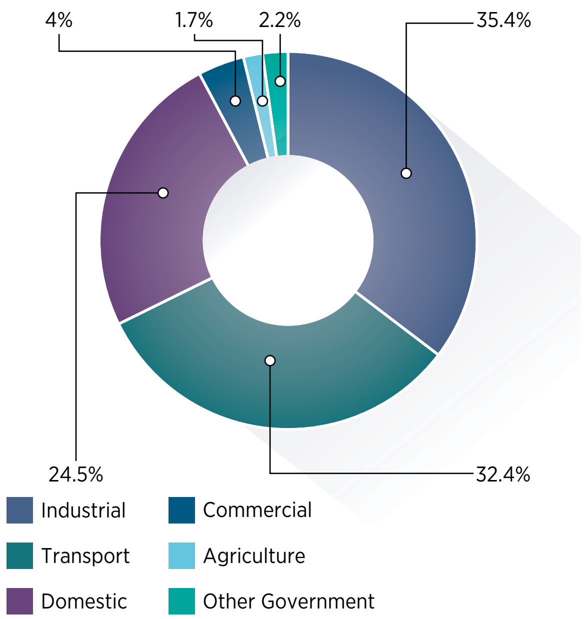

Based on Hydrocarbon Development Insitute of Pakistan (2016)

The remaining supplies consist of hydropower, LPG, coal, nuclear, renewables and imported electricity. Pakistan has been increasing its share of nuclear power, for which an additional generation capacity of 2 880 megawatts (MW) is under construction (Pakistan Atomic Energy Commission, 2017). Renewables (excluding hydro) amounted to only 0.3% of TPES in FY 2015 (Hydrocarbon Development Institute of Pakistan, 2016). A large part of the country's rural population relies on traditional biomass use, although this is not officially estimated and published by the government. The International Energy Agency (IEA) estimates that the number relying on traditional biomass amounted to 105 million Pakistanis in 2014 (IEA, 2016c). According to IRENA's final renewable energy consumption statistics for 2015, traditional biomass use amounted to 8.2 Mtoe. LPG and imported electricity are sourced mainly from Iran and form a small share of the total energy supply.

Final energy consumption (i.e. energy consumed by end users, excluding consumption for power generation) amounted to 41.98 Mtoe in FY 2015

(Hydrocarbon Development Institute of Pakistan, 2016). The industrial sector accounted for 36% of final energy consumption, followed by the transport (32%), domestic (also known as residential or household) (24%), commercial (4%) and agricultural (2%) sectors (Figure 4). Only agriculture recorded a negative compound annual growth rate in FY 2015.

**Figure 4.** Final energy supply by source, 2015




Based on Hydrocarbon Development Insitute of Pakistan (2016)

## 2.2 Power system

Over the last decade, neither population growth nor rising industrial and commercial energy demand have been matched with adequate capacity additions. The country's electrification rate increased from 54% in 2006 to 73% in 2016 (IEA, 2016a), resulting in a grid demand-supply gap that emerged in the second half of 2005. It was reported at 55 MW in FY 2006 (NEPRA, 2008) and rose further to 4 574 MW in FY 2008, reaching a historic high of 6 758 MW in FY 2012. Table 1 represents the power deficit in Pakistan's power system during peak hours for the period including FY 2006 to FY 2016.

Installed power generating capacity remained higher than growing peak demand for most of the last decade, but the system's generation capability was significantly lower. This is due both to old power plants being de-rated as a result of ageing and deterioration, and the deficiencies of the transmission grid. The Planning Commission estimates that electricity demand will continue to rise by 4–5% each year over the next five years (Planning Commission, 2015).

**Table 1.** Power deficit during peak hours in the Pakistan power system (NTDC + K-Electric), 2006-2016

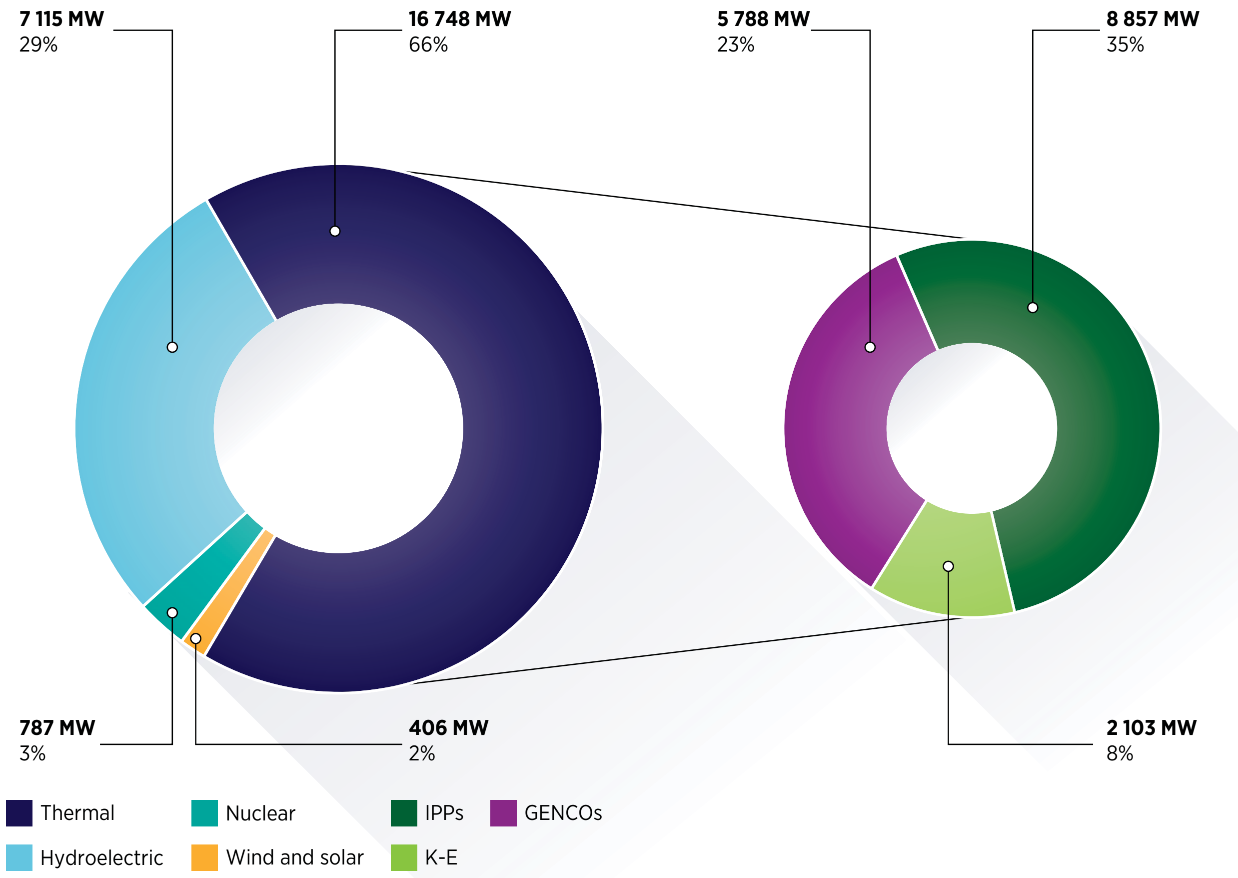
| FY | Installed capacity (MW) | Maximum generation capability (MW) | Demand during peak hours (MW) | Deficit (MW) |
|---|---|---|---|---|
| 2006 | 19 550 | 15 168 | 15 223 | -55 |
| 2007 | 19 681 | 15 575 | 17 487 | -1 912 |
| 2008 | 20 232 | 14 707 | 19 281 | -4 574 |
| 2009 | 20 556 | 16 040 | 20 314 | -4 274 |
| 2010 | 21 614 | 15 144 | 21 029 | -5 885 |
| 2011 | 23 342 | 15 430 | 21 086 | -5 656 |
| 2012 | 23 487 | 15 896 | 22 654 | -6 758 |
| 2013 | 23 725 | 16 846 | 21 605 | -4 759 |
| 2014 | 23 702 | 18 771 | 23 505 | -4 734 |
| 2015 | 24 961 | 19 132 | 24 757 | -5 625 |
| 2016 | 25 374 | 20 121 | 25 754 | -5 633 |

Sources: NEPRA (2015a) *State of Industry Report 2014*; NEPRA (2016a), *State of Industry Report 2015*

## Electricity supply and demand

The country's electricity system consists of two interconnected power systems, the Pakistan Electric Power Company (PEPCO) and the K-Electric network.[4] By end of FY 2016, total installed generation capacity was 25 374 MW. Of this, more than 90% is connected to the PEPCO system, serving an estimated 92% of the total consumer base of the country. Thermal power generation capacity, consisting of natural gas, residual fuel oil, high-speed diesel and coal, is the largest source of power generation in the country (Figure 5). For the PEPCO system, its 14 645 MW of thermal capacity comprises: 10 174 MW of natural gas; 4 304 MW of residual fuel oil; 150 MW of coal; and 17 MW of high-speed diesel. Some plants also use high-speed diesel as back-up fuel, which may increase the share of diesel in total power generation. Other sources include hydropower, nuclear and new renewables,[5] namely solar photovoltaic (PV), wind and biomass.[6] As shown in Figure 5, thermal power ownership is made up of independent power producers (IPPs), state-owned generation companies and K-Electric. The Central Power Purchasing Agency (CPPA) serves as the single power buyer for the PEPCO system. Hydropower capacity is mostly owned by the government through the Water and Power Development Authority (WAPDA), while the private sector owns 214 MW

**Figure 5.** Share of installed grid-connected capacity by source, December 2015



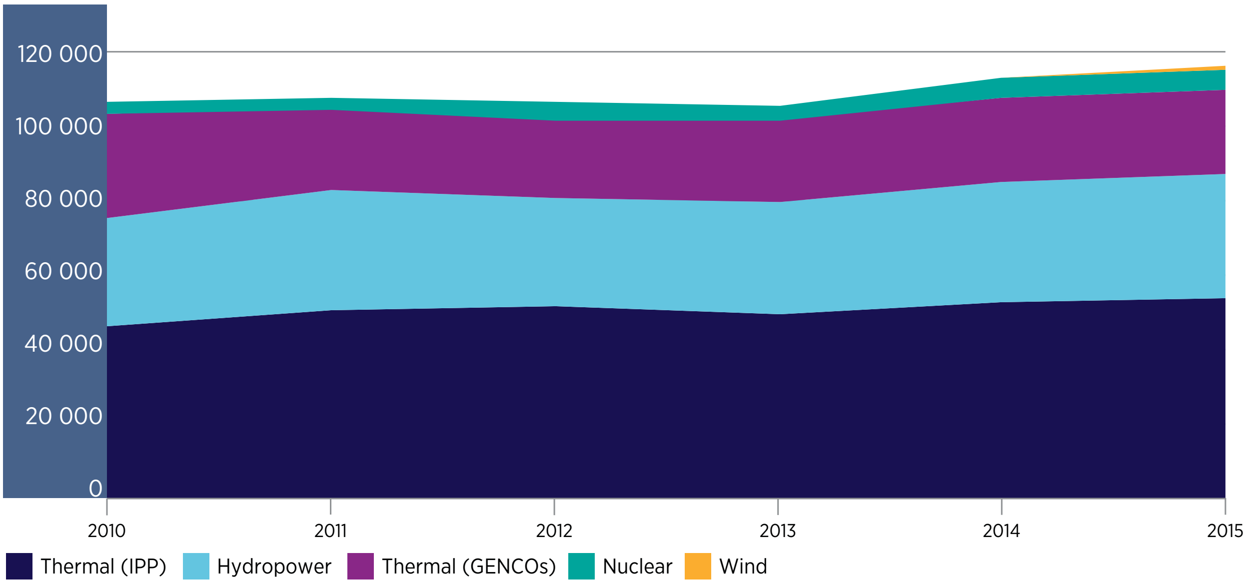

Based on NTDC (2015a), *Power Systems Statistics 2014-15*
Note: GENCOs = state-owned generation companies

[4] The PEPCO system consists of a set of government-owned thermal power generation companies, a transmission company (NTDC), the distribution companies (DISCOs) and K-Electric. The last of these is the only private vertically integrated power utility in the country and operates in the city of Karachi.

[5] The latest figures from AEDB show that additional solar and wind power projects are operational, namely 991 MW of installed capacity in new renewables at the end of 2016. This comprised 591 MW of wind and 400 MW of solar PV. A list of projects with their commissioning status at end 2016 can be found in Annex III.

[6] The information gathered from AEDB shows operational waste-to-energy projects amounting to 145.1 MW at end 2016. However, NTDC statistics for 2014-2015 did not mention this. To avoid any anomaly, this report uses only NTDC statistics for power generation and installed capacity. Whether sugar mills with bagasse power generation plants are supplying electricity to the grid is unclear.

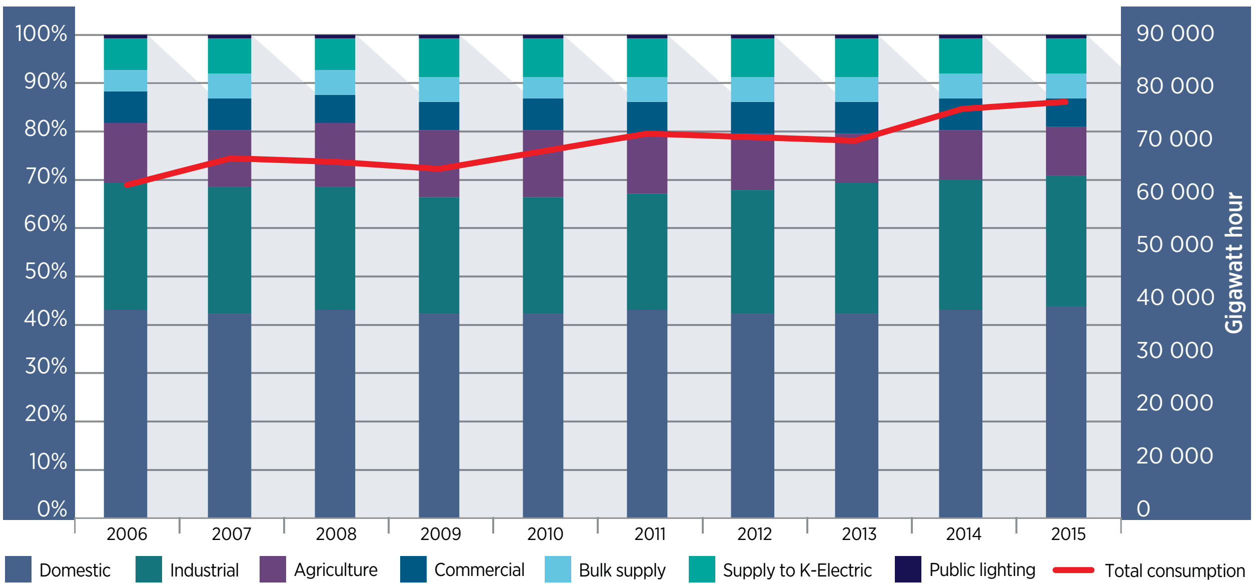
**Figure 6.** Electricity generation trend, 2010-2015




Based on NEPRA *State of Industry* reports, 2014 and 2015

Figure 6 shows the gross annual electricity generation for the National Transmission & Dispatch Company (NTDC) system from FY 2010 to FY 2015. These generation values do not take into account any transmission, distribution or non-technical losses. As shown in the figure, the privately owned thermal IPPs and state-owned thermal generation companies were a major source of power generation between 2010 and 2015. They contributed 70.4% in 2010, but this fell to 66.3% in 2015 largely because nuclear electricity and hydropower production were scaled up. Although installed capacity in the NTDC system exceeds 22 gigawatts (GW), average power generation has been significantly lower due to poor maintenance, shortage of natural gas, the crumbling financial liquidity of the power sector and low operating efficiencies of generation company power plants.[7] This leads to brownouts[8] lasting several hours in both urban and rural areas, which seriously impact the country's economic, industrial and commercial activities. Load management further deteriorates during the summer when commercial and household demand surges.

**Figure 7.** Power consumption by sector, 2006-2015




Based on NEPRA *State of Industry* reports, 2014 and 2015

[7] See Section 2, NEPRA *State of Industry Report 2014* and NEPRA *State of Industry Report 2015* for a detailed evaluation of the generation companies' operating efficiencies, their causes and challenges, and a comparison between the public and privately owned plants.

[8] A brownout is an intentional or unintentional fall in voltage in the country's electrical supply. It is used as a tool for load management in the wake of a shortage of power supply.

**Table 2.** Electricity demand and supply projections (NTDC and K-Electric)

| FY | Capacity addition per year (MW) | Total installed capacity (MW) | NTDC peak demand (MW) |
|---|---|---|---|
| 2017 | 2 585 | 27 959 | 27 175 |
| 2018 | 8 422 | 36 381 | 28 668 |
| 2019 | 1 656 | 38 037 | 30 138 |
| 2020 | 5 422 | 43 459 | 31 619 |

Source: NEPRA (2016a), *State of Industry Report 2015*

Electricity consumption has significantly grown over the last six years. Total electric power consumption increased by 13.4% in the period 2010-2015. Consumption is skewed towards domestic consumers, who make up almost 48% of total demand. The industrial sector accounts for 29.3%, agriculture accounts for 9.5%, and the commercial sector accounts for 7.6% (Figure 7 primary horizontal axis) (NTDC, 2015a). Industrial consumption has risen from 26.9% of the total in 2010 to 29.3% in 2015. By contrast, agriculture is experiencing a consistent decrease in demand; it made up 9.5% of total consumption in 2015 compared to 13.2% in 2010. Commercial sector consumption remained stagnant.

During the next three years around 18 GW of capacity is due to be added to meet growing demand in Pakistan, as shown in Table 2. The National Power Policy adopted in 2013 laid out an ambitious plan to increase power generation capacity and eradicate the power supply gap by 2017. To achieve its targets, the government started/accelerated various projects and programmes. The government initiated the China-Pakistan Economic Corridor (CPEC), a programme with Chinese assistance, giving high priority to the energy sector. About 9 300 MW of CPEC projects are expected to be connected to the national grid by 2019, comprising coal, hydropower and renewable energy (NEPRA, 2016a).

In addition, several other initiatives have been launched to increase power generation capacity and are due to be completed by 2020 (NEPRA, 2016a) They include an estimated 3 600 MW fuelled by imported LNG, power plants amounting to around 1 200 MW fired by imported coal, over 1 000 MW of solar, wind and biomass, and another 3 000 MW of hydropower projects. When realised, these may add around 9 000 MW to the national grid by 2020. NTDC predicts peak demand at 31 619 MW by 2020, met by total installed capacity of 43 459 MW.

## Transmission and distribution network

The transmission and distribution networks are operated under the Ministry of Energy through various government entities. NTDC maintains and operates the transmission network whereas distribution operations are run by ten distribution companies (commonly known as DISCOs). K-Electric, the only vertically integrated power utility, operates only in the metropolitan area of Karachi.

Power generated is fed into the national grid operated by NTDC and is transmitted to the DISCO network for onward distribution to final consumers. The transmission network consists of 500 kilovolt (kV) and 220 kV transmission lines and substations, and the DISCOs run their operations through 132 kV and 11 kV lines and substations.

As well as operating and maintaining the current network, NTDC carries out transmission network reinforcements and enhancements. As of 30 June 2015, the NTDC infrastructure included:

- 13 substations of 500 kV; 37 substations of 220 kV; 758 substations of 132 kV or less; total capacity of 78 544 megavolt amperes (MVA)
- 5 187 kilometres (km) of 500 kV transmission lines
- 9 687 km of 220 kV transmission lines.

In 2014-2015, the NTDC transmission system added 1 200 MVA and 3 520 MVA of transmission capability to the 500 kV and 220 kV systems respectively. The transmission lines were extended by 1 814 km, including 40 km at 500 kV, 1 082 at 220 kV and the rest at 132 kV and 66 kV (NTDC, 2015a). To enhance transmission capacity during 2015-2016, about 10 970 MVA of transformers containing 500 kV and 220 kV systems were installed, along with 1 236 km of transmission lines (Planning Commission, 2015).

The transmission network at present carries 17 000 megawatt-peak of electricity only, with losses estimated at 18.5% (Rehan, 2015). NEPRA states that NTDC will require over USD 9 billion to install transmission lines and substations for power evacuation from the planned large hydropower, coal and nuclear power projects (NEPRA, 2015a). NTDC's five-year expansion plan contains short-, medium- and long-term targets, and is an effort to improve grid capacity. On the basis of that plan, the transmission network will contain an additional 10 500 MVA of transformation capacity on the 500 kV system and 16 200 MVA on the 220 kV system. However, how NTDC will mobilise resources to implement its development plan remains unclear.

### Electricity generation costs and tariffs

As sole power market regulator, NEPRA has been determining tariffs for generation, transmission and distribution since 1998. It draws its powers from an establishing document, "National Electric Power Regulatory Authority (Tariff Standards and Procedure) Rules, 1998". Renewable energy projects are categorised as "Solicited" or "Unsolicited". The government requests proposals for solicited projects from investors based on predefined specifications by conducting a competitive bidding/reverse auction. This practice has been carried out in the thermal power sector, for which the Private Power Infrastructure Board (PPIB) has successfully conducted multiple international competitive calls for coal and other thermal projects since 2008. In the renewables sector, AEDB has not yet solicited any projects. However, NEPRA issued directives in January 2017 for future utility-scale wind and solar PV projects to undergo a competitive bidding process as solicited projects.

For unsolicited projects, NEPRA determines the generation tariff by employing either a cost-plus or upfront (feed-in) tariff mechanism. In both cases, NEPRA determines the technical and financial parameters for capital and operating expenditures and applies a rate of return on equity as stipulated in the applicable government policy. At the same time, it allows for tariff adjustments prompted by changes in currency exchange rates, interest rates and fuel costs (already practised for thermal power projects). Project proponents have the choice to opt for either of the two mechanisms.

The proponent of a project opting for cost-plus submits a tariff petition to NEPRA along with the detailed project feasibility study. NEPRA's panel of technical and financial experts reviews the quoted costs and energy production numbers and enters into a tariff negotiation with the petitioner. Prior to announcing the tariff, NEPRA organises a public hearing of the negotiated tariff for transparency and to take comments from stakeholders. If required, the proposed tariff is adjusted in line with the public hearing before NEPRA makes it official. By contrast, NEPRA sets the tariff in advance in co-ordination with other government agencies such as AEDB and PPIB for project types where upfront tariffs are announced. This is based on these organisations' own research and due diligence. They arrange a public hearing to receive comments from industry experts and stakeholders and subsequently offer the predefined feed-in tariff to all projects falling within the applicable category (e.g. wind projects up to 50 MW).

NEPRA sets the distribution tariffs for each DISCO separately. The tariff includes the fixed amount for power procured and a "distribution margin". This margin accounts for the revenue required for reimbursement of costs associated with the use of the utility's infrastructure, services and an adjustment for distribution losses. Transmission and grid operations are paid according to a transmission tariff determined on the basis of investment costs as well as operation and maintenance (O&M) costs incurred by NTDC after it has gained NEPRA's approval. Both transmission and distributed tariffs are set as fixed amounts rather than a charge per kilowatt hour (kWh).

[9] Tariffs are determined using the London inter-bank offered rate (LIBOR) or Karachi inter-bank offered rate (KIBOR) for foreign and domestic financing respectively. If changes occur in LIBOR/KIBOR during the operation of the power plant, the tariff is adjusted accordingly. Similarly, currency exchange fluctuations are noted and the tariff altered accordingly because tariffs for foreign-financed projects are based on US dollars whereas costs (especially O&M) are incurred predominantly in Pakistan rupees (PKR).

**Table 3.** Gap between consumer tariff determined by NEPRA and notified by government

| | FY 2011 | FY 2012 | FY 2014 |
|---|---|---|---|
| NEPRA average sale rate (PKR/kWh) | 9.58 | 11.89 | 14.66 |
| Government average sale rate (PKR/kWh) | 7.78 | 8.72 | 11.67 |
| Gap in PKR/kWh | 1.8 | 3.17 | 2.99 |

Sources: Sustainable Development Policy Institute (2014), *Pakistan Energy Vision 2035*; Senate Secretariat (2015), 115th Session, 15 May 2015

Electricity consumers are charged the same whichever DISCO they are served by, in accordance with a single set of consumer tariffs that specify prices according to consumer category, time of use and level of consumption. Consumers are divided into residential, commercial, industrial and agricultural categories. For example, the electricity tariffs of "lifeline" consumers (using up to 200 kWh a month) and agricultural categories are lower than the average consumer tariff to provide relief. The Incremental Block Tariff structure, following a progressive tariff regime, is applied based on different slabs for electricity units consumed in each calendar month. Similarly, the time-of-use structure applies different prices to peak and off-peak hours during the day for each season. A higher rate is charged for peak hours.

As the federal government follows a policy of electricity tariffs being uniform across the NTDC system, it notifies the tariffs that are applicable to consumers. The government identifies the DISCO with the lowest distribution tariff and determines the whole range of consumer tariffs based on that company's specific costs and revenue history. It then instructs DISCOs to charge these tariffs on a uniform national basis, while reimbursing DISCOs the difference as a subsidy. Thus if the lowest determined distribution tariff for an individual DISCO were PKR 11/kWh, and the tariff for an average DISCO were PKR 12/kWh, the government would reimburse the average DISCO the difference of PKR 1 per unit as subsidy. This subsidy is commonly referred to as the Tariff Differential Subsidy (World Bank, 2011).

For political and socioeconomic reasons, the government has persisted with the Tariff Differential Subsidy. For example, the consumer tariff was frozen at 2003 levels by the government from November 2003 to February 2007 (World Bank, 2011), although NEPRA increased the DISCO tariffs during this period. Even though oil and gas prices increased by over 70% from 2004 to 2008, consumer tariffs remained unchanged for much of this time. The rise in the subsidy was mainly attributed to the increased use of imported fuels for power generation. This trend has reversed in the recent past due to the slump in oil prices. The NEPRA State of Industry Report 2014 states that the tariff of which consumers are notified by the government has remained higher than the tariff determined by NEPRA (NEPRA, 2015).

One of the aims of the National Power Policy 2013 is to phase out subsidies in the power sector, except where offered to poor households consuming less than 200 units per month (Government of Pakistan, 2013). This led to the "National Power Tariff and Subsidy Policy Guidelines 2014", which set short-, medium- and long-term objectives for setting tariffs and removing subsidies (Government of Pakistan, 2014). For now, the government is banking on significant capacity additions based on coal, LNG, large hydropower and renewable energy to reduce overall generation cost.

Box 1:

# Financial performance of power sector and circular debt

According to Pakistan's *National Power Tariff and Subsidy Guidelines 2014:* "The circular debt is the Central Power Purchasing Agency's cash shortfall that it cannot pay to power supply companies. The overdue amount is a result of: (a) the difference between the actual cost and the consumer tariff determined by NEPRA i.e. the DISCO's loss above collections determined by NEPRA; (b) the delayed or non-payment of subsidies by government; and (c) delayed establishment and notification of tariffs. The government's policy is to reduce, limit to a certain amount which would be reduced over time, and eliminate the causes of the circular debt."

During the period 2010-2015, minimal improvement was noted in transmission and distribution efficiencies. Though the loss of value of overall production decreased from 19.7% to 18.5%, it remained significantly higher than the average among Organisation for Economic Co operation and Development (OECD) countries and others in South Asia, such as Bangladesh and Sri Lanka. In addition, some DISCOs incurred commercial losses due to low collection of electricity bills. In 2015, the bill collection rate of the overall sector, DISCOs and K-Electric, was 89.1% of the amount billed. This created a financial loss of PKR 105 billion, equivalent to around USD 1 billion. Persistent technical and non-technical network losses, bill collection deficits and the Tariff Differential Subsidy resulted in breaks in payments to power plants that created delays in payments to fuel suppliers. This generated the intercorporate debt that brought the system to a partial gridlock, in which fuel supply intermittency led to loss of power generation causing extended hours of reduced electricity supply to consumers.

This situation has seriously affected the financial viability of the power sector and remains a major concern. In its State of Industry Report 2016, NEPRA noted: "based on the currently notified consumer end-tariff of 10 June 2015, if DISCOs fail to show any improvement in their actual level of losses, the impact of missing the Authority's set transmission and distribution loss target would result in an annual gap of PKR 49 billion" (NEPRA, 2016a). NEPRA had set an average loss target of 15.3% for FY 2015 whereas DISCO losses remained at around 18.7%, resulting in a further increase in circular debt. This was reported as PKR 648 billion by end June 2015 (State Bank of Pakistan, 2016).

## 2.3 Power sector institutions and governance

The two main segments of Pakistan's energy sector, electricity and petroleum (oil and gas), used to be governed by the Ministry of Water and Power and the Ministry of Petroleum and Natural Resources, respectively. However, on 4 August 2017, the federal Ministry of Energy was formed (Dawn, 2017). It took over the power and oil and gas sections of the previous ministries as its two administrative divisions. Each division is further served by multiple implementation agencies and independent regulatory bodies. Historically, the sector was publicly owned and managed through two vertically integrated public utilities, the Water and Power Development Authority (WAPDA), a government-owned statutory body, and the Karachi Electric Supply Corporation (KESC), a public limited liability company with government controlling interest. WAPDA has since been restructured and is now responsible only for developing and maintaining large hydropower and water resource projects. The Karachi Electric Supply Corporation, or K-Electric as it is now called, is still a vertically integrated power utility serving Karachi. It has been privatised, and the government holds a 22% stake.

The power division of the Ministry of Energy remains the executive body holding administrative oversight of the sector, with NEPRA playing its role as independent regulator (Figure 8). The division is responsible for preparing policy drafts and analyses, and proposing legislative changes presented to the cabinet or parliament.

The national parliament is the supreme forum for legislation. Federal government entities such as AEDB, PPIB and PAEC are responsible for implementing, co-ordinating and facilitating policy for the division. Provincial governments have established provincial energy departments to draft and implement energy and power policies. Annex I presents a list of key government institutions in the power sector along with their assigned roles and responsibilities.

**Figure 8.** Institutional arrangement for power sector

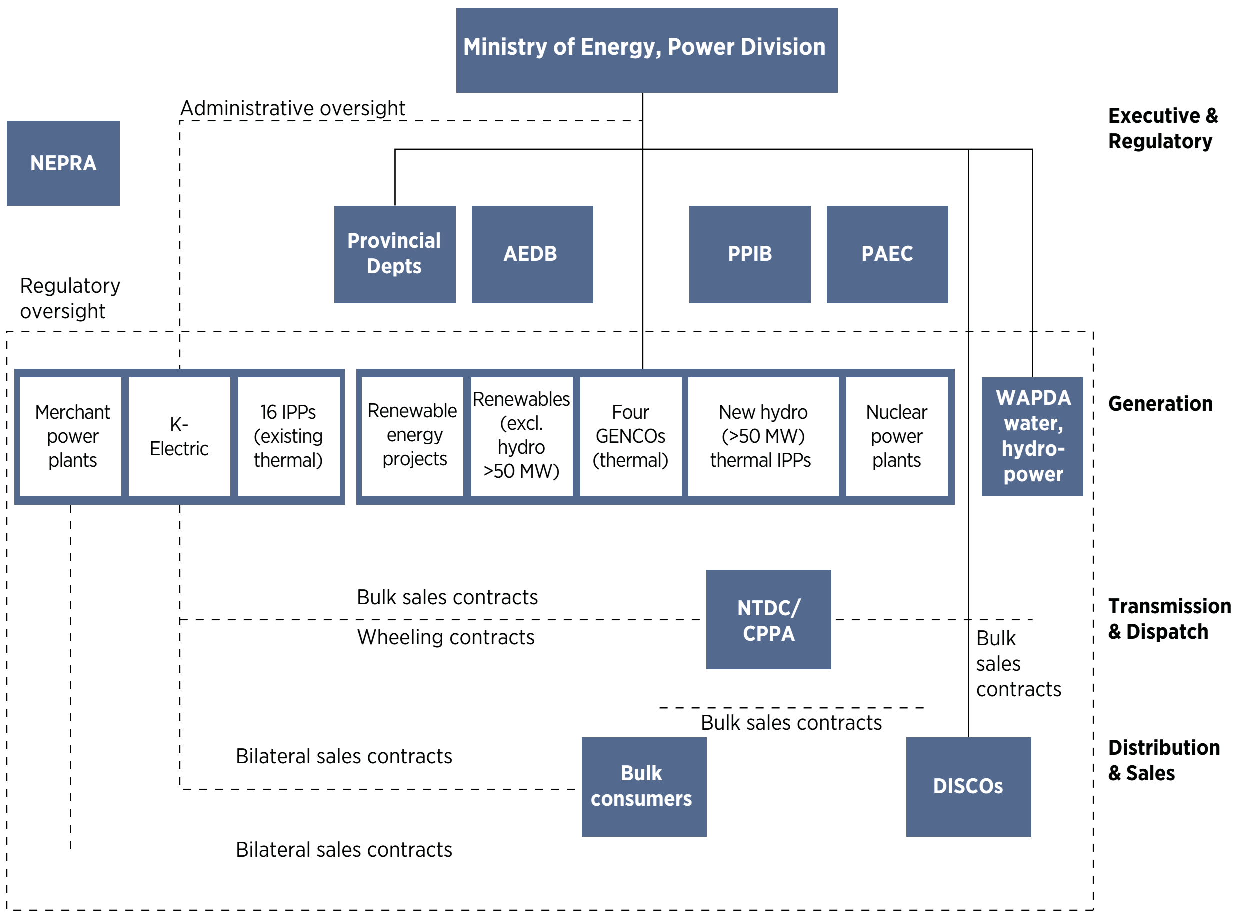



Figure prepared by AEDB

## 2.4 Power planning and policies

Power sector planning has historically been part of the country's five-year development plans conceived by the Ministry of Finance. These plans were mainly economic and defined government public spending limits for economic development initiatives in various sectors. Energy remained a cornerstone of the development plans. However, they did not adequately address all key aspects of power sector planning. Moreover, public budgets were not sufficient to meet the ever-increasing demand. To overcome the challenge, the government opened the sector up to private-sector investment by forming PPIB. This introduced the "Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan", commonly referred to as the Power Policy 1994.

Though not in force at present, this was the first comprehensive policy framework for the country's power sector that allowed establishment of privately owned power generation projects that could opt for any form of technology and fuel/source of energy (including solar, wind and geothermal), geographical location etc. It allowed the sale of electricity to WAPDA and the Karachi Electric Supply Corporation under long-term power purchase agreements (Parish, 2006). The various federal and provincial government policies currently in place are summarised below.

### Federal government policies

Until the formation of the Ministry of Energy in August 2017, two separate ministries (the former Ministry of Water and Power and the Ministry of Petroleum and Natural Resources) managed the energy sector. For this reason, existing power sector policies mainly focus on power generation and transmission, elaborating project development processes, procedures and incentives for investors rather than an integrated plan for the power sector looking at demand-side management and optimal fuel mixes.

The four policies currently in force at federal government level under which power projects may be developed in Pakistan are described below.

**Policy for Development of Renewable Energy for Power Generation 2006**

The Policy for Development of Renewable Energy for Power Generation 2006 (also known as the Alternative and Renewable Energy Policy 2006) is Pakistan's first energy policy exclusively aimed at promoting renewable energy power projects (Government of Pakistan, 2006). While the policy initially covered solar, wind and small-scale hydropower projects, an addendum from March 2013 led to the inclusion of bagasse, biomass and waste-to-energy. Under this policy AEDB offers project initiation permits referred to as "letters of intent"[10] to private-sector project developers.

The salient features of the policy, processes and incentives on offer are elaborated upon in Section 3.3.

**National Policy for Power Co-Generation by Sugar Industry 2008**

Notified in January 2008, this policy was developed specifically for power generation from the sugar industry using bagasse and/or coal as fuel. Under this policy, the incentives offered for co-generation projects are similar to those for IPPs under the renewable energy policy, as further explained in Section 3.3. Though the co-generation policy allows bagasse and coal to be used as interchangeable fuels, the upfront tariff for co-generation from sugar mills announced by NEPRA is applicable to power generated using bagasse alone.

The upfront tariff for bagasse co-generation is discussed in more detail in Annex II.

[10] A letter of intent is a project initiation permit issued by a federal or a provincial government agency. It allows the project developer to conduct a feasibility study for a proposed project within the given timeframe, but is legally non-binding. The issuing authority can revoke it any time before its expiry date. Refer to Section 3.2 for further details.

### National Power Policy 2013

The National Power Policy 2013 laid down an ambitious plan to increase power generation, minimise inefficiencies and eradicate non-technical and other financial losses while simultaneously decreasing the overall cost of power generation. Some of its goals included building additional power generation capacity and ensuring affordable electricity for domestic, commercial and industrial use by using indigenous resources such as coal and hydropower (Government of Pakistan, 2013). When quantified, these goals were expressed as follows: elimination of demand/supply gap by 2017 (from 4 000-5 000 MW); bringing the average power generation cost down to PKR 9.99/kWh from PKR 12.00/kWh; reduction in transmission and distribution losses to less than 16% from 22%; raising bill revenue collection from 87% to 95%.

The policy offers a thorough analysis of the different challenges in the generation, transmission, distribution and governance sectors while articulating measures that may help overcome those challenges. The policy pays particular attention to eliminating electricity load shedding.

### Power Generation Policy 2015

The Power Generation Policy 2015 is the dominant power policy for thermal and large hydropower development, mainly for private-sector and public-private partnership projects. It replaces the Policy for Power Generation Projects 2002.[11] The more recent policy aims to provide better incentives and simplified processes for power project developers. The government stated that the policy was approved "in pursuant of the decision of the Council of Common Interest" (Ministry of Water and Power, 2015).

The policy covers development of new thermal and large hydropower projects (greater than 50 MW) in both the public and private sectors. It lays down the framework for project development and underlines the importance of promoting least-cost power generation. With the Alternative and Renewable Energy Policy 2006 still in force, small hydropower and other renewables were not included in the 2015 policy.

### Regulatory framework

In light of the policy frameworks set up by the government, a comprehensive regulatory regime has been under development for the whole power sector. The most significant achievement so far has been the establishment of NEPRA through the NEPRA Act 1997. The act clearly defines the structure, role and responsibilities of the authority. The NEPRA tariff guidelines define how to set the applicable tariff based on all the costs and various financial and fiscal incentives on offer. NEPRA has also been issuing various regulations for the smooth functioning of the sector and promoting new forms of renewable energy. For instance, the NEPRA (Alternative and Renewable Energy) Distributed Generation and Net Metering Regulations were issued in 2015 and are further discussed in Chapter 3.

## Provincial government policies

The constitution of Pakistan empowers the provinces to put in place provincial energy policies and regulations, develop power projects and set up transmission and distribution lines for power use within the province. Now that WAPDA has been restructured and private investment into the power sector is increasing, provincial governments are prioritising and playing a more proactive role in the energy sector.

The federal Policy for Power Generation Projects 2002 first presented an institutional arrangement whereby provincial energy departments could facilitate power project implementation up to 50 MW, while larger projects would exist within the domain of the federal government (i.e. PPIB). The 2002 policy's successor – the prevailing Power Generation Policy 2015 – has removed the capacity limit for projects that may be facilitated by the provinces. The provinces may issue the necessary letter of intent; however, the implementation agreement, which gives project developers the sovereign guarantees of the Government of Pakistan, has to be signed by a federal entity. This is designated as AEDB for renewables and hydropower projects under 50 MW, and PPIB for thermal and large hydropower. Furthermore, NEPRA has the jurisdiction to decide the tariffs for all projects connected to the federal infrastructure (NTDC and DISCOs).

[11] The Policy for Power Generation Projects 2002 was the third power policy allowing the development of privately owned power projects. The previous policies were the Policy for New Private Independent Power Projects 1998 and the Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan 1994.

Brief introductions to various provincial power policies, with specific reference to renewable energy development, are presented below.

### Power policies in Sindh

For renewable energy development, the Sindh provincial government has adopted the federal renewable energy policy, the Alternative and Renewable Energy Policy 2006, and issues the letters of intent for renewable projects under this policy. Fiscal and financial incentives offered by the provincial government are therefore the same as those offered by the federal government. To further facilitate renewable energy investment, the Sindh government introduced the Sindh Land Grant Policy for Renewable Energy Projects 2015. This aims to simplify and fast-track access to land for investors in renewable energy projects by offering lease agreements for up to 30 years at favourable terms.

### Power policies in Baluchistan

The Baluchistan provincial government devised the Baluchistan Power Generation Policy 2007 for promoting project development using renewable and indigenous coal resources. The policy document consists of various procedures and incentives mainly adopted from the previous federal power policy, the Policy for Power Generation Projects 2002. Under this policy, the provincial government established the Baluchistan Power Development Board as a one-window facilitator to help the private sector invest in the province's vast renewable energy potential, particularly solar and wind. Due to the challenging terrain and long distances from the grid, the board has thus far not been able to mobilise private investment in renewable energy projects in the province.

### Power policies in Punjab

The Punjab provincial government has implemented the Punjab Power Generation Policy 2006 with the aim of maximising the utilisation of indigenous energy sources, including coal, biomass, hydropower, wind and solar for power generation. The policy covers development and facilitation of power projects in the private and public sector as well as through public-private partnerships. The policy elaborates guidance and procedures for land acquisition for renewable energy projects, especially hydropower projects on canal falls because these would be located on provincial land.

Revised in 2009, the policy empowers the Punjab Power Development Board (established in 1995 as a liaison institution with PPIB and other federal power sector entities) to constitute a provincial committee. This is akin to PPIB and AEDB and would review and approve project proposals and act as a one-window facilitator for investors setting up power projects in Punjab. The board now co-ordinates with federal agencies on behalf of the project developers on tariff and grid connectivity matters. The policy requires the board to seek approval from NTDC before issuing any letters of intent. This is because the projects under facilitation of the board will use federal infrastructure and sell power to the CPPA.

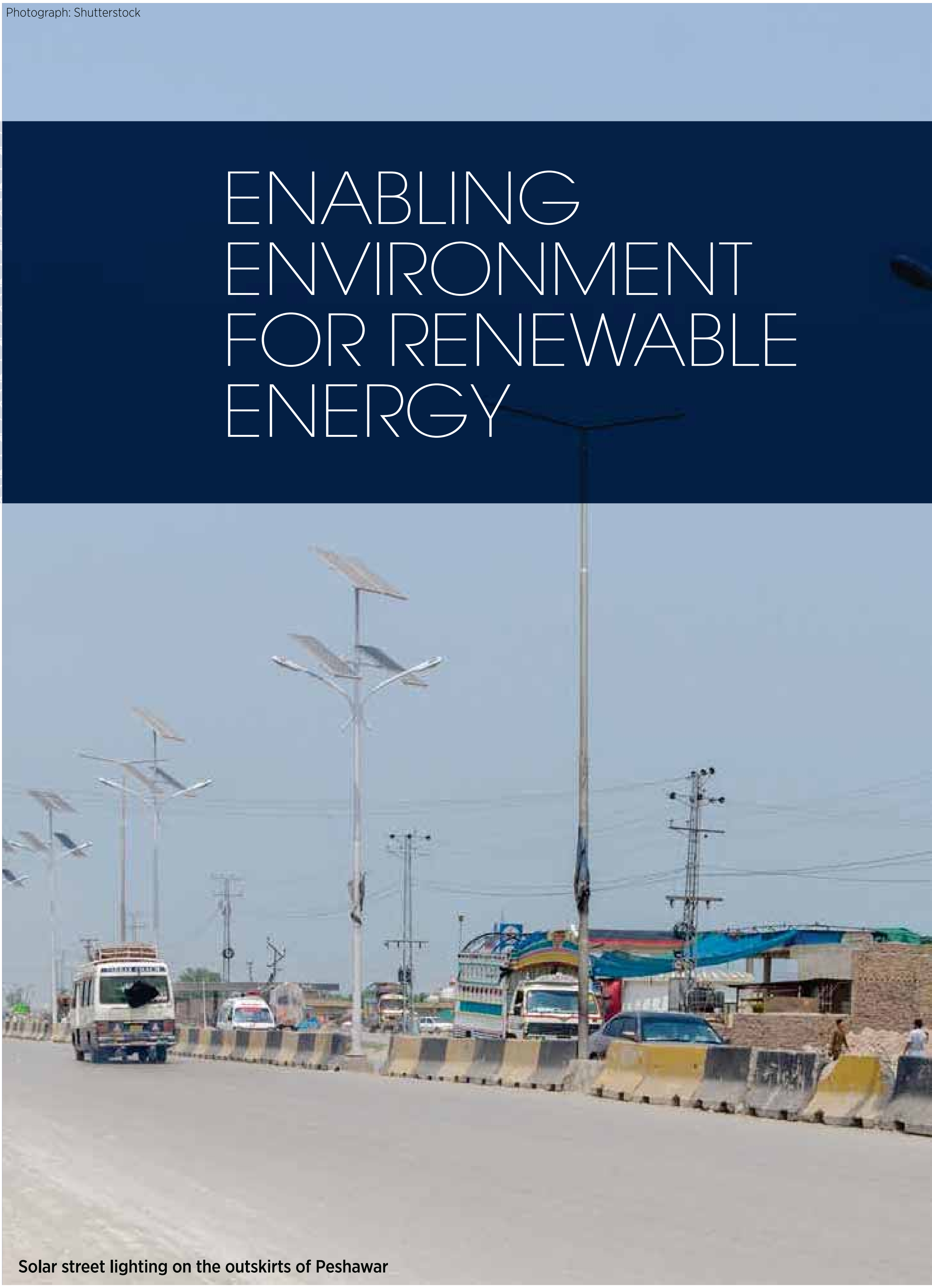
### Power policies in Khyber Pakhtunkhwa

The province of Khyber Pakhtunkhwa has adopted the federal Alternative and Renewable Energy Policy 2006 for all renewable energy projects except hydropower. With the objective of maximising utilisation of the immense hydropower potential, the provincial government has put in place the Khyber Pakhtunkhwa Hydropower Policy 2016. The provincial government has also developed a ten-year action plan for developing hydropower projects in the province both through public funds and private-sector investments.

There are differences between the provincial policy and the federal policy of 2006. In particular, the latter assigns grid interconnection responsibility to NTDC while the provincial policy requires the project developer to construct the transmission line. The cost of extending transmission lines from project site to an existing DISCO or NTDC network is included in the project cost and embedded in the tariff.

Photograph: Shutterstock

# ENABLING ENVIRONMENT FOR RENEWABLE ENERGY



Solar street lighting on the outskirts of Peshawar

# 03

Hydropower has traditionally been the most prominent source of renewable energy in Pakistan. Other renewables have only recently come into the mix after the country introduced a set of support mechanisms to foster renewable energy deployment in the mid-2000s.

The sections that follow map out the country's resource base for various forms of renewable energy, support policies and initiatives at the federal and provincial levels, and grid infrastructure facilities.

## 3.1 Renewable energy resources and applications

Pakistan has abundant renewable energy resources that can be utilised for power generation and end-use sectors. In its northern region, the high mountain ranges and glaciers provide hundreds of potential sites for hydropower projects of varying sizes. At the same time, the plains and desert lands in the centre of the country receive ample sunshine suitable for solar power. Wind potential has been identified in the provinces of Sindh and Baluchistan in southern Pakistan. Thanks to extensive agricultural activity and a well-established sugar-refining industry, large amounts of agricultural residues can also be used for energy purposes.

However, the resources need to be carefully mapped out to unlock their potential. Funded by the Energy Sector Management Assessment Program (ESMAP), the World Bank is closely collaborating with AEDB on renewable energy resource assessment and mapping (Renewable Resource Mapping Project for Pakistan). The project aim is to assess and map the renewable energy resources in high resolution, including biomass, solar and wind energy.

IRENA's *Global Atlas for Renewable Energy* facilitates access to renewable energy resource data, analysis and methods in order to accelerate development worldwide. The platform and its related services assist the identification of the best areas for investigating prospective renewable energy projects. The platform is freely accessible at www.irena.org/GlobalAtlas.

## Hydropower

Hydropower is among the cheapest and most promising sources of power generation in Pakistan. By June 2015 the country had a total installed hydropower capacity of 7 116 MW: 6 902 MW owned by WAPDA and 213 MW owned by IPPs. The private sector has also started to engage in large-scale project development. For example, SK Hydro, Azad Pattan and Chakothi Hattian are being built by the private sector with installed capacities of 870 MW, 640 MW and 500 MW respectively. These projects are at an advanced stage and have successfully negotiated tariffs with NEPRA. Total installed capacity remains far below the country's economically and technically viable 60 GW potential for all scales and types (PPIB, 2011). The provinces of Khyber Pakhtunkhwa and Gilgit-Baltistan benefit from over 45 GW of the total potential. Potential hydropower sites of over 10 GW (large- and small-scale) that can be developed relatively quickly have been identified in Gilgit-Baltistan (GIZ, 2013). However, lack of connection to the national grid remains a major constraint affecting the development of projects in the private sector in Gilgit-Baltistan.

In addition to large hydropower,[12] there is significant potential for development of small-scale (1-50 MW) run-of-river hydropower (AEDB, 2015a). The geographical layout of the country with its natural water flow systems and irrigation canals – especially in Punjab – offers ideal opportunities for hydropower.

Hydropower potential in Khyber Pakhtunkhwa is being exploited through both public- and private-sector projects. To tap the small hydropower potential, the Pakhtunkhwa Energy Development Organization is constructing eight small public-sector projects with a combined capacity of 271 MW. In the private sector, 28 projects with cumulative capacity of about 122 MW are at various stages of development (Khyber Pakhtunkhwa Energy and Power Department, 2016a). There are numerous off-grid micro-hydropower installations in Khyber Pakhtunkhwa and Gilgit-Baltistan. Estimates show that the combined capacity of micro-hydropower installations is around 130 MW (GIZ, 2013). Several small-scale hydropower projects are under development on canal falls in Punjab. The Punjab Power Development Board has issued letters of intent for 11 small hydropower projects with a combined capacity of 230 MW. Additionally, the Punjab government is developing ten projects with a total 80 MW capacity.

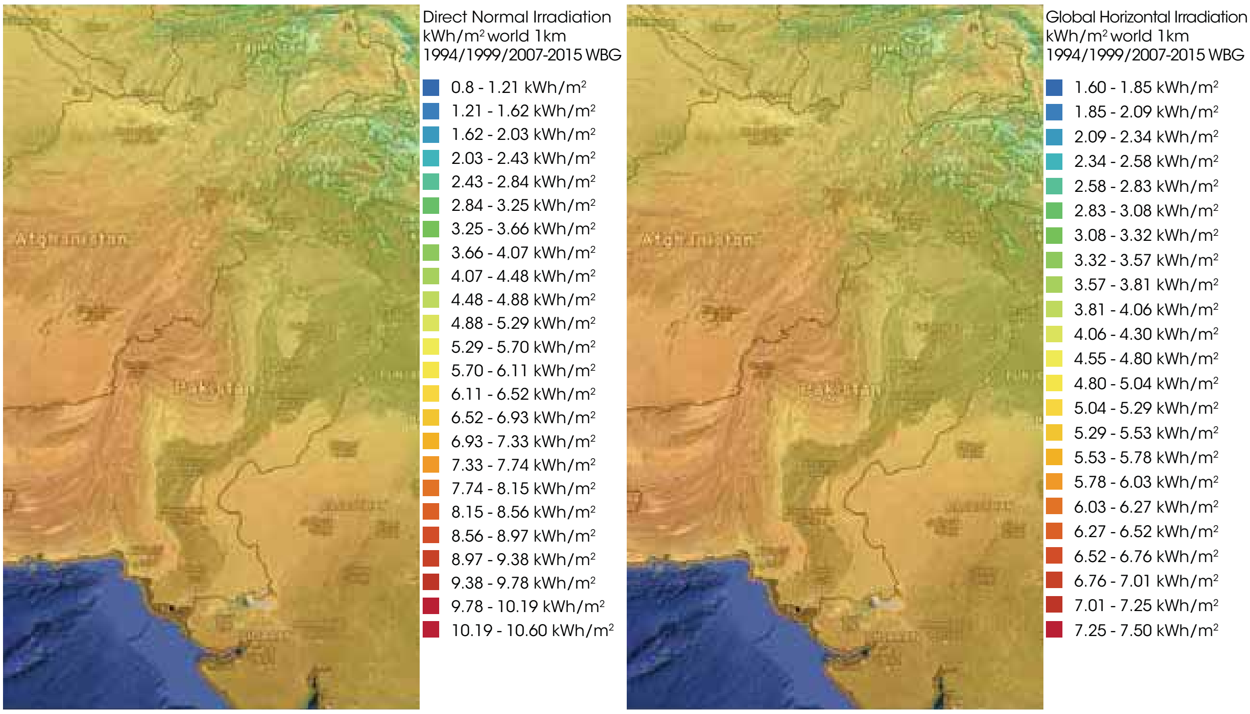
## Solar energy

Pakistan has good solar irradiation, and the southern and southwestern parts of the country record greater irradiation levels than the north. This consideration is integrated into the upfront tariffs for solar PV power generation, which differ in the northern and southern parts of the country. Figure 9 shows the solar irradiance maps of Pakistan. The highest global horizontal irradiance is in southwest Pakistan, gradually decreasing towards the north and northeast of the country; it is at its lowest in the Himalayan and Karakorum mountain ranges. Global horizontal irradiance is a good resource measure for solar PV installations. Baluchistan in the southwest is the site of the country's maximum annual global horizontal irradiance at just over 2 300 kWh per square metre ($m^2$). The estimated values only decrease gradually as one moves up towards the northeast of the country and still exceed 1 500 kWh/$m^2$ per year in more than 90% of the land area (World Bank-ESMAP, 2014).

The direct normal irradiance, a useful measurement for concentrating solar power, reaches its highest values on dry plateaux or rock deserts, which pick up little or no dust from surrounding regions. Generally, high direct normal irradiance is available all over Pakistan except for the Himalayan Mountains. Estimated peak values exceeding

[12] PPIB defines large hydropower as all projects above 50 MW. Small hydropower is 1-50 MW and micro-hydropower is less than 1 MW. The same capacity ranges are used in the federal renewable energy and provincial energy policies. Run-of-river hydropower may fall within the category of large hydropower depending on the site.

**Figure 9.** Pakistan solar energy resource maps




Notes: Left represents direct normal irradiance; right represents global horizontal irradiance.
Source: IRENA (n.d.), *Global Atlas for Renewable Energy*, using data from World Bank-ESMAP.
The boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA.

2 700 kWh/m$^2$ per year can be found in western Baluchistan, while 83% of the land area still exceeds the threshold of 2 000 kWh/m$^2$ per year. These maximum values are as good as the maximum values around the Sinai Peninsula – one of the top locations for irradiance in the Middle East and North Africa (World Bank-ESMAP, 2014).

The sector is taking off following the completion of 400 MW of solar PV projects in 2015-2016. Meanwhile, 24 additional letters of intent issued by AEDB, amounting to a total installed capacity of 556.5 MW, are at an advanced stage of completion (Annex III). Punjab has issued eight letters of intent for 1 419 MW, Sindh has issued 17 letters of intent for 1 200 MW and Khyber Pakhtunkhwa has issued one letter of intent for a 50 MW project.

In addition, energy shortages and frequent load shedding have created a market for stand-alone solar systems with battery back-up. There has been a surge in service providers for solar technologies offering a range of solar home system products, solar water pumping systems, solar lighting solutions and solar water heaters.

The solar industry is still nascent, but estimates indicate that it employs more than 15 500 people (Table 4). Most of this workforce is involved in small-scale residential and commercial deployment, which tends to be more labour-intensive than utility-scale installations. Jobs in installation (construction workers, installers etc.) account for the bulk of employment, followed by jobs in business development. Employment in PV manufacturing remains limited to the industries that prepare mounting structures and electrical equipment. As deployment grows in both small- and large-scale markets, solar and other renewable energy technologies can provide a growing labour force with much-needed job opportunities.

**Table 4.** Jobs in Pakistan's solar sector by market segment and by activities in the value chain

| | Residential | Commercial | Utility-scale | All |
|---|---|---|---|---|
| Installed capacity FY 2015 (MW) | - | - | - | 600* |
| **Value chain activities** | **Jobs (approximate) **** | | | |
| Manufacturing*** | 400 | 200 | 100 | 600 |
| Supply chain | 1 000 | 500 | 100 | 1 600 |
| Installations | 4 000 | 1 600 | 300 | 5 900 |
| Design | 100 | 300 | minimal | 400 |
| Business development | 4 000 | n/a | n/a | 4 000 |
| Project development | n/a | 1 200 | minimal | 1 200 |
| O&M | 1 000 | 600 | 200 | 1 800 |
| **Total employment** | **10 500** | **4 400** | **700** | **15 500** |

* Based on IEA (2016b), *Snapshot of Global Photovoltaic Markets.*
** Based on employment factors defined in Engelmeier et al. (2014), "Beehives or elephants? How should India drive its solar transformation?"
*** Assuming 20% local manufacturing primarily in structures and electrical equipment.
Note: n/a = not applicable.

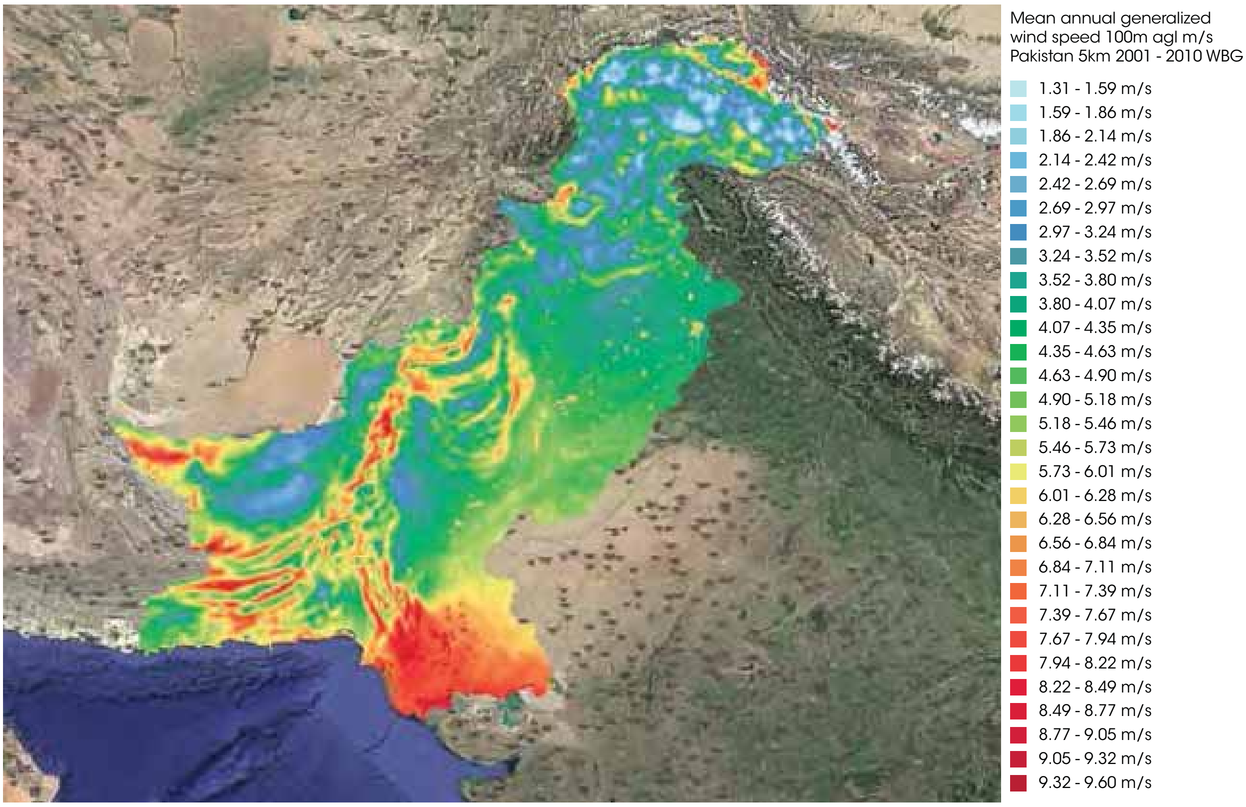
## Wind energy

The US National Renewable Energy Laboratory created a wind map of Pakistan based on satellite data. This provided a starting point for wind development as it identified many parts of the country that could have commercially exploitable wind potential. The theoretical potential for wind power in Pakistan estimated in this map is about 340 GW, but this estimate does not consider technical and economic constraints. The World Bank-ESMAP initiative is producing a more precise wind atlas of Pakistan based on ground-level wind speed measurement using wind masts of various heights at different locations. With an approximate theoretical potential of over 50 GW, the Gharo-Keti Bandar wind corridor in southern Pakistan was prioritised by the government at the very beginning of renewable energy development in the country. This is due to its good resource potential and relative proximity to major load centres and the national grid (AEDB, 2013). At the moment, all the installed wind power in Pakistan is in this corridor.

To date, AEDB has issued 35 letters of intent for wind power projects, with a cumulative capacity of 1 747.5 MW. By the end of 2016, 12 projects with a combined capacity of 590.5 MW were supplying power to the national grid. A further five projects with a cumulative capacity of 297.6 MW had achieved financial closure and were in various stages of construction, aiming to start up on a commercial basis by 2018 (Annex III). The Sindh provincial government is actively trying to maximise wind power. Through the Sindh Energy Department, it has issued 23 letters of intent for wind power projects with a combined capacity of 1 710 MW. Punjab province is also eager to explore wind power potential. The Punjab Power Development Board has identified and earmarked a location in southern Punjab for a 1 000 MW wind farm. The letter of intent for the first project, which has a 250 MW capacity, has been issued to a leading Danish wind power developer. The project was expected to start commercial operations in 2018.

Figure 10 displays the wind energy resource map prepared using satellite data from 2001 to 2010 showing wind speeds at a height of 100 metres. The World Bank-ESMAP wind atlas of Pakistan is presently at the measurement phase, with the results expected towards the end of 2018. Once finalised, these resource maps will provide more precise wind speeds measured at ground level and will inform decision makers planning generation and transmission infrastructure by, for instance, facilitating site selection.

**Figure 10.** Pakistan wind energy resource map




Sources: Source: IRENA (n.d.), *Global Atlas for Renewable Energy*, using data from World Bank-ESMAP.
The boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA.

## Bioenergy

The third part of the World Bank-ESMAP Renewable Resource Mapping Project for Pakistan is dedicated to biomass resource availability. The final biomass atlas, completed in mid-2016, consists of two components:

- theoretical biomass feedstock potential based on land use classification using satellite images and ground survey analysis
- technical feedstock potential based on ground survey results for current utilisation patterns of harvest residue (World Bank, 2016).

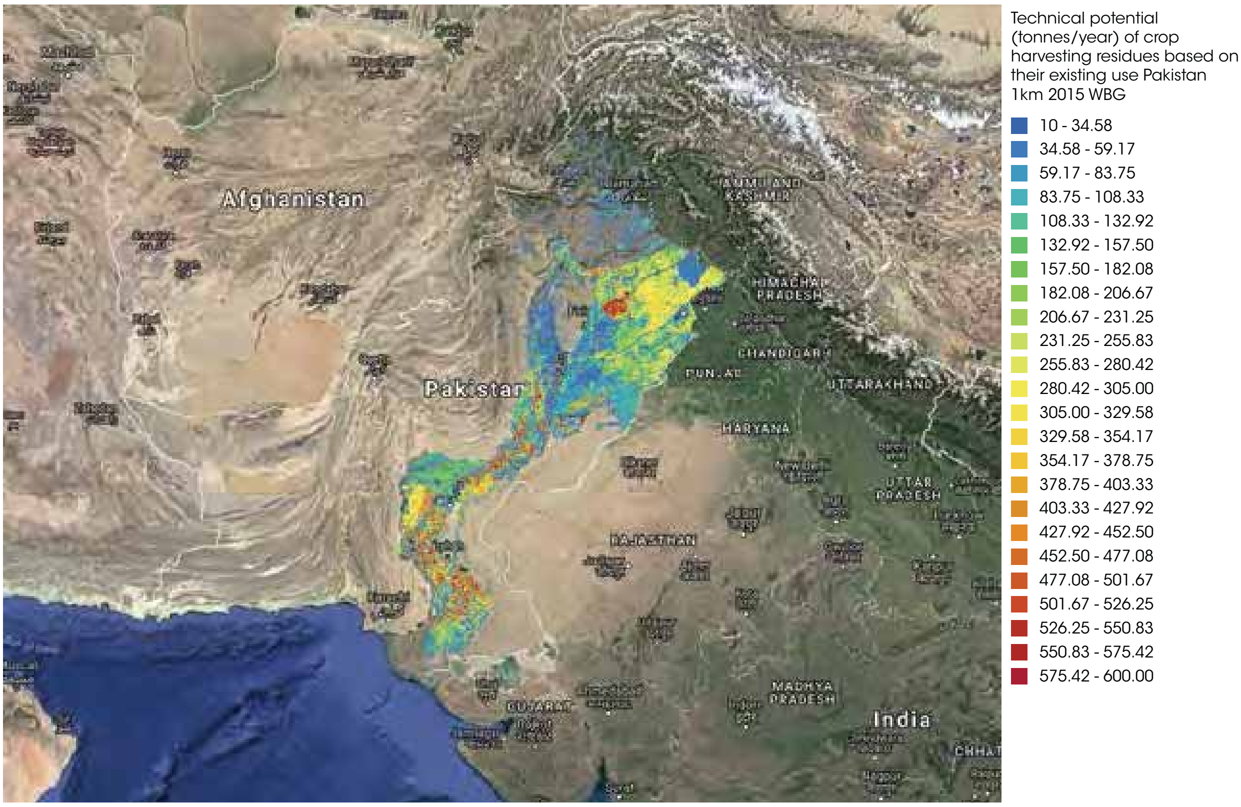
The biomass feedstock available from industrial processes includes maize husk, rice husk, corn cob and bagasse. By contrast, biomass feedstock from agricultural residue includes, for instance, rice straw, sugarcane trash, wheat straw, cotton stalk and maize stalk. Table 5 summarises the technical and theoretical potential of all these sources. However, existing economic use of agricultural residue (e.g. as animal fodder, natural fertiliser) can reduce its availability for energy, particularly in winter, while loss of agricultural land to real estate development may further reduce availability (see Figure 11).

**Table 5.** Biomass feedstock potential

| | | Theoretical potential (‘000 tonnes/year) | Technical potential (‘000 tonnes/year) |
|---|---|---|---|
| Industrial biomass feedstock | Maize husk | 526 | 57 |
| | Rice husk | 4 360 | 1 841 |
| | Corn cob | 789 | 86 |
| | Bagasse | 11 031 | 3 915 |
| Agricultural biomass feedstock | Rice straw | 21 800 | 9 203 |
| | Sugarcane trash | 4 413 | 1 566 |
| | Wheat straw | 52 337 | 8 260 |
| | Maize stalk | 2 988 | 327 |

Source: World Bank Group (n.d.), “World Bank Open Data”; http://data.worldbank.org/

**Figure 11.** Pakistan biomass energy resource map




Sources: Source: IRENA (n.d.), Global Atlas for Renewable Energy, using data from World Bank-ESMAP
The boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA.

By December 2016, four sugar mills had bagasse power generation units with a combined installed capacity of 145.1 MW. In addition, 216.4 MW of capacity was close to completion, with plants expected to start commercial operation by 2018 (AEDB, 2016). NEPRA has approved the tariff for an additional 210 MW of capacity that would take the total to 571.5 MW (NEPRA, 2015a). Considering all projects at any implementation stage, the aggregate installed capacity of bagasse power projects should reach around 731.7 MW by end-2018.

In addition to biomass feedstock from industrial and agricultural residue, municipal waste offers significant power generation potential. The ESMAP study indicates that around 26 000 tonnes of municipal waste is produced across the country every day (World Bank, 2016). Converting this waste into energy could generate up to 360 MW of power (AEDB, 2013).

The ESMAP analysis identifies bagasse as the biggest potential source via its use as fuel for co-generation, with total generation potential of 1 844 MW, followed by rice husk with 162 MW. The potential for power plants using crop residues was also assessed, with site suitability analyses conducted for 21 different energy-conversion combinations.

### Geothermal energy

Pakistan's geothermal resources remain largely unexplored. No comprehensive assessment of the potential has been made nor does a policy framework exist to encourage private participation in the sector. Some scientific studies have located potential geothermal resource areas in the country. Most of the world's high enthalpy geothermal resources are within the seismic belts associated with zones of crustal weakness. One example is the seismotectonic belt that passes through Pakistan, which has a long history of geotectonic events (Zaigham, Nayyar and Hisamuddin, 2009). Thus the country in all probability has commercially exploitable geothermal resources. The sporadic efforts to assess the potential have all concentrated on identifying geothermal phenomena and locating production zones. However, assessors need to go further and integrate their efforts. They need to estimate the size of the resource base, determine heat content of fluids and compile a comprehensive database (Zaigham, 2005).

Conscious of geothermal as a potentially valuable renewable energy resource, Pakistan became a member of the Global Geothermal Alliance[13] in December 2015 and adopted the Florence Declaration at the alliance's high-level ministerial meeting in Florence, Italy, in October 2017. In so doing, Pakistan has joined the global commitment to a fivefold increase in geothermal power generation and a 100% increase in geothermal heat by 2030.

## 3.2 Renewable energy policies and initiatives

The Alternative and Renewable Energy Policy 2006 provides a comprehensive framework for deploying renewable energy technologies. Although the 1994 Power Policy had allowed the private sector to develop the wind, solar and biomass subsectors along with thermal projects, this was restricted by the lack of economic viability at the time. Technological improvements leading to dramatic cost reductions underlined the vast potential of renewable energy technologies. Pakistan was among the few developing countries that devised policies to attract private-sector investment in the sector at the early stages of their global uptake. The resulting renewable energy policy in Pakistan laid down attractive fiscal and financial incentives for private-sector investors. Some of its salient features are listed in Box 2.

So far, the on-grid renewable energy market has been developing only through unsolicited projects. However, this practice will cease for grid-connected wind and solar power once the recent NEPRA directives on competitive bidding for solar and wind energy are implemented (further discussed below).

[13] www.globalgeothermalalliance.org

Box 2:

## Fiscal and financial incentives provided under Alternative and Renewable Energy Policy 2006

- Provision of grid connection and interconnection would be the responsibility of the power purchaser.
- Guaranteed market through mandatory purchase of all electricity.
- Mechanism for reimbursement is offered under the standardised power purchase agreement against damages incurred due to an unforeseen “political event” for which insurance cover is not available at a reasonable commercial rate.
- No customs duty or sales tax for machinery, equipment and spares (including construction machinery, equipment and specialised vehicles imported on a temporary basis).
- Exemption from income tax, turnover rate tax and withholding tax on imports.
- Repatriation of equity along with dividends freely allowed, subject to rules and regulations prescribed by the State Bank of Pakistan.

For unsolicited projects, the proponents notify their interest in setting up a renewable energy project on a particular site. After proposal evaluation, the AEDB letter of intent grants approval for conducting the feasibility study. The proponents then must complete a set of feasibility studies, including technical, environmental and commercial considerations. They have to seek AEDB’s approval to follow up with the energy regulator, NEPRA, for a generation licence and tariff setting. On condition of NEPRA approval, the project proponent submits a performance guarantee in favour of AEDB. The letter of support is then issued, and both solicited and unsolicited projects then proceed to negotiate and sign the project documents with the relevant authorities. The most important of these documents are the Energy Purchase Agreement, the Implementation Agreement and the site sublease for land acquisition (in case land is allocated by AEDB). These agreements are an integral part of the process towards financial closure, followed by project construction and commissioning within the stipulated timeframe. A detailed activity flowchart with applicable timelines for unsolicited projects is shown in Figure 12.

Provincial governments can also issue letters of intent for renewable energy projects.[14] Project proponents can choose which entity they approach. The subsequent process for project development is the same as shown in the flow chart in Figure 12. Provincial governments can only sign the project implementation agreement if the power purchaser is a provincial entity. Since all grid-connected renewable energy projects are currently selling electricity to the federal entity, the CPPA (signatory of the energy purchase agreement), AEDB signs the implementation agreement with project developers, providing guarantees on behalf of the Government of Pakistan.

[14] The provincial agencies follow an 18-month timeline in accordance with AEDB, apart from the Punjab Power Development Board, which offers letters of intent valid for nine months before the letter of support stage is reached.

**Figure 12.** Flow chart for unsolicited project development

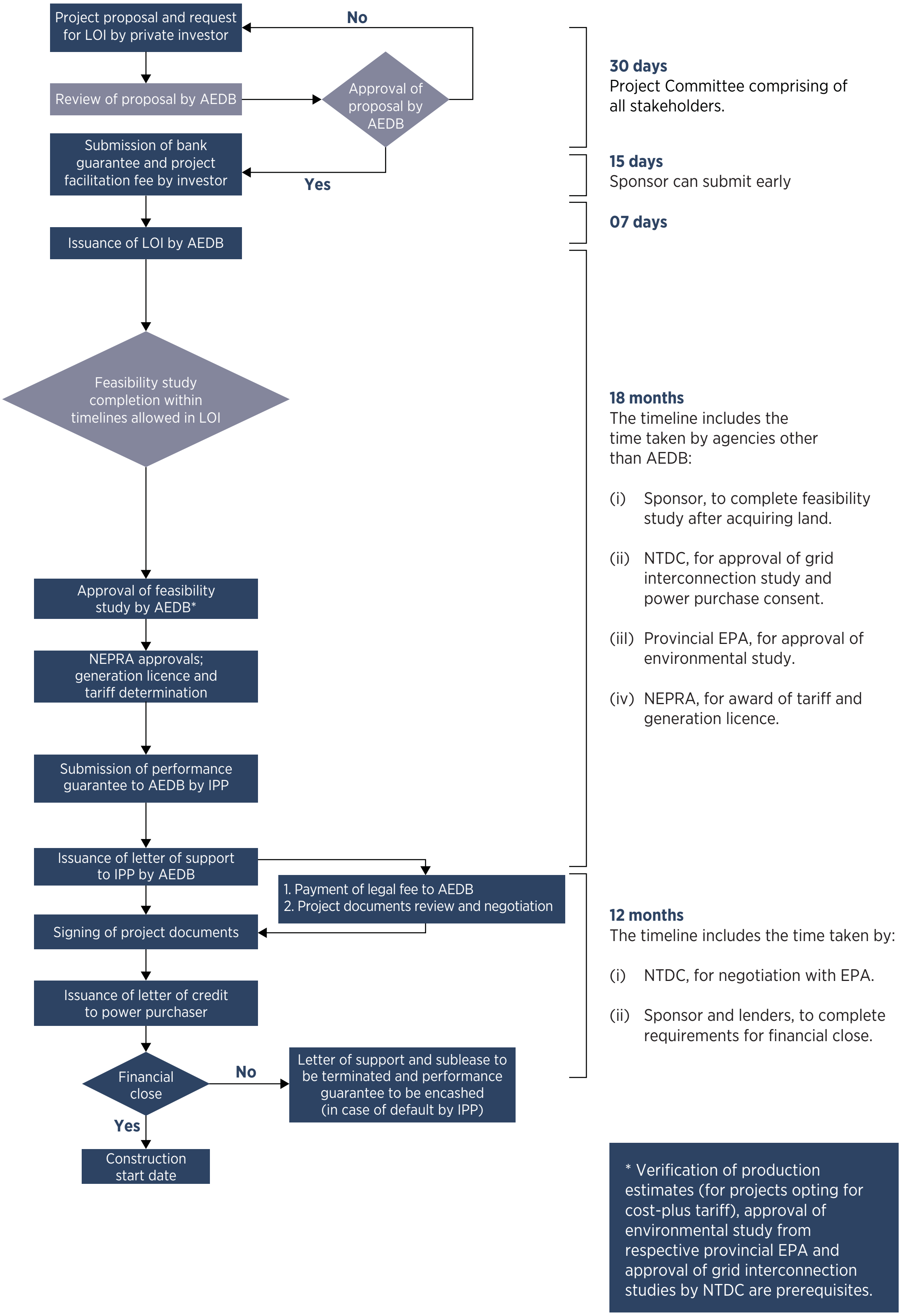



Figure prepared by AEDB

## Renewable energy support initiatives at the federal level

Numerous initiatives have been taken in line with the Alternative and Renewable Energy Policy 2006 guidelines, leading to positive albeit slow renewable energy sector development in Pakistan. As the pivotal organisation mandated to facilitate renewable energy development, AEDB has led most of these initiatives. It has used its own resources, often also supported by bilateral and multilateral development partners, to remove barriers to private-sector investment. Some of the most prominent initiatives are listed below.

- **Allocation of land (sublease agreements).** Initially AEDB prioritised wind power deployment because it had better commercial viability and a proven resource base in the southern part of the country. Since the ownership of government land remains with the provincial governments, AEDB leased land from the Sindh provincial government and entered into sublease agreements with wind energy developers. The process went smoothly for the first crop of wind developers as the land was allocated along with the letter of intent with minimal requirements from the developers. Subsequently this facility was no longer offered as it diverged from the regular procedures for allocation of public land to private ventures and was creating administrative problems for the relevant land revenue department.

- **Upfront tariffs for renewable energy technologies.** With technical assistance from development partners such as GIZ, AEDB initiated upfront tariffs (feed-in tariffs) for wind, biomass and solar PV technologies to help investors fast-track the financial closure of projects and avoid lengthy individual tariff negotiations with NEPRA. After conducting due diligence and evaluation, NEPRA announced tariffs for the procurement of power for all three technologies for a limited duration. These tariff regimes were readily available for investors, subject to revisions based on variation in technology, O&M, financing, land and other associated costs. Upfront tariffs for each renewable energy technology and their current status in light of recent developments are discussed in more detail in Section 3.3.

- **Standardised templates.** Standard templates have been devised for energy purchase agreements and implementation agreements for solar PV, wind and biomass/bagasse power generation projects. This has improved transparency in the process and saves considerable time and cost to private investors, who would otherwise need to delve into lengthy negotiations and pay high legal fees.

- **Net-metering.** The regulations for distributed generation and net-metering were announced by NEPRA in September 2015, providing an opportunity for residential, commercial and industrial consumers to feed self-generated surplus power into the grid. Section 3.4 further discusses these regulations.

- **Grid study for integration of intermittent renewable energy sources.** With the initiation of large-scale grid-connected solar and wind power projects, the grid's capability to accommodate power from variable renewable energy sources into the power system was called into question. The United States Agency for International Development (USAID) assisted NTDC on a study to assess the technical and financial feasibility of integrating power from solar PV and wind. Details of the study's findings can be found in Box 3 (USAID, 2015).

- **Grid integration code for solar and wind energy projects.** NEPRA has amended the grid codes traditionally developed for thermal power projects to facilitate interconnection and power evacuation from wind, solar power plants. The grid analysis mentioned above has recommended further amendment of the grid codes to improve integration of solar and wind energy to optimise the benefits of renewable power generation.

- **Grid infrastructure development for renewable energy projects.** The renewable energy resource base of the country is not close to the traditional load centres, especially the wind corridor identified in the Jhimpir and Gharo regions of Sindh. Offering sufficient power transmission facilities for new wind power projects has not surprisingly been a key challenge for NTDC. In addition, the Quaid-e-Azam Solar Park has been built in the less populated southern part of the province of Punjab, so NTDC has to allocate more resources to the network. For this purpose, it has devised multistage plans for grid enhancement and extension to evacuate power from these two regions. A three-stage plan is under way to evacuate 1 000 megawatt peak (MWp) solar power from the Quaid-e-Azam Solar Park. At the same time, a four-stage plan explained in Annex IV is in progress for evacuating a maximum of 1 750 MWp of wind power from Jhimpir and Gharo. The milestones for these plans are summarised in Annex IV.

- **Quality standards for importing solar equipment.** Pakistan's off-grid solar market has suffered from the influx of low-quality and substandard equipment. With support from GIZ, AEDB has established a quality standards protocol which has been approved by the Federal Cabinet. This aims to restrict low-quality solar equipment imports into the country and as a result will increase consumer confidence in investing in solar systems.

- **State Bank of Pakistan finance scheme for renewable energy.** In 2009 the State Bank of Pakistan launched a scheme of subsidised loans for renewable energy promotion. The scheme was revised in June 2016 to make it more attractive to both project developers and financing institutions. Private banks in Pakistan can use funds allocated by the State Bank of Pakistan to finance renewable energy projects ranging from 4 kilowatts (kW) to 50 MW installed capacity.

- **NEPRA guidelines for competitive bidding (auctions).** Following several rounds of upfront (or feed-in) tariff determination, NEPRA has issued directives for competitive bidding through reverse auctions for utility-scale power generation and transmission projects. The authority set a benchmark tariff for wind projects in January 2017 and instructed AEDB and other relevant agencies to initiate competitive bidding. For solar PV projects, no benchmark tariff has been determined either by NEPRA or any other agency. For these auctioning rounds, NEPRA requires the process to be developed in line with the NEPRA Competitive Bidding (Approval and Procedures) Regulations 2014.

[15] SNEPRA set a benchmark tariff for wind energy projects at PKR 7.0839/kWh (about 6.7 US cents, or USD 0.067) for foreign-financed projects and PKR 8.1208/kWh (about 7.7 US cents) for locally funded projects. No benchmark tariff was set for solar energy projects.
[16] NEPRA directed relevant agencies to prepare a request for proposal that would illustrate the bidding process, project developer qualification criteria and targeted capacity. By July 2017, no proposal has been issued by any of the relevant government agencies.

Box 3:

## Study to determine limit of integrating intermittent renewables into Pakistan's national grid

USAID supported a technical study to evaluate different levels of variable renewable energy in the national grid of Pakistan, their relative impacts on the operational capacities of the system, and overall financial feasibility. The study's assumptions included planned renewable energy projects and the NTDC development plan. The study's main findings are reproduced below.

- 2.2 GW of wind and solar projects can be integrated into the national system up to 2016/17.
- A few major system reinforcements and additional transmission lines at Lal Suhanra, Jhimpir and Gharo will enable the system to integrate up to 4.06 GW of variable renewable energy up to 2019/20.
- Up until 2021/22, the country could integrate the planned 9.4 GW in variable renewable energy, subject to the completion of numerous grid reinforcements at 500 kV, 220 kV and 132 kV.
- Certain grid code amendments for solar and wind integration are necessary for grid stability.
- The amount of spinning reserve required remains manageable and can be further reduced by introducing additional intra-day prediction.
- Even without considering lost GDP caused by load shedding, variable renewable energy integration will reduce costs compared to a system without additional variable renewable energy.
- The use of variable renewable energy represents a cost-effective and technically reliable option for alleviating the energy shortfall in Pakistan.

Source: USAID (2015)

## Provincial government initiatives

All grid-connected renewable energy projects are dependent on federal infrastructure, so most of the initiatives for promoting renewable energy projects remain, at present, at the federal level. However, provincial governments have been demonstrating considerable interest in promoting renewable energy deployment. They issue permits to investors for setting up renewable energy projects within their respective provinces. In addition, they are also helping renewable energy project development, particularly on issues such as land acquisition, setting up renewable energy zones/parks as well as establishing co-ordination with federal entities for facilitating approvals/negotiations for project developers.

Table 6 summarises key initiatives taken by provincial energy departments to promote renewable energy.

**Table 6.** Provincial energy department initiatives on renewable energy

| | |
|---|---|
| Punjab Energy Department | • Established the Quaid-e-Azam and Chishtian solar parks. Over 10 000 acres of land dedicated to solar PV installations.<br>• Set up hydropower projects in public and private sectors.<br>• Runs programmes for electrification of schools, basic health units and tube wells using solar energy.<br>• Establishing the Quaid-e-Azam wind park in southern Punjab. |
| Khyber Pakhtunkhwa Energy and Power Department | • Focuses primarily on hydropower because the province has enormous hydropower potential.<br>• Develops hydropower projects in both public and private sectors through a dedicated special purpose entity, Pakhtunkhwa Energy Development Organization.<br>• Achieves rural electrification through solar and micro-hydropower projects. |
| Sindh Energy Department | • Issued letters of intent for wind and solar PV projects with combined capacity of over 2 900 MW.<br>• Implemented Sindh Land Grant Policy for renewable energy projects to facilitate wind and solar power projects to letter of intent applicants. |
| Baluchistan Energy Department | • Undertaking various programmes for off-grid solar applications for water pumping and residential systems.<br>• Reports indicate memorandum of understanding signed between provincial government and an international developer to construct a 300 MW solar power project (Express Tribune, 2013). |
| Gilgit-Baltistan | • Developing hydropower plants and mini-grids to connect multiple villages in the region.<br>• Making efforts to connect Gilgit-Baltistan with national grid. |

## 3.3 Tariff determination for renewable energy projects

The Alternative and Renewable Energy Policy 2006 allows both cost-plus and upfront tariff-setting regimes[17] as well as provisions for competitive bidding. NEPRA has offered cost-plus tariffs to a few wind power projects in the past. The levelised tariff of these projects is PKR 11.35–13.697/kWh.[18] Due to the difference in foreign and local interbank offered rates, the projects with a higher foreign financing component tend to cost less in Pakistan. Following a policy shift, technology-specific upfront tariffs were adopted that are applied to unsolicited projects. The upfront tariffs announced for a particular technology can have different values for different project sizes. For different technologies, tariff validity periods (length of power purchase agreement) may differ.

The tariff determination mechanism adopted by NEPRA considers factors such as resource availability, capacity factor, equipment and financing costs, O&M expenses, project construction periods and length of energy purchase agreements. Certain components of the tariff, such as debt servicing, are subject to periodic adjustments/indexations based on variations in currency exchange rate and consumer price indices.

Since 2009 NEPRA has announced upfront tariffs for solar PV, wind, bagasse co-generation and small hydropower projects (up to 25 MW). However, only upfront tariffs for bagasse and small hydropower are in force because NEPRA initiated a tariff review and update process following the expiry of validity periods of solar and wind projects in 2016. NEPRA subsequently decided not to determine the upfront tariff and has instead directed AEDB and provincial energy departments to conduct competitive bidding for solar and wind power projects (March 2017).

For wind power, NEPRA has determined a benchmark tariff of 6.75 US cents (USD 0.0675)/kWh and 7.73 US cents (USD 0.0773)/kWh for projects funded through foreign and local financing respectively. At this stage, the procuring agency is expected to be AEDB, which would adopt this benchmark tariff as the ceiling price to carry out a reverse auction with prospective project developers. For solar PV projects, no benchmark tariff was issued.

Table 7 summarises the prevailing upfront tariff rates for renewable energy technologies. Details of the upfront tariff mechanism and the previously offered tariffs for renewables can be found in Annex II.

**Table 7.** Prevailing upfront tariffs for renewable energy projects

| Technology | Tariff notification | Tariff duration | Tariff | |
|---|---|---|---|---|
| Bagasse co-generation | November 2017 | 30 years | 9.09 (LF) PKR/kWh | |
| Small hydropower (up to 25 MW) | April 2017 | 30 years | Low-head (US cents/ kWh) 10.89 (FF) 12.78 (LF) | High-head (US cents/ kWh) 10.06 (FF) 11.83 (LF) |

FF= foreign financing; LF= local financing

Sources: NEPRA (2017b), "Determination of the Authority regarding Upfront Tariff 2017 for New Bagasse Based Cogeneration Power Projects", www.nepra.org.pk/Tariff/Upfront/Bagasse/TRF-UTB%2018490-92%2010-11-2017.PDF;
NEPRA (2017c), "Decision of the Authority in the matter of Upfront Tariff for Small Hydro Power Generation Projects up to 25 MW Installed Capacity – Extension of Date of Acceptance of Upfront Tariff", www.nepra.org.pk/Tariff/Upfront/2017/UTH-01%20UPTO%2025%20MW%2010-04-2017%204943-4945.PDF.
Note: one US cent = USD 0.01

[17] Commonly known as feed-in tariff in other parts of the world.
[18] USD 1 = PKR 104.7 on 24 August 2016. During the five-year period August 2011–August 2016, the exchange rate ranged over PKR 86.08–108.50 per US dollar.
[19] A detailed breakdown of the cost assumptions and other tariff components for each technology is provided in Annex II.

Costs for renewable energy technologies have significantly decreased over the last few years in Pakistan, resulting in a decrease in upfront tariffs. (The upfront tariff for wind power announced in 2011 was14.66 US cents (USD 0.1466)/kWh compared to the benchmark tariff of 6.75 US cents/kWh in 2017.)These cost reduction trends are in line with the increasing cost-competitiveness of renewables across the globe. Box IV offers further details on global cost trends.

Grid installation work in progress

Box 4:

# Global trends in renewable energy costs

The cost-competitiveness of renewable power generation technologies has reached historic highs. Most impressively, solar PV module costs have come down by as much as 80% since 2009, with the cost of solar PV electricity falling by almost three-quarters during 2010-2017. Onshore wind electricity costs declined by almost a third in the same period, making this one of the most competitive sources of electricity. Offshore wind projects in some markets consistently deliver electricity for as little as four US cents (USD 0.04)/kWh. Projects that will soon be commissioned may provide power for as little as three cents (USD 0.03)/kWh.

IRENA analysis has shown that increasing economies of scale, more competitive supply chains and further technological improvements will reduce the costs of solar and wind power. With the right policies in place, the cost of electricity could continue its downward trend. By 2025 solar PV technology costs could fall by 59%, and offshore and onshore wind power technologies by 35% and 26% respectively. Concentrating solar power could achieve a 37-43% reduction in cost.

The global weighted average cost of electricity from projects commissioned in 2017 stood at five US cents (USD 0.05)/kWh for hydropower and six cents (USD 0.06)/kWh for onshore wind, while the levelised cost of electricity from utility-scale solar PV projects fell to ten cents (USD 0.10)/kWh.

Sources: IRENA (2018), *Renewable Power Generation Costs in 2017;*
IRENA (2016a), *The Power to Change: Solar and Wind Cost Reduction Potential to 2025.*

## 3.4 Net-metering regulations

In September 2015, NEPRA adopted regulations for distributed generation and net-metering from renewables (NEPRA, 2015b). These allow domestic, commercial and industrial consumers to sell surplus power generated by renewable energy systems up to 1 MW to DISCOs. The key features of the distributed generation and net-metering regulations are described below.

- Consumers with a three-phase 400 volt (V) or 11 kV connection to a DISCO are eligible to submit an application to become a "distributed generator".
- The DISCO will forward applications from consumers to NEPRA for review. Subject to a technical feasibility assessment, the applicant will be given a Distributed Generator Licence.
- The agreement between the distributed generator and the DISCO will last three years, which may be automatically renewed by mutual consent.
- A DISCO cannot terminate an agreement without prior approval from NEPRA.
- The distributed generator will ensure that the equipment installed conforms to the standards set by NEPRA. These include fulfilling protection requirements, voltage and frequency range, and prevention of interference.
- The responsibility for all interconnection costs up to the interconnection point, including meter installation, will be carried by the distributed generator.
- The tariff applicable will be the off-peak rate of the respective consumer category

As per the regulations, the tariff applicable to residential and commercial consumers is around 11.7 US cents (USD 0.117)/kWh, whereas industrial consumers have a net-metering tariff of 11.3 US cents (USD 0.113)/kWh. Details of the consumer tariffs are presented in Annex IV.

The regulations aim to encourage consumers to set up small-scale solar PV or wind power systems within their premises. However, many DISCOs expressed reservations on net-metering, citing technical challenges and questioning financial viability. Nonetheless, NEPRA had issued several dozen distributed generation licences for rooftop solar installations (NEPRA, 2017a). Substantial efforts are currently underway in this direction, including credit facilitation and awareness creation of the business case, as well as tax and duty exemption on net-metering equipment.

## 3.5 Rural electrification: Off-grid systems

Pakistan's electrification rate is estimated at 74%. This means 51 million people (26% of the population) have no access to electricity, most of whom reside in rural Pakistan (IEA, 2017). More than 32 500 villages in Pakistan (NTDC, 2015a) – an estimated 40% of the rural population – live a long way from the grid, making grid connection a less viable solution (Iftikhar, 2014). Distribution utilities are reluctant to expand their grids into these rural areas, citing technical, financial and economic viability constraints. Government authorities, development agencies, rural support programmes and non-governmental organisations (NGOs) have taken initiatives on solar home systems, micro- and mini-hydropower, and biogas installations into rural areas with varying degrees of success. For example, AEDB initiated a rural electrification programme in 2005 to provide over 7 000 villages in Sindh and Baluchistan with electricity by deploying solar home systems. The project was implemented through a grant from the Government of Pakistan. It suffered a shortfall in funding and could not achieve its targets. Project evaluation in 2011-2012 revealed that most systems were not operational as the batteries had become obsolete.

The Alternative and Renewable Energy Policy 2006 covers the development of procedures and initiatives for providing renewable energy services to rural areas with specific emphasis on hydropower projects. However, apart from the rural electrification programme mentioned above, no significant measures have been taken at the federal government level. On the other hand, the provincial governments have undertaken several rural electrification initiatives based on renewables, using their own resources as well as support from development partners. The Punjab Energy Department is devising a model for rural electrification with specific emphasis on solar PV systems for schools in off-grid localities (Gillani, 2015).

The Department of Energy of the Baluchistan provincial government is making efforts to provide solar energy systems to remote and rural communities in the province. It has completed a project installing solar home systems and solar water pumps in households in the districts of Khuzdar and Jaffarabad. Solar home systems are now being fitted to another 1 300 households in the districts of Kalat, Khuzdar and Mastung (Balochistan Energy Department, 2016).

The Khyber Pakhtunkhwa Energy and Power Department has initiated similar programmes for solar home systems in 200 villages in rural communities (Khyber Pakhtunkhwa Energy and Power Department, 2016b) The provincial government of Khyber Pakhtunkhwa has also established a "Hydel Development Fund" for constructing 356 community-based micro-hydropower power projects across the province (Express Tribune, 2014). Each project will supply electricity to a small off-grid village or community. The Directorate of Alternative Energy, Sindh Energy Department, is carrying out several rural electrification programmes based on solar PV. Stand-alone solar PV systems along with fan and three light bulbs are being fitted to 350 schools in the Tharparkar District, and 140 solar home systems and 15 solar street lights are planned for two villages in the Sanghar District. Both projects have solar home systems comprising solar arrays in the range of 100-200 watt-peak with battery back-up.

Meanwhile, the Pakistan Poverty Alleviation Fund (PPAF), a non-government entity supported by bilateral and international donors, is prioritising energy provision to rural communities across the country. It has been actively involved in shaping several community micro-hydropower projects and has also initiated solar rural electrification based on microfinance. With the support of German development bank KfW, the PPAF is currently involved in community-based run-of-river hydropower and solar energy projects in

Khyber Pakhtunkhwa. The whole project has two phases, with total financial outlay amounting to EUR 22.5 million (about USD 27 million). It consists of establishing 96 solar PV mini-grids with a total installed capacity of 500 kW and several run-of-river hydropower plants with a total capacity of 803 kW.[20] PPAF is also equipping 100 villages in the province of Punjab with solar PV lighting systems. Private-sector involvement in off-grid electrification and mini-grids is proving to be successful in many parts of Africa and developing Asia. IRENA organised the 3rd International Off-grid Renewable Energy Conference (IOREC) in Nairobi, Kenya between 30 September and 1 October 2016. Key recommendations and findings from the conference are presented in Box 5.

Box 5:

## International Off-grid Renewable Energy Conference (IOREC)

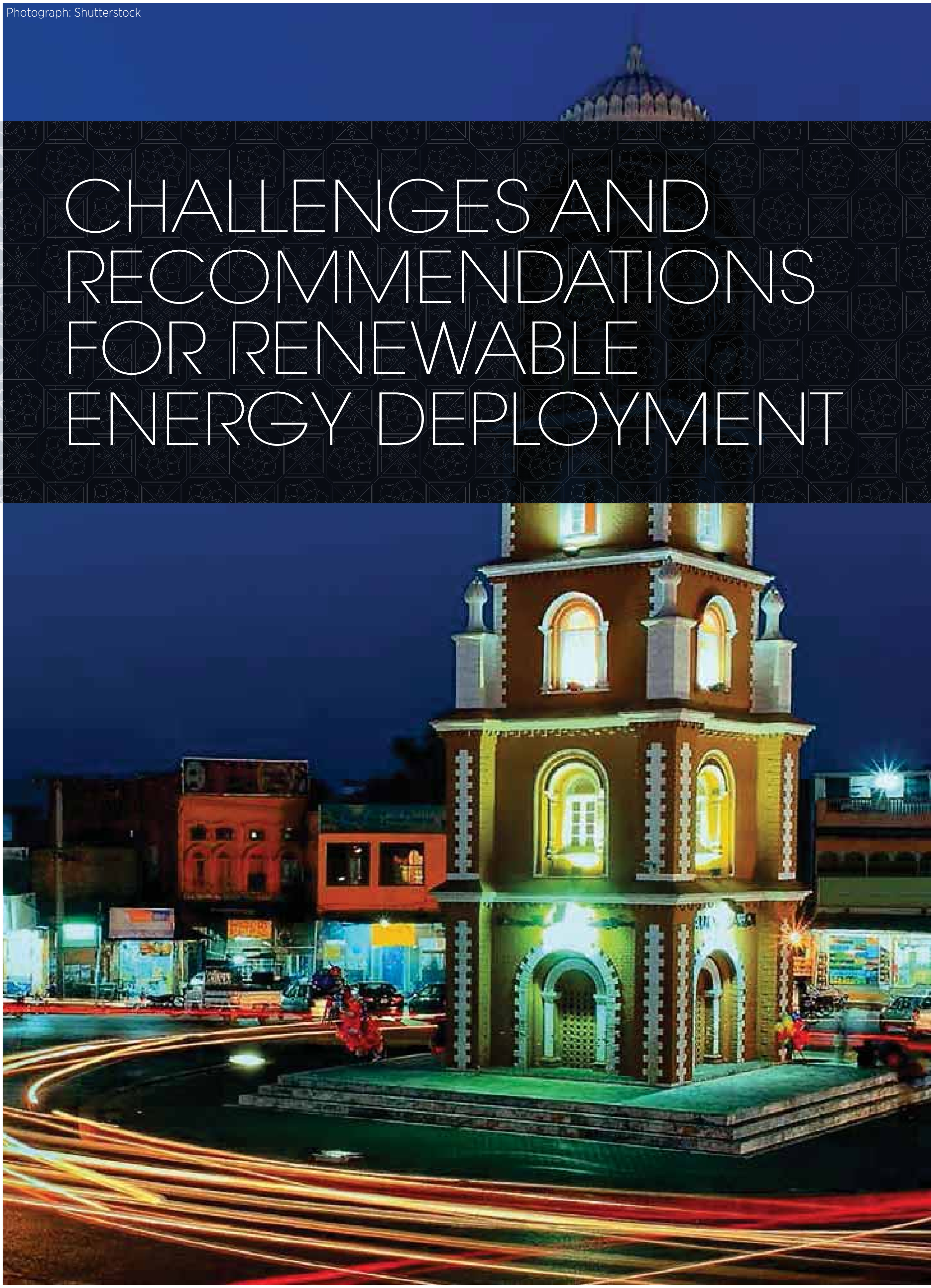
IOREC is the global platform for sharing experience and best practices in designing and implementing enabling policies, tailored financing schemes, innovative business models and technology applications for stand-alone and mini-grid systems.

The conference convenes diverse stakeholders from across the sector, gathers perspectives on key deployment barriers and facilitates dialogue to highlight solutions to accelerate rural electrification through off-grid renewable energy systems.

IOREC was first convened in Accra, Ghana, in 2012 and then in Manila, Philippines, in 2014. The third IOREC conference took place in Nairobi, Kenya, on 30 September and 1 October 2016. It was organised by IRENA in partnership with the Kenya Ministry of Energy and Petroleum and the Alliance for Rural Electrification, and brought together over 550 stakeholders from the sector. Findings of the 3rd IOREC stressed the need to mainstream off-grid renewable energy in national electrification strategies, as both standalone systems and mini-grids are more affordable and reliable than ever. It stressed the importance of having dedicated policies for off-grid electrification with a look towards bringing in the private sector by having the right set of incentives and regulatory safeguards to ensure a sustainable business case for off-grid electrification.

[20] www.ppaf.org.pk/hre.html

# CHALLENGES AND RECOMMENDATIONS FOR RENEWABLE ENERGY DEPLOYMENT



Photograph: Shutterstock

# 04

Pakistan has made positive efforts to develop renewable energy sources over the past few years as a way to resolve the country's power shortage. However, optimising the benefits of renewable energy requires more careful policy articulation and effective implementation. This chapter discusses the main issues identified during the literature review, and following insights gained from respondent interviews, focus groups and multi-stakeholder round table discussions.

This section presents the main challenges and recommended action to address them.

## 4.1 Long-term renewable energy planning

In 2009 the Energy Experts Group, constituted by the Economic Advisory Council and Ministry of Finance, developed the Integrated Energy Plan 2009-2022 targeting 17 400 MW of wind and solar power and 17 392 MW of hydropower to be developed by 2022. In 2011, an integrated energy plan was developed with technical assistance from the Asian Development Bank to support the Pakistan Ministry of Planning, Development and Reform with the involvement of all relevant government agencies and ministries (International Resources Group, 2011). That plan utilised the most comprehensive and inclusive development process ever seen in Pakistan. Yet the government adopted neither of these plans as a comprehensive energy policy, and they remain indicative at best.

Integrated planning, guided by comprehensive ex-ante cost-benefit analyses, has the potential to help the government eliminate the current practice of reactive policies in the absence of adequate strategic planning. The Pakistan Vision 2025 (Planning Commission, 2013), formulated by the Ministry of Planning, Development and Reforms in 2014, provides guidance on the development of an integrated energy plan where the energy mix optimises the use of indigenous energy resources with increased penetration of renewable energy. Pakistan appears to approach renewables deployment from a strictly technical and financial vantage point without fully valuing the social, economic and environmental benefits they present. This undermines the prioritisation renewables deserve in the Pakistan power market.

For the renewable energy sector, a need for a well-co ordinated development plan is further necessitated given that the provinces are empowered under the constitution to devise their own power policies, plans and infrastructure. Moreover, their operating procedures can differ depending on a province's needs or capacities. Therefore letters of intent are not always issued by provincial authorities in a co ordinated way. For instance, Punjab's letters of intent are issued by a panel of experts that includes a National Transmission and Dispatch Company (NTDC) official, whereas in Sindh letters of intent are issued independent of any federal agency involvement – both of which are in compliance with the respective province's policy. However, this lack of co ordination means around 2.9 GW in letters of intent issued by Sindh are not represented in the NTDC grid development plans. This can exacerbate the difficulty of connecting those projects to the grid when the time comes.

### Recommended action 1:
### Co-ordinate the development and implementation of an integrated energy plan

Building on the foundations of past endeavours, Pakistan needs to develop and implement an integrated national energy plan.[21] This could assist policy makers in evaluating the costs and benefits of both demand-side and supply-side interventions under a given set of technological, economic, resource and environmental constraints. The current ownership structure of the power market sectors, the availability of renewable resources across the provinces and the constitutional powers of provincial governments further accentuate the need for an integrated planning process.

The process should involve stakeholders from the public and private sectors considering investments in power generation, transmission, distribution and energy efficiency. It needs to be designed and implemented in a collaborative and participatory manner. This would also help ensure its ownership by various stakeholders and governments. Furthermore, an integrated plan would help set priorities for the technology, volume and location of renewable energy projects that would make the competitive bidding process for renewable energy technologies more effective and sound.

If an integrated energy plan is used as a basis for establishing the optimal resource and technology mix for Pakistan's power sector, it should consider a variety of factors ranging from financial and technical matters to social, economic, environmental and institutional issues. Least-cost power planning helps determine a mix of power sources to meet demand in the most cost-effective manner. However, including considerations such as socioeconomic benefits (e.g. job creation, income generation and improved trade balance) and reduced vulnerability to fuel cost fluctuations produces more robust and long-term plans. These determine optimum levels of renewables in a techno-financially viable, socioeconomically sound and ecologically sustainable manner.

Similarly, an integrated energy plan can help Pakistan align its energy-related infrastructure development with energy production planning, a major challenge currently faced by the power sector of Pakistan. The formation of the Ministry of Energy in 2017 brings together the country's electricity and oil and gas actors under one ministry. This presents a unique opportunity for Pakistan to develop an integrated energy plan that is better co-ordinated, reduces institutional obstacles and, most importantly, creates a unified position on renewable energy. Furthermore, such integrated energy planning can also be used as a basis for formulating and realising Pakistan's Nationally Determined Contribution (NDC) under the Paris Agreement to reduce its projected 2030 greenhouse gas emissions by 20%.

IRENA's report, *Planning for the renewable future: Long-term modelling and tools to expand variable renewable power in emerging economies* (IRENA, 2017), discusses a planning checklist for developing an integrated energy plan with a high share of variable renewable energy in the power sector, highlighting best practice for using long-term modelling and tools for such planning.

### Recommended action 2:
Set targets for renewable energy

Prioritisation of renewable energy technologies is essential for Pakistan to benefit from its immense potential. A possible way to achieve this is by setting well-defined, realistic and time-bound targets for renewables, which would also provide the necessary push for mainstreaming renewables into the Pakistan energy sector. Most targets today remain non-binding due to the difficulty governments face in implementing self-enforcement mechanisms. Binding targets reassure investors because they are less vulnerable to changes in the political climate. However, fiscal constraints could dictate that the country first evaluate the financially and technically optimised share of renewables before allocating the necessary financial resources, reinforcing the need for an integrated energy plan.

A decision on the desired level of renewable energy deployment, ideally coming out of an integrated planning exercise, should act as the basis for the official target. In order for the set targets to translate into concrete projects, they need to be supported by policy instruments. For example, specific obligations, such as renewable portfolio standards, tend to be more effective as they ensure measurability and are mandated by law.

For Pakistan, these binding targets may imply the introduction of an act duly approved by the Parliament and Senate. This would require either a consolidated target or the assignment of renewable portfolio standards to distribution utilities. Legally binding renewable energy targets would provide much-needed clarity to private investors and public-sector agencies for policy implementation and market regulation. A report published in June 2015, *Renewable Energy Target Setting*, elaborates the foundation, functions, key design features and lessons learned from renewable energy target setting for both aspirational and mandatory renewable energy targets (IRENA, 2015a).

[21] The government could consider developing either an overarching integrated energy plan covering all energy subsectors, such as power and transport, or alternatively it could develop an integrated resource plan (IRP) for the power sector. Although it seems more consistent with steps to integrate different economic sectors, the first of these two options requires substantially greater resources and capacities than an IRP. The Planning Commission of Pakistan and USAID are working together on an Integrated Energy Plan for the country. This report restricts its findings to the power sector, since that is the main emphasis of this RRA and also at the top of the government's list of priorities.

## 4.2 Perception of high costs and technical difficulties associated with renewables

Various government agencies take significantly different views on renewables deployment. Some policy makers frequently cast doubts on the affordability and reliability of renewables, whereas the rest believe there is potential for further cost reduction and that technical challenges can be addressed. This view does little to change the perception of some agencies that renewables are somewhat costlier and experience more technical difficulties for grid operation when compared to conventional power technologies.

Costs of renewable energy projects have been coming down significantly in Pakistan. This is evident from the downward trend in renewable energy tariffs. (In 2011, the upfront tariff for wind power projects was 14.66 cents (USD 0.1466)/kWh, while the benchmark tariff now is USD cents 6.75 cents/kWh.) Conversely, the costs of fossil-based power generation remain volatile at best. Furthermore, renewable energy sources do not require the heavy investment in infrastructure that may be necessary for power based on coal and LNG in Pakistan. Despite these factors, government appetite for promoting thermal power appears to be greater than for renewables. This could be because the Pakistan renewable energy market has thus far been driven by feed-in tariffs that, although potentially an effective measure to develop the market by incentivising renewables, might lead to high costs where the tariff is set too high or does not capture dynamics in the market, such as falling costs (IRENA, 2014).

The USAID grid study found that: "The integration of wind and solar power is highly beneficial for the Pakistan energy mix and for the end-user's basket price in the short term and long term" (USAID, 2015). In other parts of the world, evidence shows that renewable resources provide an indigenous, non-exhaustive source of energy and offer a potentially more prudent approach to diversifying the energy mix without compromising system reliability (IRENA, 2015b). The government's apprehensions towards renewables on technical grounds could be explained by the Alternative and Renewable Energy Policy 2006, as it puts the responsibility on NTDC to ensure grid availability for renewables, with developers free to choose their project locations.

**Recommended action 3:**
Encourage renewable energy zoning and competitive procurement

A wide variety of policy instruments are available to support renewable energy deployment, and the choice of policy instrument is highly context-specific, depending on variables such as energy sector, technology and level of development of the sector. NEPRA's directive to introduce an auction (competitive bidding) for solar and wind while using benchmark tariffs as the ceiling for a reverse auction can offer an opportunity to further decrease the price of renewable power generation. For instance, the wind energy benchmark tariff at 6.75 cents/kWh makes wind power cheaper than thermal power generation.

Auctions have served as a real price discovery mechanism in many countries. Mozambique, for example, has recently adopted auctioning as a price-setting mechanism. By blending public and private resources, the country has brought down the cost of solar PV to between six and eight cents/kWh. Similarly, since the introduction of auctioning for onshore wind in South Africa towards the end of 2011, costs per kilowatt hour have come down from 14 cents (USD 0.14) to five cents (USD 0.05).

Guidlines are available for countries to devise effective and efficient auctioning frameworks. These include *Renewable Energy Auctions: A Guide to Design* (IRENA and CEM, 2015) and *Renewable Energy Auctions in Developing Countries* (IRENA, 2013). Competitive procurement mechanisms, such as auctions, can procure renewable energy at the lowest possible price if there is significant interest from investors and thus a high degree of competition. Policy makers therefore need to address any barriers to supporting renewable energy posed by the wider framework. Policy consistency and predictability have significant influence on private-sector investment decisions.

Auctions may not only be an effective tool for real price discovery, but are also flexible in their design and can be tailored to the specific context and country objectives. Since Pakistan plans to introduce auctions for solar and wind, the commissioning of such projects in designated renewable energy zones should be encouraged whenever possible.

To alleviate concerns that renewable energy projects make grid operations difficult, new renewable energy zoning should consider and synchronise with existing government grid development plans. Quaid-e-Azam Solar Park is a good example of renewable energy zoning.

The Government of Pakistan should make sure that these zones have excellent resources, available land and grid access. Such initiatives could pave the way to utilising the excellent solar and wind potential in the western areas of Pakistan such as Baluchistan and the coastline along the Arabian Sea. This would create jobs and could increase economic activity in the region.

Binding targets, competitive procurement and renewables zoning are policy tools that, when guided by an integrated energy plan, can help deploy the desired level of renewables in a cost-effective, technically efficient and sustainable manner.

Photograph: China Three Gorges South Asia Investment Limited

Pakistan has nearly 600 megawatts of wind power generation capacity

## 4.3 Constraints on grid and transmission infrastructure

Renewable energy growth in the country has been concentrated in a few geographical locations, most notably the Quaid-e-Azam Solar Park in southern Punjab and the wind corridors of Jhimpir and Gharo in Sindh. Such large clusters need anticipatory grid planning and extensive infrastructure improvement, requiring dedicated 132 kV and 220 kV substations. However, NTDC's limited financial resources have been creating a serious challenge to meeting the sector's requirements. Some development partners are providing financial assistance for infrastructure development in Jhimpir and Gharo. However, development funding might not suffice for the scale of investment required to satisfy the infrastructure need. This funding amounts to a mere 30% of the total budget necessary to evacuate the planned renewable power capacity of 9 400 MW by 2022.

Due mainly to the limitations of public funding and the private sector's absence from this sector, the transmission infrastructure in Pakistan remains weak. The 1995 policy[22] failed to attract the desired private capital investment for grid development. Nonetheless, a renewed effort was launched in 2015 with the introduction of a new policy, whose benefits remain to be seen.

Grid reliability and stability are an important concern for some of the operational wind power projects. There have been reports of frequent tripping at the connected wind power projects in Jhimpir due to the weak grid infrastructure. Stages 1 and 2 of the NTDC wind power evacuation plan have extended transmission lines to provide four wind power projects in Jhimpir with grid interconnection. However, financial limitations affected capacity increase or grid strengthening to resolve frequent tripping and forced plant outages. Instead of making the most of periods of high wind, some wind power projects have experienced curtailment due to the infrastructural bottleneck (Imran, 2016). A 220 kV substation is under construction near the Jhimpir wind cluster with the capability to evacuate power from wind projects with a combined capacity of 750 MW. A network of 220 kV and 132 kV lines is also being constructed to connect wind projects to the national grid. Almost 850 MW of wind power projects were due to reach commercial operations by 2018, but mobilising sufficient resources to construct new substations and associated transmission line upgrades is daunting for NTDC. There is, therefore, a greater risk of increased tripping frequency, which may reduce turbine integrity and raise O&M costs above the NEPRA benchmark.

The maximum power generation dispatched so far by the national grid is around 17 000 MW – well below existing generation capacity. Grid enhancement and reinforcement is thus necessary for additional power projects – renewables and non-renewables alike. The publication entitled *Study to Determine the Limit of Integrating Intermittent Renewable (Wind and Solar) Resources onto Pakistan's National Grid* (USAID, 2015) concluded that if NTDC could develop the suggested grid and transmission capacity, it could integrate up to 9 332 MW of variable renewable energy. However, this requires significant time and resources; NEPRA notes that NTDC needs USD 9 billion to fund its development plans (NEPRA, 2015a).

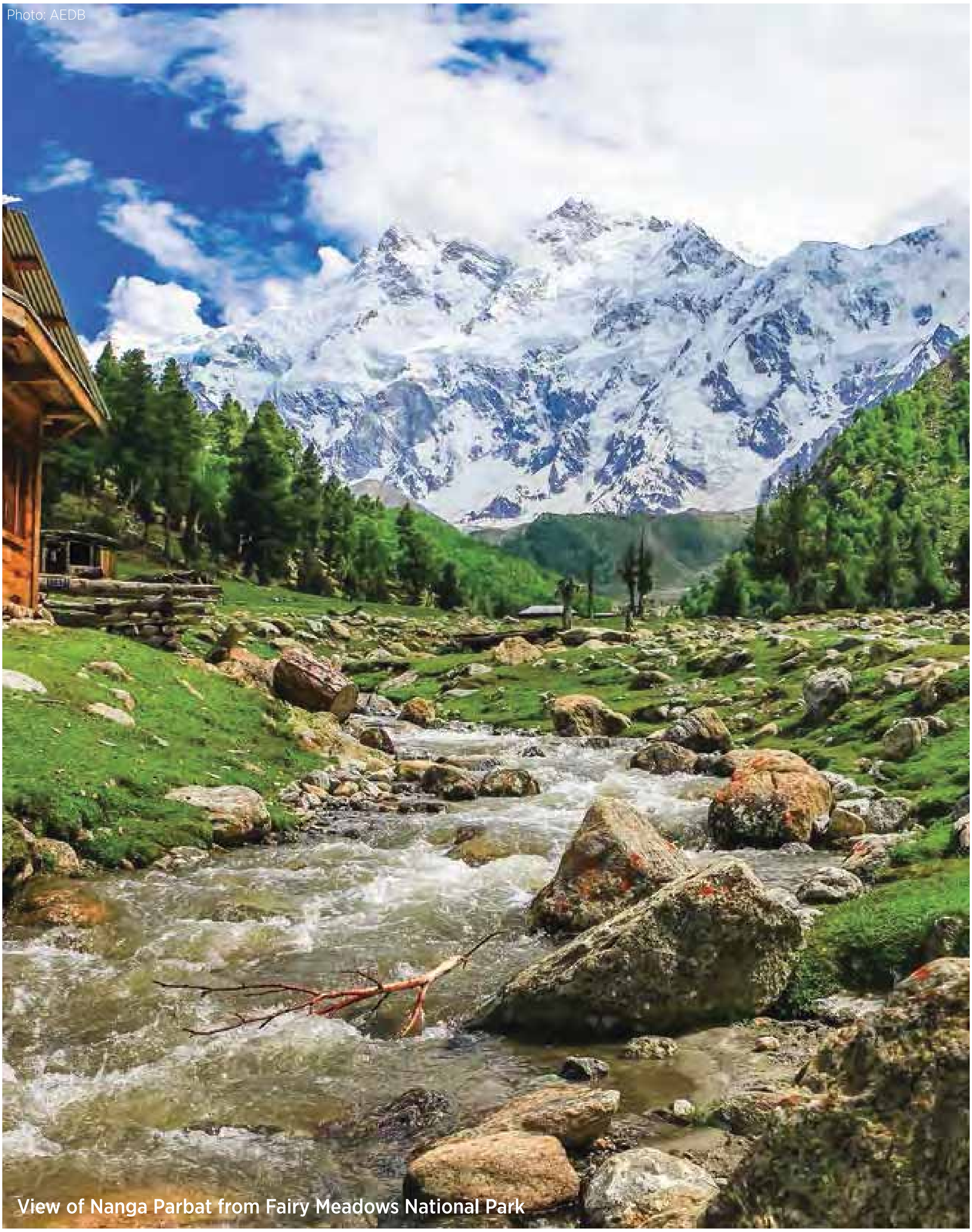
### Recommended action 4:
### Involve private sector in transmission development

The dominant PPIB Transmission Lines Policy 2015 is a step in the right direction for Pakistan. Under this policy, NTDC was able to propose a transmission project to be developed by a private company. NEPRA recently issued this project with a transmission tariff.[23] This transmission infrastructure project is the first to be developed in the private sector in Pakistan and will follow the BOOT modality. The realisation of this project would set a precedent for the private sector to mobilise resources and help the government overcome the financial constraints of the transmission sector. The tariffs set for future transmission projects need to ensure profitability because this may ultimately determine the level of interest from the private sector.

[22] Policy Framework and Package of Incentives for Private-Sector Transmission Line Projects in Pakistan, 1995.
[23] This 660 kV, 878 km transmission line will have transmission capability amounting to 4 000 MW. For detailed information about the project and its financial and technical features, please see NEPRA's tariff determination document (NEPRA, 2016b).

All the renewable energy letters of intent will be for grid-connected projects. This means the government's grid enhancement and extension plans need to be reassessed through the lens of identifying suitable transmission projects to be developed by the private sector. This would reduce the government's requirement to mobilise public funds and allow grid extension and reinforcements, amendments to grid codes and construction of new substations to take place on time. To avoid bottlenecks in both grid availability and stability for the emergent renewable energy projects, work on these improvements should start immediately.

Photo: AEDB



View of Nanga Parbat from Fairy Meadows National Park

## 4.4 Distributed power generation

The Distributed Generation and Net-Metering Regulations, introduced by NEPRA in September 2015, landed DISCOs in unfamiliar territory. Having no prior experience of a mechanism through which to purchase electricity from consumers, several DISCOs expressed reservations about the technical and financial viability of net-metering. They stated that their staff lacks the technical expertise to implement the regulations or evaluate interconnection feasibility and that a large number of distributed generators may destabilise system reliability.

Most consumers who apply for the distributed generator licence will be high-paying industrial/ commercial customers. The switch in their role from high-volume consumers to partial sellers of electricity may affect the revenues of DISCOs, at least in the short term. Moreover, if the net kilowatt hours supplied by the distributed generator exceed the kilowatt hours supplied by the DISCO, the utility will be obliged to pay the distributed generator on a quarterly basis. Although this would help increase generation capacity and potentially alleviate the country's power deficit, excessive distributed generation capacity installations may quickly challenge the financial liquidity of DISCOs.

In addition, the enforceability of these regulations remains ambiguous because NEPRA holds the mandate to regulate the market, but not to define policy frameworks and incentive mechanisms. Co ordination between NEPRA and other government agencies in regulation design has improved, but the distributed generation sector too overlooks the importance of integrated planning. Distributed power generation and its related challenges at this stage can be compared to the early years of utility-scale renewable energy deployment in Pakistan. It remains to be seen which government agency will assume the supervisory role for creating a net-metering market. The roles of various agencies have yet to be defined.

**Recommended action 5:**
Develop a comprehensive distributed power generation plan

NEPRA's net-metering regulations offer an opportunity to exploit the vastly available and geographically scattered solar energy. Given the importance of grid integrity and overall financial viability to the DISCOs, the technical and financial impacts of distributed power generation should be an integral part of Pakistan energy planning. Since the dynamics of distributed power generation differ significantly from the conventional power generation system, growth would create challenges that decision makers must resolve appropriately.

Concerns about commercial viability expressed by various DISCOs are not quantifiable at this stage. However, these concerns cannot be ruled out since they echo those of distribution utilities in other countries. Integrated energy planning should thus include a rigorous analysis of distributed power generation potential and its impacts on the economics of the power market. This is important to ensure the fair distribution of anticipated dividends so that net-metering may be seen as mutually beneficial to both buyer and seller.

Technical challenges and lack of experience in distributed power generation are valid concerns that can be addressed by building capacity. The government should facilitate such programmes, but DISCOs would remain responsible for allocating sufficient resources to develop their in-house capacities. The same can be said of administrative and security challenges that DISCOs must resolve to ensure compliance with NEPRA standards. The government could consider installing flagship projects at various locations to help DISCOs gain much-needed confidence and technical knowhow without added commercial obligations.

Photo: Shutterstock

Sheosar Lake in Deosai National Park

## 4.5 Insufficient focus on rural electrification and the off-grid market

At the federal government level, the focus is primarily on utility-scale projects in areas already served by the national grid. However, 27% of the population still lack access to reliable and affordable electricity. A number of renewable energy applications promoting stand-alone systems or mini-grids to provide access to electricity in remote areas have proved successful in other developing countries, but have seen limited application in Pakistan to date. Policy, economic and technical obstacles remain before this market establishes itself and grows. In addition, a co ordinated effort is necessary between key stakeholders, including government agencies, development agencies, NGOs and microfinance institutions.

The Alternative and Renewable Energy Policy 2006 stipulates facilitating off-grid and dispersed renewable power generation by allocating to AEDB and relevant provincial agencies the responsibility for developing deregulated and simplified procedures (Government of Pakistan, 2006). The policy, which concentrates on small hydropower, does not elaborate on implementation mechanisms, and promotional models have not been worked out in detail. Annex B of the policy noted that similar policies were to be developed and completed by July 2008 for other off-grid renewable energy technology applications for community or isolated grid distribution. These include wind, solar and biomass power generation. So far, no federal or provincial agency or department has formulated any such policy mechanism (AEDB, 2015b). This means the private sector is nowhere to be seen in this critically important area of the economy and social development.

In addition, the lack of technical expertise is a factor limiting the use of micro/mini-grids for rural electrification. Limited capacity to design, install, operate and maintain energy services based on renewables, further exacerbated due to lack of standardisation, has resulted in the poor performance of small-scale renewable energy projects and lowered end-user confidence in stand-alone systems (Ali, 2015). Private-sector investment in rural areas is restricted due to several economic and financial challenges, such as:

- higher perceived commercial risks and investment costs
- limited knowledge of market potential
- lack of financing and government support.

Lack of financing facilities curtails the demand for renewable energy solutions in rural areas. An assessment of demand conducted by the Pakistan Poverty Alleviation Fund and GIZ revealed that over 72% of respondents were willing to take microfinance loans for solar home systems (MicroEnergy International, 2014). This represents strong demand for electricity in rural communities. However, facilities to provide such loans are extremely limited, while prospective consumers cannot afford to pay the full price upfront. Demand for energy services in off-grid areas is high, but the rural renewable energy market cannot sustain itself alone without regulatory or policy intervention from the government. This needs to create an enabling environment for the private sector, taking into account the economic hardships of the rural poor.

**Recommended action 6:**
Create enabling environment for private-sector involvement

A master plan for rural electrification in line with the country's integrated energy plan is required for a co ordinated approach to addressing the technical, financial and policy barriers. Specific policies and regulations need to be put in place to promote mini-grids and stand-alone hybrid systems. They should cover deployment in rural communities outside the reach of the national grid or in places where the commercial viability of extending the grid is questionable. In such cases, the role of mini-grids is worth investigating, as they tend to offer greater flexibility and can provide electricity at a lower cost than fossil-fuel power plants (Franz et al., 2014).

The Alternative and Renewable Energy Policy 2006 prescribes deregulated and simplified processes for setting up mini-grids (AEDB, 2015b). However, the experience of countries that have an established mini-grid market, such as India, Nepal, Tanzania and Kenya, demonstrates that dedicated off-grid policies should be put in place. These should provide details of incentives, procedures and risk coverage for private entities to invest in renewable energy mini-grids. When devising policies and processes for mini-grids, several key factors need to be considered. They include: the size and structure of the mini-grid; available energy resource; suitable grid operator (DISCO, private company or community-based organisation); financing options; household tariffs; and end-user affordability. To build investor confidence, suitable policies and regulatory frameworks are needed to ensure appropriate tariff structures, permit and licensing procedures, concessions, demand guarantees etc. are put in place. IRENA published a report in 2016 entitled Policies and Regulations for Private-Sector Renewable Energy Mini-grids. This provides a comprehensive overview of the policy actions and initiatives that could be put in place by energy sector decision makers as well as other institutions and actors in the public and private sectors (IRENA, 2016b). Key findings of this report are presented as Box 6.

Box 6:

## Facilitating private investment in renewable mini-grids

Governments have an important role in facilitating private-sector participation in mini-grid development as this market is closely tied to national policy priorities and prevailing regulatory frameworks. Supporting mini-grids may require adjusting the centralised power system framework to the diverse technological, business and financing aspects of mini-grid solutions. Typical mini-grid policies targeting private-sector investment need to include certain key elements, as outlined below.

- Legal and licensing provisions: the private sector must have the legal right to generate, distribute and sell electricity to consumers.
- Cost recovery and tariff regulation to ensure sustainability of private-sector mini-grids, taking into consideration economic viability both for the mini-grid developer and consumers.
- Mitigation of risk posed by the unexpected arrival of the main grid.
- Facilitation of access to finance.
- Technological configurations and service aspects.

The report concludes that a well-designed policy and regulatory framework improves project sustainability and maximises socioeconomic benefits. Electricity access generates substantial roots for further rural development, marked by considerable improvements in productivity, income and livelihoods, all of which create their own ripple effect. Indeed, renewable energy solutions have the potential to advance many Sustainable Development Goals. Given these interlinkages, policy makers are encouraged to examine the opportunities that mini-grids offer for solving electrification and other aspects of sustainable development.

Source: IRENA (2016b), *Policies and regulations for private-sector renewable energy mini-grids*

## Annex I. Key power sector institutions of Pakistan

| Organisation | Type | Roles and responsibilities |
|---|---|---|
| Power Division, Federal Ministry of Energy | Federal ministry division | The executive arm of the Government of Pakistan for all issues pertaining to power generation, transmission, distribution, pricing, regulation and consumption.<br>Co-ordinates and plans the nation's electricity sector; formulates policy and specific incentives.<br>Liaises with provincial governments and has oversight for all line agencies and autonomous bodies. |
| NEPRA | Regulator | Independent regulator with a mandate to ensure transparent, competitive and commercially oriented power market operations including generation, transmission and distribution.<br>Issues generation, transmission and distribution licences, and determines tariffs for the power sector. |
| PPIB | Agency | A "one-window" facilitator on behalf of the federal government to promote private-sector participation in the power sector for large hydropower and non-renewable technologies. |
| AEDB | Agency | Autonomous body under the Ministry of Energy with the mandate to promote and facilitate exploitation of renewable energy resources.<br>Develops national strategies, drafts policies and plans for utilisation and promotion of renewable energy.<br>Co-ordinates and facilitates commercial application of renewable energy technologies as well as facilitating private investors.<br>Forum for evaluation, monitoring and certification of renewable energy projects and products. |
| NTDC | State-owned public limited company | Responsible for all properties, rights, assets, obligations and liabilities of the 220 kV and 500 kV grid stations and transmission lines and networks. |
| CPPA (Guarantee) | State-owned limited guarantee | Responsible for power procurement from generation companies, hydropower and IPPs on behalf of DISCOs for delivery through 500 kV, 220 kV and 132 kV networks.<br>Performs power market clearing function. |
| Power utilities (DISCOs) | State-owned companies | Ten separate electricity retail companies responsible for administering the O&M, supply, distribution, construction and expansion of the 132 kV and 11 kV grid network within their respective areas of jurisdiction. |
| K-Electric | Private power utility company | Responsible for generation, transmission and distribution of electric power for the city of Karachi. |
| Provincial energy departments | Provincial government departments | Four provincial energy departments (Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan) and the AJK Power Development Organization support energy project implementation within their respective regions. Responsibilities include liaising with the federal government to implement policies and measures to incentivise energy project development. |
| WAPDA | Agency | Responsible for large-scale hydropower project development and water sector projects. |
| Generation companies | State-owned companies | Government-owned but independently operated companies responsible for O&M of public-sector thermal power plants. |
| PEPCO | State-owned company | Established in 2007 to manage the transition of government entities from a bureaucratic structure to a corporate, commercially viable entity. It is responsible for the management of all the affairs of the corporatised nine DISCOs, four generation companies (GENCOs) and NTDC, all of whom are working under an independent Board of Directors |

# Annex II. Breakdown of upfront tariffs for renewable energy technologies

## Solar PV upfront tariff

To determine the upfront tariff of solar PV power generation, NEPRA has divided Pakistan into two zones based on solar irradiance. A higher tariff is applied to northern Pakistan, where irradiance levels are lower and consequently the capacity factor is 17%. By contrast, it is 18% in southern Pakistan (Baluchistan, Sindh and Southern Punjab).

In case annual power generation exceeds these benchmarks, NEPRA has structured a mechanism for sharing excess revenue with the power purchaser.

| Capacity factor (north/south) | % of tariff chargeable |
|---|---|
| Above 17%/18% to 18%/19% | 80% |
| Above 18%/19% to 19%/20% | 90% |
| Above 19%/20% | 100% |

Source: NEPRA

**Tariff**

Based on the various cost assumptions, the upfront tariff for solar PV valid from 1 January to 30 June 2016 is summarised in Table I.

**Table I.** Solar PV upfront tariff 2016

| Solar PV upfront tariff – north (US cents/kWh) | | | | Indexations |
|---|---|---|---|---|
| **Category** | **> 1 ≤ 20 MW** | **> 20 ≤ 50 MW** | **> 50 ≤ 100 MW** | |
| O&M | 1.7823 | 1.7826 | 1.7823 | CPI, US CPI, PKR/USD |
| Insurance | 0.7483 | 0.7338 | 0.7194 | Actual |
| Return on equity | 3.7058 | 3.7054 | 3.7029 | PKR/USD |
| Debt servicing (10 years foreign financing) | 7.8242 | 7.7179 | 7.6100 | PKR/USD, LIBOR/KIBOR |
| Total tariff (1–10 years) | 14.0604 | 13.9394 | 13.8146 | |
| Total tariff (11–25 years) | 6.2363 | 6.2215 | 6.2046 | |
| Levelised tariff | 11.5327 | 11.446 | 11.356 | |
| **Solar PV upfront tariff – south (US cents/kWh)** | | | | **Indexations** |
| **Category** | **> 1 ≤ 20 MW** | **> 20 ≤ 50 MW** | **> 50 ≤ 100 MW** | |
| O&M | 1.6832 | 1.6832 | 1.6832 | CPI, US CPI, PKR/USD |
| Insurance | 0.7067 | 0.6930 | 0.6795 | Actual |
| Return on equity | 3.4999 | 3.4995 | 3.4971 | PKR/USD |
| Debt servicing (10 years foreign financing) | 5.0022 | 4.9343 | 4.8652 | PKR/USD, LIBOR/KIBOR |
| Total tariff (1–10 years) | 13.2792 | 13.1650 | 13.0470 | |
| Total tariff (11–25 years) | 5.8898 | 5.8758 | 5.8598 | |
| Levelised tariff | 10.892 | 10.8101 | 10.7251 | |

Note: CPI = consumer price index ; O&M = operation and maintenance; one US cent = USD 0.01
Source: NEPRA

## Wind upfront tariff

NEPRA announced a revised wind upfront tariff on 24 June 2015 valid for a period of six months. However, the upfront tariff was reviewed and its validity extended to six months starting from the date of notification of review, i.e. 19 October 2015, under the considerations described below.

**Net annual capacity factor**

The net annual capacity factor defined by NEPRA under the current wind upfront tariff is 35%. Like the mechanism employed for the solar PV upfront tariff, generation exceeding 35% is subject to revenue sharing as per the following schedule:

| Capacity factor | % of tariff chargeable |
|---|---|
| 35% to 36% | 75% |
| 36% to 37% | 80% |
| Above 37% | 100% |

Source: NEPRA.

**Project costs**

The total project costs assumed by NEPRA, taking into account engineering, procurement and construction, land, financing and associated costs, are **USD 2.15 million/MW** based on 100% foreign financing and **USD 2.26 million/MW** based on local financing.

**Table II.** Wind upfront tariff reference table

| Wind upfront tariff – 100% foreign financing | | Indexations |
|---|---|---|
| **Component** | **Tariff (US cents/kWh)** | |
| O&M | 1.4816 | CPI, US CPI, PKR/USD |
| Insurance | 0.6255 | Actual |
| Return on equity | 3.5537 | PKR/USD |
| Debt servicing | 6.633 | PKR/USD, LIBOR |
| Total tariff (1–10 years) | 12.2938 | |
| Total tariff (11–20 years) | 5.6609 | |
| Levelised tariff | 10.4481 | |
| **Wind upfront tariff – 100% local financing** | | **Indexations** |
| **Component** | **Tariff (US cents/kWh)** | |
| O&M | 1.4816 | CPI, US CPI, PKR/USD |
| Insurance | 0.6255 | Actual |
| Return on equity | 3.7261 | PKR/USD |
| Debt servicing | 9.2629 | PKR/USD, KIBOR |
| Total tariff (1–10 years) | 15.0962 | |
| Total tariff (11–20 years) | 5.8333 | |
| Levelised tariff | 12.5186 | |

Source: NEPRA

Table III below presents the different solar and wind upfront tariffs announced by NEPRA at different times.

**Table III.** Summary of solar and wind upfront tariffs in Pakistan

| Technology | Tariff notification | Tariff validity period | | Tariff (US cents/kWh) | |
|---|---|---|---|---|---|
| | | | | North region | South region |
| Solar PV | January 2014 | Duration: 25 years | | 17.01 | 16.31 |
| | January 2015 | Duration: 25 years | < 20 MW | 15.02 | 14.41 |
| | | | 20–50 MW | 14.89 | 14.28 |
| | | | 50–100 MW | 14.76 | 14.15 |
| | December 2015 | Duration: 25 years | 1–20 MW | 11.53 | 10.89 |
| | | | 20–50 MW | 11.45 | 10.81 |
| | | | 50–100 MW | 11.36 | 10.73 |
| Wind | October 2011 | December, 2012<br>For 1 500 MW capacity<br>Duration: 20 years | | 14.66 (FF)<br>20.10 (LF) | |
| | April 2013 | 365 days<br>For 500 MW capacity<br>Duration: 20 years | | 13.52 (FF)<br>16.69 (LF) | |
| | June 2015 | 180 days<br>Duration: 20 years | | 10.45 (FF)<br>12.51 (LF) | |

FF= foreign-financed; LF= locally financed ; one US cent = USD 0.01
Source: NEPRA.
Note: one US cent = USD 0.01

## Bagasse co generation upfront tariff

On 7 July 2015, NEPRA approved an adjustment to the upfront tariff for new bagasse co generation power plants, which had initially been announced on 14 October 2013.[24] Projects for bagasse co-generation would be set up under the framework for co generation policy. The adjusted tariff is applicable only to co generation projects granted the upfront tariff by NEPRA. The assumptions and terms of the adjustment in tariff are explained below.

**Project cost and duration**

The project costs per megawatt assumed by NEPRA are given in table below for an assumed project duration of 30 years.

| Category | % of tariff chargeable |
|---|---|
| Engineering procurement construction cost | 796 000 |
| Other project cost | 68 200 |
| Financing fee and charges | 17 300 |
| Interest during construction | 98 000 |
| **TOTAL** | **979 500** |

Source: NEPRA.

[24] NEPRA announced the first bagasse upfront tariff as 10.62 US cents/kWh.. This tariff was based on local financing and was offered for a 30-year period with a validity period of 365 days.

**Tariff**
Table IV provides reference for the levelised tariff calculation for bagasse co generation projects based on the stated assumptions.

**Table IV.** Reference table for bagasse co generation upfront tariff

| Bagasse co generation upfront tariff – 100% foreign financing | | Indexations |
|---|---|---|
| **Component** | **Tariff (US cents/kWh)** | |
| Variable O&M (local) | 0.1178 | Local CPI |
| Variable O&M (foreign) | 0.3340 | PKR/USD, US CPI |
| Fixed O&M (local) | 0.3144 | Local CPI |
| Fuel cost | 5.8880 | Fuel price |
| Insurance | 0.2169 | Actual |
| Working capital | 0.1706 | KIBOR |
| Debt servicing | 3.8356 | KIBOR |
| Return on equity | 1.018 | PKR/USD |
| Total tariff (1–10 years) | 11.8956 | |
| Total tariff (11–20 years) | 8.0598 | |
| **Levelised tariff** | **10.5601** | |

Note: one US cent = USD 0.01

## Small hydropower upfront tariff

The upfront tariff for small hydropower up to 25 MW was announced by NEPRA on 2 April 2015. Separate tariffs were set for low- and high-head project sites on a BOOT basis. Projects with a head of less than 20 metres were categorised as low-head and with more than 20 metres as high-head.

Two investors filed for a review of the upfront tariff on the basis of engineering, procurement and construction (EPC), civil work, financing and other minor costs. NEPRA took the investors' arguments into account and issued a revised upfront tariff on 14 October 2015.

**Project cost**
The project development costs, incorporating EPC, land, civil work, financing, interest during construction etc., are determined separately for low-head and high-head projects as follows:

| | 100% foreign financing | 100% local financing |
|---|---|---|
| Low-head | USD 3.94 million/MW | USD 4.21 million/MW |
| High-head | USD 2.79 million/MW | USD 2.99 million/MW |

**Tariff**

The reference upfront tariff on a BOOT basis for both low-head and high-head hydropower projects is given in Table V.

**Table V.** Upfront tariff for small hydropower projects

| Low-head hydropower upfront tariff (US cents/kWh) | | |
|---|---|---|
| **Component** | **Foreign financing** | **Local financing** |
| ENERGY CHARGE | | |
| Variable O&M (local) | 0.1274 | 0.1274 |
| Variable O&M (foreign) | 0.1274 | 0.1274 |
| CAPACITY CHARGE | | |
| Fixed O&M (local) | 0.6114 | 0.6114 |
| Fixed O&M (foreign) | 0.1528 | 0.1528 |
| Insurance | 0.7338 | 0.7338 |
| Return on equity (1–10 years) | 4.7583 | 5.0893 |
| Return on equity (11–30 years) | 4.8518 | 5.1892 |
| Debt servicing | 6.6128 | 9.0030 |
| Total tariff (1–10 years) | 13.1592 | 15.8804 |
| Total tariff (11–30 years) | 6.6399 | 6.9773 |
| **Levelised Tariff** | **10.8892** | **12.7804** |
| **High-head hydropower upfront tariff (US cents/kWh)** | | |
| **Component** | **Foreign financing** | **Local financing** |
| ENERGY CHARGE | | |
| Variable O&M (local) | 0.1160 | 0.1160 |
| Variable O&M (foreign) | 0.1160 | 0.1160 |
| CAPACITY CHARGE | | |
| Fixed O&M (local) | 0.5569 | 0.5569 |
| Fixed O&M (foreign) | 0.1392 | 0.1392 |
| Insurance | 0.7499 | 0.7499 |
| Return on equity (1–10 years) | 4.3821 | 4.7001 |
| Return on equity (11–30 years) | 4.4682 | 4.7924 |
| Debt servicing | 6.0899 | 8.3146 |
| Total tariff (1–10 years) | 12.1502 | 14.6929 |
| Total tariff (11–30 years) | 6.1463 | 6.4706 |
| **Levelised tariff** | **10.0597** | **11.8299** |

Source: NEPRA
Note: one US cent = USD 0.01

# Annex III. Status of projects with letters of intent issued by AEDB

## Wind power projects

By December 2016, AEDB had issued 35 wind power project letters of intent, making a cumulative capacity of 1 747.5 MW. Out of that total, 12 projects with a cumulative capacity of 590.5 MW are supplying electricity to the grid. Five wind power projects with a cumulative capacity of 297.6 MW have achieved financial closure and are under construction. All these projects are based on the upfront tariff regime.

**Projects under construction**

| Serial No. | Name of project | Capacity (MW) | Location |
|---|---|---|---|
| 1 | M/s Hydrochina Dawood Power | 49.5 | Gharo |
| 2 | M/s United Energy Pakistan | 99 | Jhimpir |
| 3 | M/s Sachal Energy Development Pvt. | 49.5 | Jhampir |
| 4 | M/s Jhampir Wind Power | 49.6 | Jhimpir |
| 5 | M/s Hawa Energy Pvt. | 50 | Jhimpir |

Information provided by AEDB.
Note: COD = commercial operations date, the date when the project starts its commercial operations

Eighteen wind power projects with a cumulative capacity of 859.4 MW are at different stages of project development.

| Serial No. | Name | Capacity (MW) | Location |
|---|---|---|---|
| 1 | Three Gorges Second Wind Farm Pakistan | 49.5 | Jimpir, Dist. Thatta |
| 2 | Three Gorges Third Wind Farm Pvt. | 49.5 | Jimpir, Dist. Thatta |
| 3 | Tricon Boston Consulting Corporation | 49.6 | Jimpir, Dist. Thatta |
| 4 | Tricon Boston Consulting Corporation | 49.6 | Jimpir, Dist. Thatta |
| 5 | Tricon Boston Consulting Corporation | 49.6 | Jimpir, Dist. Thatta |
| 6 | Western Energy Pvt. | 50 | Jimpir, Dist. Thatta |
| 7 | Burj Wind Energy Pvt. | 14 | Jimpir, Dist. Thatta |
| 8 | Hartford Alternative Energy Pvt. | 49.3 | Jimpir, Dist. Thatta |
| 9 | Zephyr Power Pvt. | 48.3 | Jimpir, Dist. Thatta |
| 10 | Shaheen Foundation | 50 | Jimpir, Dist. Thatta |
| 11 | Trans Atlantic Energy Pvt. | 50 | Jimpir, Dist. Thatta |
| 12 | Norinco International Thatta Power Pvt Ltd. | 50 | Jimpir, Dist. Thatta |
| 13 | Act 2 Wind | 50 | Jimpir, Dist. Thatta |
| 14 | Artistic Wind Power Pvt. | 50 | Jimpir, Dist. Thatta |
| 15 | Harvey Wind Power Project | 50 | Jimpir, Dist. Thatta |
| 16 | Zulikha Energy | 50 | Jimpir, Dist. Thatta |
| 17 | Gul Ahmed Electric | 50 | Jimpir, Dist. Thatta |
| 18 | Din Energy | 50 | Jimpir, Dist. Thatta |

Information provided by AEDB.

## Solar power projects

AEDB is pursuing 28 solar power projects with a cumulative capacity of approximately 956.5 MW, and the following solar power projects, with combined capacity of 400 MW, have started commercial operations

| Serial No. | Name of project | Capacity (MW) | Location |
|---|---|---|---|
| 1 | M/s Quad-e-Azam Solar Power | 100 | Lal Sohanra |
| 2 | M/s Appolo Solar Pakistan | 100 | Lal Sohanra |
| 3 | M/s Crest Energy Pakistan | 100 | Lal Sohanra |
| 4 | M/s Best Green Energy Pakistan | 100 | Lal Sohanra |

Information provided by AEDB.

The following seven solar power projects with a cumulative capacity of 72.52 MW had obtained a letter of support from AEDB by December 2017.

| Serial No. | Name of project | Capacity (MW) | Location |
|---|---|---|---|
| 1 | M/s Access Electric Pvt. | 10 | Pind Dadan Khan |
| 2 | M/s Bukhsh Solar Pvt. | 10 | Bahawalpur |
| 3 | M/s Safe Solar Power Pvt. | 10 | Bahawalpur |
| 4 | M/s Access Solar Pvt. | 11.52 | Pind Dadan Khan |
| 5 | M/s Blue Star Hydel Pvt. | 1 | Pind Dadan Khan |
| 6 | M/s Harappa Solar Power Pvt. | 18 | Harappa, Sahiwal |
| 7 | M/s AJ Power Pvt. | 12 | Adhi Kot, Khushab |

Information provided by AEDB.

Eighteen wind power projects with a cumulative capacity of 859.4 MW are at different stages of project development.

| Serial No. | Company | Capacity (MW) | Location |
|---|---|---|---|
| 1 | M/s Integrated Power Solution | 50 | Sindh |
| 2 | M/s Jafri & Associates | 50 | Sindh |
| 3 | M/s Solar Blue Pvt. | 50 | Sindh |
| 4 | M/s R.E. Solar I Pvt. | 20 | Cholistan, Punjab |
| 5 | M/s R.E. Solar II Pvt. | 20 | Cholistan, Punjab |
| 6 | M/s Jan Solar Pvt. | 10 | QSP, Punjab |
| 7 | M/s Lalpir Solar Power Pvt. | 10 | QSP, Punjab |
| 8 | M/s Blue Star Electric Pvt. | 1 | Pind Dadan Khan |
| 9 | M/s Siddiqsons Energy Karachi | 50 | Punjab |
| 10 | M/s Adamjee Power Generation Pvt. | 10 | QSP, Punjab |
| 11 | M/s Forshine Pakistan | 50 | Badin |
| 12 | M/s ET Solar | 50 | Dist Attock |
| 13 | M/s ET Solar | 25 | Jhimpir |
| 14 | M/s Crystal Energy Pvt. | 2 | Sialkot |
| 15 | M/s ACT Solar Pvt. | 50 | Sindh |
| 16 | M/s Asia Petroleum | 30 | Bahawalnager |
| 17 | M/s First Solar Pvt. | 2 | Kalar Kahar |
| | **Total** | **484** | |

Information provided by AEDB.

**Biomass/waste-to-energy projects**

Eighteen wind power projects with a cumulative capacity of 859.4 MW are at different stages of project development.

| Serial No. | Name of project | Capacity (MW) | Location |
|---|---|---|---|
| 1 | JDW Sugar Mills (U-II) | 26.35 | RYK, Punjab |
| 2 | JDW Sugar Mills (U-III) | 26.35 | Ghotki, Sindh |
| 3 | RYK Mills | 30 | RYK, Punjab |
| 4 | Chiniot Power | 62.4 | Chiniot, Punjab |

Information provided by AEDB.

The following 18 projects, sponsored by sugar mills, amounting to 577.6 MW, are at an advanced stage of development and are expected to be commissioned in 2019.

| Serial No. | Name of project | Capacity (MW) | Location |
|---|---|---|---|
| 1 | Hamza Sugar Mill | 15 | Rahim Yar Khan, Punjab |
| 2 | Layyha Sugar Mills | 41 | Layyah, Punjab |
| 3 | Almoiz Industries | 36 | Mianwali, Punjab |
| 4 | Safina Sugar Mills | 20 | Chiniot, Punjab |
| 5 | Alliance Sugar Mills | 30 | Ghotki, Punjab |
| 6 | Etihad Power Generation | 74.4 | Rahim Yar Khan, Punjab |
| 7 | Shahtaj Sugar Mills | 32 | Mandi Bahaudin, Punjab |
| 8 | Chanar Energy | 22 | Faisalabad, Punjab |
| 9 | RYK Energy | 25 | Rahim Yar Khan, Punjab |
| 10 | Sheikhoo Power | 30 | Muzafar Gargh, Punjab |
| 11 | Indus Energy. | 31 | Rajanpur, Punjab |
| 12 | Hamza Sugar Mill (Unit-II) | 30 | Rahim Yar Khan, Punjab |
| 13 | Hunza Power Pvt. | 49.8 | Jhang, Punjab |
| 14 | Bahawalpur Energy | 31.2 | Bahawalpur, Punjab |
| 15 | Mirpurkhas Energy | 26 | Mirpurkhas, Sindh |
| 16 | Faran Power | 26.5 | Tado Muhammad Khan |
| 17 | Ittefaq Power Pvt. | 31.2 | Bahawalpur, Punjab |
| 18 | **Mehran Energy** | 26.5 | **Tando Allahyar** |

Information provided by AEDB.

## Annex IV. Schedule of electricity tariffs

| NEPRA proposed tariff (2013-2014) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulars | Fixed charges (PKR/kWh per month | PESCO | TESCO | IESCO | GEPCO | LESCO | FESCO | MEPCO | HESCO | SEPCO | QESCO |
| | | Variable charges (PKR/kWh) | | | | | | | | | |
| **Residential** | | | | | | | | | | | |
| For sanctioned load < 5 kW | | | | | | | | | | | |
| < 50 units | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| For consumption > 50 units | | | | | | | | | | | |
| 1–100 units | | 13.00 | 12.70 | 10.50 | 13.26 | 10.00 | 11.09 | 13.00 | 11.06 | 10.50 | 10.50 |
| 101–200 | | 16.24 | 14.50 | 12.50 | 16.90 | 12.33 | 14.00 | 16.90 | 12.50 | 12.50 | 12.50 |
| 201–300 | | 16.24 | 14.50 | 12.50 | 16.90 | 12.33 | 14.00 | 16.90 | 12.50 | 12.50 | 12.50 |
| 301–700 | | 17.90 | 16.50 | 15.00 | 17.90 | 15.00 | 15.00 | 17.90 | 15.50 | 15.50 | 15.00 |
| > 700 units | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| For sanctioned load > 5 kW | | | | | | | | | | | |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | | 13.30 | 11.50 | 11.50 | 13.50 | 11.50 | 11.50 | 13.30 | 11.50 | 11.50 | 11.50 |
| **Commercial** | | | | | | | | | | | |
| For sanctioned load < 5 kW | | | | | | | | | | | |
| For sanctioned load > 5 kW | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| For consumption > 50 units | | | | | | | | | | | |
| Regular | 400.00 | 16.00 | 15.00 | 15.00 | 16.00 | 15.00 | 15.00 | 16.00 | 15.00 | 15.00 | 15.00 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 400.00 | 13.30 | 11.50 | 11.50 | 13.50 | 11.50 | 11.50 | 13.30 | 11.50 | 11.50 | 11.50 |
| **Industrial** | | | | | | | | | | | |
| B1 < 5 kW | | 15.50 | 14.50 | 14.50 | 15.50 | 14.50 | 14.50 | 15.50 | 14.50 | 14.50 | 14.50 |
| B1 peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| B1 off-peak | | 13.30 | 11.50 | 11.50 | 13.50 | 11.50 | 11.50 | 13.30 | 11.50 | 11.50 | 11.50 |
| B1 5–500 kW | 400.00 | 15.00 | 14.00 | 14.00 | 15.00 | 14.00 | 14.00 | 15.00 | 14.00 | 14.00 | 14.00 |
| B2 ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| B2 ToU off-peak | 400.00 | 13.10 | 11.30 | 11.30 | 13.30 | 11.30 | 11.30 | 13.10 | 11.30 | 11.30 | 11.30 |
| B3 ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| B3 ToU off-peak | 380.00 | 13.00 | 11.20 | 11.20 | 13.20 | 11.20 | 11.20 | 13.00 | 11.20 | 11.20 | 11.20 |
| B4 ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| B4 ToU off-peak | 360.00 | 12.90 | 11.10 | 11.10 | 13.10 | 11.10 | 11.10 | 12.90 | 11.10 | 11.10 | 11.10 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bulk supply** | | | | | | | | | | | |
| C1 (a) supply at 400 V (< 5 kW) | | 16.00 | 15.00 | 15.00 | 16.00 | 15.00 | 15.00 | 16.00 | 15.00 | 15.00 | 15.00 |
| C2 (b) > 5 kW | 400.00 | 15.50 | 14.50 | 14.50 | 15.50 | 14.50 | 14.50 | 15.50 | 14.50 | 14.50 | 14.50 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 400.00 | 13.30 | 11.50 | 11.50 | 13.50 | 11.50 | 11.50 | 13.30 | 11.50 | 11.50 | 11.50 |
| C2 supply at 11 kV | 380.00 | 15.30 | 14.30 | 14.30 | 15.30 | 14.30 | 14.30 | 15.30 | 14.30 | 14.30 | 14.30 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 380.00 | 13.10 | 11.30 | 11.30 | 13.30 | 11.30 | 11.30 | 13.10 | 11.30 | 11.30 | 11.30 |
| C3 supply > 11kV | 360.00 | 15.20 | 14.20 | 14.20 | 15.20 | 14.20 | 14.20 | 15.20 | 14.20 | 14.20 | 14.20 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 360.00 | 13.00 | 11.20 | 11.20 | 13.20 | 11.20 | 11.20 | 13.00 | 11.20 | 11.20 | 11.20 |
| **Commercial** | | | | | | | | | | | |
| Salinity Control and Reclamation Programme (SCARP) | | 15.50 | 13.50 | 14.50 | 15.50 | 14.50 | 14.50 | 15.50 | 14.50 | 13.60 | 14.00 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.000 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 200.00 | 13.00 | 11.20 | 11.20 | 13.20 | 11.20 | 11.20 | 13.00 | 11.20 | 11.20 | 11.20 |
| Tube wells | 200.00 | 15.00 | 12.97 | 14.00 | 15.00 | 14.00 | 14.00 | 15.00 | 14.00 | 13.00 | 13.61 |
| ToU peak | | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 19.00 | 17.50 | 17.50 | 17.50 |
| ToU off-peak | 200.00 | 13.00 | 11.20 | 11.20 | 13.20 | 11.20 | 11.20 | 13.00 | 11.20 | 11.20 | 11.20 |
| Public lighting | | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Residential colonies attached to industries | | | | | | | | | | | |
| | | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Railway traction | | | | | | 15.00 | | 15.00 | | | |
| Special contracts –AJ&K | 360.00 | 14.38 | | 14.38 | 15.00 | | | | | | |
| ToU peak | | 19.00 | | 17.50 | 19.00 | | | | | | |
| ToU off-peak | 360.00 | 13.00 | | 11.20 | 13.20 | | | | | | |
| Special contract issued to a WAPDA facility – Rawat Lab. | | | | 15.00 | | | | | | | |

Notes: PESCO = Peshawar Electric Supply Co.; TESCO = Tribal Areas Electric Supply Co.; GEPCO = Gujranwala Electric Supply Co.; LESCO = Lahore Electric Supply Co.; FESCO = Faisalabad Electric Supply Co.; MEPCO = Multan Electric Power Co.; HESCO = Hyderabad Electric Supply Co.; SEPCO = Sindh Electric Power Co.; QESCO = Quetta Electric Supply Co.; ToU = time of use.

| Government of Pakistan notified tariff (2013–2014) | | | | |
|---|---|---|---|---|
| Particulars | With effect from 11 Oct 2013 | With effect from 1 Oct 2014 | | |
| | Fixed charges (PKR/ kWh per month) | Variable charges (PKR/kWh) | Fixed charges (PKR/kWh/month) | Variable charges (PKR/kWh) |
| **Residential** | | | | |
| For sanctioned load < 5 kW | | | | |
| < 50 units | | 2.00 | | 2.00 |
| For consumption > 50 units | | | | |
| 1–100 units | | 5.79 | | 5.79 |
| 101–200 | | 8.11 | | 8.11 |
| 201–300 | | 12.09 | | 12.09 |
| 301–700 | | 16.00 | | 16.00 |
| > 700 units | | 18.00 | | 18.00 |
| For sanctioned load > 5 kW | | | | |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | | 12.50 | | 12.50 |
| **Commercial** | | | | |
| For sanctioned load < 5 kW | | 18.00 | | 18.00 |
| For sanctioned load > 5 kW | | | | |
| Regular | 400.00 | 16.00 | 400 | 16.00 |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | 400.00 | 12.50 | 400 | 12.50 |
| **Industrial** | | | | |
| B1 < 5 kW | | 14.50 | | 14.50 |
| B1 peak | 400.00 | 14.00 | 400.00 | 14.00 |
| B1 off-peak | | 18.00 | | 18.00 |
| B1 5-500 kW | | 12.50 | | 12.50 |
| B2 ToU peak | | 18.00 | | 18.00 |
| B2 ToU off-peak | 400.00 | 12.30 | 400.00 | 12.30 |
| B3 ToU peak | | 18.00 | | 18.00 |
| B3 ToU off-peak | 380.00 | 12.20 | 380.00 | 12.20 |
| B4 ToU peak | | 18.00 | | 18.00 |
| B4 ToU off-peak | 360.00 | 12.10 | 360.00 | 12.10 |

| | | | | |
|---|---|---|---|---|
| **Bulk supply** | | | | |
| C1 (a) supply at 400 V (< 5 kW) | | 15.00 | | 15.00 |
| C2 (b) > 5 kW | 400.00 | 14.50 | 400.00 | 14.50 |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | 400.00 | 12.50 | 400.00 | 12.50 |
| C2 supply at 11 kV | 380.00 | 14.30 | 380.00 | 14.30 |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | 380.00 | 12.30 | 380.00 | 12.30 |
| C3 supply > 11kV | 360.00 | 14.20 | 360.00 | 14.20 |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | 360.00 | 12.20 | 360.00 | 12.20 |
| **Agricultural** | | | | |
| SCARP | | 13.01 | | 13.01 |
| Agricultural tube wells | 200.00 | 10.35 | 200.00 | 11.51 |
| **SCARP 5 kW and above** | | | | |
| ToU peak | | 17.00 | | 17.00 |
| ToU off-peak | 200.00 | 10.00 | 200.00 | 10.00 |
| Agricultural 5 kw and above | | | | |
| ToU peak | | 10.35 | | 10.35 |
| ToU off-peak | 200.00 | 10.35 | 0 | 10.35 |
| Public lighting | | 15.00 | | 15.00 |
| Residential colonies attached to industries | | 15.00 | | 15.00 |
| Railway traction | | 15.00 | | 15.00 |
| Special contracts – AJ&K | 360.00 | 12.22 | 360.00 | 12.22 |
| ToU peak | | 18.00 | | 18.00 |
| ToU off-peak | 360.00 | 12.22 | 360.00 | 12.22 |
| Rawat Lab | | 15.00 | | 15.00 |

## Annex V. NTDC grid enhancement plan for solar and wind power evacuation

| | |
|---|---|
| **1 000 MW solar power evacuation plan for Quaid-e-Azam Solar Park** | |
| Phase 1: 100 MW solar power evacuation at 132 kV (completed)<br>Federal ministry division | • 132 kV D/C transmission line approximately 4 km long on rail conductor for looping in/out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants |
| Phase 2: additional 300 MW solar power evacuation at 132 kV | • 132 kV D/C transmission line approximately 8 km long on rail conductor for looping in/out of the proposed 132 kV Bahawalpur Cantt. – Lal Suhanra S/C at solar power plants<br>• 132 kV D/C transmission line approximately 4 km long on rail conductor for looping in/out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants<br>• 132 kV D/C transmission line approximately 40 km long on rail conductor from Bahawalpur New to Lodhran and looping in/out of one circuit at Baghdad-ul-Jaded |
| Phase 3: additional 600 MW solar power evacuation at 220 kV | • 220/132 kV collector substation at Lal Suhanra substation with 3x250 MVA 220/132 kV transformers<br>• 220 kV D/C transmission line, approximately 40 km long on twin-bundled rail conductor from 220 kV Lal Suhanra to Bahawalpur substation<br>• Three 132 kV D/C transmission lines, each approximately 8 km (total 24 km) long on rail conductor from 220 kV collector substations to individual solar power projects |
| **1 750 MW wind power evacuation from Jhimpir and Gharo** | |
| Stage 1: 200 MW wind power evacuation at 132 kV for two wind power projects in Jhimpir and two in Gharo (completed) | • 132 kV D/C t/line 64 km long from FWEL-I and FWEL-II wind power projects to the existing Thatta 132 kV substation<br>• Rehabilitation of the existing 132 kV lines (i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old) in the vicinity of wind power project clusters |
| Stage 2: 100 MW wind power evacuation at 132 kV for two wind power projects in Jhimpir<br>(completed) | • Stringing 2nd Jhimpir-Nooriabad 132 kV circuit, approx. 30 km long on Cairo conductor<br>• 132 kV D/C t/line for looping in/out of Jhimpir-Nooriabad 2nd 132 kV circuit at TGF and Sapphire<br>• One of the existing 220 kV D/C circuit from Jamshoro to KDA33 will be looped in at Nooriabad 132 kV substation and energised at 132 kV |
| Stage 3: 330 MW wind power evacuation at 132 kV Jhimpir and Gharo clusters | • New 132 kV substation at Jhimpir<br>• New 132 kV D/C t/line on Greeley conductor from Jhimpir-New to existing T.M. Khan substation (approx. 82 km)<br>• 132 kV t/lines on Greeley conductor from wind power projects to Jhimpir New 132 kV collector station (25 km)<br>• Energisation of 220 kV D/C line on 132 kV until the commissioning of Gharo 220/132 kV grid station |
| Stage 4: 1 120 MW wind power evacuation at 132 kV Jhimpir and Gharo clusters | • Upgrade of 132 kV Jhimpir to 220 kV Jhimpir-New substation with 3x250 MVA 220/132 kV transformers<br>• New 220 kV D/C t/line on twin-bundled Greeley conductor from proposed 220 kV Jhimpir-New to existing 220 kV T.M. Khan Road substation (approx. 70 km)<br>• 220/132 kV Gharo-New GIS substation with 2x250 MVA 220/132 kV transformers<br>• New 220 kV D/C t/line on twin-bundled Greeley conductor from proposed 220 kV Gharo-New to the proposed 220 kV Jhimpir-New substation (approx. 75 km)<br>• 132 kV t/lines from wind power projects to Jhimpir New and Gharo New 220/132 kV substations (65 km and 20 km respectively)<br>• Extension of third 450 MVA 500/220 kV transformer at Jamshoro 500 kV substation<br>• New 220 kV D/C t/line on twin-bundled Greeley conductor from looping in/out of Jamshoro – KDA33 220 kV circuit at NBT wind power project (approx. 10 km) |

Notes: D/C = double circuit; FWEL = Foundation Wind Energy-I Limited; S/C = single circuit; t/line = transmission line; TGF = Three Gorges First.
Source: NTDC (2015b), "Solar and wind interconnection scope of work".

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