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Abstract

Pakistan has been mired in a crippling energy crisis for several years, but is experiencing a rapid turnaround in the energy sector with several new projects coming online. However, government interventions rely heavily on imported fuel such as oil, coal, and LNG. An import-driven energy policy is not sustainable for Pakistan. Besides being a drain on its foreign exchange reserves, it exposes the economy to international energy price shocks, putting the entire economy at risk.

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A green energy-based energy policy can help Pakistan meet its energy requirements while reducing its dependence on imports and hence reduce the cost of energy to the country. This paper describes how the regulations and the structure of the power market support the financial viability of renewable energy in Pakistan and enable easy access to financing. The one-buyer, take-or-pay model of power purchase ensures that any new project that may produce expensive power but provides other benefits like clean energy or an improvement in the balance of payments (use of local fuel instead of imported fuel) can be financially viable provided the government approves it. However, the increased financial viability comes at the cost of higher energy prices to consumers due to low operational efficiencies and a higher subsidy burden on the government. The paper also discusses the challenges faced by distributed renewable energy projects (like home rooftop solar energy solutions) since they do not benefit from the same one-buyer, take-or-pay support. However, subsidized financing can help increase the penetration of this source of energy.

Keywords

Pakistan energy sector · Green finance · Energy policy

JEL Classification

Q42 · Q48

Introduction

Pakistan's economy is facing the dual challenge of a burgeoning annual fuel import bill and climate change. The oil import bill for 2017–18 was US\$13 billion (a 30% year-over-year increase) (Hussain 2018). Although the national power generation mix has been restructured in recent years to reduce reliance on imported oil, the new fuel mix leans heavily toward imported LNG. Pakistan should continue to expand indigenous sources including renewables, reduce reliance on imported fuels, and incentivize the development of green energy projects by providing a conducive policy environment, raising awareness, and improving access to green finance.

Currently, renewable energy comprises less than 3.0% of Pakistan's total power generation fuel mix. However, the government is actively trying to promote its development, particularly the use of solar photovoltaics, small hydro, and wind facilities. The government is also exploring initiatives to improve the management of demand and supply in this market by introducing net metering, which would allow consumers to sell power back to the grid. While the concept is theoretically sound, Pakistan's biggest challenge is the lack of adequate electricity transmission and distribution infrastructure to absorb large quantities of power from intermittent renewable energy sources such as wind and solar.

This chapter focuses on the economic case for renewable energy in Pakistan, discusses the financial barriers to the development of green energy projects, and outlines the policy instruments needed to unlock the potential of commercial banks

to finance such projects. The second part of this chapter provides an overview of the energy sector in the country and the accompanying macroeconomic challenges. In the third section we describe how the structure of the power market in Pakistan supports the financial viability and bankability of utility-scale renewable energy projects. In the fourth section we discuss the challenges to developing new projects of hydro, wind, solar, and distributed energy (despite the favorable regulatory framework) that are specific to each source of energy, and finally in the fifth section we present some policy recommendations for increasing the share of renewable energy in Pakistan's energy mix.

Overview of Pakistan's Energy Sector

Pakistan has a structured and formalized energy sector, accessible to both local and international investors. Except for the transmission and distribution of electricity and gas, which are currently almost entirely owned by the government, most other energy sectors are open to private investment. The two main independent regulators overseeing the energy sector are the Oil and Gas Regulatory Authority (OGRA) and the National Electric Power Regulatory Authority (NEPRA). OGRA monitors pricing and the protection of consumer interests in the midstream and downstream petroleum sector, while NEPRA does the same in the generation, transmission, and distribution of electricity (Figures 1 and 2).

Import-Reliant Fuel Mix

Overall, Pakistan imports nearly one-third of its energy supplies in the form of oil, coal, and recently LNG. This share of imports is expected to grow drastically as Pakistan's own gas fields are depleted. OGRA projects local gas production to fall

Figure 1: Pakistan's Primary Energy Supply Mix 2017. (Source: Pakistan Energy Yearbook 2017, Ministry of Energy, Government of Pakistan)

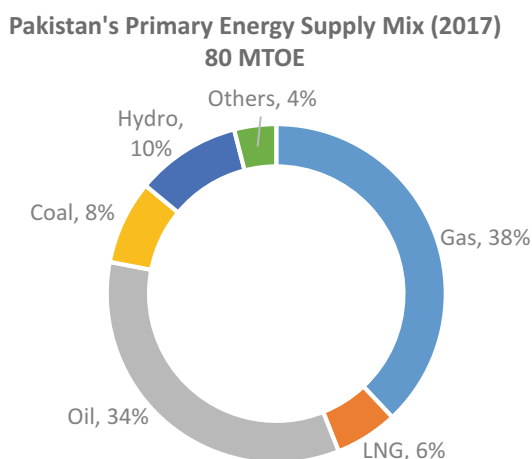


Figure 2: Pakistan’s Electricity Generation Mix 2017. (Source: State of Industry Report 2017, NEPRA, Government of Pakistan)

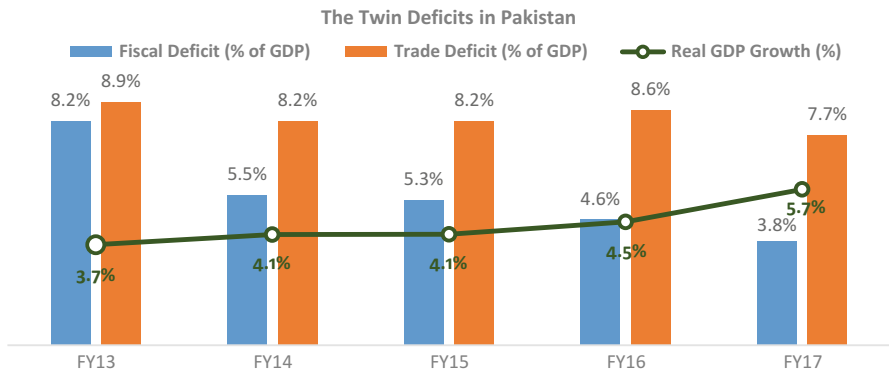
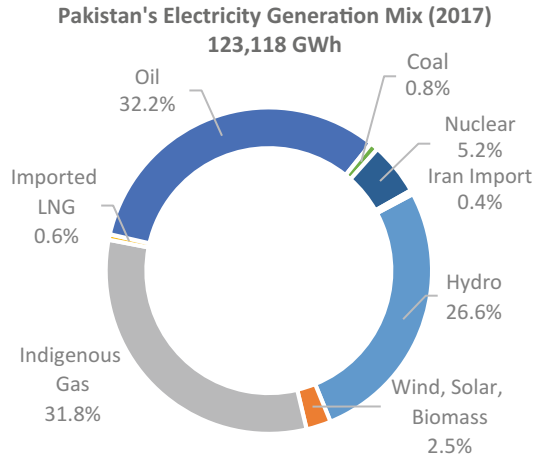


Figure 3: Fiscal and Trade Deficit (% of GDP). Note: The FY17 numbers are provisional and the FY17 number for trade deficit is for the 9 months July 2016 to March 2017. (Source: Pakistan Economic Survey 2016–17, Ministry of Finance, Government of Pakistan)

from about 3.7 billion cubic feet per day currently to about 1.8 billion cubic feet per day by 2025 (OGRA 2018). Over the same period, it expects demand for gas to increase by over 1.5 billion cubic feet per day. To just cover this incremental 3.5 billion cubic feet per day shortfall, Pakistan’s energy imports (in tonnes of oil equivalent, TOE) would have to double by 2025.

An import-driven energy policy is not sustainable for Pakistan. Besides being a drain on its foreign exchange reserves, it exposes the economy to international energy price shocks, which put the entire economy at risk through inflation, and reduce the competitiveness of the country’s exports, which further constrains the country’s capacity to pay for energy imports. In addition, international price shock-related energy price increases inflate the energy subsidy budget, making it increasingly challenging for the government to manage its fiscal deficit (Figure 3).

Spurred by growing gas and electricity shortages, the energy sector in Pakistan has gone through a massive phase of investment over the last 5 years. Roughly 10 GW of new power generation capacity and 1.2 billion cubic feet per day of new LNG importing infrastructure have been either commissioned or will be commissioned by 2018. The new power generation capacities include 1 GW of wind and solar power projects and 2.3 GW of hydroelectric power. Further, expansion in power generation capacities (especially renewables) is constrained by slow upgrades and capacity enhancements of the electricity transmission and distribution network (T&D).

Inadequate Transmission and Distribution Capacity (T&D)

The T&D network in Pakistan is owned and operated by state entities, with the exception of the network in the city of Karachi and its adjoining areas, which is operated by K-Electric, the country's first privatized utility. The T&D sector in Pakistan faces several concurrent challenges:

1. **High T&D losses:** The national average of electricity transmission and distribution losses stands at 16–18% (NEPRA 2017) with district-wise grid losses ranging widely from less than 10% to greater than 30%. These losses include both technical losses and power theft.
2. **Overloaded distribution infrastructure:** Developments in the T&D sector have not kept pace with the electricity demand and with the additions of new power plants. As a result, a sizable share of power transformers, 11 kV feeders, and distribution transformers are overloaded or operating at capacity. Overloading increases the likelihood of technical faults and grid failures.
3. **Addition of renewable power:** As electricity generated from renewable energy like solar and wind varies with the time of the day and season, T&D operators need to rethink grid management to adapt to renewable energy-related grid stability challenges. In addition, as distributed power generation, such as home rooftop solar solutions, takes off, the grid needs to be ready for smart metering.

The T&D sector in Pakistan lags behind other energy sectors in attracting private investment as reforms to allow and encourage private sector participation have been slow in the making. The government is ambivalent about whether or not it will proceed with the privatization of distribution companies as the results of privatization of K-Electric, the first utility to be privatized in the country, are inconclusive. K-Electric has seen a financial turnaround, from being a loss-making entity to becoming a profitable company—the new management managed to improve operational efficiencies and payment recoveries. However, it is now coming under increased criticism and scrutiny for not investing enough in its T&D infrastructure and for failing to eliminate power shortages on its network.

To summarize, Pakistan is facing three major challenges in the energy sector:

1. Improving energy security by diversifying the fuel mix and reducing the share of imported fuels,
2. Reducing the cost of energy and hence the energy subsidy burden, and
3. Improving the transmission and distribution networks of electricity.

Green energy, like solar, wind, and hydro power, can make a significant contribution in reducing the share of imported energy, buffering the economy from international energy price shocks, and reducing the subsidy burden on the government. Rethinking the design and management of T&D networks to accommodate renewable power generation and distributed renewable power generation is key to unlocking this potential.

Financial Viability of Pakistan's On-Grid Utility-Scale Renewables

One-buyer Electric Power Market

On-grid utility-scale renewables energy projects in Pakistan are easily able to access conventional debt and equity to finance the project. The structure of the country's power market and its long-term power purchase agreements ensure that approved renewable projects do not face any more challenges in sourcing financing when compared with approved non-renewable projects.

Pakistan has a one-buyer model where all grid-connected electric power produced (whether by private companies or state-owned companies) is procured by the Central Power Purchasing Agency (CPPA-G), a government-owned entity, which then sells to the distribution companies. The distribution companies sell power to individual consumers (industrial, commercial, and residential) and recover payments from them, which are used to pay the CPPA-G, which in turn pays the power companies (Figure 4).

There are standard long-term power purchase agreements between the CPPA-G and the power-producing companies, with a sort of take-or-pay mechanism, which ensures that even if a power company could supply power but the CPPA-G did not offtake (because, for example, it was more expensive or because there were government infrastructure-related power evacuation constraints), the CPPA-G still makes certain payments to the power company, which are enough to cover its (a) debt payments, (b) equity investor returns, and (c) fixed operating costs. Further, the Government of Pakistan (GOP) offers a sovereign guarantee to power companies to back the CPPA-G. Under this guarantee, in the case of a long-standing default of payments leading to the termination of power purchase agreements, the power companies can exercise a put option to sell their plant to the GOP and recover their investment and return on investment.

In addition, most of the long-term power purchase agreements have tariffs with pre-defined indexation formulas, which allow the tariffs to change with changes in

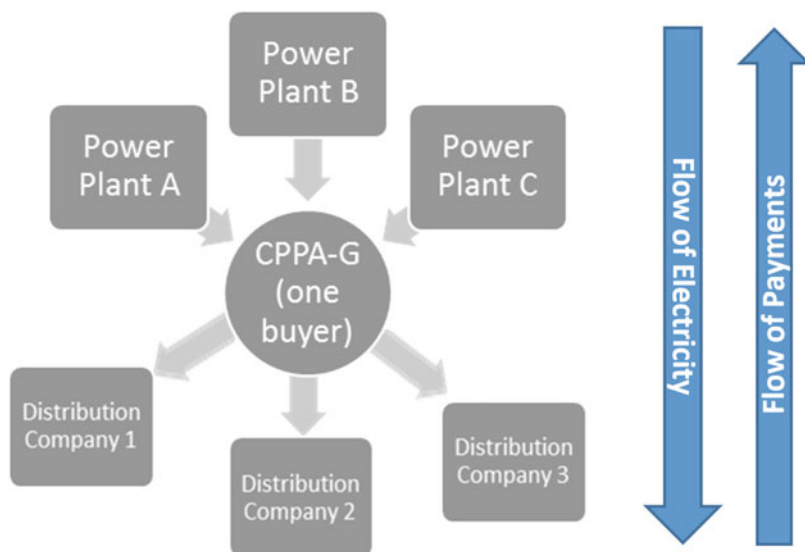


Figure 4: Pakistan's One-buyer Electric Power Market. *CPPA-G* Central Power Purchasing Agency. (Source: Authors)

consumer price index, the Pakistani rupee to US dollar exchange rate, fuel prices, and LIBOR/KIBOR rates. Some projects also have indexation for natural degradation in operational performance, which allows power plants to recover the costs of increased fuel consumption as the plant becomes old and less efficient (the degradation curve is pre-defined). These indexation mechanisms allow power projects to earn higher cash flows to cover higher costs of operations and financing that may arise over the life of the project, and also protect the lenders and investors from macroeconomic instability. Furthermore, when the government/*CPPA-G* agrees to a pre-defined tariff indexation formula, it offers investors greater long-term transparency on project returns, reduces the risk of adverse government intervention in tariff setting (especially after the project has been constructed), and makes the project more bankable.

In this regulated and highly protected environment, a power-producing companies face losses only if their operations are subpar (lower than planned efficiencies, unplanned shutdowns/failures). Otherwise their ability to service debt and pay dividends is pretty much protected even if their power is not being bought by the *CPPA-G*. Tariffs are pre-determined and there is no market competition driving them down and forcing the operating power companies to reduce costs. This one-buyer, take-or-pay model of power purchase ensures that any new power project that may produce expensive power but provides other benefits like clean energy or an improvement in the balance of payments (use of local fuel instead of imported fuel) can be financially viable provided the *GOP* approves the project and the *CPPA-G* enters into a long-term power purchase agreement with it. Consequently, when lenders evaluate approved power projects they do not feel renewables have

more financial risk than non-renewables and are just as likely to lend to renewable projects. In fact, they observe that non-renewable power projects have added risks of fuel supply sourcing and management, making renewable energy projects more attractive to lend to.

Shortcomings of Pakistan's Electric Power Market Model

While the one-buyer, minimum take-or-pay model enables financial viability and financing access to all approved power projects, including renewable ones, it has its limitations. There is no inbuilt mechanism in such models to incentivize power companies to strive for operational efficiencies and cost reductions for the benefit of the end consumer. Also, such a contracting structure overprotects projects, especially in the end-of-life stage when they face challenges in terms of technology obsolescence. The CPPA-G is committed to making at least the minimum payments to power plants throughout the life of the power purchase agreements, even if lower-cost power options become available, whereas in a competitive market, such projects would have been retired. Second, under such a tariff structure with pre-defined operating parameters the power companies stand to gain or lose in the case of operational outperformance (lower operating costs) or underperformance (higher operating costs) and this gain or loss does not transfer to end consumers. The result, at a macro level, is that operational efficiencies that could drive down the cost of energy in Pakistan do not end up getting realized.

In recent project tariffs, the regulator has introduced an efficiency gains-sharing mechanism, whereby a portion of the gains from operational outperformance are passed on to consumers. It has introduced in some cases competitive tariff bidding for power projects whereby investors self-select into the lowest tariff possible with limited indexation. It has not yet solved the problem of getting locked into a power purchase agreement where the technology is rapidly evolving and risks obsolescence. This problem is perhaps more severe in solar and wind power projects where the cost of electricity generation has decreased significantly in this decade alone due to technological improvements. The result is that the government has gone into a wait-and-see mode to see where the cost of wind and solar energy plateaus before approving new projects.

Another issue with the indexation structure of power tariffs is indexing certain components of the tariff with the Pakistani rupee (PRu) to US dollar (USD) exchange rate movements such as those related to compensation for fuel, foreign operations cost, foreign debt, and return on equity. Any step taken by the government to increase the competitiveness of Pakistani exports through currency devaluation leads to an increase in the cost of power, and hence the cost of doing business in Pakistan, which in turn undermines export competitiveness. This offsetting impact in reality is muzzled by the government's electric power subsidy program, so devaluation leads in part to an increase in the subsidy burden of the government and in part to an increase in electricity tariffs to end-consumers.

The government is promoting renewable energy and local fuel-based power projects in a bid to reduce the impact of devaluation on energy prices in Pakistan by reducing its dependence on imported fuels. Additional steps can also be taken like offering PRe-based returns on equity for power projects instead of USD based ones and pursuing policies to incentivize equipment and technology suppliers to increase the localization of their maintenance services.

Transition to the Competitive Trading Bilateral Contract Market (CTBCM)

The one-buyer, take-or-pay model protects power companies (renewable or non-renewable) against commercial risks, certain macroeconomic risks, and technology obsolescence risks. However, this protection and increased financial viability comes at the cost of the electricity consumers and the government. The consumers face higher electricity costs and the government has to set aside ever-growing budgets for power subsidies. The government realizes these shortcomings of the model and in the medium to long term it is developing a framework to transition from a one-buyer model to a competitive market in an attempt to weaken the monopolies, increase operational efficiencies, and lower energy prices for consumers (CPPA 2018).

In the first phase it aims to set up a Competitive Trading Bilateral Contract Market (CTBCM) to introduce multiple buyers who would enter into power purchase agreements with the various power producers. The CPPA-G, which currently procures power from the power companies, will step out and the distribution companies will directly procure power from the power companies. The CPPA-G will play the role of a market operator (for example settlements, balancing, and invoicing, administering independent auctions for new capacity procurement, etc.).

The design of the CTBCM aims to build on existing conditions and types of take-or-pay power purchase agreements. Both energy (to cover electric consumption) and generation capacity (to cover security of supply) will be sold in the market. While generation capacity procurement is likely to ensure certain minimum revenues to power companies, the government will not be offering a sovereign guarantee to back the distribution companies' commitments in their power purchase agreements as it has been doing with the CPPA-G. While the CTBCM model is still being finalized, it remains to be seen how moving toward a more liberalized market is likely to change the financial incentives and protections currently available to power projects and how well investors adapt to the new regulatory and market environment.

In the liberalized power markets of the world there are two major financial barriers for development of renewable energy projects: (i) a lower rate of return when compared with fossil fuel projects and (ii) higher credit risk. As a result, many banks and lending institutions are reluctant to lend to renewable energy projects; therefore, a comprehensive incentive mechanism for increasing the rate of return and reducing risk of investment is required in order to secure the green finance and development of these projects (Yoshino and Taghizadeh-Hesary 2018). In Pakistan

we foresee that due to the rapidly decreasing costs of wind and solar energy and increased maturity of these technologies, these two sources of green energy at least are likely to be well positioned to compete in the new liberalized markets and maintain their economic viability and access to financing.

Challenges Facing Pakistan's Green Energy Sector

In this section we discuss the three major sources of green energy in Pakistan—hydropower, wind, and solar—and the unique challenges being faced by each source of energy prior to government approvals and the signing of power purchase agreements with the CPPA-G. The utility-scale projects either operate on a cost-plus tariff basis or an upfront tariff basis. In the cost-plus tariff case the electric power regulator, NEPRA, evaluates a project and its costs basis and determines a tailor-made, unique tariff for the project. In the upfront tariff model (for a particular fuel type and size of project), NEPRA determines a fit-for-all tariff structure and invites projects to opt for it.

Hydropower

Pakistan is estimated to have the potential of roughly 40 GW of hydropower, whereas its installed hydropower capacity by June 2017 stood at only 7.1 GW (NEPRA 2017). This consists of all sizes of hydropower plants, including storage-based and high-head schemes on mountainous streams in the north, and low-head, run-of-the-river plants on rivers and canals in the southern plains. Most of the installed hydropower capacity of the country is owned by the public sector (WAPDA) and only 214 MW of installed hydropower capacity is owned by the private sector.

Pakistan has a three-stage cost-plus tariff process for hydro projects (feasibility stage, EPC stage, and COD stage). At each stage, the tariff mechanism allows changes in certain costs of the project, for example cost variation due to geology, a change in the price of materials used, and variation in resettlement costs. This is designed to protect investors from geological and commodity price risks during the long construction period. The improved mitigation of project cost overrun risks (arising from factors not in control of the investor) helps make these projects more bankable. However, the three tariff stages also increase the development cycle of the project as historically the tariff approval process has been fraught with delays and disputes. Upfront tariffs, which could speed up the tariff approval process, are difficult to determine due to the geological and hydrological uniqueness of each project site.

Hydropower projects take at least 6–10 years to develop, finance, construct, and commission. This investment horizon is typically longer than a government's tenure, longer than a management team's tenure within the private sector, or even a transaction team's tenure in a lending institute (employees leave the transaction

due to promotions, relocations, retirements, or resignations). Projects with long execution and investment horizons tend to be explored by stakeholders only when other “easy gains” opportunities have been exhausted. Moreover, since 2015 the delivered tariffs on solar and wind energy in Pakistan have fallen sharply to around 6–7 cents per KWh. At these tariff levels, hydropower projects become the least competitive source of renewable energy. However, the development of hydro projects has a larger impact on the economy, including water resource management, improvement in grid support and infrastructure, which otherwise would not have been possible.

Pakistan commissioned its last mega hydropower project in the early 2000s, the 1.4 GW Ghazi-Barotha Hydropower project. Since then, mega projects like the Kalabagh Dam have been stalled by fierce political and provincial partisanship, due to their impact on water flows and agricultural output in provinces downstream of the projects. Since then, as new hydropower opportunities have been identified, successive governments have rightly shifted their attention to developing less controversial mega projects, like the 969 MW Neelum-Jhelum hydropower project (expected to be completely operational within 2018) and the 4.5 GW Diamer-Bhasha Dam and power project (currently raising financing).

One of the main financial challenges with water and power projects like the Diamer-Bhasha project is that although electricity is reasonably priced in Pakistan, water is underpriced. Water and sewerage utilities charge only a nominal amount for these services, which does not vary with actual consumption. As a result, combined water and power projects are not able to generate enough revenue on their own to achieve financial viability and are almost entirely constructed by the government with funding coming from its development budgets or lending to the government (not to the project) by commercial banks/international lenders and donors.

Trying to recover the investment and operating costs of such projects entirely through the power tariff makes it unfeasible compared to other sources of electricity. Moreover, it misallocates the costs of the project to the wrong consumer—agriculture is the largest consumer of water while residential, commercial, and industrial sectors are the largest consumers of electricity. Conversely, increasing the price of water is a politically unpopular policy. Also, the implementation of better pricing would require heavy financial investment in infrastructure to measure and control the use of water across the country, the costs of which might be prohibitive for a government with limited means.

Wind

Pakistan is said to have a wind power potential of 50 GW, with only about 0.8 GW of installed capacity commissioned by June 2017 (NEPRA 2017). However, compared with hydro and solar, this is the most favored renewable project among private sector investors due to the bite-size investment costs, fewer challenges in finding ideal sites with grid interconnection options, and a short development and construction timeline.

Table 1: History of Wind Power Tariff Regimes

Year	Tariff type	Tariff (US cents/kWh)	Required net plant capacity factor ^a	Wind power capacities added Under different tariff regimes
2010	Cost-plus Tariff	16.1	33.1%	355 MW
2013	Upfront Tariff	13.5–16.7	31.0%	430 MW
2015	Upfront Tariff	10.4–12.5	35.0%	447 MW
Outlook	Competitive Bidding	<7.0	>35.0%	

^aNote: The Net Plant Capacity Factor is the annual generation by the plant in megawatt hours divided by the total generation possible if the plant operates at 100% capacity for 24 hours a day and 365 days a year. The Required Net Plant Capacity Factor is the minimum generation benchmark set by the government. If a project's actual net capacity factor is below the required benchmark the project investors earn less than the government-allowed returns.

Source: NEPRA (2014); NEPRA (2015); NEPRA (2016); NEPRA (2017).

The tariff and financial incentives for wind power have evolved very rapidly since the first incentive scheme launched in 2010 (Table 1). In less than 8 years tariffs have reduced from ~16 cents per kWh to less than 8 cents per kWh. After the two rounds of upfront tariffs, wind tariffs in Pakistan were still considered to be high on a global basis and there was an evident paradigm shift to wind auctions in the international market. Technology evolution, economies of scale, material improvements, efficient manufacturing, and an improved supply chain led to lower overall construction costs, leading global markets to move away from the era of subsidies and incentives. Therefore, stakeholder institutions in Pakistan agreed to introduce competitive bidding to search for competitive tariffs.

The government is required to develop a competitive bidding document in collaboration with the CPPA-G and transmission and distribution companies (to determine the maximum wind power evacuation capacity of the grid). Meanwhile, delay in the availability of a bidding document has led developers to file cost-plus tariff petitions: 14 projects totaling 751 MW have filed petitions with an average tariff of 7.16 c/kWh. Decisions on these petitions are still pending.

Solar

Much of Pakistan, especially the regions of Balochistan, Sindh, and southern Punjab, receives abundant solar irradiation in the order of over 2 MWh/m² and 3,000 hours of sunshine a year, which is at the highest end of global insolation averages (Alternative Energy Development Board 2006). However, only about 418 MW of utility-scale solar projects are in operation. The major challenges slowing the development of utility-scale solar power plants in Pakistan are:

- **Tariff Uncertainty:** Projects awarded tariffs under the 2014 and 2015 solar upfront tariff determinations have been stalled, as international tariffs on solar have decreased sharply compared to the announced tariffs. New cost-plus tariffs are now being announced.
- **Land Identification:** Land identification is one of the main hurdles for developers interested in investing in the Pakistani market. If a local partner who already has land access is not found, it may take some time to identify lands that are suitable for development. This is further hampered by a lack of public access to good digitalized maps (IFC 2016).
- **Transmission Bottlenecks:** The grid interconnection approval process takes time in Pakistan and a number of applications are pending with the relevant government agency for solar projects. It is recommended that project developers initiate the approval process as soon as possible and work with the government transmission and distribution companies as well as local consultants to identify areas that are most suitable for evacuation of power that do not require substantial construction of transmission lines (IFC 2016).

Distributed Solar

The distributed solar industry in Pakistan evolved during the early 2010s at the time of growing power shortages (many parts of the country were getting no power for 8–16 hours a day during peak summer months). Since the financial barriers to entry are low, many small players characterize the rooftop solar power solutions industry. The solutions offered range from the simple sale of equipment to the installation of systems (panels, inverter, and batteries) to designing, selling, and installing a site-specific system. No solution provider has a sizable market share of the industry in Pakistan. Until recently there were no regulations to ensure quality product offerings, and lack of consumer awareness meant that solution providers could not differentiate on the basis of quality. The industry has, as a result, become very price sensitive with low net margins, which is forcing quality players out of the market.

The government recently rolled out new regulations on net metering and for certification of companies providing solar and wind products, installation, and servicing. The scope of these regulations covers pre-qualifying vendors who can offer complete solar power solutions along with smart meters to home owners interested in selling excess power to the grid. Only pre-qualified vendors will be allowed to sign agreements with power-distributing companies for setting up net-metering systems. This would help the consumers by filtering out subpar suppliers from the market.

So far there has been limited penetration of distributed solar energy solutions in the residential and commercial sectors of Pakistan. Smart metering has not been commercially launched by the distribution companies as the regulations to determine the price at which system owners can sell electricity back to the grid have only recently been issued. Without net metering or the ability to sell surplus power back to

the grid, owners of distributed power projects are limited to deriving their economic viability only from the savings earned from substituting their consumption of expensive grid energy with renewable energy. Therefore, payback periods of such investments tend to be long. Such projects make more sense in off-grid locations where the only alternative is power from diesel-fueled generators, which is more expensive than grid power or no power at all. However, even in such projects, investors/owners struggle to raise affordable project financing.

Commercial lenders such as banks consider loans for procuring and installing distributed energy solutions just as risky as unsecured personal loans. Where the underlying asset is immovable, has good resale value, and can be easily repossessed, it can be used as collateral to secure the loan, but distributed energy equipment such as rooftop solar panels can be uninstalled and moved, does not have good resale value, and is installed within the premises of consumers and is therefore difficult to access. Interest on unsecured personal loans ranges from KIBOR + 16% to KIBOR + 20%; with KIBOR currently close to 8% this means unsecured loans are priced at about 24%–28%. At such high interest rates, no consumer is tempted to procure distributed energy systems by taking a loan.

In 2009, the State Bank of Pakistan (SBP) announced a scheme for financing power plants using renewable energy, with a view to promoting renewable energy projects in the country. Bearing the low utilization of the scheme in mind, the scope and financial mechanism were revised to make them more attractive to borrowers and financing banks/DFIs (SBP 2016). The revised scheme provides concessionary financing for renewable energy projects by offering debt financing at fixed subsidized interest rates of only 6.0% per annum. The scheme is structured as a refinancing facility, with the SBP lending to commercial banks and development finance institutions (DFIs) at a 2.0% interest rate, who in turn lend to end-consumers at 6.0% (earning themselves a spread of 4.0%). The commercial banks are responsible for credit due diligence of each end-consumer and therefore bear the loss of defaults. The result is that while commercial banks are actively working on extending this subsidized facility to utility-scale renewable power projects and to rooftop solar power projects being installed by commercial entities like factories (as both can provide alternate assets and securities as collateral), they are less enthusiastic about extending this facility to individuals for procurement of distributed renewable systems unless they too can offer alternate assets as collateral such as land or their houses.

As smart meters are widely installed and the regulatory framework for procuring power from consumers is finalized, the ability to sell surplus power back to the grid (instead of being wasted) will enable distributed power system owners to recover their investment costs faster. If at the same time the SBP continues to offer subsidized financing, more individual consumers will be able to afford the installation of renewable energy systems at home and pay for their debt costs by selling surplus power back to the grid. The only remaining challenge to enable widespread access to subsidized financing will be finding good collateral to secure the loan.

One solution is for the SBP to modify its terms and conditions and allow the facility to be extended to companies selling distributed energy systems and services

(suppliers) instead of being extended to owners of renewable energy systems only (investors). Such companies will be able to offer their inventory and receivables as collateral to secure the facility. They would in turn offer their customers products and services on affordable credit terms. In this case, banks will take credit exposure on the supplying companies who in turn will take the exposure on their end-consumers. In many cases, these suppliers are better positioned to make recoveries from their customers as they can remotely monitor and control the energy systems. Another solution to secure debt recovery from individuals purchasing distributed energy systems is to enable at-source salary deduction. Corporations, institutions, organizations, and government agencies maintain their employees' salary accounts in designated banks. Banks can arrange access and first right to cash flow in these salary accounts to secure their debt repayments.

Finally, the authors recommend that SBP should also introduce an Islamic version of this subsidized financing scheme to offer Islamic consumers access to affordable financing for renewable projects. For example an *Ijara* scheme i.e. a leasing agreement where the bank buys the asset and leases it back to the customer over a period of time or a *Murabaha* scheme where the customer buys the asset from the bank on a deferred basis. SBP can offer such Islamic refinancing schemes at subsidized leasing terms or profit rates. This will further encourage the penetration of distributed energy solutions in the country.

Conclusion and Policy Implications

Over the last 5 years, the energy sector in Pakistan has gone through a massive phase of investment. Roughly 10 GW of new power generation capacity and 1.2 billion cubic feet per day of new LNG-importing infrastructure have been either commissioned or will be commissioned by 2018. These include 1 GW of wind and solar power projects. New initiatives such as distributed power and net metering have been launched, but are at a premature stage. Consequently, Pakistan is well positioned to fulfill its immediate energy priority of eliminating power and gas shortages, which had slowed down industrial and economic growth in the country. It now needs to turn its attention to the following medium-term challenges:

1. **Improving energy security by reducing the share of imported fuels:** Pakistan imports nearly one-third of its energy. This share of imports would double by 2025, with the impending depletion of Pakistan's gas fields, and if no shift is made, moving energy demand to alternate local fuels.
2. **Improving the transmission and distribution networks of electricity:** The existing infrastructure is degraded, overloaded, and requires urgent enhancements to keep pace with the growth in power generation capacities, especially renewables.
3. **Reducing the cost of energy:** Over three quarters of the country's energy needs are met through natural gas (including imported LNG) and oil, which will be

largely imported by 2025. Therefore, the country's economy is exposed to international energy price shocks.

Renewable energy can play an important role in improving Pakistan's energy security, reducing the cost of energy, and reducing the contribution of international energy market shocks to its trade and fiscal deficits. The country offers a protected environment to utility-scale renewable projects, enabling them to access financing (debt and equity) with the same ease as non-renewable projects. Pakistan's one-buyer, take-or-pay electricity procurement model protects power companies (renewable or non-renewable) against commercial risks, certain macroeconomic risks, and technology obsolescence risks, making them financially viable and, therefore, bankable. However, this protection and increased financial viability come at the cost of electricity consumers and the government. Consumers face higher electricity costs and the government has to set aside ever-growing budgets for power subsidies.

Although steps are being taken to share the gains of operational efficiencies with the end-consumers, and to reduce the cost of electricity through competitive tariff bidding, certain challenges remain. The long-term take-or-pay power purchase agreements overprotect power projects, especially toward their end-of-life phase when they are more likely to face technology obsolescence. In a competitive market, at such a stage projects would have been retired. Wind and solar power projects are particularly facing the fallout from this problem as their technology has undergone rapid evolution over this decade leading to a slowdown in new project approvals.

The government is promoting renewable energy and local fuel-based power projects in a bid to reduce the impact of PRe devaluation on energy prices in Pakistan by reducing the country's dependence on imported fuels. Additional steps can also be taken like offering PRe-based returns on equity for power projects instead of USD-based returns, and pursuing policies to incentivize equipment and technology suppliers to increase the localization of their maintenance services.

Hydropower in Pakistan is able to attract only limited interest from the private sector, due to the long gestation periods of such projects and the availability of more attractive alternative renewable energy investment options like wind and solar power. Combined water storage and power generation hydro projects face the added challenge of water mispricing. Loading the entire investment costs of these projects on the power tariff makes the tariff less competitive than other sources of electricity and also misallocates the costs of water storage from the agricultural sector (the largest consumer of water) to the domestic, commercial, and industrial sectors (the largest consumers of electricity).

The regulatory environment in Pakistan for renewable distributed energy projects and off-grid renewable projects is not as supportive and protective as it is for utility-scale on-grid projects. Smart metering and net metering are still being commercially launched by the distribution companies. Without net metering or the ability to sell surplus power back to the grid, owners of such projects are limited to deriving their economic viability only from the savings earned from substituting their consumption of expensive grid energy with renewable energy. Payback periods of such investments, therefore, tend to be long. Furthermore, commercial lenders in Pakistan

consider loans for procuring and installing distributed energy solutions as risky as unsecured personal loans charging interest rates in the range of 24–28%.

Recently, the State Bank of Pakistan launched a subsidized financing scheme to offer financing to renewable projects at a subsidized interest rate of 6.0% per annum. This facility ends up being extended more to commercial entities who have the capacity to offer alternate collateral (land, other plants, and equipment) than to individuals who have limited collateral options. One solution could be for the SBP to allow the financing to be extended to distributed energy equipment and services suppliers rather than the buyers. Such companies will be able to offer their inventory and receivables as collateral to secure the facility and in return offer their customers products on affordable lease terms. Another option to mitigate the risk of loan default is to enable at-source deduction from salary accounts of buyers. Finally the authors recommend that in addition to the conventional subsidized financing, SBP should also introduce an Islamic version of this scheme to encourage the financing and adoption of distributed energy solutions among Islamic investors. Islamic products such as *Ijara* and *Murabaha* at subsidized terms should be introduced to promote the adoption of renewable energy.

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