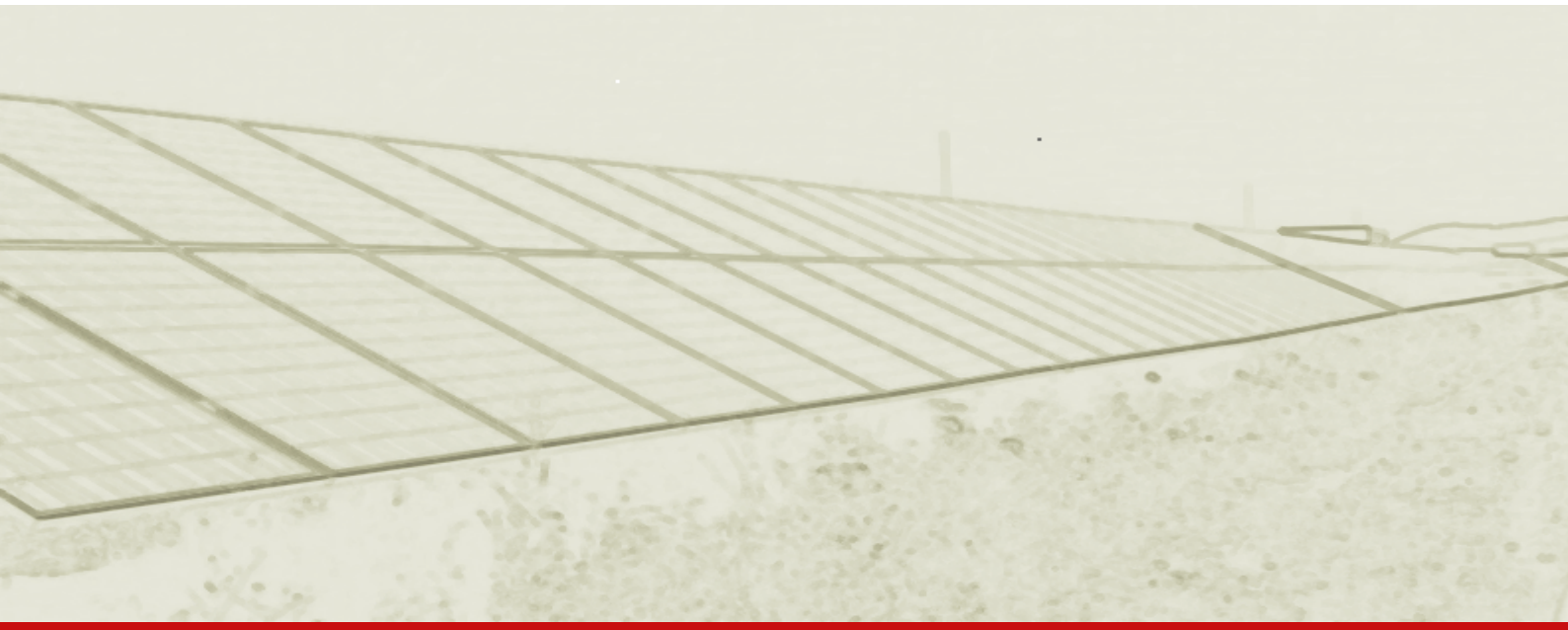

Roadmap for the Rollout of Net Metering Regulations in Pakistan

9th September, 2016

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Die Sachverständigen
für Erneuerbare Energien
The Experts in
Renewable Energies

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List of Abbreviations

AEDB	**A**lternative **E**nergy **D**evelopment **B**oard
DG	**D**istributed **G**eneration
DISCO	**Dis**tribution **Co**mpany (mostly identical with what is internationally called a *utility*)
etc.	**et c**etera
FiT	**F**eed-**i**n **T**ariff
i.e.	**i**d **e**st
IRR	**I**nternal **R**ate of **R**eturn
kW	**K**ilo**w**att
kWh	**K**ilo**w**att **h**our
kWp	**K**ilo**w**att-**p**eak (nominal installed power)
MoWP	**M**inistry **o**f **W**ater and **P**ower
NEPRA	**N**ational **E**lectric **P**ower **R**egulatory **A**uthority
NPV	**N**et **P**resent **V**alue
O&M	**O**perations and **M**aintenance
PKR	**Pa**k**i**stani **R**upee
PV	**P**hoto**v**oltaic
RE	**R**enewable **E**nergy
UPS	**U**ninterruptible **P**ower **S**upply
USD	**U**nited **S**tates **D**ollar

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A. Introduction

1. Purpose of this Roadmap

The NEPRA Regulations on Net-Metering for Distributed Generation in Pakistan are in force since September 1, 2015. For the first time, this milestone in energy market legislation allows all electricity customers to avail net metering for their own photovoltaic and wind power plants from 1 kW up to 1 MW capacity. While the legal framework is defined, the actual implementation of the policy has only just begun. So far, only few net metering agreements have been signed between customers and distribution companies as there are still a number of hurdles to be removed until net metering can become a success story in Pakistan. These include the lack of knowledge and technical capability at different organizational levels of the distribution companies, unawareness of customers as well as limited access to tailored finance and reliable local suppliers.

The purpose of this Roadmap is to:

1. Give an overview on the different kinds of hurdles which net metering faces.
2. Develop a vision for the role of distributed generation in the future energy mix of Pakistan.
3. Recommend solutions, action items and time frames to overcome market barriers.

This Roadmap is addressed to national policymakers, specifically at the Ministry of Water and Power (MoWP), but also to the distribution companies, NEPRA as the relevant authority, and other stakeholders in the energy market. This document shall shed light on how to overcome the mentioned hurdles. The fostering of net metering in Pakistan has further benefits beyond purely technical and economic aspects: Net metering has the potential to bring renewable energy technology to the public and thereby make it a national cause in Pakistan.

2. Structure of this document

This document is structured into sections: Chapter A gives an introduction to the topic of net metering and to this document. Chapter B explains about the background of net metering on the international and the national level. Chapter C develops a vision for the mid-term potential of net metering in Pakistan. Chapter D presents necessary actions, milestones and time frames to facilitate the rollout of net metering deployment in Pakistan.

3. Net metering and the energy context in Pakistan

In today's world, reliable and cost-efficient energy supply is considered the key determinant of economic development and prosperity of any country. Pakistan has been facing an unprecedented energy crisis for the past few years as the demand and supply gap has widened. The country's current energy demand far exceeds its indigenous generation resources, fostering dependency on imported oil that puts substantial burdens on the economy. The dire implications include a burgeoning oil import bill and increasing costs of power production, leading to a severe domestic shortage of electricity and gas.

The country faces a significant challenge in revamping the transmission network for stable supply of electricity. Load-shedding and power blackouts have become severe issues for the country in recent years. Pakistan's energy constraints have become more pronounced over the past seven years, as energy supplies have failed to meet the demand. The demand-supply mismatch has affected millions of domestic consumers, industries, and the overall economy. According to the Annual Plan 2014-15 of the Ministry of Planning, Development and Reform, the average supply of electricity remained at 14,400 MW against the demand of 18,400 MW, implying a power shortfall of 4,000 MW. The electricity load pattern in the country varies from season to season with highest demand during summer season, mostly due to air conditioning of buildings. As per the National Power Policy 2013, such demand-supply gap leads to load-shedding of 12 to 16 hours per day especially in rural areas. The negative effects can be observed in many villages across Pakistan. The acute power shortage forces the industrial sector to work at underutilization levels, a development that severely threatens the trade balance of the country.

The Government of Pakistan has understood these challenges and has defined the end of load-shedding as its top priority[1]. A combination of measures has been already taken, these include a diversification of electricity and gas imports as well as an amount of 8,000 MW[2] additional new generation capacities to come online until 2018. A part of these new power plants is foreseen to come from renewable sources, including hydropower, solar and wind.

Net metering, as a driver for distributed solar power plants, can play an important role in this context.

[1] http://thewire.in/44311/pakistan-could-end-energy-rationing-in-two-years-says-asian-development-bank/
[2] State of the Industry Report 2015, NEPRA, 2016

Net metering solar power plants:

National Assembly and Pakistan Engineering Council (Islamabad)

To date, the number of distributed power plants based on net metering in Pakistan is very limited. The most prominent installation is a 1,000 kWp Solar PV plant located on the National Assembly Building in Islamabad.

The system, which employs multi-crystalline solar panels by Yingli, is expected to generate some 1.6 million kilowatt-hours of solar electricity annually. The system was commissioned and approved for net metering scheme in June 2016. The installation will reduce the building's electricity costs by an estimated PKR 28 million annually.

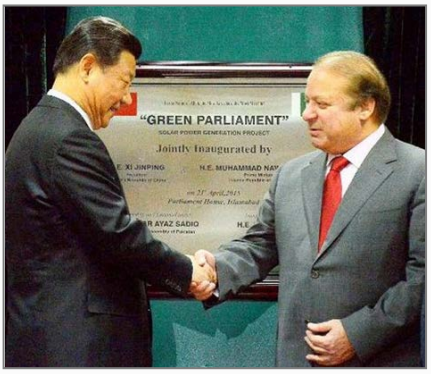

Figure 1: Pakistan's Prime Minister Muhammad Nawaz Sharif and Chinese President Xi Jinping inaugurate the solar power plant at the Parliament House in Islamabad on April 21st, 2016[3]

A solar power plant with a capacity of 356 kWp has been built at the premises of the Pakistan Engineering Council (PEC) and the Planning Commission (PC) in 2011/12. The plant was funded by the Japanese International Cooperation Agency (JICA). The panels are mono-crystalline Sanyo modules and the 10 kW string inverters are installed centrally in a dust protected and air conditioned container unit. The plant is divided into two parts, while the 178 kWp plant at the PEC site is connected to the grid on low voltage level (400 V), the 178 kWp plant at PC site is connected to the 11 kV grid.

The solar power plant is functioning regular, the production rate is currently 1,160 kWh per kWp as per information provided by PEC. This suggests that the plant is in good condition.

The plant is equipped with a bidirectional energy meter (PEL Pvt. Ltd., Pakistan made). The license for net metering is in place and the application for the net metering agreement with IESCO is yet pending as of August 2016. Therefore, no electricity was fed into the grid yet.

Figure 2: Solar plant at PEC site, Bidirectional energy meter at PEC site[4]

[3] Source: Government of Pakistan, 2016
[4] Source: http://blog.paktron.net (first picture), 8.2 (second & third picture), 2016

B. Context of net metering in Pakistan

1. Background on net metering

Net metering is an incentive scheme for distributed generation, typically through renewable energy sources. Under a net metering scheme, a consumer may install an on-site renewable energy power plant, primarily for reducing his own grid consumption. At the same time the consumer is granted interconnection to the grid and is allowed to supply any surplus energy units from his installation to the electricity grid. These units are recorded and are later on "netted-off" (i.e. subtracted) against the units consumed from the grid. In this way, a net metering scheme provides an incentive to consumers to install decentralized renewable energy systems.

Net metering gives consumers the certainty that they will benefit from any electricity produced through the system, either through own consumption or through feeding it into the grid. Net metering is different from a feed-in tariff where all generated renewable energy is remunerated at a special rate by the utility company (mostly called DISCO in Pakistan). Feed-in tariff schemes usually offer additional incentives such as long term purchase agreements with guaranteed grid access, the net metering regulations in Pakistan at the moment only foresee a three-year agreement between consumer and DISCO and no guaranteed grid access.

The world's first physical net metered connections occurred in 1979, in the U.S. state of Massachusetts, when the architect and solar pioneer Steven Strong installed solar panels in two of his two building projects. Strong initially 'forgot' to inform the local utility about the interconnection of the PV systems to the electricity grid, and later successfully negotiated official interconnection[5].

Given the obvious advantages of on-site electricity production based on net metering such as vicinity between electric load and supply, the idea spread gradually in the 1980s. Net metering was introduced by certain utilities in Arizona and Massachusetts by 1982, and in 1983, Minnesota became the first U.S. state to enact a net metering law. Today, net metering regulations are in place in 43 US states. Net metering was adopted in Japan from 1990 onwards, and was implemented around the globe thereafter[6].

[5] Switching to Solar, Bob Johnstone, 2011
[6] Crossing Over: The Energy Transition to Renewable Electricity, Roberto Verzal, 2015

2. Net metering in Pakistan

The Government of Pakistan promotes and facilitates the exploitation of renewable energy (RE) sources in Pakistan through AEDB. Distributed generation and net metering are a part of the overall RE policy. The National Electric Regulatory Authority (NEPRA) announced the official Distributed Generation and Net Metering Regulations on September 1st, 2015[7]. As per these regulations, any customer of the electric grid (three-phase connections) can avail grid connection and can enter into a net metering agreement for on-site small-scale renewable energy installations.

The net metering regulations allow the consumer to receive quarterly remuneration for any excess electricity supplied to the grid during this period. The rate for the excess electricity units supplied to the grid is equal to the off-peak electricity rate of the connection.

3. Status quo of net metering in Pakistan

To date, the number of distributed power plants based on net metering in Pakistan is very limited. The first and most prominent installation is the 1,000 kWp solar PV plant located on the National Assembly Building in Islamabad.

Figure 3: Solar PV power plant on the National Assembly Building[8]

[7] SRO 892 -2015
[8] Source: AEDB

Furthermore, a 2 x 178 kWp solar power plant has been built at the site of the Pakistan Engineering Council in 2011/12, financed through JICA funds.

Other small-scale PV systems on buildings have been installed on a very limited scale so far. Before net metering was introduced in September 2015, small-scale solar power plants were mostly used for own consumption and not officially connected to the grid. According to reports by the DISCOs, the number of systems officially connected to the grid under the net metering regulations has been negligible so far. However, this situation is now changing. The DISCOs report more and more net metering applications. NEPRA has granted three application licenses for net metering customers (as per end of August 2016).

C. Vision for deployment of net metering in Pakistan

1. Status of solar PV in Pakistan

Apart from some smaller installations, the development of solar power plants started in Pakistan with the introduction of the Upfront Feed-in tariff in 2014. Currently, the largest PV installation is the Quaid-e-Azam Solar Park in Bahawalpur. The site area and the first project phase have been developed by Quaid-e-Azam Solar Power (Pvt.) Limited, a public sector company set up by the Government of Punjab. The initial project phase with an installed capacity of 100 MWp has been commissioned in July 2015.

The second stage with a capacity of additional 100 MWp has been completed in 2016 and a plant with further 150 MWp is currently under construction. The total park is planned to have an installed capacity of 1 GWp power in total at the final stage. The park is so far the only utility-scale solar power project in Pakistan to reach its commercial operation.

A number of large-scale solar plant projects are in various stages of planning and permitting within the Upfront Feed-in tariff scheme since 2014/2015. AEDB has reported that at present, 28 projects of 956.80 MW capacity are under development within the framework of AEDB policies and procedures, whereas, around 3,000 MWp solar power projects are being initiated under the regime of provincial governments. These projects are at various stages of development. So far, 400 MWp solar PV power is installed and comissioned in QA Solar Park, Bahawalpur, Punjab; 1x100 MWp is undertaken by M/s QA Solar (Pvt.) Ltd., Government of Punjab and three projects of cumulative 300 MWp are installed by M/s Zonergy Pakistan Ltd. through its three separate subsidies. Seven projects of cumulative 72.48 MWp are in process of achieving financial close after obtaining Letter of Support (LOS) and 21 projects of 484.32 MWp capacity are at various stages of development.

Since April 20, 2015, the issuing of new Letters of Intent through AEDB has stalled, in result a number of projects have come to a halt. So far, new proposals of more than 4,500 MW solar PV power projects from 87 companies are received in AEDB, but due to halt, the requests of these companies have not been reviewed.

In terms of small-scale grid-tied solar power plants, the Punjab government has been actively working to reduce the dependence of public buildings on the national grid. One of the most prominent projects in implementation is the “Solarization” of approximately 4,000[9] schools across Punjab. With power capacities ranging from 1 kWp to 5 kWp, the solar power plants to be installed under this project will have a cumulative installed capacity of 6.15 MWp.

[9] http://eproc.punjab.gov.pk/Tenders/45177_DoPP_EOI_SCHOOLOFFGRID_AD_13012016.pdf

Another project initiated by the Government of Punjab, will accomplish the installation of 3 kWp solar power plants in 100[10] Basic Health Units (BHUs) during its pilot phase. The program aims to equip a total of 1,000 BHUs with similar PV systems for uninterrupted power supply in the second phase. All these PV systems have been designed with the provision of net metering functionality, reducing burden on the national grid and decreasing the monthly electricity cost for the BHUs significantly.

[10] http://eproc.punjab.gov.pk/Tenders/46742_CEP_EOI_SOLARSOLUTIONBHUS_AD_18022016.pdf

2. Successful net metering deployment in other countries

Net metering is among the most important policy schemes driving solar PV deployment around the globe. New PV installations which work under net metering accounted for about 15% of the total newly installed PV capacity worldwide of 50 GWp in the year 2015[11].

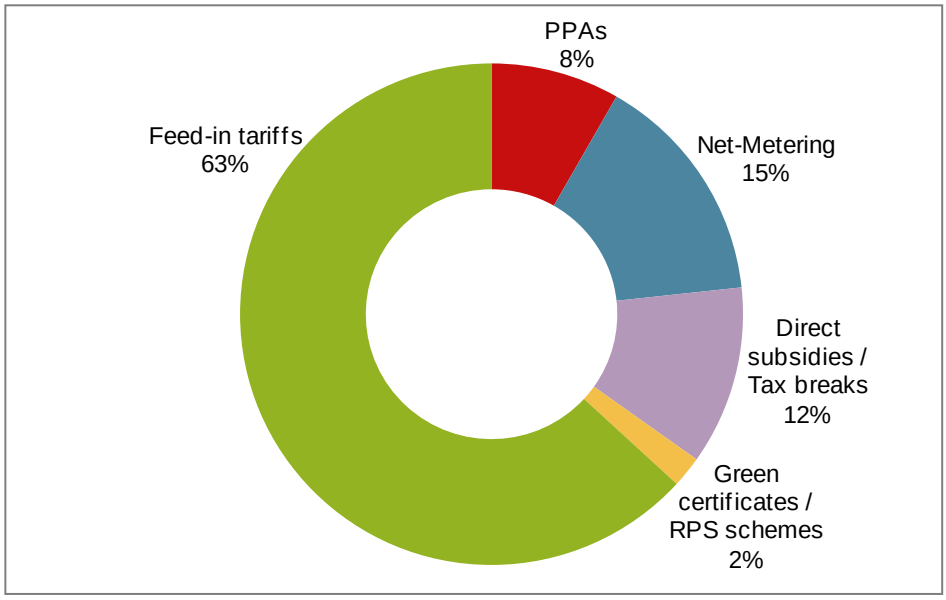

Figure 4: Policy Drivers for solar PV in 2015

Net metering has been very successful in the USA. In California, mandatory net metering is in place for utilities that allows customers to zero-out their bills and credits customer accounts at full retail rates. Customers that generate a net surplus of energy at the end of a twelve-month period can receive a payment for this energy under special utility tariffs. The program is accompanied by public and utility funding for cash rebates and promotion of DG through the programs 'Go Solar California' and 'California Solar Initiative'. An investment of 3.3 bn. USD by state and utilities has enabled the installation of over 3,000 MW distributed solar power plants from 2007 until 2016[12].

Under these programs, in addition, to cash rebates, owners of installed systems are eligible to receive tax credits of up to 30% of the investment cost. Over 60% of systems under the program have been financed by third-party investors in 2014. Under this concept, investors aggregate many systems and lease these back to homeowners or businesses thus reducing cost of finance and enabling users to use solar without own equity investment.

[11] Source: Solar Power Europe, Global Market Outlook 2016-2020
[12] See: http://www.gosolarcalifornia.org/, specific prices ranged between 4-8 USD/kWp during the programs funding period

3. Net metering deployment in Pakistan – A scenario

The following section outlines a scenario for future deployment of net metering generation in Pakistan. The analysis is based on the assumption that the dissemination of new technologies in general follows an adoption curve over time. The underlying theory for this assumption was published by Everett Rogers in 1962, in the seminal publication „Diffusion of Innovations“. In it, Rogers describes how the adoption of new technologies follows a S-curve – a theory that has been proven to be correct for numerous innovations over the past century.

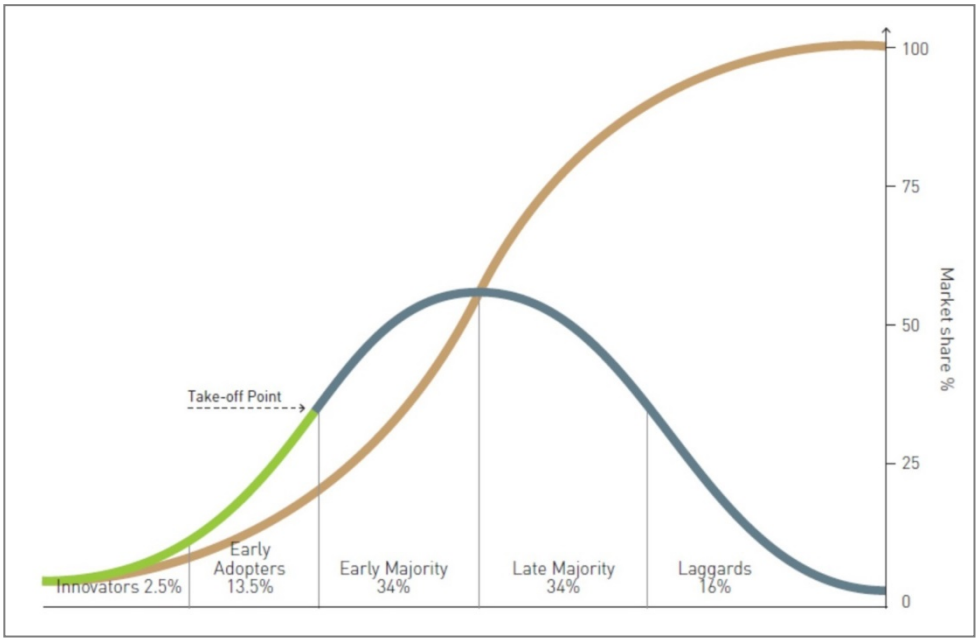

Figure 5: Diffusion model for new technologies

Data for the development of the German solar PV market shows a very similar pattern: The market developed rather slowly during 2000-2008 as only relatively few Innovators and Early adopters invested in solar power plants. By 2008, in line with the introduction of more favourable feed-in tariffs and cost reductions along the solar production chain, the technology adoption reached its tipping point and market growth took off.

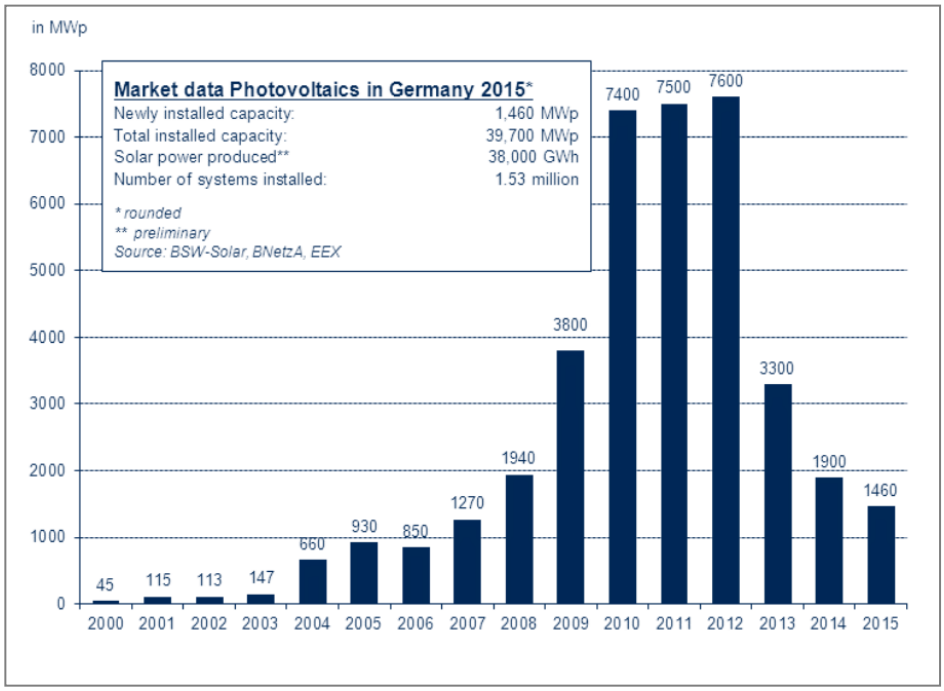

Figure 6: PV market development in Germany[13]

In the following, the model for the diffusion of innovations is applied to the sector of distributed electricity generation and net metering in Pakistan.

The electricity distribution grid of Pakistan is serviced by a total of twelve distribution companies (DISCOs) according to NEPRA[14] (plus a number of Small Power Producers holding a Distribution Licence who serve a very minor number of connections).

[13] German Solar Association, 2016
[14] State of Industry Report 2015, NEPRA

Public Distribution Companies		Number of customers
1	Peshawar Electric Supply Company Limited	2,956,567
2	Tribal Areas Electricity Supply Company Limited	441,562
3	Islamabad Electric Supply Company Limited	2,462,167
4	Gujranwala Electric Power Company Limited	2,923,493
5	Lahore Electric Supply Company Limited	3,909,862
6	Faisalabad Electric Supply Company Limited	3,445,357
7	Multan Electric Power Company Limited	5,116,072
8	Hyderabad Electric Supply Company Limited	976,888
9	Sukkur Electric Supply Company Limited	722,392
10	Quetta Electric Supply Company Limited	564,887
Private Distribution Companies		
11	K-Electric Limited	2,158,290
12	Bahria Town (Pvt.) Limited	16,879
Total:		**25,694,416**

Figure 5: Distribution Companies and connections in Pakistan (source: State of Industry Report 2015, NEPRA)

All in all, the DISCOs serve a total of 25.7m consumers in Pakistan. These are divided into the following consumer types[15]:

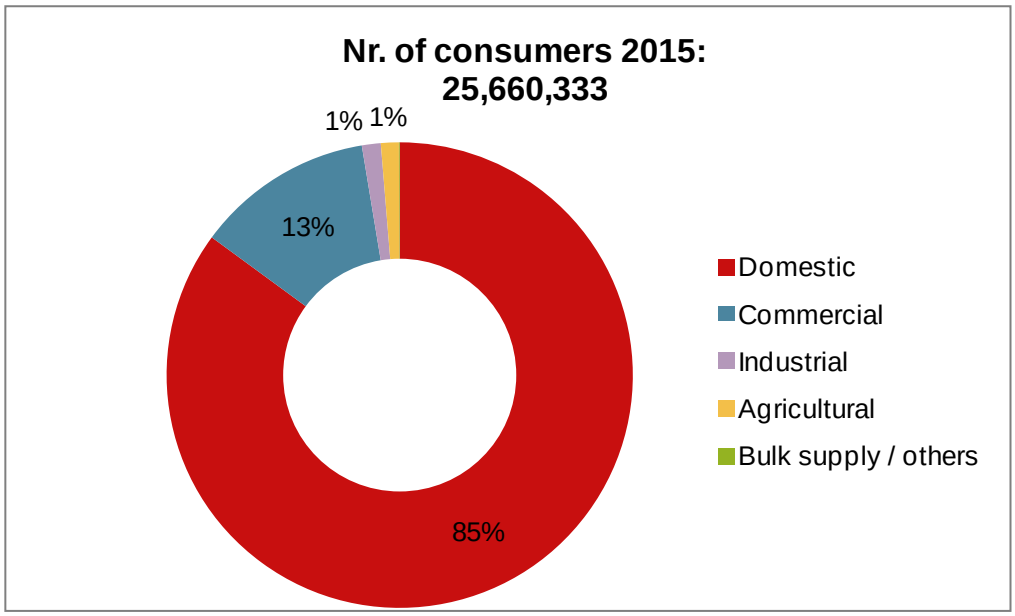

Figure 6: Number of electricity consumers in Pakistan by branch (source: State of Industry Report 2015, NEPRA)[16]

[15] State of Industry Report 2015, NEPRA
[16] Note: The total number varies slightly to number in the table; this deviation is also present in the source document.

Domestic consumption accounts for almost half of the annual electricity consumption in Pakistan.

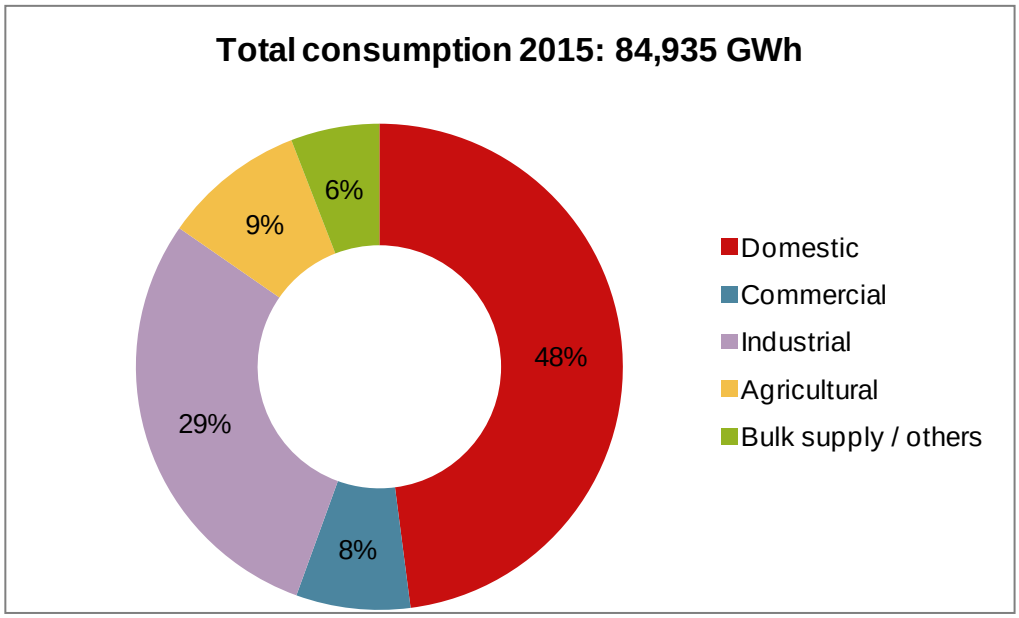

Figure 7: Share of electricity consumption in Pakistan by branch

In order to develop a future scenario for net metering adoption in Pakistan, the total number is needed of residential, commercial, industrial and agricultural sites which are suited for PV installation on roofs or ground in direct neighborhood. We assume 5% of total connections to have sufficient space availability for the residential customers, 10% for each of commercial and industrial customers and 50% for the agricultural customers who are typically located in rural areas with more space available. These assumptions result in a total number of 1.6m connections suitable solar net metering installations for all categories combined. For the same groups, we assume average solar plant installation sizes of 5, 20, 250 and 50 kWp respectively. A total cumulative potential exceeding 28 GWp of solar net metering installations can be derived from these parameters.

Now based on the above described presented adoption model, we conservatively only consider the first two groups, i.e. the innovators (2.5% of total suitable sites) and early adopters (13.5% of total suitable sites), and assume that these 16% of the mentioned 1.6m connections will adopt net metering over the next years; the innovators over the next 5 years and the early adopters over the next 8 years. This leads to the scenario shown in Figure 8.

It can be seen that installation numbers increase very slowly at the beginning, but then start to rise quickly once the tipping point is reached. After 5 years, a cumulated number of 1,000 MWp of installed capacity is reached, and after another 3 years, 4,500 MWp are reached. This

compares to a total installed electric generation capacity in Pakistan of currently about 23 GW in 2015[17].

These numbers are only the beginning 16%; later on, the remaining 84% may come until all suitable connections in Pakistan have adopted net metering.

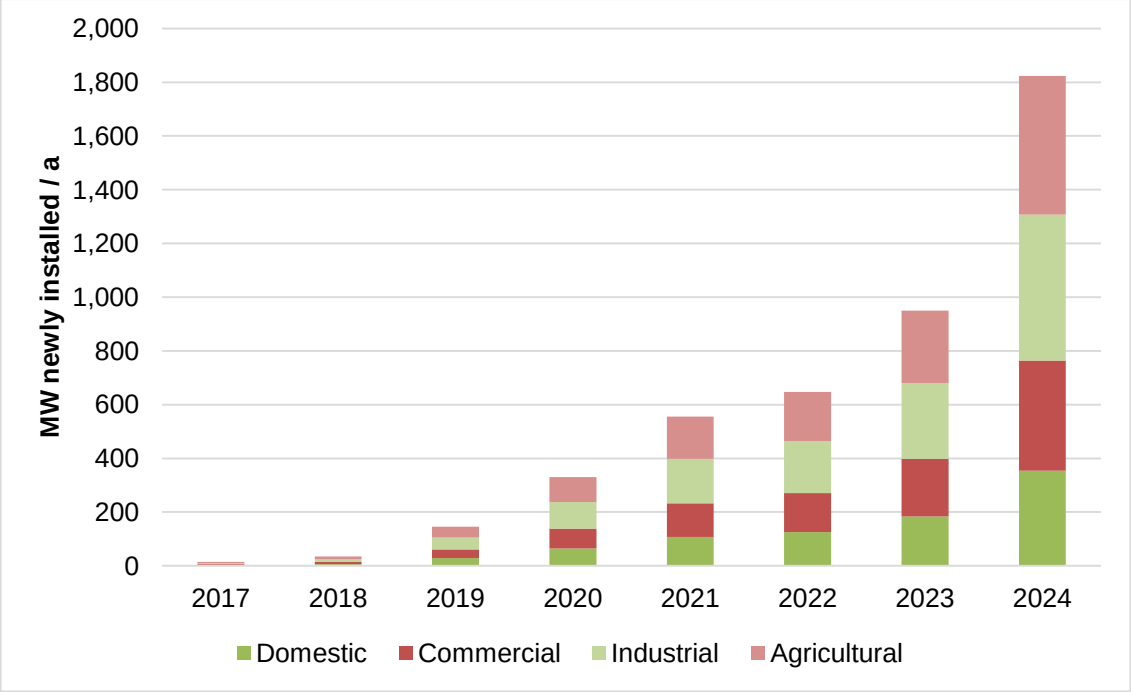

Figure 8: Scenario of new installations under net metering scheme

This adoption scenario would result in a total generation of solar electricity through net metering of about 6,900 GWh per year in 2024. This amount equals about 8% of the total electricity consumption in Pakistan in 2015.

This scenario can be seen as a realistic case if the measures laid out in this Roadmap are implemented. The faster the recommendations given in following sections are being put in practice, the faster the uptake of installation rates will be.

[17] State of Industry Report 2015, chapter 2.2 “Source-wise installed capacity”.

D. Market Barriers and Action Roadmap

1. Key Success Factors

The development and deployment of commercially viable distributed generation based on net metering, or in fact any other incentive scheme, depends on the following key success factors: awareness among the potential customers, technical standards and processes, and a viable business case.

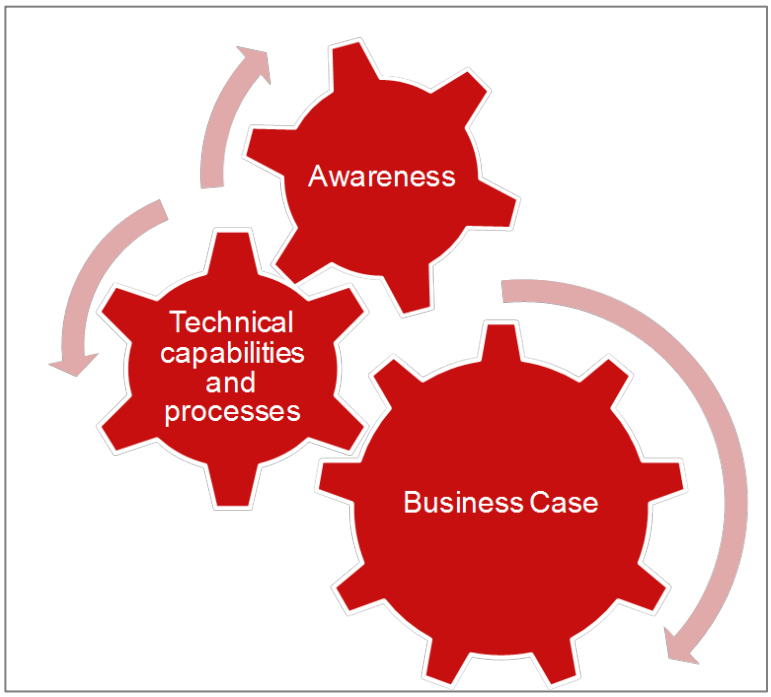

Figure 9: Key Success Factors for Distributed Generation deployment

A. Attractive business case for investors

The first and foremost requirement for the installation uptake of Distributed Generation (DG) power plants is the attractiveness of the underlying business case. By their nature, DG power plants based on renewable energy require an upfront investment for planning, procurement of components and turnkey installation and commissioning. Potential plant owners might be interested in purchasing their own solar power plant for various reasons. In order to achieve a high penetration of small-scale solar power plants, the financial returns of the required investment need to reach certain profitability so that private persons and companies will be motivated to bring up the necessary investment.

B. Technical capabilities and efficiency of processes

The technical capabilities of market participants and processes applicable for DG power plant grid interconnection, operation and integration are vital to enable DG market development. As an example, although the profitability for investors of PV plants in Italy was higher than in Germany from the beginning, the deployment has been much slower due to a very difficult administrational process. So installation rates will only increase substantially if standards and processes are clearly defined and implemented.

Among others, this requires the definition of clear standards and certification requirements for DG power plant equipment. Standardized requirements for power quality delivered by DG power plants, ideally in line with capabilities of state-of-the art equipment, help to reduce grid integration complexity. A transparent billing procedure is required as well as a fast and straightforward license application process.

C. Awareness

Any new technological solution takes time for their deployment, and follow a technology adaptation curve, even if they have obvious benefits for the customer. Potential end-users need to understand the functionality of renewable power plant technologies to a certain extent until they will have sufficient confidence to invest into such a system. DG power plants based on net metering applications are a novel possibility for electricity consumers in Pakistan, allowing them to participate in the energy market and become electricity producers. The active promotion of DG systems under net metering regulations is therefore critical to achieve awareness among the public and generate substantial deployment rates.

2. Business Case

A. Status

In a separate document titled “Business Case for Implementation of Net Metering Regulations 2015” which was developed by GIZ/8.2, the profitability of small-scale solar plants under the net metering scheme in Pakistan has been analyzed in detail. From the overview given on the following page, it becomes clear that payback periods for small-scale solar under net metering in Pakistan may be acceptable in industrialized countries. However, this is less so the case for a typical investor’s perspective in Pakistan, here shorter payback periods are often expected.

B. Influencing Factors

The business case for solar power plants based on the net metering is attractive for the larger-scale commercial and industrial scenarios. The attractiveness for residential systems, is lower as the specific installation cost is higher and savings are lower compared to the other cases, where diesel is saved during load-shedding hours.

The following main influencing factors for the profitability of the business case of small-scale solar power plants under net metering are identified:

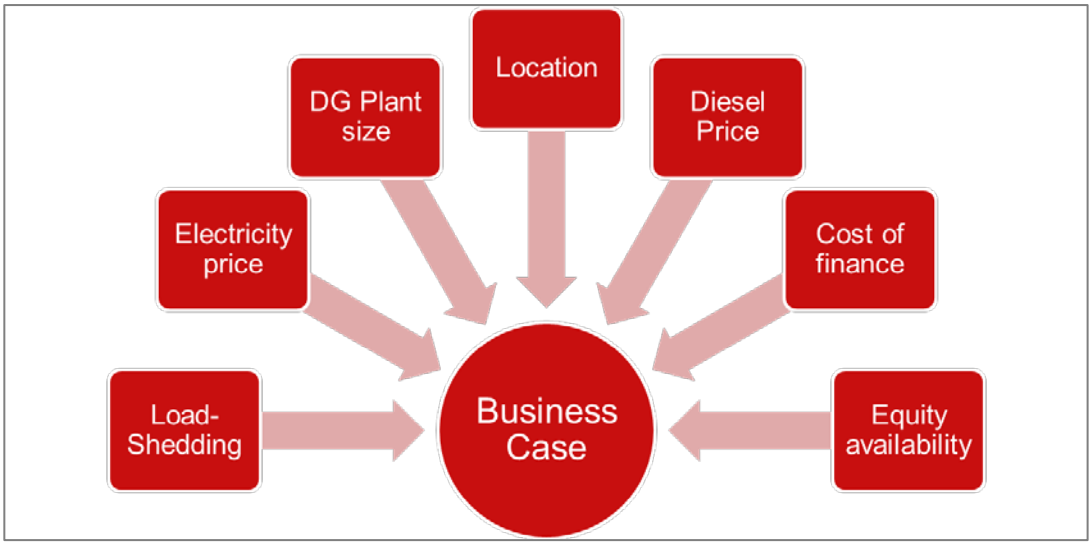

Figure 10: Influencing factors for net metering Business case

The business case for net metering systems has been analyzed by GIZ/8.2 under different conditions and assumptions. Regular hours of load-shedding and different kinds of backup systems lead to the fact that the simulation and analysis is slightly more complex as in other countries.

The document analyzes three cases: residential (5 kWp, incl. battery), commercial (50 kWp) and industrial (500 kWp).

The following table highlights the financial results of the case 50 kWp / commercial sector as an example:

Investment	**6,700,000 PKR**
Payback (years)	6.9
IRR (unleveraged[18])	19%
IRR (leveraged)	26%

Figure 11: Financial Results of Commercial Case[19]

The payback periods of the modeled cases range from 6 to 15 years, depending on the plant size, kind of backup system used and location. The likely case for most systems is a payback between 7 to 9 years for larger-scale commercial and 9 to 12 years for smaller-scale residential cases. The corresponding IRRs can range around 18% / 25% (without / with leverage through loans) for the larger-scale cases, while the IRR for the residential system is of around 10% (independent of leverage).

Profitability of distributed solar generation in Pakistan therefore remains a challenge where investment decisions are typically taken on a perspective of less than five years – which might change, however, in the future when fuel prices increase and solar equipment prices drop further.

The following chart illustrates the cash flow of the case 50 kWp / commercial sector.

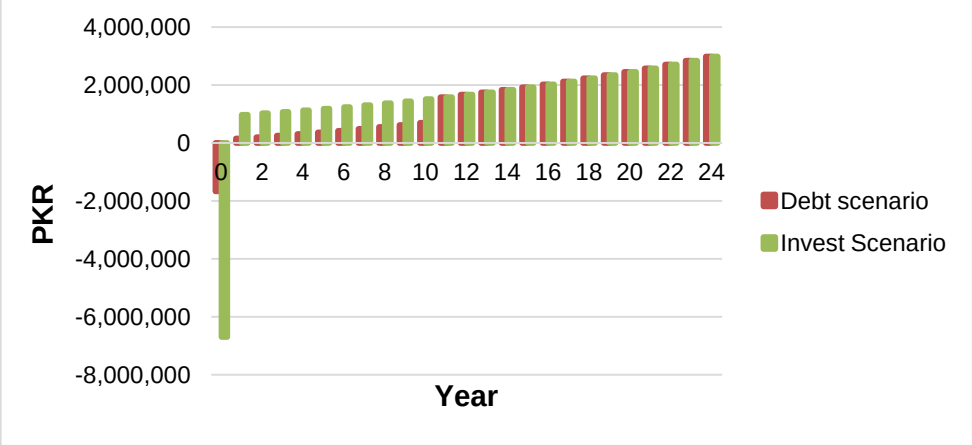

Figure 12: Annual Cash Flow – Commercial System

[18] "Unleveraged" means full equity IRR. "Leveraged" means the IRR when assuming a debt ratio of 75% with 10 years debt tenor at an interest rate of 10%. 10% is the current KIBOR rate plus 3% margin. KIBOR is 6.95 according to latest available information. See e.g. http://www.pakistaneconomist.com/c-database/kibor.php - "3 years, Offer".

[19] Assumptions: Annual consumption of the consumer: 100MWh, hours of load shedding: 4 per day, diesel generator backup system, electricity price including surcharges: 12.5/18 PKR per kWh (normal/peak rate), diesel price: 80 PKR per liter, solar system: 50 kWp, no battery, specific cost of solar system: 134 PKR per kWp all included. Financial assumptions: 75% debt, interest rate 10%, tenor 10 years; inflation of all energy-related prices: 5% per year.

The influence factors which can be modified through targeted actions are:

1. The profitability of net metering strongly depends on the load-shedding situation: If no backup system is used, every hour of grid disconnection per day decreases the profitability of solar power plants as available solar power is lost. On the other hand, if a generator is used as backup, fuel is saved during load-shedding and the profitability is thereby increased.
2. The general price of electricity which is replaced by solar production is a key determent for the financial viability. The electricity rates are comparatively low in Pakistan compared with other countries in the region and also in relation to the actual generation cost of fossil fuel based power plants. This situation reduces the attractiveness of solar power generation.
3. On the financial side, important influence factors are the conditions for debt finance and the availability of equity which is needed to cover the upfront capital expenditure of the solar power plant installation.

C. Attractiveness of the business case

The attractiveness of the business case for distributed solar power plants will make or break a successful development of the net metering sector. The following actions are recommended to improve the cost-benefit ratio for net metering customers and thereby stimulate investment.

The profitability of solar power plants under net metering is directly affected by the electricity rates. For example, an assumed increase of the base tariff by only 2.5 PKR (15 instead of 12.5 PKR per kWh) leads to the standard payback period for the commercial case dropping from 7 to 6 years. Now electricity prices in Pakistan are mostly not subsidized, so currently the financial urgency to the authority to increase them is low. However, international fuel prices are very low at the moment, so there is the likelihood that they will go up again. Assuming steady, even if limited, energy price increases for the years to come, an according increase in electricity rates in Pakistan would be the natural consequence. This would positively affect the net metering business case as the electricity produced receives a higher value.
On the supply side, if load shedding can be considerably reduced during the next years (as the current energy planning by the government foresees) this will give better planning reliability to customers of net metering. Every additional hour of grid-connection during the day means an additional hour of grid feed-in for the customer.

Another very relevant point is related to the regulations of net metering currently in place: For the agreement between net metering customer and the DISCO, a term of 3 years is defined. As 3 years is a very short time period compared to the payback periods and lifetime of solar

power plants, this should be corrected to at least 10 years as soon as possible. This correction should entail an additional clause stipulating that the DISCO will issue a new agreement after the end of a term, if no relevant objections are observed.

Recommendation:

1. Implement measures to increase value of electricity production from distributed generation, such as a mid-term increase of base electricity retail tariffs and a significant and reliable reduction of load-shedding.
2. Increase the agreement term in the net metering regulations from 3 to 10 years, including clause of automatic renewal in absence of relevant objections.

D. Financing of small-scale solar plants

The financing of privately owned renewable power plants is a new business segment for commercial banks in Pakistan. Until the banks understand the associated risks and benefits, they will be reluctant to fund such projects, and if they do they will charge relatively high interest rates in the beginning. To overcome this situation, soft loan programs by state banks are a very helpful institution. The State Bank of Pakistan provides refinance to banks in Pakistan who offer loans to net metering customers with installations of 4-1,000kW as per IH&SMEFD Circular No. 03 of 2016 from June 20th, 2016. The end-user interest rate is 6% for up to 12 years.

The availability of such low cost financing facilities has proven a successful facilitator for DG power plant investment in many countries. E.g. in Germany the state-owned bank Kreditanstalt für Wiederaufbau (KfW) is among the largest financing entities of renewable power plant projects.

Even with this facility being there, awareness and confidence of banks into these new technologies needs to be developed so that soft loans actually reach the end consumers.

Recommendation:

Promote the availability of lower cost debt finance from State Bank of Pakistan and other state-owned or development banks among commercial banks and help them gain confidence into the new technologies.

Third-party finance models and Net Metering

Net metering has been a most successful tool to spark market development in the USA when companies like SunEdison, Solarcity and others started to bundle equity in investment funds that finance, own and operate large portfolios of DG net metering plants. This third-party owned model is a popular model frequently applied in the residential home sector in the USA, where turnkey installers lease rooftop solar power plants to individual households who in turn pay them a monthly lease rental. The owner of the house provides the rooftop space and the third party owner/investor typically offers an integrated service of leasing, commissioning and maintaining the systems to homeowners and guaranteeing standards of performance. The electricity generated from such DG system is used to meet the on-site captive load while the excess generation is fed into the grid on net metering basis. Over 60% of net metering systems installed in California have been financed by third-party investors in 2014.

The third-party financing model is illustrated in the following figure.

The third-party finance model has proven high PV deployment rates due to the following reasons:

- The building owner avoids the large upfront investment for the solar equipment and, depending on the legal setup, may also avoid assuming the technology or performance risk of solar systems.
- The developer generates revenues by way of lease rental or electricity sale from the building owner under a commercial agreement between the parties. As he continues to be owner of the equipment, he also qualifies for claiming depreciation on the capital cost of the PV systems, with associated direct tax benefits. Being a large-scale investor and operator, he can achieve much better equipment prices than individual private customers.

Similar models could be enabled in Pakistan in a second phase of net metering roll-out. To enable this, parts of the regulations would need to be changed to allow for third-party ownership of systems and the entering into net metering agreements between the DISCOs and third-party owners.

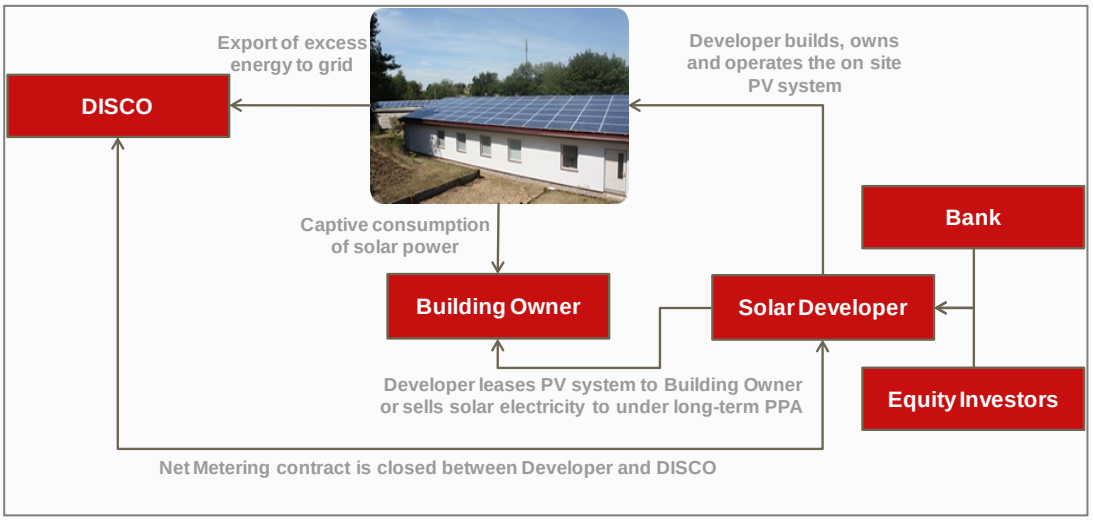

Figure 13: Third-party finance model

3. Technical Standards, Capabilities and Processes

The prevalent technical standards, the capabilities of net metering stakeholders and efficient implementation processes are critical foundations for a successful distributed generation rollout. In the following sections, the status of technical standards, capabilities and processes is described and recommendations for actions to improve the current situation are given.

A. Technical standards

Clear standards and certification requirements need to be established in the first place for DG power plant equipment. For the import of material, custom regulations are already in place in Pakistan, and the Ministry of Trade and Industry is planning to establish industry standards for solar equipment which shall apply both for imported and locally manufactured equipment.

With regards to standardized requirements for power quality delivered by DG power plants that limit negative effects on grid stability, an amendment to the distribution grid code will soon be decided on by the Distribution Code Review Panel (DCRP). This body consists of the DISCOs together with the authority, NEPRA. GIZ/8.2 has made a suggestion for this amendment, based on international equipment standards, to facilitate the process.

A clear license application process has been defined in the net metering regulations. Regarding the billing structure, the principles have also been laid out. The DISCOs now need to introduce the necessary changes to their billing software and come up with any pending questions regarding billing so that NEPRA can clarify those.

Recommendation:
Finalize relevant technical standards and support the DISCOs in development of suitable net metering SOPs and billing procedures.

B. Bidirectional meters

Bidirectional meters are the only additional component of a solar plant connected via net metering compared to a solar plant connected under the feed-in tariff scheme or similar. At the same time, bidirectional meters have not been in use in Pakistan so far. The availability of bidirectional meters on the market is therefore crucial for the deployment of net metering, where electricity needs to be accounted into both directions. The same task can principally

also be done by two one-directional meters, but this increases cost and comes with a higher probability of accounting errors.

There is at least one company in Pakistan that already assembles meters which are suitable for bidirectional use, and bidirectional meters are in place in some installations. However, many distribution companies and government officials are so far unaware of the availability, although limited, of bidirectional meters in the Pakistani market.

The ready availability and awareness of meters needs to be ensured. In order to furthermore reap the benefits of producing locally, it should be actively pursued and incentivized that more meter suppliers in Pakistan manufacture and market bidirectional meters.

Recommendation:
Incentivize wider spread of nationally manufactured bidirectional meters to help to ensure availability and contribute to local economy at the same time**.**

C. Technical capability of the distribution companies

Some distribution companies so far have been interested and active in introducing and implementing net metering. But even if senior staff members from the different distribution companies want to support net metering, they still struggle with the lack of capability on different levels:

1. Field level: Many employees on the field level are not aware of the net metering regulations and do not know how to process applications for interconnection.
2. Central level: The lack of a central unit dedicated to the promotion and implementation of net metering means that the whole topic is left to itself. There is no responsible entity for applicants or field level staff to reach out to, and which can give directives to technical/analytic, administrational and field staff.
3. Technical level: As per regulations, a detailed grid impact study needs to be performed for all net metering systems[20]. However, as net metering systems are connected in multiple numbers and at the distribution level, which is a novelty for Pakistan, the responsible units at the distribution companies need support to accomplish this new kind of grid studies in a safe, but time-efficient manner.

[20] According to a recent decision of the DCRP, net metering systems of less than 10 kW peak are exempted, but for all larger systems, such a study is mandatory.

In order to tackle the three mentioned hurdles, the following approach is suggested:

A train-the-trainers program is held for senior staff from the distribution companies, preferably staff who was already active as internal trainers.

In these trainings, two topics will be addressed:

1. The net metering application process is discussed in detail and broken down to small action items and responsible persons. Thereby it becomes clear what and when needs to be done by the distribution company staff, especially in the field level, during the application process.
2. A technical training is given regarding the accomplishment of grid studies, based on specific software which the distribution companies are already using[21]. Between trainers and participants, an efficient way of replicating the grid study process for different sites shall be identified and practiced.

Recommendation:
Conduct a train-the-trainer program which defines training materials and enables senior DISCO staff to train field and technical staff.

Additionally, to these trainings, a central net metering task force shall be designated by every distribution company. To ensure this, the NEPRA, under the umbrella of Ministry of Water and Power, may give a directive to all distribution companies and support the process with additional funding. Every net metering task force should consist of at least one full-time senior staff and one full-time support staff as well as further employees from other units who would assist on a demand-based basis.

[21] Ideally, there should be one software standard for all distribution companies such as the GIS-based software which was recently donated by USAID.

The responsibilities of the net metering task force shall be as follows:

- Act as the internal support for all field staff on any questions regarding net metering.
- Function as representative to the customers regarding all questions around net metering.
- Coordinate all activities regarding net metering with other distribution companies as well as the authority (NEPRA).
- Ensure that information on net metering on the distribution company's website and other information channels is available and up-to-date.
- Ensure that internal processes around net metering are in place and defined according to the regulations, which means especially that the grid impact assessment is done in a proper and timely manner by the distribution company's grid assessment department.

The establishment of a central task force within every DISCO has the great advantage that these staff members can be trained thoroughly on net metering and all its aspects. Meanwhile, this staff will work full-time to ensure that all customers of net metering receive necessary information in time. The task force would also take care that tasks of the DISCOs, such as application processing and grid studies, are accomplished within time. Field level and technical staff can receive all training and information they need about net metering – including updates and changes in the regulation or in the DISCOs internal SOPs which might happen from time to time.

As the DISCOs are already struggling to deal with the implications of net metering and are worried that net metering might decrease their profit, these task force teams would probably need to be funded by additional funds from the Government of Pakistan. For this topic, being new and innovative and related to renewable energies, the Ministry of Water and Power should have good chances to avail donor funds and international environmental funds if needed.

Recommendation:
Establish dedicated net metering units within the distribution companies to help bundling net metering knowledge and centrally addressing all capability bottlenecks at the distribution company level.

D. Application process

The application process for net metering in Pakistan is comparable to the process in other countries, like the Philippines. Some DISCOs and other stakeholders have asked for changes in the time frames defined by NEPRA, so these might be updated in the future. The process as such will probably remain the same.

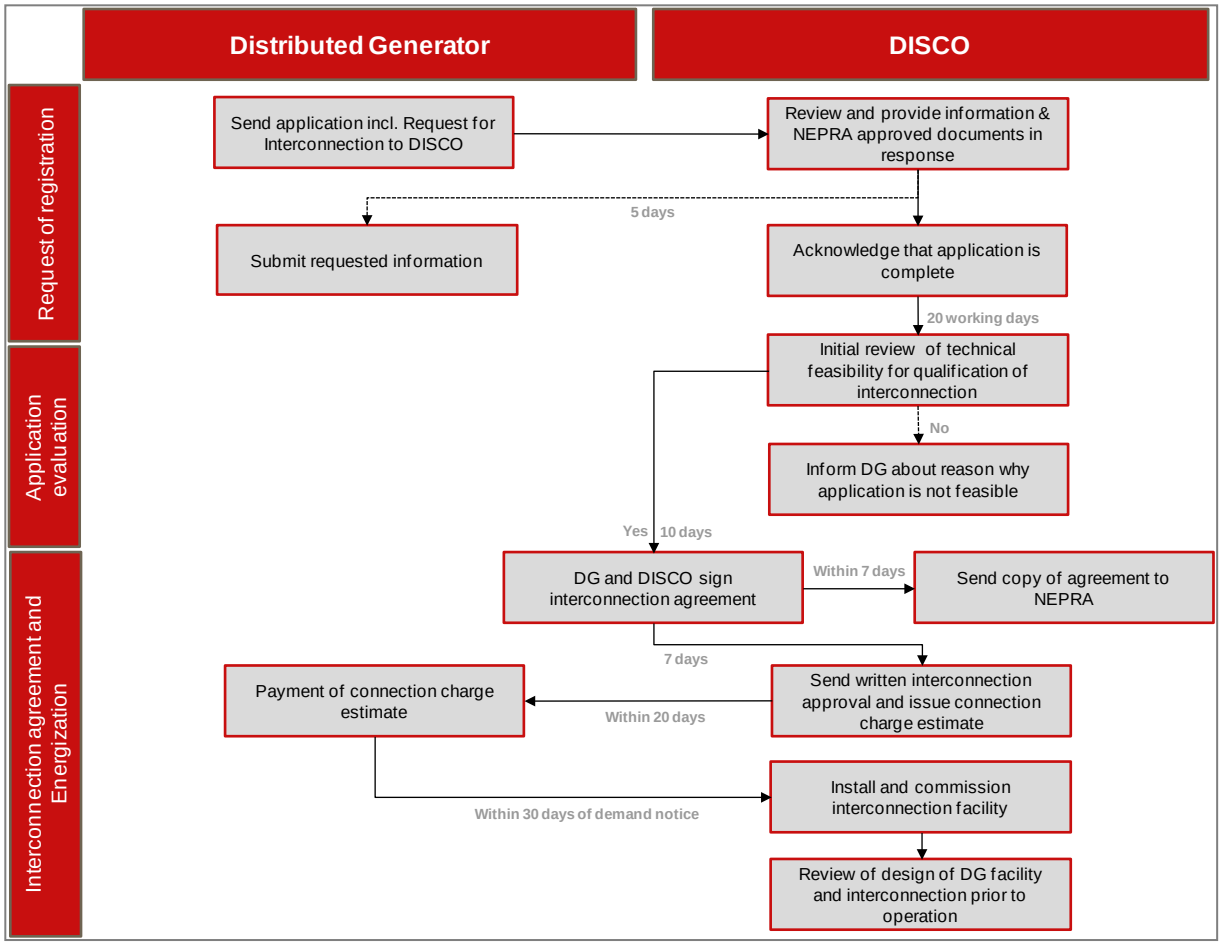

Figure 14: Application process according to net metering regulations

The process has a certain complexity which is however necessary as it reflects the technical, administrational and financial implications of the agreement which is closed between the DISCO and the consumer. It needs to be ensured that the relevant DISCO staff is trained so that they can handle the applications adequately.

4. Awareness on net metering

An important bottleneck for large deployment of net metering is the lack of awareness of electricity customers. Even in industrialized countries where on average the public information level on renewable energies is higher, and where a larger share of electricity consumers avail sufficient resources to install rooftop solar installations at their premises, awareness campaigns are often used by the governments to facilitate a widespread acceptance of renewable energy incentive schemes such as net metering or feed-in tariffs.

To actively promote net metering in Pakistan, the following marketing activities are recommended.

A. Marketing material and distribution plan

If net metering is to be a success in Pakistan, it needs to be actively promoted to potential customers. Especially as targeted customers in this case are especially small-scale enterprises and private households, it cannot be assumed that information about the attractiveness and potential of net metering is circulated at substantial levels by the customers themselves (as it might be the case for public support schemes to very specific sectors). Other countries who have introduced net metering also have accompanied this introduction with awareness material.

The necessity to actively inform target customers is even more important as the business case of net metering in Pakistan is less attractive than in other countries because of load shedding and low electricity prices. Only if the customers know that the option of net metering exists, where they can buy equipment and what the additional benefits of small scale solar installations are, substantial deployment can be reached.

Regarding marketing material, two important points have to be considered:

1. The type of material, e.g. brochure, guidebook, leaflet, websites, further online material.
2. The form of distribution, e.g. governmental organizations, multipliers, on specific events.

Net Metering in the Philippines

The Philippines has adopted a "Renewable Energy Act" in 2008 which established the National Renewable Energy Board (NREB, similar to AEDB in Pakistan) and foresaw net metering as one support mechanism for renewable energies in the Philippines. The net metering regulation was officially launched on July 24, 2013.

A specialty in the Philippines' regulations is that the tariff which consumers receive for feeding electricity into the grid is not actually the purchase price of electricity (about USD 0.20 per kWh in 2015), but instead a lower rate which equals the average generation costs of electricity to the utilities (about USD 0.12 per kWh in 2015). As a consequence, feeding electricity into the grid is less attractive than using it for own consumption.

In "More Meralco[22] customers shift to net metering", June 25, 2016, The Philippine Star quotes Meralco officials, saying that the number of net metering customers of Meralco have grown from 0 to over 200 between 2013 and 2015. As of May 16, Meralco reports 392 net metering customers with an average capacity of 4 kWp with a recent month-to-month growth of 7% in the number of installations[23].

Assuming the numbers quoted by Meralco (totaling about 1.6 MWp in May 2016) and understanding that Meralco so far has been the utility which had by far the highest number of net metering customers, the total amount of installed net metering systems in the Philippines in mid-2016 must be somewhere around 500 installations with a total capacity of 2 to 3 MWp.

It is however important to notice that the upper limit of 100 kWp for installations on net metering in the Philippines significantly limits the total numbers; for example, in Pakistan, the solar plant installed at the Parliament Building in Islamabad alone has a size of 1 MWp and will operate under the net metering scheme.

GIZ has supported the introduction of net metering in the Philippines through several documents, such as a manual on interconnection of rooftop PV systems, a guideline for distribution grid impact studies and a reference guide on net metering in the Philippines.

Figure 15: Promotion picture on small-scale solar via net metering. Source: Meralco

[22] Meralco is Philippines biggest utility, responsible for Manila and its surroundings.
[23] http://www.philstar.com/business/2016/06/25/1596294/more-meralco-customers-shift-net-metering

Type of material:

GIZ has developed a valuable guide for net metering and photovoltaic plants in the Philippines[24]. The document contains all necessary background information on net metering regulations in the Philippines, the application process, what to take care of when purchasing and financing PV plants, and an extensive list of addresses of suppliers. To facilitate the process in Pakistan, similar information material needs to be developed. In order to create material which is even more targeted to different groups and topics, it is recommended to create different, short brochures on the following topics:

- "How to apply": Description of how net metering works, what conditions a customer needs to fulfill and how an interested customer can apply for it.
- "How to buy": Description of important points to take care of when purchasing a system, different options and technologies and their advantages and disadvantages, and including a list of addresses of suppliers and related non-commercial associations and government bodies.
- "How it has been done (References)": Successful case studies from Pakistan, including numbers on grid consumption and diesel savings and payback periods.

Such information shall be made available on both hardcopies (brochures, leaflets) as well in online media hosted, promoted and frequently updated by public authorities.

Form of distribution:

The form of distribution of the material is crucial for a successful awareness campaign. A random or least effort distribution of printed material does not at all cause the desired outcome. It needs to be assessed carefully how the target group can be reached in the best way. In order to be able to reach the target group most likely to become the early adopters of net metering, this target group needs to be defined first.

A suitable target group for the first net metering customers could be: "Private households, as well as commercial and industrial enterprises with access to capital and awareness for the environment and sustainability". Another target group could be: "Professional technical companies who supply electricity and energy services to households and enterprises".

Once these target groups are defined, suitable multipliers can be identified who can then be integrated into the distribution plan. Such multipliers could be: the Pakistan Engineering Council, the Green Building Association as well as similar institutions. Governmental

[24] GIZ: Net Metering Reference Guide (Philippines), November, 2013, Manila, Philippines.

institutions such as the Ministry of Water and Power and its subsidiaries should also be integrated. The AEDB should be in the lead to identify these institutions and manage the process.

Secondly, once the marketing material as well as the distribution plan are defined and developed, an official launch event chaired by the Ministry of Water and Power, and AEDB, together with the DISCOs and other stakeholders as well as the mentioned multipliers would be an effective way to start the awareness campaign and give it the necessary initial momentum via press releases and public discussion.

Recommendation:

1. The marketing material to be developed needs to be defined. Suggestion: Separate brochures on the application process, on how to purchase quality equipment and on reference cases.
2. The target group for the marketing needs to be defined, e.g. affluent and environmentally aware households and enterprises.
3. The multipliers for the marketing campaign need to be defined, e.g. associations were already active in environmental and renewable energy topics.
4. An official launch of the awareness campaign including stakeholders and the press helps to gain momentum.

B. Establishment of a national helpdesk

A big hurdle to successful implementation of net metering is the lack of awareness of the DISCOs' field staff. These are the ones who need to process the applications and actually connect the systems to the grid. Training of field staff is proposed in the respective chapter and is the most important measure to tackle this issue. However, even if the DISCOs work at full effort, it will take some time until all field level staff all over the country will be trained and capable to efficiently and successfully deal with all net metering affairs. Therefore, an additional and very helpful measure would be the establishment of a nationwide central helpdesk. The purpose would be to help interested customers to answer all their questions regarding net metering and assist them whenever their interaction with the local DISCO office becomes difficult.

The great advantage of a central dedicated helpdesk is that staff can be trained specifically for the purpose of assisting customers in net metering affairs. Moreover, the communication can be set up in a way that it supposes the minimum effort by the customer, e.g. via email or through a toll free telephone hotline. Another advantage of a central helpdesk is that any issues, questions and doubts of interested customers of net metering can be registered in a centralized and structured way. The helpdesk thus functions like a stethoscope which can directly measure the "pulse of net metering implementation", i.e. identify any difficulties and issues around net metering among potential customers.

Crucial for the setup of the central helpdesk for net metering is that it receives sufficient resources right from the beginning. It needs to be ensured that staff can be trained properly, all communication facilities can be set up, and operation is secured at least for 2 to 3 years. Equally important is that interested customers get to know about the helpdesk. The helpdesk

should have an own website and telephone line. The contact details of the helpdesk shall be highlighted in all marketing materials and should be posted in all customer offices of the DISCOs throughout Pakistan.

The most suitable institution where the helpdesk could be established is NEPRA as the authority who is in charge of the net metering regulations themselves. However, AEDB or others could also be used to establish this helpdesk.

Recommendation:

Establish a nationwide helpdesk (preferably at NEPRA) including toll-free hotline for potential customers of net metering that helps to address issues on the customer level effectively and allows identifying of remaining hurdles for net metering on the ground.

5. Overall roadmap and action plan

A total installed capacity exceeding 4,500 MWp of solar power plants through net metering is assumed to be a realistic scenario for Pakistan until 2025. The more immediate goal should be the first 1,000 MWp through net metering by 2021. In order to meet or exceed these numbers, the measures laid out in this roadmap are crucial. They are summarized in the following.

A. Overall roadmap

The following chart summarizes the measures and their timeline.

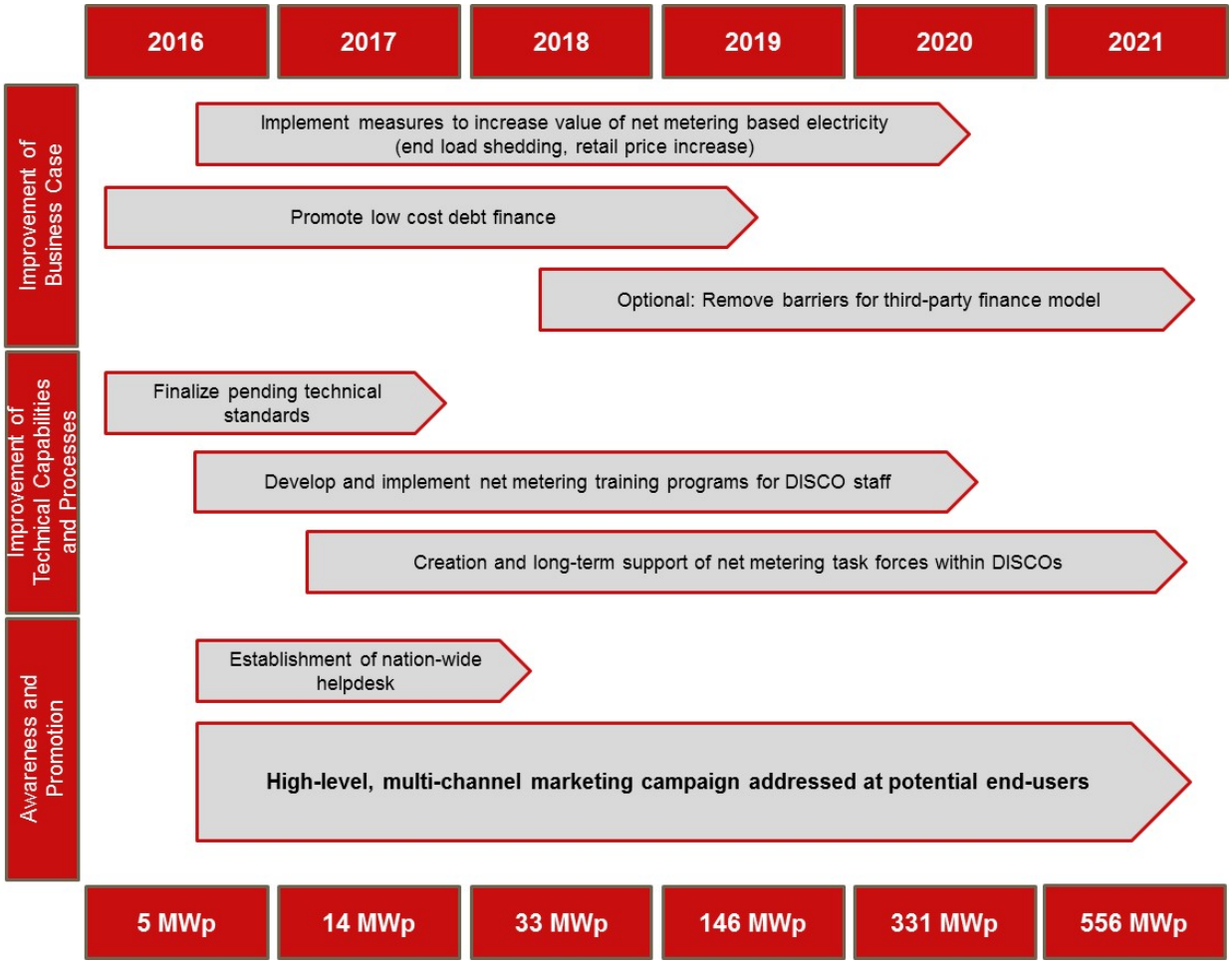

Figure 16: Roadmap of action items according to the timeline

B. Action plan

The main tasks to make net metering a success in Pakistan and achieve substantial deployment of distributed solar power plants within the next 10 to 20 years are:

- Improvement of the commercial profitability of net metering via end of load-shedding, supportive finance and electricity prices which reflect the international energy costs; through the government
- Increase of the technical capability of DISCO staff and finalization of pending technical standards through the DISCOs and NEPRA, supported by the government.
- Creation of awareness via a concerted high-level promotion campaign through AEDB.

The measures recommended in this Roadmap are as follows.

The Government of Pakistan (i.e. the Ministry of Water and Power, together with other concerned ministries) should:

- Increase the value of electricity production from distributed generation through a mid-term increase of base electricity tariffs which reflects international energy prices which are bound to rise during years to come and a significant and reliable reduction of load-shedding.
- Incentivize wider spread of nationally manufactured bidirectional meters to help to ensure availability and contribute to local economy at the same time**.**

The State Bank, together with other financial institutions should:

- Promote the availability of lower cost debt finance from state-owned or development banks so that it is available and within the awareness of the end-customer.

NEPRA as the regulating authority should:

- Increase the agreement term in the net metering regulations from 3 to 10 years, including clause of renewal in absence of relevant objections.
- Consider removing legal barriers for third-party finance model and actively promoting this financing approach for commercial and industrial customers as a second phase of net-metering.
- Finalize pending technical standards and support the DISCOs to come up with suitable net metering billing procedures.

AEDB should:

- Conduct a train-the-trainer program which defines training materials and enables senior DISCO staff to train field and technical staff.
- Define the marketing material, target group and multipliers for the awareness campaign on net metering, than conduct the campaign through an official launch and further implementation.

NEPRA or AEDB should:

- Establish a nationwide helpdesk including toll-free hotline for potential customers of net metering that helps to address issues on the customer level effectively and allows identifying of remaining hurdles for net metering on the ground.

The DISCOs should:

- Establish dedicated net metering units within the distribution companies to help bundling net metering knowledge and centrally addressing all capability bottlenecks at the distribution company level.

The faster these measures are implemented and actually put in practice, the faster will be the uptake of solar power plant installation under the net metering scheme. Sustainable success will only be achieved of all stakeholders work together and closely coordinate their respective actions.

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