Institute of Policy Studies
Islamabad

Barriers and Drivers of Solar Prosumage
A Case Study of Pakistan

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A Case Study of Pakistan

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Foreword

Institute of Policy Studies, founded in 1979 is an autonomous not for profit, civil society organization, dedicated to promoting policy-oriented research. Energy is one of its comprehensive research programme—where one of the objective remains to facilitate renewable energy uptake.

This report is based on a series of study stages designed under the 10-month project. In order to support a sustainable transition in the energy sector, the study intended to probe challenges surrounding Distributed Solar photovoltaics (DSPV) in Pakistan—a technically mature and economically competitive alternative for energy generation. Based on gained insights, it recommends an intervention framework which could address the identified challenges and accelerate DSPV diffusion among larger sections of society.

The lead person of the project as well as lead author of the report is Naila Saleh. Further, Institute of Policy Studies would like to thank all participants including respondents of the surveys, the electricity distribution companies, respective public authorities and most importantly the respected members of IPS Energy Steering Committee especially Mr. Mirza Hamid Hasan, Mr. Ashfaq Mehmood, Ms Ameena Sohail, Mr. Syed Akhtar Ali for their inputs and feedback on this study.

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Executive Summary

Distributed generation (DG) is gathering pace globally. Pakistan also issued Net-metering regulations in 2015 to encourage self-generation. These regulations allowed on-site renewable generation to all category type consumers for capacities up to 1 MW—while complying relevant DISCOs for granting the interconnection.

Despite the launching of net-metering facility, not only its growth has remained significantly slow over the past 5 years but also strong uneven adoption rates exist across the 11 DISCOs. Following this insight on insignificant growth and geographic uneven distribution, this study was therefore organized to identify and assess challenges as well as drivers that discourage/encourage solar prosumage uptake; as well probe factors behind the understated divergence in different DISCOs.

The project overall gathered some very interesting findings surrounding distributed generation growth. The following is a summary of the key findings and conclusions:

1- Key Drivers

Prosumage in Pakistan has largely been upheld by high cost of grid provided energy; unreliable energy supply in terms of load shedding; a desire to be independent from the grid as well as environmental consciousness.

2- Barriers in Space

- **Administrative and Regulatory Barriers at Inter-connection Phase**: Overall, challenges at inter-connection phase were identified as dominant challenge to PV deployment. This included time lapse in acquiring of 3 phase metering equipment at the initial stage; absence of online facility for applications, in availability of bi-directional meters, and unnecessary delay in processing of the applications at every stage. So the cumbersome procedure and unnecessary hiccups at different intervals overall increases the transaction cost for applicants.

- **Financial Barriers:** A major finding of this study was installation of solar PV systems by end-users at their own expense. In parallel, heavy concentration of solar prosumage uptake was found among resourceful sections of society. One factor for this skewed concentration is 'high cost of solar PV installation' and the interlinked challenge of 'difficulty in access to borrowing' for financing the solar PV system.

  Although 'SBE RE Finance Scheme' is an active scheme—providing loans to potential solar system installers on very easy terms which include low interest rate and long pay-back periods. However as per the findings of this study, two broader problem statements were identified in relation to the understated scheme

  (a)-The scheme has so far been launched by very limited no of commercial banks. The factor behind this low diffusion among commercial banks includes: voluntary adoption of the scheme; limited awareness on it by most banks; transaction cost of adoption by the scheme which includes designing SOPs for its implementation vis-à-vis the human resource and time investment in refinancing the

loans advanced from SBP (since the entire process is manual); and finally probability of high investment risk.[1]

(b)-Even those banks which have introduced the scheme—have designed their SOPs in a way that it makes the access of loans—once again—really difficult for common man. This includes low payback period as well as high down payment.

- **Lack of Technical Oversight and Quality Assurance**

Where on one hand solar suppliers/vendors are mushrooming in Pakistan, in parallel weak regulatory oversight on the suppliers and robust 'accountability mechanism'—where the solar vendors/suppliers could be penalised for providing sub-par technology or misleading /false claims on their product—could overtime plague the overall solar PV uptake in the country and undermine the otherwise strong willingness to adopt the technology.

- **Geographic Uneven Distribution**

Distribution companies have been a particularly important factor in both driving or inhibiting PV adoption rates within their respective jurisdictions. Some important barriers at the end of DISCOs identified in this study included (a) Several bumps at the inter-connection phase (b) Inadequately trained SDOs (c) Poorly planned stocks of bi-directional meters and instances of its unavailability (d) Absence of help desk/complaint portal for tracking the status of application or registering complaints (e) Unnecessary delays in processing the application and issuing licenses to the distributed generators. This rigidity at distribution level has been particularly responsible for uneven growth across the DISCOs.

- **Absence of *Fee of Service* Models**

The prosumage trend in Pakistan is dominated by dealer models wherein the PV systems are exclusively installed and operated by the prosumers. The 'Fee of service' models as well as role of commercial actors in distributed generation uptake are practically non-existent in Pakistan.

3- Recommendations

Based on gained insights, following recommendations are proposed:

- Addressing challenges at inter-connection phase and introducing a user-friendly registration process.
- Strong political will for resolving the inertia at DISCOs end and turning the regulations into concrete achievements in terms of distributed generation uptake.
- Streamlining innovative solutions for technical integration of distributed generation.
- Promoting concessionary financing for renewable energy.
- Policy initiatives and financial instruments for private sector engagement in driving growth of fee of service models—for large scale diffusion of distributed generation.
- Launching campaigns to create awareness and promote adoption of distributed generation.

[1]Since in the case of these loans the system bought itself is collateral. However as there are no secondary markets for solar system purchase, any default on behalf of applicants become a investment risk.

Chapter 1
Introduction

This chapter provides a general background to the study; underlying objectives of the project; and methodology. Detailed findings of the three major stages of the project could be traced in subsequent chapters.

1.1- Background

Prosumerism[2] has instilled new hope for addressing challenges surrounding a reliable, affordable, and climate-friendly energy supply. Pakistan—a country with naturally high potential for solar prosumage issued net metering regulations in 2015. These regulations hence allowed for on-site solar and wind generation for capacities ranging between 1 KV and 1 MW, while complying relevant DISCOs for implementing the regulations. It covers for *three-phase 400 V or 11 kV* connections by domestic, commercial or industrial end-users.

To avail the facility, the consumers initially register their applications with DISCO. The DISCOs after reviewing the application, forward it to NEPRA for issuance of license. Once the license is issued to the applicant by NEPRA, he/she deposits the Connection Charge Estimate (CCE) in designated Bank and notifies the DISCO office in writing. Finally, the end-users are connected to the grid and automatically enter a 7-year purchasing agreement with the relevant DISCO.[3] So on average, this whole procedure takes less than 3 months. Upon connection, a bi-directional meter accounts for the net-balance of the energy being generated vis-a- vis consumed by the Distributed Generator. The remuneration scheme under net-metering in Pakistan adjusts for net balance—subtracting amount of electricity consumed from the grid against the units added—at the end of every month. In the case of positive net balance, the prosumer receives a payment every 3 month, whereas in alternate scenario he/she is charged for the netted amount consumed via monthly billing cycle. So, on-site renewable energy generation does not only offset grid consumption but also in case of positive net balance, the surplus energy units to the electricity grid are compensated at off-peak retail tariff.

However, despite the launching of net-metering facility, its growth has remained insignificant overtime, reaching the cumulative capacity of 148 MW in 2020.[4] **Fig.1.1** demonstrate the year-wise cumulative installed capacity of distributed generation in Pakistan till Dec 2020, whereas **Table.1.1** shows the overall year-wise distribution of licenses across the 11 DISCO's. So as could be observed, compared to the total 29.5 million connections to the grid, 8006 licenses were issued over a period of 5 years. Further, the data given in Table 1.1 reveals the geographic uneven uptake across the DISCOs. The distributed generation growth is largely dominated by 3 key DISCOS namely KEL, IESCO and LESCO. Some

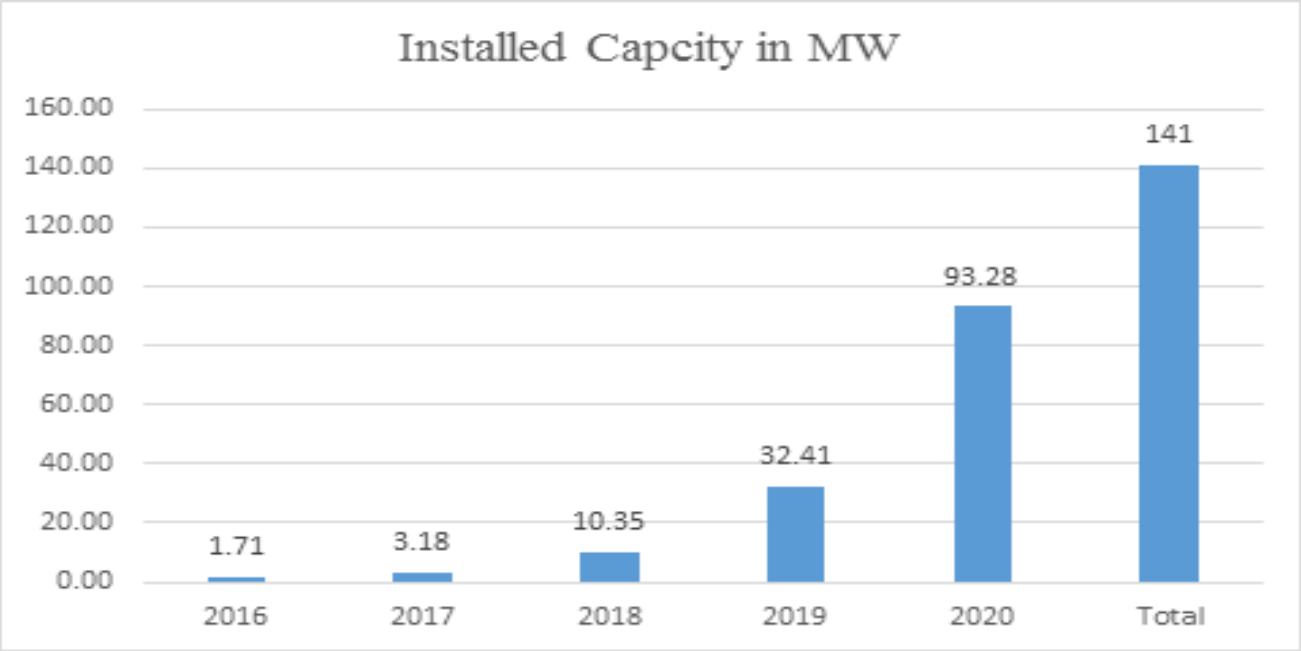
[2] We define **prosumers as** grid-**connected** electricity consumers who use their installed systems to produce their own electricity at times, draw electricity from the grid at other times, and feed electricity to the grid at yet other times. Further, the terminology prosumers and distributed generators is used interchangeably in this study.

[3]Initially the PPA period was three years, extended to seven years after amendment in the act; NEPRA. (2017b). (ARE) Distributed Generation and Net Metering Regulations, 2015, Amendment-1 vide S.R.O. 1025(1)/2017 (Date: October 10), and, Amendment-2 vide S.R.O. 1261(J)/2017 (Date: December 20).

[4]This include 141 MW in the 10 public DISCOs and KE, and over 6.76 MW of installed capacity in 2 small private utilities namely Bahria Town and DHA -XII.

of the largest DISCOs such as MEPCO, FESCO, PESCO, GEPCO lag way in terms of prosumage distribution. Few others such as SEPCO, HESCO, and QESCO have only issued a couple of licenses. Whereas TESCO has not yet embraced distributed generation.

Fig.1.1 Year-Wise Distributed Generation Growth (MW)



Source: Compiled by the authors from NEPRAs website[5]

Table. 1.1 Distribution of Year-Wise Licenses' issued

DISCO's	Total Connections	Year-Wise Issued Net-Metering Licenses					Total
		2016	2017	2018	2019	2020	
LESCO	4598784	2	95	204	704	1487	2492
IESCO	2837238	18	86	189	682	1261	2236
KE	2583435	0	0	124	511	826	1461
GEPCO	3326274	0	6	44	96	235	381
MEPCO	6072783	0	0	26	84	505	615
FESCO	3953132	0	0	20	82	357	459
PESCO	3330907	0	0	4	37	301	342
SEPCO	745308	0	0	0	2	4	6
HESCO	1080714	0	0	0	3	5	8
QESCO	609004	0	0	0	1	5	6
TESCO	442401	0	0	0	0	0	0
Total	29579980	20	187	611	2202	4986	8006

Source: Compiled by Authors from NEPRAs website [6]

[5]The data accounts for all installations till 31th December 2020.

[6] ibid

Against the slow growth and stated divergences in distribution of licenses issued—the barriers, drivers and enablers of prosumerism in Pakistan are rarely known in the existing literature. This study was therefore organized to take holistic overview of the factors behind the slow prosumage growth vis-à-vis probe the factors responsible for the geographic uneven uptake in the country context.

1.2- Objectives of the Study

The objective of the study was two-fold:

(a) To understand barriers and drivers encouraging/discouraging solar prosumage growth in Pakistan

(b) To understand factors behind slow and geographically uneven growth of distributed generation in different DISCO's settings.

Overall, the broader objective remained to understand the barriers and drivers in relation to solar prosumage uptake under the net-metering regulations and based on gained insights propose the Government of Pakistan and the responsible agencies a framework on facilitating diffusion of distributed generation in the country.

1.3- Methodology

For an inclusive picture on the drivers, barriers and enablers of prosumage, the study specifically focused on three principal stakeholders: Prosumers (end-users who have engaged in distributed generation), Non-Prosumers (end-users who have not yet engaged) and finally the Distribution companies (the key intermediaries responsible for connecting end-users to the grid). **Table 1.2** shows the detailed analysis on sample size and mode of data collection for each stakeholder category.

Table. 1.2 Methodological approach

Stakeholders	Actor/Source	Sample Size	Mode of Data Collection
Prosumers	Those who have already engaged in DG	333	Survey
Non-Prosumers	Those who have not engaged yet	578	Survey
Distribution Companies	Electricity distribution companies	06	Interviews

Following chapters showcase the findings and analysis of the surveys and interviews conducted on each stakeholder category.

Chapter 2
Prosumer Survey Analysis

In line with the objectives and research questions of study, this survey analyses the data from prosumers survey—which aimed at identifying and assessing the barriers and drivers to solar prosumage in different DISCOs settings. The analysis contributes to an improved understanding on the overall as well as DISCO wise slow uptake of solar prosumage in Pakistan.

2.1- Socio-Economic Demography

This survey was carried out among 333 prosumers wherein the no of participants was non-uniformly distributed across different DISCOs as well as different categories. This non-uniform distribution was primarily due to non-uniform growth of distributed generation in both different DISCOs as well as sectors. The overall participation from each DISCO and category in numbers and percentage could be seen in **Table.2.1**.

Table.2.1 DISCO Wise and Category Wise Distribution of Respondents

DISCO wise Distribution of Respondents								
IESCO	**LESCO**	**KEL**	**FESCO**	**GEPCO**	**PESCO**	**MEPCO**	**HESCO**	**SEPCO**
94(28.2%)	113(33.9%)	61(18.3%)	15(4.5%)	16(4.8%)	14(4.2%)	17(5.1%)	1(0.3%)	2(0.6%)

Category wise Distribution of Respondents				
Household	**Industrial**	**Commercial**	**Agriculture**	**Other**
297 (89.1%)	8 (2.4%)	19 (5.7%)	1 (0.3%)	8 (2.4%)

Table. 2.2 shows the socio-demographic characteristics of the surveyed population. Vast majority of prosumers is occurring in middle or old age adults. In parallel, education level in this study was indicated an important factor in relation to DG uptake. Another important finding was concentration of DG uptake among relatively resourceful sections of the society as well as those end-users who owned the building/ property where they installed their solar system.

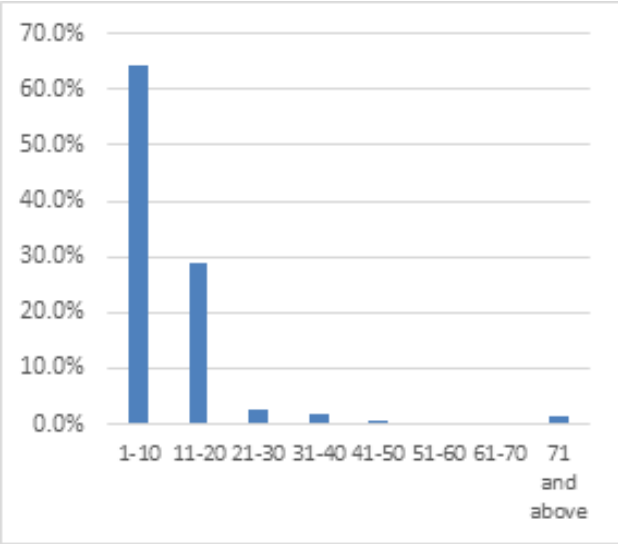
Table.2.2 Socio-economic demography

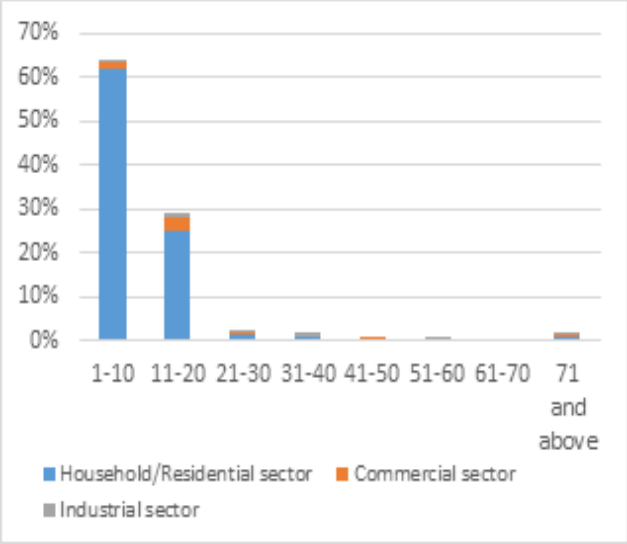
	Frequencies & percentages
Gender	
Female	20(6%)
Male	313(94%)
Age	
25-34	43(12.9%)
35-44	64(19.2%)
45-54	71(21.3%)
55-64	74(22.2%)
64 or above	81(24.3%)
Education	
Postgraduate degree	216(64.9%)
Secondary/Higher secondary education	11(3.3%)
Undergraduate degree	106(31.8%)
Occupation	
Employed	117(35.1%)
Retired	82(24.6%)
Self-employed	130(39%)
Student	1(0.3%)
Un-employed	3(0.9%)
Income	
150,000 or above	214(64.3%)
120,000-149,999	31(9.3%)
30,000-59,999	16(4.8%)
60,000-89,999	24(7.2%)
90,000-119,999	45(13.5%)
less than 30,000	3(0.9%)
Status of living	
Coping on current income	59(17.7%)
Finding it difficult to live on current income	14(4.2%)
Finding it very difficult to live on current income	9(2.7%)
Living comfortably on current income	180(54.1%)
Living very comfortably on current income	71(21.3%)
Building/ Property Ownership on which the solar system is installed	
Yes	94%
No	06%

2.2- Distribution of Installed Capacity, System Cost and Mode of Finance

The market for distributed generation/grid-tied prosumage in Pakistan continues to be driven by household sector—with PV systems largely concentrated in smaller sizes i.e. kW range of 1-20. To further breakdown this analysis, 64.3% of the installed capacity lied in the range of 1-10 kW; 28.8% under the bracket of 11-20 kW; and remainder 8% of capacity was spread out in the range > than 20 kW. The mean/average installed capacity was thus skewed toward 10 kW; whereas the maximum installed capacity in this survey was indicated as 1125 kW. The left graph in **Fig.2.1** illustrates the overall distribution of installed capacity, whereas the right graph shows category wise installed capacity.

Fig.2.1 System Size (kW)





44% of the respondents in this survey indicated that they were using hybrid solar systems with backup provided by batteries whereas 56% were relying on systems without batteries. On the question related to cost of solar PV systems—including modules, inverters and cables—prosumers quoted a wide range of prices. Based on these quotations—**Table.2.3** shows average cost of the systems installed (with and without batteries) in the range of three different categories of kW capacities i.e. < 5 kW; 6-10 kW and 11-15 kW.

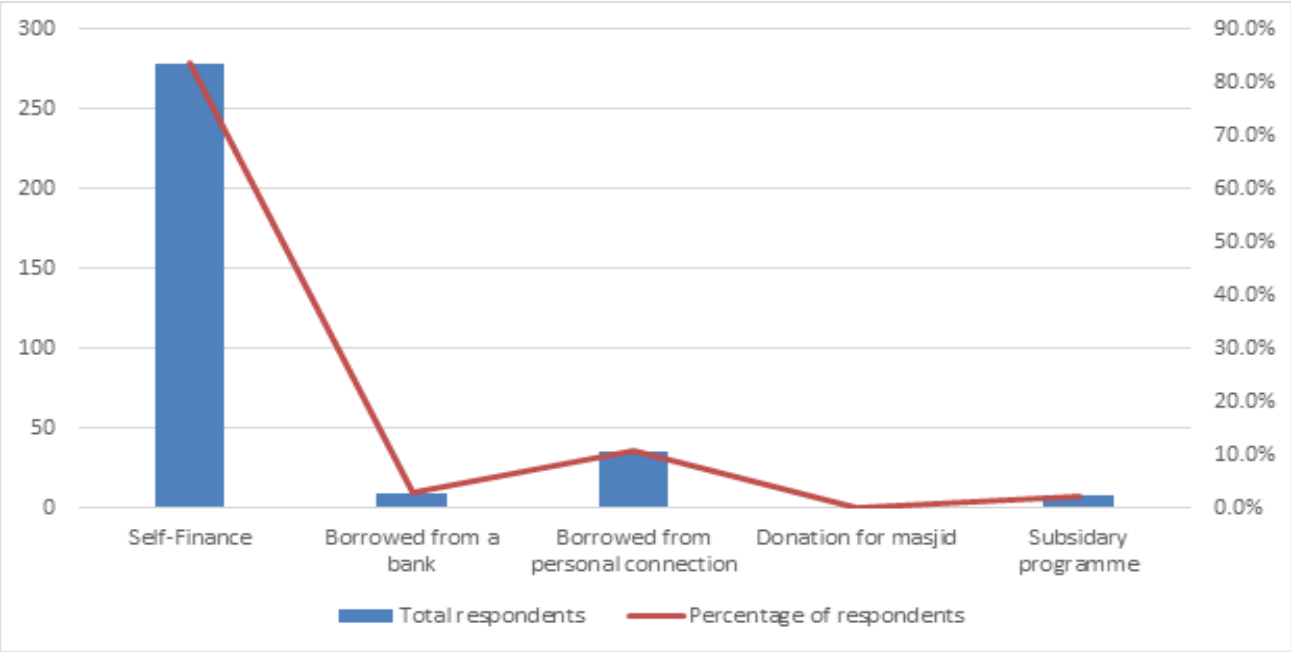
Table.2.3 Cost of PV System (PKR) and Modes of Financing

System Size	< 5 kW	6-10 kW	11-15 kW
Average cost with batteries	750,652	1,705,108	3,135,000
Average cost without batteries	555,455	1,450,933	1,583,158

Since, the upfront cost of PV system—remains a dominant barrier discouraging end-users from installing these systems—easy-to-access loans in this regard potentially facilitate solar PV uptake. To promote Solar PV and DG uptake, State Bank of Pakistan launched 'Financing Scheme for Renewable Energy'

initially introduced in 2009, recently revised in 2019.[7] The **Category II** of the scheme applies to customers considering small-scale installations of up-to 1 MW for which distributed generators qualify. Maximum loan period for loans under the stated category is 10 years, mark-up payments are charged at 6% which could be repaid on monthly or quarterly basis whereas the principal is repayable in monthly, quarterly or half-yearly installments. The maximum loan amount for single borrower has been set at PKR 400 million. However, most prosumers in the context of Pakistan—as probed by this survey—installed their systems on self-finance. With this overall context the following picture of modes of financing emerges

Fig.2.2 Mode of Finance



As shown in **Fig.2.2** vast majority (83.5%) of prosumers in Pakistan self- financed their PV systems upfront. Out of the total 13.8% participants who accessed loans for installing their systems—10.8% borrowed the money from personal connections and an insignificant number (only 3%) borrowed the money from banks. The cumbersome approval process vis a vis strong credentials put in place by banks for qualifying respondents in relation to these loans were cited as key barriers restricting diffusions of solar PV finance in the country. Further, as small scale renewable installations remain a new business segment in the country, most commercial banks are reluctant to invest in small RE applications because of high perceived investment risk and prolonged pay-back period. Finally, 2.4% of installation as indicated in this survey were carried out under a subsidiary program whereas one prosumer indicated financing installation of solar system on mosque with money from donation which in view of a very large charity sector in Pakistan, suggests social and welfare sector also to be an important potential area for solar prosumage.

2.3- Drivers and Barriers in Space

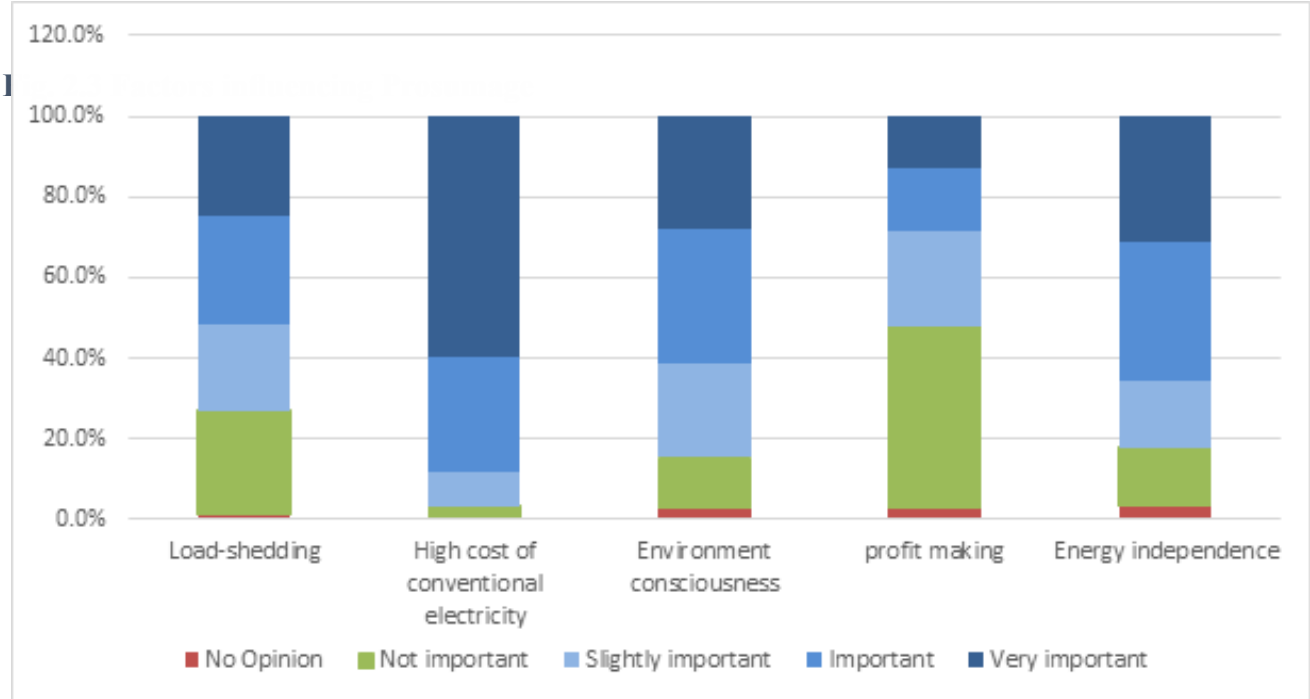
In order to build knowledge on *drivers and barriers* behind prosumage—this study probed it from two dimensions (a) Overall picture in the context of all DISCOs (b) DISCO wise overview of drivers and

[7]SBP, 'Financing Scheme for Renewable Energy; (2019)

barriers i.e. taking into account the spatial dimension wherein the nature as well as scale of the *drivers and barriers* might vary in different ways in different geographical places.

Drivers of Solar Prosumage

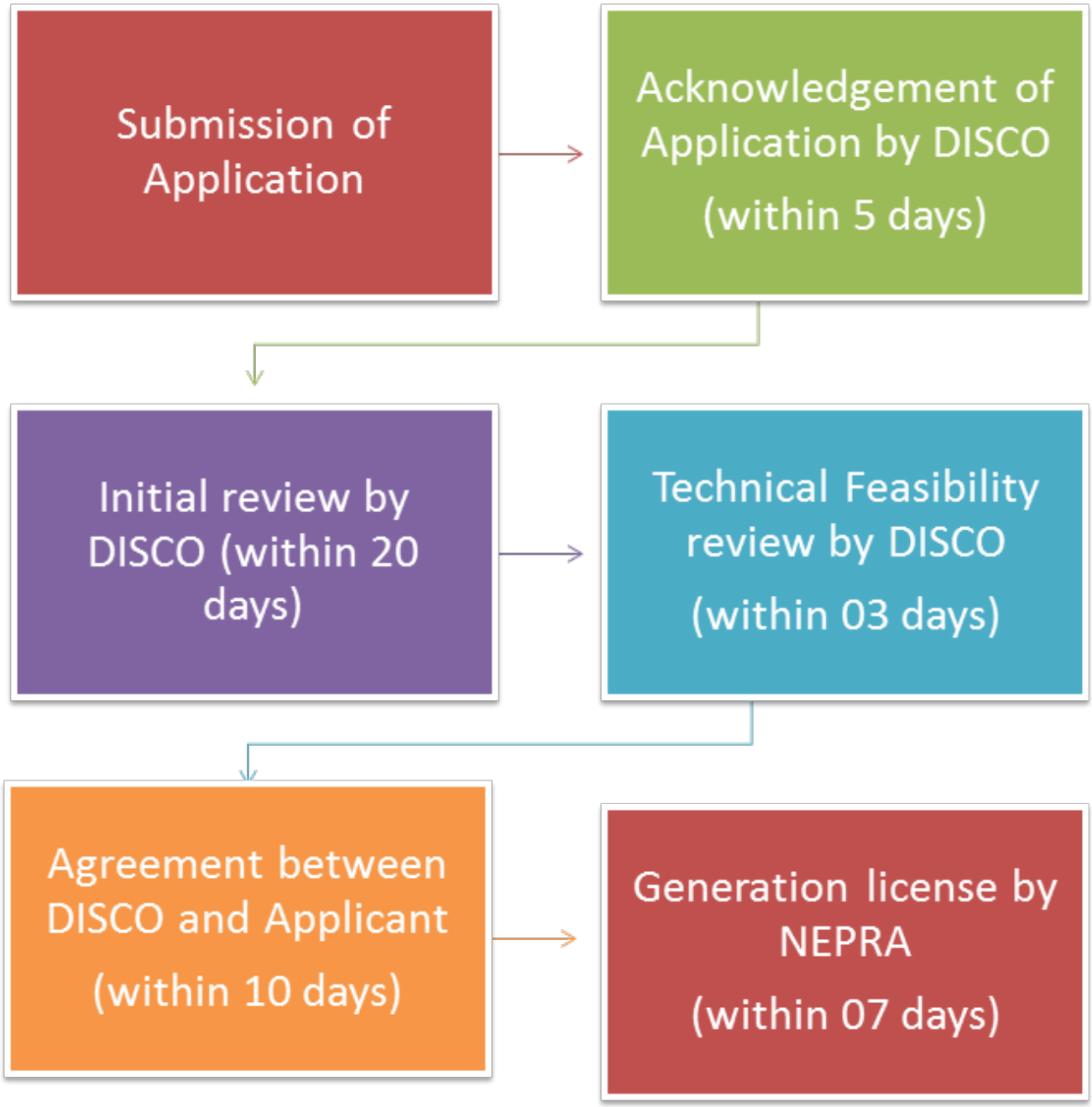
High cost of grid provided energy, environment consciousness, load shedding and desire to be independent from grid were indicated primary drivers of prosumage. **Fig.2.3** shows the overall picture on drivers influencing end-user's decision to become prosumers.



Inter-connection Process and Challenges

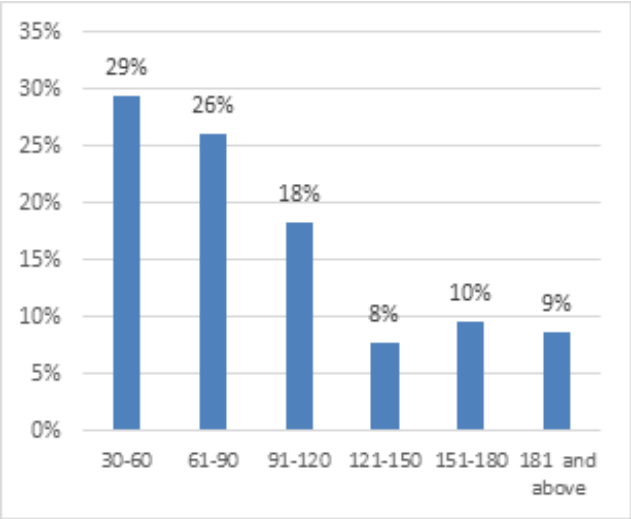
From the regulatory point of view—the cumbersome process of availing net-metering continues to be a dominant barrier. **Fig. 2.4** shows the standard process of availing net-metering license as indicated by the 'Net-metering Reference Guide for Electricity Consumers'.

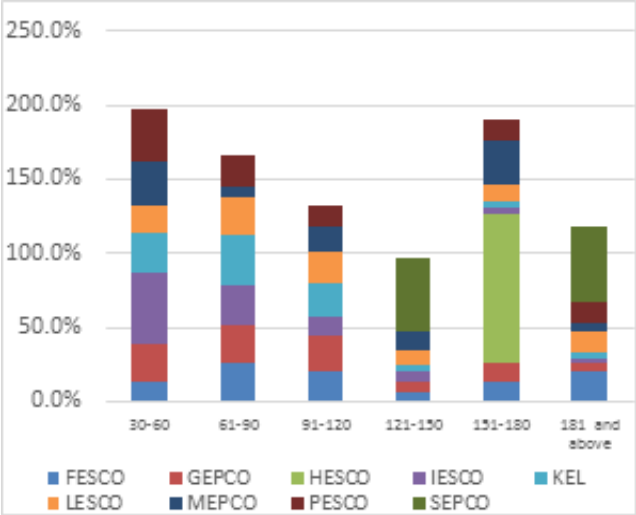
Fig. 2.4 Net-Metering Application Process



The figure depicts that on average, the whole procedure takes around 3 months. However, this survey indicated that this tentative timeframe as outlined by NEPRA was not followed by DISCOs while issuing the licenses. In this regard, **Fig. 2.5** illustrates days taken for issuing licenses to the applicants.

Fig. 2.5 Overall and DISCO wise distribution of days taken for issuing net-metering licenses





As could be observed, the timeframe for inter-connection as laid in regulation is not strictly followed by almost all DISCOs. However, a comparison of various DISCOS, IESCO seems most efficient where 75% of applicants were issued licenses within 90 days; followed by KEL (62.3%); PESCO (57.1%); GEPCO (50%); LESCO (43.4%); FESCO (40%); and MEPCO (35.3%). In contrast, the incidence of delay in providing Net-metering facility was more frequently observed in the case of LESCO; MEPCO; FESCO and PESCO. SEPCO and HESCO which so far issued negligible licenses were also found very slow in terms of *time taken for issuing licenses*.

While most solar vendors in Pakistan are currently providing their services for accessing net-metering application on behalf of prosumers—however four out of ten (cumulative 41.1%) stated that they availed their licenses on their own. **Table.2.4** presents the association between mode of availing licenses vis a vis incidence of challenges faced while availing the licenses.

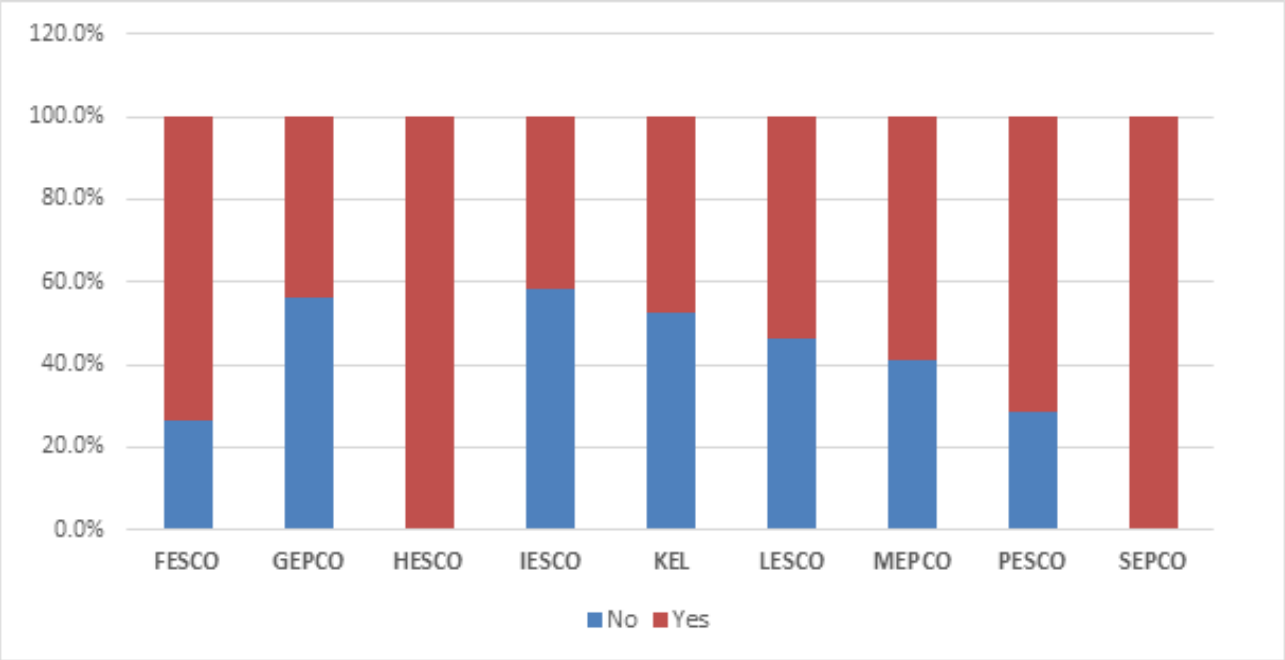
Table.2.4 Association between mode of accessing net-metering licenses vis a vis challenges faced

Challenges while accessing net-metering licenses	Accessing net-metering on your own			
		No	**Yes**	**Total**
	No	111	52	163
	Yes	85	85	170
	Total	196	137	333

The above cross tabulation illustrates that overall 41% prosumers indicated facing challenges while accessing net-metering. This percentage was found relatively higher in case of prosumers who availed licenses on their own as 62% indicated facing challenges in this category compared to 44% in case of those prosumers whose licenses were availed by their respective vendors. So, although there is slight reduction in challenges faced if instead of prosumer the vendor processes the application process for availing license. However, this being stated, the overall probability of facing challenges even in the

latter case remains significantly high. To further probe the spatial dimension of 'challenges faced while availing licenses'—**Fig.2.6** reveals some interesting information.

Fig.2.6 Challenges faced while availing licenses: DISCO wise distribution

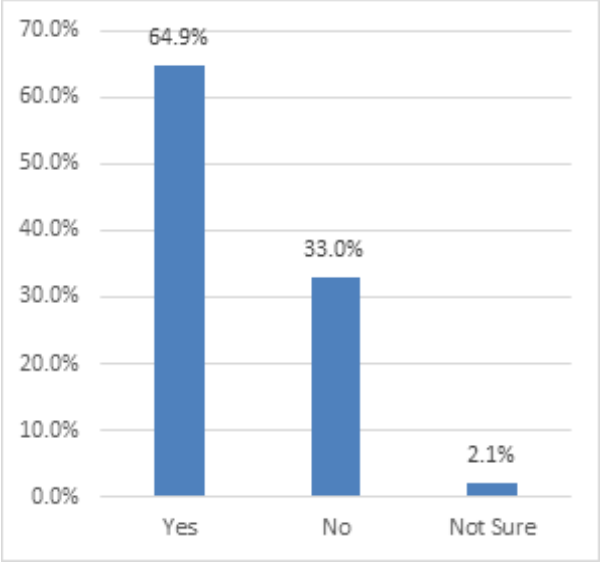


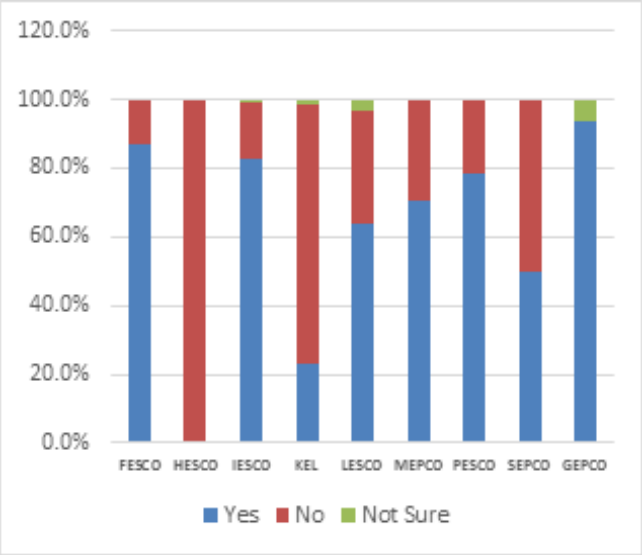
Strong diversity was observed in the DISCO wise distribution of *challenges faced while availing licenses*. The percentage of prosumers *who did not face any challenges while availing the licenses* was relatively lower in the case of LESCO (46%); GEPCO (56.3%); KEL (52.4%) and IESCO (58.5%). On the other hand, the distribution of *challenges faced while availing licenses* tended to be more strongly found in the cases of MEPCO, PESCO, SEPCO, FESCO and HESCO.

Satisfaction with Remuneration Scheme

The economic profitability of net-metering is also twofold. First, on-site renewable energy generation offsets grid consumption of the prosumer. In parallel, any added surplus energy units to the electricity grid is compensated at **off-peak** retail tariff. The remuneration scheme under net-metering in Pakistan hence adjusts for net balance—i.e. subtracting amount of electricity consumed from the grid against the units—at off-peak rate. In the case of positive net balance, the prosumer receives a payment every 3 month, whereas in alternate scenario he/she is charged for the netted amount consumed via monthly billing cycle. In this way, the scheme incentivizes the prosumers both through self-consumption vis a vis monetizing the surplus fed in the grid. In relation to the stated remuneration scheme, this study probed prosumers satisfaction with it. The left graph in **Fig.2.7** shows happiness with the scheme across the DISCOs whereas the right side graph illustrates DISCO wise distribution.

Fig.2.7 Satisfaction with remuneration scheme



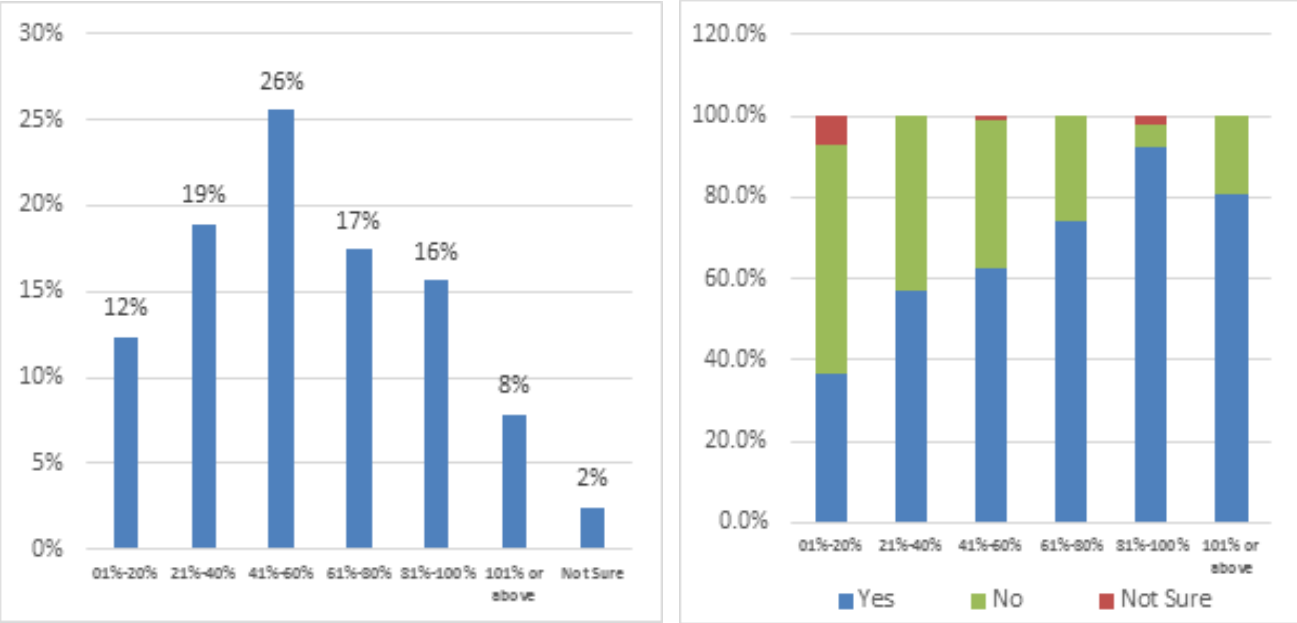


Overall, majority of prosumers, two out of three, indicated their satisfaction with the scheme. Whereas the DISCO wise distribution indicated that the prosumers belonging to KEL, HESCO and SEPCO tended to be more dissatisfied with net-metering remuneration. In the case of SEPCO and HESCO, it is important to note here that only 2 and 1 respondents participated respectively from the stated DISCOs. In the case of KEL however, the reasons highlighted for dissatisfaction included lack of transparency in billing, and the deduction of sales tax on gross consumption from the grid. It is important to note here that KEL is the only private DISCO in Pakistan and these the grievances highlighted i.e. lack of transparency in billing as well as the charging the tax on gross sales are only restricted to the case of KEL.

Electricity Bill Savings

On average savings made on monthly electricity utility bills post net-metering installation, the left graph in **Fig.2.8** illustrates the average percentage of saving on electricity bills whereas the right graph shows the level of happiness in each corresponding category. Higher proportion of savings were observed in the category of 41-60%. In parallel, as could be seen in the right side graph, prosumers with greater shares of savings on the utility bills tended to be happier compared to the ones with less percentage of savings. However, it is important to note here that the stated savings largely depends both on consumption level of the household and the size of the system installed respectively.

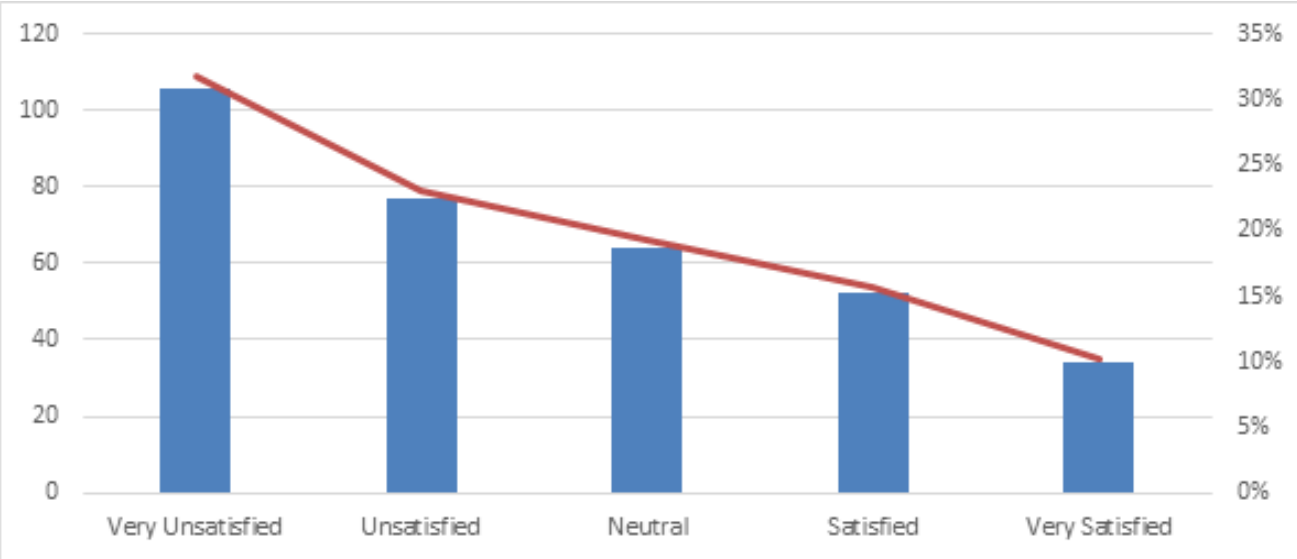
Fig.2.8 Saving on electricity utility bill



Satisfaction with Technology

Fig.2.9 illustrate the overall satisfaction level of prosumers with their installed technology. Those who were unsatisfied were requested to indicate factors explaining their discontentment with the technology. Substandard technology in the market (including low quality modules and inverters); high cost of technology and below needed size installations; frequent breakdown of control panel; poor sale service by vendors; lower power output against stated quotations etc. were indicated as major factors of dissatisfaction.

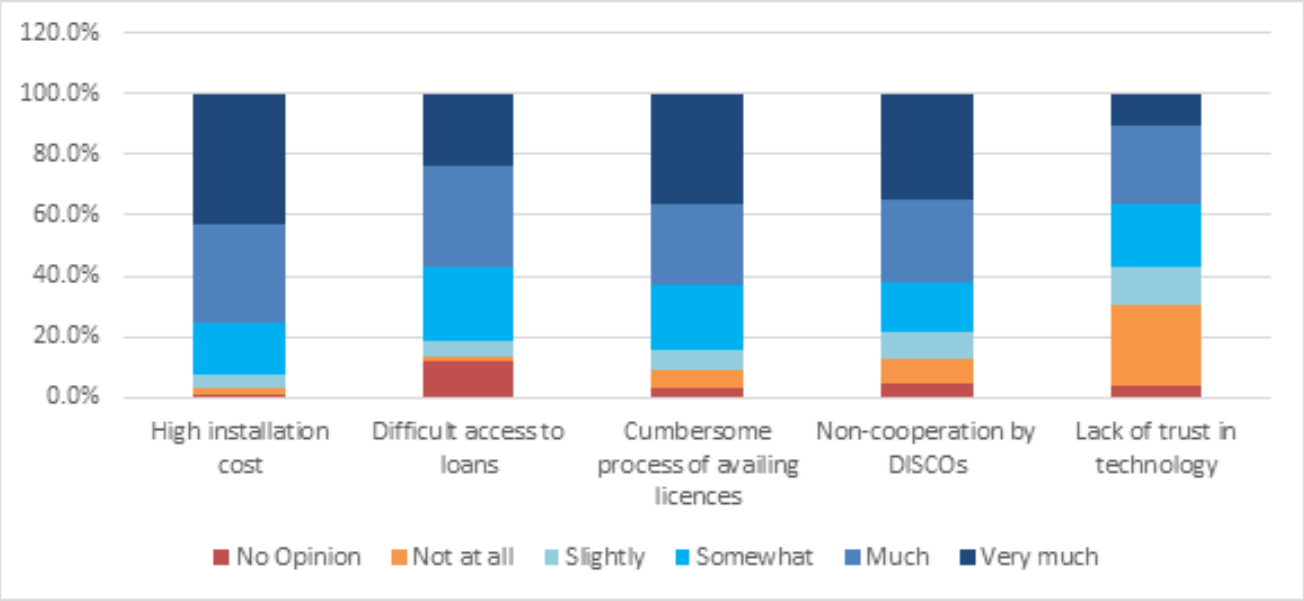
Fig.2.9 Satisfaction with technology



Overall Barriers Restricting Solar PV Uptake

Finally, **Fig 2.10** illustrates challenges surrounding distributed generation. High cost of technology, difficult access to loans and cumbersome process of availing licenses were highlighted as dominant barriers. Whereas lack of trust in technology was also rated as an important barrier by the prosumers.

Fig.2.10 Challenges surrounding Distributed Generation



2.4- Summarized Overview

Solar prosumage in Pakistan is largely driven by high cost of conventional electricity; unreliable energy supply in terms of load shedding; a desire to be independent from the grid as well as environmental consciousness. The study also gathered some very interesting findings especially on challenges surrounding distributed generation growth. This includes: cumbersome application process; serious financial barriers, inertia at the end of DISCOs; low trust in technology; absence of awareness programs; as well as absence of fee-of service models.

Against the context, the DISCOs have been a particularly important factor in both driving or inhibiting PV adoption rates within their respective jurisdictions. The marginal effect of logit model that was run on the collected the data for all DISCOs indicated that challenges/barriers experienced by an applicant reduces the probability of DG uptake by 7.5 percent.

Finally, a major finding of this study was also skewed installation of solar PV systems among resourceful sections of society vis-à-vis those prosumers who owned the accommodation/property where the system was installed. This skewed concentration continues to be rooted in 'high cost of solar PV installation' in parallel with the dilemma of 'difficulty in access to borrowing' for financing the solar PV system—and most importantly absence of *Fee of Service* models such as third party investors—in the country.

Chapter 3
Non-Prosumer Survey Analysis

Since probing the factors behind slow diffusion of distributed generation was a major research question of this study—it was therefore important to analyze why end-users were not engaging in distributed generation. Against the context, this chapter takes stock of factors restricting solar PV uptake among end-users who, described by non-prosumers.

3.1- Socio-economic Status

This section reveals information on background socio-economic characteristics of surveyed respondents. Table 3.1 shows the information on gender, age groups, education level, income level and finally accommodation/property ownership status of the surveyed respondents.

Table. 3.1 Socio-economic demographic characteristics

	Frequency and Percentage
Female	223 (38.6%)
Male	355 (61.4%)
Age	
18-24	102 (17.6%)
25-34	339 (58.7%)
35-44	85 (14.7%)
45-54	34 (5.9%)
55-64	11 (1.9%)
65 and above	7 (1.2%)
Education	
No formal qualification	3 (0.5%)
Primary education	8 (1.4%)
Secondary/Higher secondary education	69 (11.9%)
Undergraduate degree	207 (35.8%)
Postgraduate degree	291 (50.3%)
Employment	
Employed	214 (37.0%)
Housewife	27 (4.7%)
Retired	9 (1.6%)
Self-employed	64 (11.1%)
Student	215 (37.2%)
Unemployed	49 (8.5%)
Household income	
Less than 30,000	110 (19.0%)
30,000-59,999	150 (26.0%)
60,000-89,999	105 (18.2%)
90,000-119,999	70 (12.1%)
120,000-149,999	46 (8.0%)
150,000 or above	97 (16.8%)

Income status	
Finding it very difficult to live on current income	102 (17.6%)
Finding it difficult to live on current income	113 (19.6%)
Coping on current income	137 (23.7%)
Living comfortably on current income	181 (31.3%)
Living very comfortably on current income	45 (7.8%)
Accommodation ownership	
Company's accommodation	1 (0.2%)
Government accommodation	3 (0.5%)
Joint Family.	12 (2.1%)
Own	423 (73.2%)
Rented	139 (24.0%)

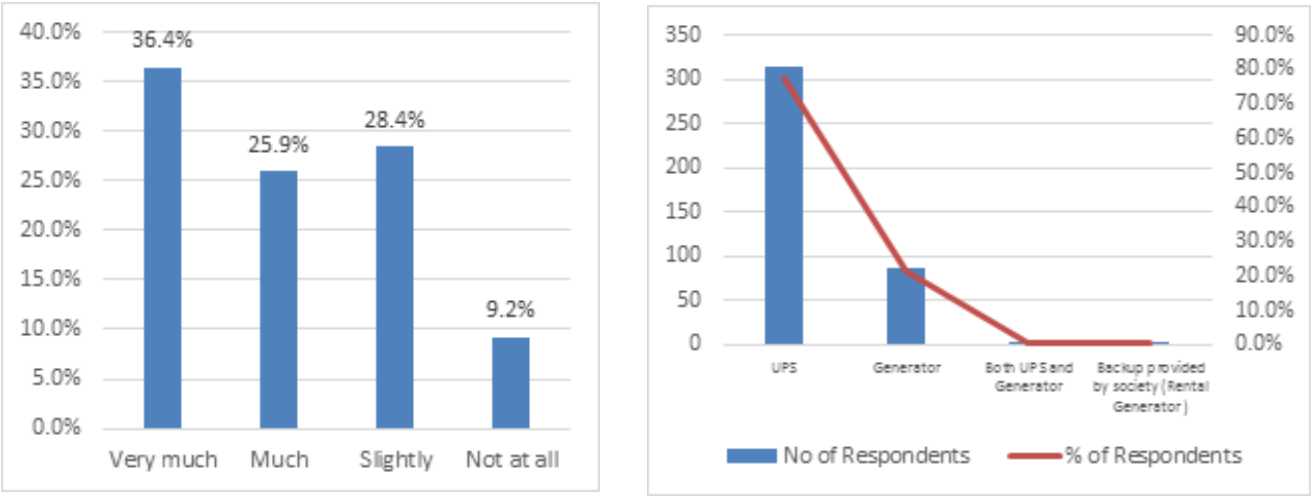
3.2- Context

This section briefly overviews degree and impacts of power blackout on end-users, type of back-up energy systems used during load-shedding hours (if any), and finally the degree of affordability in relation to conventional electricity bills.

Reliance on Back up Energy System

With frequent blackouts and load shedding as the context, vast majority of end-users in the country already rely on some kind of back-up energy systems for fulfilling their energy needs during the load-shedding hours. Against the background, 82.4% of respondents in this study indicated that they were facing load-shedding within their respective locality whereas 68.7% of respondent indicated that they had some kind of backup systems. The left graph of **Fig.3.1** shows the effect of load shedding on the surveyed respondents whereas the right graph shows the type of back-up energy system which respondents in this study indicated to be using for mitigation of load-shedding.

Fig.3.1 Effect of load shedding vis-à-vis type of backup energy system installed

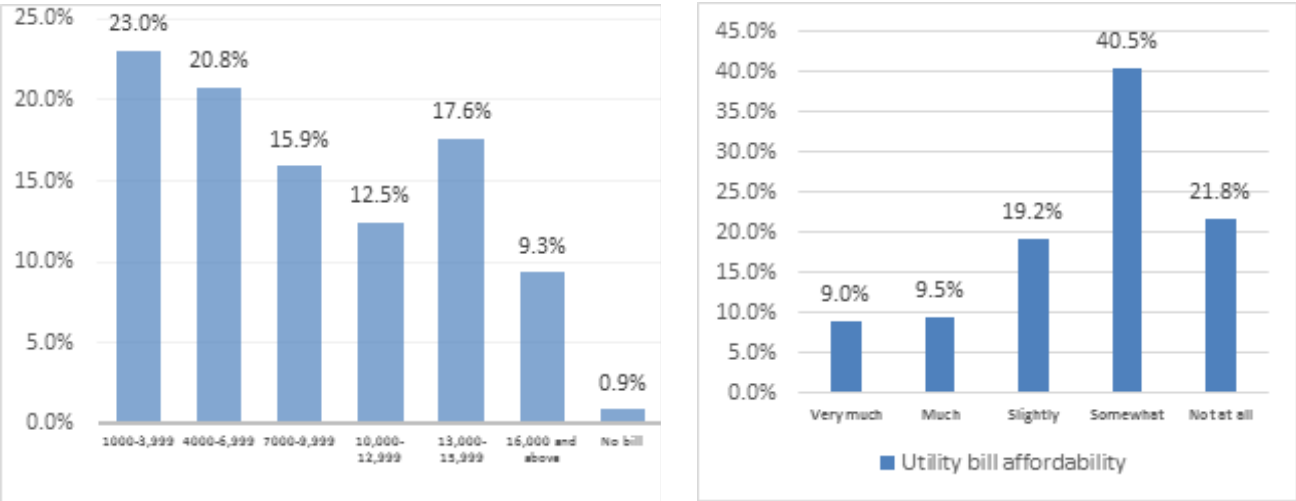


UPS was one of the most commonly identified back-up energy system used by 77.5% of the respondents followed by generators (which was used by 21.5% of the respondents). Some respondents also indicated using hybrid back-ups whereas a negligible percentage i.e. 0.5% mentioned being connected to the backup system provided by society.

Electricity Affordability

Further, since high cost of grid provided electricity is one primary motivation behind self-generation, the left graph in **Fig.3.2** showcases the average monthly electricity utility bill of respondents (PKR) of respondents whereas the right-side graph represents their views on its affordability. As could be observed, majority of the respondents indicated that their bills were slightly or somewhat affordable. Only 18.5% indicated complete satisfaction with the electricity bill affordability.

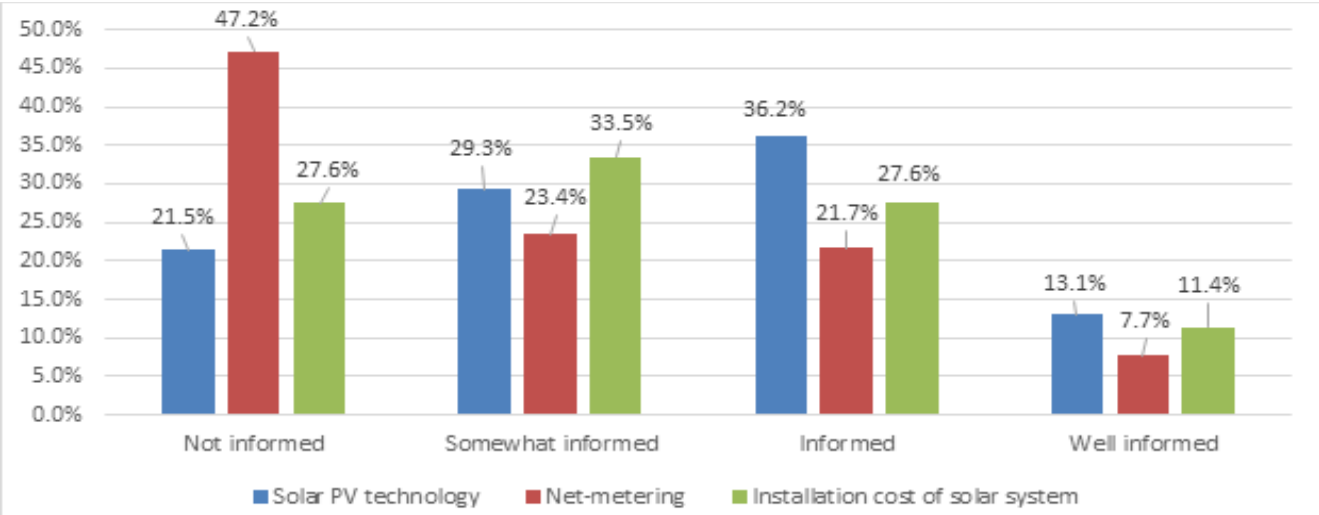
Fig.3.2 Electricity bill (in PKR) vis-à-vis affordability



3.2- Awareness and Knowledge on Solar PV technology and Related Policies

Lack of awareness on solar PV technology and available schemes could be one factor behind slow diffusion of clean energy uptake. Keeping this aspect in perspective, this study probed the degree of awareness on solar technology, its installation cost as well as net-metering regulations in Pakistan. **Fig.3.3** shows the awareness on solar technology, its installation cost and net-metering regulations. As could be observed—except for the case of net-metering where an overwhelming 47.2% indicated complete unawareness on it—overall awareness on solar PV tech and its installation cost was indicated to be quite wide-spread.

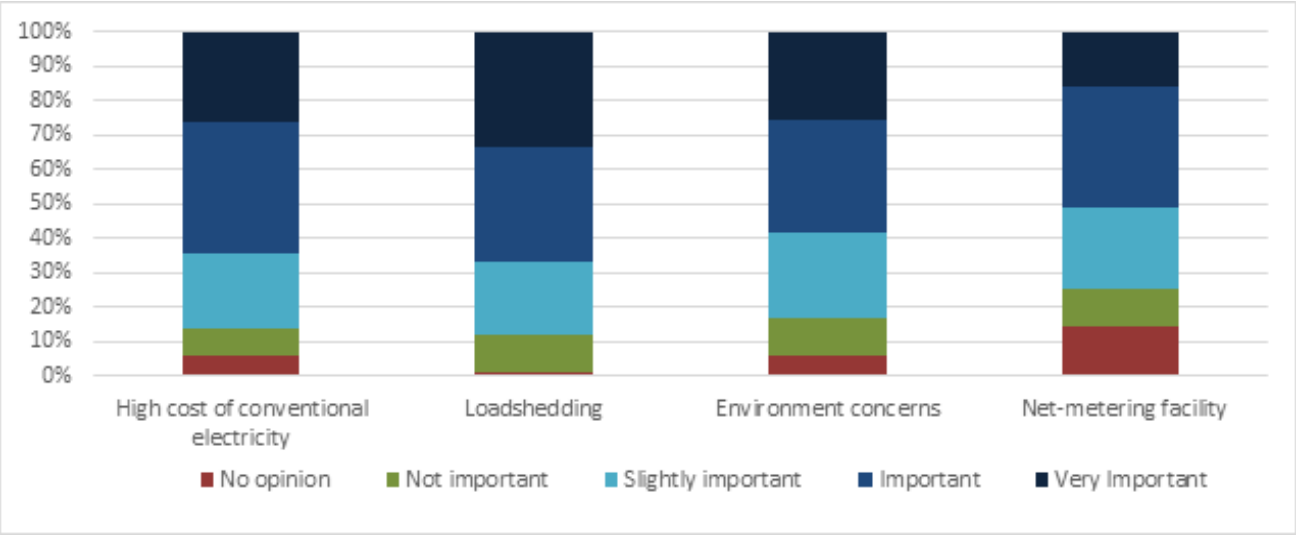
Fig. 3.3 Awareness and Know-how on solar technology, its installation cost and net-metering regulations



3.3- Motivations to Adopt Solar PV vis-a-vis-Barriers

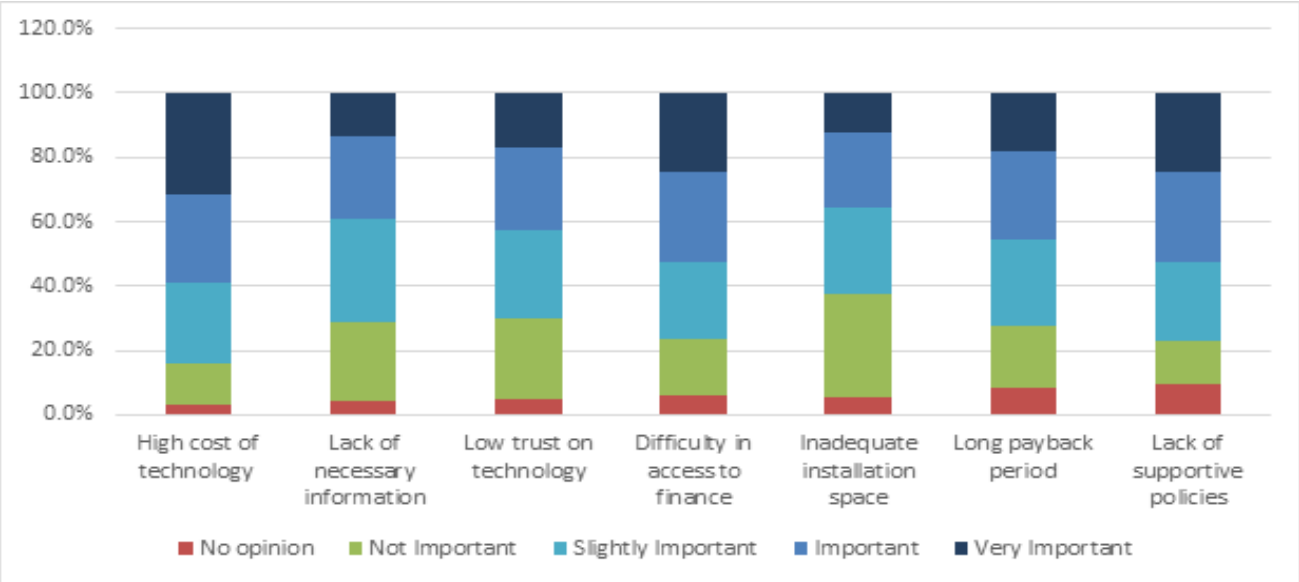
One primary objective of this study was to probe the motivation behind adoption of solar PV system among end-users and assess barriers discouraging people from its adoption. Against the context, the respondents were asked to indicate if they ever seriously considered installation of solar PV. Half of the respondents (50.2%) indicated that they did seriously consider installation of solar system. **Fig.3.4** shows the factors influencing the motivation to adopt solar PV as indicated by the overstated 50.2% of the respondents. As could be observed, high cost of conventional electricity, load shedding hours, environmental concerns and net-metering facility—all were indicated as important factors influencing the motivation to consider solar PV installation.

Fig.3.4 Factors influencing motivation to adopt solar PV



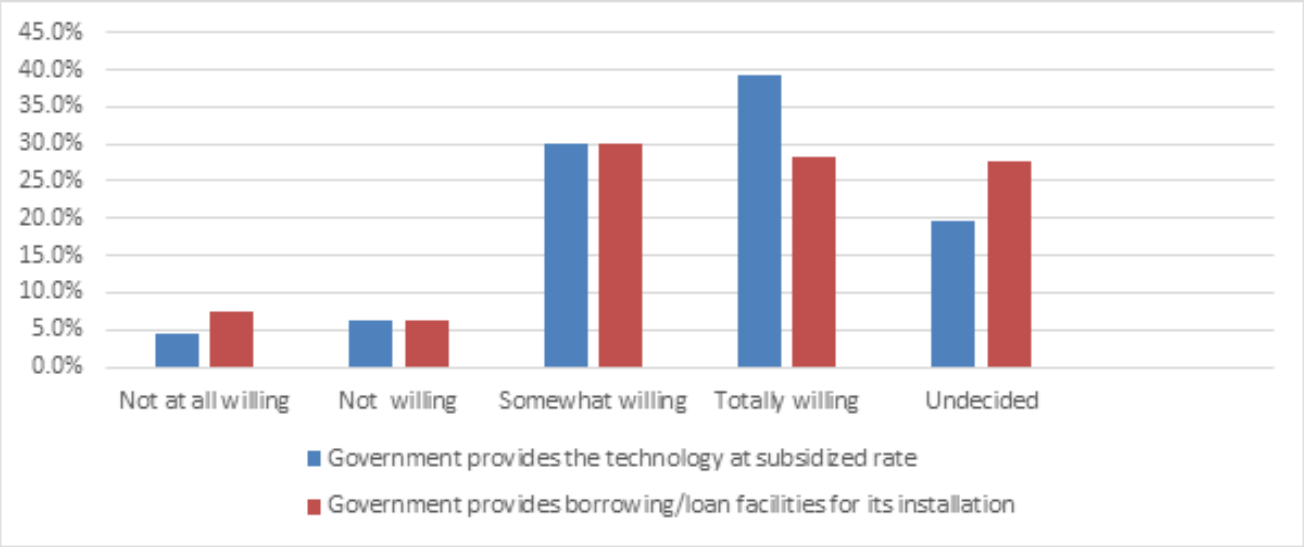
Also to probe the factors discouraging end-users from considering solar PV adoption—**Fig.3.5** identifies and assess the barriers. High cost of technology was indicated as dominant barrier followed by difficulty in access to finance, lack of supportive policies, long payback period, lack of trust on technology, lack of necessary information and finally inadequate space for installation.

Fig.3.5 Barriers discouraging solar PV adoption



Finally, to assess the willingness to install solar PV, two scenarios were built for the respondents (a) if government provides solar PV technology at subsidized rates (b) if government provides loans for installing solar PV. **Fig.3.6** illustrates the responses to the understated question where four out of ten (39.3%) of the respondents indicated that they were totally willing to install solar PV system if government provides it at subsidized rates while three out of ten (30.1%) said that they were somewhat willing to install it. An almost similar (28.4%) number of respondents indicated that they were totally willing to install solar PV if government provides loan facilities for its installation, whereas 30.1% of respondents said they will be somewhat willing to consider its installation in the understated scenario.

Fig.3.6 Willingness to install solar PV in case of subsidized provision of solar PV or access to loans



3.3- Summarized Overview

This chapter was organized to probe the questions that 'why end-users were slow or reluctant to engage in solar prosumerism as well as 'what factors discourage or encourage end users to consider adoption of solar PV system'.

Following is a brief summary of key insights:

First of all, the interrupted power supply—as is the case in many DISCOs—has already distilled a momentum toward alternate energy systems. 68.7 % of the respondents indicated that they were already relying on back up energy systems where the choice for a back-up system was mostly dominated by UPS followed by generators. Secondly, since vast majority were not satisfied with the cost of grid provided electricity—this explains the strong motivation for installing solar PV among majority end-users. This motivation is additionally driven by factors such as unreliable access to conventional energy, net-metering facility and environmental concerns.

Some common barriers discouraging PV adoption included high cost of the technology, difficulty in access to finance, lack of supportive policies, low trust in technology and lack of necessary information. Further except in the case of net-metering, overall awareness on the solar technology and its cost was quite extensive.

To conclude, diffusion of solar PV in Pakistan is mostly held back by an 'unfriendly environment' wherein in absence of supportive policies and enabling environment, people continue to rely on alternative back up energy systems which comparatively have a 'low upfront cost; and is affordable for larger section of society.

Chapter 4
DISCOs Interviews

DISCOs have an important role to play in facilitating and promoting Distributed Generation—since they are the primary intermediaries responsible for connecting end-users to the grid. Among the ten operating power DISCOs in Pakistan, 6 were interviewed in this study. The objective was to qualitatively assess the DISCOs opinions on the challenges as highlighted by prosumers vis-à-vis probe specific challenges that the DISCOs themselves were facing (if any) in relation to net metering regulations. For the study, the preliminary selection of these DISCOs was based upon their performance and progress demonstrated in terms of installed connections and power capacity. **Table.4.1** shows the 6 utilities interviewed for the study.

Table. 4.1- Comparative Analysis of DISCOs (based on MW installations)

Installed Capacity	> 10 MW	1 MW - 10 MW	Less than or equal to 1 MW
Distribution Companies	IESCO	PESCO	SEPCO
	K-Electric	MEPCO	QESCO

This interviews probed information on 2 key areas:

(a) Reflection on the challenges as highlighted by the distributed generators (based on our surveys).

(b) Nature and extent of the challenges faced by DISCOS in relation to 'Distributed Generation'.

Generic questions were asked on the 2 key dimensions. The responses were then thematically scoped—the analysis could be followed in subsequent sections:

4.1- Inter-Connection Challenges

Typical inter-connection barriers encountered in our study included absence of online portal to applicants; inadequately trained SDOs; in- availability of bi-directional meters; delays in testing of meters; overall delay in issuing of licenses; delay in accounting the net-metered units into prosumers bill.

Against these challenges, majority DISCOs maintained that they have not yet introduced online portal to the customers (except IESCO). Some of them however have designed an online portal for solar vendors—who could apply on behalf of the applicant. On Bi-directional meters, few DISCOs maintained that they encountered instances of 'bi-directional meters' shortages due to poorly planned stocks. However according to majority DISCOs, they have started keeping stock of these meters in advance now the DISCOs also seconded the fact that there are instances where the standard timeframe for inter-connection are not followed—which results in delays for issuing the licenses. These delays are either due to limitations at DISCOs end or applicant end and so its nature varies on the basis of location, remoteness, inefficiencies of staff and system. Also, since the manual application system is very slow and so a major obstacle behind delay might be rooted in this factor.

Overall the analysis revealed that inter-connection delays were rooted in following factors:

a. Lack of preparedness of DISCOS for the adoption of distributed generation.

b. Transaction cost of manual applications—which is very time consuming as well.

c. Lack of trained/specialized staff/SDOs.

d. No incentive for promoting distributed generation.

4.2- Technical Limitations/Challenges

Since distributed generation is associated with integration of the energy exported into grid—it necessitates the need for prior forecast on supply side, system-wide load changes, frequency and voltage regulations etc. Although in Pakistan the distributed generation uptake so far is negligible, yet it was important to assess if the DISCOs were encountering or anticipating to encounter any challenges in relation to its uptake.

Except for 2 DISCOs, majority claimed that they have not encountered any technical challenges in relation to distributed generation. However, most of them said that overtime with its growth, grid integration challenges could emerge as a key problem. Further, lack of specialized and technically trained staff was identified as a common limitation by most DISCOs. Almost all DISCOs emphasized the need for hosting capacity—for safe and reliable operations of distributed generation. 3 DISCOs also highlighted the risks of obsolete/unreliable technology being installed by end-users—which if unaddressed could have a consequential impact on DISCOs operations. Also KEL specifically maintained that installation of the PV equipment should follow set international standards surrounding grid integration, which solar vendors on the other hand take lightly. Ensuring these standards on their own results in additional transaction cost for the DISCO, also contributing to delay in the processing of application.

4.3- Actual/Perceived Fear of Revenue losses

Except for KEL all DISCOs expressed concerns on potential revenue losses overtime.

The following concerns were expressed in relation to revenue losses in future:

a. Loosing large no of customers in long-run.

b. Loosing bulk customers in ‘compliant region’.

c. Unaccounted expense in accommodating distributed generation uptake.

d. Capacity payments to CPPA not accounted in net-metered billing.

In parallel, majority of utilities recommended redesigning tariff structure in a way that it does not become a threat to their revenues. Overall, these perceived fears/challenges continue to be a major factor responsible for the reluctance at the end of DISCOs to promote Distributed Generation.

4.4- Summarized Overview

This section documented the actual/perceived barriers and challenges faced by DISCOs—responsible for implementing net-metering regulations and distributed generation uptake within their respective jurisdictions. According to few DISCOs, at the time net-metering regulations were issued, DISCOs

were not taken on board. The regulations were therefore imposed on them. This resulted in overall lack of preparedness by the DISCOs. Further while complying with net metering regulations, no standard guidelines were issued on how to process applications and advance the licenses. Few DISCOs also claimed that net metering is a new concept for most of their staff. So although regulations were issued in this regard, however no follow up awareness, educational or training programs were launched to train them for dealing with it prudently. On the technical side, the grid infrastructure was indicated to be mostly old and obsolete—for potentially higher shares of distributed generation. Against the context, almost all DISCOs mentioned the need for 'hosting capacity' to be set by the regulator.

Further keeping in perspective the common perceived barrier of potential revenue losses in the future, majority DISCOs recommended re-designing tariff in a way that it does not undermine their profit margin even in scenario of potential distributed generation uptake. This study also found variance in terms of technical capabilities and human resource where the good performing DISCOs (IESCO and KEL) negated presence of any technical vis-à-vis non-technical barriers/challenges compared to the low-performing DISCOs.

Finally, most DISCOs candidly expressed that in the wake of associated administrative burden of processing net-metering application when they already have 'surplus energy'—they don't feel compelled to promote or encourage distributed generation uptake. In a nutshell, 'increased transaction cost' of processing applications and the 'no-aligned incentives' dilemma for implementing the net-metering regulations—continues to be a major factors responsible for reluctance/inertia in promoting distributed generation.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

Data collected from the prosumers as well as non-prosumers, document analysis, and interactions with relevant authorities and organizations, the following picture emerges:

5.1- Synthesis of Findings

❖ Cumbersome Application Process

Overall, challenges at inter-connection phase were identified as dominant barrier to PV deployment. This included time lapse in acquiring 3 phase metering equipment at the initial stage; absence of online facility for applications, in availability of bi-directional meters, and unnecessary delay in processing of the applications at every stage. So the cumbersome procedure and unnecessary hiccups at different intervals of the application substantially collectively increases the transaction cost for applicants.

❖ Financial Barriers

A major finding of this study was installation of solar PV systems by end-users at their own expense. In parallel, heavy concentration of solar prosumage uptake was found among resourceful sections of society. One factor for this skewed concentration is 'high cost of solar PV installation' and the interlinked challenge of 'difficulty in access to borrowing' for financing the solar PV system.

Although 'SBE RE Finance Scheme' is an active scheme—providing loans to potential solar system installers on very easy terms which include low interest rate and long pay-back periods. However as per the findings of this study, two broader problem statements were identified in relation to this scheme

(a)-The scheme has so far been launched by very limited no of commercial banks. The factors behind this low diffusion among commercial banks includes : Voluntary nature of the scheme for banks; limited awareness on it transaction cost of adopting the scheme which includes designing SOPs for its implementation vis-à-vis the human resource and time investment in refinancing the loans advanced from SBP (since the entire process is manual); and finally high investment risk.[8]

(b)-Even those banks which have introduced the scheme—have designed their SOPs in a way that it makes the access of loans—once again really difficult and not readily accessible for average citizen. This includes low payback period as well as high down payment.

❖ Lack of Technical Oversight and Quality Assurance

Where on one hand solar suppliers and vendors are growing in Pakistan, in parallel weak regulatory oversight on the suppliers and the lack of standardization or quality tests has resulted in low-quality solar PV systems imports and supply. In parallel—there is no appropriate 'regulatory and accountability

[8]Since in the case of these loans the system bought itself is collateral. However as there are no secondary markets for solar system purchase, any default on behalf of applicants become a investment risk.

mechanism'—where the solar vendors/suppliers could be penalized in case of providing sub-par technology or misleading/false claims on their product. This 'obsolete technology paradigm' could overtime plague the overall solar PV uptake in the country and potentially undermine the otherwise strong willingness to adopt the technology.

❖ Institutional Inertia at DISCOs end

The Distribution companies have an important role in both driving or inhibiting PV adoption rates within their respective jurisdictions. Several important barriers at the end of DISCOs as highlighted by this study included: (a) Bumps at the inter-connection phase (b) Inadequately trained SDOs with little knowledge on net-metering (c) In-availability of bi-directional meters (poorly planned stocks) (d) Absence of Help Desk/Complaint portal for tracking the status of application or registering complaints (e) Unnecessary delays by the DISCOs in processing the application and issuing licenses to the distributed generators. This rigidity at distribution level has been particularly responsible for making the net-metering application process very complicated and cumbersome.

❖ Absence of Fee of Service Models

The prosumage trend in Pakistan is dominated by dealer models wherein the PV systems are exclusively installed and operated by the prosumers. The 'Fee of service' models as well as role of commercial actors in distributed generation uptake are practically non-existent in Pakistan in this sector.

5.2 Roadmap for Developing and Implementing Prosumer Enabling Framework

For prosumage to play a pivotal role in the power sector of Pakistan, there is a strong need to address and overcome several inter-connection, administrative, regulatory, and financing challenges. Based on the gained insights of the study findings, we propose the following roadmap:

❖ User Friendly Registration Process

A major impediment to becoming distributed generator is—getting the connection and generation license. The registration process needs an urgent overhaul. It should be simplified and made more user friendly. As a first step online application portal should be introduced at all DISCOs on urgent basis. The applicants should be able to track the progress of their application on the portal. The portal should also have a complaint window—which should be overseen by a 3rd party for unbiased handling and resolution. This oversight authority should also be responsible for ensuring timely issuance of licenses to the applicants as well as taking note of any issues arising during the entire process.

❖ Overcoming the inertia at DISCOs end

As explored by this study, a strong inertia exists at DISCOs end. Further in the context, currently the share of installed capacity under net-metering is miniscule. This inertia could therefore become more intense with the growth of prosumage. In the wake of this inertia, the prospect of potential net-metering drive could be daunting. Based on the context, there is a strong need not only to overcome the passive opposition from DISCOs but also to replace it with appropriate regulations vis-a-vis incentives alongside orientation and trainings, skewed in favor of distributed generation growth. In this regard, consultative sessions should be organized with DISCOs; their genuine concerns shall be taken into account; and finally some kind of regulations shall be put in place which prioritizes net-metering growth and accordingly compliance of all DISCOs.

❖ Low Tech Solutions for Grid Integration: Managing System Behind the Meter

Although currently the solar prosumage growth in Pakistan is still in its infancy however with increasing shares of distributed PV, management of distribution systems might get complicated. A key strategy for better system integration is what is called "blind system integration" where new standards and regulations improve visibility—helping utilities in actually knowing what is going on behind the meter. These technical innovations could also be integrated in the Pakistani self-consumption regime. 2 key initiatives in this regard shall include:

a. DISCO-Wise Net Metering Registries: In the context, in absence of digitalization of electricity and energy systems, real-time communication on DG growth and load profiles (e.g., system size, typical onsite load patterns, typical (or actual) generation patterns, etc.) could help in more streamlined and stabilized integration. This could be done by creation and meaningful utilization of regional and national registries on DG installations.

b. Binding Regulations for Smart Inverters: Modern inverters and other technological solutions can provide ancillary services to stabilize the distribution grid (voltage control). These regulations should also be set in national or regional grid codes by utilities or grid operators.

❖ Capacity Building and Training Programs

One key barrier identified in this survey was 'inadequately trained SDOs' –contributing to inter-connection challenges. Lack of appropriate trainings and capacity building at DISCOs is a major factor behind this barrier. Although AEDB has organized some trainings in the past for DISCOs, however many DISCOs indicated that they still require adequate human resource and capacity building for efficiently dealing with net-metering. In this regard, regular training programs organized after defined intervals—could to a greater extent help in resolving the capacity building and staff know-how constraints in respective DISCOs.

❖ Easy Access to Rooftop Solar Loans

Pakistan is a country where strong synergies reinforces prosumage. The unreliable energy supply as well as recent hike in energy prices has already distilled a large scale momentum toward alternate energy systems. As per an estimate, $ 2.3 billion per annum alone is spent on alternative lighting products by Pakistani households.[9] However diffusion of solar PV in Pakistan is mostly held back by absence of supportive financial policies, people continue to rely on alternative back up energy systems which comparatively have a 'low upfront cost; and is affordable for larger section of society. This study advocates strong regulations that leverage diffusion of 'SBP Financing Scheme for Renewable Energy' across the commercial banks; and resolves the difficulties in accessing the finance by designing common man-friendly procedures.

❖ Provisions for Private Sector Engagement in On-Site Generation

The **Fee of Service Models**—such as third party investors—are entirely non-existent in the case of Pakistan. This might be rooted in several key barriers such as low access to debt finance, high installation cost of technology and specific regulations gap. It is important to note here that existing rate design/ remuneration scheme under net-metering regulations with system caps (wherein consumers are not allowed to install Solar PV system sizes greater than 1.5 times of their sanctioned load) mostly complement

[9]Pakistan Off-Grid Lighting Consumer Perceptions Study 2015, (IFC) World Bank Group.

self-generation i.e. generating energy to meet one's own needs by off-setting grid consumption. In the context, a different tariff design need to be introduced for large-scale investors—which in the case of most countries is Feed in Tariff. The export rate for this new tariff design could be either pegged to the retail tariff rate or below the retail tariff—to equally incentivize DISCOs and accommodate for grid use charges. A dual tariff regime under net-metering regulation i.e. retaining the existing net billing scheme for prosumers while designing a new tariff arrangement for investors selling all electricity to be exported to the grid—would on its own drive rooftop solar developers in the country. So a combination of designed tariffs scheme will simultaneously promote prosumage as well as advance private sector engagement in on-site generation and overtime introduction of Fee of Service models. This study therefore recommends framing of regulations and focused interventions for facilitating private sector engagement in rooftop solar.

❖ Regulatory Oversight on Solar Vendors

AEDB has made remarkable progress in accrediting certified solar vendors wherein as of currently their number has grown to 125. However, the study finds that users continue to have strong reservations on the malpractices by solar vendors; quality of technology; poor enforceability of guarantees; as well as absence of an appropriate platform where technology related complaints could be lodged and the vendors could be held accountable.

In conjunction with these findings, a robust monitoring system should be designed that enables users to easily lodge complaints against vendors as well as penalizes any fraudulent malpractices operational in the market.

❖ Strong Political Will

Finally, and most importantly, a strong political will and state-level enthusiasm favoring distributed generation could help in tapping the enormous potential that solar prosumage offers for advancing renewable energy in the country vis-à-vis addressing challenges surrounding an affordable, reliable and sustainable energy supply. This could be done through:

- Setting explicit targets for distributed generation in the overall renewable energy goals.
- Public awareness campaigns on net-metering regulations and related financial schemes.
- Annual growth reports on DISCO-wise distributed generation growth.
- Regulations for solar PV system installations in public buildings as well as newly planned housing and commercial projects.

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Annexure

Prosumer-Survey Questionnaire

A- <u>Sociodemographic Information</u>

Name: _____

Contact/Email _____

1. I identify my gender as
   - ☐ Male
   - ☐ Female
   - ☐ Other
2. I fall under the following DISCO
   - ☐ IESCO
   - ☐ LESCO
   - ☐ KEL
   - ☐ GEPCO
   - ☐ MEPCO
   - ☐ FESCO
   - ☐ PEPCO
   - ☐ SEPCO
   - ☐ HESCO
   - ☐ QESCO
   - ☐ TESCO
3. I live in (Please indicate the name of the place)

   _____
4. I fall under the following age bracket
   - ☐ 25-34
   - ☐ 35-44
   - ☐ 45-54
   - ☐ 55-64
   - ☐ 65 or above

5. I have completed the following highest level of education

   ☐ Not formal qualification

   ☐ Primary education

   ☐ Secondary/Higher secondary education

   ☐ Undergraduate degree

   ☐ Postgraduate degree

6. I am

   ☐ Student ☐ Employed

   ☐ Self-employed ☐ Unemployed

   ☐ Retired

7. My income falls in the following range

   ☐ Less than 30,000

   ☐ 30,000-59,999

   ☐ 60,000-89,999

   ☐ 90,000-119,999

   ☐ 120,000-149,999

   ☐ 150,000 or above

8. I describe my current income as

   ☐ Finding it very difficult to live on current income

   ☐ Finding it difficult to live on current income

   ☐ Coping on current income

   ☐ Living comfortably on current income

   ☐ Living very comfortably on current income

9. I own the building where I have installed the solar system

   ☐ Yes

   ☐ No

   ☐ Other

10. I have installed the solar system with following arrangement

   ☐ Full Payment Installation

   ☐ Monthly Payment Installation

   ☐ Other

11. This solar system falls under following category type

☐ Full Payment Installation

☐ Monthly Payment Installation

☐ Other

B- Solar technology/Net-Metering Information

12. How did you know about Solar technology?

☐ Internet/social media

☐ TV/Radio/Newspaper

☐ Through a friend/colleague2018

☐ Through technology installation by someone in locality

☐ Personal know-how

☐ Other

13. What is the size of your system in KW?

_____

14. Is this solar system attached to a battery?

☐ Yes ☐ No

☐ Other _____

15. Roughly, how much did your solar system cost (in PKR)?

_____

16. Roughly, how much were the grid connection charges (in PKR)?

☐ No charges

☐ Less than 10,000

☐ 10,000-19,999

☐ 20,000-29,999

☐ 30,000-39,999

☐ 40,000-50,000

Other:_____

17. How did you finance the installation of solar system?

☐ Had the money

☐ Borrowed the money from a bank (formal loan)

☐ Borrowed the money from family or a personal connection (informal loan)

Other:_____

18. (a) Have you used any public support to get your solar system?

☐ Yes

☐ No

(b) If yes, please specify _____

C- Drivers and Barriers

19. **How important were the following factors in influencing your decision to self-generate/ install your own solar system?** where **1** means Not important, **2** means Slightly important, **3** means Important, **4** means Very Important.

	Not important		*Very Important*		
Load-Shedding		*1*	*2*	*3*	*4*
High cost of conventional/Grid-provided energy		*1*	*2*	*3*	*4*
Environment conciousness	*1*	*2*	*3*	*4*	
Incentive of profit making	*1*	*2*	*3*	*4*	
Energy Independence	*1*	*2*	*3*	*4*	

Other (Cite according to importance) _____

20. (a)-Did you try to access loan from bank for installation of your solar system?

☐ Yes

☐ No

(b)-If yes, did you face any challenges while trying to access loan from the bank?

_____

_____

21. Roughly, how much time did the DISCO take for providing you the net-metering facility (in no of days)?

☐ 30-60

☐ 61-90

☐ 91-120

☐ 121-150

☐ 151-180

Other: _____

22. (a)Did you face any challenges while accessing net-metering facility?

☐ Yes

☐ No

(b)-If yes, please specify the nature of these challenges?

_____

_____

23. At what price do you sell back electricity to the grid?

☐ Off-Peak rate

☐ Other

24. Are you happy with the remuneration scheme under 'Net-Metering Arrangement'? How much time did the DISCO take for providing you the net-metering facility?

☐ Yes

☐ No

☐ Other _____

25. Now that you are generating your own energy, how much are you saving on your utility electricity bill (compared to before)?

☐ 1%-20%

☐ 21%-40%

☐ 41%-60%

☐ 61%-80%

☐ 81% or above

26. Are there any other economic benefits of self-generation. If yes, please specify?

_____

_____

27. (a) On a scale of 1-5, please rate your satisfaction with the technological performance of your solar system?

○	○	○	○	○
Very Unsatisfied	Unsatisfied	Neutral	Satisfied	Very Satisfied

(b)- If you are not satisfied with the technological performance of your solar system, please indicate why?

_____

_____

28. Based on your experience, to what extent following challenges discourage people from becoming a distributed generator/prosumer? Where **1** means: *Very much*, **2** means *Much*, **3** means *Somewhat*,

4 means *Slightly*, **5** means *Not at all*.

High cost of technology		1	2	3	4	5
Financial borrowing barriers	1	2	3	4	5	
Difficult/Cumbersome process of availing net-metering		1	2	3	4	5
Non-cooperation by DISCOs while providing net-metering facility	1	2	3	4	5	
Lack of trust in technology	1	2	3	4	5	
Solar energy meets my energy needs	1	2	3	4	5	

29. Are you aware of any 'Fee of Service' solar delivery companies in Pakistan? If yes, please specify ***(Fee of Service are concession models where some private company install and maintain the solar PV system for consumers and take monthly fee from consumers for providing the service)**.generation?

_____

_____

30. What recommendations would you give to the government for addressing challenges surrounding distributed generation/prosumerism in Pakistan?

_____

_____

Non-Prosumer Survey Questionnaire

A- Sociodemographic Information

1. I identify my gender as

   ☐ Male

   ☐ Female

   ☐ Other_____

2. I fall under the following DISCO

   ☐ IESCO ☐ LESCO

   ☐ KEL ☐ GEPCO

   ☐ MEPCO ☐ FESCO

   ☐ PEPCO ☐ SEPCO

   ☐ HESCO ☐ QESCO

   ☐ TESCO

3. I live in (Please indicate the name of the place)

   _____

4. Please indicate the age bracket you are in

   ☐ 25-34

   ☐ 35-44

   ☐ 45-54

   ☐ 55-64

   ☐ 65 or above

5. I have the following (highest) level of education

   ☐ Not formal qualification

   ☐ Primary education

   ☐ Secondary/Higher secondary education

   ☐ Undergraduate degree

   ☐ Postgraduate degree

6. I am

   ☐ Student ☐ Employed

   ☐ Self-employed ☐ Unemployed

   ☐ Retired

7. My household income fall in the following bracket

☐ 10000-30,000

☐ 30,001-60,000

☐ 60,001-90,000

☐ 90,001-120,000

☐ 120,001-150,000

☐ 150,000 or above

8. I describe my current income as

☐ Finding it very difficult to live on current income

☐ Finding it difficult to live on current income

☐ Coping on current income

☐ Living comfortably on current income

☐ Living very comfortably on current income

9. I identify myself in the following category

☐ Household

☐ Commercial

☐ Industrial

☐ Agriculture

B. **Background Information**

10. Is this accommodation (where you live) your own or rented?

☐ Own

☐ Rented

☐ Other _____

11. (a)Does your locality experience load-shedding hours?

☐ Yes

☐ No

(b) If yes, please indicate to what extent does it affect you

☐ Very much

☐ Much

☐ Somewhat

☐ Slightly

☐ Not at all

12. (a)Apart from grid-provided/conventional energy, are you relying on any other alternate/back up energy system for meeting your energy needs?

☐ Yes

☐ No

Other: _____

(b) If yes, please indicate the type of alternate/back-up energy system?

☐ UPS

☐ Generator

Other: _____

13. What is your average monthly electricity utility bill (in PKR)?

☐ 1000-3000 ☐ 3001-6000

☐ 6001-9000 ☐ 9001-12,000

Other: _____

14. Do you consider the monthly electric utility bill affordable?

☐ Very much

☐ Much

☐ Somewhat

☐ Slightly

☐ Not at all

C. Awareness

15. Please indicate the level of your awareness on the following, where 1 means not informed and 5 mean well informed?

	Not informed			Well informed	
Solar PV System Technology	1	2	3	4	5
Net-Metering Facility	1	2	3	4	5
Cost of Solar System	1	2	3	4	5

Before we proceed to the next section, we would like to give you some background information on Solar PV system and net-metering facility. Solar PV is a system composed of one or more solar panels that use energy from the sun to generate electricity. It allows adopters to produce and use their own electricity. The technology could either be installed on your rooftop or some other physical landscape (ideally positioned in a way so as to catch maximum sun rays). Whereas net-metering facility connects this solar system to the conventional grid. So at all times when your system is producing more than you consume, the excess electricity is added into the grid. The units against the amount of energy you add –is then adjusted in the electricity bill.

D. Drivers and Barriers

16. Have you ever seriously considered installation of Solar system? (if no, skip to question 17)

☐ Yes

☐ No

Other: _____

17. **Rate the following factors according to *how important are they in encouraging you to install solar technology,* where 1 means the factor is not important at all and 5 means the factor is very important.**

	Not important				*Very Important*
High cost of conventional energy	1	2	3	4	5
Load shedding hours/interrupted supply of conventional	1	2	3	4	5
Environmental concerns	1	2	3	4	5
Issuance of net-metering facility	1	2	3	4	5
Incentive of profit-making	1	2	3	4	5

Other (Cite according to importance) _____

_____

18. **Rate the following factors according to *how important they are in discouraging you to install solar technology,* where 1 means the factor is not important at all and 5 means the factor is very important.**

	Not important				*Very Important*
High installation cost of solar technology	1	2	3	4	5
Lack of necessary knowledge/information	1	2	3	4	5
Lack of trust on technology	1	2	3	4	5
Lack of finance/borrowing opportunities	1	2	3	4	5
Lack of supportive policies	1	2	3	4	5
Lacking/Inadequate installation space	1	2	3	4	5
Long payback period/investment risks	1	2	3	4	5
Limited access to solar technology	1	2	3	4	5

Other (Cite according to importance) _____

_____

19. (a) Are you aware about government's policy/schemes related to solar technology installation?

☐ Yes

☐ No

☐ Don't know

(b) If yes, how effective, in your opinion, is Pakistan Government's effort in promoting solar

technology?

☐ Very much

☐ Much

☐ Somewhat

☐ Slightly

☐ Not at all

20. a) Are you aware about government's policy/schemes related to net-metering facility?

☐ Yes

☐ No

(b) If yes, how effective, in your opinion, is net-metering scheme in its existing form?

☐ Very much

☐ Much

☐ Somewhat

☐ Slightly

☐ Not at all

21. How willing would you be to invest in solar technology if government provides the technology at subsidized rate?

☐ Not at all willing

☐ Not really willing

☐ Undecided

☐ Somewhat willing

☐ Totally willing

(b) If answered ***not at all willing*** or ***not really willing***, why is this?

_____

_____

_____

22. How willing would you be to invest in solar technology if government provides borrowing/loan facilities for its installation?

☐ Not at all willing

☐ Not really willing

☐ Undecided

☐ Somewhat willing

☐ Totally willing

(b)- If answered ***not at all willing*** or ***not really willing***, why is this?

_____

_____

_____

DISCOs Level Analysis: Questionnaire

1- What are the most pressing challenges/greatest obstacles surrounding distributed generation posed to your utility? How do you believe these challenges could be overcome?

2- What is the remuneration scheme of net-metering? What are your opinions on the economic efficiency of this scheme/rate design?

3- How much staff (no of people and positions) at your relevant DISCO is responsible for carrying out net-metering connections?

4- Has your staff received training programs for advancing net-metering connections?

5- Do they have enough capacity and knowledge for complying with net-metering regulations? If not, what are the gaps and how could it be plugged.

6- In response to the continuous growth in distributed generation, do you have the capacity to accommodate it? If not, what are the technological/capacity needs of your utility.

7- Do you have standard time frame for processing net-metering applications or does it vary from case to case? In the case of former please indicate the time frame, in the case of latter please explain why?

8- Do you have pending net-metering requests? If yes, what is the major factor behind these pending requests?

9- Some distributed generators have been complaining that they have to arrange bi-directional meters on their own while connecting their systems to the grid. What is your take/opinion on it?

10- Has distributed generation been affecting your revenues? If yes, please indicate to what extent.

11- Last year (in June) NEPRA issued regulations on digitalizing net-metering applications and providing one-window facility to customers. In this regard what is the progress at your respective DISCO? What are the barriers facing digitalization of these applications?

12- How much units of energy have been rolled back (exported to the grid) from the net metering prosumers as recorded by you in time interval of one year in your utility? This data shall be required to assess efficiency of net metering yield.

13- What major technical issues have your utility faced in relation to grid integration of Net Metered PV system?

14- Please state the nature of power system disturbances caused by grid integration of net metered system (might include Frequency Distortion, Harmonics Distortion, Islanding and False tripping problems and Voltage Dips/Rise and Fluctuations/Transients). Kindly provide us with the number of events for the respective system disturbances occurred within your utility.

15- Additional feedback for support/assistance required by DISCOs from relevant public authorities with reference to net-metering/distributed generation.

*** Please note this is a semi-structured questionnaire. The underlying objective is to understand the nature and extent of challenges faced by DISCOs in relation to distributed generation. Besides the stated question, you can provide us any information—overlooked in the questions—for a comprehensive understanding on the stated challenges.**