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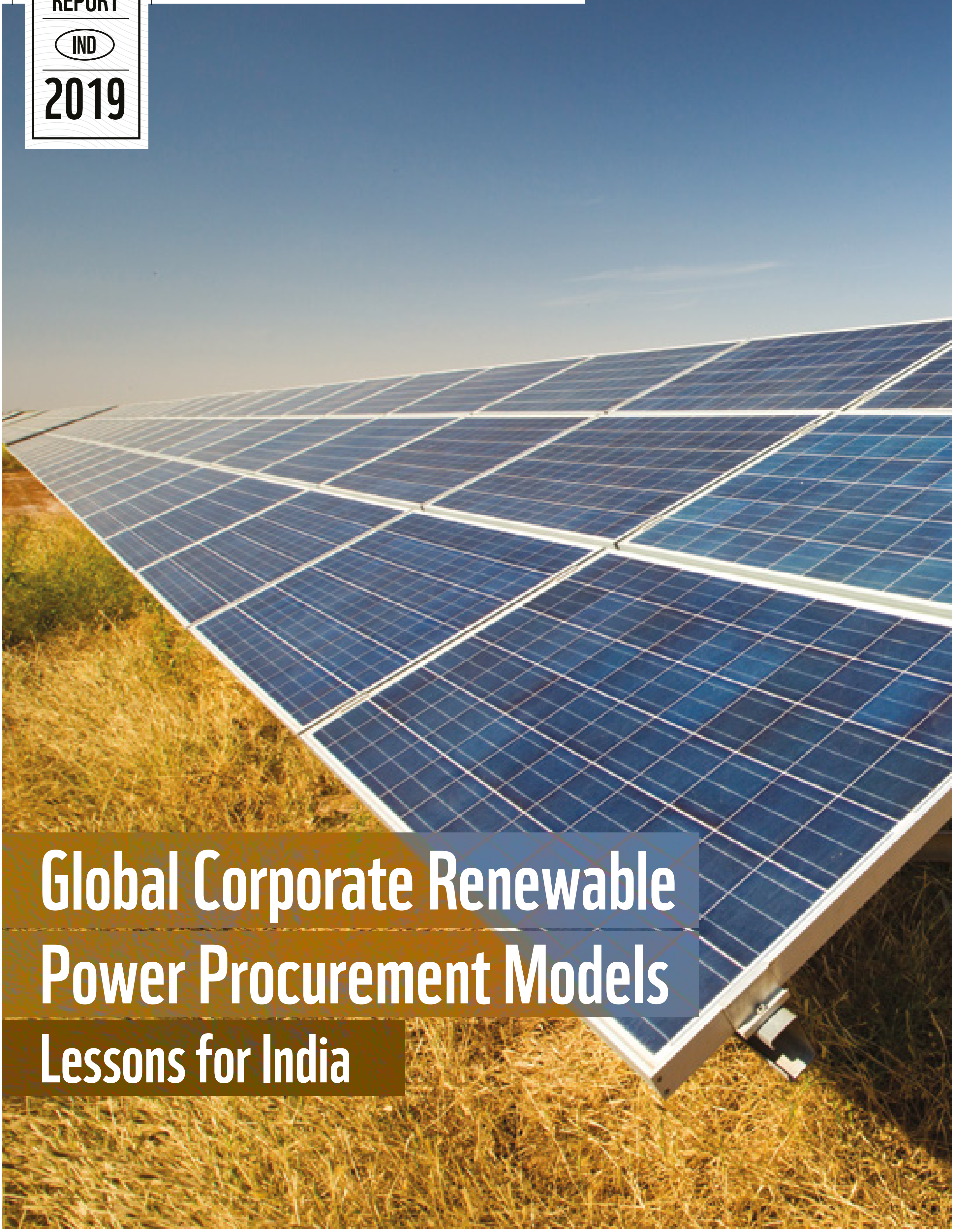

Global Corporate Renewable Power Procurement Models

Lessons for India

CREDITS

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Contents

Acronyms

AS	Additional surcharge
APERC	Andhra Pradesh Electricity Regulatory Commission
APPC	Average power purchase cost
BNEF	Bloomberg New Energy Finance
CAPEX	Capital expenditure
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
C&I	Commercial and industrial
CAGR	Compounded annual growth rate
CSS	Cross subsidy surcharge
DERC	Delhi Electricity Regulatory Commission
DBT	Direct benefit transfer
EA 2003	Electricity Act 2003
FIT	Feed-in-tariff
FY	Financial year
GW	Giga-Watt
GO	Guarantee of origin
HT	High tension
IEX	Indian Energy Exchange Limited
INR	Indian Rupee
I-REC	International REC
IRENA	International Renewable Energy Agency
KERC	Karnataka Electricity Regulatory Commission
kV	kilo-Volt
kW	kilo-Watt
kWh	kilo-Watt hour
LDC	Load despatch centre
LT	Low tension
MERC	Maharashtra Electricity Regulatory Commission
MSEDCL	Maharashtra State Electricity Distribution Company Limited
MW	Megawatt

MWh	**Mega-watt hour**
MWp	**Megawatt peak**
MNRE	**Ministry of New and Renewable Energy**
MOP	**Ministry of Power**
NASDAQ	**National Association of Securities Dealers Automated Quotations**
NLDC	**National load despatch centre**
NREL	**National Renewable Energy Laboratory**
OA	**Open access**
OPEX	**Operating expenses**
P2P	**Peer to peer**
PXIL	**Power Exchange of India Limited**
PPA	**Power purchase agreements**
RLDC	**Regional load despatch centre**
REC	**Renewable energy certificate**
REDE	**Renewable energy demand enhancement**
RPS	**Renewable portfolio standard**
RPO	**Renewable purchase obligation**
RBI	**Reserve Bank of India**
RMI	**Rocky Mountain institute**
SEBI	**Securities And Exchange Board Of India**
SLDC	**State load despatch centres**
TNERC	**Tamil Nadu Electricity Regulatory Commission**
TWh	**Tera Watt hour**
TIGR	**Tradable instruments for global renewables**
TRANSCO	**Transmission company**
UAE	**United Arab Emirates**
UK	**United Kingdom**
USA	**United States of America**
USD	**US Dollar**
UPERC	**Uttar Pradesh Electricity Regulatory Commission**
VPPA	**Virtual power purchase agreement**
WRI	**World Resources Institute**
WWF	**World Wide Fund for Nature**

Preface

Commercial and industrial (C&I) consumers worldwide are increasingly looking to procure renewable power for various financial, environmental, regulatory and strategic reasons. In India, popular routes include direct power purchase agreements (PPAs) with renewable power producers, captive generation and rooftop solar installations. There is an additional option for consumers to purchase Renewable Energy Certificates (RECs). However, each of these options faces critical challenges. Overall, the supply is not able to cater to the growing demand because of a number of operational and policy constraints.

The objective of this report is to review the progress made in renewable power procurement by C&I consumers in India and explore alternative options for faster adoption of renewable power. Virtual power purchase agreements (VPPAs), green tariffs, internationally tradable RECs (I-RECs), dedicated renewable power exchanges and peer-to-peer (P2P) trading have emerged as attractive alternative procurement options internationally. However, some of these options are yet to be tested in India for their relevance and efficacy.

The first part of this report examines current market framework for renewable power procurement in India and various challenges faced by the consumers, as well as power producers. The second part reviews alternative options and variants that are growing in other countries. The report examines each of these options, reviews their suitability for India and makes preliminary suggestions for their introduction, based on further stakeholder consultations.

We have focused mainly on market precedents in the USA, UK and Australia due to maturity of these markets, strong regulation, as well as growing consumer demand. The study methodology relies on a mix of primary and secondary research. We have held interviews with multiple stakeholders including power consumers, project developers, traders, regulators, financial institutions, service providers and other experts active in the area of C&I renewable power procurement, including specialists at WWF's international offices.

Executive Summary

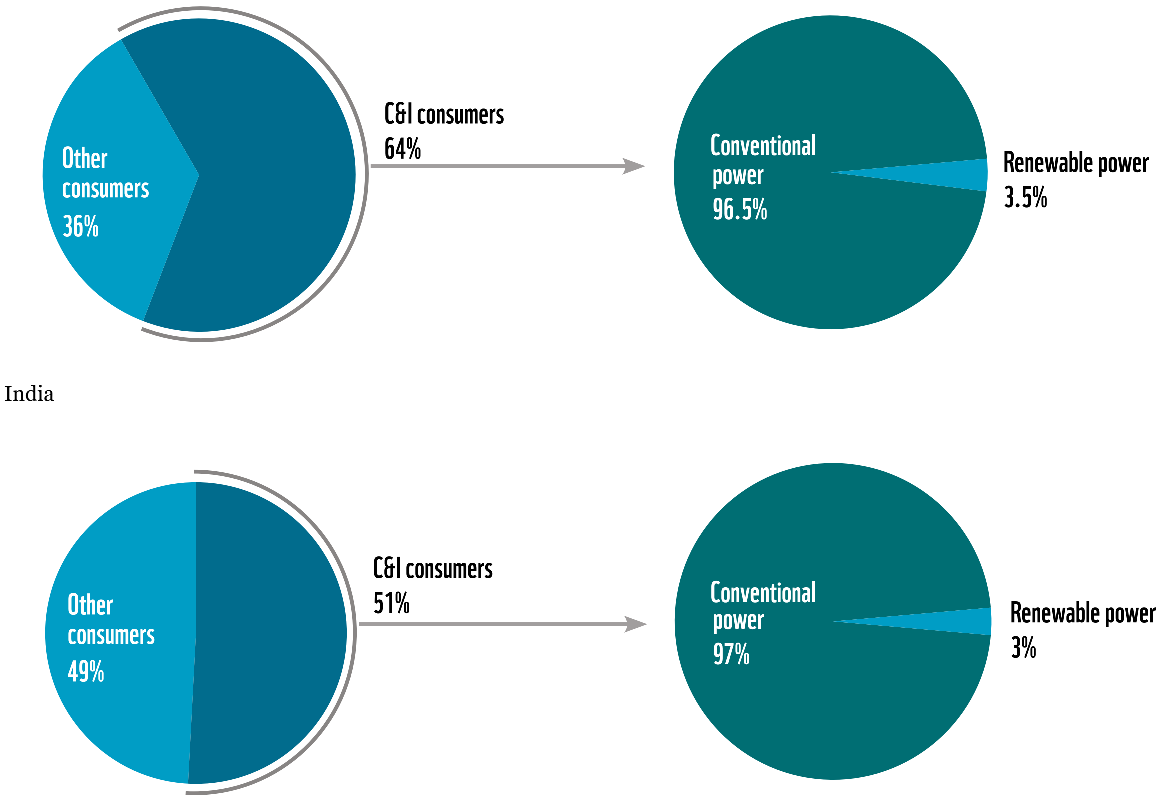
Commercial and industrial (C&I) consumers account for 64 per cent of total electricity consumption worldwide, but only 3.5 per cent[1] of total renewable power consumption[2]. In India, the respective C&I numbers are 51 per cent[3] and 3 percent for FY 2018[4]. As part of a stronger Climate Action Plan, India has committed to increase renewable power capacity target from 175 GW in 2022 to 450 GW by 2030. Greater adoption of clean energy by C&I consumers is critical for meeting these national renewable energy and climate change commitments.

Bulk of the C&I power requirement in India is met by coal-fired captive power (27 per cent) and 'brown' power supplied by electricity distribution companies (DISCOMs) (63 per cent, an estimated 90:10 mix of conventional power and renewable power). Captive coal-fired capacity in the country is estimated at 52,933 MW.[5] Combined share of renewable power in their consumption mix is estimated at only 10.5 per cent.

With renewable power costs falling rapidly, C&I consumers have a very strong financial incentive to switch to clean energy. They can not only make attractive savings of around 30-60 per cent on grid power, but also reduce carbon emissions and comply with Renewable Purchase Obligations

Fig. 1. C&I power consumption share

International scenario



Sources: BRIDGE TO INDIA research; 19th Electric power survey, CEA; Ministry of Statistics & Program Implementation, Energy Statistics, 2019

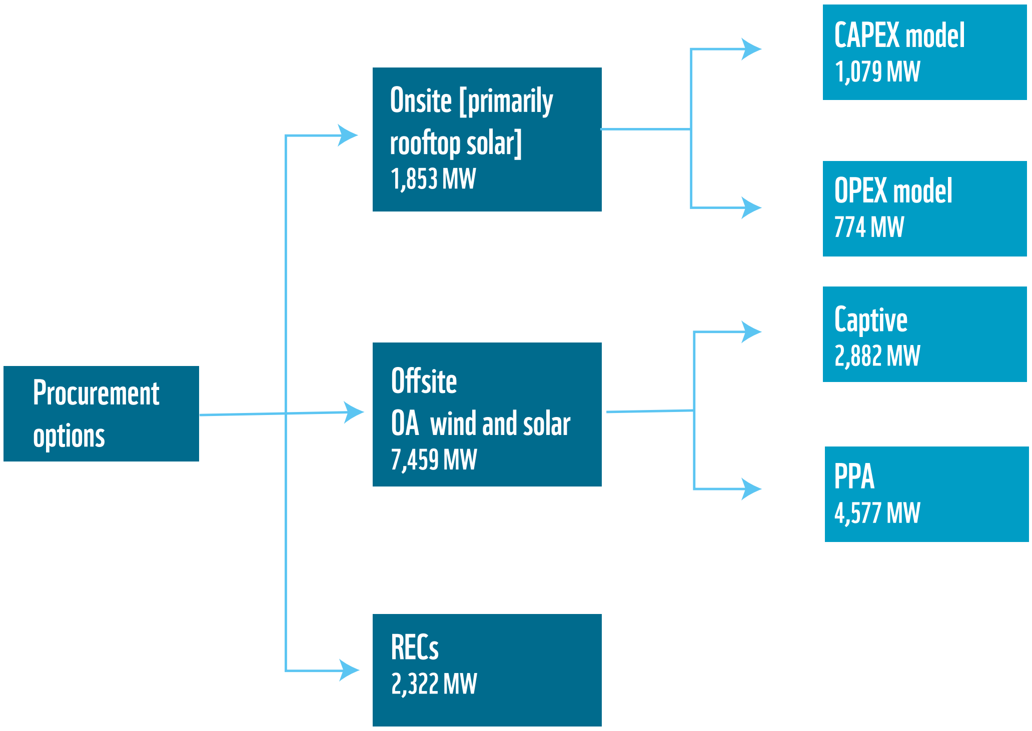
1 Excludes blended renewable and conventional power supply by electricity utilities
2 Corporate sourcing of renewables: Market and industry trends, IRENA, 2018
3 Energy Statistics 2019, Ministry of Statistics and Programme Implementation, India
4 Excludes combined supply of renewable and conventional power by DISCOMs
5 BRIDGE TO INDIA research; Central Electricity Authority (CEA) executive summary, September 2019 (grid interactive captive power for industries having demand of 1 MW and above as on 31 March 2018)

(RPOs)[6], where applicable. Many corporates have announced voluntary targets for carbon mitigation and/ or increasing consumption of renewable power with some of them signing up for initiatives, such as RE 100[7] (commitment to 100 per cent renewable electricity by 2050) and Renewable Energy Demand Enhancement (REDE)[8,9], to increase uptake of renewable energy and to catalyse solutions to address challenges that are significantly restricting demand.

Currently, the avenues available to C&I consumers to procure renewable power are limited to rooftop solar installations, open access solar and wind power, and RECs. However, even these options are not freely available because of various policy and market constraints.

With the growing C&I renewable power market worldwide, many new alternative procurement options have opened up. Virtual power purchase agreements (VPPAs), green tariffs, internationally tradable RECs (I-RECs) have already been successfully tried and tested in many countries. There are also proposals to set up dedicated renewable power exchanges and facilitate peer-to-peer (P2P) trading. An examination of these options shows that there are various advantages and disadvantages for each option, making it suitable for specific consumer categories or segments. A high-level comparison of the various options is presented below, with more details in the later sections of the report.

Fig. 2: Renewable power procurement options for C&I consumers in India



Sources: BRIDGE TO INDIA research, Indian Energy Exchange, Power Exchange of India

Notes:

i) Rooftop solar installation data is as of 31 March 2019.

ii) Open access market size data is as on 30 September 2019.

iii) RECs equivalent to 2,322 MW renewable power capacity are estimated to have been sold to C&I consumers in FY 2019.

6 In 2015, the Supreme Court upheld the validity of the Rajasthan Electricity Regulatory Commission's (RERC's) regulations on RPO compliance and payment of surcharge in case of non-compliance by captive generation plants and other obligated entities (Hindustan Zinc Ltd versus RERC).
7 Led by The Climate Group and CDP
8 Renewable energy demand in India, corporate buyers' perspective, WWF India, 2019
9 Led by WWF

Fig. 3. Comparison of alternative C&I procurement options

Option	Growth potential	Cost of power	Regulatory and policy effort required	Ideal consumer profile
Green tariffs	High	Increase in cost	Not required	Small and medium consumers
VPPAs	Medium	No change	Not required	Large consumers
I-RECs	Medium	Significant decrease	Not required	Medium and large consumers
Dedicated renewable power exchange	Medium	Moderate decrease	Required	Large consumers
P2P trading	Low	Significant decrease	Major amendments required	Small and medium consumers

Salient points about each of these options are noted below:

In the **green tariff model**, C&I consumers procure renewable power from DISCOMs, who, in turn, contract to purchase renewable power from generators. Green tariffs can be implemented within the existing regulatory and policy framework with no additional infrastructure requirement. This option is very simple and suitable for small and medium consumers. Its main advantage is that it allows DISCOMs to retain their C&I consumers and hence, faces least resistance from them.

VPPA, also known as Contract for Difference, is a derivative contract wherein a consumer agrees to buy a specified power output from a project developer, at a fixed price (strike price) for a fixed duration. Both the parties trade electricity on the exchange, at the prevailing market price. RECs are transferred from the developer to the consumer to avail the benefit of green energy consumption, as part of the contract. VPPAs allow both power consumers and producers to hedge long-term power price. The other main advantage is greater renewable power adoption in areas with poor renewable resource or land availability. There is no policy or regulatory intervention required, as long as VPPAs are structured as bilateral contracts and not traded on any exchange.

Dedicated renewable power exchange can be used to trade renewable power, as compared to electricity and RECs being traded separately on the exchange. It can enhance market transparency and liquidity. Creation of intra-day and day-ahead renewable power markets would also help power producers in meeting their Deviation and Settlement Mechanism (DSM) obligations and DISCOMs and Load Despatch Centres (LDCs) in grid balancing.

I-RECs are internationally tradeable RECs that can be purchased by consumers to meet their voluntary renewable power consumption targets or compliance standards imposed by international clients at a relatively lower cost than RECs.

P2P trading is an emerging concept where blockchain enabled online platforms bring together power producers and consumers to trade renewable power. It could be an efficient model for trading small amounts of rooftop solar power between local consumers and rooftop system owners.

Our preliminary findings indicate that some of these options - green tariffs, VPPAs and I-RECs (for compliance of voluntary renewable power targets) are relatively easier to implement compared to the other options. However, deeper consultation is required between policy makers, regulatory authorities, DISCOMs, generators and consumers to further examine these options. A collaborative effort to undertake pilot programmes and consumer awareness initiatives can build market confidence and momentum in the drive to increase renewable power consumption by C&I consumers.

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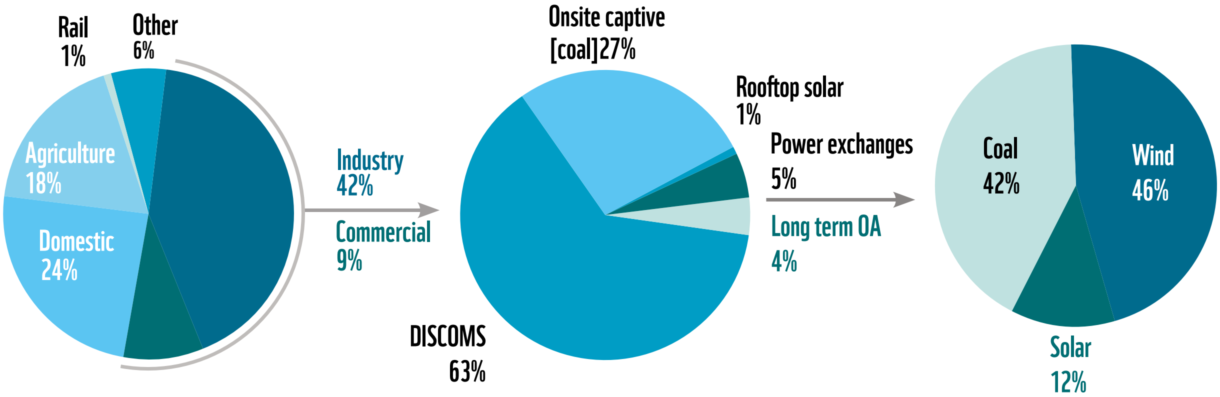
Chapter 1: Indian Market Scenario

Fig. 4: Power procurement by C&I consumers in India (2017-18)



Sources: BRIDGE TO INDIA research; 19th Electric power survey, CEA; Ministry of Statistics & Program Implementation, Energy Statistics, 2019

C&I consumers account for 51 per cent of the total electricity consumption in India, which is equivalent to 1,130 TWh per annum[10]. Their power demand is met principally by grid power (63 per cent) and onsite captive generation (27 per cent, mostly coal fired). Only 4 per cent is met by long-term open access (OA) sources. Share of direct RE procurement including rooftop solar is estimated at only 3.2 per cent.

With renewable power now becoming the cheapest new source of power, C&I consumers have a very strong financial incentive to switch to clean energy. They can hope to save around 30-60 per cent on grid power in most cases. In addition to financial benefits, C&I consumers benefit from reducing their carbon emissions and meeting their Renewable Purchase Obligations (RPOs)[11], where applicable. As a result, there is growing demand for renewable power by C&I consumers. Some consumers have even announced voluntary targets for carbon mitigation and/or increasing consumption of renewable power[12], such as Science Based Targets, RE100, REDE.

1.1 Renewable power procurement options

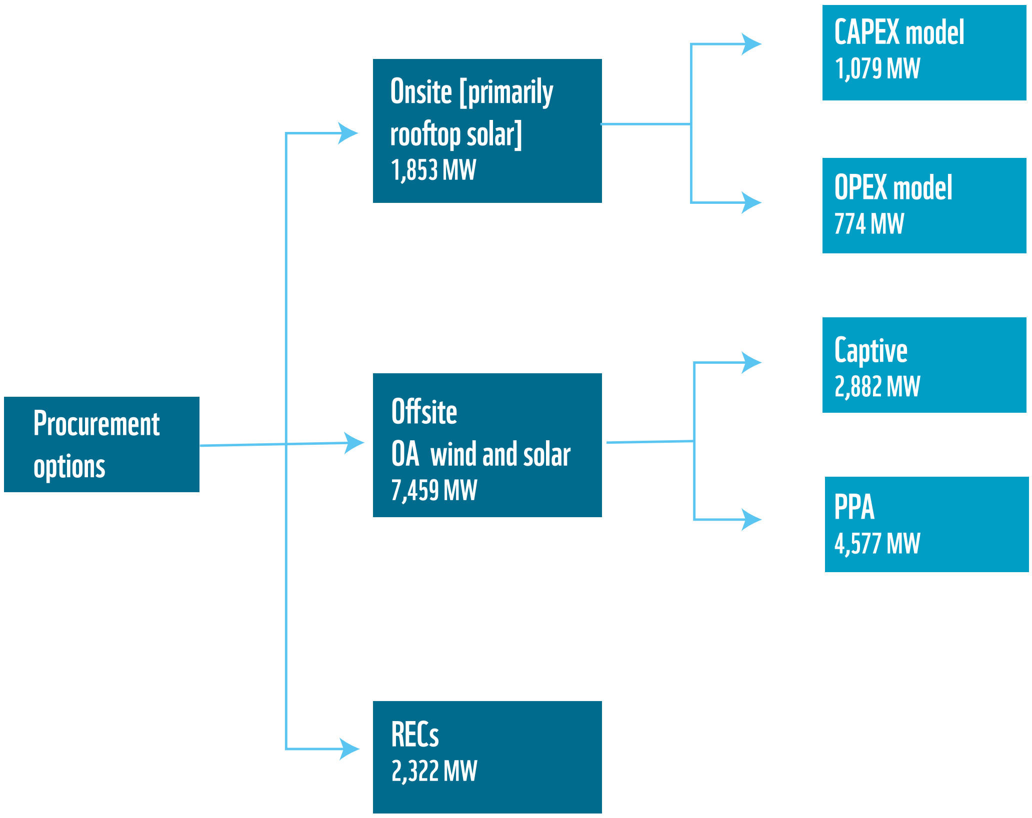
There are three principal options for C&I consumers to procure renewable power in India. Offsite generation under captive or PPA model accounts for the largest share of the market.

Rooftop solar

Rooftop solar adoption by C&I consumers has grown at a CAGR of 77 per cent in the last five years. Most states introduced attractive net-metering and/or gross-metering based grid connection policies over the last five years, but some of these policies are gradually being overturned. Falling cost and a vibrant marketplace with several thousands of system integrators, offering a wide range of installation and investment solutions, has enabled rapid growth of rooftop solar.

10 Ministry of Statistics & Program Implementation, Energy Statistics, 2019
11 In 2015, the Supreme Court upheld the validity of the Rajasthan Electricity Regulatory Commission's (RERC's) regulations on RPO compliance and payment of surcharge in case of non-compliance by captive generation plants and other obligated entities (Hindustan Zinc Ltd versus RERC).
12 Renewable energy demand in India, corporate buyers' perspective, WWF India, 2019

Fig. 5: Renewable power procurement options for C&I consumers in India



Sources: BRIDGE TO INDIA research, Indian Energy Exchange, Power Exchange of India

Notes:

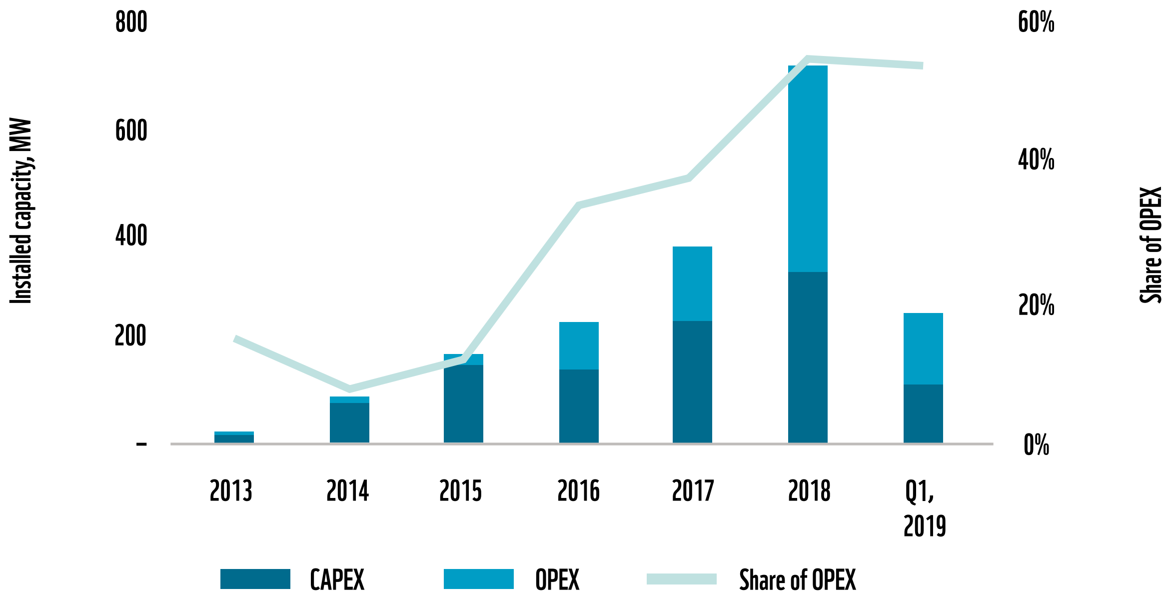
i) Rooftop solar installation data is as of 31 March 2019.

ii) Open access market size data is as on 30 September 2019.

iii) RECs equivalent to 2,322 MW renewable power capacity are estimated to have been sold to C&I consumers in FY 2019.

However, most large consumers face major constraints in adopting rooftop solar. Typically, they can meet only 5-10 per cent of their total power requirement from rooftop solar, because of physical space constraints. Also, state grid connection policies usually specify several caps on rooftop solar system size – ranging from absolute caps (typically, 500-1,000 kW) to a fixed percentage (80-100 per cent) of the consumer's sanctioned load and/or about 15-60 per cent of the local distribution transformer capacity. For example, the Maharashtra Electricity Regulatory Commission's regulations for net metering (2015) specify that the system size may not exceed the lower of 1 MWp, 100 per cent of sanctioned load and 40 per cent of local distribution transformer capacity. C&I consumers must therefore rely on other sources for further procurement of renewable power.

Fig. 6. Installed capacity of C&I rooftop solar, MW



Source: BRIDGE TO INDIA research

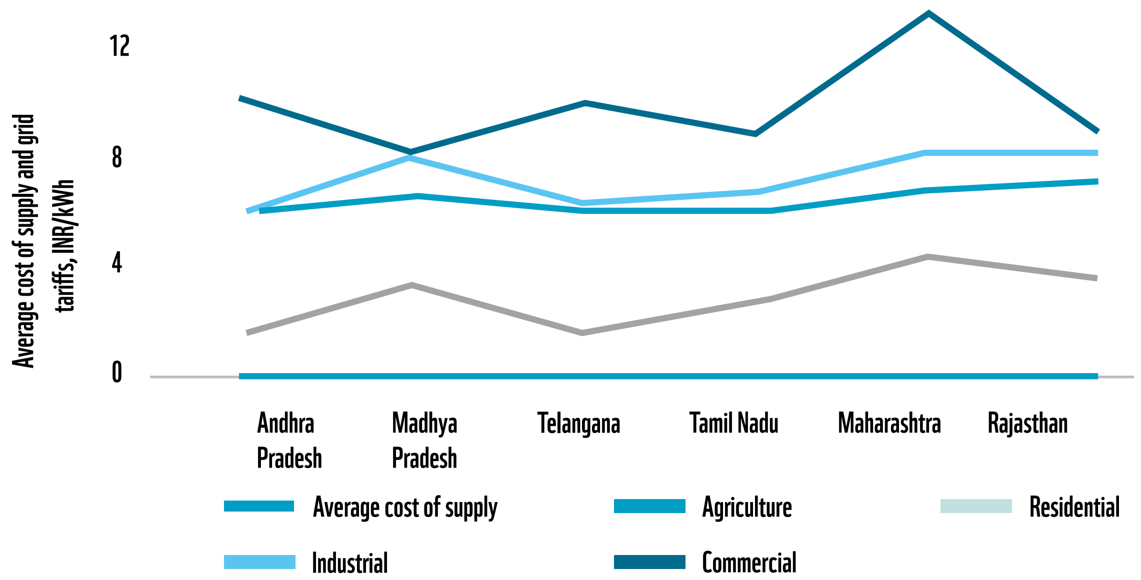
DISCOMs price C&I power at a premium in order to subsidise cheap supply to agricultural and residential consumers. They are, therefore, reluctant for C&I consumers to switch to alternate power sources.

As in many other countries, the states are beginning to pull back from free net metering. Abrupt policy reversals are severely affecting financial viability of rooftop solar installations:

1. In January 2019, Uttar Pradesh cancelled net metering for C&I and other institutional consumers. Surplus power generation is now compensated at INR 2.00/ kWh, instead of the prevailing average power purchase cost (APPC) rate of INR 3.73/ kWh. A switch to gross metering has reduced financial savings[13] under net metering to a weighted average tariff for solar auctions of 5 MW+ system size in the previous financial year, plus an incentive of 25 per cent.
2. Maharashtra's largest DISCOM, Maharashtra State Electricity Distribution Company Limited (MSEDCL), has recently petitioned the state regulator to replace net metering with gross metering.
3. In Tamil Nadu, net metering has been replaced with net feed-in tariff determined by the state regulator as the lower of: (i) 75 per cent of pooled cost of power purchase, (ii) 75 per cent of the last feed in tariff determined by the regulator, and (iii) 75 per cent of tariff discovered in the latest round of competitive bidding for utility scale solar projects. This works out to be substantially lower than the grid tariff payable for 90 per cent of power exported by the C&I consumer, as per the 2012 solar policy of the state. While C&I consumers with high tension electricity connections were included under the policy of 2012, they have been excluded from the net feed-in facility in the policy of 2019.

13 Average billing rates considered vary from INR 6.23/ kWh - INR 12.89/ kWh for industrial consumers as per the UPERC tariff order for FY 2020. Commercial consumers paid INR 10.76/ kWh – 18.61/ kWh on average. (p 415

Fig. 7. Average cost of supply and grid tariffs for consumers, INR/ kWh



Sources: Tariff orders of state electricity regulatory commissions, 2018-2020

Notes:

i) Residential tariffs are for consumers with a monthly consumption of up to 50-100 kWh.

ii) Agricultural tariffs shown are for unmetered connections.

iii) Industrial and commercial tariffs shown are for 33 kV and LT connections respectively.

There are other policy roadblocks holding up faster growth of rooftop solar. For example, Maharashtra does not allow net metering and open access to be availed simultaneously, while Gujarat allows net metering only for rooftop solar plants owned by consumers.

These developments have cast huge uncertainty on growth prospects of rooftop solar.

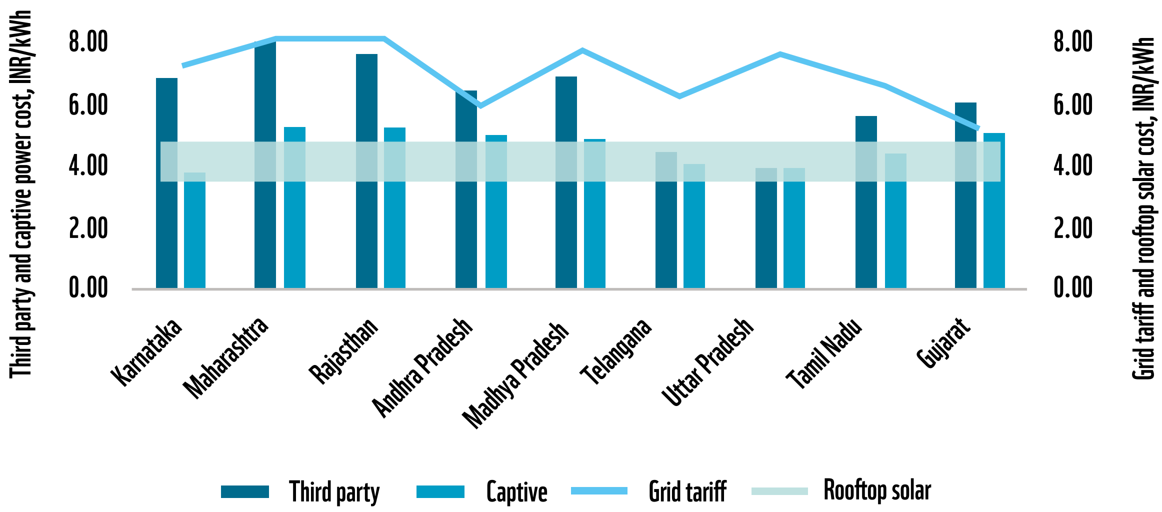
OA wind and solar

OA renewable power does not suffer from any of the system size or physical space constraints faced by rooftop solar. It allows large consumers to procure renewable power in larger amounts. OA is allowed to all bulk consumers under the provisions of the Electricity Act, 2003. Power producers or consumers can apply for short-, medium- or long-term OA to the respective Load Dispatch Centre (LDC). Available grid capacity is allocated on a first come, first serve basis. Electricity is injected and drawn from the grid as per a schedule submitted to the LDC.

Another factor facilitating growth of OA renewable power is the attractive saving potential over grid tariff. Many states provide OA cost and surcharge waivers including exemption from cross subsidy surcharge (CSS), additional surcharge (AS), transmission and wheeling costs, resulting in potential 30-40 per cent savings for OA solar power.

PPA route is the most popular OA option as most C&I consumers prefer to source power from experienced renewable power developers. Development of large projects requires specific expertise in land acquisition, grid connectivity, financing, construction and risk management. However, most transactions are structured as 'captive' projects under the Electricity

Fig. 8: Landed cost of OA solar power vs grid tariffs for industrial consumers in select states (INR/ kWh)



Sources: BRIDGE TO INDIA research, tariff orders of respective states

Notes:

i) This analysis has been conducted for industrial consumers connected at 33 KV for FY 2020.

ii) Cost of OA power is considered as 3.75 INR/kWh at the point of generation. OA charges considered include CSS, AS, transmission charges and losses, wheeling charges and losses, and banking charges.

iii) Grid tariff includes variable energy charge and fuel surcharge. It does not include fixed (demand) charges.

iv) Cost of rooftop solar power is considered as 3.75 – 4.50 INR/ kWh.

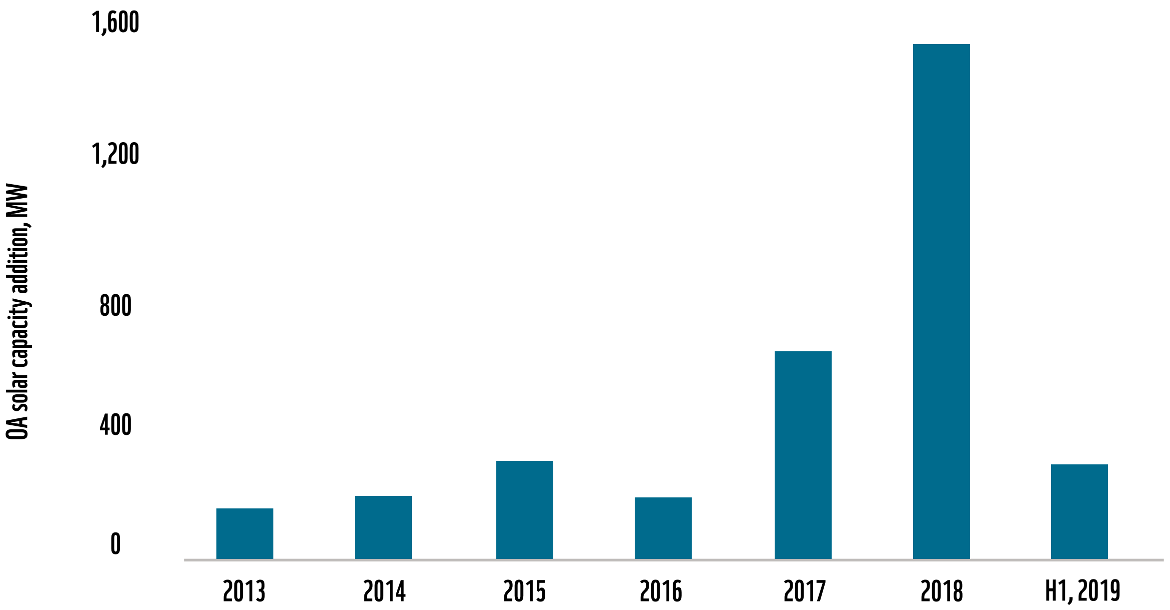
Act 2003, which allows consumers to avail attractive benefits, including easier project clearances and exemption from CSS and, in certain states, AS. In turn, the DISCOMs and state regulators have been tightening interpretation of 'captive' policy norms, leading to re-imposition of exempted charges making this a low cost, but a high-risk model.

As in the case of rooftop solar, there is fierce backlash from DISCOMs and state governments against open access renewable power, creating similar uncertainty in this market. OA cost exemptions have been gradually withdrawn by many states including Karnataka, Andhra Pradesh, Madhya Pradesh and Maharashtra. In addition, many states simply deny grid connectivity approvals or frustrate project developers through arbitrary implementation issues.

Consequently, OA solar capacity, which had grown rapidly in 2017 and 2018 (with 1,545 MW added in 2018 alone) slowed down sharply with only 283 MW of new capacity added in H1-2019.

OA renewable power also faces several implementation challenges varying from state to state. For instance, in Andhra Pradesh, monthly settlement of accounts between power producer, consumer and the DISCOM or TRANSCO is often delayed and can take up to 6-12 months. In Madhya Pradesh, electricity duty is being charged on third party PPAs at 9 per cent of the applicable grid tariff and fuel cost adjustment, even though it is exempted for ten years in the state policy. Power producers are paid only INR 1.00/ kWh instead of APPC of INR 2.83/ kWh as compensation for unused banked power. In Telangana, the state regulator has clarified that the CSS exemption, as per the solar

Fig. 9. OA solar capacity addition in India, MW



Source: BRIDGE TO INDIA research

power policy, can be provided only if the state government reimburses DISCOMs for loss of revenue. This has created uncertainty as DISCOMs can levy CSS anytime until a specific clarification is issued annually by the state government for reimbursement.

Further, inter-state scheduling of renewable power is generally not allowed in India. This makes it impossible to set up generation in solar or wind resource rich states and transmit power to other states. Transmission capacity constraints and resistance from DISCOMs and State Load Despatch Centres (SLDCs) has created significant uncertainty in this market.

Renewable Energy Certificates

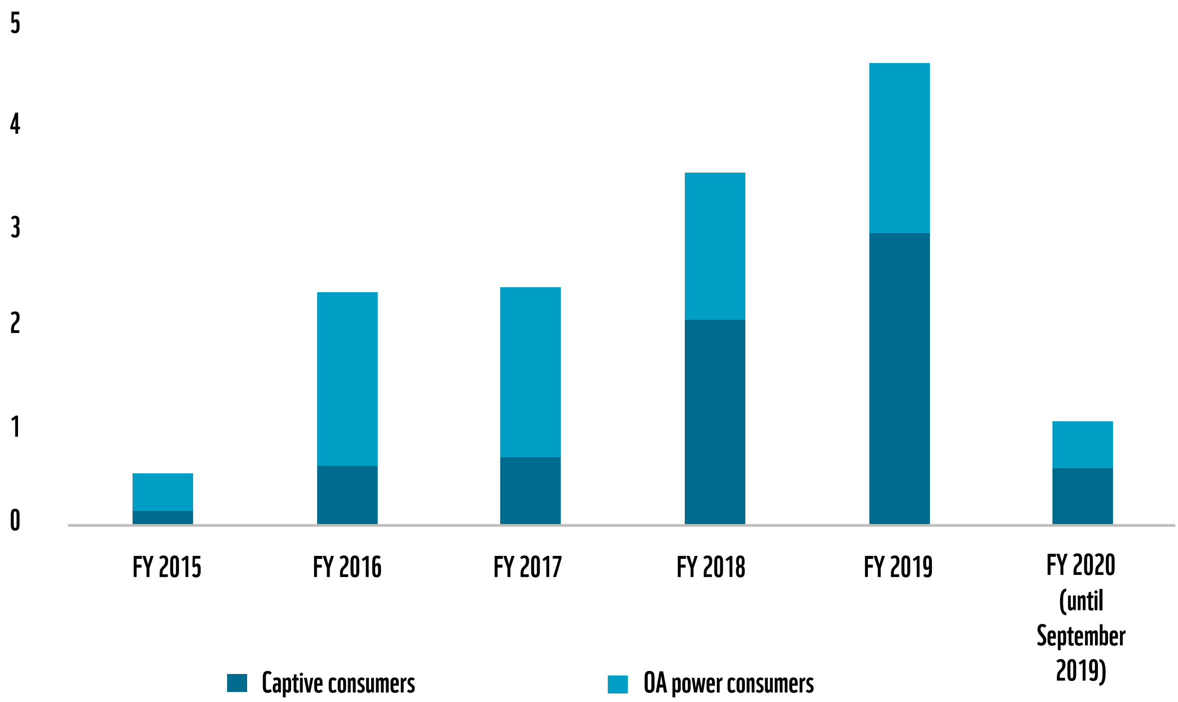
Purchase of RECs[14] by C&I consumers increased steadily until FY 2019, when solar and non-solar RECs equivalent to 2,322 MW were sold. However, REC trading volumes have declined considerably this year due to limited supply. Many projects, registered under the REC mechanism, have been compelled to switch to OA due to considerable delays and/ or reduction in payments from DISCOMs.

REC prices have risen sharply, nearly doubling this year, in response to shrinking supply. Consequently, consumers are shying away from this option as it is cheaper to procure renewable power rather than a combination of 'brown' power and RECs (effective cost of INR 1.00-2.00/ kWh).

Outlook for REC route remains negative because of limited supply concerns. RECs are, therefore, likely to play a marginal role in renewable power procurement by C&I consumers.

14 Accreditation and registration of generation capacity is done by a state agency and the National Load Despatch Centre respectively. Quantum of energy injected is certified by the SLDC. RECs are issued by NLDC and traded on the exchange. Each REC acquired by a consumer or utility is then extinguished to ensure no-double counting takes place.

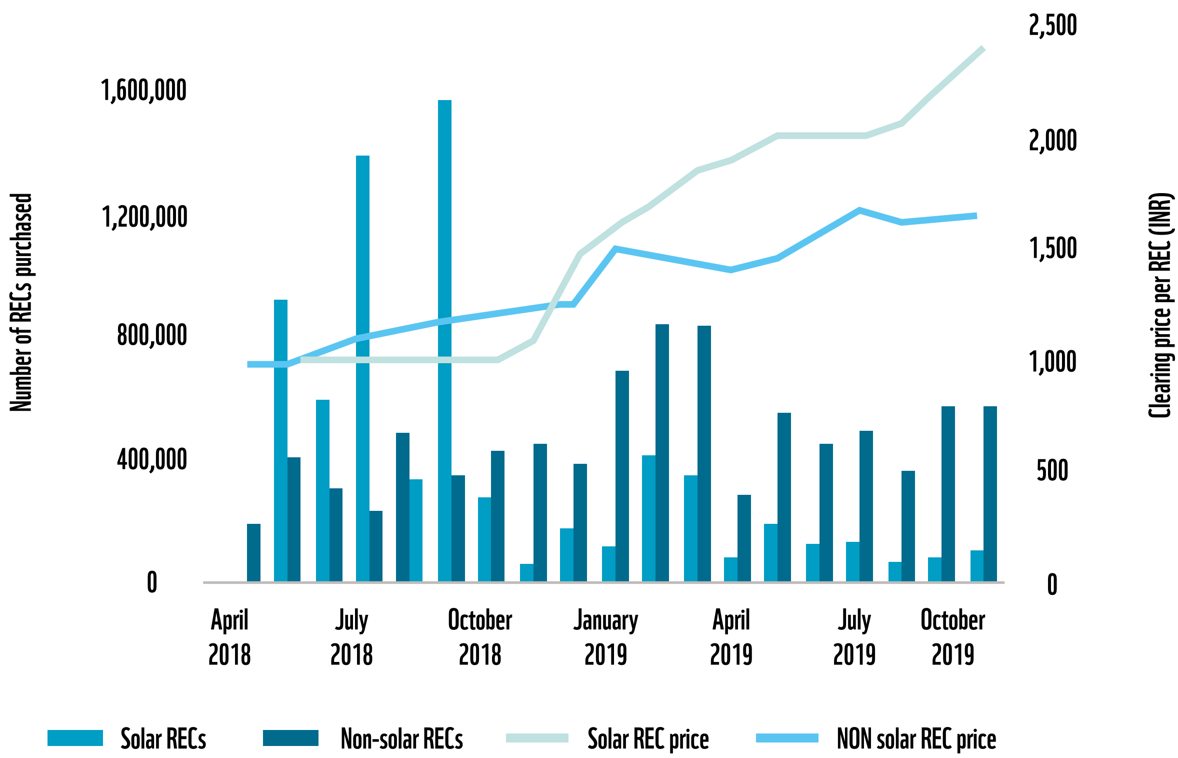
Fig. 10: REC purchases by C&I consumers (in millions)



Source: Indian Energy Exchange (IEX)

Note: Each REC represents 1 MWh of renewable power.

Fig. 11: REC trading volume and price history

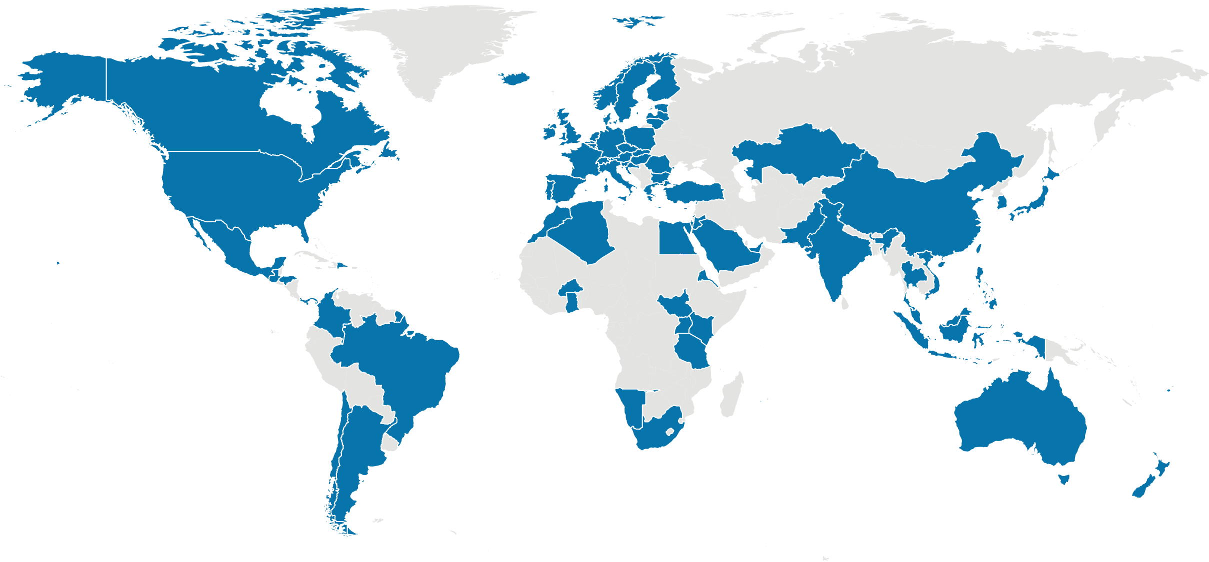


Source: Indian Energy Exchange, Power Exchange of India

Note: Average of IEX and PXIL prices have been considered.

Chapter 2: International Market

Fig. 12: Countries with active procurement of renewable power by C&I consumers



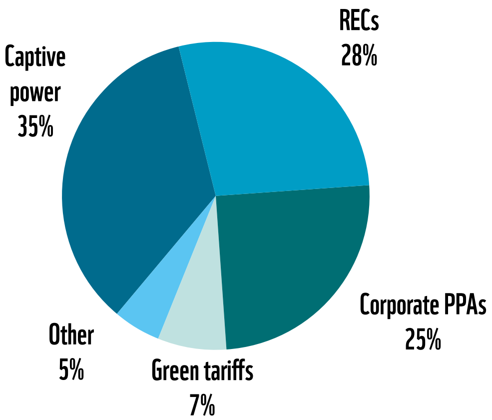
Source: Corporate sourcing of renewables: Market and industry trends, IRENA, 2018

Renewable power procurement by C&I consumers has gained popularity in many countries.

In 2017, C&I consumers actively sourced 465 Terawatt-hours (TWh) of renewable power equivalent to 3.5 per cent of their power consumption worldwide[15], mostly from captive power plants, RECs and corporate PPAs.

In the USA, corporate PPAs accounted for 13 per cent and VPPAs, a relatively new option, accounted for 43 per cent of total corporate offsite solar power procurement up to 2017.

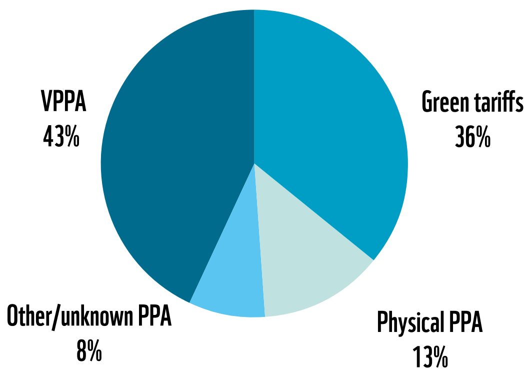
Fig. 13: Renewable power procurement by C&I consumers worldwide in 2017, TWh



Source: Corporate sourcing of renewables: Market and industry trends, IRENA, 2018

Note: 'Others' include VPPAs and internationally traded RECs

Fig. 14: Corporate offsite solar power procurement in the USA up to 2017, MW



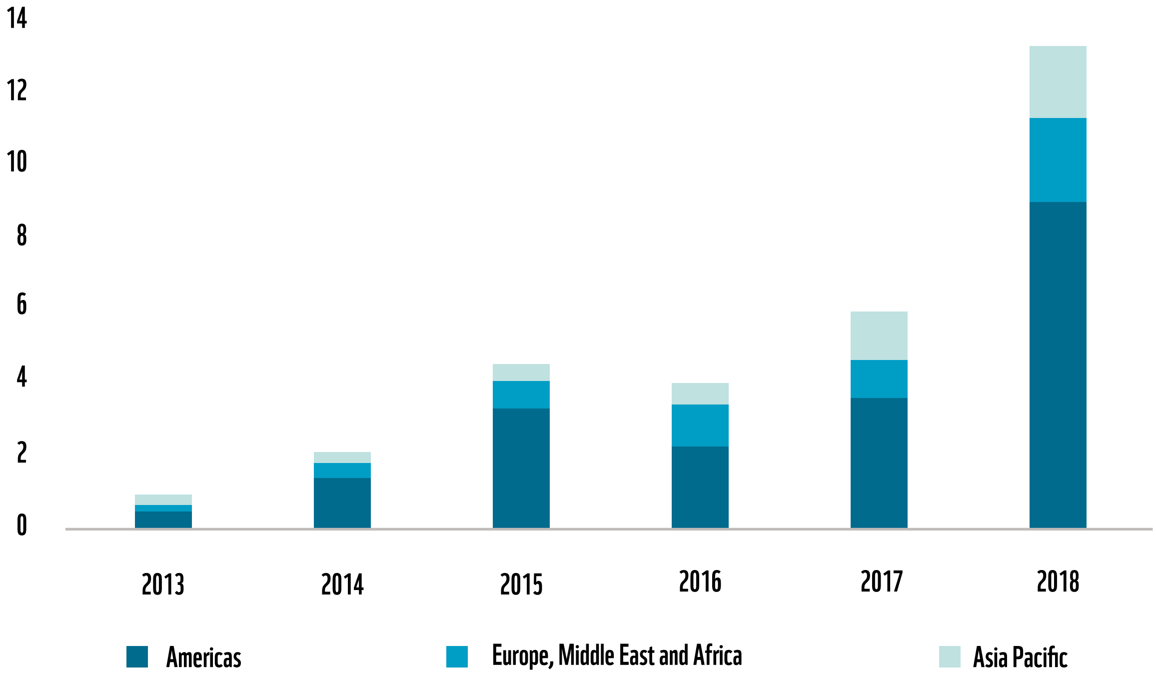
Source: Charting the Emergence of Corporate Procurement of Utility-Scale PV, NREL, 2017

15 Corporate sourcing of renewables: Market and industry trends, IRENA, 2018

The corporate PPA market worldwide increased from 6.1 GW in 2017 to 13.4 GW in 2018[16].

This option remains very popular across the world including in the USA, Mexico, Brazil, UK, Poland, Denmark, Finland and Australia.

Fig. 15: Global corporate PPA volumes, GW



Source: Bloomberg New Energy Finance, January 2019

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16 Corporate Clean Energy Buying Surged to New Record in 2018, Bloomberg NEF, January 2019

Chapter 3: Alternative Renewable Power Procurement Options

New procurement options including electricity derivatives, such as virtual PPAs are becoming increasingly popular across the world. Purchase of renewable power from power exchanges is being considered in Australia. Peer to Peer (P2P) trading is being tested in the USA, Germany, Japan, UK and Australia.

Table 1: Alternative renewable power procurement options for India

Option	Description	Benefits	Drawbacks
1.Virtual PPA (Contract for difference)	Consumer and generator buy and sell electricity on the power exchange and settle the price difference on a monthly basis: if market price is greater than the strike price, the generator pays the difference to the consumer. If the market price is less than the strike price, the consumer pays the difference to the generator. Used in Australia, USA, UK	Price hedge for both consumers and developers; secures project financing for developers Large consumers may sign multiple VPPAs to diversify their technology, supplier and regional risks Possible to aggregate two or more consumers with low volume commitments in a single VPPA Enable geographically dispersed generators and consumers to transact	Need almost perfectly functioning power market in terms of liquidity and efficiency; any failure to inject or draw power reduces effectiveness of the hedge Counterparty credit risk increases payment uncertainty and reduces effectiveness of the hedge Small C&I consumers lack capacity to negotiate VPPAs
2. Green tariffs	Renewable power procured from the local power utility combined with green attributes Used in Australia, USA, UK	Very simple to procure, ideal for medium consumers No upfront investment, no project risk for consumers Ability to lock-in power cost for a fixed period of time Utilities get better visibility on business by retaining their consumers Reduced risk of curtailment as network planning is undertaken by the local power utility	More expensive than direct procurement of renewable power and regular grid tariff Not possible for short term power procurement Restricts consumer choice in the absence of retail competition

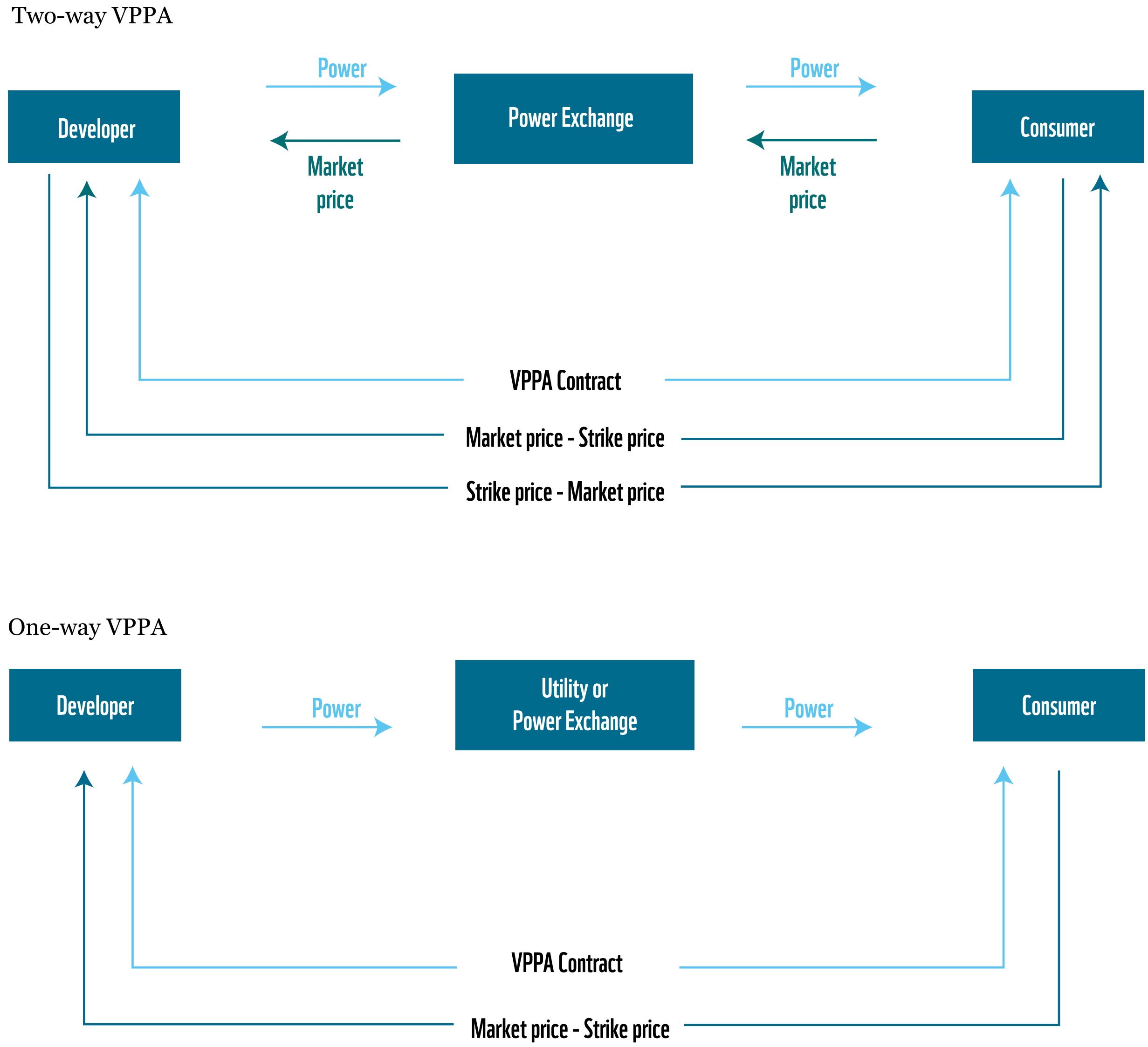
Option	Description	Benefits	Drawbacks
3. Purchase of internationally traded RECs (I-RECs)	Consumer buys I-RECs to meet green energy commitment target UK, China, Brazil, Spain, South Africa, TIGRs in Singapore and Vietnam	Easy to procure, relatively low cost, no long-term commitment for consumer Generators and consumers can be located anywhere in the world Suitable for complying with emission reduction targets stipulated by international investors and clients Price transparency	Price subject to market risk May not be suitable for long-term purchase Depends on respective country regulations
4. Dedicated renewable power exchange or renewable power purchases from exchange	Consumer buys power from dedicated renewable power exchange Dedicated renewable power exchanges are being planned in Australia and India	No need for consumers to enter into long-term contracts Transparent price discovery, suitable for smaller consumers Generators and consumers can be located anywhere in the country. No credit risk	May not be suitable for long-term purchase Risk of power price volatility Risk of OA policy volatility - denial of approvals and/or unpredictable changes in OA charges Risk of transmission congestion, power curtailment
5. P2P trading	Blockchain enabled online trading of power directly between consumers and power producers US, Germany, Japan, UK, Australia	Very low transaction costs, suitable for small consumers and generators Facilitates demand response to variations in renewable power generation, helps in local grid balancing Enables growth of decentralised generation, a highly beneficial power source with reduced T&D system losses and no land or transmission grid access requirements	Not allowed at present under the existing regulatory framework, strong resistance likely from DISCOMs Lack of visibility over long-term prices Not suitable for large consumers Susceptible to cyber security threats and loss of data privacy

3.1 Virtual PPAs

A virtual PPA (VPPA), also known as Contract for Difference, is a derivative contract wherein a consumer agrees to buy a specified power output from a project developer, at a fixed price (strike price) for a fixed duration. Both the parties trade physical power on the exchange, at the prevailing market price. As a part of the contract, RECs are transferred from the developer to the consumer to avail the benefit of green energy consumption.

There are two structures of VPPAs- a two-way VPPA and a one-way VPPA. In a two-way VPPA, if the market price is below the strike price, the consumer compensates the developer for the difference. If the market price is higher than the strike price, the difference is passed by the developer to the consumer. In this option, both parties get a perfect hedge on power price. In a one-way VPPA, only the consumer compensates the developer if the market price is below the strike price.

Fig. 16: VPPA structures



The VPPA model is best used when a renewable power plant is not able to supply physical power directly to the consumer because of sub-optimal location (lack of suitable land or high cost, low radiation) and/ or transmission constraints. Under this model, there is no need for the two parties to be connected to the same utility or regional transmission network. However, it requires a very efficient and liquid exchange-based market with market price parity between the points of power generation and consumption. Any deviation in prices at the two points reduces the effectiveness of the hedge. Moreover, VPPAs work only when there is very low curtailment risk for the developer. If the developer is not able to inject power, it would be exposed to unquantifiable market risk.

Certain C&I consumers, including retail chains, use VPPAs where a direct PPA wouldn't work for their small, geographically distributed loads. The VPPAs are used to hedge the cost of RECs purchased.

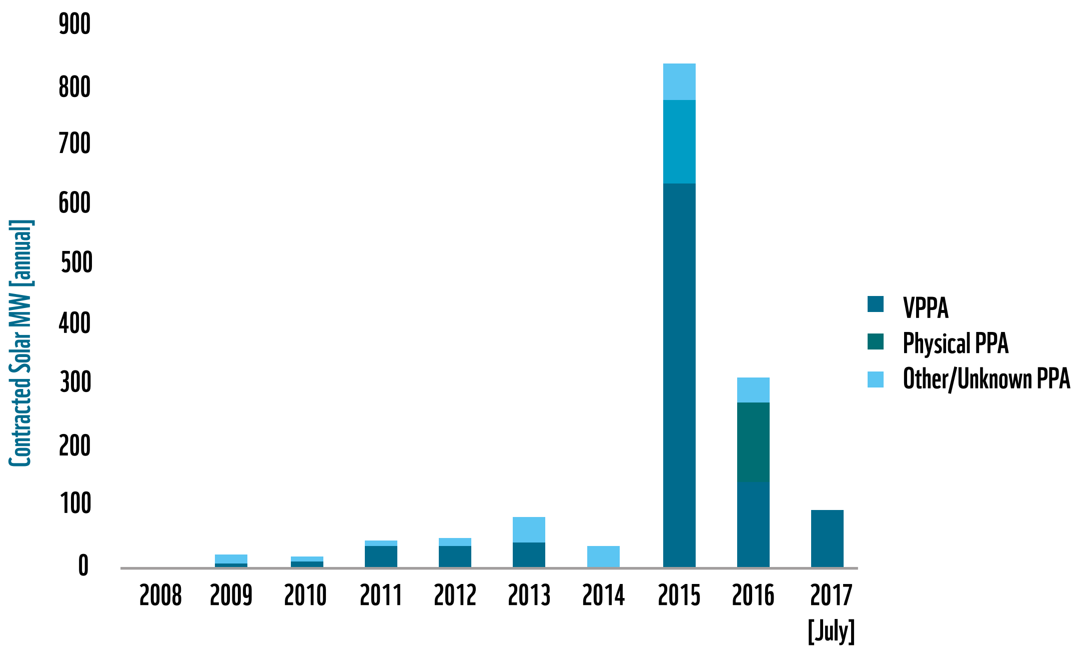
In the USA, 985 MW of solar VPPAs (43 per cent of cumulative C&I solar power procurement) were executed by C&I consumers up to 2017. But the market has grown rapidly with 6.4 GW of VPPAs signed in 2018 and another 3.8 GW signed in H1 2019[17]. Contract period for VPPAs usually ranges between 12-25 years.

Adoption prospects and challenges in India

VPPAs can help C&I consumers overcome lack of inter-state scheduling of OA renewable power in India. There has been some uncertainty about regulatory jurisdiction over VPPAs. However, we believe that as long as VPPAs are structured as bilateral contracts and not traded on any platform, there is no approval required from any regulatory or capital market body for entering into VPPA transactions.

With the strengthening of the national grid over the past few years, power prices traded on the exchanges have become aligned across the country. However, regulatory approval for a dedicated renewable power exchange is still pending. The VPPA model is unlikely to be viable until there is a liquid renewable power trading market.

Fig. 17: Corporate solar VPPAs growth in the USA



Source: Charting the Emergence of Corporate Procurement of Utility-Scale PV, NREL, 2017

17 Data from an interview with respondents working on C&I procurement of renewable power in the USA

The other major potential challenge for VPPAs in India is the growing curtailment risk faced by renewable power in many states despite its must-run status. As discussed earlier, the risk of the developer not being able to despatch power is likely to make this route un-bankable for most investors and lenders. MNRE's recent initiative to offer 100 per cent compensation for project developers in the event of curtailment should help in this regard.

High OA charges or inordinate delays in OA approvals can also impede adoption of VPPAs, as both generators and consumers require OA approvals to trade power via exchange.

Recommendations for policy makers and regulators

1. CERC and SEBI should work together to clarify jurisdiction and issue regulations for introduction of electricity derivatives. Regulations can then be issued for physical and non-physical delivery-based options.

2. Regular updates on intra-state transmission network availability should be issued by respective SLDCs to allow generators and consumers to plan project capacities. Greater transparency is also needed in OA policy implementation particularly on process of granting approvals and determination of OA charges.

3. The central government, together with Regional Load Despatch Centres (RLDCs), should monitor power curtailment data regularly and undertake strict measures to combat this risk.

3.2 Renewable power purchase from utilities (green tariffs)

Under this option, C&I consumers procure renewable power from utilities, who, in turn, contract to purchase renewable power from generators. Green tariffs can take many different forms:

i. **Sleeved PPAs** granting access to individual physical PPAs at an incremental cost to the consumers

ii. **Subscriber programmes** whereby consumers "subscribe" to power output from a large renewable power project which has signed a PPA with the utility

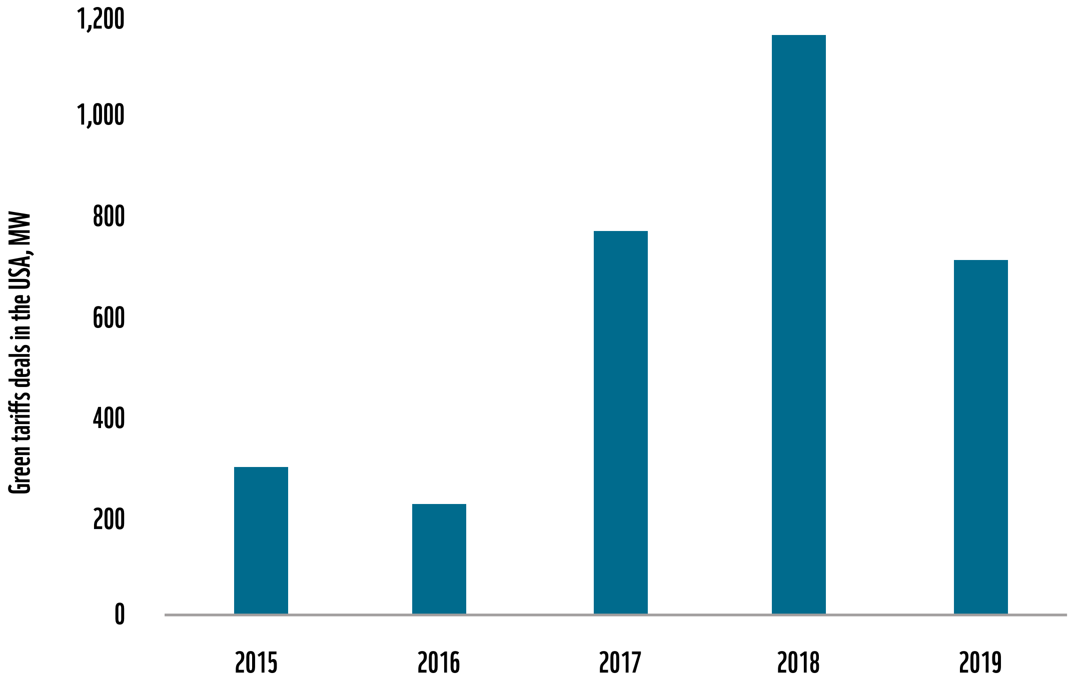
iii. **Market-based rate programmes** allowing wholesale market participation through the utility

Green tariffs allow consumers the benefit of renewable power access without the need to bear financial or execution responsibility for renewable projects. There are other potential benefits - green tariffs can provide greater flexibility and lower transaction costs, due to utilities' expertise in procuring large scale power capacity. They may also allow consumers to lock in renewable power for a long-term, with fixed rates over a pre-agreed term.

The downside of green tariffs is that they are usually higher than comparable grid tariffs, despite the rapidly falling cost of renewable power at the point of generation. The utilities need to price green tariffs at a premium to 'brown' grid power to avoid all consumers switching to this new mechanism. However, green tariffs may still be cheaper than the combined cost of procuring normal 'brown' grid power and of buying RECs.

Green tariffs have grown rapidly in the USA since their introduction in 2013. Till 2017, 842 MW of solar power was procured by C&I consumers through various green tariff structures in the USA. New deal volumes have consistently grown and touched 1,176 MW in 2018.

Fig.18: Growth of green tariff deals in the USA, MW



Source: Green tariff deals, World Resources Institute (WRI), 2019[18]

Note: Data available till 12 November 2019 is considered.

Adoption prospects and challenges in India

The green tariff model could help DISCOMs to retain consumers who may otherwise switch to OA power. It is relatively easy to adopt in principle, but the main challenge is unwillingness of Indian consumers to pay any premium over grid power.

The Andhra Pradesh Electricity Regulatory Commission (APERC) had introduced green tariffs (INR 6.70/ kWh) in FY 2009[19]. But the cost - 56- 86 per cent higher than normal grid tariffs for industrial consumers, made it unacceptable in the market. The Karnataka Electricity Regulatory Commission (KERC) had also introduced a green tariff in the form of INR 1.00/ kWh premium over applicable grid tariff for HT[20] consumers in FY 2012[21]. The premium was reduced to INR 0.50/ kWh in FY 2014 and is still available to C&I consumers today. However, uptake has been negligible and feedback from consumers suggests that a premium over grid tariffs is not commercially acceptable to them.

Recommendations for policy makers and regulators

1. Green tariffs should also be offered at LT transmission levels for small and medium consumers to source renewable power.
2. DISCOMs may allocate specified portion of renewable power at grid tariff parity on first come, first serve or rationed basis to specific consumers as a financial incentive. This policy could be allied with state or national industrial policy as a mechanism to promote specific industries, new manufacturing investments or growth of export-oriented units.

18 https://www.wri.org/resources/charts-graphs/grid-transformation-green-tariff-deals
19 APERC tariff order for FY 2009
20 High Tension (HT) transmission connection
21 KERC tariff order for FY 2012

3. Competition on the supply side has led utilities to offer more competitive green tariffs in the USA. Introduction of competition at the retail level in India could spur similar reduction in green tariffs and make them acceptable to consumers.

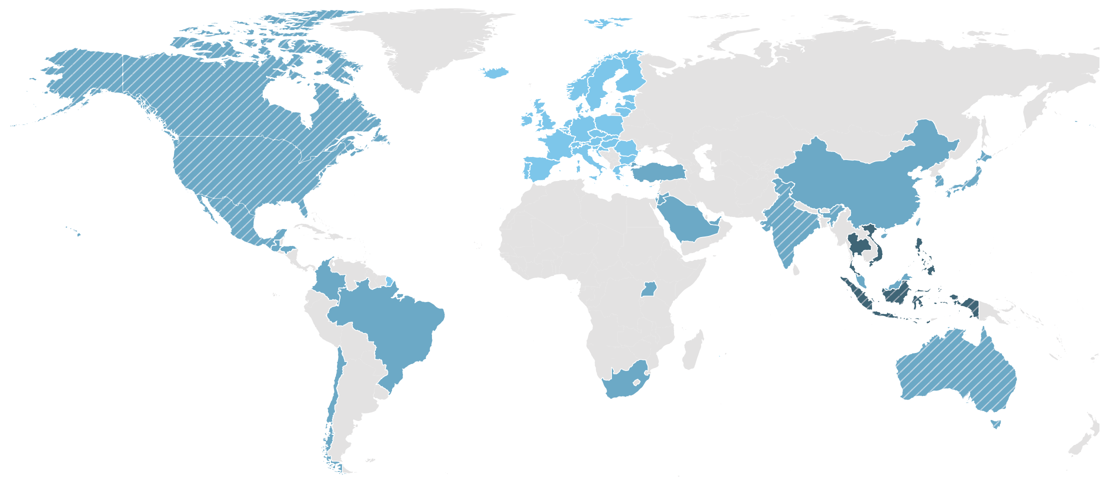
3.3 Internationally tradeable renewable energy certificates (I-RECs)

I-RECs are very similar to RECs as traded in India, with the only difference being that the institutional mechanism to facilitate their issuance, sale, purchase and retirement is specified and defined under the International Renewable Energy Certificate (I-REC) standard and the Tradable Instruments for Global Renewables (TIGRs)[22] standard. I-RECs can be issued by renewable power plants around the world if renewable generation has not been used for RPO fulfilment and has not availed any concessions which could have made it ineligible for RPO fulfilment.

As I-RECs are not included in central and state regulations, they cannot be used by C&I consumers in India to meet domestic RPO requirements. However, consumers can use I-RECs to meet voluntary renewable purchase targets.

Brazil and China account for 107 projects (7,000 MW) and 80 projects (5,238 MW) registered, respectively, under the I-REC framework. Other countries include Spain, Philippines, South Africa and UAE.

Fig. 19: Types of RECs used in different countries

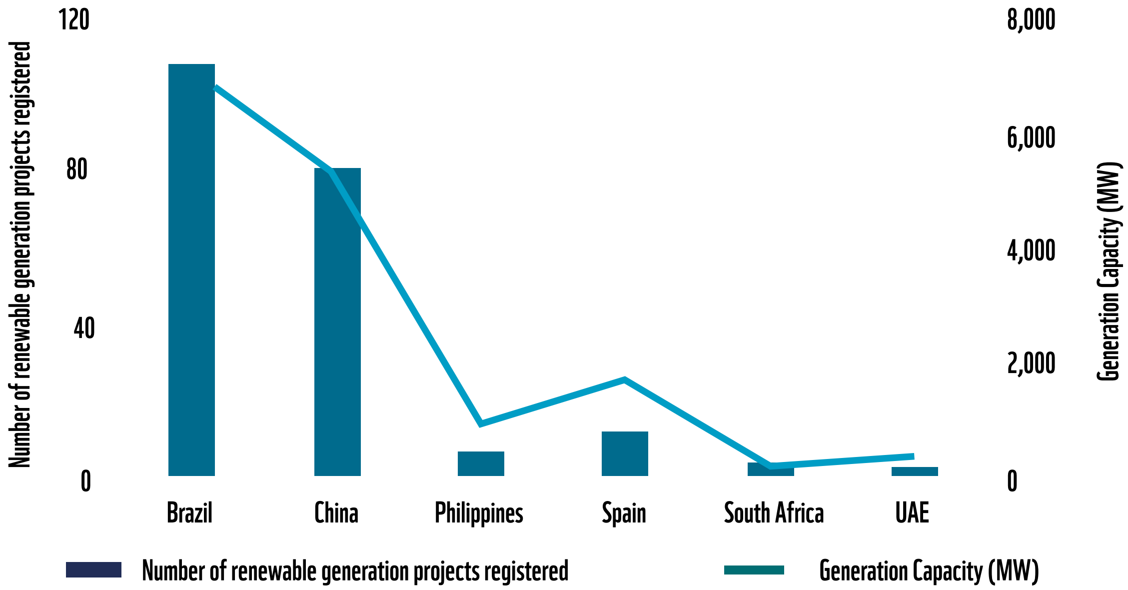


- Guarantees of Origin [GOs]
- International Renewable Energy Certificates [I - RECs]
- National Renewable Energy Certificates [e.g. RECs]
- Only Tradable instruments for Global Renewables [TIGRs]
- International Renewables Energy Certificates [I - RECs] and Tradable Instruments for Global Renewables [TIGRs]

Source: Corporate sourcing of renewables: Market and industry trends, IRENA, 2018.

22 TIGRs are administered by APX, an online trading platform and service provider

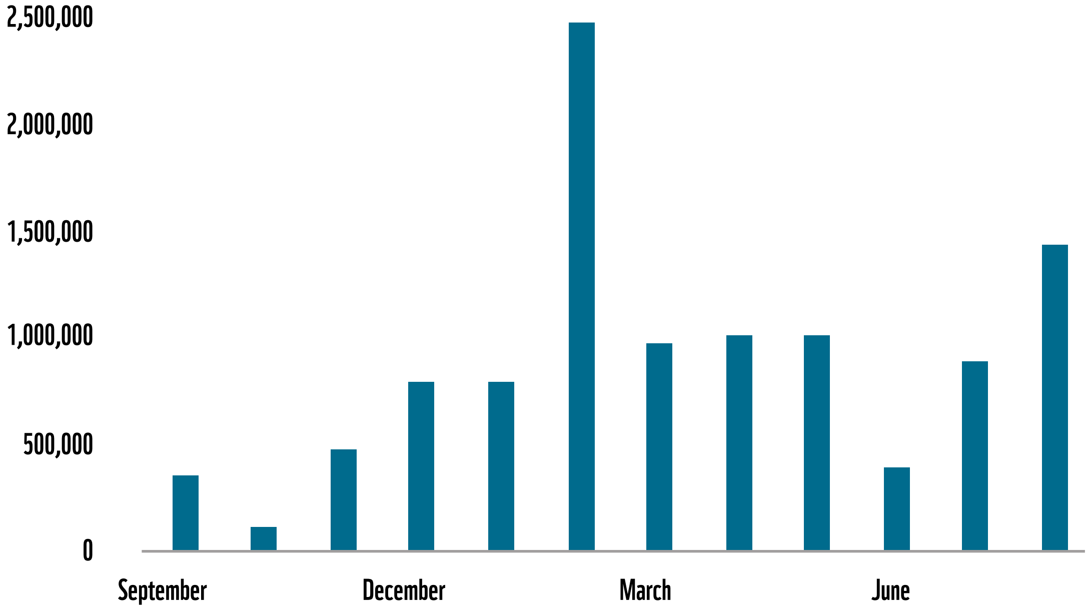
Fig 20: Registration of renewable power generation projects for I-RECs



Source: I-REC registry (https://registry.irecservices.com/Public/ReportDevices/)

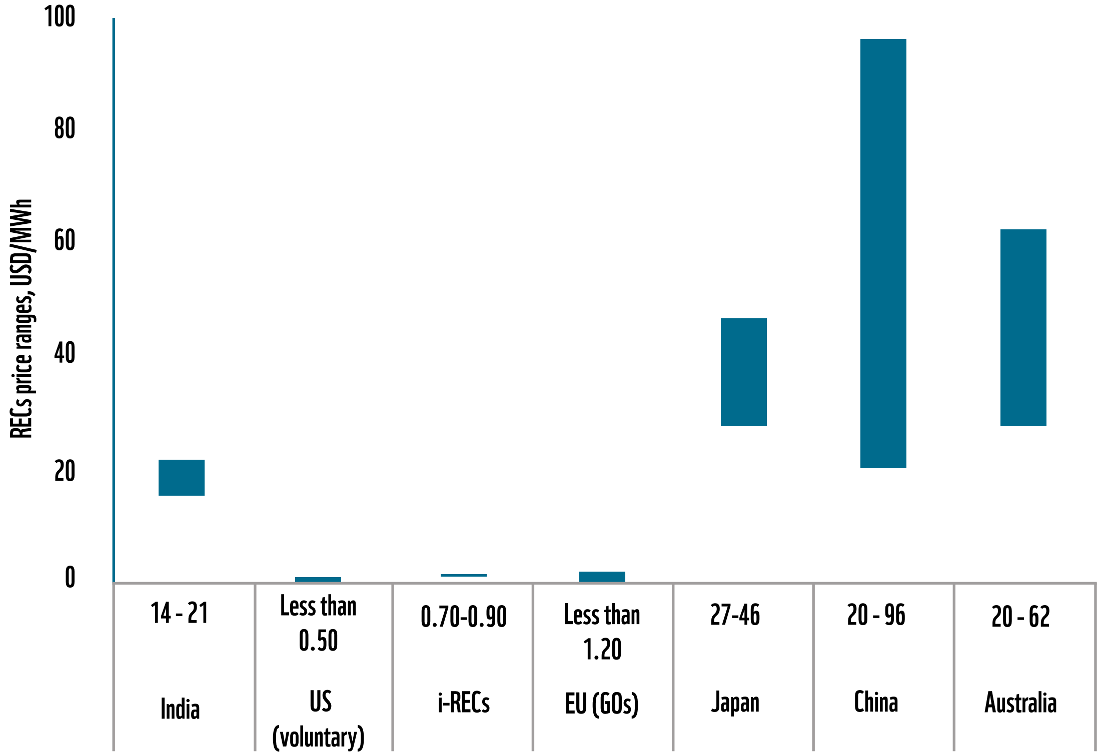
Trading volume of I-RECs has been volatile over the previous year as shown in the graph below.

Fig. 21: I-REC trading volume globally (September 2018-August 2019)



Source: I-REC registry

Fig 22: Comparison of REC price ranges, 2017-18, USD/ MWh



Sources: CERC, floor and forebearance price, 2017; International best practices for implementing and designing Renewable Portfolio Standard (RPS) Policies, NREL, 2019; The Rocky Mountain Institute (RMI); Corporate sourcing of renewables: Market and industry trends, IRENA, 2018.

Notes:

i) The exchange rate considered is USD 1 = INR 70.

ii) These prices do not reflect associated brokerage and fees.

I-RECs cost only about 0.70–0.90 USD, as against 14–21 USD for RECs in India and up to USD 1.20 for a Guarantee of Origin (GO) in Europe. Compared to most RECs, I-RECs are an affordable option for C&I consumers worldwide.

Adoption prospects and challenges in India

Initiatives including RE 100[23] and REDE[24] have encouraged many C&I consumers to increase voluntary commitment and procurement and expand the scope of renewable power procurement.

Demand for I-RECs would not really lead to greater domestic renewable power capacity in India as consumers would prefer to buy I-RECs from countries with lower cost of power, for example, in Middle-East or Latin America. It appears unlikely, therefore, that CERC or any state regulator would deem I-RECs as eligible instruments for compliance with domestic RPO targets.

However, as discussed earlier, many consumers remain keen to procure renewable power over and above their RPO requirement or voluntarily. Such consumers may find I-RECs an attractive proposition to reduce their carbon emissions, particularly because of their very low cost.

23 Led by The Climate Group and CDP
24 Led by WWF

Recommendation for policy makers

The Government of India could consider ratification of Article 6 of the Paris Agreement on the use of internationally transferred mitigation outcomes towards nationally determined contributions as a first step for select consumers, e.g. to meet their voluntary renewable energy commitments.

3.4 Dedicated renewable power exchange

Power and RECs are traded separately on power exchanges. However, 'renewable' power, combining the attributes of 'brown' power and green credentials, is currently not traded on exchanges anywhere in the world. The main constraint is that there is no mechanism for the accounting and settlement of renewable power from generation to consumption on a single platform. Going forward, as renewable power grows, this lacuna will be filled up gradually. Australia is in the process of setting up a decentralised energy exchange for trading power from distributed energy sources including solar PV, battery storage and demand response. It is expected that network operators would use this power to improve grid stability and postpone construction of costly additional networks[25].

Both power producers and consumers would benefit from reduced complexity in trading renewable power instead of trading power and RECs separately. Such a mechanism would ensure greater market transparency and efficiency over both fragmented trading and bilateral contracts.

Term ahead markets (TAM) on the exchange can facilitate trade of renewable power for a period of 7 days. Power injection schedules should be submitted by power producers to the exchange one day before the trade and shared with C&I consumers to plan their drawl. A day-ahead contingency market can help power producers buy or sell renewable power to match revisions in forecast generation. An intra-day market to trade power 3-4 hours ahead of scheduled injection can meet deviations in generation schedules on the day of delivery. Similarly, DISCOMs can buy or sell renewable power in the contingency market and facilitate grid balancing.

Adoption prospects and challenges in India

Procurement of renewable power from the exchange would help to meet the growing preference of C&I consumers and DISCOMs to source renewable power rather than RECs. It would also facilitate procurement by C&I consumers in states with low renewable power potential. India's biggest power exchange, Indian Energy Exchange (IEX), has already applied to CERC, the central regulator, to set up green day-ahead and term ahead markets for trading renewable power. CERC denied approval for day-ahead green power markets in 2017 due to low volume of renewable power available for short-term sale, which did not justify setting up a complex system of registration, accounting and settlement. Further, if consumers migrated from long-term PPAs to the short-term power market, it would adversely affect existing investments in RE generation. The proposal to commence term-ahead trading is still under consideration for regulatory approval.

To trade renewable power on the exchange, consumers and power producers would need to factor in transmission congestion, OA hurdles including delays or denials of approvals, and additional costs incurred in deviation settlement.

Recommendations for policy makers and regulators

1. Updated transmission and distribution capacity and scheduled maintenance downtime information should be made available by SLDCs

25 Australian Renewable Energy Agency, https://arena.gov.au/projects/decentralised-energy-exchange-dex/

and DISCOMs so that power producers and consumers can assess viability of renewable power trading.

2. SLDCs and RLDCs should be directed to monitor renewable energy transactions on the exchange in real time for validation.

3. Day-ahead and intra-day contracts should be undertaken in 15-minute time slots instead of 1-hour slots to minimise effect of variability.

4. A contingency market should be created on the power exchanges to trade electricity 75 minutes in advance of scheduled injection of power and enable generators to either meet their schedules and avoid paying penalties for deviation or to revise the schedule.

3.5 Peer to peer trading

Peer to peer (P2P) trading of renewable power is an emerging concept that involves use of blockchain enabled online platforms to bring together renewable power producers and consumers. In the USA, NASDAQ exchange enabled authentication of solar power production in May 2016. Solar power systems must be connected to the NASDAQ platform to measure generation. Anonymous certificates are then created for online sale to buyers.

P2P trading has very low transaction costs and is suitable for small entities including rooftop solar power producers and consumers. This P2P route could also be used for trading RECs and sale of power to electric vehicles. There are three options available for facilitating P2P trading– regular power grid, a microgrid and a combination of both. Usage of the grid would require OA approvals and incur additional cost of grid usage. Alternatively, microgrids could be set up and run by cooperative associations of local consumers and producers with project development and operational responsibilities outsourced to third-party contractors. Such microgrids would need installation of battery storage systems and/or access to the grid to ensure technical stability.

Cryptocurrencies are used to reward solar power generators. Transactions using local currency would be permissible wherever P2P trading is recognised

Adoption prospects and challenges in India

P2P trading is not allowed in India at present. Existing laws require a distribution licence for sale of electricity to consumers and it is impossible to obtain a licence for small generators. Regulatory approval for 'parallel distribution' of electricity in competition with the DISCOMs for the same supply area is also highly unlikely. However, a couple of exploratory steps have recently been initiated for development of this market:

1. A P2P trial for 5-6 MW of rooftop solar power is planned by BSES Rajdhani Power Limited (BRPL), a Delhi DISCOM[26] using a P2P trading and cryptocurrency platform provided by Power Ledger in 2020 subject to approval from the Delhi Electricity Regulatory Commission (DERC).

2. The Uttar Pradesh Electricity Regulatory Commission (UPERC) has directed state DISCOMs and the state renewable power development agency to jointly submit a proposal for implementation of P2P transactions using block chain technology[27] for providing flexibility of sale and purchase of power from rooftop solar.

Meanwhile, the Ministry of Power has also proposed an amendment to the Electricity Act 2003 for separation of carriage from content. Such a move is intended to free

26 https://www.finder.com.au/power-ledger-partners-with-delhis-largest-electricity-distributor-for-p2p-solar-trial

27 UPERC (Rooftop Solar PV Grid Interactive Systems Gross / Net Metering) Regulations, 2019

power supply business and give an option to consumers to source power from a number of alternate suppliers. By extension, the move would also facilitate P2P transactions. Passage of this amendment by the Parliament and subsequent implementation by states is awaited.

The Reserve Bank of India currently prohibits use of cryptocurrencies in India. The Government of India is yet to formulate a policy on cryptocurrencies.

Recommendations for policy makers and regulators

1. In anticipation of necessary amendments to the Electricity Act 2003, state policies should allow P2P trading of renewable power.
2. More pilot projects should be encouraged to evaluate potential gains and challenges from P2P trading of power.

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Chapter 4: Conclusion

India has an ambitious renewable capacity roadmap. The electricity sector has transformed rapidly, with a substantial fall in renewable energy prices in the last few years, reaching grid parity with conventional coal. That has resulted in significant interest from corporate consumers. However, there is no specific policy initiative encouraging greater renewable power consumption by C&I consumers. The RPO mechanism applies to selective entities (companies generating captive thermal power and/or consuming conventional open access power) and is prone to regulatoryuncertainty and poor implementation.

C&I consumers in India face high grid tariffs and, in turn, many large consumers rely extensively on cheap coal-fired captive power for a significant share of their power needs[28]. There is a stronger push for renewable power due to a combination of financial and environmental factors, but the consumers face multiple challenges in procurement. Each of the options currently available to them – rooftop solar, open access power and RECs – presents critical market, policy and regulatory constraints. The fundamental problem, of course, is the heavy financial dependence of DISCOMs on these consumers. As C&I consumers subsidise cheap power sales to other consumers, the DISCOMs are reluctant for them to walk away.

Policy makers need to proactively assist C&I consumers in maximising consumption of renewable power that would not only make them cost competitive and spur macro-economic growth but also play a significant role in reducing India's carbon emissions. One set of potential reforms entailing tariff reform – reduction of cross subsidies and channelling of government subsidies directly to consumers – has already been mooted and is under consideration by the Indian government. The other measure involves opening up new avenues for these consumers to buy green energy.

Fig 23. Comparison of alternative C&I procurement options

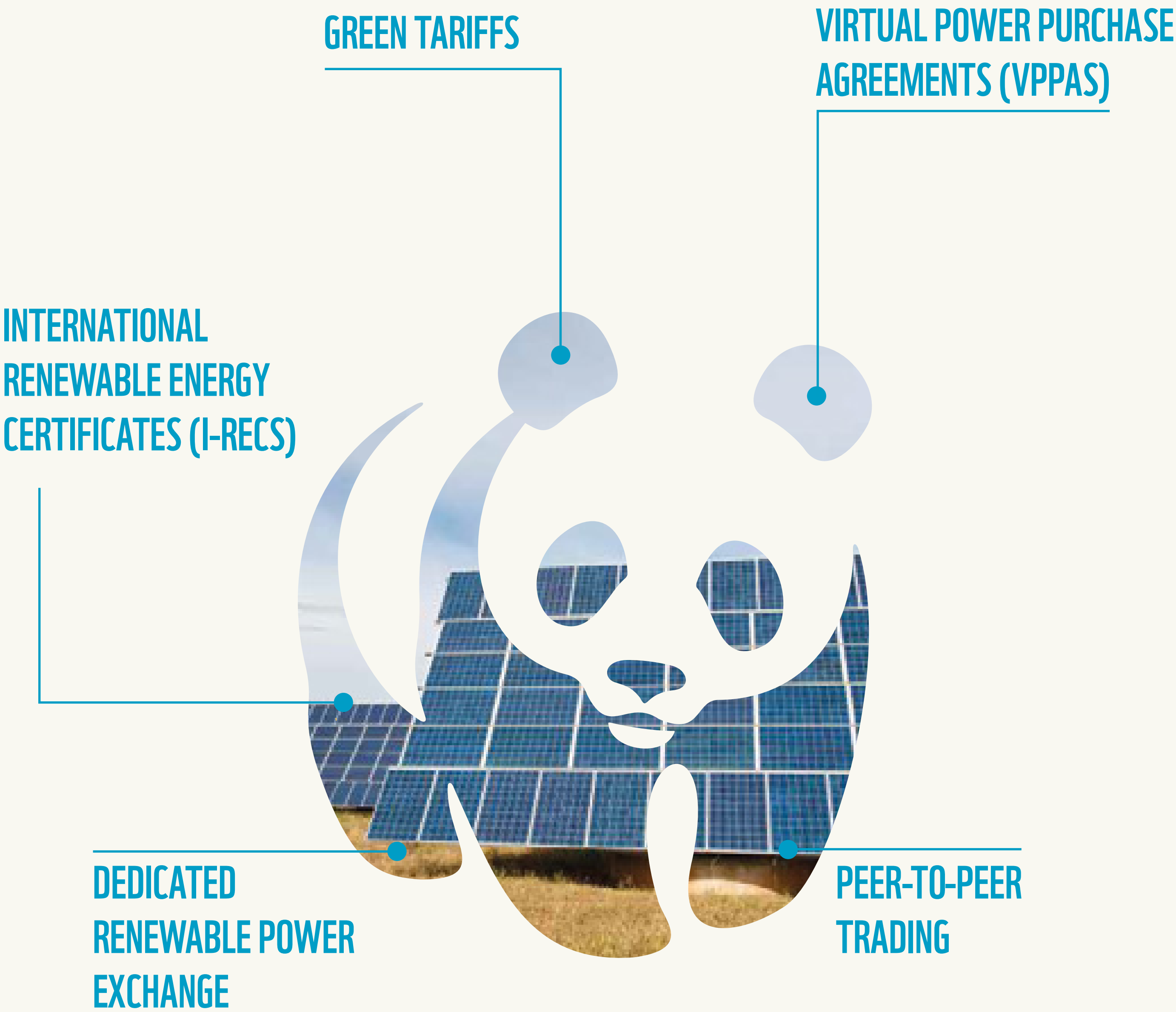
Option	Growth potential	Cost of power	Regulatory and policy effort required	Ideal consumer profile
Green tariffs	High	Increase in cost	Not required	Small and medium consumers
VPPAs	Medium	No change	Not required	Large consumers
I-RECs	Medium	Significant decrease	Not required	Medium and large consumers
Dedicated renewable power exchange	Medium	Moderate decrease	Required	Large consumers
P2P trading	Low	Significant decrease	Major amendments required	Small and medium consumers

28 Unofficial estimates indicate that diesel based generation capacity for C&I consumers could have been as high as 90,000 MW in 2014 (https://indianexpress.com/article/india/india-others/gensets-add-up-to-under-half-of-installed-power-capacity/)

The alternative procurement options examined by us have various advantages and disadvantages making them suitable for specific consumer categories or segments. A high-level comparison of various options is presented in Fig 23.

Our preliminary findings indicate that some of these options - green tariffs, VPPAs and I-RECs (for compliance of voluntary renewable power targets) are relatively easy to implement. Nonetheless, deeper consultation is required between policy makers, regulatory authorities, DISCOMs, power producers and consumers to further examine these options.

A collaborative effort to undertake pilot programmes and consumer awareness initiatives can build market confidence and momentum in the drive to increase renewable power consumption by C&I consumers.



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