

Vast Potential of Rooftop Solar in India

Setting the Pace for Rapidly Increasing Rooftop Solar Installations in India

The Government of India in 2015 set a huge renewable energy capacity target of 175 gigawatts (GW) by 2022 for transitioning to a low-carbon pathway. Of this, 100 GW was earmarked for solar capacity with 40 GW (40%) expected to be achieved through decentralised and rooftop-scale solar projects.

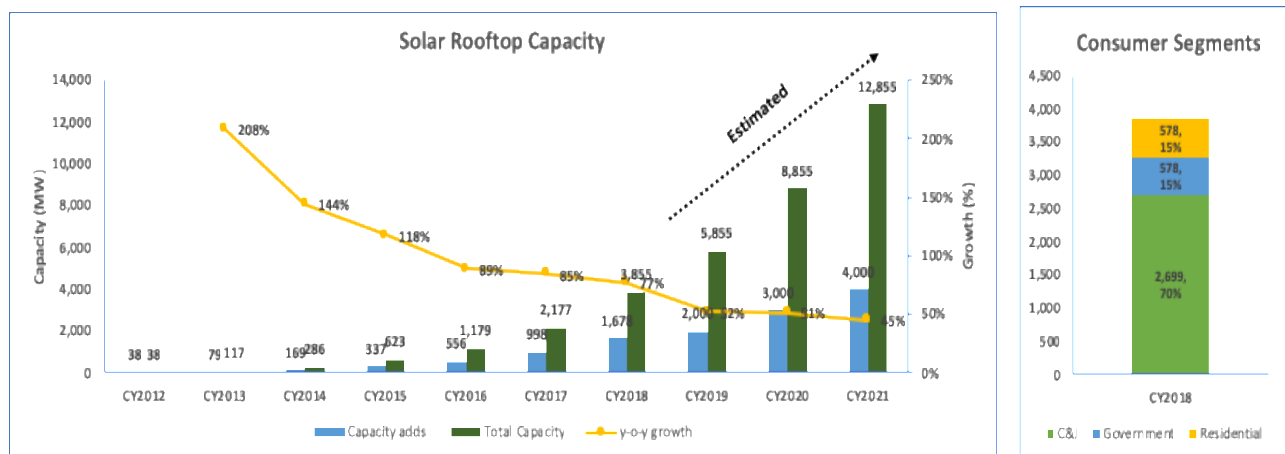
India has already installed 28 GW of solar capacity as of March 2019,¹ a fourfold increase in less than three years.

The share of rooftop solar to-date is just 14% of the cumulative solar installation in India, reaching 3,855 megawatts (MW) by December 2018. This is well below the run-rate anticipated by the Government of India's audacious 2015 renewable energy plan.

Albeit from a low base, rooftop solar has been the fastest growing renewable energy sub-sector in India.

On the positive side, there has been significant investment and 'learning by doing', necessary to prepare a positive regulatory framework and upskill the workforce for small scale deployments, as well as educating the market on this relatively new technology.

Figure 1: Solar Rooftop Capacity and Growth Over the Years



Source: Bridge to India, Mercom India, IEEFA Estimates

¹ CEA, All India Installed Capacity, March 2019.

IEEFA notes that from a historically low base, rooftop solar has been the fastest growing renewable energy sub-sector in India, with a compound annual growth rate (CAGR) of 116% between 2012 and 2018.

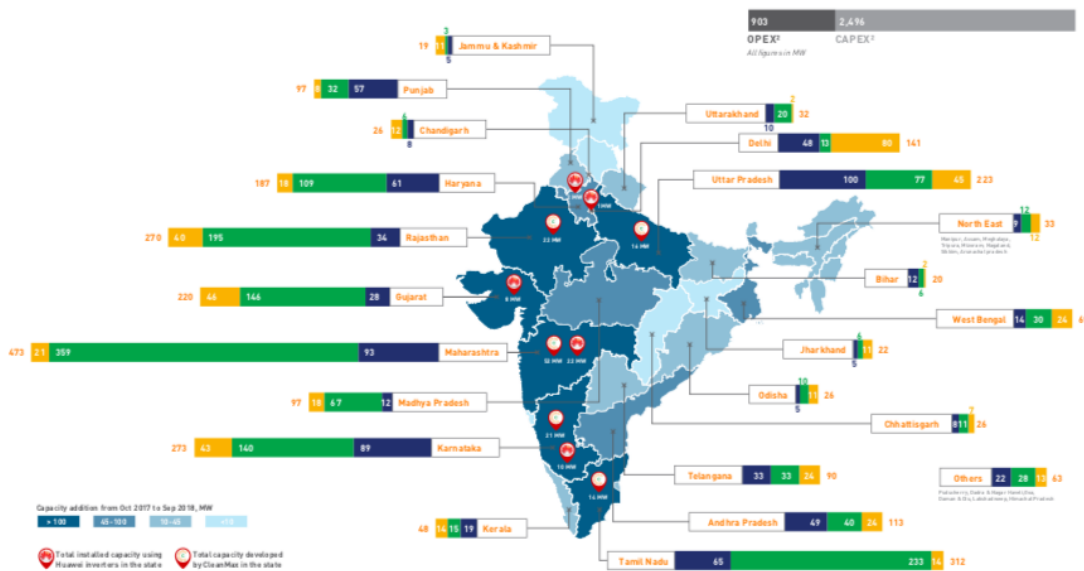
Some 70% of the market growth has been driven by commercial and industrial (C&I) consumers, clearly incentivised by the very high tariffs applying to these two sectors. (India has a very heavy cross-subsidy from C&I to residential and agricultural users, which in turn acts as a key incentive making self-generation for C&I immediately cost effective.) The balance of 30% is split equally between government and residential consumers.

The top five states account for 54% of total rooftop solar capacity in India according to Bridge to India.² Maharashtra has the highest installed capacity of rooftop solar (473 MW) followed by Tamil Nadu (312 MW), Karnataka (273 MW), Rajasthan (270 MW) and Uttar Pradesh (223 MW).

The increased adoption of rooftop solar in Indian states can be attributed to high retail tariffs for C&I consumers, favourable net metering policies, corporate social responsibility programs and increased consumer awareness.

IEEFA estimates that for the next three years, rooftop solar installs will grow at a CAGR of 50% suggesting a cumulative 13 GW of installed capacity by FY2021-22.

Figure 2: India Solar Rooftop Map, September 2018



Source: Bridge to India

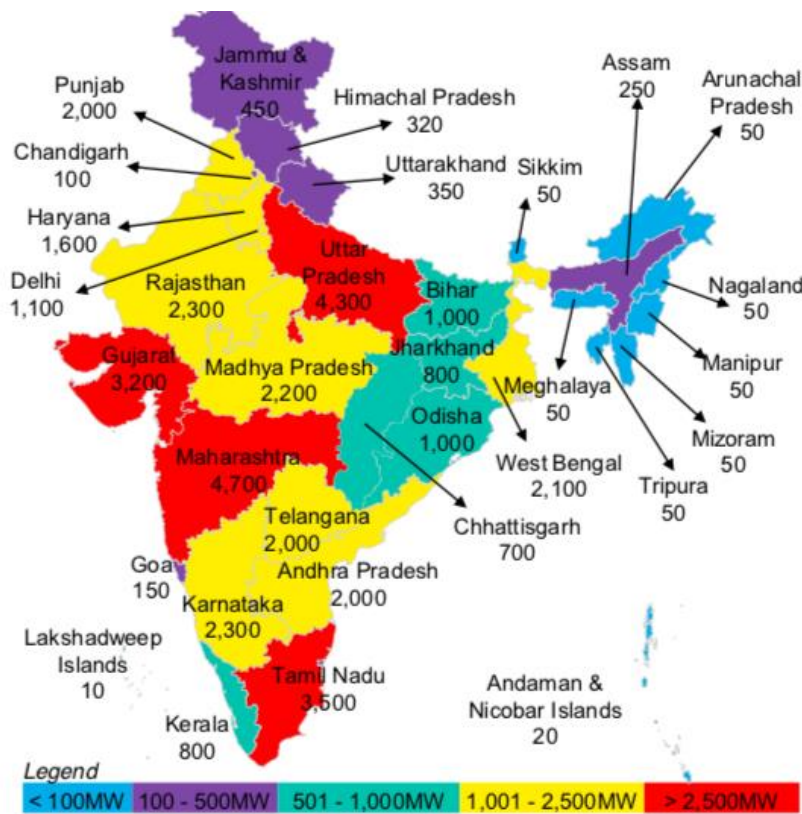
² Bridge to India, India Solar Rooftop Map, September 2018.

Financial Assistance to Accelerate the Pace of Rooftop Solar Installations

Despite strong growth, India has to-date achieved only 10% of its target capacity addition of 40 GW by financial year (FY) 2022.

To achieve the 2022 target, India will have to accelerate the pace of new solar rooftop installations, while the rooftop solar photovoltaic (PV) segments including C&I, government and residential must be mobilised and encouraged for large scale adoption.

Figure 3: Rooftop PV Installation Targets to March 2022



Source: Bloomberg New Energy Finance

While the government recently provided a 30% subsidy for residential rooftop systems, greater clarity and positive messaging could further build consumer awareness of the financial and sustainability merits of rooftop solar.

This is particularly relevant as residential storage technologies become commercially viable for high-end residential customers over the coming 2-3 years (particularly relative to expensive, noisy and heavily polluting diesel back-up power generators).

To assist the Government of India achieve its ambitious 2022 target, the [World Bank is providing US\\$625m in financial support](#) for a grid connected rooftop solar project. The project supports the shift to renewable energy by financing the installation of at least 400 MW of grid connected rooftop solar photovoltaic (GCRSPV) units across India, providing discounted, long tenor finance to both the suppliers of solar PV units as well as consumers wishing to install them.

The World Bank is implementing the scheme with the State Bank of India (SBI) and up to 31 December 2018, it included approved credit of around US\$123m to support more than 235 MW of rooftop solar capacity to be added to the grid. The World Bank and SBI are further accelerating the process by developing new credit instruments.³

Further international financial assistance includes concessional loans of around US\$750m from the Asian Development Bank (ADB) and the New Development Bank (NDB). These have been made available to the SBI, the Punjab National Bank (PNB) and the Canara Bank for rooftop solar projects.⁴

The German state development bank KfW is also extending €200m in financial support for rural solar deployments,⁵ and is [considering](#) a US\$1.1bn loan support program for rooftop solar in India.

Expansion of Rooftop Solar on Government Buildings

While many state governments have demonstrated an intent to make it mandatory for all public buildings to have rooftop solar panels, progress so far has been limited.

Due to the strong push by national and local governments, the Solar Energy Corporation of India (SECI) and Indian Railways have come up with various rounds of auctions.

To avoid upfront costs, government buildings have largely adopted the [Renewable Energy Service Company \(RESCO\) model](#). Developers also prefer the same model, as the off-take risk is less.

As per BNEF's report,⁶ more than 1 GW of rooftop solar PV projects were auctioned by various government bodies in the first nine months of 2017.

Madhya Pradesh's state-owned electricity distribution company (discom) discovered ultra-low tariffs in the range of Rs1.38 -2.17/kWh (net of capital subsidies) in its 8.6 MW solar rooftop auction held in October 2018. Some of India's

³ The World Bank, [India Project Update: Grid Connected Rooftop Solar Photovoltaic Program](#), 27 February 2019.

⁴ PIB, [MNRE](#), 27 December 2017.

⁵ Clean Technica, [KfW Signs €200 Million Loan To Promote Renewable Energy In Rural India](#), 23 August 2018.

⁶ BNEF, [Accelerating India's Clean Energy Transition](#), 28 November 2017.

top solar developers such as Cleantech Solar, Hero Energy and Azure Power won capacities in these auctions.⁷

A similar RESCO model auction for rooftop solar by the Delhi-based discom BSES obtained a tariff of Rs2.66/kWh (net of generation-based incentive) in Dwarka. According to BSES, 100 housing societies and apartment complexes signed up for the initiative in Dwarka and of these, around 25 are reported to have installed rooftop solar capacities of 1.5 MW.⁸

The Government of India is supporting installation of rooftop solar PV by providing a subsidy of Rs18,750/kW(peak) (Rs45,000/kWp for special category states), requiring commissioning in a specified amount of time. With rising competition and falling solar module prices, this has further enabled a price reduction in tenders for the installation of rooftop solar in government buildings.

Indian Railways has also committed to developing 5 GW of solar by 2025. The corporation is currently buying power at Rs5/kWh. The installation of solar power from an array of PV cells deployed along electrified tracks and on railway station rooftops will help them save 20% of their energy bill in the first year and 40% thereafter.⁹

Commercial and Industrial Consumers Driving Growth

Solar is now cheaper than commercial and industrial grid tariffs in all major states in India, with average tariffs between Rs6-11/kWh. This is due to the fall in the levelized cost of electricity (LCOE) for rooftop solar, averaging between Rs3-5/kWh.

For C&I consumers the payback period is down to 3-4 years and will likely further reduce with the fall in equipment costs coupled with the rise in retail tariffs of C&I consumers by ailing distribution utilities.

As such C&I consumers can, over time, enjoy a financial gain if they shift to rooftop solar plus battery storage on account of tariff arbitrage - the practice of purchasing electricity from the grid when it is cheap and storing it for later use.

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Carbon emission reduction is also an important driver for many C&I consumers. This is particularly so for multinational firms who have signed up for the global RE100 program - a global corporate leadership initiative bringing together influential businesses committed to 100% renewable electricity.¹⁰

⁷ Mercom India, [Lowest Tariff Drops to ₹1.38/kWh in Madhya Pradesh's 8.6 MW Rooftop Solar Auction](#), 5 October 2018.

⁸ Mercom India, [Delhi's BSES Launches its second phase of its solar city program](#), 29 Oct 2018.

⁹ PV Magazine, [Indian Railways plans to tender 4 GW solar project](#), 17 January 2019.

¹⁰ RE 100, [there100.org](#).

Despite the high upfront capital cost of rooftop solar installation, with such a fast payback, C&I consumers have the ability to make the investment on their own.

Further, the accelerated depreciation benefit allowing investors to claim 40% asset depreciation in the first year of installation - reduced from an 80% accelerated depreciation allowance prior to 2017 - is an additional factor driving the market.

Large C&I consumers are now opting for the RESCO model to reduce technology and performance risk. However, the lack of financing for RESCO firms is a dampener.

To avail net metering benefit provided to consumers and not developers, many C&I providers are offering storage and energy management solutions. However, with a lack of familiarity and proven case studies, plus complications with roof leasing, this model has not been very successful to date.

Uncertainty in regulations is slowing the pace of rooftop installation by C&I consumers. For instance, there is a high degree of uncertainty regarding the open access charges.

Most states provide exemptions including the energy export fee (wheeling charges), the cross-subsidy surcharge (CSS) and the additional surcharge, however certain states are now rolling back such concessions.

This is a counterproductive move in terms of achieving national benefits, but reflective of the massive consumer subsidies for electricity and the lack of financial viability of most distribution companies.¹¹

The economic costs are potentially greatly impacted with changes in these charges, creating uncertainty and impacting the viability of rooftop solar projects.

Residential Rooftop Solar to Drive Growth in the Future

The residential consumers rooftop solar uptake has been limited in India, despite the 30% capital subsidy offered by the government (70% to special category states).

Various factors have contributed to this slow growth including:

- Timely disbursement of subsidies
- Low residential electricity tariffs
- Availability of finance
- The difficulty of the process and the lack of timely approvals of net metering applications
- Lack of consumer awareness

¹¹ Renewable Watch, [Big Consumers, C&I segment emerges as the mainstay of the rooftop solar business](#), February 2019.

- Policy uncertainty
- Bureaucratic hassles
- Limited support from loss-making discoms that fear revenue leakage.

Recently, the Government of India announced Phase II of the Grid Connected Rooftop Solar Programme.

In the second phase, the government is offering a 20- 40% financial subsidy to residential consumers for new rooftop solar installations ranging between 3- 10kW, including user-clusters such as housing societies.¹² This financial support should accelerate residential rooftop solar installations.

Rooftop solar can be a win-win solution for both consumers and discoms while reducing Indian reliance on imported fossil fuels.

Rooftop solar is a win-win solution for consumers and discoms.

For consumers, it can provide a reliable supply and assist in the replacement of polluting, imported diesel generator sets. It can also be harnessed for demand side management and be a source of revenue - by selling excess power into the market.

For discoms, it can help minimise transmission and distribution losses given local power consumption.

With the continuing decline in LCOE due to the reduction in capital costs, and with increasing competition in the market, affordability is improving.

The development of new financing models and improved consumer awareness over time will also lead to better growth prospects for this market.

Consumers are increasingly more informed about rooftop policies and incentives, cost savings, equipment quality, operations and maintenance (O&M) care, and other industry innovation and best practices.

Net metering could also boost rooftop solar uptake. Simplifying the application process and removing regulatory uncertainties around net metering, open access charges and so forth can help accelerate the deployment of rooftop solar by residential consumers.

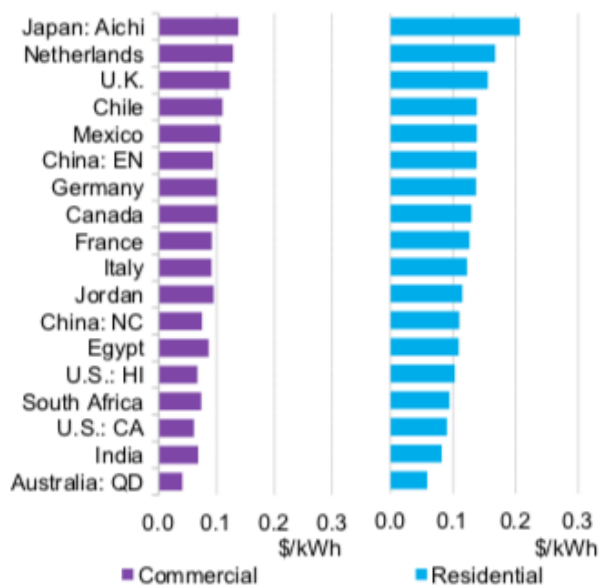
¹² ET Energy World, [Rooftop solar: Another welcome push in the right direction](#), 2 April 2019.

India Can be a World Leader in the Rooftop Solar Market

India's rooftop solar PV costs are among the lowest in the world.

As per the BNEF report,¹³ the LCOE of rooftop solar PV for both residential and commercial consumers in India is low due to low capital expenditure costs. It is now 39-50% lower than the global average cost.

Figure 4: Global Rooftop PV Subsidised Levelized Cost of Electricity (LCOE) in 2017



India's rooftop solar PV costs are among the lowest in the world.

Source: Bloomberg New Energy Finance

California

California has become the global leader in renewable energy, with renewables supporting 34% of total state energy needs.

California's renewable energy portfolio standard requires power companies to have a 50% share of energy from renewable energy sources, providing the much-required impetus in harnessing clean energy technologies.

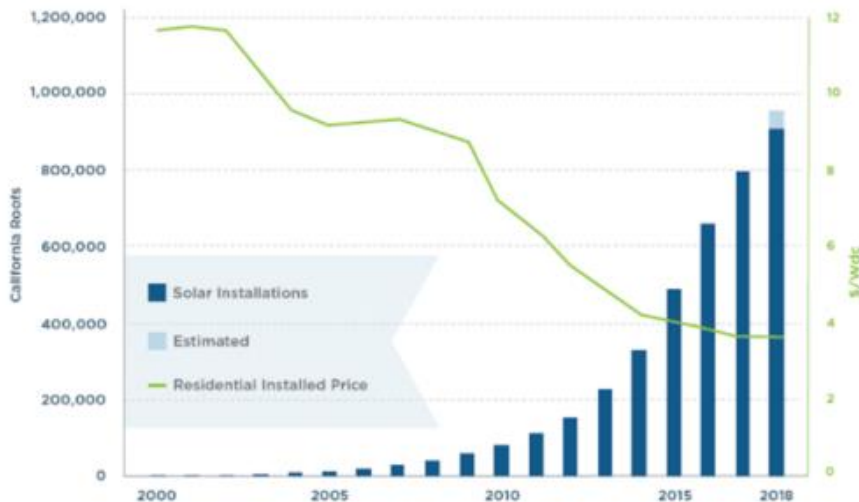
The state has made tremendous progress, reaching 1 million rooftop solar installations by early 2019.

In May 2018, the state government mandated compulsory rooftop solar on all new single-family homes from 2020 onwards as a new strategy to continue to enhance energy efficiency gains across the state.

¹³ BNEF, *Accelerating India's Clean Energy Transition*, 28 November 2017.

The rooftop solar requirement will add around US\$9,500 to the cost of new houses but is expected to be offset by energy bill savings of US\$19,500 over the 30-year period.¹⁴

Figure 5: Rooftop Solar Installations in California



Source: California Energy Commission, IEEFA

Japan

Japan has promoted the development of rooftop solar PV installations through subsidy incentives to developers in the form of a generous solar feed-in-tariff (FIT) - a rate paid for electricity fed back into the electricity grid from a designated renewable electricity generation source such as a rooftop solar.

As part of ongoing efforts to reduce high solar power prices in Japan, the FiT has been progressively reduced and a tender program introduced from FY2017.

Japan's PV installation peaked in 2015 with 10.8 GW and installation rates have progressively declined since then.

Despite this, Japan is likely to achieve its solar installation target of 64 GW by 2030 in the next two years, a decade ahead of schedule.

For residential consumers, the solar FiT is set at JPY 24 -26/kWh (US\$0.22-0.24) depending upon the region.

Residential consumers are now looking at options post FiT business model and beyond self-consumption, in combination with electric vehicles (EVs) or batteries, retrofitting storage, sale of surplus electricity via one-on-one contracts with utilities or power producers and suppliers (PPSs), and a newly formed power distribution business under Japan's electricity market reform.

¹⁴ CNBC, [California clears final hurdle for state's landmark solar panel mandate for new homes](#), 6 December 2018.

Further, in 2018 Japan Electric Power Exchange (JEPX) issued tenders for non-fossil-fuel certificates and is also planning to introduce futures contracts. Such measures will drive solar rooftop installation in Japan over the coming years.

Figure 6: Solar PV Installation in Japan

Annual installed PV capacity in Japan 2011–2019



Source: *PV Magazine*

For the non-residential sector, the Japanese Ministry of Economy Trade and Industry (METI) has reduced the FiT by 22% from the previous year. It has also set a 3-year deadline for the completion of projects over 10kW in size that had signed contracts with a utility after 1 August 2016.

Given the slow progress of construction, in December 2018 METI announced new measures to address the FiT approved pipeline which had not yet commenced operation. Further, the government is pushing deployment through the tender route.

With improved economic cost due to the decline in PV module and inverter prices, but also the declining availability of land, it is likely there will be increased developer interest to install rooftop solar PV.

Australia

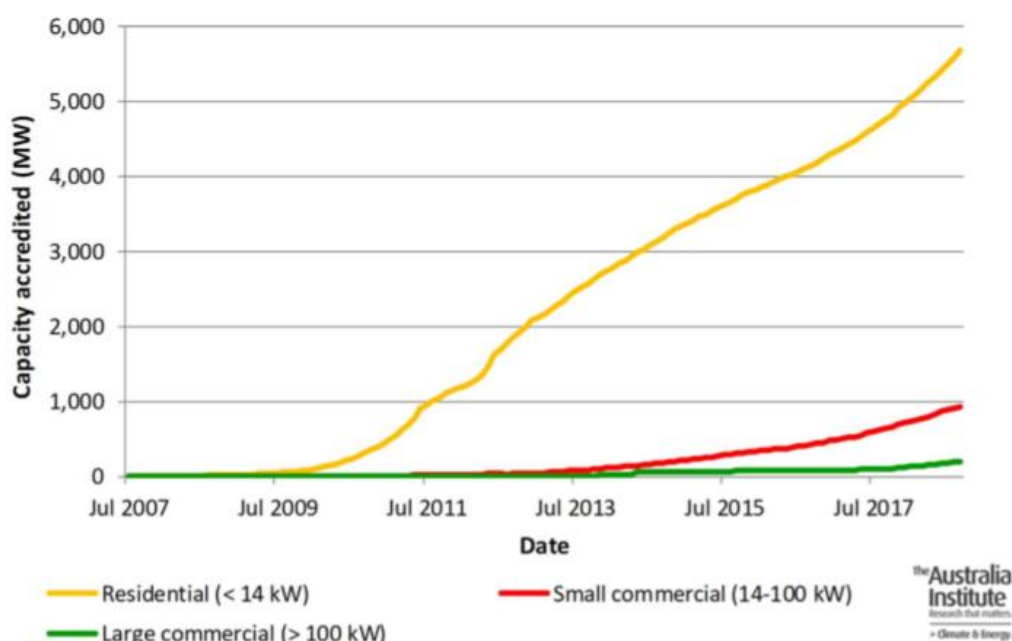
Australia is seeing a massive surge in solar generation contributing to 14-15% of total generation in the country. In the last six months, total renewable generation (including wind, biomass and hydro-electricity) has increased to consistently supply 20-25% of Australia's total electricity generation.

The declining LCOE of solar PV has made it increasingly competitive with other sources of generation, even adjusting for the cost of firming.

The rate of rooftop solar installs has continued to accelerate to a record 1.6 GW of total additions in calendar year (CY) 2018, with residential rooftop solar dominating the solar growth story in Australia over the last decade.

The surge was led by generous feed-in-tariff subsidies and more recently by the successful implementation of the Renewable Energy Target (RET) - an Australian government scheme designed to reduce emissions of greenhouse gases in the electricity sector. Now the surge reflects simple cost-competitiveness.

Figure 7: Total Rooftop Solar Capacity in Australia's National Electricity Market (NEM)



Source: *National Energy Emission Audit, Electricity Update*

Since 2017, the large-scale C&I market in Australia has been 'taking off', having moved below grid parity.

IEEFA expects 2019 to be a record year of near 100% year-on-year growth in this sector. This is being driven by the uptake of corporate power purchase agreements delivering on wider corporate social responsibility goals while also providing an immediate 20-30% annual electricity cost savings, as wholesale electricity price inflation in Australia continues to inflate C&I tariffs.

The growth in self-generation from rooftop solar has helped the country replace ten end-of-life coal-fired power plants in the last six years, reducing CO₂ emissions and at the same time providing the replacement capacity to meet demand.¹⁵

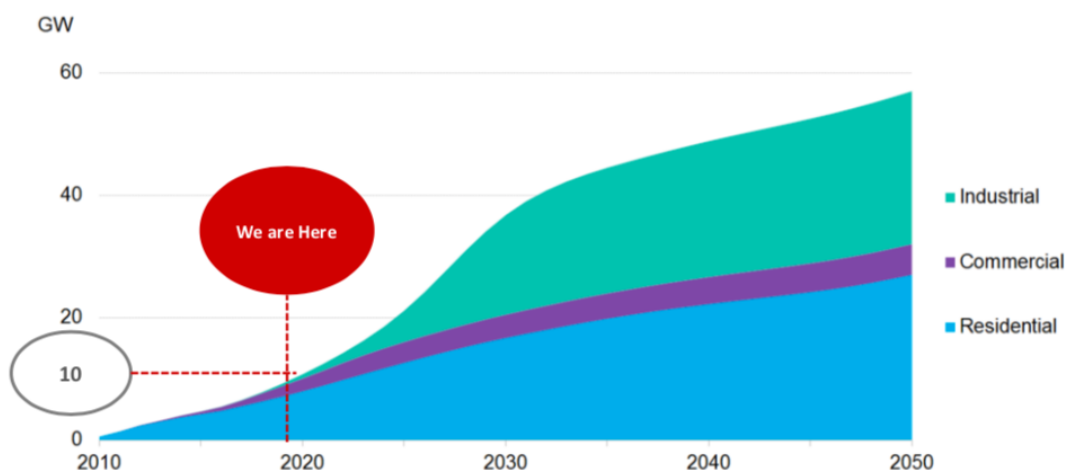
¹⁵ Climate Council, [End of the Line: Coal in Australia](#).

The transition to clean energy is being led by Behind-the-Meter (BtM) solar plus storage in Australia, changing the nature of both supply and demand. Both grid-scale, electric vehicle-related and BtM residential storage is reporting enormous growth of this new and increasingly commercially competitive technology.

While the rapid uptake of utility-scale renewable energy is bringing with it grid congestion, distributed rooftop solar is increasingly viewed favourably as a better alternative distributed energy resource (DER), combined with the deployment of smart meters and advanced demand response management (DRM) technologies.

As per BNEF forecasts, there is a huge potential market in Australia for BtM solar PV capacity along with storage capacity, and it is likely Australia will become a leading market for storage and rooftop solar PV installation.

Figure 8: Behind-the-Meter PV Capacity in Australia



Source: BNEF, Australia Behind-the-Meter PV & Storage Forecast, May 2018

Untapping the Huge Potential of India's Rooftop Solar

The rooftop solar market holds huge growth potential across India and should be exploited to help meet the growing energy requirements of the population.

Rooftop solar PV can meet the electricity needs of consumers, and given the government's push for induction cooking, it can also enable people to switch from imported kerosene or biomass to clean, sustainable domestic cooking solutions.

With declining PV module and storage costs, rooftop solar can provide a quality and reliable electricity supply in a cost-effective way.

By reducing grid demand growth, distributed rooftop solar also helps address growing transmission connectivity infrastructure requirements.

Distributed rooftop solar can be incorporated in such a way as to help reduce the financial losses of discoms in India. Given discoms perceive rooftop solar as a threat

to their business, it is important their concerns are protected through technical and financial support.

There are already many lessons to be drawn from successful utilities employing rooftop solar. Examples include Tata Power discoms who have successfully launched residential rooftop solutions in Delhi, Mumbai, Ajmer, Bhubaneswar, Gandhinagar, Bengaluru, Cochin, Chennai, Hyderabad and Chandigarh.¹⁶ And Tata Power, with government subsidy support, has provided quality products, world-class customized solutions, and extensive service support to rapidly increase the deployment of rooftop solar installations.

India can also learn from the success stories of other countries like Australia, Japan and California (USA) to become one of the leading countries in rooftop solar installations.

California for instance succeeded in becoming a progressive green state by raising awareness, providing subsidies, introducing policies and enforcing mandates of renewable energy targets.

India should follow the same footsteps and create a conducive environment by offering policy certainty, easing the process of net metering application, providing policy support for domestic manufacturing, favouring quality products, offering financial support, and raising consumer awareness.

To achieve 40 GW of rooftop solar installation by 2022, the total funding requirement is estimated to be over INR 2.8 lakh crore (USD 40 billion).¹⁷ Access to finance and innovative financial instruments needs to be introduced to provide the required capital for rooftop solar PV installation.

Increasing rooftop solar installation will help the government via huge savings gained from switching from diesel and coal for electricity and kerosene and liquefied petroleum gas (LPG) for cooking. Those savings can be redirected for the promotion of rooftop solar.

Shifting subsidies away from imported fossil fuels and reallocating to assist the capital cost of rooftop solar deployments is one way to fund the energy transition for marginalised households.

Recently, the Ministry of New and Renewable Energy (MNRE) requested the Ministry of Petroleum and Natural Gas (MoPNG) divert a part of the cooking gas and kerosene subsidy (INR 25,000 crore per year) towards solar PV cooking.¹⁸

¹⁶ Tata Power, [Tata Power Solar now launches an extensive residential rooftop solution at Hyderabad](#), 14 February 2019.

¹⁷ Down to Earth, [Renewable energy in India: why rooftop remains the most untapped solar source](#), 20 January 2019.

¹⁸ Financial Express, [Power to the kitchen: Govt to promote electricity as cooking fuel](#), 25 April 2019.

The government should also consider the redirection of kerosene and LPG subsidies towards rooftop solar PV as it can help achieve the twin objectives of meeting the lighting and cooking requirements of consumers.

About IEEFA

The Institute for Energy Economics and Financial Analysis conducts research and analyses on financial and economic issues related to energy and the environment. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy. www.ieefa.org

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