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Role of distributed resources in energy transition: A multi-country perspective

- *Despite the continued dominance of centralised electricity systems built around large power plants and transmission networks, distributed energy resources (DERs) are demonstrating their ability to deliver clean, affordable energy. Case studies of Australia, India and Bangladesh highlight the growing role of DERs, with rooftop solar emerging as the dominant source.*
- *In Australia, solar panels are now installed on 40% of homes. Supported by early feed-in tariffs and government rebates, rooftop solar grew from near-zero to 13% of total electricity generation in the country's largest electricity grid between 2014 and 2025, while coal's share fell from 75% to 52%. Australia is now experiencing a residential battery boom, with nearly 10 gigawatt-hours (GWh) installed less than a year since federal rebates were introduced.*
- *In Bangladesh, rooftop solar has grown faster than other DERs. While government data reports 418.1 megawatts (MW) of rooftop solar capacity till June 2026, IEEFA estimates it has reached 667MW in 239 establishments, including groups of companies. If the assessment were to include units below 0.15MW, Bangladesh's rooftop solar capacity might already be around 1,000MW. This growth has contributed to a slight decline in daytime power demand, based on comparisons between 16 April–11 June 2024 and the same period in 2026.*
- *Government-led schemes have driven India's DER growth, particularly solar. Subsidies, concessional finance, and supportive policies have accelerated rooftop solar and agricultural solarisation, increasing distributed solar capacity from 1.8GW in financial year (FY) 2018 to 31.5GW in FY2026.*

Background

Electricity systems have traditionally been built around large power plants and transmission networks. While these centralised systems continue to dominate, distributed energy resources (DERs) — such as rooftop solar, solar irrigation, biogas, and small-scale batteries — are increasingly demonstrating their ability to deliver affordable and clean energy.

As countries electrify their transport systems, electric vehicles (EVs) are also emerging as a potential form of DER through technologies such as vehicle-to-grid (V2G), allowing them to store and feed electricity back into the grid when needed.

Recent global energy supply disruptions, including those triggered by the West Asia crisis and the resulting spikes in fuel prices, have once again highlighted the urgency of accelerating energy transition. Supported by enabling policies, DERs could rapidly transform energy systems across the globe.

Different countries have achieved varying degrees of success in harnessing DERs and their experience could offer valuable lessons for others. For instance, both Australia and India have significantly scaled up DERs in recent years supported by favourable policy frameworks. Meanwhile, after a slow start, Bangladesh's DER sector is gaining momentum for an accelerated expansion.

Through country-specific case studies, this briefing note reviews the status of DERs in Australia, India and Bangladesh, and how such technologies are shaping their power sectors. It also assesses the barriers each country faces in realising its DER potential and offers directions for future development.

Case study: Australia

Status and potential

Australia is a global leader in the uptake of DER, with around 40% of Australian homes having solar panels on their roof. The rise in rooftop solar has had a transformative impact on the country's largest electricity grid — the National Electricity Market (NEM).

Rooftop solar grew from near-zero to over 13% of total electricity generation in the NEM between 2014 and 2025, while coal generation reduced from 75% to 52% in the same period. In certain regions, uptake is even higher than the NEM-wide average. Under the right conditions, rooftop solar in South Australia can supply more than 100% of the state's electricity demand in the middle of the day.

Rooftop solar has impacted wholesale electricity prices in the NEM. In most regions, electricity spot prices are routinely close to zero or negative during the middle of the day, as solar competes with coal generators. And while several factors have led to increased electricity prices in Australia over the past decade, evidence suggests that wholesale prices are considerably lower than they would have been in a counterfactual scenario where renewable energy, including rooftop solar, had not displaced coal.

The emerging frontier for DER in Australia is residential batteries. In July 2025, the federal government launched its Cheaper Home Batteries Program, offering significant subsidies for the installation of residential batteries. Within the first 10 months, Australians installed more than 340,000 small-scale batteries, adding a total storage capacity of 9.4 gigawatt-hours (GWh). This is significant, considering that the NEM had 16.6GWh of registered utility-scale battery storage at the start of 2026.

The rapid uptake of residential batteries could have a transformative effect of its own. Batteries are highly effective at reducing household energy demand during peak periods. This could displace some of the need for gas generation, one of the most expensive forms of electricity generation in the NEM and a major driver of electricity prices.

Policy and drivers

Early uptake of rooftop solar in Australia was accelerated by lucrative feed-in tariffs that rewarded households for exporting excess solar power to the grid. Between 2009 and 2010, the earliest adopters in New South Wales and Victoria could take advantage of feed-in tariffs that went as high as AUD0.60/kilowatt-hour (USD0.42/kWh). However, following a period of strong growth in rooftop solar, feed-in tariffs fell to around AUD0.05–0.15/kWh (USD0.04-0.11/kWh) by the mid-2010s.

Rooftop solar installations received a further boost with the introduction of the federal government's Small-scale Renewable Energy Scheme (SRES) in 2011.

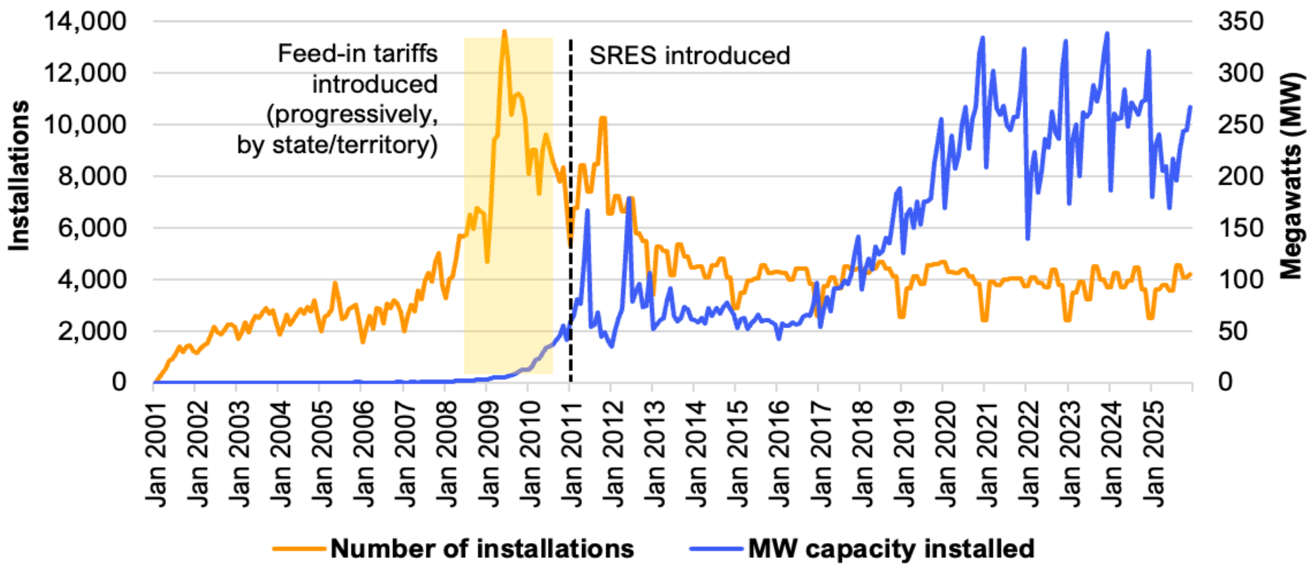
Under the SRES, rooftop solar installations generate small-scale technology certificates (STCs) which can be sold to energy retailers, who are required to purchase these certificates to meet annual renewable energy obligations. This effectively creates a subsidy, passed through to households as a discount on the cost of rooftop solar panels.

SRES rebates were designed to decline over time, and generous feed-in tariffs are now mostly gone. In Victoria, for instance, there is no longer a minimum feed-in tariff and retailers can choose not to offer a feed-in tariff.

However, this has not stopped Australians from installing rooftop solar. While incentives have reduced, so has the cost of solar panels. The strong, early growth in rooftop solar also means Australia has a very mature solar installation industry, with installation costs far lower than other comparable economies. Meanwhile, retail electricity prices have risen. This combination has meant there is still a strong value proposition for installing rooftop solar for self-consumption purposes.

In fact, while the number of rooftop solar installations has declined from its 2009 peak, the average size of installed systems has grown significantly in recent years. As a result, annual rooftop solar capacity reached its highest-ever level during the 2020s (see Figure 1).

Figure 1: Monthly rooftop solar installations in Australia (Jan 2001 to Jan 2026)



Source: Clean Energy Regulator
Note: Initial feed-in tariff schemes were introduced by states and territories between July 2008 and July 2010.

And, of course, households now also have an alternative to exporting their surplus electricity to the grid — storing it in a battery for later use.

The response to small-scale battery subsidies has far exceeded most expert forecasts. The sheer number of installations has been remarkable with an average of 35,000 batteries being installed per month since the scheme began, peaking at 46,000 in March 2026. Meanwhile, the average size of batteries has expanded from about 12kWh before the programme's implementation to around 29kWh today. And while Australia's federal government announced several tweaks to the Cheaper Home Batteries Program in 2025 that may temper the installation of some larger systems, it is still expected to deliver 2 million small-scale batteries by its conclusion in 2030 — equivalent to 40GWh storage capacity.

Analysis by IEEFA shows why solar and battery systems are such an attractive option for consumers, offering the potential to lower energy bills by 82–94% when combined with other home energy upgrades.

Challenges

Due to its high uptake of DERs, Australia is one of the first countries to also confront the challenges associated with these resources.

For example, electricity distribution networks have had to adapt to significant two-way flows of electricity. While initial approaches were blunt, imposing conservative, static export limits of five kilowatts (kW) or less, some networks have moved towards flexible exports, also known as dynamic operating envelopes (DOEs), which lets the export limit be adjusted depending on actual network conditions, and generally allow for much higher export limits most of the time.

The regulations that govern electricity networks were not designed with high DER uptake in mind. As DER adoption grows, it has raised questions about whether electricity networks should still be considered monopoly service providers. DER presents a cost-effective alternative or complementary way to access electricity for many households.

A meta-analysis by IEEFA found that DER could deliver AUD19 billion (USD13.3 billion) in economic benefits to Australia by 2040, with AUD11 billion (USD7.7 billion) coming from reduced network costs. However, a first-principles review of electricity network economic regulation is likely needed to ensure these benefits are passed on in full to consumers.

In recent times, the uptake of DER has raised some questions on equity. For instance, renters comprise a little over 30% of Australian households. They are responsible for paying energy bills, but landlords are the ones responsible for property improvements. This creates a structural 'split incentive' problem which cannot be overcome without measures such as minimum energy efficiency standards for rentals.

Apartment dwellers are also less likely to have access to rooftop solar and batteries, as are lower-income households. However, rooftop solar and battery ownership in Australia shows a weak negative correlation with median suburban income, indicating adoption is not concentrated in wealthier areas.

Targeted government policies will be needed to overcome these divides. So far, policy responses to this challenge have been piecemeal and, in some cases, may even risk undermining the uptake of DERs.

Recommendations

While most forecasts expect continued growth in rooftop solar and battery installations in Australia, many of these forecasts have struggled to keep up with the rapid surge in residential batteries under the Cheaper Home Batteries Program.

In the near term, policies will need to focus on ensuring this uptake is equitable, and that more households, including renters and apartment dwellers, can access the benefits of solar and batteries.

There is also growing recognition that commercial and industrial (C&I) sites have underutilised hosting capacity for rooftop solar and storage. However, these projects face particular challenges, including complex and inconsistent network tariffs, as well as slow and unpredictable grid connection processes. Unlocking the capacity in this market segment will require further work.

The boom in residential batteries also presents some unexpected opportunities. Most households are installing very large batteries (20kWh and above), which could result in significant underutilised residential capacity on many days of the year. This capacity could be put to work if households are encouraged to export energy to the grid during peak periods, whether as part of a virtual power plant (VPP) or other technology pathways backed by supportive pricing structures.

The continued development of technical standards will also be important to enable more DER technologies to contribute to the broader grid. For example, via interoperability and flexibility requirements. Australia's federal government has now appointed a regulator responsible for developing a National Technical Regulatory Framework.

Finally, as with many countries, the recent West Asia crisis has prompted an uptick in interest in EVs in Australia. In addition to being a cost-effective electric transport option, EVs could be a form of DER themselves. In fact, the battery built into an EV is typically far larger than a standalone residential battery, and often cheaper on a per-kWh basis (with the added bonus of an included car).

As EV uptake rises, the effective roll-out of vehicle-to-home (V2H) and vehicle-to-grid (V2G) technologies could unlock significant, valuable storage capacity for the electricity system. Many EVs are equipped with the necessary technology to enable this, although only a small number of vehicles officially support it. A limited number of V2G trials exist in Australia, and a range of regulatory/administrative barriers will need to be unblocked to enable more widespread use of V2G. It will also be critical to ensure the infrastructure and tariff arrangements exist to enable EV owners to charge their vehicles in the middle of the day, when abundant solar energy is available, and avoid evening peak periods.

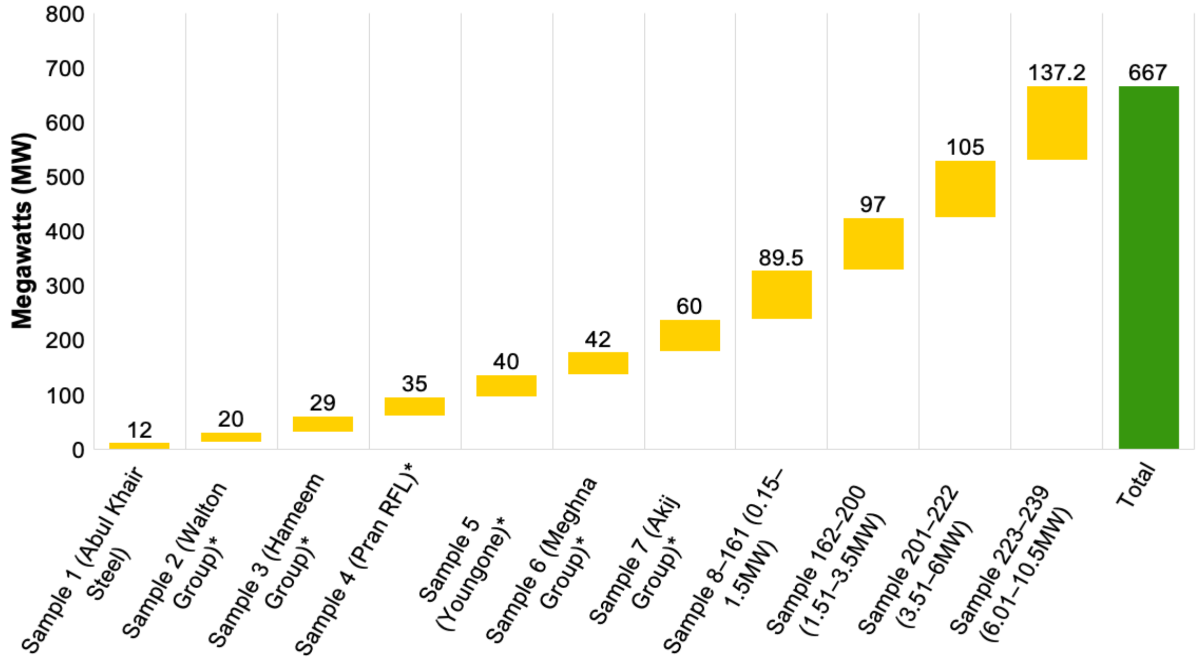
Case study: Bangladesh

Status and potential

Bangladesh's DER sector is beginning to take shape, following increasing industrial interest in rooftop solar as a cheap energy source. In the agriculture sector, there is a growing demand for solar-powered irrigation. Other DER sources, such as biogas, could play a significant role in rural areas, particularly for clean cooking. The difficulty in acquiring land for utility-scale renewable energy projects makes DERs a compelling choice for Bangladesh.

Data from Bangladesh's Sustainable and Renewable Energy Development Authority (SREDA), updated to June 2026, shows that the installed rooftop solar capacity, including net-metered and non-net metered systems, reached 418.1 megawatts (MW). However, IEEFA's analysis — based on discussion with industries; engineering, procurement, and construction (EPC) companies; as well as secondary sources — shows that the country's combined rooftop solar capacity across just 239 establishments, comprising groups of companies, has already reached 667MW (see Figure 2). IEEFA's analysis excludes hundreds of small rooftop solar units with capacity below 0.15MW due to a lack of information. If the assessment were to factor in all small-scale rooftop solar units, the combined capacity would likely reach 1,000MW. Compared to the grid-scale variable renewable energy capacity of 859MW as of June 2026, the country's growing rooftop solar capacity provides an encouraging signal for Bangladesh's power sector.

Figure 2: Rooftop solar capacity in select establishments



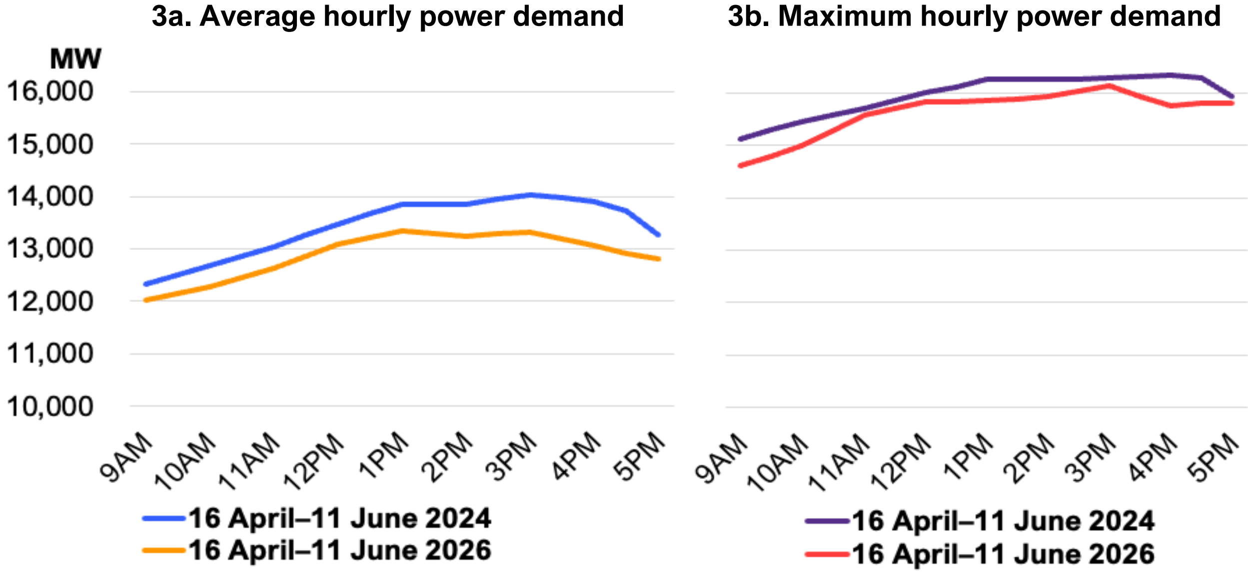
Sources: Discussion with industries and EPC companies; industry and EPC company websites and media briefings; Infrastructure Development Company Limited (IDCOL); SREDA; IEEFA analysis.

**The sample organisations are expanding rooftop solar.*

Note: Since rooftop solar installation are considered based on availability of information, this combined capacity does not include all rooftop solar systems installed in Bangladesh. The combined capacity also excludes any rooftop solar system below 0.15MW. Up to sample 7, big installations by individual companies are mentioned. Following that, samples are grouped within a threshold. For instance, samples 8–161 include installations ranging from 0.15–1.5MW, and they have a combined capacity of 89.5MW.

The installation of rooftop solar systems is gradually influencing Bangladesh's daytime power demand. A comparison of half-hourly daytime power demand data between 16 April and 11 June 2024 and the same period in 2026 substantiates that Bangladesh is experiencing a demand destruction of up to 6% (see Figure 3). Besides comparatively comfortable weather in April and May 2026 and the industry sector's stagnation, the rooftop solar expansion of around 1,000MW appears to have played a catalytic role in this slight destruction in daytime power demand. The highest temperature recorded in April 2026 was less than in April 2024. Moreover, April 2026 also saw more rain; and May 2026 registered below normal maximum temperature. Many industries also reportedly suspended operations due to a financial crisis.

Figure 3: Bangladesh's daytime power demand pattern (9AM–5PM)



Source: Power Grid Bangladesh PLC; IEEFA analysis
Note: Given the impact of FIFA World Cup 2026 football matches on morning power demand, data from 12 June onwards has been excluded

The rooftop solar sector will likely experience accelerated growth over the next one year, with EPC companies holding a project pipeline exceeding 500MW capacity. However, Bangladesh needs to scale up efforts to tap into the potential of several thousand MW of rooftop solar capacity that the industry sector alone offers. Furthermore, the installation of just 30kW of rooftop solar capacity per village could deliver more than 2,600MW across around 87,000 villages.

Likewise, Bangladesh's diesel-dominated irrigation sector offers vast opportunities for the uptake of solar-powered irrigation systems. Despite the implementation of 3,556 solar irrigation pumps, over a million diesel-run systems continue to operate in the country. A full transformation of the sector could lead to an additional solar capacity of 4,000MW, reducing annual diesel imports of around 862.4 million litres. IEEFA's analysis shows that replacing one-third of the operational diesel-powered irrigation systems could cut the country's annual diesel import bill by about USD244 million (BDT30 billion), assuming a conservative diesel price of USD0.85/litre.

On the other hand, biogas currently accounts for a meagre contribution of 0.69MW of installed capacity. While biogas seems to hold significant potential, a proper assessment is necessary.

Policy and drivers

In 2010, the Bangladesh government provided a directive to new buildings and industries to install rooftop solar systems to secure grid connections. Later, in 2018, it issued net metering guidelines to expand rooftop solar through a bi-directional meter. The guidelines were revised in 2019 and then in 2025 to improve the framework conditions to attract industries and other establishments to rapidly scale up rooftop solar systems. These guidelines included increasing the cap on rooftop solar installation from 70% of the sanctioned load to 100%, and waiving the limit of 10MW rooftop solar capacity for a single establishment, allowing buildings/industries with large spaces to install higher capacity solar rooftop systems. It further set a timeline of 10–15 days to approve requests for net metering connections.

The Bangladesh government also approved separate guidelines to allow grid integration for solar irrigation systems in 2020. In 2025, the government announced a goal of installing 3,000MW of rooftop solar capacity in less than six months, targeting establishments, like government offices, educational institutions and hospitals. However, amid concerns over feasibility, it relaxed the timeline.

Rooftop solar, solar irrigation pumps and biogas are eligible for Bangladesh Bank's green finance offered at low-interest rates. Moreover, the Infrastructure Development Company Limited (IDCOL), with access to low-cost funding from multilateral development agencies, is a major source of debt finance for these sectors. The IDCOL, alongside Bangladesh Agricultural Development Corporation (BADC), supported by development agencies, provides subsidies for solar irrigation systems to make them financially viable.

Despite the presence of guidelines and low-cost financing, it is the rising power tariff that has emerged as one of the key factors for adoption of rooftop solar in the country. Likewise, the high cost of diesel motivates agricultural entrepreneurs to invest in solar irrigation systems.

Challenges

High duties on imported accessories, ranging from 28.73% to 61.8%, raise project cost and discourage the large-scale adoption of rooftop solar and solar irrigation in Bangladesh. The government has reduced import duties for rooftop solar systems under both capital expenditure (CAPEX) and operating expenses (OPEX) models, with similar benefits extended to rooftop solar projects integrated with battery energy storage systems. However, EPC companies are required to provide evidence of a project implementation contract to avail the duty benefits. Since traders, who mostly sell components for small projects in rural areas, are not EPCs, many of these projects are unlikely to receive the duty benefits. Additionally, the new duty structure increases the cost of rooftop solar projects in industries. Stakeholders have shared that prior to the recent change, industries could import rooftop solar components under the provision of capital machinery at 1% duty, but they now attract a 17% duty. With the government stipulating a target to install a renewable energy capacity of 10,450MW between 2026 and 2030 in its strategy document, relying on rooftop solar for more than 50% of new capacity, a full duty waiver for all rooftop solar projects will likely help achieve the goal.

Despite the fixed timeline for approving the application for net metering connections, both rooftop solar and solar irrigation projects encounter delays in obtaining net metering connections through distribution utilities. This is a significant bottleneck. IEEFA, based on available data, calculates that more than 93% of the solar irrigation capacity (MW) is off-grid. Since Bangladesh requires irrigation for around 110–150 days a year, solar irrigation pumps normally remain idle for the rest of the year without net metering connections. This raises feasibility concerns about solar irrigation projects.

While low-cost financing is available, the funding size is limited, and financial institutions are reluctant to provide loans to rooftop solar projects. Barring IDCOL, most financial institutions do not normally offer loans to solar irrigation projects due to perceived risks and lack of information on the borrowers' credit profiles. Small-scale biogas projects experience similar challenges in accessing finance. Most financial institutions seek high collaterals which industries or businesses often find difficult to provide.

Additionally, a lack of quality control and monitoring has led to a surge in installation of sub-standard rooftop solar systems, particularly in the new apartment buildings, impacting the households' confidence in rooftop solar.

Recommendations

Scaling up DERs in Bangladesh will hinge on effective policy and a financing ecosystem. While the government has taken an important step towards reducing the high duties on imported distributed solar components, the requirement of a project implementation contract may prevent many stakeholders, such as households, from accessing these benefits from the customs department. Further, industries are facing higher duties. The government should revisit its policy stance to provide a full duty waiver under an inclusive approach. Further, the government should extend this benefit to solar irrigation projects as well.

Since the existing Bangladesh Bank green finance fund size is inadequate to meet the demand of the DER sector, the government could consider expanding the funding base. It should also design a credit risk guarantee scheme to reduce the requirements for collaterals and address financial institutions' concerns about extending loans to DER projects.

Net metering connections are vital for both rooftop solar and solar irrigation projects. The SREDA and the Ministry of Power, Energy and Mineral Resources should monitor the status of online applications for net metering connections and undertake measures to avoid delays in approval.

SREDA should devise a protocol for quality checks in small-scale DERs to dispel uncertainty over performance of such systems. It should also update the installed capacity of DERs to help the government assess the county's overall renewable energy capacity and take informed policy decisions for the power sector.

While the industry sector is mainly driving the rooftop solar expansion, the government could consider incentivising households to take up the same. In addition to duty benefits, a capital subsidy to households with lower energy tariffs could help accelerate the rooftop solar promotion.

Case study: India

Status and potential

India has significant potential for distributed renewable energy, particularly solar, driven by strong resource availability and decentralised demand. According to the Ministry of New and Renewable Energy, the country receives 4–7kWh per square meter per day (kWh/m²/day) of solar radiation, with an estimated 5,000 trillion kWh of solar energy annually. This creates a strong foundation for decentralised solar deployment across households, agriculture, and small enterprises.

Government assessments indicate that rooftop solar alone has a technical potential of 637GW, while the residential segment accounts for a substantial share of this potential. In addition, the agriculture sector presents a major opportunity, with over 29 million irrigation pumps that can be solarised under decentralised models such as feeder-level solarisation and standalone solar pumps.

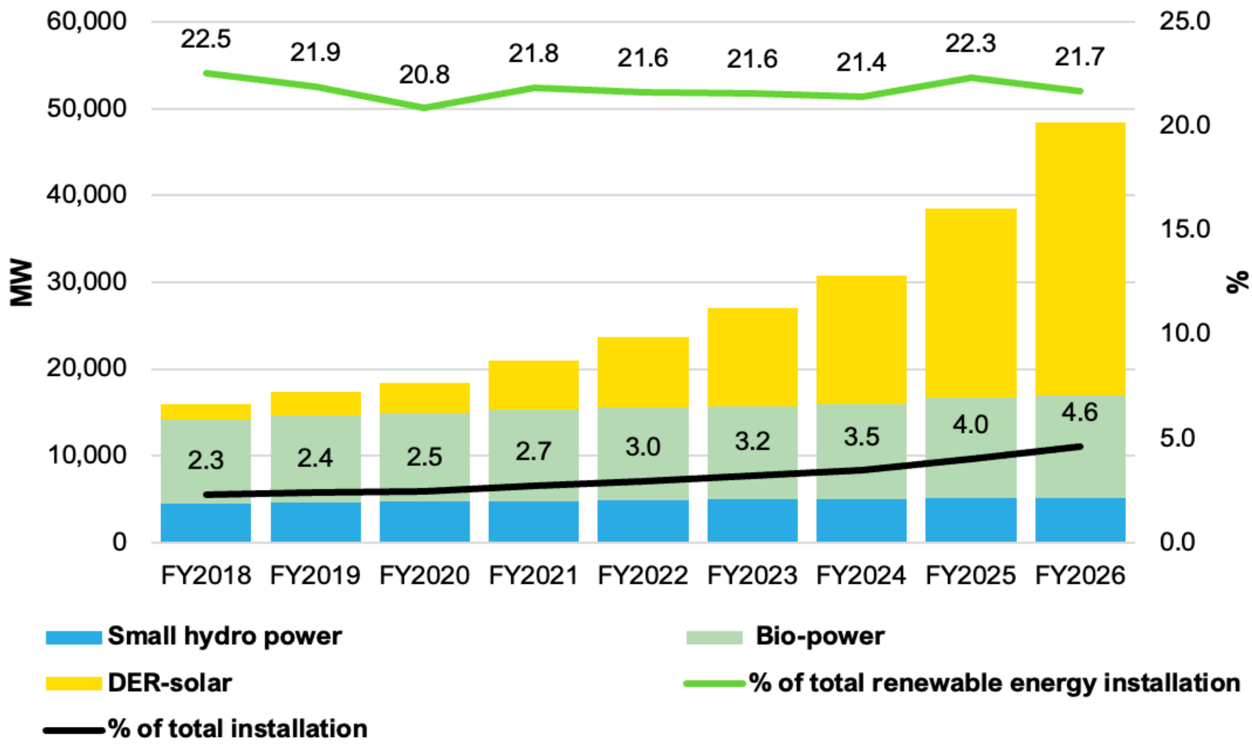
Beyond solar, other DERs, such as small hydro and bioenergy, also offer meaningful decentralised generation potential. India's small hydro potential is estimated at 21GW, primarily in hilly and remote regions, of which only about a quarter has been tapped, indicating significant scope for expansion. Similarly, bioenergy potential is estimated at 42GW, based on the availability of agricultural residues, biomass, and urban waste.

DER also plays a critical role in improving energy access, reducing transmission and distribution losses, and enabling productive rural livelihoods. Its decentralised nature makes it particularly relevant for states with dispersed populations and weak grid infrastructure.

India's DER segment presents a nuanced picture when viewed against the broader renewable energy transition. While DER capacity, particularly solar, has grown significantly in absolute terms, its share within total renewable energy has remained largely stagnant at around 21–22% between financial year (FY) 2018 and FY2026 (see Figure 4). This stagnation is primarily due to the much faster expansion of utility-scale solar capacity in India, which has dominated overall renewable energy additions. As a result, even though DER-solar increased sharply from 1.8GW to 31.5GW, its relative contribution within the renewable mix has not improved meaningfully.

The C&I segment has historically been the primary driver of India's rooftop solar market supported by high retail electricity tariffs, attractive payback periods, and increasing corporate sustainability commitments. While the residential rooftop solar segment has witnessed rapid growth since the launch of the Pradhan Mantri Surya Ghar Muft Bijli Yojana, the C&I sector continues to account for a significant share of the country's distributed solar capacity. In 2025 alone, industrial and commercial consumers accounted for about 23% of new rooftop solar installations (18% industrial and 5% commercial), while the residential sector accounted for most of the new additions driven by government subsidies.

Figure 4: Growth of DER in India



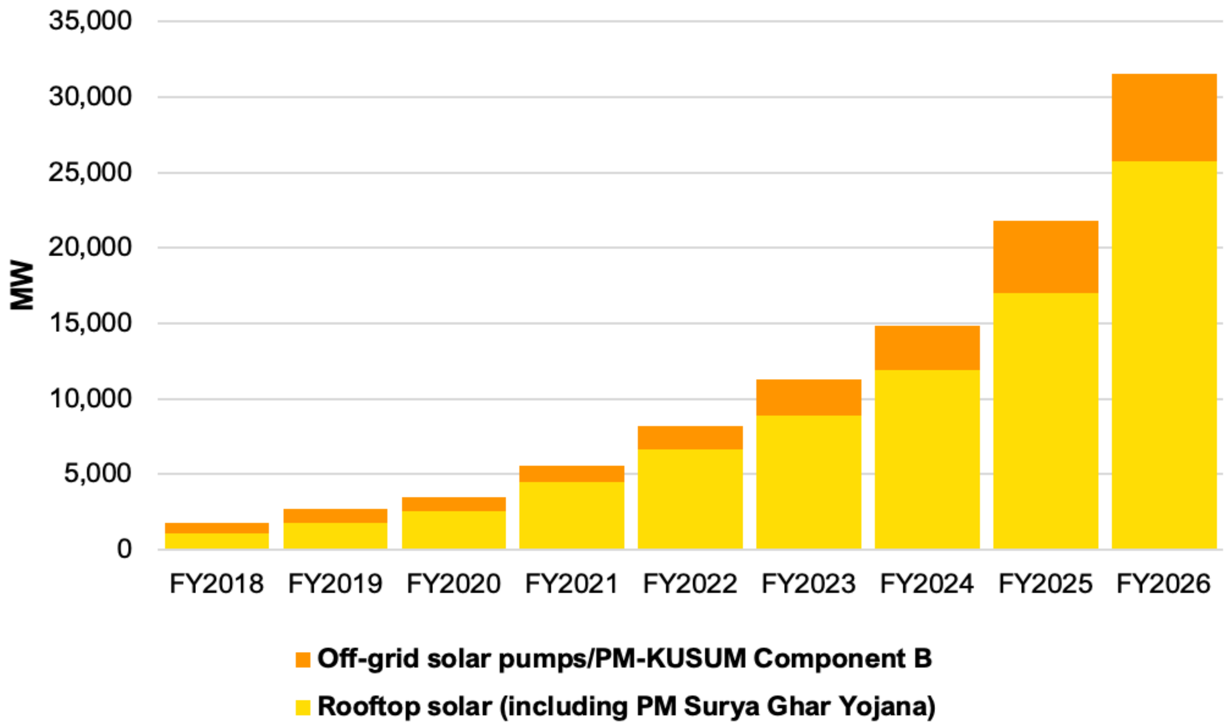
Sources: MNRE reports.

Policy and drivers

Major schemes on DER

The PM Surya Ghar Muft Bijli Yojana and Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) are India's flagship schemes driving distributed solar deployment across residential and agricultural segments. PM Surya Ghar aims to install rooftop systems in 10 million households, supported by capital subsidies of up to 60%, concessional financing, and simplified digital processes, significantly accelerating residential adoption in urban and semiurban areas. In parallel, PM-KUSUM targets 30.8GW of distributed solar capacity through solar pumps and feeder-level solarisation, reducing farmers' reliance on grid electricity and diesel while easing distribution companies' (DISCOM) subsidy burdens. Together, these schemes have created strong market demand, expanded deployment across consumer segments, and accelerated the growth of distributed solar capacity in India.

Figure 5: DER-solar installations in India



Sources: MNRE reports.

The data shows a strong acceleration in distributed solar in India, aligned with targeted government schemes. Rooftop solar, including under PM Surya Ghar, grew from 1.1GW in FY2018 to 25.7GW in FY2026, with rapid expansion post-FY2022 driven by subsidies and simplified processes. In parallel, off-grid solar pumps under PM-KUSUM Component B increased from 0.7GW to 5.8GW, reflecting steady growth in the agriculture segment. While rooftop solar has scaled rapidly, KUSUM scheme's deployment has been slower due to financing and implementation challenges. Overall, both schemes have been key drivers of DER growth, with PM Surya Ghar accelerating scale-up and PM-KUSUM enabling gradual expansion in rural areas.

Business models

India's DER expansion is driven by diverse business models across segments. Under PM Surya Ghar, the CAPEX model dominates, with households investing upfront and benefiting from subsidies and net metering. Renewable energy service companies (RESCO)/OPEX models are gaining traction in the residential segment and are well established in the C&I segment, driven by tariff savings and long-term contracts. The scheme also promotes a utility-led implementation model, where DISCOMs aggregate consumer demand, empanel vendors, and facilitate rooftop solar deployment while receiving performance-linked incentives. This model aims to simplify consumer adoption and better align utility interests with DER expansion.

In the agriculture sector, PM-KUSUM supports mixed models: Farmer-owned CAPEX for solar pumps, utility- or community-led feeder solarisation, and developer-led projects with assured offtake. Beyond these, mini-grids and rural enterprises use pay-as-you-go and service-based models. This diversity of business models has broadened market access, attracted private sector participation, and accelerated DER deployment across urban and rural areas.

Financing and institutional mechanism

The growth of DER in India has been enabled by a combination of public financing, policy incentives, and institutional support. Capital subsidies from MNRE, concessional lending, and priority sector lending provisions have improved the financial viability of distributed renewable energy projects. Institutional mechanisms led by MNRE, supported by the Central Electricity Authority (CEA) of India and state-level agencies, have facilitated programme implementation, market development, and stakeholder coordination. Access to digital platforms, streamlined approval processes, and dedicated implementation frameworks have further strengthened deployment efforts. Together, these financing and institutional mechanisms have played a critical role in mobilising investment, expanding market participation, and supporting the large-scale adoption of DER technologies across India.

Challenges

Despite significant progress, several barriers continue to constrain DER deployment across India. Insights from IEEFA's analysis on residential rooftop solar highlight barriers such as DISCOM resistance, delays in approvals and subsidy disbursement, limited access to affordable financing, and low consumer awareness, all of which constrain residential uptake despite strong policy push. In the C&I segment, frequent changes in net metering regulations, uncertainty around banking and open access policies, lengthy approval processes, and inconsistent DISCOM implementation reduce investor confidence and increase project costs. Limited access to affordable financing also remains a key constraint for micro, small, and medium enterprises (MSMEs). In addition, domestic manufacturing capacity has at times struggled to keep pace with demand, particularly due to domestic content requirement (DCR) provisions.

Beyond rooftop solar, the implementation of PM-KUSUM has been uneven due to financing constraints for farmers, land availability issues, weak DISCOM coordination, and slower feeder solarisation. Meanwhile, other DER technologies, including small hydro and bioenergy, lack comparable mission mode support, resulting in slower deployment despite significant untapped potential. This has led to a solar-dominated DER landscape, highlighting the need for a more balanced policy framework that supports a diverse DER portfolio.

Recommendations

Looking ahead, scaling DERs in India will require a more integrated and predictable policy and regulatory framework. Harmonising net metering regulations across states, ensuring time-bound approvals, and expanding single-window digital platforms for approvals and subsidy processing will improve the ease of deployment and investor confidence. Providing regulatory certainty on open access and banking provisions will further accelerate deployment, particularly in the C&I segment.

Expanding access to affordable finance through blended finance, credit guarantees, and aggregation platforms can mobilise private capital and improve MSME participation. At the same time, strengthening domestic manufacturing capacity will be critical to avoid supply bottlenecks, particularly under DCR provisions, and to support sustained growth in DER deployment. The utility-led implementation model under PM Surya Ghar provides a promising framework for improving consumer outreach and project implementation. Strengthening this approach and extending it to other DER segments could accelerate deployment while aligning

DISCOM incentives with distributed energy adoption. Wider deployment of smart meters and digital monitoring systems will further enhance network visibility and grid integration.

Looking beyond rooftop solar, India should also strengthen policies for emerging DER technologies and business models. Scaling virtual power plants (VPPs), enabling V2G integration as EV adoption increases, and expanding innovative models such as RESCO and feeder solarisation can unlock greater system flexibility and consumer participation. Together with stronger institutional capacity, these measures will position DERs as a key pillar of India's clean energy transition.

Lessons learned from three countries

There are similarities among Australia, Bangladesh and India in terms of policy ecosystem. For instance, all three countries have implemented net metering, while Australia also has feed-in-tariffs. However, there are differences in areas such as approval timelines for net metering connections, and the adoption of smart metering, among others. This section offers a comparative assessment of the enabling factors shaping DER adoption across the three countries.

Enabling factors	Australia	India	Bangladesh
Net metering or feed-in tariffs.	Net metering and feed-in tariffs.	Net metering is available across most states, although eligibility, capacity limits, and compensation mechanisms vary by state and consumer category.	Net metering is available.
Connection timeline	Distribution network approval for a new solar power system typically takes three to five days.	Most SERC regulations prescribe approval timelines of around 15 to 30 days, but stakeholders report approvals often take 30 to 90 days.	The net metering guidelines (2025) mandate distribution utilities to approve connections for new rooftop solar projects in 10 to 15 days. However, stakeholders experience delays in obtaining approvals.
Technical standards	Technical standards cover installation requirements and inverter specifications. A framework for broader standards, including interoperability, has been committed to.	Comprehensive technical standards exist through the CEA, covering grid connectivity, metering, safety, inverter requirements, and distributed generation interconnection.	SREDA has approved technical standards and specifications for DER components. Yet, quality concerns arise, particularly in very small projects.
Cost-reflective tariffs	Time-of-use tariffs are widely available. Feed-in tariffs are usually static.	Time-of-day (ToD) tariffs are being progressively introduced for commercial, industrial and high-consumption residential consumers under national electricity rules. Dynamic tariffs remain limited, and most residential consumers continue to face conventional retail tariffs.	Current electricity tariffs make rooftop solar viable for industries, commercial buildings and households with higher energy consumption. Households with lower energy consumption pay highly subsidised tariffs.

Smart meters	56% of meters in the NEM are smart meters, with a target of 100% by 2030. 99% of meters in Victoria are already smart meters.	More than 250 million smart prepaid meters are targeted under the Revamped Distribution Sector Scheme (RDSS). Deployment is progressing rapidly but remains uneven across states, with conventional meters still dominating nationally.	Net energy meters installed are not smart meters. However, new rooftop solar systems will likely consider smart meters.
DER financing	Some concessional financing is enabled via federal programmes. Some states offer zero-interest loan schemes.	Multiple financing mechanisms exist, including MNRE capital subsidies for residential rooftop solar (PM Surya Ghar Yojana), concessional loans from public sector banks and non-banking financial companies (NBFCs), priority sector lending, and state-level incentives. Access remains challenging for low-income households and MSMEs.	Green financing facilities at concessional rates are available through the Bangladesh Bank. However, the loan disbursement process is lengthy and requires a lot of documents.
Visibility and communications	Many existing inverters lack communication capabilities. But it is increasingly standard for new systems, and required in some states, for instance to support dynamic operating envelopes.	New rooftop solar systems require DISCOM approval and bi-directional metering. Smart inverters and remote monitoring are gradually being adopted, but there is low smart meter penetration.	New net-metered rooftop solar systems are using smart inverters. The adoption of smart meters is still at the initial stage.
Institutional DER capacity	Market bodies, governments and networks are highly experienced at supporting DER. Governance and regulatory barriers have arguably inhibited interoperability, and V2G uptake.	MNRE, SERCs, and DISCOMs have established rooftop solar frameworks, but institutional capacity for DER integration and digitalisation varies significantly across states.	The SREDA is developing capacity of both public and private sector organisations involved in DER projects. However, industries and EPC companies often highlight that limited capacity and distribution utilities' reluctance hindered the expansion of rooftop solar projects.
Single-window clearance/one-stop service	Planning approvals and subsidy applications have not been a significant barrier to rooftop solar uptake in Australia. Grid connection processes vary by distribution network, which can be an administrative burden for installers. However, unified platforms have not been proposed as a solution and may be challenging to implement.	The PM Surya Ghar portal provides a unified digital platform for residential rooftop solar applications, approvals, and subsidy disbursement, significantly improving consumer access. However, approvals remain dependent on DISCOM processes, and similar integrated digital platforms are largely absent for other DER segments such as C&I rooftop solar, battery storage, and EV integration.	While SREDA acts as the nodal agency and maintains a website that offers important information on DERs, stakeholders often feel that it should update data and information more frequently. The data on rooftop solar capacity shows a significant gap between the installed and the reported capacity.

Conclusion

DERs are reshaping power sectors by reducing grid power demand, thereby limiting fossil fuel dependence. Rooftop solar has been a significant factor in driving a reduction in coal-fired generation in Australia, and the rise in residential batteries is likely to displace gas generation in the evening peak period. Likewise, the rising rooftop solar is one of the reasons behind the minor reduction in daytime power demand in Bangladesh. In India, the rapid expansion of rooftop solar and agricultural solarisation under schemes such as PM Surya Ghar and PM-KUSUM is helping reduce demand on the conventional grid, lower peak power procurement requirements, and decrease reliance on coal-based electricity generation, particularly during daylight hours.

With further expansion of DERs, Australia, Bangladesh and India will likely reduce their fossil fuel dependence at an increasing rate.

The analysis demonstrates that rooftop solar has been a dominant aspect of DER uptake in all three countries. In Australia, the presence of incentive mechanisms and enabling policies has accelerated rooftop solar adoption in the residential sector.

In contrast, adoption in Bangladesh's household sector has remained limited due to high import duties and the absence of incentives. While the Bangladesh government has reduced duties on imported components of distributed solar, stringent conditions to produce project implementation contracts at customs may exclude traders from receiving the duty benefits. For industries, the new duty structure is, in fact, increasing the cost. The government of Bangladesh could consider providing a full duty waiver under an inclusive mechanism for all rooftop solar projects keeping in mind its goal of adding a renewable energy capacity of 10,450MW between 2026 and 2030.

India's residential solar sector has been held back by policy implementation challenges, including lengthy approval processes, delayed subsidy payments, limited financing, and inconsistent DISCOM support.

While the household segment accommodates most of the rooftop solar systems in Australia, the C&I sector is the primary driver of rooftop solar in Bangladesh and India. Rooftop solar in the commercial and industrial sectors presents as an area ripe for further policy development in Australia.

Australia is now experiencing a boom in installations of residential batteries, driven by government incentives, which have the potential to transform the energy system even further by allowing households to put their solar energy to use in the evening peak period and overnight.

India and Bangladesh could promote the deployment of battery storage alongside DERs, particularly rooftop solar. Integrating battery storage into India's flagship residential solar programmes would help shift excess daytime solar generation to evening peak hours, reducing grid demand, lowering peak power procurement requirements, and improving system flexibility.

For predictability and better management on the part of utilities, both India and Bangladesh should gradually adopt smart meters. Some Australian states are already at an advanced stage of installing smart meters. However, more work is needed to increase uptake across the country, which could be done while ensuring consumers have appropriate protections and retain their choice of energy tariff.

It is also imperative for both India and Bangladesh to support the wider adoption of DERs through streamlined access to low-cost finance and targeted financing mechanisms for households, farmers, and small businesses.

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The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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