

Executive summary

It has been five years since we published our inaugural *State of Renewable Energy in India (the SO-RE 2014)*, in January 2014. These five years have proven to be transformational for the renewable energy industry in the country. In 2014, the industry had barely taken roots. Making a timely intervention, our *SO-RE 2014* offered several recommendations to encourage and nurture a sustainable growth for the sector. It called for pursuing a predictable, consistent policy course; developing an integrated policy and plan for 2050; and setting up ambitious goals, especially in view of the fact that the growth in capacity had exceeded official targets. It urged policymakers to pay more attention to distributed generation such as mini-grids to efficiently provide energy access to unconnected households; reduce subsidies and promote reverse bidding to push the sector to reach grid parity. It also advocated rationalisation and enforcement of RPOs (renewable purchase obligations) to stimulate demand from discoms.

Some of these recommendations, we are happy to note, have found a place in the country's policies. Meanwhile, the renewable sector has made tremendous strides — according to the Union Ministry of New and Renewable Energy (MNRE), renewable capacity has reached 73 gigawatt (GW), accounting for over 20 per cent of the country's total. Solar has performed particularly well: in 2017-18 alone, around 10 GW of solar was installed equaling the entire installed base. The capacity growth was driven by a sharp fall in tariffs, with both solar and wind auctions attracting bids that were lower than the cost of power from coal-based plants.

Generation of renewable energy has also increased sharply. Its share in total electricity supply had stalled at around 5.5 per cent during 2011-16. But in 2017-18, its share jumped to 7.8 per cent; in June 2018, when wind generation is strong, it was around 12.5 per cent. The growth was supported by a favorable policy environment offering low import duties, a payment security mechanism and efficient auction processes, combined with a dip in PV prices.

While 2017 left us with a sense of success, a lot still needs to be done to maintain the momentum. Indeed, 2018 has seen a reversal of some of the positive trends. Installations dropped to ~6.6 GW in the months between January to September. Tariffs went up as the government introduced a safeguard duty on imported PV modules. Solar auctions were cancelled or retendered for a lower size due to lack of developer interest and discoms' demand for lower tariffs. The wind sector was disrupted by the auction regime introduced in June 2016 which impacted installation — though,

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auction volumes climbed up in 2018 following the release of auction guidelines in December 2017.

Issues and challenges

Some of this slowdown is a temporary phenomenon, since longer term trends — such as declining PV module costs — remain in place. But there are also some policy and implementation hiccups that need to be addressed to ensure the sector continues to grow strongly.

Unpredictability in policy

Nothing can be more disruptive for an emerging sector that seeks to attract global investors, than *ad hoc* and abrupt policy changes. In the case of renewable energy, the most recent example has been the introduction of a safeguard duty on imported PV modules — this has resulted in an uncertainty about project costs, increase in tariffs and, consequently, a drop in installations.

So far, the growth in India's solar capacity has been built on an overwhelming (almost 90 per cent) share of imported PV modules because their costs are up to 30 per cent lower. In fact, the government has encouraged imports by keeping duties low — as a result, domestic manufacturing units have suffered financial distress and have experienced capacity utilisation of only around 50 per cent. The recently injected safeguard duty points to the fact that the government has not resolved its dilemma between its professed goal to 'Make in India' and the need for cheap electricity based on imported panels and equipments.

The sector's growth has been marred in the past as well by several ill-considered steps. Auctions with 'domestic content requirement' have been introduced to support local manufacturers, but the World Trade Organization (WTO) has contended that the move violated international trade rules. The government announced a safeguard duty of 70 per cent, withdrew it, and reintroduced a 25 per cent duty in June 2018. Import duties were increased to up to 10 per cent in late 2017 and subsequently removed. In early 2018, the Solar Energy Corporation of India (SECI) announced an exclusive auction of 10 GW linked to new manufacturing capacity — the move flopped. After multiple modifications and several rounds of auctions, only one company made an offer to install 600 MW.

The wind industry has been caught unawares, similarly, by the introduction in June 2016 of an auction-based regime to award bids from the feed-in tariff (FiT) process. The transition has resulted in a dip in installations. Auctions too declined sharply and recovered only after detailed guidelines to address policy gaps were issued in December 2017.

Hiccups in auctions and PPAs

Over the last year, there have been a number of incidents that have proved to be damaging to the auction process. Several auctions have been cancelled after the winning bids were announced because the buyers felt the rates were not low enough; in some cases, discoms refused or delayed signing

the power purchase agreements (PPAs). In a few others, arbitrary tariff caps were introduced resulting in auction failures.

There have been media reports as well about regulators and discoms clamouring to renegotiate PPAs. In 2017, Karnataka's Electricity Regulatory Commission (ERC) rejected PPAs that had been approved, forcing the state government to step in and overrule its decision using a rarely used provision. It is important to maintain the sanctity of the auction process and the PPAs to ensure sustained investor interest in this sector.

The trouble with discoms

- ***Curtailment and payment delays:*** Renewable power enjoys a 'must run' status, which means it should be scheduled first by the discoms unless there are technical constraints such as grid congestion or unavailability. However, there have been reports and court cases of "illegal" curtailment. State Load Dispatch Centres (SLDCs), in collusion with discoms, have reportedly asked developers to shut down the supply for commercial reasons. Some developers have alleged curtailment in excess of 25 per cent, which severely reduces their revenues.

To add to this, discoms have reportedly been delaying payments to developers by several months. These problems are directly related to the financial weakness of the discoms. Renewable companies operate with thin margins and small capital, and will have difficulty remaining viable if these issues are allowed to fester.

- ***Procurement policies:*** Most discoms have a sizable share of contracted capacity under long-term, two-part tariff PPAs, which provide the back-up supply to intermittent renewable power. However, an excessive share of thermal PPAs amounts to an inefficient process — it will prevent discoms from contracting renewable energy and will result in higher consumer tariffs. Yet, the Union Ministry of Power (MoP) has been encouraging discoms to sign more PPAs with thermal power plants.

Power procurement policies need to be more sophisticated, with a lower share of long-term PPAs combined with peaking power and low marginal cost renewable energy. This would require developing a real-time electricity market. In addition, regulators may need to modify the tariff structure of both thermal power plants and renewables and the principles governing dispatch of power.

- ***Non-implementation of policies:*** New regulations that have been introduced to open the electricity market or to promote renewable energy can result in potential revenue losses for discoms. Therefore, many discoms appear to have withheld support for implementation of such policies. For example, open access regulations, which allow large consumers to choose their power suppliers, have encouraged them to contract the lower-cost renewable power producers (waiver of

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transmission and distribution charges makes them even more attractive). Also, the bulk of open access is short term, which imposes additional costs on discoms to balance the grid and maintain back-up supply.

Similarly, rooftop installations may lead to revenue losses for discoms. Migration of large, profitable customers will leave the discoms with an increasing share of subsidised customers. Regulators need to ensure that discoms are not burdened with unfair costs on account of open access consumers. Additionally, discoms need to explore innovative business models, such as partnering with renewable companies in the rooftop sector, to offset revenue losses.

Decentralised distribution: Not yet in vogue

- **Mini-grids ignored:** The government's focus on grid-based power supply to ensure universal access, a long-standing goal, seems misplaced. The failure to provide universal access is not only a measure of the challenge; it also underscores the inadequacy of various policies over the decades. The two latest iterations — extending the grid to all villages (through the Deen Dayal Upadhyaya Gram Jyoti Yojana, or DDUGJY) and providing electricity connection to all households (through the SAUBHAGYA scheme) are also unlikely to succeed.

One reason for the likely failure is that the burden of ensuring 24-hour, affordable supply will rest primarily on financially-stressed discoms. Historically, the discoms have been reluctant to provide power supply to poor households given their small consumption, subsidised tariffs and poor collection. Our survey reveals that households that were recently connected do not enjoy regular power supply. Furthermore, the cost of the power is prohibitive for most poor families. Mini-grids can be a more efficient and quicker route to providing access to a sizable number of consumers, point out energy experts as well as state regulators — but is the Central government listening?

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- **Solar rooftop's untapped potential:** In a similar vein, the potential of solar rooftop has not been exploited — the growth in renewables has been powered almost entirely by utility-scale projects. Solar rooftop has garnered a major share in many developed markets and it can be a key contributor to India's renewable ambitions as well. Residential solar rooftop offers a unique set of benefits: lower electricity bills, reduced T&D losses and a sizable number of retail investor-consumers; additionally, consumers can do away with polluting diesel generating sets for their back-up supply. But the lack of awareness about solar PV technology — their performance and maintenance — and high up-front costs dissuade retail consumers. Although India has set itself a massive goal of 40 GW of solar rooftop by 2022, only 3.4 GW had been installed till September 2018 — most of it by commercial and industrial customers, as the government has not promoted it with the right set of policies.



Wind: In the sun's shadow

Wind power, which still has a leading share of renewable capacity, has received little attention from policymakers. Wind provides valuable daily and seasonal balancing to solar generation. It also provides an additional benefit of supporting local manufacturing. Yet, the sector has suffered from periodic policy flip-flops such as abrupt changes in accelerated benefits, unexpected introduction of auctions etc. Moreover, various policy initiatives such as repowering, offshore or hybrid have been introduced with little details, which has resulted in their failure. Repowering is a very cost-effective approach to increase wind capacity of old projects (many of which are located in prime wind sites) that have a capacity utilisation factor (CUF) of as low as 10 per cent; in comparison, the latest turbines can reach CUF of over 40 per cent.

The wind industry — both the turbine manufacturing segment and wind developers — is a mature sector with significant installations over the years. The government's modest long-term goals for it, and its lack of policy support, are therefore inexplicable.

The way forward

The energy sector is at a critical juncture. Climate change and its accompanying risks have meant the world needs to plan for a decarbonised power sector. The falling cost of renewable power and grid-scale storage

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point us to the fact that a 100 per cent renewable-based electricity supply is technically and economically feasible in not too distant a future.

Furthermore, renewable-based distributed generation offers advantages over supply from a centralised infrastructure. A new supply model will need to ensure viability of various providers, competitive price discovery and new policies to determine tariffs and schedule power. Meanwhile, electric vehicles and super-efficient, internet-connected devices, combined with demand-side management tools, will modify demand patterns. These changes will require redesigning the grid. In short, a new energy architecture would be needed.

Energy decarbonisation

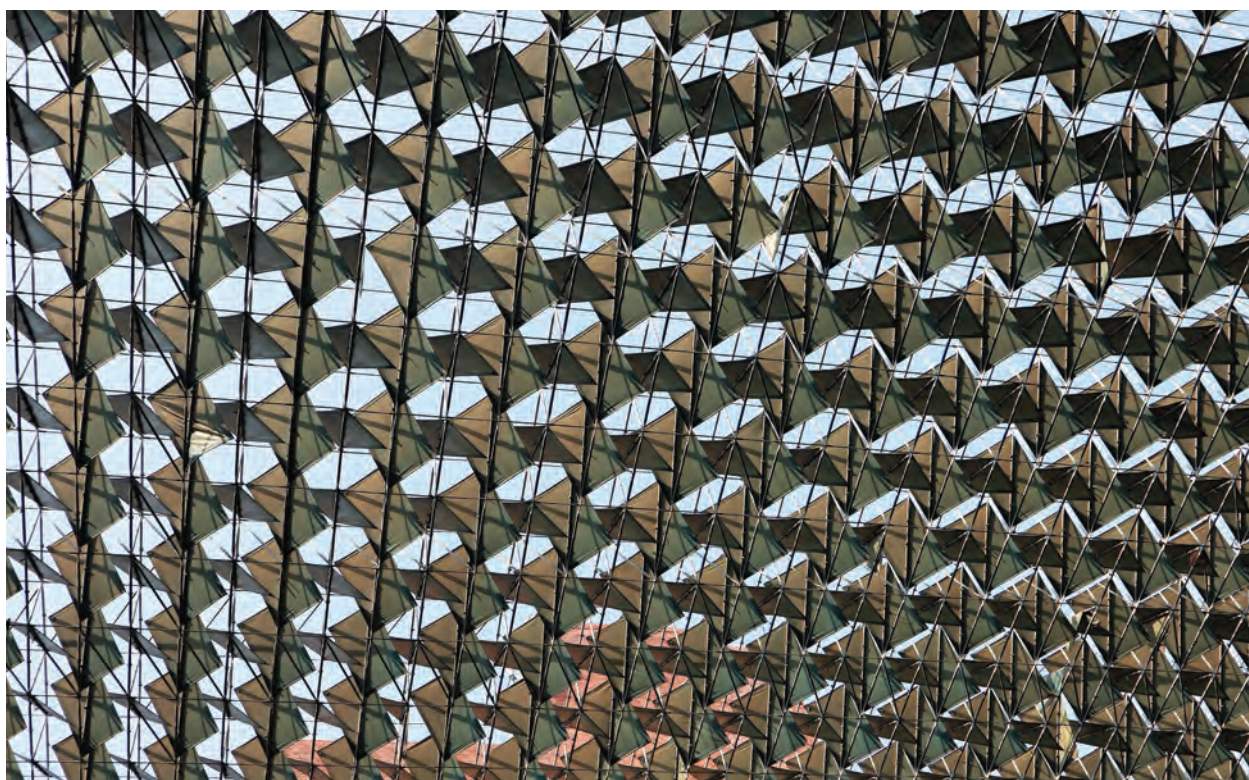
To begin with, the country needs an ambitious low-carbon growth pathway. India's INDC (Intended Nationally Determined Contributions) goal for 2030 — building up a non-fossil fuel capacity of 40 per cent of the total — is not ambitious enough and would be easily surpassed. The Niti Aayog's draft National Energy Policy, 2017 assumes a largely centralised, conventional fuel-based supply. It projects 570 GW of renewable capacity by 2040, less than half of the total capacity of 1,200 GW, while the share in electricity supply is projected to be only 28 per cent by 2040, with fossil fuels contributing over 60 per cent. The country needs to have an ambitious goal to generate 100 per cent power from non-fossil fuel sources by 2050-2060.

Secondly, while the 175-GW goal has led to investor interest and boosted the sector, there is no clarity about the assumptions behind the target. The rationale for various sub-sectors — 40 GW for solar rooftop or 60 GW for wind — is even less convincing. Going forward, there should be an integrated renewable strategy which would include balanced targets for the various sub-sectors.

Thirdly, there should be a clear plan for fossil-fuel based capacity — its role will steadily transition from being central to the country's energy mix to becoming the back-up supply for renewables. The National Electricity Plan (NEP), 2018 prepared by the Central Electricity Authority (CEA) is based on questionable assumptions such as a deceleration in renewable growth (100 GW during 2022-27 compared to 117 GW in 2017-22). Consequently, it has concluded that a huge 93 GW of additional coal capacity was required during 2017-27. As a result, 70 GW of thermal power plants are under construction as of September 2018. But some of these plants in the pipeline are already stalled or stressed. In this scenario, no more new coal-based plants should be approved. In fact, old, inefficient and expensive plants should be shut down.

Distributed generation

The second major trend that policymakers need to plan for is the increase in the share of distributed renewable generation (DRE). This is already contributing a major share in several parts of the world, given its falling costs compared to grid-based supply. However, DRE has received little policy support in India.



SOUPARO BANERJEE / CSE

Solar rooftop: So far, to promote solar rooftop, the government has relied on subsidies to residential households. This approach does not address the main bottlenecks: high up-front costs and lack of financing; discoms' reluctance to support installations; low comfort with technology; and bureaucratic hurdles. The government's latest proposed policy, Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI), appears misguided and is essentially a short-term approach — it compensates discoms for potential revenue losses from rooftop installation, instead of encouraging sustainable and innovative business models.

The problem of high up-front cost and doubts about technology can be addressed by RESCOs (Renewable Energy Service Companies) that can offer long-term supply contracts to households. A multi-pronged effort would be needed to build the RESCO industry for the residential sector: ensuring sanctity of PPAs, making repossession of defaulters' assets easy, and encouraging discoms to partner with RESCOs in customer sourcing, installation and bill collection.

Mini-grids: Mini-grids have the potential to efficiently provide energy to households in regions that might not be satisfactorily served by discoms. In fact, mini-grids also thrive in areas that are connected to the grid. The government needs to introduce a comprehensive policy that requires mini-grids to provide a certain standard of supply (for example, total hours of supply and a minimum supply during peak hours) and incentivise mini-

grids to ensure tariffs are in line with those of grid-based supply. Secondly, the policy should provide for a viable business model for mini-grids, which means mini-grids should have reasonable and well-defined exit options (sale price of mini-grids' assets, tariff for sale of power to discoms etc), once the grid supply does become reliable in their markets. For this, the mini-grids' network should comply with the grid codes so that they can be seamlessly integrated with the grid, which in turn would require capital support for additional investment in distribution network.

There are other models as well that are emerging. The government is planning to distribute around 1.8 million solar water pumps, which can be linked together in a mini-grid and supply to the grid when they are not needed to draw water. This would prevent wasteful extraction of water and provide an alternate source of income. In many developed markets, groups of residential blocks are establishing micro-grids, a market that is essentially similar to rooftop solar in residential societies. Policies need to both anticipate and plan for these developments.

Grid of the future

Integrating 175 GW of renewable by 2022, which translates into around 20 per cent share of renewables in total energy, will not be a challenge. A recent report by the NREL estimates this can be achieved with curtailment of only 1.4 per cent by using the inherent flexibility of the country's coal-based fleet. Importantly, current grid expansion plans, if executed on schedule, would be sufficient. Regulations such as forecasting and scheduling, deviation settlement mechanism and ancillary services mechanism are being implemented across states, which will help in efficient integration.

The future electricity scenario — which is expected to include very high penetration of variable renewable energy, sizable distributed supply, more volatile demand and internet of things — will require 'smart grids' that use communications infrastructure, control systems and information technology for efficient delivery. The National Smart Grid Mission was a good start, but its ambition and outlay (Rs 990 crore for 2017-20) are extremely limited in the context of a rapid increase in renewables.

Smart grids have real-time awareness of the grid, which can enable efficient dispatch and balancing when power dynamically flows in multiple directions. Distributed energy resources (including EV batteries) can be linked in micro-grids and balanced through flexible resources (such as batteries) leading to lower cost of operations. Micro-grids can also provide ancillary services and improve grid resiliency. Advanced metering infrastructure and smart appliances will allow automated demand management; data analytics can identify meter tampering. Remote sensing and control systems and machine learning can accurately locate faults and quickly resolve outages.

While some of the scenarios presented above are still in the future, a number of countries are already in advanced stages of smart grid implementation to assist in efficient integration of distributed renewal energy and demand side management using market signals.

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Reforming discoms

The country's ability to reach the target of 175 GW by 2022 will depend on the health of discoms, which are at the heart of the electricity market. Most discoms in India incur significant losses due to a combination of high aggregate technical and commercial (AT&C) losses, inadequate tariff increases, cross-subsidies and poor billing. The renewable energy market is already witnessing problems such as muted demand for new capacity, attempts to renegotiate PPAs or cancellation of auctions, curtailment of power for commercial reasons and delays in payments to developers. Some of the problems stem from poor governance/political difficulty of raising tariffs. Others are on account of misguided strategies — for example, excessive long-term capacity contracts. New policies to promote renewables, if ill-considered, may result in revenue losses and higher costs for discoms, exacerbating their financial distress.

The government's latest effort to reform the discoms, the Ujjwal Discom Assurance Yojana (UDAY) scheme, has translated into shifting their substantial debt load on to the states. However, UDAY does not appear to be succeeding in resolving the fundamental challenges to discoms' sustainability — cutting AT&C losses and rationalising tariffs.

The discom model needs to be rethought of. A separation of carriage and content, which implies customer choice and competition among suppliers, is required. However, it will lead to migration of high-tariff paying customers, leaving the discoms with an unprofitable and subsidised consumer base. Policies should ensure that open access consumers pay an equitable amount for network access and back-up supply; in the initial years, there should also be a provision for a cross-subsidy. Legacy discoms need to be compensated to service remaining customers through explicit budgetary support.

Discoms also need to explore newer revenue sources such as supporting DER, enabling retail exchange for producer-consumers, energy efficiency and demand response, and ancillary services to/from retail customers

Building storage ecosystems

Inexpensive energy storage is critical to achieving a high penetration of variable renewable energy. The levelised cost of lithium-ion battery, which has become the dominant technology, has fallen to US \$0.2/kWh for grid-scale storage (similar to a gas peaking plant). A rapid dip in prices has resulted in grid-scale storage being deployed to balance the grid. Industry experts predict battery pack costs will halve to US \$100/kWh in five years, at which point there would be a quantum shift in its value addition.

Bloomberg predicts 1,000 GWh of storage by 2040, which will require US \$620 billion of investment. Countries such as China, the US, Korea and Japan are building huge capacities to dominate this market, with their governments providing significant funding for R&D. India runs the risk of becoming an importer of Chinese batteries, similar to what happened in the case of solar cells.

However, the future of storage is not only about lithium-ion — India has some time to establish a competitive industry. The use of the battery will

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be varied and so should be the storage types — from pumped hydro and compressed air to batteries using different materials. Varied battery types reduce reliance exposure to few materials. Indigenous research can improve upon existing technology in terms of cost and performance. Policy support for EVs, DRE etc — potentially a very large domestic market — can drive scale for the battery industry. The country should also consider providing seed capital or subsidised financing to support industries of the future. Finally, policies should promote a wide storage ecosystem — for example mobile storage, leasing, conversion of IC engines to electric etc — to expand the market.

The first word

As pointed out earlier in this chapter, we stand at the cusp of a momentous shift in the energy sector. For the first time, decarbonised electricity appears feasible in the foreseeable future; it is not an abstract vision. The question is, whether India will reach peak coal and 100 per cent renewable quickly and efficiently, or whether it will be a delayed process, merely egged on by global momentum.

Secondly, will the transition bring about innovations in the electricity market, or will it result in undesirable disruption in delivery of electricity and in the well-functioning segment of the market? Thirdly, will we be able to use this opportunity to develop indigenous research and manufacturing to service both the domestic and the vast global markets, or will we become an importing client? Only the right strategy, policies and incentives can help us get the right answers.