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India's Grid Transmission Infrastructure Needs Further Modernisation, Urgently

Growth in Renewable Energy Investment Slowing Due to Grid Limitations

By Tim Buckley and Kashish Shah

January 22, 2019 (IEEFA India): India's tremendous growth in renewable energy capacity over the last three years has been vindicated by the continued evidence of near record low solar and wind power tariffs and speed of development that has set the nation on a clear and achievable path towards its renewable energy target of 275 gigawatts (GW) by 2026/27.

India is now home to the world's largest utility-scale solar park and India's wind power capacity has grown steadily over the past decade. Renewable energy infrastructure has provided India with a much-needed deflationary opportunity to diversify the electricity system by leveraging domestic, sustainable resources, thereby improving energy security.

Wind power commissioning however has slowed during the last two years, in large part due to current structural limitations in India's national transmission grid. And more recently, solar tariffs have slightly increased from the record lows achieved in 2017 of Rs2.44/kilowatt hour (kWh) to Rs2.70-80/kWh.

Given there is zero indexation for the 25-year term, with electricity tariffs flat for the length of the contract with no upward adjustment for inflation, renewable energy remains India's low-cost source of new energy supply.

A key prerequisite to continuing India's renewable energy investment ambitions is the need to concurrently build out and modernise India's national transmission grid, accelerating the enormous progress achieved over the last decade.

In this article we examine India's significant grid investment progress over the last year and review the activities of the three major participants: Power Grid Corporation of India; Adani Transmission; and Sterlite Power.

Current state of play

During the financial year (FY) 2018/19, India has been unable to capitalise on the momentum of the previous year in which a record 12GW of renewable capacity was added.

The imposition of safeguard duties on imported solar modules, currency depreciation and rising interest rates as well as policy uncertainty have made investors cautious in

bidding for renewable power capacity, despite an active tender pipeline. In addition, the lack of power evacuation and transmission infrastructure has been a key reason developers remain disinterested in recent auctions.

As an accelerated investment in renewable energy capacity needs to be matched with equivalent investment in grid capacity expansion, the challenge now for India's electricity market is grid integration of large amounts of variable renewable energy while minimising integration cost.

India's growing renewable energy capacity is outgrowing the grid

India's transmission network capacity grew at a compounded average growth rate (CAGR) of 12% between FY2013/14 and FY2017/18 (in terms of Mega Volt Ampere (MVA)). With regard to circuit kilometres (ckm), the transmission lines expanded at a CAGR of 7% from 274,588 ckm to 390,970 ckm by the end of March 2018. (Figure 1)

Figure 1: Growth of India's Transmission Sector Between FY2013 to FY2018

	As on March 2013	As on March 2018	Addition	CAGR (%)
Inter-regional Power Transmission Capacity of National Grid (MW)	29,750	86,450	56,700	24%
All India Power Transmission Network (ckm)	274,588	390,970	116,382	7%
Transformation Capacity	473,216	826,958	353,742	12%

Source: CEA

The Indian government planned an investment of US$2.15bn to electrify some 212 million households under the 'Saubhagya' scheme - a project aiming to provide electricity to all households. As of December 2018, 99% households have been electrified, an enormous achievement by the government of India. The challenge now is to sustainably grow India's economy so these new households can actually afford to buy electricity and sustainably improve their standard of living without a massive blowout in electricity subsidies.

Despite the tremendous innovation, the flow-on effect of mass electrification combined with a greater reliance on low cost but variable renewable energy is the increase in demand for inter-regional transmission lines and the need for capacity enhancement of inter-regional power evacuation infrastructure.

And while tariff based competitive bidding for projects has allowed the private sector to actively participate in the expansion of India's transmission grid in recent years, an investment of US$60-80bn will be needed in the next five years to keep pace with growing generation capacity.

Leading players accelerate India's grid transformation

Power Grid

The Power Grid Corporation of India (POWERGRID) is a 56% state-owned, listed company and India's largest power transmission utility, owning and operating 38% of India's total transmission assets in terms of ckm.

POWERGRID added 9,072 ckm of extra high voltage transmission lines, and 41,620 Mega Volt Ampere (MVA) transformation capacity with 15 new substations in the FY2017/18 year. This required the utility to fund capital investments of Rs25,791 crore (US$3.6bn) during the same year, with a stellar profit of Rs8,238 crore (US$1.2bn, +9.6% year on year). With a capex plan of Rs25,000 crore (US$3.6bn) for FY2018/19, POWERGRID looks set to repeat another year of strong performance.

POWERGRID must now compete for tenders with private players under the bidding-based regime. Consistent with most major infrastructure projects across India (and internationally), most transmission projects face construction delays. New competition from the private sector should increase cost efficiency in the construction operations of POWERGRID, while providing a much-needed boost for the growth of India's power sector.

Figure 2: Leading Players in India's Transmission Sector

Transmission Lines (ckm)	India	Power Grid	% of total	Adani Transmission	% of total	Sterlite Power	% of total
Added in 2017/18	23,119	9,072	39%	3,150	14%	3,236	14%
At the end of 2016/17	367,851	139,077	38%	5,450	1%	8,000	2%
Growth in FY2017/18	6.3%	7%		58%		40%	
Total at the end of FY2017/18	390,970	148,149	38%	8,600	2%	11,236	3%

Source: Company Annual Reports, IEEFA Estimates
Note: Sterlite Power Transmission infrastructure numbers includes its subsidiary, India Grid Trust.

Adani Transmission
Incorporated in 2013 and listed on the Indian stock exchange in July 2015, Adani Transmission is the fastest growing transmission utility in India. The company has a target of building 20,000 ckm of transmission lines by 2022, with 8,600 ckm already commissioned by the end of FY2017/18. Adani Transmission registered a 58% growth in the same year with the commissioning of an additional 3,150 ckm of lines.

In August 2018, the company acquired Reliance Infrastructure's highly profitable integrated generation, transmission and distribution business based in Mumbai, Maharashtra. The acquired transmission capacity was 3,063 ckm making Adani Transmission's cumulative network reach around 11,350 ckm, from which approximately 9,000 ckm are under operation and approximate 2,350 ckm under various stages of construction. The acquisition, worth Rs18,800 crore (US$2.6bn), is reflective of the company's ambitions.

Sterlite Power
Sterlite Power Grid Ventures has emerged to be one of the top private players in the transmission sector, winning some 30% of the total capacity awarded through bidding routes in recent years.

In FY2013/14, Britain's Standard Chartered made a private equity investment of Rs500 crore (US$70m) into the company. In 2018, Sterlite Power bought back a 28.4% stake of its transmission infrastructure business from Standard Chartered for Rs1,010 crore (US$142m), fetching double the value of the original investment value for Standard Chartered.

In 2017, Sterlite Power carved off its inter-state transmission assets into an infrastructure investment fund called India Grid Trust (IndiGrid). In August 2018, Sterlite Power commissioned a 414 ckm transmission line in Jammu and Kashmir two months in

advance of deadline, a rare achievement in India's transmission sector as claimed by the company.

Sterlite Power also has an array of assets in Brazil, including a total of 4,107 ckm of transmission lines. The company emphasises the need for accelerated investment in renewable energy rich states to support planned generation capacity.

Building inter-regional transmission capacity between renewable-rich zones

Given India's geographic spread of renewable rich states on the western and southern coasts, inter-regional transmission capacity for transmitting power from energy surplus states to deficit states will be needed, as well as better load balancing capacity.

In August 2018, a committee on power transmission networks proposed transmission system infrastructure in renewable energy specific zones to support 50GW of solar capacity and 16.5GW of wind capacity cumulatively in seven states, as illustrated in Figure 3. The transmission infrastructure will be implemented in two phases by FY2019/20 and FY2020/21 with the total cost estimated to be Rs42,235 crore (US$6bn).

Figure 3: Planned Transmission Infrastructure in Renewable Energy Zones

	Solar (GW)	Wind (GW)	Total
Rajasthan	20	-	20
Andhra Pradesh	5	3	8
Karnataka	5	2.5	7.5
Gujarat	10	6	16
Maharashtra	5	2	7
Madhya Pradesh	5	-	5
Tamil Nadu	-	3	3
Total	**50**	**16.5**	**66.5**

Source: CEA

The states Rajasthan, Gujarat and Tamil Nadu in particular possess India's best solar and wind sites. While Tamil Nadu has been India's leader in wind energy over the past couple of decades, more than 70-80% of the states' wind power capacity is built on out-dated turbine technology with smaller blades and turbines, and shorter pole heights.

IEEFA notes there lies an enormous opportunity for a tenfold augmentation of the country's cheapest wind power generation by repowering these end-of-life wind farms with new technology, but a key pre-requisite is that this US$40bn wind investment needs to be supported by adequate power evacuation and transmission infrastructure.

In December 2018, the Indian government announced the revival of a long-delayed mega power project of 23GW grid-connected solar power in the region of Leh and Ladakh in the states of Jammu and Kashmir, and an associated transmission line of 850 km (road length) extending to Punjab in the north. The first phase will have 2.5GW of solar in the Kargil region and 5GW in the region of Leh. The challenge of constructing network infrastructure in the tough mountainous terrains of Leh and Ladakh are extreme. However, private players including Sterlite Power and Adani Transmission have proven that competition and innovation can bring bidding tension and efficiency in construction management.

The need for inter-regional grid connectivity will increase with an increase in demand for power even in economically poor regions, as India's economy is foreseeably set grow at 7-8% per annum over the coming decade.

Currently, power production and consumption within pockets of the same regions creates grid congestion. Due to limited connectivity across Indian states it is hard to address grid congestion problems in high demand areas, forcing a reduction in power supply scheduling despite the demand for electricity. Going forward, this is likely to change with power generation occurring in remote areas where some of the best solar and wind sites are available. National and even international grid interconnectivity will help in reducing existing congestion zones, so long as non-congestion zones are equipped with sufficient transmission capacity.

As discussed in IEEFA's previous reports, flexible generation will be key to movement away from expensive, unreliable, high-emission fossil fuel based energy systems.

Moreover, states lacking renewable energy potential are relying on interstate purchases to meet their Renewable Purchase Obligations (RPOs). The interstate renewable power trade will allow distribution companies (discoms) from financially stretched states such as Uttar Pradesh and Bihar to reduce the cost of power purchased and relieve their financial distress in the long run, building India's national capacity to accommodate ever larger investments in domestic renewable energy capacity, while increasing energy security and allowing more sustainable economic growth.

Further initiatives urgently needed

While there is a dire need to ramp up the building of infrastructure in the transmission sector, the simultaneous digitalisation of the grid is equally important. This will provide greater transparency across the value chain in terms of building an intelligent system that incorporates asset monitoring, consumer behaviour and demand loads.

Energy systems of the future will enable more and more prosumers (consumers that produce their own electricity from rooftop solar). The growing distributed rooftop solar market and the Indian government's ambition to accelerate the distribution of solar irrigation agriculture pumps will increase distributed energy generation which will improve the dynamics of the entire value chain, including two-way electricity flows.

Further, with the proposal for wide-scale rollout of smart meters, India is putting in place the right building blocks. Competitive auctioning for smart meter manufacturing has brought the cost down more than 60% in the last two years.

Grid expansion possible to neighbouring countries

IEEFA's previous reports have highlighted a massive opportunity for India to be a clean energy leader in South Asia through two-way electricity trade with neighbouring countries such as Nepal, Bhutan, Bangladesh and potentially Sri Lanka.

India imported 5 terawatt hours (TWh) of electricity annually from Bhutan and exported 4.7 TWh to Bangladesh in FY2016/17.

In September 2018, India and Nepal strengthened their electricity trade with the commissioning of the first high-voltage (220 kilovolt kV) Dhalkebar substation in southern Nepal, the main interconnection point between India and Nepal. Excess electricity available from various hydro power plants will flow to the Dhalkebar substation via the

implemented by Nepal Electricity Authority's Hetauda–Dhalkebar–Inaruwa north-south transmission line currently under construction.

Recently, the guidelines for cross-border electricity trade were revised. While the old guidelines required bilateral agreements between countries, the new guidelines allow Indian generation or distribution entities to trade coal-fired, hydro- and renewable power across borders through Indian government approved licences. According to the new guidelines, any Indian power trader may trade in Indian Power Exchanges on behalf of any company of a neighbouring country with an approval from the Indian government. This creates a whole new market, especially for renewable energy developers who are finding it difficult to sell power to Indian discoms due to a lack of demand.

Grid expansion to neighbouring countries should improve energy security and allow a stronger diversification of the energy mix by taking advantage of geographic renewable endowments, time zones and possible differences in peak hours.

A robust, digitally integrated grid network expansion is key to integrating least cost but variable renewables into India's system as quickly as possible.

Conclusion

There has been a noticeable growth in private investment in expanding India's grid infrastructure, predominantly driven by the government's move to allow private players to participate through competitive bidding systems for project allocations.

Grid infrastructure is as much an investment opportunity as the renewable energy sector is in India, both of which are critically important for the country's sustained economic growth and to reduce India's excessive reliance on fossil fuel imports.

An efficient and robust grid network is crucial in minimising grid curtailments for renewable power and ensuring that renewable assets do not face the financial risk of asset stranding, as is currently occurring in the Indian thermal power sector.

A modernised grid will ensure consistent low cost, deflationary renewable power uptake, improving renewable energy investments viability.

A clear focus on deploying transmission infrastructure in renewable-rich regions is imperative to the modernisation of India's electricity network while concurrently working to address growing water stress and air pollution pressures.

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