Renewable Power Market and OM Services for Wind Energy

Inox Green Energy Services Limited

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Review of India's economy

India's GDP shrank 6.6% in fiscal 2021. As per the data released by the National Statistical Office, the Real GDP at Constant (2011-12) Prices in the fiscal 2022 attained a level of Rs.147.4 lakh crore, as against the First Revised Estimate of GDP for the fiscal 2020-21 of Rs. 135.6 lakh crore, released on 31st January 2022. The growth in GDP during fiscal 2021-22 was 8.7% as compared to a contraction of 6.6% in fiscal 2020-21.

In fiscal 2021, though, the economy contracted 6.6% as per the NSO's First Revised Estimate of GDP, amid challenges heaped by the COVID-19 pandemic in the first half of the year, the economy turned positive in the second half of the year, with fourth quarter GDP estimated to have posted a mild 1.6% uptick. However, a fierce second wave of the pandemic in the first quarter of fiscal 2022 has once again buffeted the economy. While this time the lockdowns have been localised in nature across the states, it has nevertheless taken a toll on the economy. With relaxation in COVID-19 induced restrictions, the GDP at Constant (2011-12) Prices in Q4 of fiscal 2022 was recorded at ₹ 40.8 lakh crore, as against ₹ 39.2 lakh crore in Q4 of fiscal 2021, showing a growth of 4.1%.

Table 1: **GDP trajectory (% change)**

At basic prices	FY17	FY18	FY19	FY20	FY21	FY22	At market prices	FY17	FY18	FY19	FY20	FY21	FY22
							GDP	8.3%	6.8%	6.5%	3.7%	-6.6%	8.7%
Agriculture	6.8%	6.6%	2.1%	5.5%	3.3%	3.0%	Private consumption	8.1%	6.2%	7.1%	5.2%	-6.0%	7.9%
Industry	7.7%	5.9%	5.3%	-1.4%	-3.3%	10.3%	Govt. consumption	6.1%	11.9%	6.7%	3.4%	3.6%	2.6%
Manufacturing	7.9%	7.5%	5.4%	-2.9%	-0.6%	9.9%	Fixed investment	8.5%	7.8%	11.2%	1.6%	-10.4%	15.8%
Mining & quarrying	9.8%	-5.6%	-0.8%	-1.5%	-8.6%	11.5%	Exports	5.0%	4.6%	11.9%	-3.4%	-9.2%	24.3%
Services	8.5%	6.3%	7.2%	6.3%	-7.8%	8.4%	Imports	4.4%	17.4%	8.8%	-0.8%	-13.8%	35.5%

Source: Central Statistics Office (CSO), CEIC, CRISIL Research

That said, favourable demographics is expected to benefit the country's long-term trajectory. Of the country's 1.4 billion people, ~67.4% were in the working age group of 15-64 years, as on fiscal 2019 (Source: World Bank). In fact, India's working population is more than the total population of Russia, Brazil and the US. A growing working population is expected to drive consumption over the long term.

Contact intensive services still feel the pinch

India's real gross domestic product (GDP) grew 8.7% in fiscal 2022, compared with 8.9% estimated as per the second advance estimates released by the National Statistical Office in February 2022. This is largely a reflection of a higher base (as the economy had shrunk 6.6% in fiscal 2021, less than 7.3% previously estimated). In fact, the fiscal 2022 real GDP in absolute terms at Rs 147.4 trillion is marginally lower than Rs 147.7 trillion estimated in February 2022, suggesting that the downside from the omicron variant of COVID-19 has proven to be mild so far. But it is also noteworthy that given the large output loss fiscal 2021, GDP is still only 1.5% above the pre-pandemic (fiscal 2020) level.

While the overall size of GDP in fiscal 2022 is slightly higher than that recorded in fiscal 2021, there has been a noteworthy compositional change. Private final consumption expenditure (PFCE) – the largest demand-side driver – which was hitherto estimated to be lagging the pre-pandemic level, recovered some of the lost ground. At Rs 83.8 trillion in fiscal 2022, PFCE is now 1.4% above the fiscal 2020 level of Rs 82.6 trillion. Given that PFCE growth still trails overall GDP growth, its share in GDP is marginally lower than that in fiscal 2020, led by a sharp slowdown in PFCE growth (to 1.8% in Q4 from 7.4% in Q3), suggesting that consumption recovery is expected to be gradual because of headwinds such as high inflation and limited direct support from the government.

Meanwhile, other demand-side drivers, such as government consumption expenditure, investment and exports, did well in fiscal 2022. While government consumption continued to grow during both the pandemic years (thanks to government's fiscal support), the latter two returned to positive territory this fiscal, after having declined in fiscal 2021. Exports have particularly done well and in fiscal 2022 were at 12.8% above the pre-pandemic level in real terms.

On the supply side, performance of the manufacturing sector stands out. At 9.8%, manufacturing GDP has grown the most compared with other supply-side components — to above the pre-pandemic level (for fiscal 2022 over fiscal 2020). To some extent, this is a reflection of sharper focus on goods, and away from services, due to the pandemic. The latter, especially the contact-intensive ones, are still reeling under the impact of the pandemic, trailing 11.3% below the fiscal 2020 levels. Agriculture experienced a slight decline in growth from 3.3% in fiscal 2021 to 3.0% in fiscal 2022.

Agriculture maintained a robust performance (with real growth rising to 4.1% in Q4 from 2.5% in Q3), despite some negative impact of heat waves on crop output to an extent. Healthy growth in contact-intensive services also provided support to overall supply-side growth in Q4. These services, such as trade, hotels, etc., finally crossed the pre-pandemic mark (Rs 7.30 lakh crore in Q4 of fiscal 2020), growing 5.3% on-year in Q4 of fiscal 2022. That said, for full fiscal 2022 these were still 11.3% below pre-pandemic i.e., fiscal 2020 level which means greater resumption of these activities would provide a positive spin to growth this fiscal. On the other hand, the manufacturing sector contracted 0.2% on-year in Q4 (from 0.3% in Q3), largely reflecting a sharp rise in input prices owing to the surge in international commodity prices and supply disruptions due to the Russia-Ukraine war.

Going forward, growth for fiscal 2023 is hampered by multiple risks. As central banks in major economies withdraw easy monetary policies to tackle escalating inflation, global growth is estimated to be slow. Further, high commodity prices, particularly oil, translates to negative terms of trade shock for India. Revival in consumption is impacted by higher and broad-based inflation. Higher input prices may result in reduced government capex, which has already seen fiscal space shrink with attention shifting to tackling rising inflation. The forecast of a normal monsoon brings respite to the country's economy, in addition to gaining momentum in contact-intensive services.

Table 2: Our key projections

	FY18	FY19	FY20	FY21	FY22	FY23F
GDP growth (%)	6.8%	6.5%	3.7%	-6.6%	8.7%	7.3%
CPI (%, average)	3.6%	3.4%	4.8%	6.2%	5.5%	6.8%
CAD/GDP (%)	1.8%	2.1%	0.9%	-0.9%	1.2%	3.0%
FAD/GDP (%)	3.5%	3.4%	4.6%	9.2%	6.7%^	6.4%^^
Exchange rate (Rs/USD M March-end)	65	69.5	74.4	72.8	76.2	78.0
10-year G-sec yield (%, March-end)	7.6%	7.5%	6.2%	6.2%	6.8%	7.5

F: Forecast. ^with upward risk, ^provisional estimate, ^^budget estimate

Source: CSO, Reserve Bank of India (RBI), CRISIL estimates; CPI: Consumer Price Index-linked; CAD: Current account deficit; G-sec: Government security; FAD: Fiscal account deficit

With the third wave of COVID-19 (with minimal economic impact) behind us, we are looking at fewer supply disruptions from COVID-19 and a fuller resumption of services activity in fiscal 2023. As a result, contact-intensive services, which still trail the pre-pandemic levels of fiscal 2020, could start contributing favourably to growth. But slower global growth and high commodity prices, especially that of oil, if sustained due to the ongoing Russia-Ukraine conflict could put downward pressure on growth. The May 31 data of provisional estimate of GDP growth for the fiscal 2023 also remains a monitorable. For now, CRISIL maintains its real GDP growth projection for fiscal 2023 at 7.3%, with downside risks.

i. Growth drivers and drags

Fiscals 2017 to 2021	Growth driver/drag	Situation in fiscals 2022 to 2023
Good monsoons and bumper agri output, and lower increase in minimum support prices (facilitated by benign global food prices)	**Monsoon**	Fiscal2022 saw a normal monsoon as per the Indian Metrological Department. Similarly, as of 20 September 2022, fiscal 2023 recorded overall normal rainfall of 99.8% of its long period average.
Cheaper interest rates offered by banks spurred loan demand in key sectors	**Interest rates**	Policy rates saw change in fiscal 2023, with increase in repo rate to 5.4% (from 4% past fiscal) and marginal standing facility to 5.65% (from 4.25%) Reverse repo remained at 3.35%. 10-year bond yields averaged 7.4% in July 2022. CRISIL Research estimates bank credit to grow at 10-12% in the current fiscal.
Construction spending grew at 6% CAGR, driven by power generation and roads in the infrastructure segment, and oil and gas, metals, and automobile sectors in the industrial segment. Outbreak of COVID-19 and subsequent lockdowns had impacted construction spending across infrastructure sub-sectors in fiscal 2021 resulting in a 16-20% on-year decline.	**Construction spends**	Construction spends surpassedpre-COVID-19 levels in fiscal 2022. Fiscal 2023 is estimated to see 9-12% increase due to growth in infrastructure segment. Over fiscals 2023 to 2027, CRISIL Research expects spends to post a CAGR of 2-4%

Fiscals 2017 to 2021	Growth driver/drag	Situation in fiscals 2022 to 2023
Inflation declined owing to policy prudence, low crude oil and commodity prices, and normal monsoons. CPI-based inflation fell to 6.2% on average in fiscal 2021, from a peak of 9.9% in fiscal 2013	**Inflation**	Inflation faces pressure from high global commodity prices, including crude and edible oils, and partial pass-through of rising input costs by producers to consumers. CRISIL Research expects CPI inflation to average 6.8% in fiscal 2023, compared with 5.5% last year, with risks tilted to the upside
India did not benefit much from a global trade recovery in fiscal 2017 because of domestic disruptions. However, exports picked up gradually over the next few fiscals.	**Exports**	In fiscal 2022, merchandise exports rose 44.7% on-year. However, fiscal 2023 saw a moderate on-year growth of 2.1% in July. The World Trade Organization expects global merchandise trade to increase 3.4% in fiscal 2023.
After a deficit in 2019 owing to continued capacity cuts in China as well as supply disruptions in Australia, Brazil, and Europe, markets turned surplus as demand fell marginally and the pandemic had minimal impact on production with players not initiating production cuts	**Commodity prices**	LME prices are expected to fall to $2250-2350/tonne in fiscal 2023 after recording a 7-year high of $2700-2800 In fiscal 2022. Demand from China is expected to subdue amid reimposition of the lockdown, in addition to rising interest rates across major economies resulting in declining liquidity. Weak global demand, export duties on steel and correcting coking coal prices to moderately reduce steel prices.
NPAs rose sharply between fiscals 2015 and 2018, led by aggressive investments during 2010 and 2011 in expectation of continuation of a high growth scenario along with regulatory tightening by the RBI. Fiscals 2019 to 2021 experienced recovery with a decline in NPAs	**NPAs**	The RBI announced measures to enhance liquidity, ease financial market conditions, address cash flow concerns, and improve sentiments. However, the Supreme Court has not allowed NPA recognition to mask asset quality and defer additional stress due to the pandemic in fiscal 2021 or fiscal 2022. However, asset quality improved in fiscal 2023, with GNPA declining from 7.4% in March 2021 to a 6-year low of 5.9% in March 2022.

Note:

Good
Moderate
Poor

Source: CRISIL Research

ii. Overview of other demographic factors

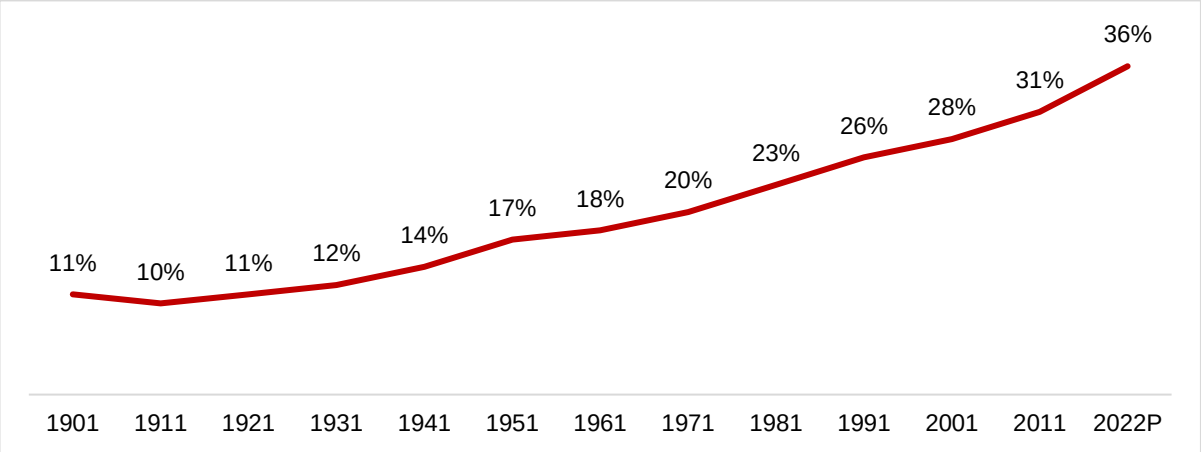
Urbanisation

Urbanisation is another big growth driver for India, as it leads to rapid infrastructure development, job creation, development of modern consumer services, and mobilisation of savings.

To be sure, the share of urban population in India in total population, which stood at ~31% in 2011, has been consistently rising over the years, and is expected to reach 36% by 2022, spurring increasing consumer demand.

Indeed, urban consumption in India has shown signs of improvement, and given India's favourable demographics along with rising disposable income, the trend is likely to continue and drive economic growth for the country.

Figure 1: Urban population as a % of total population of India



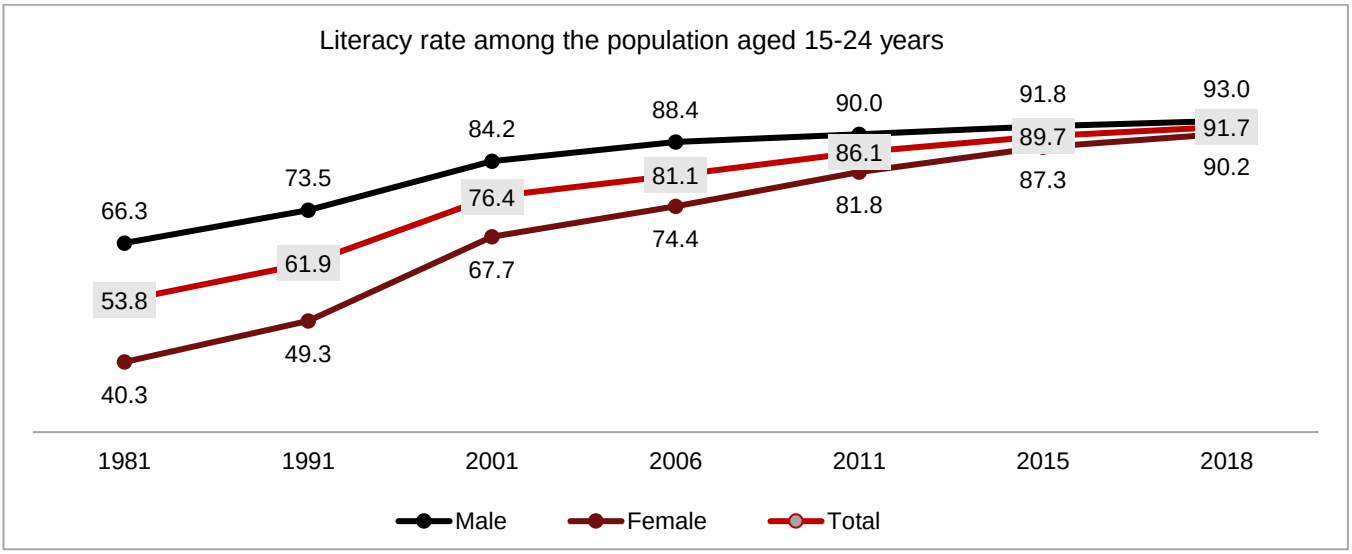
P: Projected

Source: Census 2011, World Urbanization Prospects: The 2011 Revision (UN)

Literacy

Literacy rate is also key for the socio-economic progress of a country. India has experienced continuous growth in youth literacy rate (aged 15-24 years), which has risen from ~54% in 1981 to ~90% in 2015. However, the pace of growth has decelerated since 2006. This is because of the growth in male literacy rate slowing down; the literacy rate for the female population, though, has continued to grow.

Figure 2: Youth literacy rate of India



Source: UNESCO, CRISIL Research

Per capita power consumption

Electricity consumption per person rose from 1,075 kWh in fiscal 2016 to 1,161 kWh in fiscal 2021, a CAGR of 1.6%, primarily due to strengthening of the transmission and distribution (T&D) network along with large capacity

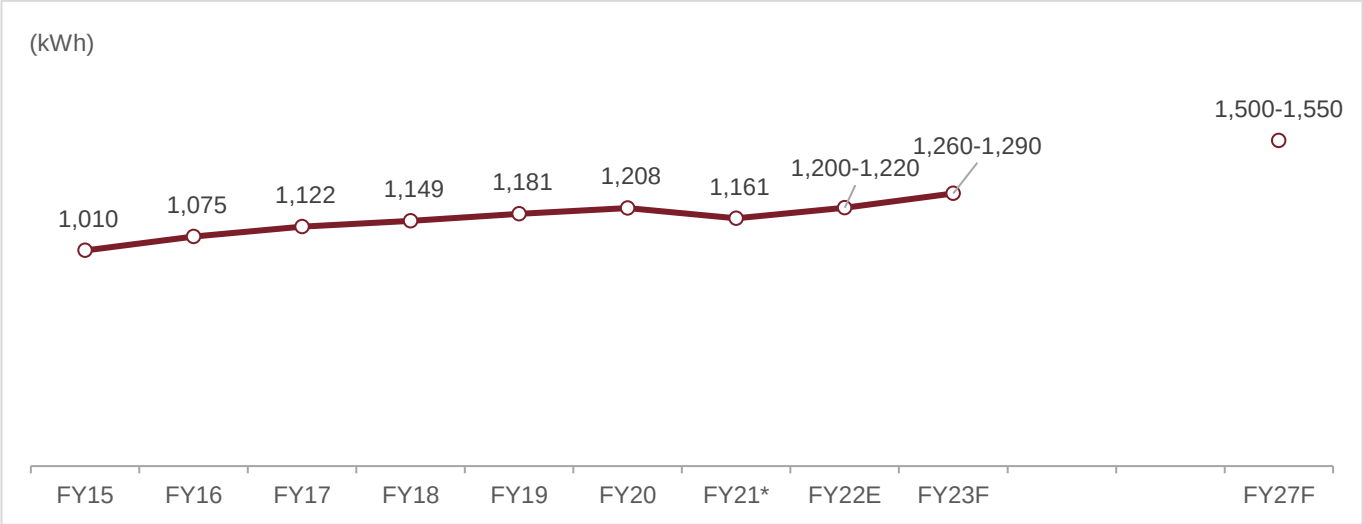
additions. After year-on-year growth in consumption, fiscal 2021 saw a decline in demand, particularly from high-consuming industrial and commercial categories on account of weak economic activity due to the COVID-19 outbreak.

Fiscal 2022 saw a recovery in per capita consumption to 1,200-1,220 kWh on the back of power demand recovery, and a similar trend is expected to continue in fiscal 2023.

Between fiscals 2022 and 2027, though, India's per capita electricity consumption is expected to grow at 4-5% CAGR over low base of fiscal 2021. Per capita consumption is expected to gradually improve in the long term as power demand picks up due to improvement in access to electricity, in terms of quality and reliability, on account of intensive rural electrification and reduction in cost of power supply, resulting in realisation of latent demand from the residential segment.

Consequently, CRISIL Research expects the per capita electricity consumption to reach 1,500-1,550 kWh by fiscal 2027.

Figure 3: Per capita electricity consumption



**Provisional, E: Estimated; F: Forecast*

Source: CEA, CRISIL Research

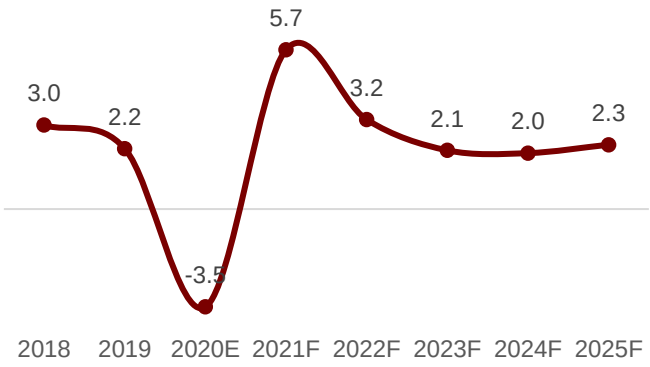
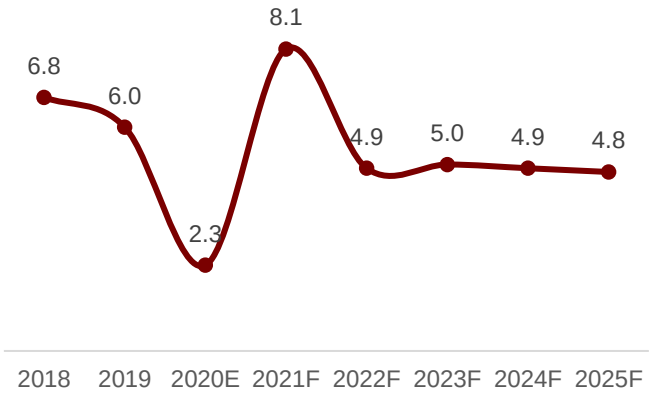
1.2. Outlook on GDP of major economies

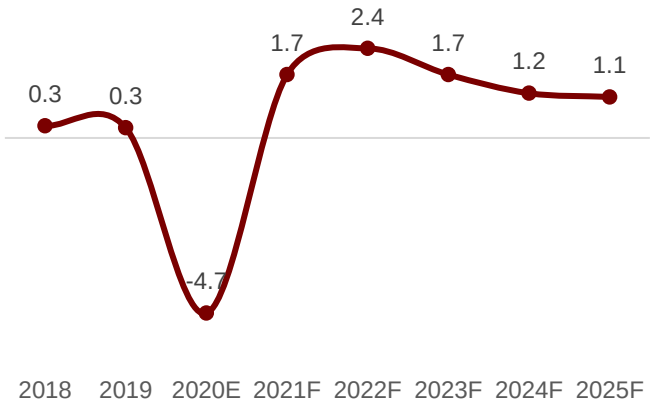
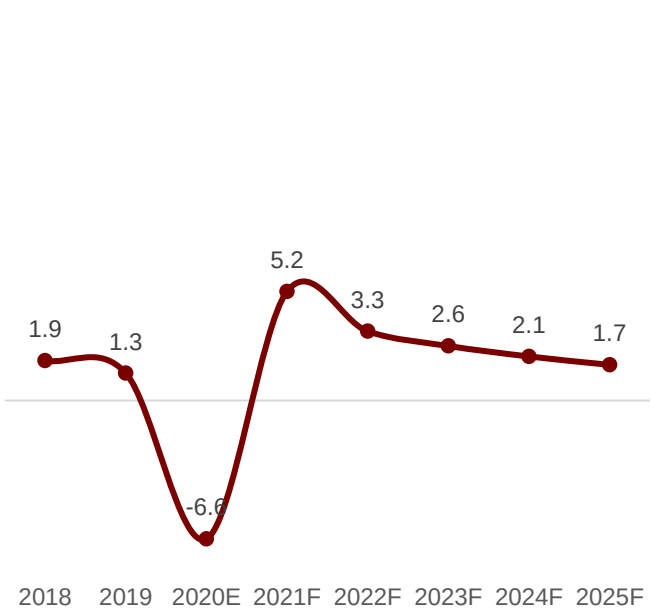
Economic outlook (real GDP growth) of key economies

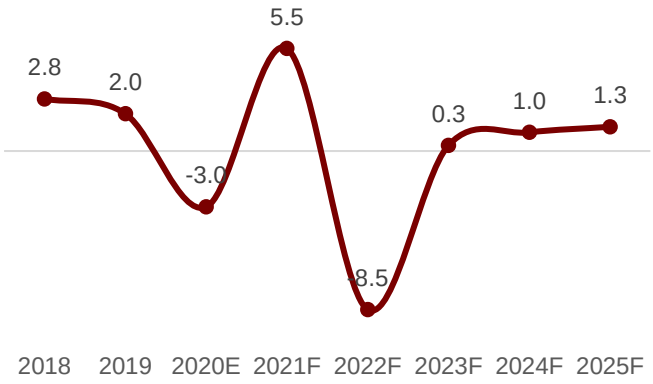
The global economy was in a reasonably strong position in the early months of 2022. The omicron variant of COVID-19 had delivered a sharp but short-lived blow to activity and was in decline almost everywhere. The Russia-Ukraine conflict's global macroeconomic effects for now seem moderate after a healthy start to 2022, including strong household balance sheets in the advanced economies. But risks are clearly on the downside: The conflict will influence direct trade effects, energy and commodity prices, confidence, and policy responses, particularly in China. S&P Global has lowered GDP growth forecast for U.S. to 2.4%, and for Asia-Pacific to 3.3%. Asia-Pacific is doing better than the rest of the world, except for China which is experiencing stringent COVID restrictions. U.K.

inflation in May was at a multi-decade high of 9.1%. This will significantly lower household spending power, weaken spending, and contribute to negative GDP growth for Q3 and Q4 of this fiscal.

Figure 4: Real GDP growth forecast of major economies*

US	The world's largest economy is relatively unaffected by the Russia-Ukraine conflict, given its energy independence and overall weak trade and financial links to these countries. Households and firms can largely absorb higher energy prices, including by using savings buffers built up from government COVID-19-related transfers. The Fed tightening cycle is the main factor behind the growth slowdown for now. GDP growth for USA for 2022 was forecasted at 3.2%, with the economy moving back toward its pre-COVID-19 path. Fiscal consolidation (higher government savings) will be offset by households drawing down their COVID-19 savings. Income distribution worsens in our baseline scenario on high food and fuel inflation, which hits lower-income households relatively hard.	
China	In Asia-Pacific, the most direct link to the Russia-Ukraine conflict is energy dependency. Most countries in the region run an energy trade deficit. Higher energy prices are the main impact variable from the conflict, hitting both growth and inflation. Overall, however, the effect of Russia-Ukraine on Asia-Pacific growth is modest. A more aggressive Fed is also an important forecast driver in the region. China will keep growth close to 5% with a fiscal stimulus to offset any growth shock from the conflict. This will likely center on infrastructure investment and easier monetary and property policy. The service sector and household sector recoveries are still soft.	

Brazil	Economic growth in Latin America toward the end of 2021 was generally better than expected, driven by a continued recovery in demand and, in some cases, fuelled by stimulus measures. By the end of last year, GDP in every major Latin American economy was back to its pre-pandemic level. The impact of the Russia-Ukraine conflict on Latin America's GDP is relatively mild compared with other parts of the world due to low trade and financial linkages with that region.	
Japan	The uncertainty over impact of COVID-19 on economy is slowly fading. Robust governance, monetary strategy, persistent current account surpluses will help Japan to revive. Advanced economy central banks have raised rates, but not the Bank of Japan, which is why the yen weakened significantly following recent Fed news. With this background, Japan's real GDP growth was forecasted at 2.4% in 2022 (2021: 1.7%) and 1.7% in 2023, supported by loose fiscal policy, rebounding consumption and easing supply chain constraints to manufacturing and exports.	
Euro area	Higher energy prices are the main driver of the European GDP growth slowdown for now. There is a lower impact from the Russia-Ukraine conflict (via gravity effects) as we move from east to west. Further, supply-chain issues are more relevant in Europe than in the U.S. The economy has exhibited good momentum in the wake of the omicron variant. Demand--now shifting to services--and confidence are still relatively strong, although the latter has fallen from high levels since the Russian invasion. Excess savings accumulated during the pandemic provide households with temporary buffers to the current price shock. Labour market developments continue to outperform the U.S., and unit labour cost growth remains contained, in part because many wage agreements were signed in late 2021. Fiscal and monetary stimulus has further supported activity, but these effects are fading. Europe's GDP growth was forecasted at 3.3% in 2022, with 1.9 percentage points carried over from 2021. There is less fiscal space than before	

	COVID-19, but discussions over EU fiscal rules will provide some room to manoeuvre. The eurozone economy will regain its pre-COVID-19 path by 2025.	
Russia	The Russia-Ukraine conflict remains geographically contained. It is expected that the economic impact to peak in second-quarter 2022, but it could drag on amid potential protracted on-again, off-again fighting. Despite its stated alliance with Russia, it is expected that China will stay out of the conflict, providing no direct support. Depending on how the conflict evolves, some sanctions may be removed. But many are likely to remain in place even in the event of a significant de-escalation or end of the conflict. Many Western businesses have already cut ties to Russia or significantly reduced or suspended operations. Russia's GDP will fall by 8%-9% in 2022 (against previous forecast 2.7% growth) and stay relatively flat next year. This lower output will affect Russia's (and Ukraine's) near abroad via gravity effects, as well as countries that rely heavily on Russia and Ukraine for food (e.g., Northern Africa).	

E: Estimated; F: Forecast

Source: S&P Global Economics, March 2022, CRISIL Research

India’s economic outlook favourable vs global average

In Asia-Pacific, the most direct link to the Russia-Ukraine conflict is energy dependency. Most countries in the region run an energy trade deficit. Higher energy prices are the main impact variable from the conflict, hitting both growth and inflation. Overall, however, the effect of Russia-Ukraine on Asia-Pacific growth is modest. A more aggressive US Federal Reserve System (FRS) is also an important forecast driver in the region.

For India, the key impact from the conflict is via higher energy prices, which affect inflation and the current account. While financial markets would probably want to see the Reserve Bank of India lean toward tighter policy, whether it will do that remains to be seen, given its focus on growth. Risks to India's economic outlook are still skewed towards the downside with an estimated growth of 7.3% in fiscal 2023 from the 8.7% in fiscal 2022.

Global growth is expected to slow this year as major economies see a withdrawal of monetary and fiscal stimulus. It will have a direct bearing on India's growth prospects as exports have been a key demand driver of domestic growth during the pandemic.

Energy prices, especially that of crude oil, are likely to continue firming up, partly owing to geopolitical issues and Brent crude will average up to USD 85 a barrel as against USD 70.44 in 2021, which will curtail growth, stoke inflation, and widen the current account deficit. In spite of this, India will see fastest GDP growth in the Asia-Pacific region as well as Global average growth. The S&P Global has forecasted a 60-basis-point (bps) reduction in global GDP growth to 3.6% for CY 2022 relative to Dec-2021 update, followed by a 20 bps fall in CY 2023.

Table 3: GDP Growth forecast in % (March 2022)*

Country/Region	2021F	2022F	2023F	2024F	2025F
India	8.9	7.8	6.0	6.5	6.6
World	6.0	3.6	3.5	3.4	3.4

** Updated as of data available on 20 September 2022*

Source: S&P Global Economic Outlook Q2 2022; CRISIL Research

1.3. Outlook on inflation, interest rates, balance of payment, and currency

Food fires up consumer inflation

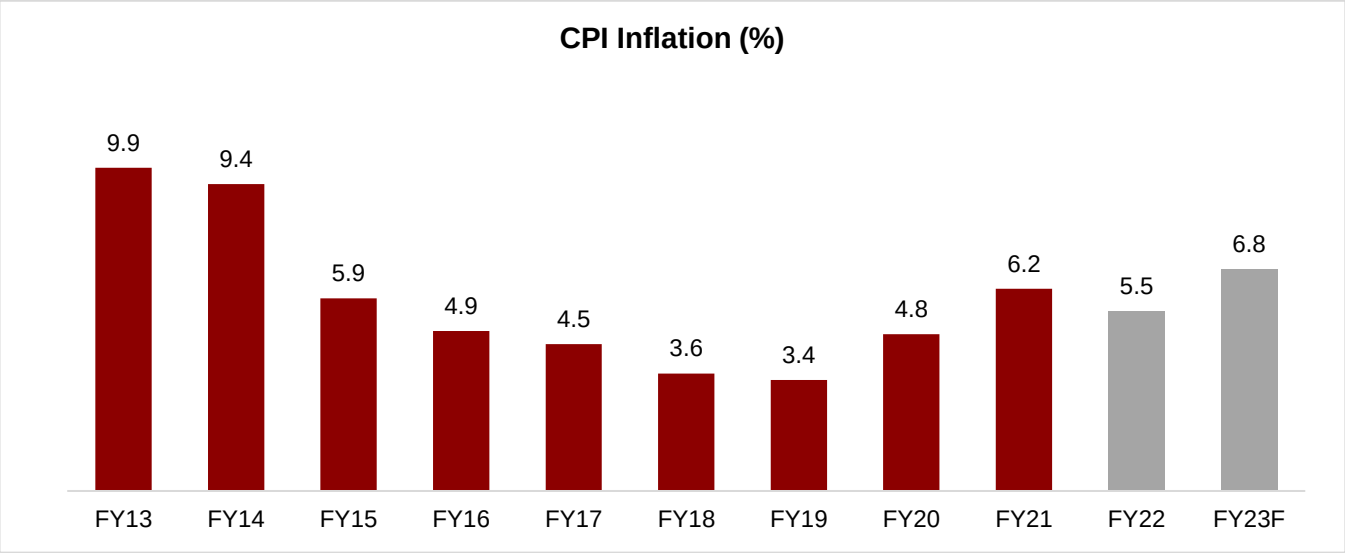
Inflation based on the Consumer Price Index (CPI), or retail inflation rose 7% on-year in August, from 6.7% in July, and higher than 5.3% a year ago. Inflation rose after moderating between May and July, driven by surge in food inflation. CRISIL Research expects CPI inflation of 6.8% in fiscal 2023 from 5.5% in fiscal 2022.

Food inflation surged, largely due to 9.6% price jump of cereals in August from 6.9% in July due to increase in wheat/flour price. Vegetables saw inflation of 13.2% from 10.9% last month due to base effect as well as rise in prices of potato, leafy vegetables, cabbage and brinjal. Milk and milk product prices surged 6.4% on-year in August. Edible oil inflation slowed to 4.6% in August from 7.5% in July.

Fuel inflation slowed in August, due to fall in prices of LNG (22.5% vs 22.9%) and kerosene (87.2% vs 108.8%). Petrol and diesel prices also declined due to excise duty cuts in May along with fall in global crude prices in August. Brent crude prices averaged below $100/barrel for the first time since the Russia-Ukraine war, driven down by global slowdown concerns.

Core inflation declined marginally by 0.1% driven by transport and communication due to falling petrol and diesel prices. Prices of appliances like ACs, refrigerators saw slow growth in inflation. On the other hand, gold prices increased 6.4% on-year in August (vs 4% in July) due to the lag effect of duty hike on gold imports announced in July. Services inflation rose for the third month in a row (5.3% vs 5.2%), driven by education, medical and personal care costs.

Figure 5: CPI inflation (%, y-o-y)



F: Forecast

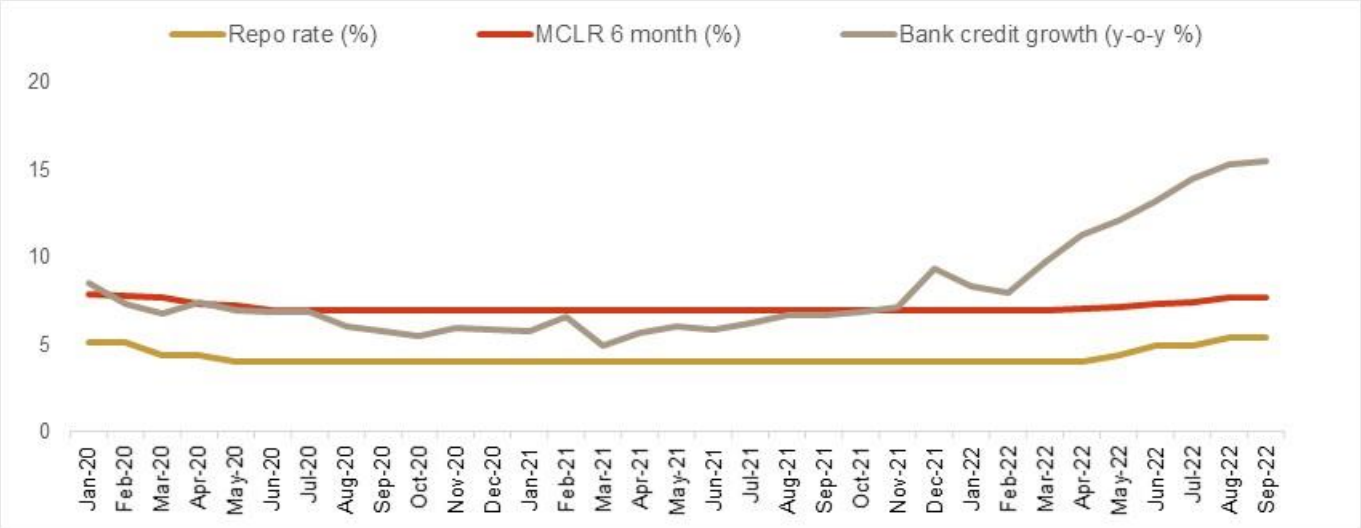
Source: NSO, CEIC, CRISIL Research

Government bond yields eased in July due to a slide in US Treasury yields and international commodity prices. Yield on the 10-year benchmark G-sec averaged 7.39% in July — 9 bps lower on-month but 124 bps higher on-year. Yields on shorter-tenor G-secs (3-5 years) saw a sharper decline.

Decline in crude oil prices and US Treasury yields along with concerns of a global slowdown helped lower domestic bond yields. On the other hand, the Centre's market borrowing was 25% higher on-month and 22% higher on-year, thus increasing the supply of G-secs for the month.

In April 2022, the RBI replaced the reverse repo rate with standing deposit facility (SDF) as the floor of the liquidity adjustment facility (LAF) corridor. The SDF would be kept 25 bps below the repo rate, compared with 65 bps for the reverse repo rate. The move meant banks could now park funds with the RBI at the SDF rate of 4.15%, which is higher than the reverse repo rate of 3.35%. This pushed up interest rates, especially of short-tenor G-secs. G-sec yields also increased as the RBI announced it will focus on withdrawal of accommodation in the coming months. This essentially meant an imminent hike in the repo rate. Yield on the 10-year G-sec rose 20 bps on the day of monetary policy meet.

Figure 6: Interest rates head lower



Source: RBI, CRISIL Research

Peak oil to push current account deficit

India's current account deficit (CAD) decreased to $13.4 billion (1.5 per cent of GDP) in Q4 of fiscal 2022 from $22.2 billion (2.6 per cent of GDP) in the previous quarter, but was higher than $8.1 billion a year ago. The narrowing of CAD in Q4 fiscal 2022 was on account slight reduction in goods trade deficit and increase in income surplus.

Net Foreign Direct Investment (FDI) in Q4 of fiscal 2022 was the highest recorded since Q3 of fiscal 2021. However, due to large outflows by Foreign Portfolio Investors (FPIs), the overall financial account surplus was eroded. Whole of fiscal 2022 recorded a current account deficit of $38.7 billion compared with a surplus of $24.0 billion in the previous year. Net FPI outflows were at -$15.2 billion, largely due to the Russia-Ukraine war, and the anticipated US Federal Reserve rate hikes, which resulted in a rush to purchase dollar assets. Net commercial borrowings were at $3.3 billion in Q4, compared to $6.1 billion a year ago.

Even though FDI inflows and FPI outflows nearly cancelled each other, Q4 recorded a financial account surplus of $14.2 billion. This is attributed to the drawdown in reserve assets to $16 billion (recorded as a credit item in Balance of Payments) due to the RBI's intervention in the forex market. There was a valuation loss of $10.3 billion as the dollar appreciated, which compared with a net accretion of $0.5 billion during Q3. As a result, the recorded financial account surplus was higher than the CAD for Q4 for fiscal 2022.

In light of global developments in the fourth quarter of fiscal 2022 and the consequent rise in crude oil and commodity prices, CRISIL Research raises the CAD forecast for fiscal 2023. The primary reason is the surge in oil prices (India's largest import item), which will push import values up. CRISIL expects Brent crude oil prices to average $105-110/barrel in fiscal 2023, compared with $80/barrel in fiscal 2022. Further, supply-chain disruptions from the Russia-Ukraine conflict and China's zero-COVID-19 policy are likely to result in high shipping / freight costs, driving up import values even more. On the other hand, external demand for India's exports will slow, as global growth is expected to moderate this year, with the Russia-Ukraine geopolitical tensions spilling over to Europe (because of the latter's dependence on Russian energy).

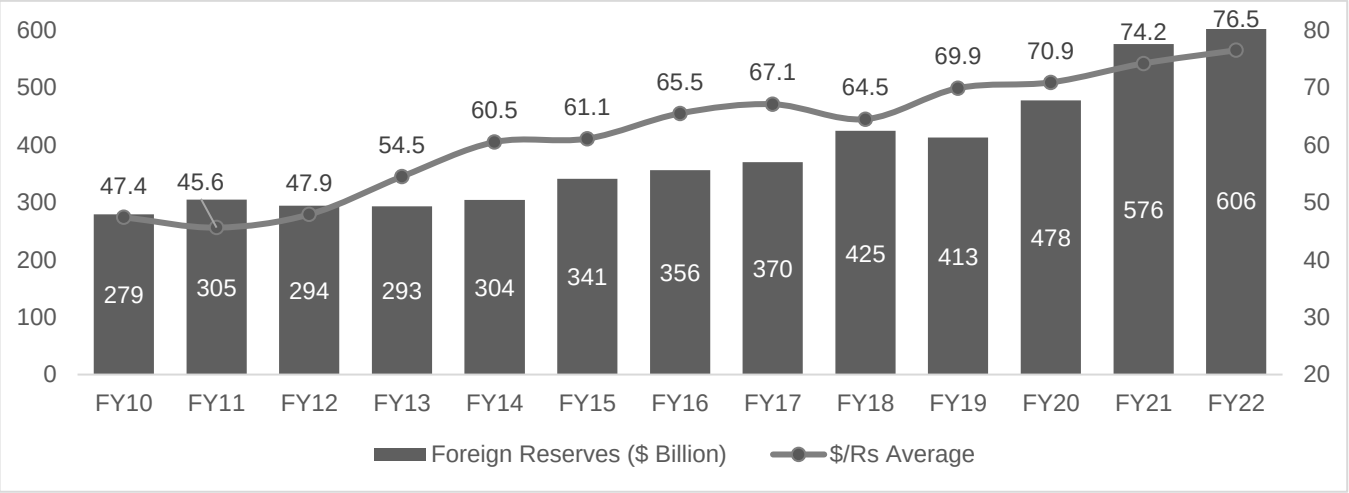
Hence, overall, CRISIL Research projects India's CAD at 3% of GDP this fiscal 2023, compared with an estimated deficit of 1.6% for the previous fiscal.

Lower rupee volatility with rising forex reserves

India's forex reserves swelled ~117%, which was ~6.7% CAGR in the past 12 years, to USD 606 billion by fiscal 2022-end, from USD 279 billion in fiscal 2010. Higher forex reserves have helped the RBI rein in currency volatility, as it provides a cushion during uncertain market events. For instance, the rupee remained relatively stable during several periods of uncertainties triggered by events such as Grexit, Brexit and hike in interest rates by the US Federal Reserve (Fed).

However, reserves came under pressure in fiscal 2019 owing to a meltdown in emerging market currencies, led by the Turkish lira, and the apex bank's intervention in the derivative currency markets to arrest the rupee's slide. The rupee is under pressure since India's current account deficit is expected to bear the brunt of the sharp rise in Brent crude prices. Therefore, the rupee is expected to depreciate to 77.5 per dollar this fiscal (fiscal 2023 average). It is, however, likely that the RBI will continue intervening in the forex market to prevent a sharper slide.

Figure 7: Rising forex reserves reined in currency volatility



Source: RBI, CRISIL Research

1.4. Raising the long-term potential

Domestic economic growth hinges on revival in private consumption, lowering of banks' non-performing assets (NPAs), improvement in the investment climate and many more such factors. The central government has taken the following steps in this regard:

- *Post-pandemic policies to revive the economy:* The Indian government has initiated several measures to revive the economy from the pandemic stress including SIDBI schemes for special liquidity support to micro, small and medium enterprises (MSMEs), state compensation schemes, increase in the threshold of default under Section 4 of the Insolvency and Bankruptcy Code, 2016 (IBC), among others. These are short-term measures, but likely to support long-term growth of the country as the economy recovers from the pandemic
- *Union Budget 2022-23:* The growth-centric and expansionary budget of 2022-23 focuses on improving India's mid-term growth trajectory. Some of the key announcements include:

- PM Gatishakti: Completion of 25,000 km national highways in the current fiscal, adoption of modern, world class infrastructure, introduction of single platform to allow data exchange among all mode operators, multimodal connectivity between mass urban transport and railway stations
- Greater financial assistance for States: Outlay for "Scheme for Financial Assistance to States for Capital Investment" was increased to Rs 15,000 crore in Revised Estimates from Rs 10,000 crore in Budget Estimates, with States being allowed a fiscal deficit of 4% of GSDP, of which 0.5% would be tied to reforms in power sector
- Boost for MSMEs: Under Credit Guarantee Trust for MSEs, an additional credit of Rs 2 lakh crore to be facilitated. Outlay of Rs 6,000 crore to be rolled out via the RAMP (Raising and Accelerating MSME Performance) program
- Public Capital Investment: Outlay for capital expenditure increased to Rs 7.5 lakh crore (by ~35%) in fiscal 2023, 2.9% of GDP. Effective Capital Expenditure for Central Government at Rs 19.68 lakh crore, ~4% of GDP. Introduction of digital Rupee by RBI and Green Bonds to mobile resources for green infrastructure

- *Improve the investment climate through the ease of doing business:* The central government has initiated a number of measures to ease the business environment, such as Goods and Services Tax (GST) and the insolvency law, and a number of other steps such as introducing an online single-window model for providing clearances and filing compliances, establishing the Central Registration Center, removing the Foreign Investment Promotion Board for fast-track foreign investments, and setting up a National Investment and Infrastructure Fund. The country has adopted a carefully designed approach to reform, with an aim to improve the business regulatory environment over the course of several years and is now among the top 10 improvers. India's position in the World Bank's Ease of Doing Business (EODB) rankings improved from 142 in 2015 to 63 in 2020; thus, it has maintained its position in the top 100 for the third straight year. However, it is still far behind large Asian economies such as China and other BRICS (Brazil-Russia-India-China-South Africa) countries. The EODB rankings of two other BRICS countries, i.e., Russia and China, have also improved impressively – from 62 and 90 in 2015 to 28 and 31 in 2020, respectively

Table 4: EODB rankings

	Brazil	Russia	India	China	South Africa
2014	116	92	134	96	41
2015	120	62	142	90	43
2016	116	51	130	84	73
2017	123	40	130	78	74
2018	125	35	100	78	82
2019	109	31	77	46	82
2020	124	28	63	31	84

Source: World Bank, CRISIL Research

Moreover, India's ranking in the Global Innovation Index improved from 81st in 2015 to 46th in 2021. However, among its BRICS peers, India continues to lag China and Russia.

Table 5: Global Innovation Index ranking

	Brazil	Russia	India	China	South Africa
2014	61	49	76	29	53
2015	70	48	81	29	60
2016	69	43	66	25	54
2017	69	45	60	22	57
2018	64	43	63	10	65
2019	66	46	52	14	63
2020	62	47	48	14	60
2021	57	45	46	12	61

Source: Global Innovation Index by Cornell, INSEAD, WIPO, CRISIL Research

- *Monetary policy:* In its April monetary policy, the RBI had replaced the reverse-repo rate with a new standing deposit facility (SDF) rate as the floor of the policy corridor under the LAF. The marginal standing facility (MSF) rate will remain at the corridor's upper end. The central bank restored the LAF policy corridor to the pre-pandemic symmetric width of 50 basis points (bps). Thus, the SDF will move 25 bps below, and MSF 25 bps above the repo rate.

  Within a month, however, the RBI raised policy rates, by sizeable basis points. In September 2022, the repo rate is at 5.4% (from 4% past fiscal), SDF rate at 5.15%, and MSF rate at 5.65% (from 4.25% past fiscal). The RBI also increased the cash reserve ratio (CRR) requirement by 50 bps to 4.50%, to take out a large quantum of liquidity from the banking system, since CRR is the share of deposits banks are mandated to park with RBI.

  The sudden hike seems to have been spurred by a sharp rise in domestic inflation, and growing risks to financial stability from the United States Federal Reserve's monetary-policy tightening. The Fed is firmly set on the path of aggressive rate hikes, already having stacked up the rate by a cumulative 140 bps since May. This has significantly tightened global financial conditions, causing foreign portfolio investor (FPI) outflows from emerging markets such as India and putting pressure on the rupee.

- *Passage of key bills:* The government has passed several key bills over the past few fiscals – the Companies (Amendment) Bill, 2020, which seeks to lower the penalties and peruse the need to decriminalise some offences by making recommendations to the central government; the Banking Regulation (Amendment) Bill, 2020, which strives to amend the act with regards to cooperative banks; and the IBC (Second Amendment) Bill, 2019, which aims at streamlining issues of troubled companies, protect corporate debtors and prevent unnecessary revocation of insolvency proceedings under the IBC.

- *Boost infrastructure:* After a sharp slowdown in the Indian economy in fiscal 2021 due to the pandemic, the outlay for capital expenditure in the Union Budget increased by 35.4% to Rs. 7.50 lakh crores in fiscal 2023 from Rs. 5.54 crores in fiscal 2022. The Budget 2022-23 focuses on public investment to enhance and modernise infrastructure over the medium term with the help of the tech platform of Gati Shakti.

- *Manufacturing thrust:* The government has made some progress in improving labour market efficiency through various programmes such as Skilling India and Make in India. The sector has shown strong resilience despite

the recent lockdowns and has remained above the 50 expansion mark. However, the overall reform process remains gradual in the manufacturing sector of India.

- *Consumption growth:* Given favourable demographics and rising disposable income, increasing middle-class population is expected to help recover and eventually spur consumption growth in India. However, amid the raging pandemic, keeping inflation and interest rates in check is important to support consumption.
- *Development of financial markets:* To develop the financial markets, the government has instituted steps such as Jan Dhan Yojana, a better monetary policy framework and the passage of bankruptcy code (amendment). Further, the Securities and Exchange Board of India (SEBI), the capital market regulator in India, approved the framework for business trusts in India: real estate investment trusts (REITs) and infrastructure investment trusts (InvITs), both of which are new asset classes for investors. While REIT is an investment vehicle that allows monetisation of real estate assets, InvIT helps promoters monetise their completed infrastructure projects (having concessionaire/development agreement). In the budget, the government approved 100% foreign direct investment (FDI) for insurance intermediaries and increased the FDI limit in the sector to 74% from 49%. This step, along with the emerging digital gold investment options and the platform for infra-debt financing, will help deepen Indian financial markets.
- *Digitalisation:* The government has been quick to board the technology bandwagon with its Digital India programme, which aims to speed up financial inclusion and deliver government services electronically, by increasing internet connectivity and improving online infrastructure. Digitisation and digitalisation will create an efficiency-led growth spurt over the medium term. In the 2021-22 budget, the government announced certain initiatives in the digital space, including establishment of a digital university, introduction of digital Rupee in fiscal 2023, and delivery of digital and high-tech services to farmers.
- *Atmanirbhar Bharat Abhiyan*: PLIs in the 14 sectors for the Atmanirbhar Bharat vision received outstanding response, with a potential to create 60 lakh new jobs.
- The five focus points of Atmanirbhar Bharat Abhiyan are economy, infrastructure, system, vibrant demography and demand. Its fives phases are:
  - Phase I: Businesses including MSMEs
  - Phase II: Poor, including migrants and farmers
  - Phase III: Agriculture
  - Phase IV: New horizons of growth
  - Phase V: Government reforms and enablers

Table 6: Sector-wise focus of Atmanirbhar Bharat

Sector	Government spend	Key schemes
Renewable Energy	-	• Rs. 4500 Cr Production Linked Incentive Scheme 'National Programme on High Efficiency Solar PV Modules' This was further increased by Rs. 19,500 Cr in budget for fiscal 2022-23 making it to Rs. 24,000 Cr • Phase – II of Grid Connected Rooftop Solar Programme for achieving 40 GW capacity from Rooftop Solar by the year 2022 • Public Procurement (Preference to Make in India) to provide for Purchase Preference (linked with local content) in respect of Renewable Energy (RE) Sector • Implementation of Pradhan Mantri Kisan Urja Suraksha Utthan Mahabhiyan (PM KUSUM) scheme; MNRE, in November 2020, scaled up and expanded the PM KUSUM scheme to add 30.8 GW by 2022 with Central financial support of Rs. 34,035 Cr • Approved Models & Manufacturers of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019 • List of Manufacturers and Models of Solar PV Modules Recommended under ALMM Order • Scheme of Grid connected wind-solar hybrid power projects • Basic customs duty (BCD) of 25% on solar cells and 40% on modules, respectively, effective April 1, 2022
Power distribution companies (discoms)	Nil	• Rs 1.35 lakh crore liquidity infusion for discoms via Power Finance Corporation/ Rural Electrification Corporation (PFC/ REC) against receivables • Rebate for payment to be received by generation companies (gencos) to be passed on to industrial customers
Agriculture finance	Nil	• Rs 1 lakh crore agriculture infrastructure financing fund for the development of farm gate infrastructure for farmers • 25 lakh new Kisan Credit Cards distributed with loan disbursement of Rs 25,000 crore • Rs 1.87 lakh crore disbursed through the PM Kisan scheme • Rs 29,500 crore refinancing assistance provided through NABARD
Agriculture procurement and sales	Rs 4,000 crore	• Amendment in the Essential Commodities Act for deregulation of sales of agriculture produce, including field crops, onion and potato • Working capital limit of Rs 6,700 crore sanctioned for procurement of food grains to state government entities • Rs 3,500 crore allocated for the distribution of 5 kg rice/wheat and 1 kg pulses to 8 crore non-card holder migrants • Rs 500 crore allocated under Operations Green for facilitation of sales of horticulture produce through 50% subsidy on storage and transport
Agri-allied	Rs 72,500 crore	• Additional allocation of Rs, 40,000 crore for Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) • Rs, 20,000 crore for fisherman over the next five years under Pradhan Mantri Matsya Sampada Yojana • Rs 13,343 crore for eradication of foot and mouth disease in Indian livestock population • Rs 15,000 crore for Animal Husbandry Infrastructure Development Fund (AHIDF) • Rs 4,000 crore for enhanced cultivation of herbal and medicinal plants • Rs 500 crore for the Indian apiculture industry • Rs 10,000 crore for formulation of micro food enterprises

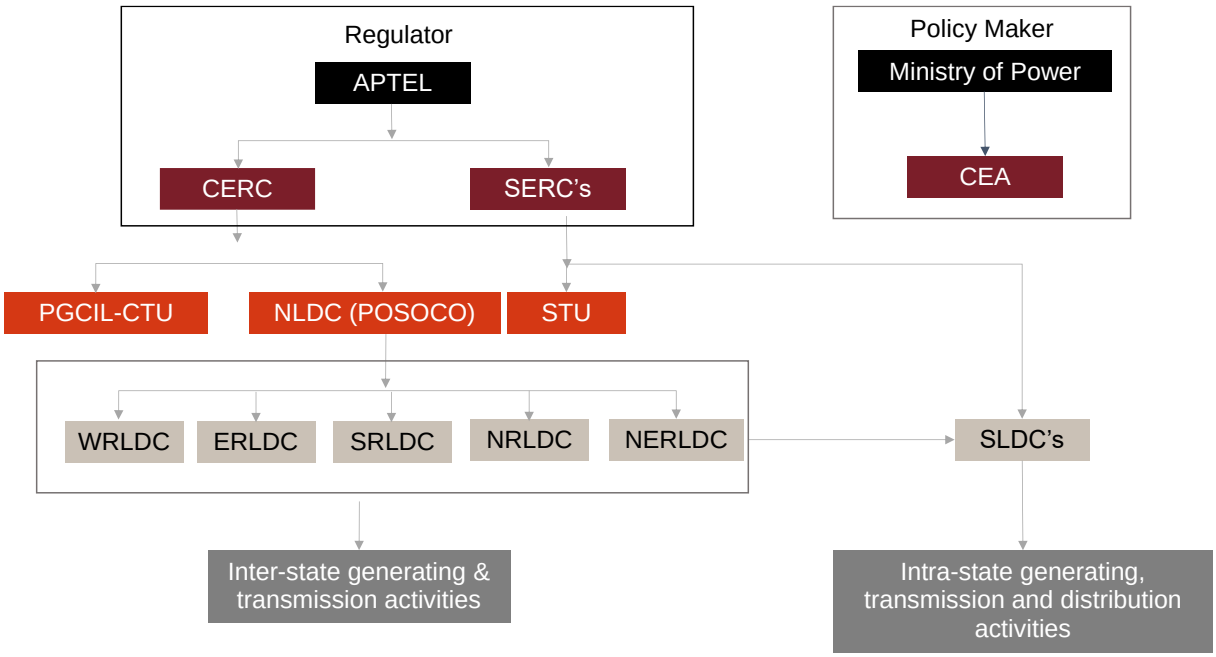
Sector	Government spend	Key schemes
Mining	Nil	• Expected to offer 500 mineral blocks, including 50 coal • Promoting commercial coal mining (ordinance to remove captive end use restriction passed in January 2020), the government to expedite policy formulation and auction process • The government to allow composite exploration/ auction of coal bed methane reserves for extraction • Rebate offered on revenue sharing quantum to incentivise early operationalisation/ higher produce • Provision of Rs 50,000 crore for evacuation infrastructure
New Energy	-	• Rs 18,100 crore PLI scheme for Advanced Chemistry Cell (ACC) Battery Storage in India launched in October to achieve 50 GWh manufacturing capacity • Green Hydrogen Policy launched in February 2022 to facilitate production of Green Hydrogen/Green Ammonia

2. Indian power sector

2.1. Overview of Regulatory sector in India

The power sector in India involves governance by the Central and state regulatory agencies. The sector is highly regulated with various functions being distributed between multiple implementing agencies. The three chief regulators for the sector are - the Central Electricity Regulatory Commission, the Central Electricity Authority and the state electricity regulatory commissions.

Figure 8: Institutional and structural framework



Note:

APTEL - The Appellate Tribunal for Electricity;

CERC- Central Electricity Regulatory Commission; CEA- Central Electricity Authority; WRLDC- Western Regional Load Despatch Centre; ERLDC- Eastern Regional Load Despatch Centre; SRDLC- Southern Regional Load Despatch Centre; NRLDC- Northern Regional Load Despatch Centre; NERLDC- North-Eastern Regional Load Despatch Centre; SLDC- State Load Despatch Centre; CTU- Central Transmission Utility; STU- State Transmission Utility.

Source: CRISIL Research

The Ministry of Power works in close coordination with the CERC and CEA. While the CERC's role is more of a regulator for approving tariffs of central utilities, approving licenses, etc., the CEA is primarily a technical advisor focused on planning, i.e., estimating power demand and generation and transmission capacity addition. The CEA also reviews the performance of power sector on a monthly basis.

2.1.1. Functions of regulatory authority

Appellate tribunals

Appellate tribunals were set up under the Electricity Act, 2003 to hear appeals against orders of the Electricity Regulatory Commissions (ERC).

Structure

- Appellate tribunals consist of a Chairperson and three members; at least one of them must be a judicial member and one a technical member; and
- A member shall hold office for a period of three years from the date of assuming office

Functions/powers

- Discovery and production of documents;
- Receive evidence on affidavits;
- Set up commissions for the examination of witnesses or documents; and
- Review its decisions

Central electricity regulatory commission (CERC)

- Regulates tariff of generating companies owned or controlled by the Central government;
- Regulates inter-state transmission of energy including tariff of the transmission utilities;
- Grants licenses for inter-state transmission and trading; and
- Advises the Central government in formulation of National Electricity Policy and Tariff Policy

State electricity regulatory commission (SERCs)

- Determine tariffs for generation, supply, transmission and wheeling of electricity, wholesale, bulk or retail sale within the state; and
- Issue licenses for intra-state transmission, distribution and trading; to promote co-generation and generation of electricity from renewal sources of energy, etc.

Central Transmission Utility (CTU)

- Undertakes the transmission of energy through inter-state transmission system; and
- Planning and coordination of inter-state transmission systems.

State Transmission Utility (STU)

- Undertakes transmission of energy through intra-state transmission system; and
- Planning and coordination of intra-state transmission system.

National Load Dispatch Center (NLDC)

- Set up as an apex body to ensure integrated power system in each region;
- Responsible for the dispatch of electricity within the regions, monitoring grid operations, etc.

Regional Load Dispatch Centers (RLDCs)

- Set up to ensure integrated power system in each region;
- Responsible for the dispatch of electricity within the regions, monitoring grid operations etc.; and
- Provides directions for ensuring grid stability.

State Load Dispatch Centers (SLDC)

- Formed to ensure integrated power system in intra state; and
- It has the responsibility for the dispatch of electricity within the state, monitoring intra-grid operations etc.

2.1.2. Functions of Central Electricity Authority (CEA)

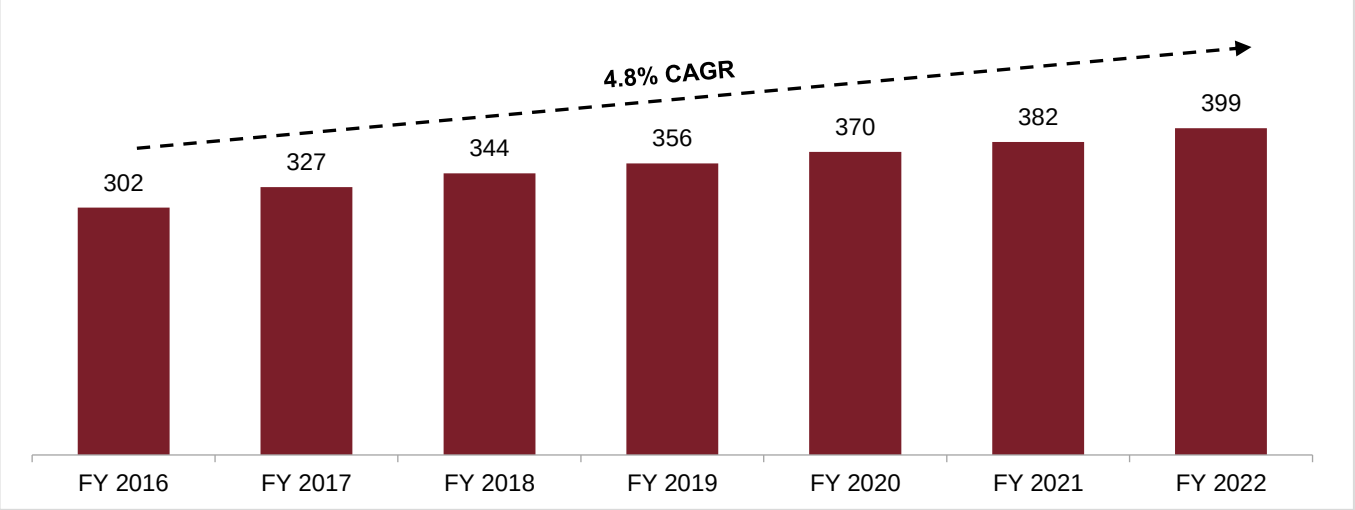
- Formulation of the National Electricity Plan in accordance with the National Electricity Policy;
- Main technical advisor of the government and regulatory commissions; and
- Specifies the technical standards and safety requirements for construction, operation and maintenance of electrical standards and electrical lines

2.2. Demand-supply review

2.2.1. Generation segment witnessed robust capacity growth of 4.8% over fiscals 2016-22

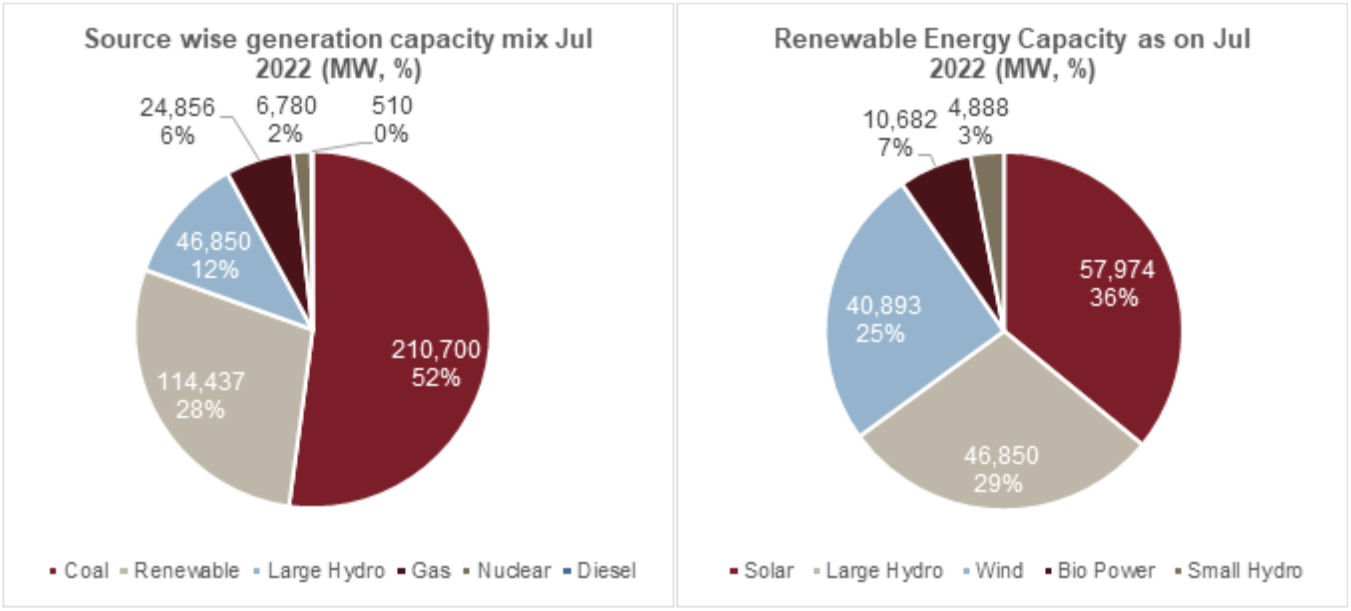
The total installed generation capacity at the end of July 2022 was 404 GW, of which approximately 97 GW of capacity was added fiscal 2016 onwards. Coal and lignite-based installed power generation capacity has maintained its dominant position over the years and accounts for ~52% as of July 2022. However, renewable energy installations (incl. large hydroelectric projects) have reached to ~161 GW capacity as on July 2022, compared with 25 GW as on March 2012 (Source: MNRE), constituting ~40% of total installed generation capacity as of date. In particular, this growth has been led by solar power, which grew at breakneck speed to ~58 GW from 0.9 GW over the same period.

Figure 9: Evolution of installed generation capacity (GW)



Note: 4.8% CAGR is for capacity additions growth between fiscals 2016-2022

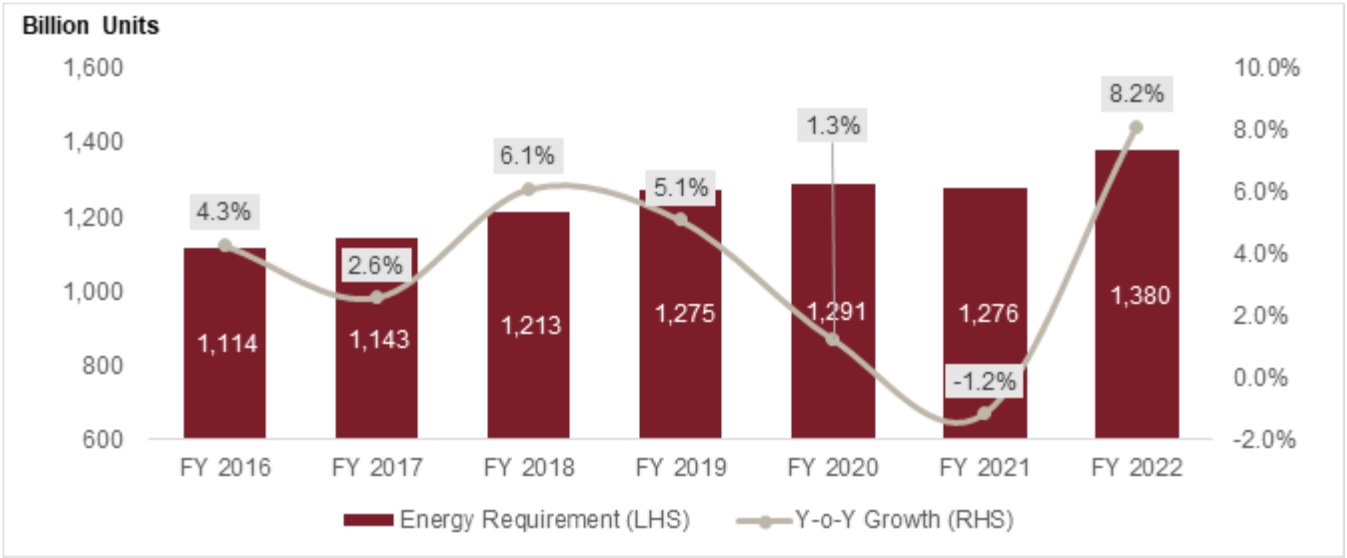
Source: CEA, CRISIL Research



Source: CEA, CRISIL Research

The Electricity Act, 2003 coupled with competitive bidding for power procurement, implemented in 2006, encouraged the participation of private players who had announced large capacity additions. Moreover, the strong government thrust on renewable energy coupled with reducing tariffs (with falling capital costs and improving efficiency) also supported renewable energy capacity additions. Tepid rise in demand growth coupled with rising supply led to drop in power deficit

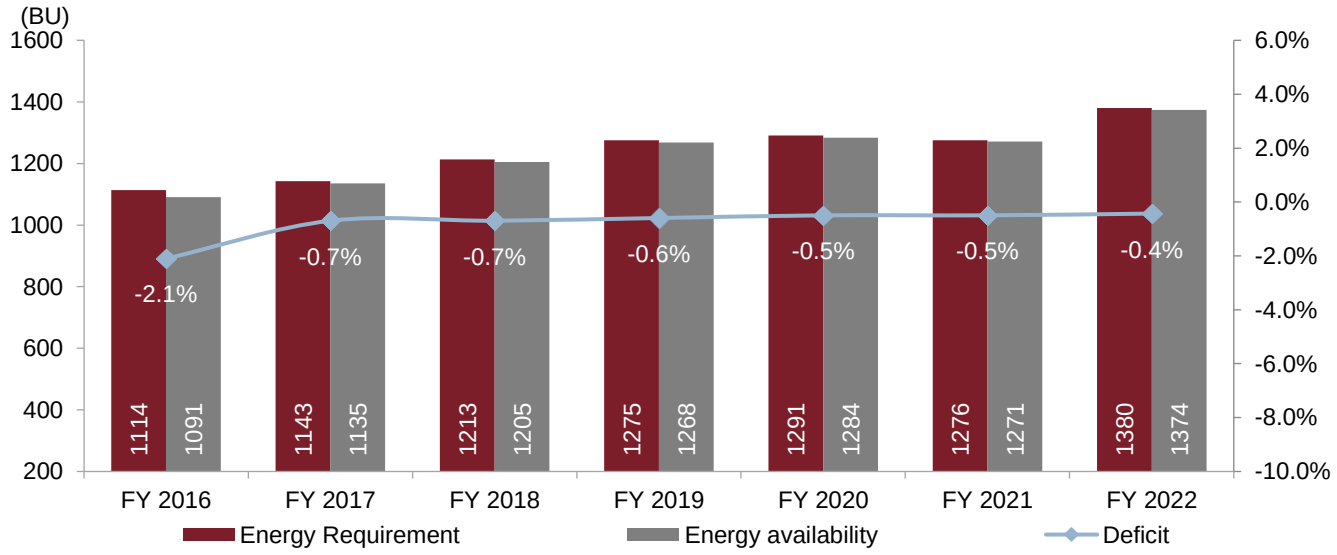
Figure 10: Trend in energy requirement



Source: CEA, CRISIL Research

The growth stood at 4.3% during fiscal 2016 and 2.6% in fiscal 2017 owing to slowdown in manufacturing activity. It improved to 6.1% in fiscal 2018, mainly driven by rising electrical connections under the rural electrification and Saubhagya schemes. Power demand growth was subdued at 1.3% on-year in fiscal 2020 owing to a slowing economy, with an extended monsoon till October 2019 further dampening demand. The extended monsoon resulted in lower cooling demand from domestic consumers as well as reducing irrigation demand from agricultural consumers. Demand recovered slightly in January-February 2020 with the onset of summer, but the pandemic downed the shutters on economic activity in March 2020, thereby pulling power demand growth into negative territory. Power demand posted a decline by (1.2) % in fiscal 2021. Economic growth made a healthy comeback in fiscal 2022 coupled with a low base effect as well as government spending on infrastructure. Consequently, power demand returned to positive territory during fiscal 2022, growing at 8.2%. Power demand surged in Q1 of fiscal 2023 due to the severe heatwave and continued momentum in economic activity, thus registering a 18.6% on-year growth in the quarter. Subsequently, demand is expected to gradually pick up on the back of healthy recovery in economic growth, expansion in reach via strengthening of T&D infrastructure, and improved power quality, thereby registering a 5-6% CAGR over fiscals 2023 to 2027.

Figure 11: Aggregate power demand supply (in billion units)



Source: CEA, CRISIL Research

India's electricity requirement is estimated to have grown at a compounded annual growth rate (CAGR) of ~3.6% between fiscals 2016 and 2022, while power availability rose quicker at ~3.9% CAGR on the back of strong capacity additions, both in the generation and transmission segments. As a result, energy deficit declined to 0.4% in fiscal 2022 from 2.1% in fiscal 2016. The decline in deficit was sharp, particularly in fiscal 2017, on account of muted demand growth of 2.6%. The low demand was the result of a decline in consumption across categories owing to energy efficiency measures, transmission and distribution (T&D) loss reduction in key states driven by adoption of UDAY scheme.

In fiscals 2018 and 2019, power demand grew at 6.1% and 5% on-year, respectively, led by a low base and gradual pickup in consumption across categories with impetus from electrification of un-electrified households, transmission and distribution network expansions, healthy economic activity, etc. Strengthening of inter-regional

power transmission capacity over the past five years has supported the rapid fall in deficit levels as it reduced supply constraints on account of congestion and lower transmission corridor availability, thereby lowering the deficit to 0.6% in fiscal 2019. However, in fiscal 2020, power demand grew at a slower 1.3% due to weakening economic activity and extended monsoon, wherein by the end of the fiscal, economic activity and capacity additions (both generation and transmission) slowed down due to the ongoing pandemic. Gradual recovery is seen post fiscal 2021, as construction activity and demand recovery post the pandemic and lifting of COVID-19 restrictions.

After a minor 1.2% decline in fiscal 2021, power demand has seen a strong rebound in fiscal 2022, registering a ~8% y-o-y growth on the back of healthy revival in economic activity.

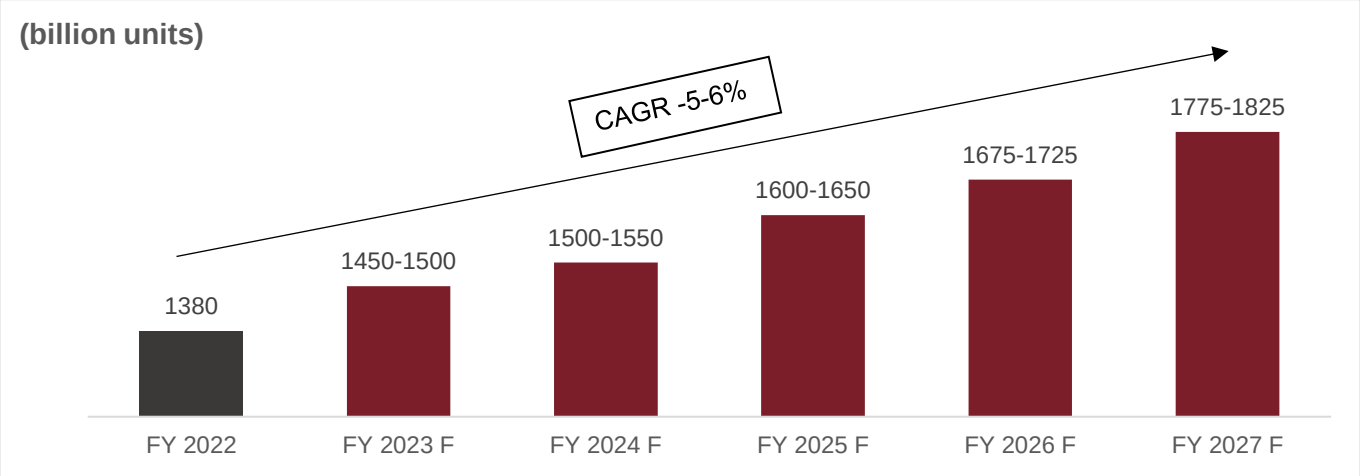
For the fiscal 2022, the average energy deficit across states and UTs currently stands at 0.4%. Between five regions, two regions have a deficit higher than all India average; the northern and eastern region with deficit of 0.8% and 0.6% respectively. Top states with highest deficit are Jammu & Kashmir (UT) and Ladakh (UT), Jharkhand, Bihar, Punjab and Uttarakhand.

However, this does not imply that the power deficit is negligible since off-grid untapped latent demand persists and intensive rural electrification as well as '24X7 power supply to all' is yet to be achieved. Further, many towns and villages in the country are deprived of the 24 x 7 electricity supply on account of multiple technical (*such as highly loaded power line frequently tripping*) and commercial (*theft and pilferage, subsidized consumers, etc*.) issues. Thus, the lower power demand is on account of lagging rural electrification as well as sub-optimal distribution infrastructure, and absence of last mile connectivity in some cases.

2.3. Demand-Supply Outlook

2.3.1. Energy requirement to rise at 5-6% CAGR over 2022-27

Figure 12: Energy requirement growth over next five years



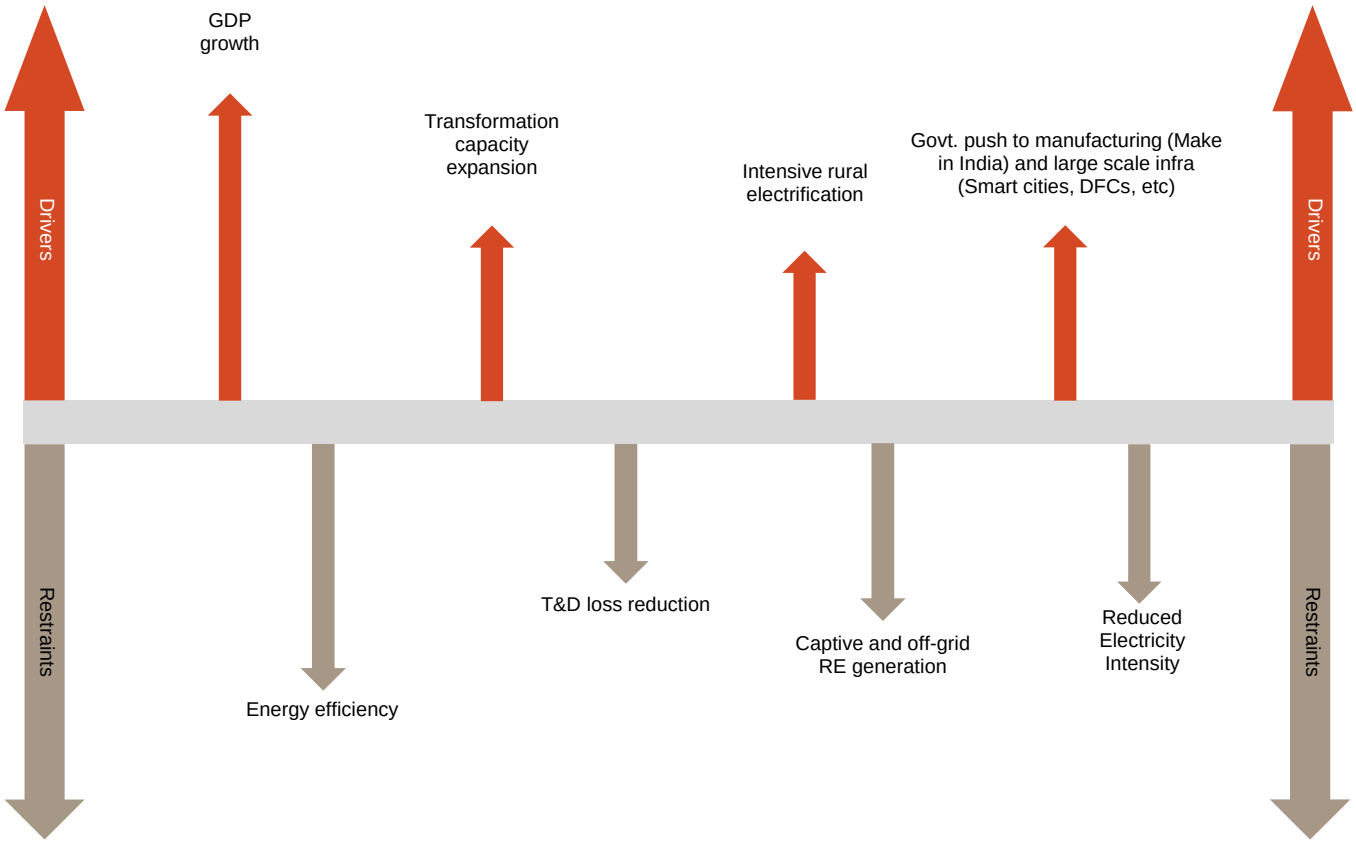
Source: CRISIL Research

CRISIL Research expects energy requirement to grow at 5-6% CAGR over fiscals 2022 to 2027, due to healthy economic growth and expansion of the power footprint. Power demand which was expected to bounce back in Q1 of fiscal 2022, was impacted by the second wave of COVID-19 infections which resulted in partial lockdowns in major states over April-May 2021. Infection rates began subsiding in June-July 2021 due to which industrial and

economic activities went back to normal in various regions of the country. Later, a less severe third wave was caused by the omicron variant, which translated to a power demand growth of 3.8% on-year in Q4 of fiscal 2022. Overall power demand during fiscal 2022 grew at 8.2%.

Q1 of fiscal 2023 saw a surge in power demand resulting from the severe heatwave in the country. This along with the continued momentum in economic activity resulted in an on-year power demand growth of 18.6% in Q1 of fiscal 2023, despite high base of Q1 FY22. Going forward, demand is to be driven by industries due to improving utilisation levels and kick-start of the capex cycle in key sectors owing to buoyant customer sentiment. Commercial power demand is also projected to improve as offices and educational institutes resume operations, albeit in a hybrid scenario. Therefore, power demand growth is estimated to rise 6-6.5% on-year in fiscal 2023, over a high base.

Figure 13: Factors influencing power demand

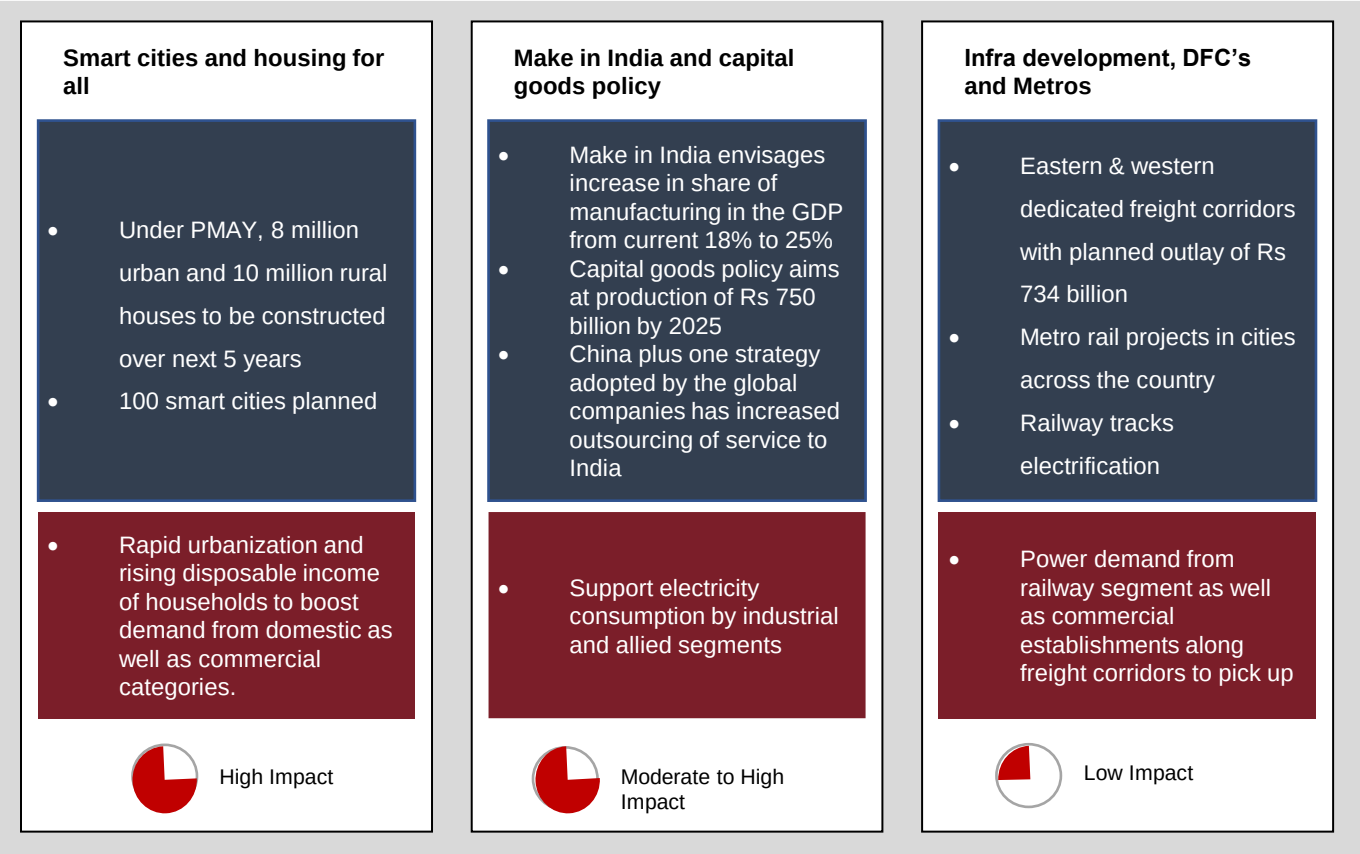


Source: CRISIL Research

2.3.2. Gradual pick-up in GDP growth and infrastructure development to support power demand

India's economy is expected to continue to grow after fiscal 2022, with a gradual pick-up in industrial growth over the medium term. Trickle-down effect of the Aatmanirbhar Bharat relief package, government spending on infrastructure through the National Infrastructure Pipeline (NIP), dedicated freight corridors (DFCs) infrastructure, service industry expansion, rapid urbanization, and higher farm income from agri-related reforms are key macroeconomic factors that will provide a boost.

Figure 14: Infrastructure development to drive power demand



Source: CRISIL Research

Various government initiatives such as Make in India, Smart Cities Mission, dedicated freight corridors, metro rail projects, railway track electrification, etc, are expected to boost power demand in the country, albeit in the medium to long term.

2.3.3. T&D network augmentation to support demand growth

With the government's focus on alleviating congestion, transmission capacities are expected to witness robust growth. About 450-470 gigavolt ampere (GVA) transformation capacity (above 220 kV level) is expected to be added between fiscals 2023 to 2027 to reach the cumulative transformation capacity of 1,500-1,600 GVA by fiscal 2027. In particular, a robust growth in high voltage (HV) lines of 400 kV and 765 kV is envisaged due to its importance in interstate transmission lines on account of the following government targets:

- Inter-regional transmission capacity expansion to 145 gigawatts (GW) by fiscal 2024 from 112 GW in March 2020
- Ultra-high-capacity green energy corridors with expected investments worth Rs 430 billion

Thus, the expected improvement in T&D infrastructure coupled with agricultural feeder separation and extensive rural electrification under the Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) will drive power demand upwards over the next five years.

Grid integration of renewables is key to the growth of the renewable generation. Instances of delay in readiness of transmission infrastructure at solar parks have caused concern amongst developers. However, an aggressive roadmap to add an incremental ~100 GW via new schemes and existing available capacity to the grid should be adequate for the expected additions. The key is timely execution of the transmission projects.

2.3.4. Long-term reforms in distribution segment expected to aid improvement in quality of power

The power sector has long been impacted by the weak financial position of state utilities, especially in the distribution sector. The same was sought to be solved under the Ujjwal DISCOM Assurance Yojana (UDAY), which ended in March 2019. The programme provided temporary relief in the form of reducing the interest burden for discoms (as debt was taken over by state governments), but discoms have again piled up significant debt as of fiscal 2022. While weak power demand, especially from the industrial and commercial categories, weighed on discoms' collections in fiscal 2021, the relief package announced in the backdrop of COVID-19 is expected to provide some relief on the liquidity and debt-servicing front. The government is expected to aid reforms on the distribution side, with strict targets for achieving infrastructure improvements and sustainable tariff revisions.

2.3.5. DDUGJY to boost rural demand

Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), which was launched in December 2014, covers works related to strengthening of rural power infrastructure and encompasses the erstwhile RGGVY programme. The objectives of DDUGJY include separation of agricultural and non-agricultural feeders, strengthening and augmentation of the T&D infrastructure in rural areas, including metering of transformers/feeders/consumers and boosting rural electrification along with decentralized distributed generation. Going forward, IPDS and DDUGJY are likely to be subsumed under the RLRDS, thereby diverting designated funds towards the mega-reforms scheme.

Investments from central government schemes such as Integrated Power Development Scheme (IPDS), Deen Dayal Upadhyay Gram Jyoti Yojana (DDUGJY) and Sahaj Bijlee Har Ghar Yojana (SAUBHAGYA) led to the investments in the distribution space. Over the past 5 years, the segment has received investments worth Rs 4-4.5 trillion.

2.3.6. Improving energy efficiency, reducing energy intensity and fall in AT&C losses to restrict power demand

Although power demand is expected to be healthy, we believe some factors will partly offset this growth. The power generation segment grapples with overcapacity and debt pile-up, the distribution segment also faces the problem of rising dues to gencos – dues of distribution companies (discoms) shot up from ₹ 386 billion as of March 2019 to ₹ 760 billion as of March 2020, and further increased to ₹ 1,010 billion as of March 2022. This is largely owing to historically high aggregate technical and commercial (AT&C) losses, which indicates lower billing and collection efficiency, and the gap between the average cost of supply and average revenue realised (ACS-ARR gap), which indicates lower profitability. This inability to service payments in a timely manner trickles down to gencos, further adding to their financial burden.

The Ujwal Discom Assurance Yojana (UDAY), which aims to gradually improve the financial position of discoms, has seen reasonable traction with all major states (except Odisha and West Bengal) signing memoranda of understanding (MoUs). With bonds worth ₹ 2.3 trillion being issued (86.3% of the target) as of February 2021, debt and interest burden on discoms was supposed to have reduced, but the target achievement stagnated during fiscal 2020 with the bond issuance remaining at nearly the same level at the end of the fiscal. On the operational

efficiency front, the ACS-ARR gap and AT&C losses – which had reduced to ₹ 0.3 per kWh and 21% in fiscal 2020 from ₹ 0.59 per kWh and ~23% in fiscal 2016, respectively – increased to ₹ 0.35 per kWh and 16.6% in fiscal 2022, respectively. However, most discoms have failed to achieve the targets on the ACS-ARR gap and AT&C loss reduction, which is expected to result in deterioration of discoms' performance over the medium term. Therefore, discoms in states with higher AT&C losses would prefer to bring down their share of electricity supply to agricultural and residential consumers and would support rooftop initiatives for such consumers.

Amid the pandemic, discoms faced a double whammy of mounting dues and lower revenue because of falling power demand, especially from the high-paying industrial and commercial customers that resorted to a near-complete shutdown. The relief package worth ₹ 900 billion in the form of loans to be extended by Power Finance Corporation Ltd. (PFC) and Rural Electrification Ltd. (REC) was further enhanced to ₹ 1.35 trillion in the light of rising dues because of lower collections on account of the pandemic. The funding is expected to provide interim liquidity relief to discoms and, consequently, to gencos. The deferment and rebate on fixed charges are likely to ease liquidity concerns for discoms, while reducing revenues for gencos and power transmission companies, particularly in the central sector. As of November 2021, loans worth ~Rs 1.35 trillion have been sanctioned to discoms, whereas disbursal to the tune of ~Rs 1.08 trillion has been completed as of March 2022. The fund disbursal from the package improved liquidity of beneficiary state discoms, which was reflected by reduction in discoms' payables from ~Rs 1,000 billion as of November 2020 to ~Rs 882 billion as of March 2021. However, the impact of the package has started fading as the payables have started rising again in fiscal 2022, reaching ~Rs 1,100 billion as of March 2022.

The government has also proposed significant long-term reforms in the power sector, namely the National Tariff Policy and the proposed Electricity (Amendment) Bill 2020. These are aimed at improving operational efficiency and alleviating financial stress in the sector, whilst promoting competition through private participation. The Union Budget 2021-22 announced the Reform Linked Revamped Distribution Scheme (RLRDS) with an outlay of ₹ 3.04 trillion, partly funded by the Central government to the tune of ₹ 976 billion, aimed at alleviating discoms' financial stress, subject to achievement of reforms such as reducing ACS-ARR gap and AT&C losses of state discoms, smart metering, upgradation of distribution infrastructure, and improving compliance through timely filing of audited annual accounts and tariff orders. However, the success of the scheme depends on the diligent implementation of the reform measures and timely disbursal of milestone-linked funds by Central and State governments.

Figure 15: Synopsis of UDAY scheme

UDAY Scheme

Reduction in power purchase cost

- Additional supply of domestic coal
- Coal linkage rationalization through swap agreements
- Allocation of cheaper power from CPSU's like NTPC
- Supply of washed and crushed coal

Reduction in interest expense

- States to take over 75% discom debt as on Sept 15
- 25% to be converted by lender into state guaranteed discom bond

Improvement in operational efficiencies

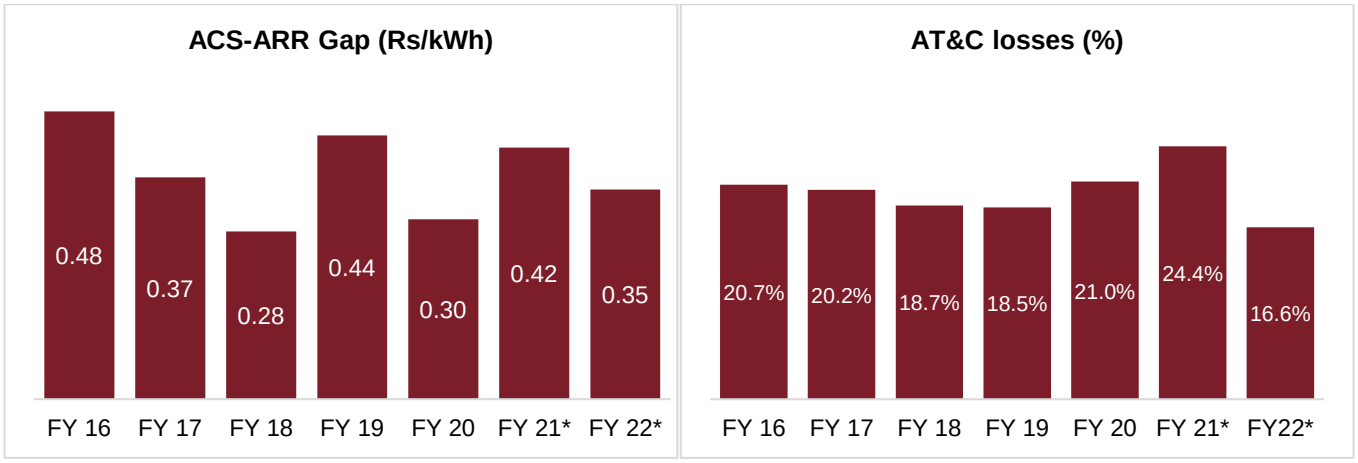
- Installation of smart meters
- Upgrade transformers
- Use of energy efficient LED's
- Additional funding from IPDS and DDUGJY

Other key provisions

- Hard budget constraints on states as discom losses post FY18 will have to be taken over by state government in phased/manner
- Restrictions on banks for funding operational losses
- Monthly monitoring of progress

Source: CRISIL Research

Figure 16: UDAY scheme progress



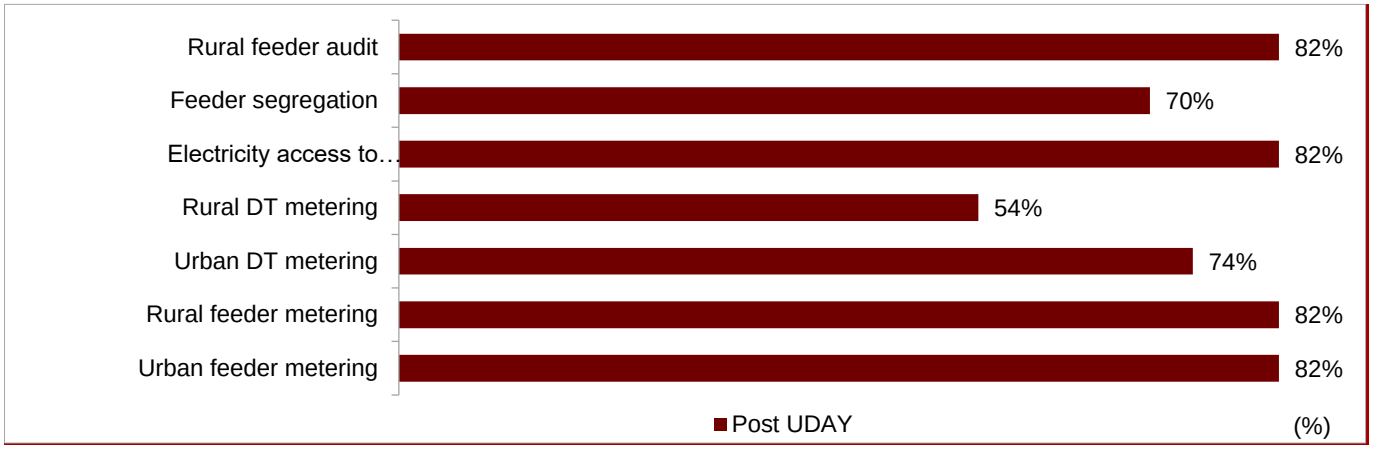
*Note: * Estimates as per reported numbers on UDAY portal*

Source: UDAY portal, CRISIL Research

ACS-ARR gap for UDAY states had reduced to ₹ 0.28 per kWh in fiscal 2018 from ₹ 0.37 per kWh in fiscal 2017 but expanded to ₹ 0.44 per kWh at the end of fiscal 2019 indicating reversal of some of the gains achieved through reduction in power purchase costs, interest burden and AT&C loss reduction over last three years. ACS-ARR gap stood at ₹ 0.3 per unit as of March 2020 and has further widened to ₹ 0.42 per unit as of March 2021, indicating further deterioration in discom financial profile. However, for fiscal 2022, it has improved to ₹0.35 per unit.

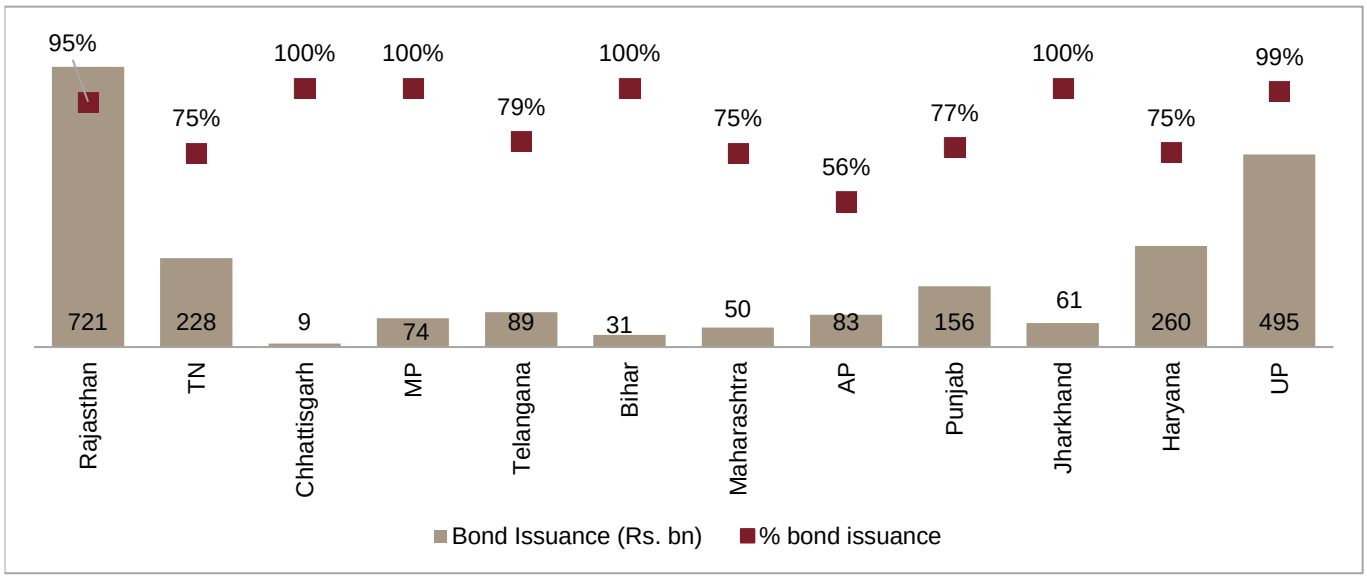
All India AT&C losses as on March 2019 as per the UDAY portal were estimated at 18.5% and increased to ~21% (as of March 2020) post UDAY. However, losses have shot up to ~24.4% as of March 2021 since the onset of the COVID-19 pandemic, which has led to deterioration of collections from a large section of the commercial and industrial consumers. However, it has improved in fiscal 2022 to 16.6 %.

Figure 17: Operational parameters for distribution infrastructure development post UDAY implementation



Source: UDAY Portal, CRISIL Research

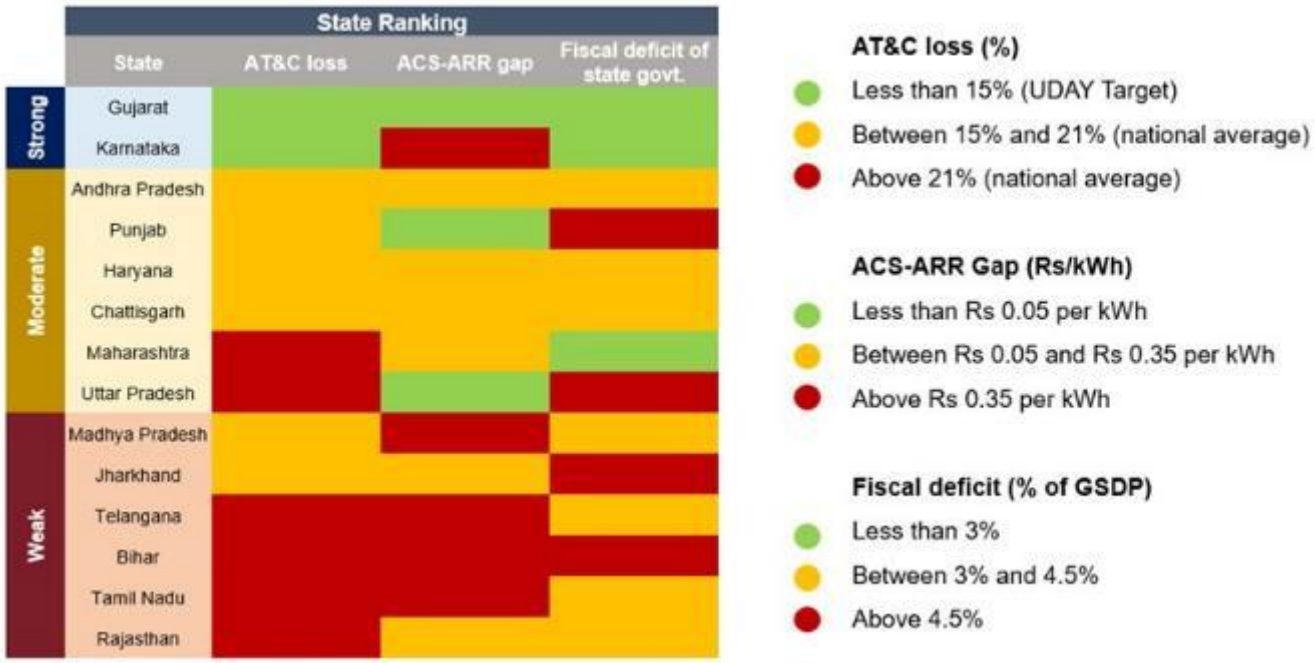
Figure 18: 86.3% of the total ₹ 2.3 trillion worth of bonds already issued as of September 2022



Source: UDAY, MoP, CRISIL Research

As on March 2019, ₹ ~2.3 trillion worth bonds had been issued (86.3% of target) which led to the debt and interest burden on discoms being reduced, resulting in higher liquidity. However, the status remains the same as of September 2022. In addition to this, the debt burden of state distribution utilities has only mounted with estimates (CRISIL Ratings Press Release – May 06, 2019) of the same reaching back to pre-UDAY level by the end of fiscal 2020.

Figure 19: Bucketing of state utilities



Note: AT&C losses and ACS-ARR gap as of March 2022.

Source: UDAY portal, RBI, CRISIL Research

2.3.7. Distribution reforms planned by the government to revive the sector

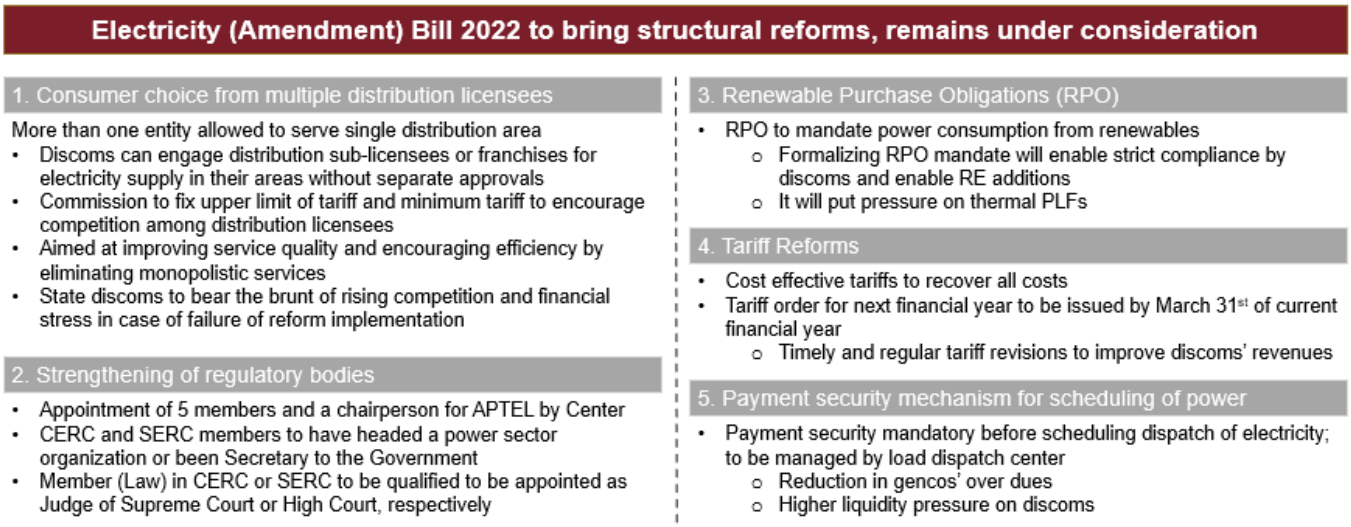
The government plans to implement several policies to resolve the issues of the ailing distribution segment, as it impacts the entire value chain. Key announcements pertaining to the same are:

- Fresh trajectory for reduction of AT&C losses to below 15%. Possible cumulation of targets and funds under DDUGJY and IPDS
- Privatisation of distribution circles - separation of content and carriage. Distribution utilities collect wheeling charges for power wheeled through their power distribution networks. However, privatization of distribution circles results in efficient power delivery. Tata Power has won the bid to service five circles within Odisha - roughly a consumer base of 2.5 million
- Letter of credit (LC) mechanism was also implemented in August 2019. This order mandated discoms to issue LCs or provide payments upfront before purchase of power. However, success of this scheme has been limited so far, due to various loopholes utilised by the discoms and the lower bargaining power of private IPPs
- Ensuring 24x7 power supply on a sustainable basis across India
- A revised tariff policy to make tariff revisions more effective and cost encompassing but at the same time not passing on costs due to discom inefficiencies

Apart from the above, the central government also introduced a ₹ 900 billion stimulus for state distribution utilities within the economic relief package announced by the government in relation to COVID-19 related negative impact, which was further enhanced to ₹ 1.2 trillion. The relief package will help discoms clear a significant portion of their outstanding dues to power generators. The latter is expected to be provided in the form of concessional loans (moratorium, lower interest rates) to the state distribution utilities, secured by discom receivables and state

guarantees. Power Finance Corporation (PFC) / Rural Electrification Corporation (REC) have been identified as key lenders for this package. The package was eventually increased further to Rs ~1.35 trillion, with the full amount being sanctioned as of November 2021, whereas disbursal to the tune of Rs ~1.08 trillion has been achieved as of March 2022.

Figure 20: Long-term measures planned for structural reforms in discoms



Source: CRISIL Research

While most of the reforms suggested by the government are positive / neutral and are targeted towards solving long term issues plaguing the sector, implementation remains key for materialisation of the improvements envisaged. Few of the proposals also need to be spelled out before their impact can be ascertained fully.

2.3.8. Stretched financials, delay in clearances, and lack of PPAs to limit conventional capacity additions to 33-34 GW over next five years

While there are ~52 GW of thermal power generation capacities under construction as of May 2022, CRISIL Research expects only 25 GW to commission between fiscals 2023 to 2027. In addition, 5-6 GW of hydro and 3-4 GW of nuclear capacities are expected to be added during the same period.

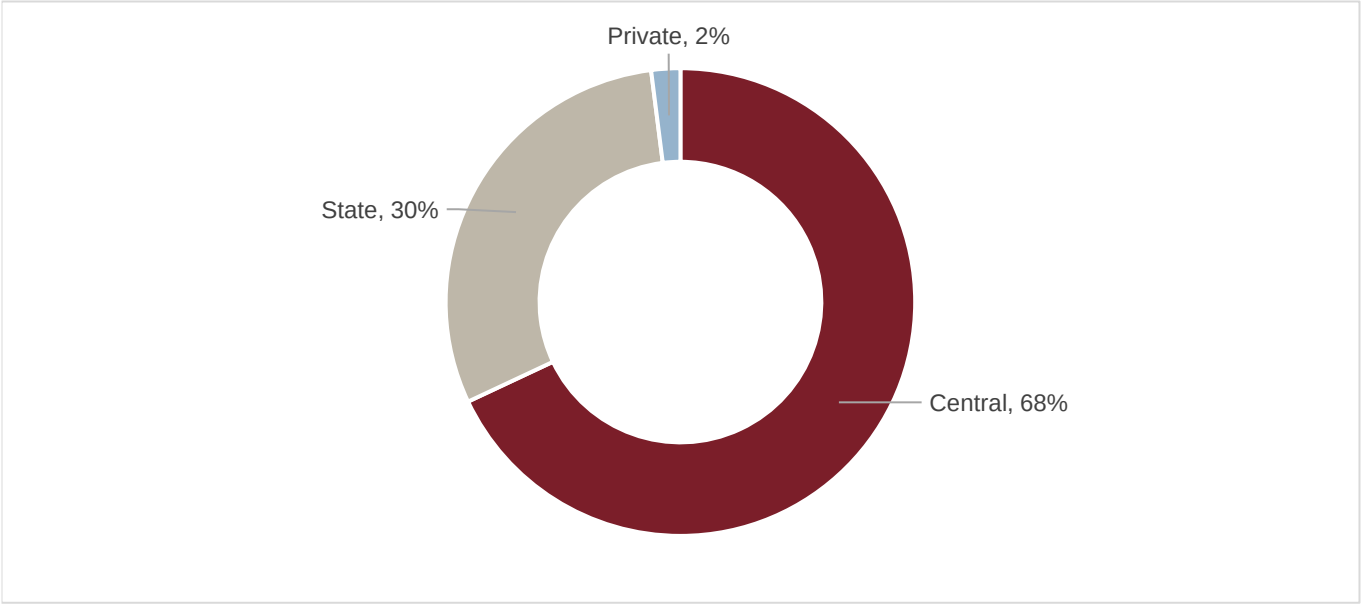
Capacity glut, especially for thermal, weakens outlook for capacity additions. Power demand is estimated to have grown at a CAGR of 3-4% between fiscals 2017 and 2022, while conventional and renewable installed generation capacities are estimated to have grown at a CAGR of 1.4% and 14.3% respectively. As a result, average plant load factors (PLFs) of coal based power plants declined from ~60% in fiscal 2017 to 55% in fiscal 2022. However, due to strong power demand in fiscal 2022, PLFs recovered to 58.8%. On the other hand, PLFs for gas-based plants declined from 22-25% (fiscal 2017-21) to 16.5% in fiscal 2022 due to surge in gas prices and is expected to further deteriorate to 13% in fiscal 2023

Power demand increased by 8.2% in fiscal 2022 due to recovery driven by economic revival, government relief measures, and strengthening of T&D infrastructure, thereby forcing slower capacity additions.

Private sector power generation segment is under financial stress. Large capacity additions by the private sector (~82 GW of conventional source-based plants between fiscals 2009 and 2022) without adequate off-take and fuel arrangement have put pressure on the financials of generation companies. With high gearing and low coverage ratio, the private sector is expected to slow down their capacity addition from that planned earlier. The trend has already been visible over the last three years when the private sector capacity additions declined to 5.3 GW in fiscal 2017, 4.5 GW in fiscal 2018, ~1 GW in fiscal 2019, and further down to a minuscule 45 MW and 99 MW in fiscals 2020 and 2021 respectively, compared with an average ~12 GW being added annually in the preceding five years (fiscals 2012 to 2016).

During fiscals 2023 to 2027, conventional capacity additions of 33-34 GW are expected, in line with ~33 GW added over the past five years. However, investments in the segment are expected to increase on account of higher nuclear capacity additions to the tune of 3.5 GW over the forecast period coupled with higher capex per unit capacity across fuels. Investments are likely to have slackened in fiscal 2021 due to construction slowdown on account of the COVID-19 outbreak but are likely to pick up fiscal 2022 onwards. In fiscal 2022, ~0.9 GW of private capacity additions took place, albeit from delayed projects, with 0.5 GW and 0.4 GW being added in coal and hydro respectively.

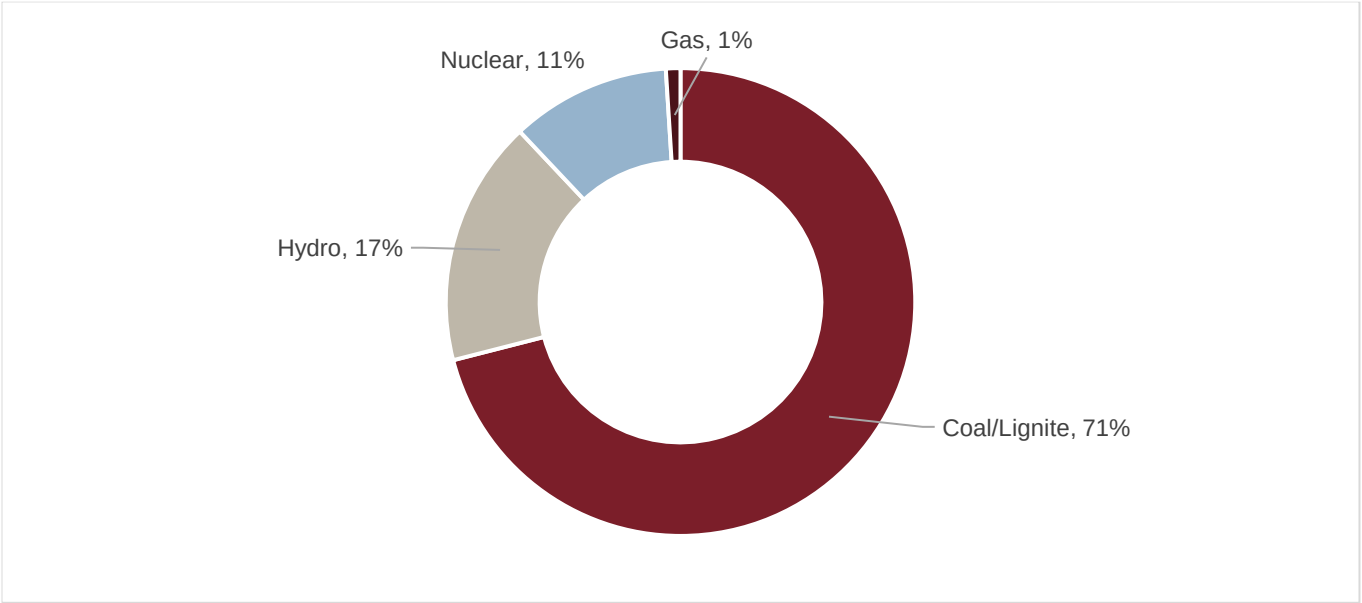
Figure 21: Sector wise break-up of estimated cumulative capacity additions (fiscals 2023-2027)



Source: CRISIL Research

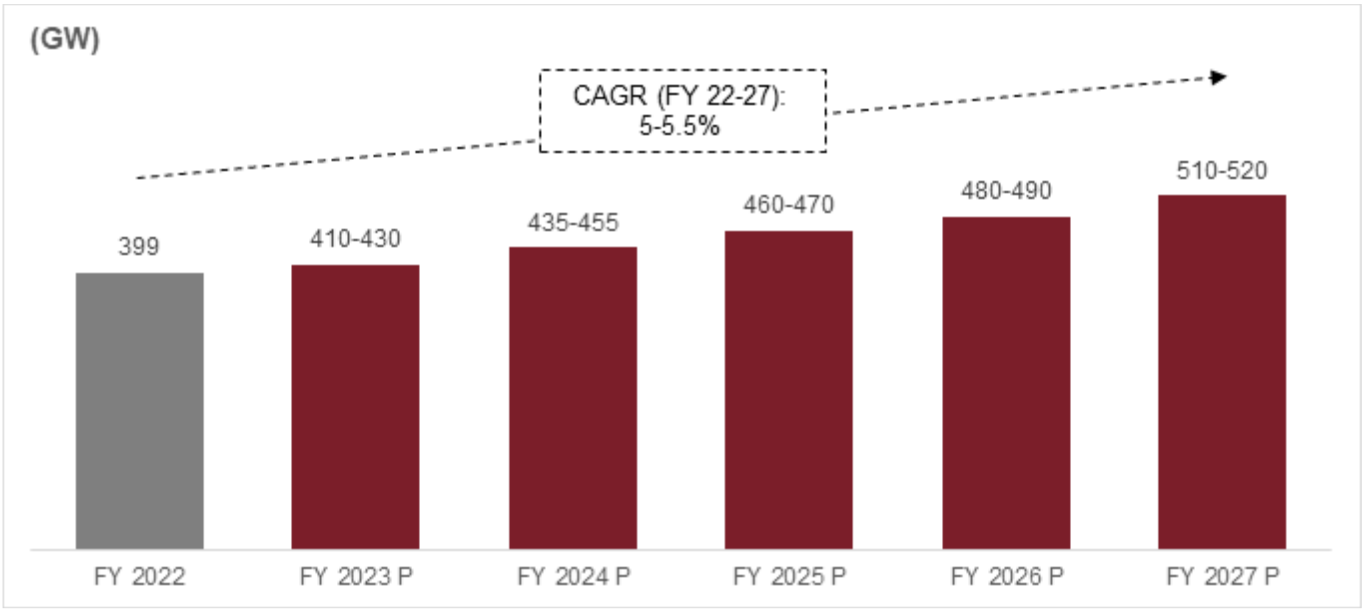
Coal-based capacities to account for 70-75% of total additions. CRISIL Research expects ~25GW of new coal-based capacities to commission between fiscals 2023 and 2027, led by large number of planned projects and the fact that coal continues to remain the most widely available and economic source of fuel among the conventional sources. Moreover, the government's policy for flexibility in utilisation of domestic coal, new linkage policy (SHAKTI), and higher domestic coal production aimed at coal import substitution would lead to significant improvement in coal availability over the next three-five years for power plants.

Figure 22: Fuel-wise break-up of conventional capacity addition over fiscals 2023 to 2027



Source: CRISIL Research

2.3.9. All-India installed capacity to reach 510-520GW by fiscal 2027, led by renewables



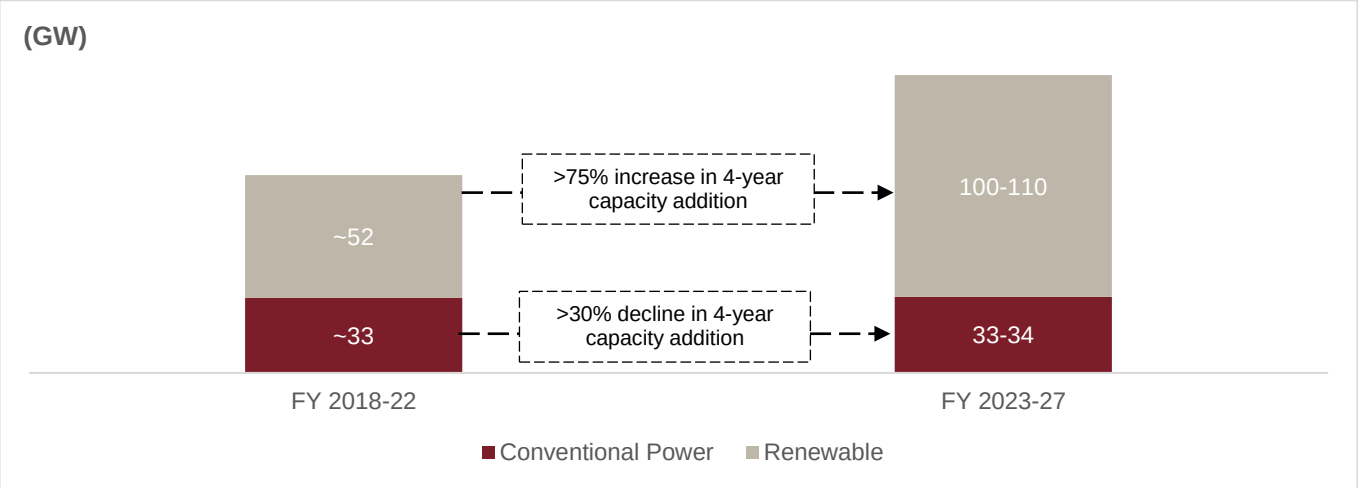
Source: CRISIL Research

Over the next five years (fiscals 2023-2027), 33-34 GW of conventional capacity is expected to be added in India. While there are ~52 gigawatts (GW) of thermal power generation capacities under construction as of May 2022, CRISIL Research expects only ~25 GW of coal-based power to commission over fiscals 2023 to 2027. In addition, 5-6 GW of hydro and 3-4 GW of nuclear capacities are expected to be added.

2.3.10. Strong growth in renewable capacity additions to continue

CRISIL Research expects 100-110 GW of renewable power generation capacities to be added between fiscals 2023-27. Capacity additions in the renewable energy segment are expected to witness robust growth. Additions in both wind and solar power are expected to be driven by strong government focus, which is evident from the fiscal and regulatory incentives, viability gap funding and execution support in terms of land and evacuation infrastructure. Improved availability of low-cost finance through various instruments / sources would also support renewable energy capacity additions.

Figure 23: Expected trend in power generation capacity addition



Note: Renewables consists of Solar and Wind power capacities only.

Source: CEA, CRISIL Research

The scheme for flexibility of generation introduced by Ministry of Power, GoI in April 2018, is aimed at promoting renewable and hydro power generation, facilitating adequate and uninterrupted supply to consumers and ensuring financial viability in the sector. It proposed bundling of power from conventional thermal plants whose PPAs have expired, or plants have completed their useful life with renewable plants through bidding process. This would reduce the overall power purchase cost for utilities and provide them with the option of round-the-clock power supply to match with demand. Additionally, it proposes state regulators to adopt RPO trajectory issued by the central government. Thus, formalising the RPO mandate will enable stricter compliance by the discom, which would further drive renewable capacity additions. The National Tariff Policy, 2006, that mandated states to procure power requirements through competitive bidding was extended to central and state utilities in January 2011 to secure PPAs for power offtake.

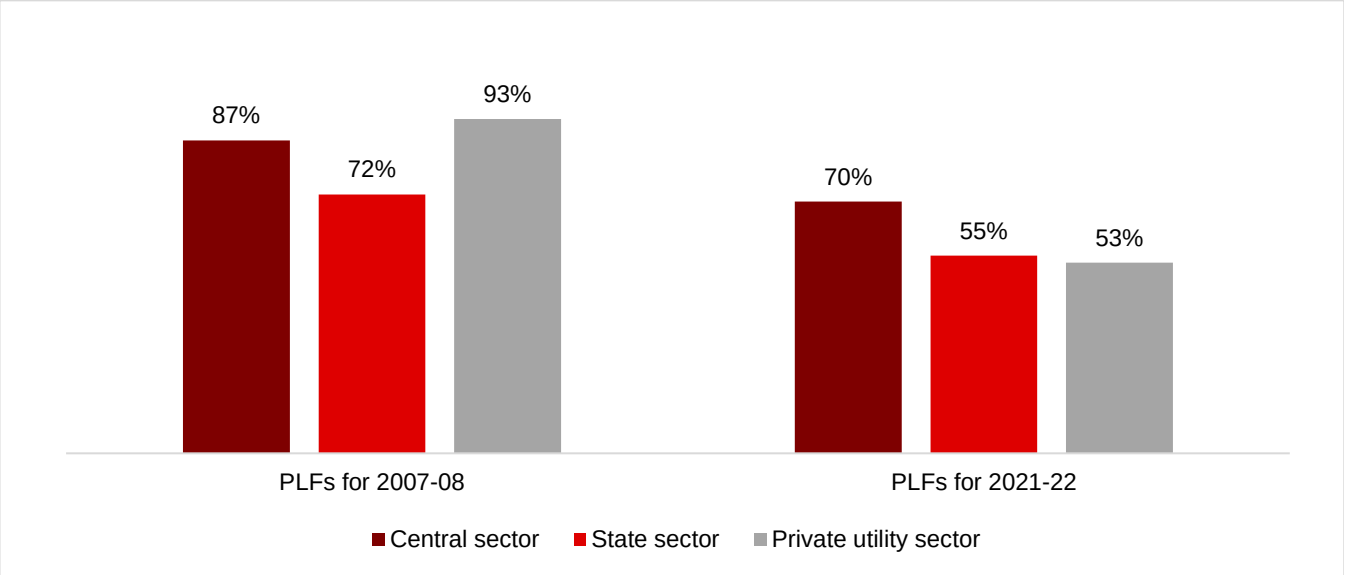
2.3.11. Low power demand and increased focus on renewable result in lower focus on conventional capacity addition

Power demand grew at a CAGR of 3.8% between fiscals 2017 and 2022, while conventional and renewable installed generation capacities grew at a CAGR of 1.4% and 14.3% respectively. Average plant load factors (PLFs) of coal-based power plants declined from 59.6% in fiscal 2017 to ~55% in fiscal 2021 but recovered to 58.8% in fiscal 2022. PLFs of gas-based plants which were at 22-25% during fiscals 2017-21, declined to 16.5% in fiscal 2022.

Lower power demand and the government's focus on increasing the share of renewables in the nation's energy mix are likely to prod gencos to go slow on new conventional capacity addition plans over the subsequent years. Major thermal gencos such as NTPC and Tata Power Company have floated separate ventures to add renewable energy (RE) capacity, signalling a decisive shift towards incremental RE capacity going forward.

Power demand increased by 8.2% in fiscal 2022 due to recovery driven by economic revival, government relief measures, and strengthening of T&D infrastructure, thereby forcing slower capacity additions. Q1 of fiscal 2023 saw a power demand surge of 18.6% and is estimated to grow at a CAGR of ~5% till fiscal 2027.

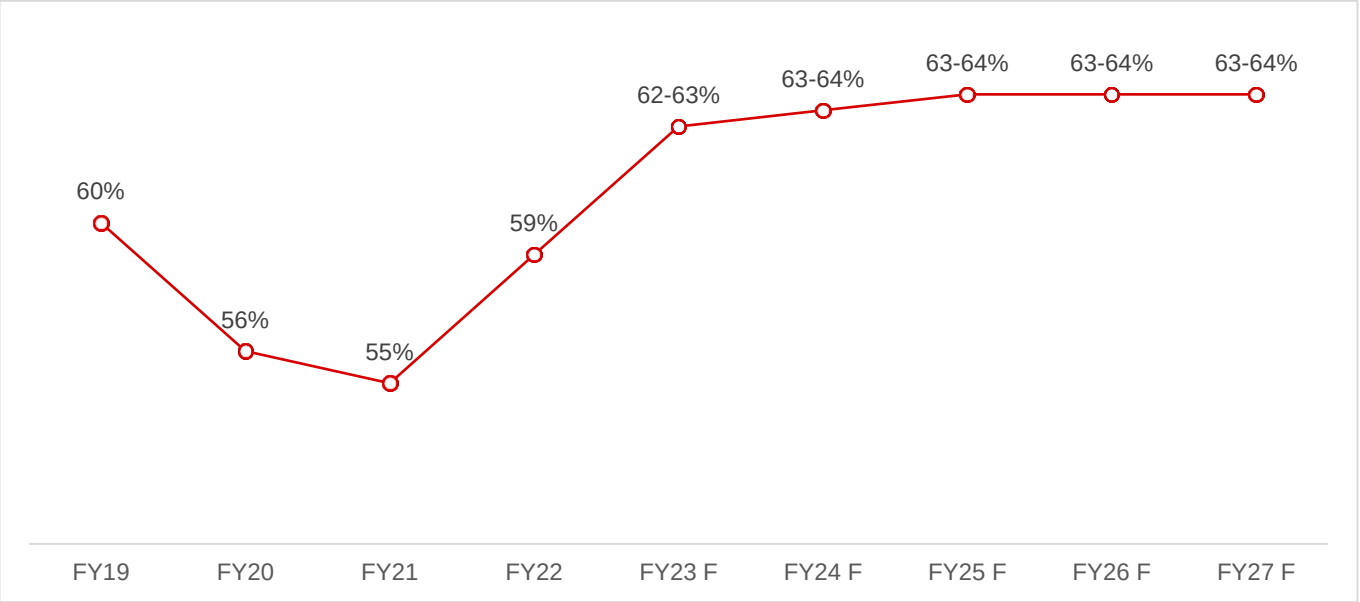
Figure 24: Coal-based PLFs



Source: CEA; CRISIL Research

2.3.12. Coal-based PLFs fell marginally in fiscal 2021 due to weak power demand, healthy recovery expected fiscal 2022 onwards

Figure 25: Outlook on PLFs of coal-based power plants



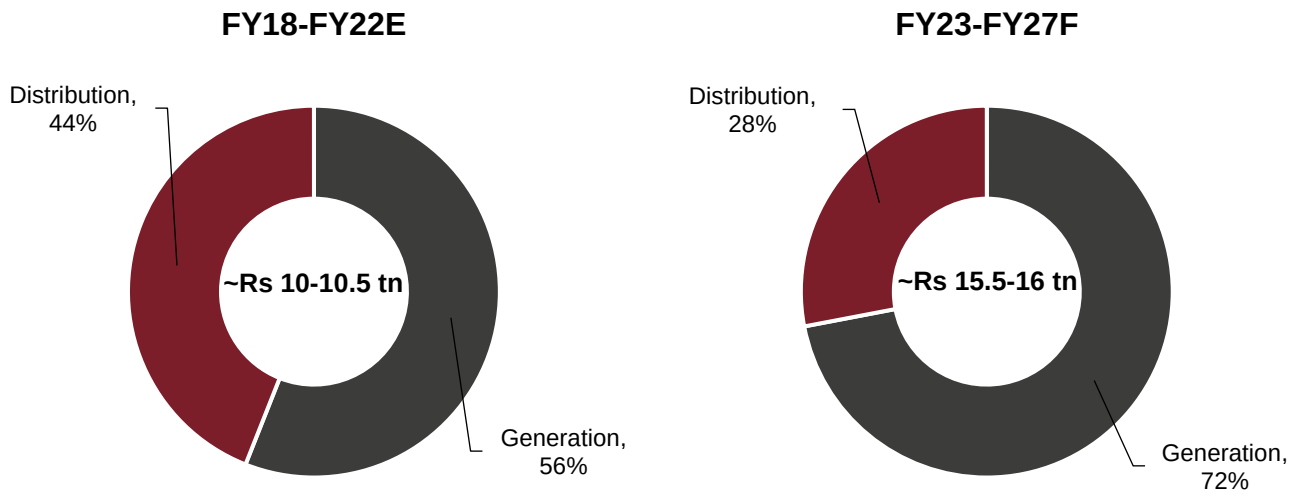
Source: CRISIL Research

F: Forecast E: Estimate

Coal-based PLFs, which had fallen from 60% in fiscal 2019 to 56% in fiscal 2020 due to weakening power demand and extended monsoon, are likely to have dipped further in fiscal 2021 on account of weakened economic activity in the aftermath of COVID-19 outbreak. Industrial and commercial activity was stalled in the first quarter of fiscal 2021 due to the COVID-19 induced lockdown, however relaxations in the second quarter put power demand onto slow recovery mode. In fiscal 2022, coal based PLFs recovered to 59%, in line with strong power demand growth of 8.2%.

From fiscal 2023-27, power demand is expected to see sustained growth, served by supply from renewable energy sources and other non-fossil fuels like nuclear power. Additionally, coal-base plants, especially new ones will operate in a flexible manner to meet volatile peak demand. Therefore, coal-based PLFs are expected to remain stable at 63-64%.

2.3.13. Investments in Power sector



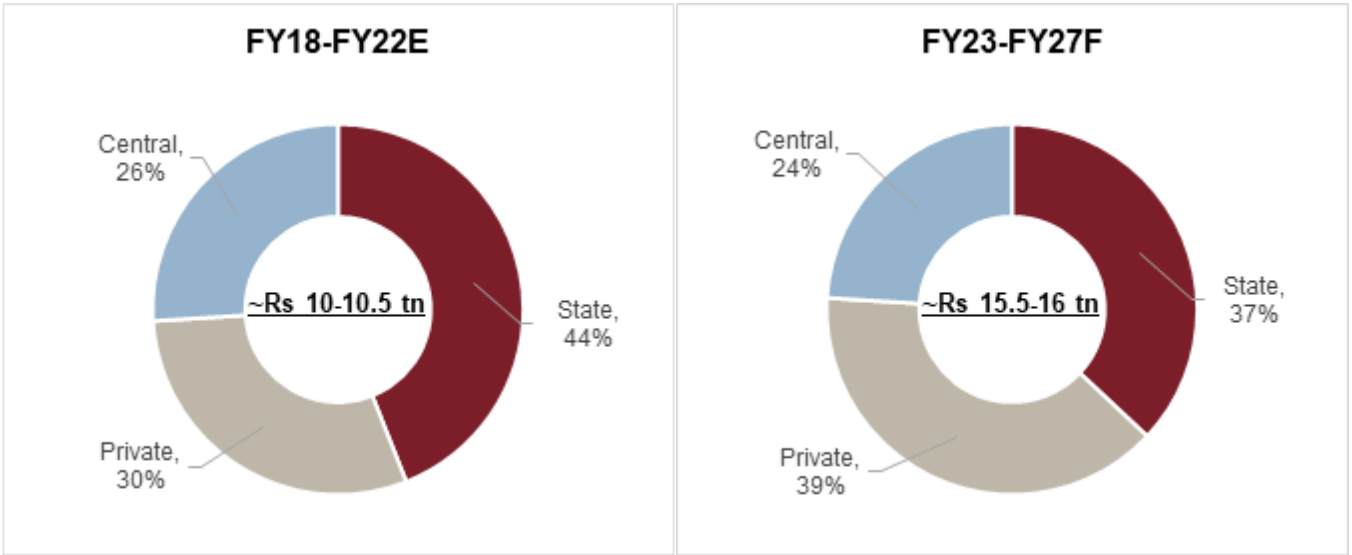
Note: E: estimates, F: forecast

Source: CRISIL Research

Investments for the generation sector are estimated to increase from ~56% to ~72%, majorly due to renewable energy capacity additions, and conventional capacity additions led by coal accounting for 70-75% of conventional capacities. Investments for the distribution sector are expected to increase due to reforms and RDSS (Revamped Distribution Sector Scheme) envisaged from fiscals 2023-27.

CRISIL Research projects investments of Rs 15.5-16 trillion over the next five years. Share of investments in generation are expected to increase, resulting in a fall of share for the distribution segment over the next five fiscals.

Figure 26: Sector-wise break-up of total investments



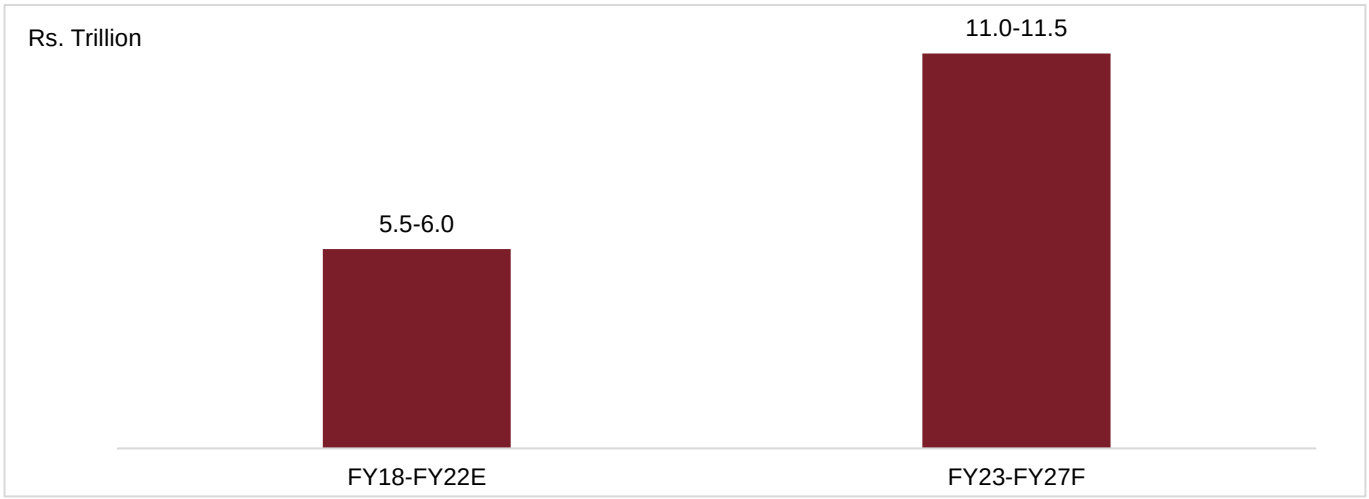
Note: E: estimates, F: forecast
Source: CRISIL Research

The share of private sector in overall power sector investments during fiscals 2023-2027 is expected to increase to 39% as against 30% over the past five years. This can be attributed to large renewable capacity additions, which are majorly financed by private investors. The share of central sector would decrease marginally to 24% over fiscals 2023 to 2027, as compared to 26% over the previous five years. Despite there being a growth in investment in absolute terms, share of central investments will decline due to doubling of private investments and increase in state investments due to RDSS. State sector's share will account of more than 35% of power investments, led by RDSS, along with moderate investments in the generation segment.

Generation segment investments to be dominated by private sectors

During fiscals 2023-27, investments in generation will be driven by renewable energy capacity additions, followed by investments in conventional capacities and FGD installations, thus indicating a shift in investment flow towards clean energy supply. Capacity additions for the next 5 years are estimated at 100-110 GW for RE sources and 33-34 GW for conventional sources. Investments in RE will constitute over 50% of overall investments in generation segment. Conventional generation investments are estimated to increase by 25% over the next 5 years as coal-based plants will be set up to meet peak load demand.

Figure 27: Outlook on investments in generation segment (fiscals 2023-2027)



Source: CEA, CRISIL Research

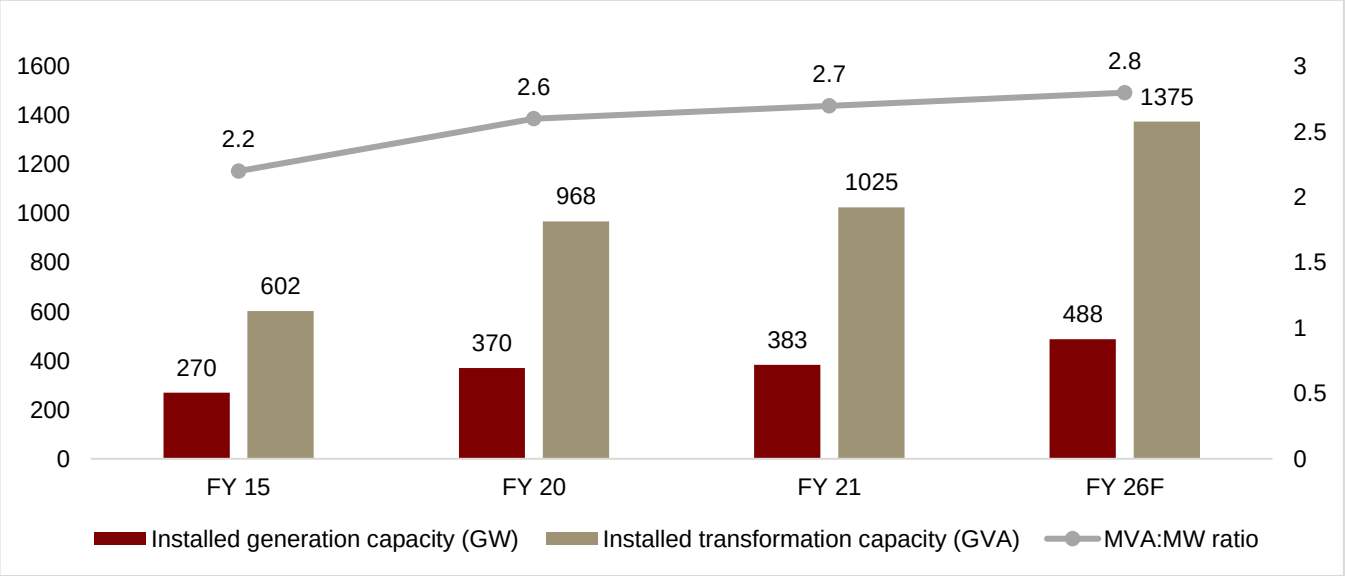
Coal-based capacities will account for ~25 GW (70-75% of the conventional capacity additions) over the next five years as coal continues to be the most abundant fuel for power generation, while 5-6 GW of hydro capacities will also be added. Nuclear capacity additions will see an uptick to over 3.5 GW with major capacities from central utilities NPCIL and BHAVINI nearing completion, thereby pushing generation investments upwards due to the higher capital cost per MW associated with nuclear power.

Transmission segment investments to rise to ₹ 4.0-4.5 trillion over next five years

To service a large generation installed base, the estimated investment in the transmission sector is expected to be ₹ 4.0-4.5 trillion over the next five years. Investments in the sector are expected to be driven by the need for a robust and reliable transmission system to support continued generation additions and the strong push to the renewable energy sector as well as rural electrification. Also, strong execution capability coupled with healthy financials of PGCIL will drive investments. Moreover, rising private sector participation with favourable risk-return profile of transmission projects will also support growth in investments. Transmission investments are estimated to have slowed down in fiscal 2021 due to COVID-19 outbreak but are expected to rebound strongly in the subsequent years.

Transformation capacity of 330-350 GVA is expected to be commissioned in the next five years. In the transmission line segment, we expect moderate growth in HV lines of 400 and 765 kV due to their importance in inter-state transmission lines. Higher voltage level enhances power density, reduces losses and efficiently delivers bulk power and it reduces requirement of right of way, a key challenge facing the transmission sector. Thus, CRISIL Research believes the Mega Volt Ampere: Mega Watt (MVA:MW) ratio would further improve to ~2.8 by fiscal 2026.

Figure 28: Outlook for transmission capacity addition



Source: CEA, Power Finance Corporation, CRISIL Research

F: Forecast

Inter-regional transmission capacity to rise led by regional system strengthening schemes

CRISIL Research believes that the northern and north-eastern regions would be required to import power and the other three regions (including western, eastern and southern regions) would be in a position to export power in fiscal 2026. To cater to this import/export requirement, a number of inter-regional transmission corridors have been planned, and some of these high capacity transmission corridors are in various stages of implementation. Newly sanctioned projects under the North-Eastern System Strengthening Scheme and system strengthening schemes focused in the Ladakh region are also expected to augment investments in the transmission segment.

In addition, the following schemes in the North-East and Kashmir are funded by the Government of India (GoI), with an estimated cumulative cost of ₹ 116 billion:

- North-Eastern region power system improvement project

- Comprehensive scheme of transmission and distribution system in Arunachal Pradesh and Sikkim
- 220 kV transmission system from Alusteng (Srinagar) to Leh (via Drass, Kargil, Khalsti and Leh Sub-stations in Jammu and Kashmir)

Overall, the inter-regional transmission capacity is expected to increase from ~104 GW in March 2020 to ~145 GW by fiscal 2024.

Inter-connection with neighbouring countries to boost investments

In order to ensure effective utilisation of regional resources, India is actively planning to inter-connect the national grid with neighbouring countries like Nepal, Bhutan, Sri Lanka and Bangladesh. Nepal is radially connected with India through 11, 33 and 132 kV lines. India and Bhutan have transmission lines of 400, 220 and 132 kV to import ~2,850 MW of power. Further, for transfer of power from upcoming hydroelectric projects in Bhutan, India is implementing two cross-border inter-connection lines of 400 kV each. Between India and Bangladesh, 400 kV DC line connecting Baharampur (India) to Bheramara (Bangladesh) and 765 kV DC line connecting Katihar (India) to Parbotipur (Bangladesh) along with 500 MW HVDC back-to-back terminal at Parbotipur are planned. A feasibility study has been carried out for two 500 MW bi-pole lines between Madurai (India) and New Anuradhapura (Sri Lanka) including submarine cable for the sea portion. Implementation of these transmission projects is expected to support investments in T&D segments over the next five years.

Rising private sector participation to support transmission segment investments

With a view to encourage participation of the private sector in building transmission capacity in India, procurement of transmission has been made mandatory on competitive bidding basis, except for urgent projects, which are required to be commissioned within 2-3-years and continue to be allotted on a cost plus basis to PGCIL. Under TBCB, interested parties are required to quote a levelised tariff through the life of the asset. Transmission schemes including 765 kV and 400 kV transmission system strengthening schemes in the northern, western, southern, north-eastern regions, would facilitate transfer of power from power surplus states such as Chhattisgarh and Odisha and new hydro-electric projects in Bhutan.

As of July 2021, of the 59 transmission projects envisaged under TBCB, 33 have already been commissioned/ready for commissioning, while 22 are under construction/ partly commissioned. Construction of two projects could not be started due to litigations, while one project has been cancelled by CERC and another one was cancelled as per the request of the transmission service provider.

Along with such inter-state projects, there will be steady investments in transmission from the state sector as well, primarily driven by the construction of associated transmission systems for upcoming power projects. States such as Maharashtra, Gujarat, Rajasthan, Chhattisgarh, Andhra Pradesh, and Karnataka are expected to witness significant investments in the transmission space.

Distribution investments to be bolstered by RDSS spending

State distribution companies (discoms), the major drivers of investments in the distribution space, have been reeling under severe financial burden for the last few years on account of collection inefficiencies and mounting receivables to power generation companies (gencos). Revenue is likely to have dipped in fiscal 2021 due to fall in demand from high-paying industrial and commercial consumers on account of reduced economic activity as a fallout of the COVID-19 outbreak. This will lead to increased financial stress for discoms, although the

government's relief package providing loans worth ₹ 1.35 trillion by Power Finance Corporation (PFC) Ltd. / Rural Electrification (REC) Ltd. for clearing power generators' dues is expected to ease discoms' liquidity problems over the short term. The relief package is, however expected to increase the debt profile of discoms, forcing them to curb investments over the medium term. In the union Budget 2021-22, the government also announced a RDSS worth ₹ 3.04 trillion for state discoms to be allocated over the next five years.

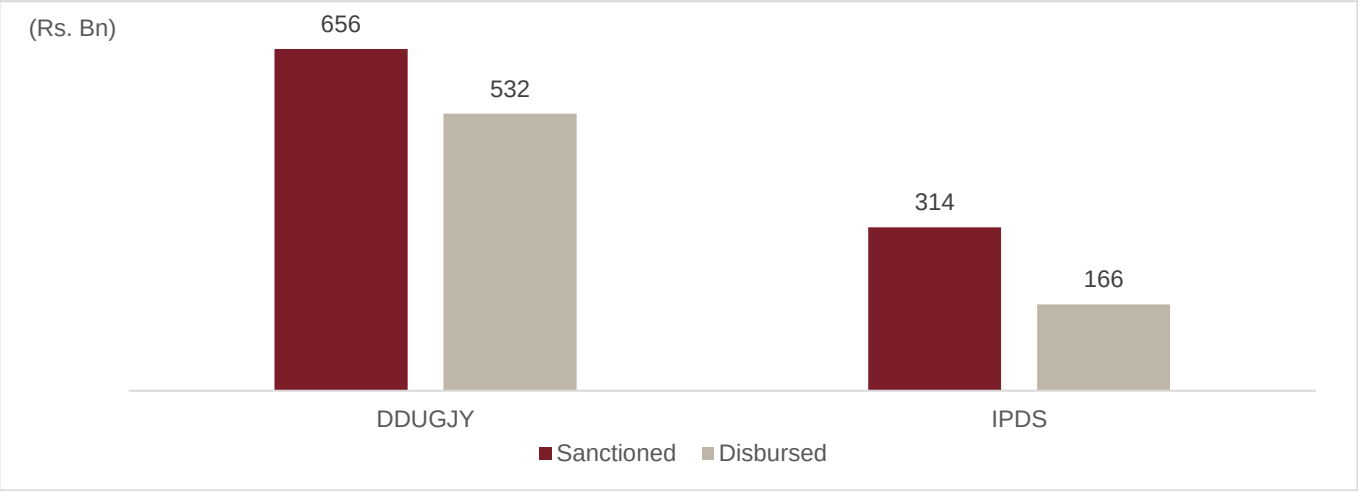
Investments in the segment are likely to gradually pick up fiscal 2023 onwards with central / state government(s) expected to provide the required funding support. Distribution segment is expected to attract investments worth ₹ 4.0-4.5 trillion over fiscals 2023-2027, led by the government's thrust on improving access to electricity and providing 24x7 power to all. Central government schemes such as Integrated Power Development Scheme (IPDS) and Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) will support development of the segment further.

IPDS was launched with the objectives of strengthening of the sub-transmission and distribution network in urban areas, metering of distribution transformers/ feeders / consumers in urban areas and IT enablement of the distribution sector. The component of IT enablement of the distribution sector and strengthening of the distribution network, approved by Cabinet Committee on Economic Affairs (CCEA) in June 2013 in the form of Restructured Accelerated Power Development & Reforms Program (R-APDRP) for 12th and 13th plans, have been subsumed under this scheme. The total cost of projects envisaged under this scheme during 12th and 13th plans is approximately ₹ 700 billion.

DDUGJY, which was launched in December 2014, covers works related to strengthening of rural power infrastructure and encompasses the erstwhile RGGVY programme. The objectives of DDUGJY include separation of agricultural and non-agricultural feeders, strengthening and augmentation of the T&D infrastructure in rural areas, including metering of transformers/feeders/consumers and boosting rural electrification along with decentralized distributed generation.

Over the past five years, the segment has witnessed ₹ 4-4.5 trillion worth of investments. State discoms invested in the distribution setup to bring down aggregate technical and commercial (AT&C) losses. Also, investments from central government schemes such as Integrated Power Development Scheme (IPDS), Deen Dayal Upadhyay Gram Jyoti Yojana (DDUGJY) and Sahaj Bijlee Har Ghar Yojana (SAUBHAGYA) led to the investments in the distribution space.

Figure 29: Snapshot of central funding under DDUGJY and IPDS (till March 2022)



Source: Power ministry, CRISIL Research

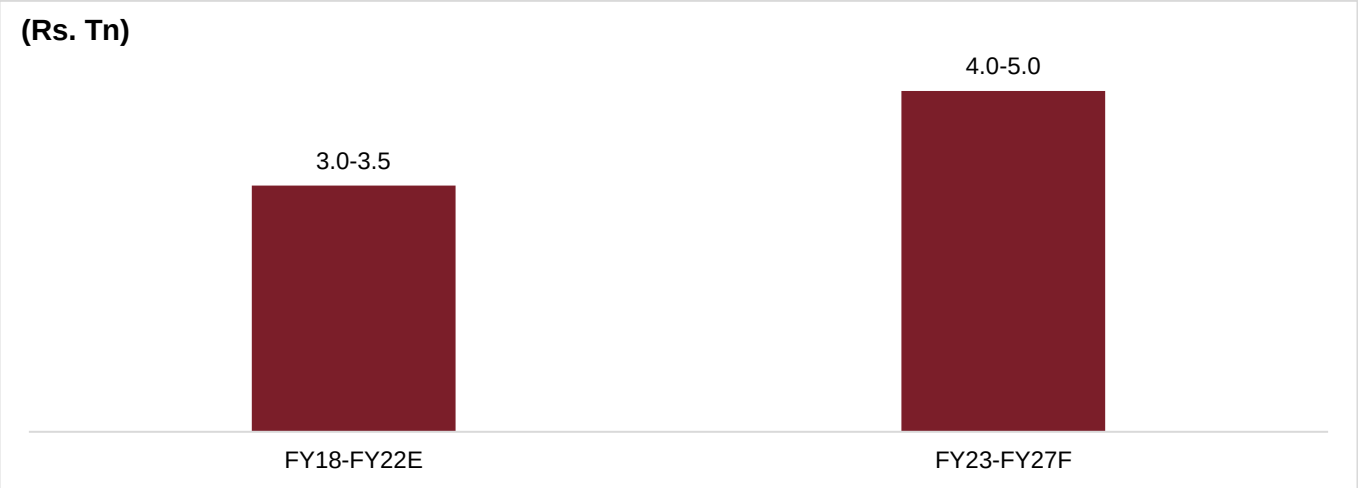
With all major states (except West Bengal) having joined the UDAY scheme and ₹ 2.3 trillion worth bonds being issued (86.3%) as of February 2021, debt and interest burden on discoms had reduced, resulting in higher liquidity. Improved liquidity enabled discoms to invest in strengthening of distributions networks, which aided a reduction in AT&C losses to 18.5% as of March 2019 from ~21% as of March 2016.

However, post UDAY, discom financials have again started deteriorating, slowing investments, and pushing up AT&C again due to higher system losses and weakened collections on account of stretched financial profile of consumers. The government's reform-linked discom package, which is likely to subsume the erstwhile UDAY scheme, is expected to lay down stringent criteria to encourage improvement in AT&C losses.

Several foreign institutions such as Japan International Cooperation Agency (JICA) and Asian Development Bank (ADB) are also expected to extend credit to the distribution sector. For instance, ADB approved a USD 48 million loan to finance the expansion and upgrading of the power distribution system in Assam, and strengthen institutional capacity of Assam Power Distribution Company Ltd. It covers a part of the state's power sector road map for enhancing the sub-transmission and distribution capacities to improve operational efficiency and electricity supply to end users.

Some states such as Rajasthan, Madhya Pradesh, Punjab, and Chhattisgarh are also expected to continue to receive state government funding in the form of equity infusion for system up-gradation projects, as witnessed in the past.

Figure 30: Outlook on investments in distribution segment (fiscals 2023-2027)



Source: CEA, CRISIL Research

CRISIL Research believes that a confluence of the above-mentioned measures will improve electricity access and in turn boost power consumption.

Electric vehicles to support demand growth, but over the longer term

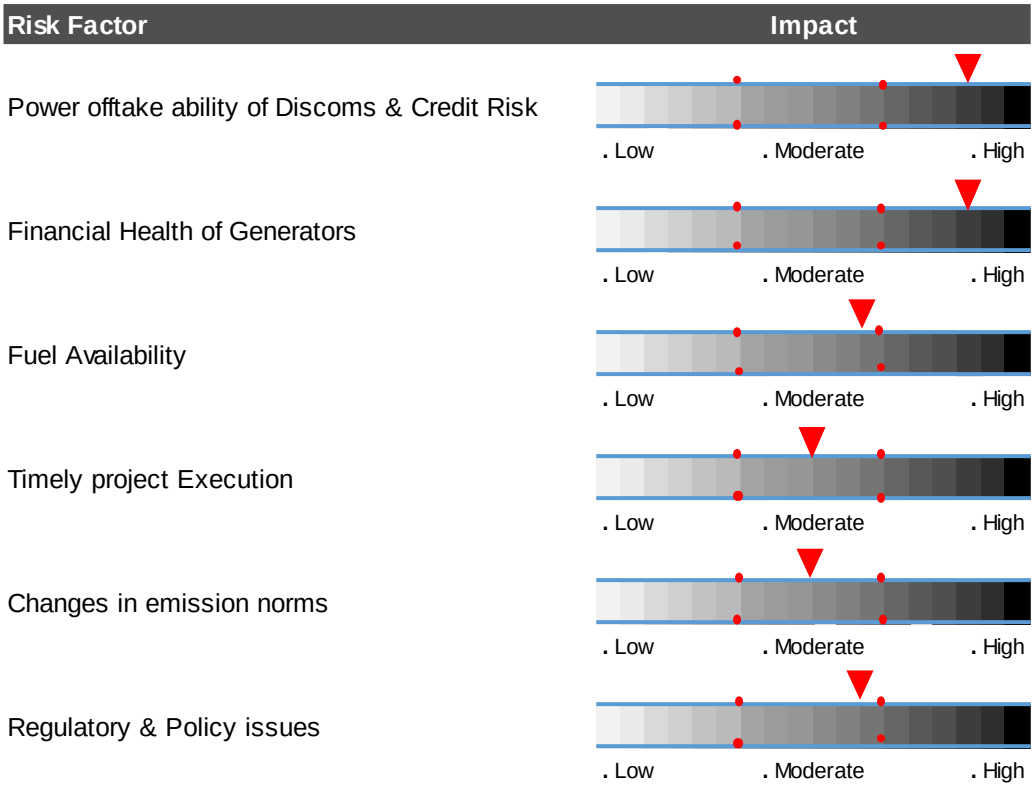
The Government of India is focusing on building charging infrastructure and creating a conducive policy environment for faster adoption of electric vehicles so as to reduce dependence on fossil fuels for transportation. India aims to increase the share of electric vehicles to 30% by 2030. Under the National Electric Mobility Mission plan, the government envisages to promote electric vehicle adoption through demand-side incentives in terms of subsidies, promoting charging infrastructure and encouraging research and development in battery technology, power electronics, battery management and system integration, etc.

In fiscal 2021, though, the EVs market faced strong headwinds as buyers cut down on big-ticket purchases, thus impacting sales of EVs, which are typically costlier than conventional vehicles. However, sales rebounded strongly in fiscal 2022, spurred by elevated fossil fuel prices, with government incentives such as Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) II worth Rs 100 billion. CRISIL Research estimates that under the base case scenario, adoption of electric vehicles will boost power demand by 4-5 billion units annually on an average over the period of fiscal 2023 to 2027.

This is to be supported by expansion of charging infrastructure across major cities as well as the concomitant growth in distribution infrastructure in addition to an appropriate tariff structure for charging of electric vehicles. In fact, the government, in the Budget 2019-20, has announced ₹ 10 billion in subsidies for building a nationwide electric vehicle charging infrastructure as a part of the FAME-II scheme. Charging stations will be installed on major highways such as Delhi-Mumbai, Delhi-Chandigarh, Mumbai - Surat - Pune, etc. with plans to having a charging station every 25 km on these highways. Several states like Gujarat, Maharashtra, Delhi and Karnataka have announced policies to boost EV adoption which will aid power demand through EV charging over the medium term.

2.3.14. Overview of the key challenges and risk factors in the sector

Figure 31: Key risk factors



Source: CRISIL Research

Power off-take ability of discoms and credit risk

Despite significant availability of power (reflected in the low plant load factors (PLFs) of coal-based plants of ~58% over last two years), offtake by discoms in various Indian states is low on account of their weak financial position. In fact, there are discoms that opt for load shedding instead of buying power as they have a revenue under-recovery (gap between average cost of supply or ACS and average revenue realized or ARR, also called as ACS-ARR gap) at all India level being Rs 0.55 per unit as of March 2021.

Energy efficiency measures such as demand side management; replacement of incandescent lamps with more efficient LED bulbs; increased use of energy efficient household appliances; and reduction in transmission and distribution loss are curtailing power demand which may affect power offtake from private generators. This is likely to impact their operational performance. Increasing capacity of renewable energy is also expected to affect utilization levels of conventional energy plants going forward.

Financial health of generators

Private sector coal-based plants without long-term PPAs are stranded due to low offtake. Their overall PLFs in fiscal 2021 stood at 54.2%, only marginally higher than 54.0% in fiscal 2020. Their financial position has deteriorated, with declining sales, reduced net margins and rise in gearing ratio.

With their financial health remaining weak despite the implementation of UDAY, discoms are not expected to sign fresh long-term PPAs over the medium term owing to excess tie-ups in the past. Thus, debt servicing ability of

private players is expected to remain weak, which would be a challenge for operational and under construction projects.

Fuel availability

For thermal plants which form 80% of installed capacity of conventional energy, fuel accounts for a large proportion of operating cost – ~75-80%. Over fiscals 2011-2014, domestic coal availability was a major issue as total non-coking coal production grew a mere 1.7% owing to stringent environmental regulations. This partly contributed to a decline in PLFs from 75% in fiscal 2011 to ~55% in fiscal 2021. Also, players were compelled to rely more on expensive imported coal (~110% costlier than comparable grade of domestic coal), which saw its share rise to ~24% in fiscal 2018 from ~11% in fiscal 2011. This, in turn, adversely impacted returns of players.

However, over the last 18-24 months, coal production has improved with faster clearances and speedier land acquisition. While the government announcing the SHAKTI (Scheme for Harnessing and Allocating Koyla Transparently in India) scheme to improve coal supplies to the power sector, signing of fresh PPAs (pre-condition for domestic coal linkage) and discount to be offered by gencos on existing PPAs would be key monitorables.

Despite of the increased domestic coal availability to power plants over the past year due increased supply from Coal India Ltd. (CIL) to power plants, the sector faced an acute shortage during the fiscal 2022. This was particularly in light of the surge in coal prices caused by international supply disruptions. As a result, the share of imports in coal supply to the power sector fell to a measly ~4% in fiscal 2022, since imported coal plants refrained from stocking expensive coal, thereby limiting power generation.

On the gas front too, there are challenges. Availability of domestic gas sharply reduced after production from Reliance Industries' KG-D6 field plummeted. Consequently, gas-based PLF reduced significantly to ~23% in fiscal 2021 from ~40% in fiscal 2013. To alleviate stress, the government announced a scheme for utilization of gas-based power generation capacity. However, it did not provide an impetus as expected and PLFs continue to languish. Thus, debt servicing ability of most gas-based power plants has eroded.

Timely project execution

Power projects are highly capital intensive and have a long gestation period. Therefore, completion of projects in a time bound manner is very critical for developers to avoid the huge time and cost overruns. In the past, thermal power projects have witnessed significant cost overruns on account of delays in getting clearances, land acquisition and achieving financial closure. In fact, certain projects saw cost overruns as high as 67% resulting in total project expenditure escalating to ₹ 75 million per MW from initial estimate of ₹ 45 million per MW.

Hydro power projects have also been crippled due to execution challenges. Securing necessary approvals (environmental and forest clearances); land acquisition; relocation of project-affected people; inadequate infrastructure for power evacuation; and other logistical issues have constantly hampered the pace of project execution in the sector. Moreover, any delays in commissioning date of projects further raises the cost of the project. This, in turn, escalates the power tariff, thereby increasing power purchase cost of discoms, making them reluctant to buying electricity from such projects.

Changes in emission norms

The coal-based plants need to adhere to the emission norms prescribed by the Ministry of Environment, Forest & Climate Change. There is additional capital expenditure associated with the equipment to be installed for keeping emissions below prescribed levels. Thus, any revision in such norms has a cost impact on the generators.

In December 2015, the Union government notified the revised standards for coal-based thermal power plants in the country, aimed at minimizing pollution and limiting water usage. The standards were more stringent for recent plants than for the earlier ones. They were the most stringent for the plants to be set up in future.

Upgradation of ESP (electrostatic precipitator); installation of flue gas de-sulphurisation (FGD) plant and modification of combustion system; and upgradation of cooling towers to reduce specific water consumption, etc. would escalate the capital cost of coal-based plants by ₹ 1.5-2.0 million per MW, that too if adequate land is available for the expansion. If land is not available, the cost could go higher still. Although the capital expenditure incurred towards these modifications can be passed on to discoms, it requires approval from respective regulatory commission and PPA clause should also allow it. Thus, change in emission norms is one of the key factors possessing moderate impact on power generation projects.

Around 48 GW of coal plants missed the December 2019 deadline to meet emission norms. Update for these projects is still awaited. The deadline for another ~166 GW of coal plants was extended for a period of three years to December 2022 from the previously set deadline of December 2019.

Regulatory and policy issues

The Electricity Act, 2003, promoted competition in the power sector and provided for the de-licensing of thermal power generation. Also, while power deficit levels were as high as ~8.4% in fiscal 2006, the generation segment was given thrust through competitive bidding (Case-I and Case-II) for PPAs and allocation of coal blocks/ signing Letter of Assurance (LoA) for coal supply. As a result, the share of the private sector in the total installed capacity (thermal) witnessed the highest traction.

However, after the cancellation of coal block allocation in September 2014, a number of plants were stalled due to want of fuel. Although the latest coal linkage policy notified in May 2017 – SHAKTI – aims to resolve this bottleneck, it has added a clause of providing discount on existing PPA tariffs which would hurt project returns. Also, denial of compensatory tariff on account of international price changes, cancellation of PPA bids by Uttar Pradesh, backing down of wind and solar generation despite its ‘must-run’ status, and re-negotiation of PPAs are some of the key risks the generation sector is facing.

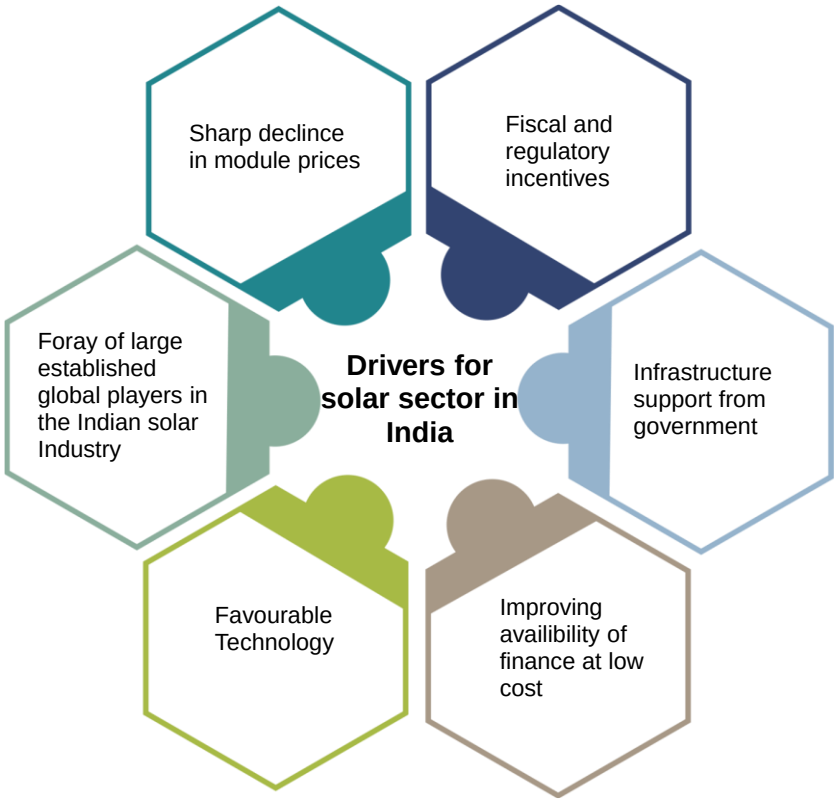
3. Renewable Energy Sector in India

3.1. Solar Power in India

In the renewable energy basket as of July 2022, solar energy accounted for a share of 50.7%. Growth in the solar power sector over the last five years has been robust. As much as 41.7 GW capacity was added in the segment over fiscals 2017-2022 registering a CAGR of ~34.5%, although on a low base. However, in fiscal 2022 the solar capacity added was higher at 13.9 GW (5.46 GW in fiscal 2021). The sector missed its capacity addition targets for the fifth year in a row. Despite the second wave of COVID-19 infections, the fiscal 2022 of this fiscal witnessed solar capacity additions of ~14 GW. In a relief to developers, the Ministry of New and Renewable Energy (MNRE) has provided total extension of seven-and-a-half months for the projects affected due to the first and second waves of pandemic. This is estimated to have delayed commissioning in fiscal 2022, leading to a spill-over into fiscals 2023 and 2024. In fiscal 2022, solar capacity additions stood at ~13.9 GW, with ~2.2 GW coming from rooftop solar projects, led by state-level incentives and the remaining from utility scale.

3.2. Growth drivers for Solar sector in India

Figure 32: Growth drivers for solar sector in India



Source: CRISIL Research

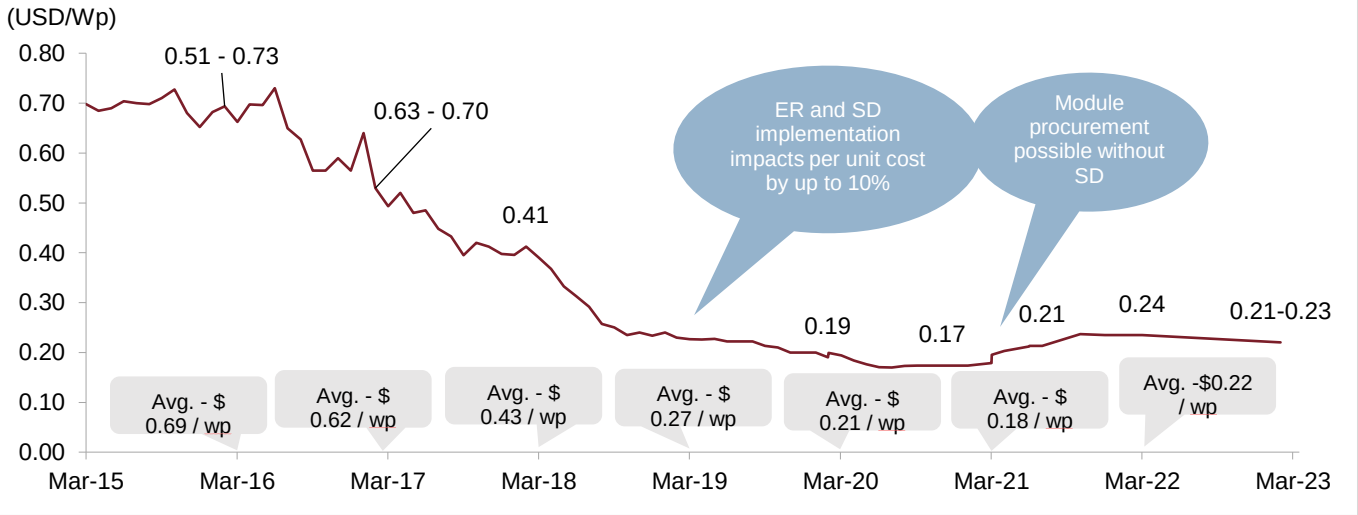
Each of the growth factors for the solar energy in India is as detailed below:

a) Declining module prices and tariffs

Global average solar module price, which constitutes 55-60% of the total system cost, crashed 73% to USD 0.47/watt since 2016 (average for January-December) from USD 1.78/watt in 2010. In fact, prices continued to

decline to USD 0.22/watt by end-August 2019, owing to the wide demand-supply gap in the global solar module manufacturing industry. Historically, global solar demand has been half of the total module manufacturing capacity. Moreover, innovation in the manufacturing processes has reduced cost, putting downward pressure on module prices. Further, declining inverter prices (6-7% of the capital cost), which fell to USD 21/watt by March 2020, reduced system costs. Module prices reached to USD 0.22 per watt-peak level in fiscal 2021. Module prices are estimated to stay at USD 0.21-0.23 per watt-peak till fiscal 2023 due to robust global demand and continued delay in supply-side expansions.

Figure 33: Module prices declined over 80% from fiscal 2010 to 2022



Source: Industry, CRISIL Research

Table 7: Safeguard duty trajectory

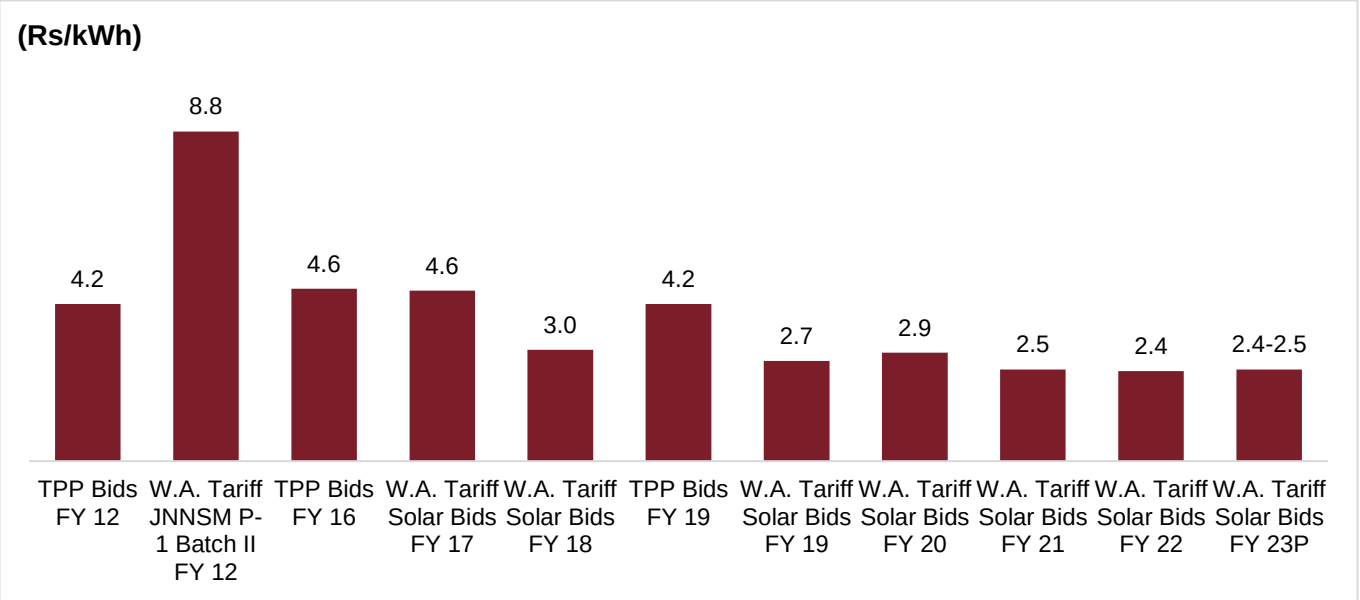
Year of imposition	July 30, 2018, to July 29, 2019	July 30, 2019, to January 29, 2020	January 30, 2020, to July 29, 2020	July 30, 2020, to January 29, 2021	January 30, 2021, to July 29, 2021	From April 1, 2022 (BCD)
Duty rate	25.0%	20.0%	14.9	14.5	15%	Module- 40% Cell- 25%

Source: CRISIL Research

DGTR has further extended safeguard duty at 14.9% from July 30, 2020, declining to 14.5% from January 30, 2021, for another six months. Declining duty has led to easing cost pressures and tariffs had also started lowering. Ministry of Finance imposed BCD of 25% & 40% on solar cell and modules respectively effective 1 April 2022. Demand fell in China due to announcement of new policies in June 2018. Consequently, the global average module prices crashed 20% from USD 0.3/watt in March'18 to USD 0.19/watt in March'20, which helped imports to remain competitive even with duty. Duty rate of 15% did lend some favour to domestic modules but effect of duty has been counteracted by drop in module prices. Later, SGD has been extended till July 2021, however the impact of lower rate of ~15% has been offset by lower module prices, thus lower duty rate is not a deterrent to solar imports.

b) Solar power tariffs have been on the lower side as compared to coal-based power

Figure 34: Competitively bid solar power tariffs are much lower vis-à-vis coal-based power



Note: TPP - Thermal power plant; JNNSM – Jawaharlal Nehru National Solar Mission;

**includes tariff for wind-solar storage capacity allocations*

W.A - Weighted average levelised tariffs

Source: Details of Case I bids, Bidding of power from stressed assets, CEA; CRISIL Research

However, while looking at solar tariffs, one will have to increasingly factor in grid integration costs as penetration levels of renewable energy increases. This is expected to increase the procurement cost from solar power plants.

c) Strong government thrust

The government has laid significant thrust on climate change for which it provided a framework, National Action Plan on Climate change (NAPCC), in 2008, where it proposed an eight pronged strategy – National Solar Mission (NSM), Energy efficiency, Sustainable habitat, Water planning, Himalayan ecosystem, afforestation, sustainable agriculture and strategic knowledge on climate change. As can be seen, the government has laid significant emphasis on the solar power in particular. This is also evident from the 100 GW out of 175 GW target set out by the government. The government support to solar sector in India is reflected from the below:

1. Introduction of the National Solar Mission (NSM)

Central level allocations under NVVN Batch II, JNNSM Phase II Batch III and IV almost entirely commissioned.

2. Operational support to execute solar projects

Apart from providing incentives, the government has lent significant support to the solar power sector for execution of projects.

Solar parks: One of the most important initiatives by the government has been setting up of solar parks in the country. This is critical given the land intensive nature (~5 acres required per MW of solar PV) of solar projects

coupled with low average holding (1.16 hectare) per person in India. Under the Solar Park Policy released in September 2014, the government planned to prepare land banks for 20,000 MW of solar projects spread across 25 states. Further, the capacity of the scheme was doubled from 20,000 MW to 40,000 MW on March 21, 2017, to set up at least 50 solar parks by fiscal 2022. Such parks significantly reduce construction/ execution risk as it includes contiguous parcel of land, evacuation infrastructure (HV/EHV substation evacuating to state grid substation) and other ancillary infrastructure and utilities such as road, water, and drainage, etc.

Currently, 25 states, including Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh, Karnataka, Telangana, West Bengal, Chhattisgarh, Tamil Nadu, Jammu and Kashmir and a few north-eastern states have started preparing land banks for solar parks, either through their own implementing agencies or through joint ventures with SECI. As per MNRE, as of February 2022, 56 solar parks with an aggregate capacity of ~38 GW have been approved.

Table 8: State-wise solar parks

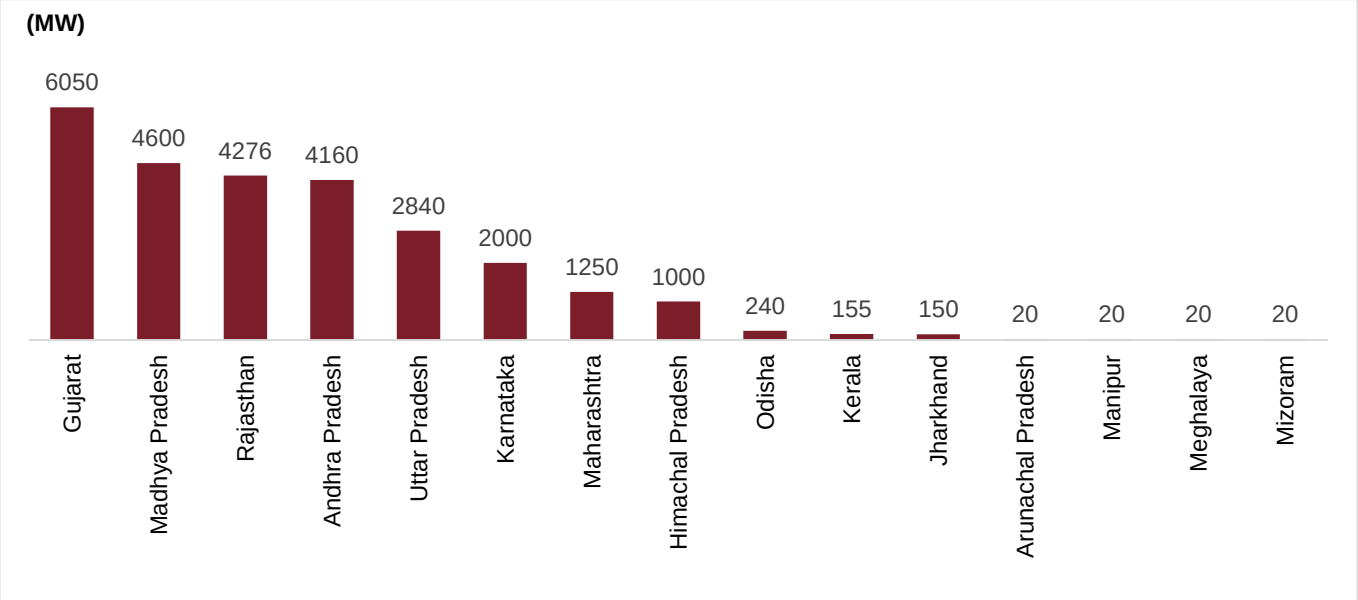
S. no.	State	Solar park	Capacity (MW)	Capacity commissioned (MW)	Capacity yet to be commissioned (MW)	Name of the solar power parks developer (SPPD)
1	Andhra Pradesh	Ananthapuramu -I Solar Park	1500	1100	400	AP Solar Power Corporation Pvt Ltd (APSPCL), JVC of SECI, APGENCO and NREDCAP
2		Kurnool Solar Park	1000	1000	-	
3		Kadapa Solar Park	1000	250	750	
4		Ananthapuramu-II Solar Park	500	400	100	
5		Hybrid Solar Wind Park	160	-	160	
6	Arunachal Pradesh	Lohit Solar Park	20	-	20	Arunachal Pradesh Energy Development Agency (APEDA)
7	Gujarat	Radhnesada Solar Park	700	-	700	Gujarat Power Corporation Ltd (GPCL)
8		Harsad Solar Park	350	-	50	
9		Dholera Solar Park	5000	-	5000	
10	Himachal Pradesh	Kaza Solar Park	1000	-	1000	Satluj Jal Vidyut Nigam Ltd (SJVNL)
11	Jharkhand	Floating Solar Park	150	-	150	Solar Energy Corporation of India (SECI)
12	Karnataka	Pavagada Solar Park	2000	2000	-	Karnataka Solar Power Development Corporation Pvt Ltd (KSPDCL), JVC of KREDL & SECI
13	Kerala	Kasargod Solar Park	105	50	55	Renewable Power Corporation of Kerala Ltd (RPCKL), JVC of SECI
14	Madhya Pradesh	Floating Solar Park by NHPC	50	-	50	

S. no.	State	Solar park	Capacity (MW)	Capacity commissioned (MW)	Capacity yet to be commissioned (MW)	Name of the solar power parks developer (SPPD)
15		Rewa Solar Park	750	750	-	Rewa Ultra Mega Solar Ltd (RUMSL), JVC of MPNRED & SECI
16		Neemuch-Mandsaur Solar Park	750	250	500	
17		Agar Solar Park	550	-	550	
18		Shajapur Solar Park	450	-	450	
19		Omkareswar Floating Solar Park	600	-	600	
20		Chhattarpur Solar Park	950	-	950	
21		Barethi Solar Park	550	-	550	
22	Maharashtra	Sai Guru Solar Park (Pragat)	500	-	500	M/s Sai Guru Mega Solar Park Pvt Ltd (formerly M/s Pragat Akshay Urja Ltd)
23		Patoda Solar Park (Paramount)	500	-	500	M/s Paramount Solar Power Pvt Ltd (formerly M/s K. P. Power Pvt Ltd)
24		Dondaicha Solar Park	250	-	250	Maharashtra State Electricity Generating Company Ltd (MAHAGENCO)
25	Manipur	Bukpi Solar Park	20	-	20	Manipur Tribal Development Corpn. Ltd (MTDCL)
26	Meghalaya	Solar park in Meghalaya	20	-	20	Meghalaya Power Generation Corporation Ltd (MePGCL)
27	Mizoram	Vankal Solar Park	20	-	20	Zoram Energy Development Agency (ZEDA)
28	Odisha	Floating Solar Park by NHPC	100	-	100	Green Energy Development Corporation of Odisha (GEDCOL)
29		Solar park by NHPC	140	-	140	NHPC Ltd
30	Rajasthan	Bhadla-II Solar Park	680	680	-	Rajasthan Solar Park Development Company Ltd (RSDCL)
31		Bhadla-III Solar Park	1000	1000	-	M/s Surya Urja Company of Rajasthan Ltd

S. no.	State	Solar park	Capacity (MW)	Capacity commissioned (MW)	Capacity yet to be commissioned (MW)	Name of the solar power parks developer (SPPD)
						(SUCRL) JVC of state government
32		Bhadla-IV Solar Park	500	500	-	M/s Adani Renewable Energy Park Rajasthan Limited (AREPRL) JVC of state government
33		Phalodi-Pokaran Solar Park	750	-	750	M/s Essel Surya Urja Company of Rajasthan Ltd (ESUCRL) JVC of state government
34		Fatehgarh Phase-1B Solar Park	421	-	421	M/s Adani Renewable Energy Park Rajasthan Ltd (AREPRL) JVC of state government
35		Nokh Solar Park	925	-	925	Rajasthan Solar Park Development Company Ltd (RSDCL)
36	Uttar Pradesh	Solar park in UP	440	165	275	Lucknow Solar Power Development Corporation Ltd (LSPDCL) JVC of UPNEDA & SECI
37		UP Jalaun Solar Park	1200	-	1200	
38		Lalitpur Solar Park	600	-	600	
39		Jhansi Solar Park	600	-	600	

Source: MNRE

Following figure summarises the state wise capacity of solar parks.



Source: MNRE; CRISIL Research

Although the potential of solar energy is high, there exist a few challenges, which are critical to achieving rapid growth of solar power.

Availability of contiguous parcels of land – With rapid capacity additions and stiff competition it becomes imperative for developers to acquire land at competitive costs and in areas with high levels of solar irradiance. The 40 GW solar park scheme is facilitative in this aspect however, beyond that capital costs and hence, tariffs do fluctuate state to state depending on land prices and irradiance quality.

Adequacy of evacuation infrastructure – Grid integration of renewables is key to the growth of the sector. Instances of delay in readiness of transmission infrastructure at solar parks have caused concern amongst developers. However, an aggressive roadmap to add an incremental ~100 GW via new schemes and existing available capacity to the grid should be adequate for the expected additions. However, timely execution is critical

Availability of low-cost capital - With the emergence of several large players in the sector, scale and experience has aided fund raising to an extent, especially with the backing of several foreign investors. However, a weak rupee, conservative risk appetite of lenders and other added cost pressures makes it imperative for developers to maintain prudent capital management to sustain over the long term. To mitigate this, developers have been tapping alternate / new routes to raise money from time to time.

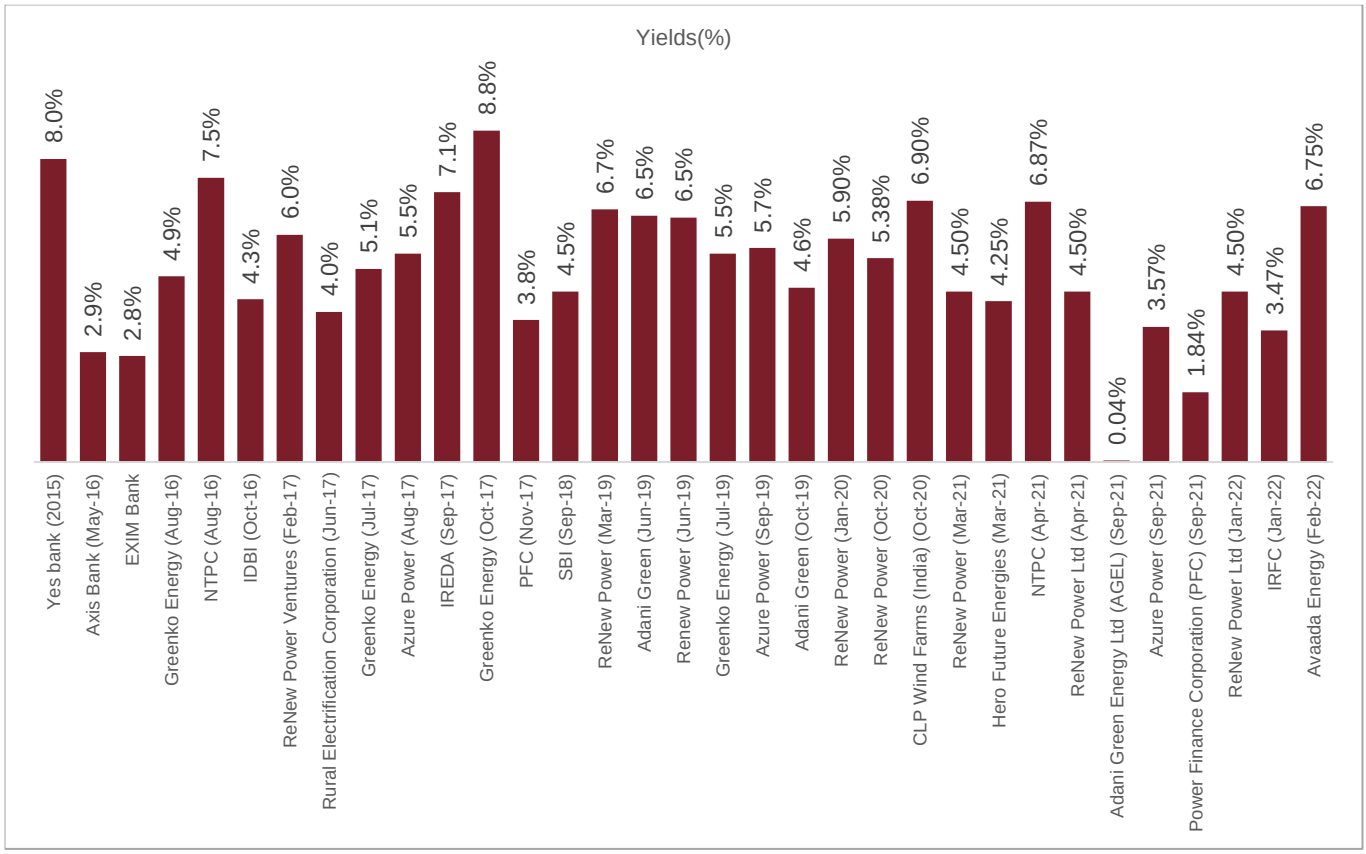
3. Availability of central and state level incentives to the solar sector

In order to facilitate growth of renewable energy and in particular the solar power sector, the government has provided several fiscal and regulatory incentives to developers. Below, we have elaborated each of these incentives:

Some of the steps taken by the government to ensure availability of low cost finance is as given below:

1. *Funding from lending institutions such as IREDA and PFS:* Government financial institutions such as PTC India Financial Services Limited (PFS), Rural Electrification Corporation (REC) and IREDA are also financing many solar projects. As of March 2019, the cumulative debt sanctioned by PFS to renewable energy projects stood at Rs. 216.4 billion. Further, IREDA, under its IREDA-NCEF refinance scheme, re-finances 30% of total loan disbursed by the scheduled commercial banks / financial institutions, to the project developer at concessional rate of interest. However, the projects which are aggressively bid are finding it difficult to achieve financial closure.
2. *Green Bond/Masala bond market:* Green bonds are like any other bond that invests the proceeds to support green energy or renewable energy projects. The tenure of the bonds typically ranges from 18 months to 30 months period and are issued for 1-10 year tenure. India is the second country after China to have a national-level guideline published by SEBI. The green bonds may be issued by the national government, multilateral organizations like Asian development bank (ADB), World Bank (WB) or by the Export-import (EXIM) bank of the country, financial institutions, and corporations. Some of the recent instances of green bond issuance in India are given below:

Figure 35: Yields of recent green bond issuances



Source: Industry; CRISIL Research

Note: Excludes certain issuances whose proceeds were not directed towards funding of renewable energy projects in India. NA means not available

3. *Pension Funds/ Endowment Funds*: The pension funds/endowment funds are expected to play key role in financing solar projects. The Canadian funds like Brookfield Asset Management and Caisse de Dépôt et Placement du Québec (CDPQ) have already announced to invest ~USD 2 billion in the country.
4. *Private equity investments and Debt Investments:* In a quest to reduce the cost of capital for projects and further improve project economics, many players have increasingly resorted to private equity and debt investments to free up capital. The proceeds are used to invest in new projects. Developers have been exploring several diverse instruments / sources to raise finance such as green bond issuances, external borrowings, private placements (Qualified institutional buyers (QIBs)) etc. This not only lowers the cost but also frees up credit from domestic banks to be used again as initial capital for new projects.

Further there have been debt investment deals in the renewable energy sector with APG, Piramal enterprise investing ~USD 132 million in Essel green energy and IFC investing ~USD 62 million in Ostro energy.

Table 9: Private equity investments

Name of the Company	Investors	Amount (USD million)	Date of Investment
Sprng Energy	Shell	1550	Aug-22

Name of the Company	Investors	Amount (USD million)	Date of Investment
Mytrah	JSW Neo Energy Limited	1320	Aug-22
Atha Group	Actis	264	Aug-22
Tata Power	Bank of America	320	Aug-22
Tata Power	Greenforest New Energies Bidco.	251	Aug-22
O2 Power	Syngene International	0.38	Aug-22
Emmvee	O2 Power	-	Aug-22
Continuum Green Energy	-	350	Jul-22
Wind Two Renergy Private Limited	Torrent Power	4.1	Jul-22
Aerem	Blume Ventures	2.5	Jul-22
Fourth Partner Energy	Filatex India	1.29	Jul-22
Ampyr Renewable Energy Resources Eleven	Syngene International	0.4	Jul-22
Tata Power Renewable Energy	Greenforest New Energies Bidco.	NA	Jul-22
Ampyr Renewable Energy Resources Eleven	Biocon Ltd	75	Jun-22
Skypower	Torrent Power	53.28	Jun-22
SolarArise	ThomasLloyd Energy	38.5	Jun-22
Cleanwin Energy SIX	Hindalco Industries	7.12	Jun-22
SolarSquare	Lowercarbon Capital, Symphony Asia, Rainmatter	4	Jun-22
Huoban Energy 6	Tech Mahindra	0.21	Jun-22
GMR Green Energy Private Limited	GMR Power and Urban Infra	NA	Jun-22
Continuum Green Energy	GE Energy	NA	Jun-22
Mytrah Energy India Private Limited	JSW Energy	2,000	May-22
Rays Power	Two global investors	90.3	May-22
Avaada KNShorapur	Bharti Airtel	0.23	May-22
Sprng Energy	Shell	155.00	Apr-22
SkyPower Group	Torrent Power	54.38	Apr-22
Avaada Mhyavat	Linde India	1.49	Apr-22
Greenko	-	750.00	Mar-22
Surya Vidyut (a subsidiary of CESC Ltd)	Torrent Power	107.00	Mar-22

Name of the Company	Investors	Amount (USD million)	Date of Investment
Lightsource Renewable Energy (India)	Torrent Power	39.30	Mar-22
Jupiter International	Edelweiss Alternative Asset Advisors (EAAA)	22.19	Mar-22
Avaada	Bharti Airtel	1.03	Mar-22
Amp Energy	Bharat Serums	NA	Mar-22
Virescent Renewable Energy Trust (VRET)	Godawari Green Energy Limited	NA	Mar-22
Avi Solar	Skyfri Group	NA	Mar-22
Visual Percept	Torrent Power	22	Feb-22
Renew Power	Fourth Partner Energy	89.9	Jan-22
Faradion	RIL	135	Dec-22
Jackson Group	Technique Solarie	NA	Oct-21
Cleanwin Energy Five	CEAT	0.08	Oct-21
Sunsole	Siemens	0.15	Oct-21
AMP Green Fifteen	Jubiliant Ingrevia Equity	0.69	Oct-21
Orrja Development Solutions	Schneider Electric Energy Access Asia	1	Oct-21
ReNew Power Ventures Private Limited	RMG Acquisition Corporation II (investee) (Business combination deal)	1,200	Feb-21
Greenko Group	Orix	980	Sep-20
Azure Power	EverSource Capital	112	Sep-20
Sembcorp Green Infra	Sembcorp	77	Dec-19
Hero Future Energies	Masdar	150	Nov-19
Greenko Group	GIC, ADIA	495	Jun-19
ReNew Power Ventures Private Limited	Goldman Sachs, CPPIB, ADIA	300	May-19

Source: Industry, CRISIL Research

Funding from Multilateral banks and International Solar alliance (ISA): Further government channelizes the funds available from multilateral banks and financing institutes like World Bank, kfw etc. Funds are also provided to Indian government under the climate investment fund of the World Bank. For instance, ~USD 625 million of soft loans having long tenure of 20 years is provided to SBI, and on the same lines 1-billion-euro loan is provided by kfw Germany through Indian renewable development agency (IREDA) for funding solar projects. Further, the European investment bank (EIB) has signed a EUR 150 million long-term loan with the IREDA to finance clean energy projects in India.

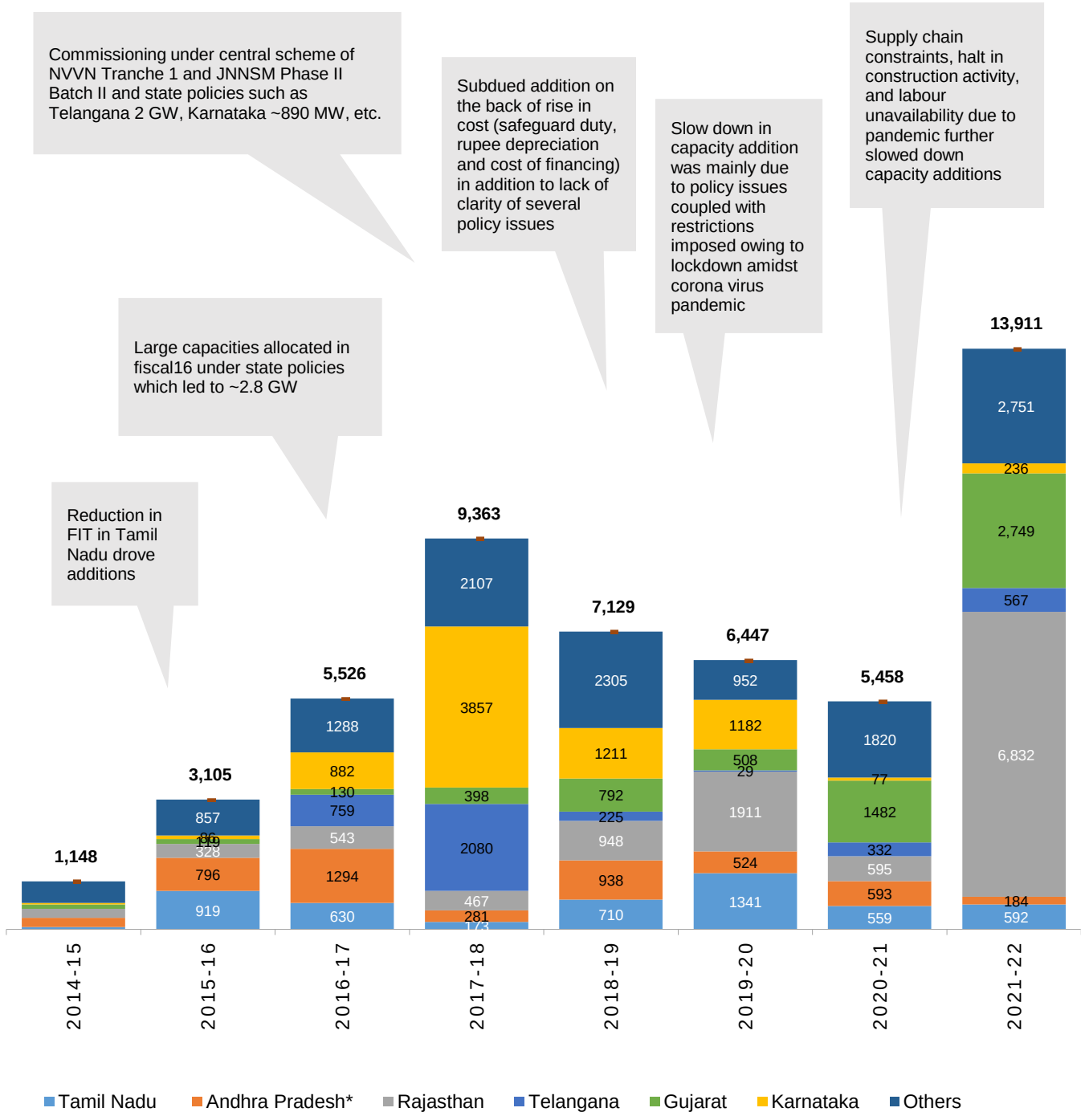
The ISA, an association of solar resource rich countries that has been launched by the government of India and France, aims at mobilizing USD 1000 bn in funds by 2030. The alliance intends to make joint efforts through various policy measures such as international credit enhancement mechanism that is expected to de-risk investments and reduce cost of financing for solar projects. The ISA member countries in collaboration with United Nations, the green climate fund, multilateral development banks, investors, insurers, private financial institution and other interested stakeholder will finance solar projects.

3.3. Review of solar capacity additions in India (fiscals 2016 – 2022)

a) Robust pick-up in solar additions in fiscal 2022; momentum expected to continue

With the central government imposing solar RPO across Indian states in CY 2011 coupled with sharp drop in capital costs, most states released solar polices, which led to a spur in solar sector investments. Till fiscal 2012, only Gujarat and Rajasthan had a state solar policy and post the success of Gujarat state solar policy other states such as Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh and Telangana introduced their respective solar polices. During 2016-17 and 2021-22, ~47 GW of the solar capacity has been commissioned compared to the expected commissioning of 62-64 GW. Despite the second wave of COVID-19 infections, fiscal 2022 witnessed solar capacity additions of ~14 GW. Robust solar capacity additions of ~3.3 GW were witnessed in the first 2 months of fiscal 2023.

Figure 36: States that helped in driving the solar capacity addition in India

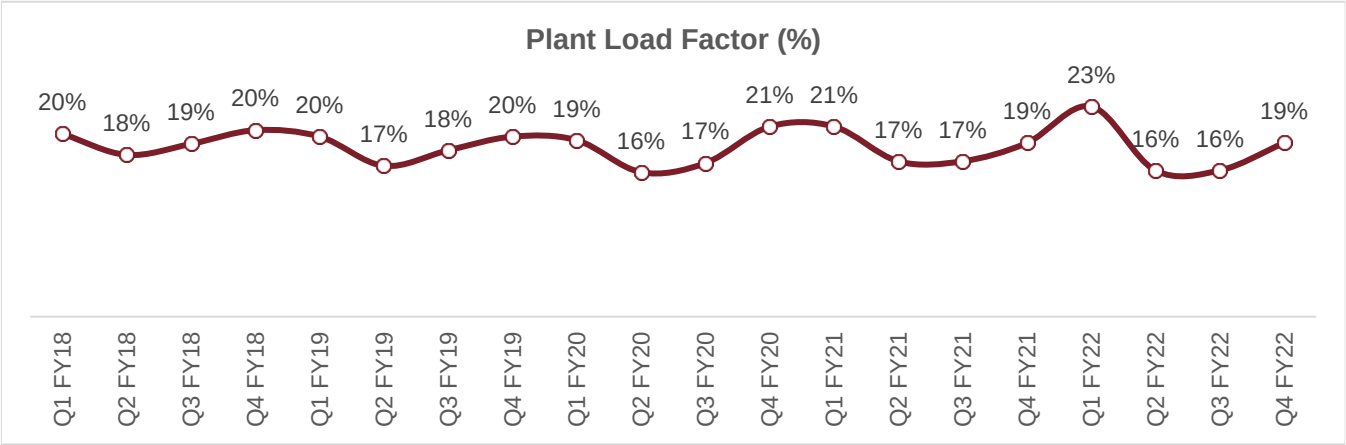


*Note - JJNNSM: Jawahar Lal Nehru National Solar Mission; *Andhra Pradesh includes the capacity additions for Telangana state till FISCAL 2016; Capacity additions for Karnataka state is mentioned in "Others" category from fiscals 12-16.*

Source: MNRE; CRISIL Research

Performance of operational projects continues to remain stable with healthy PLFs of mostly 18-20 per cent over the past 12 quarters, (dip in Q2 each fiscal due to monsoons). Players have been designing projects utilizing a trend called DC (direct current) overloading which entails connecting more modules on the DC side of the plant to generate incrementally more in the non-peak generation hours. This has helped improve PLFs for larger developers / newer projects to the 22-25% range. Players have been known to utilize DC overloading up to 40-50% of AC (alternating current) side capacity.

Figure 37: PLF of the operational projects



Source: Company Filings; CRISIL Research

3.4. Outlook on solar capacity additions in India (fiscals 2023 – 2027)

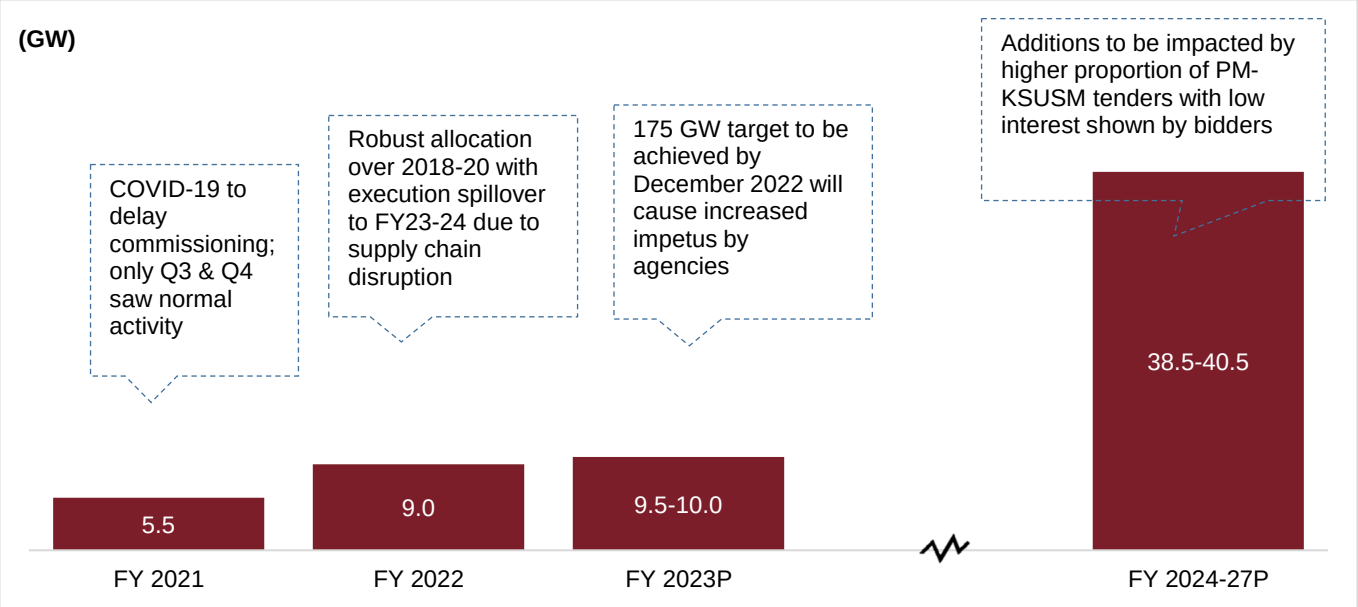
3.4.1. Robust pick-up in solar additions in Q1 of fiscal 2023

Fiscal 2022 witnessed robust pick-up in capacity additions of ~13.9 GW. Despite supply chain constraints during the first half of the year, utility-scale installations were ~10 GW. Rajasthan & Gujarat witnessed highest capacity additions at ~6836 MW & ~3435 MW respectively. The slowdown in capacity addition during 2021 was mainly due to continued localized restrictions, extension to timelines and a rise in solar module pricing stemming from shortage of upstream components (glass and poly-silicon). Several large projects under various schemes - such as SECI ISTS-I 2000 MW, SECI 1200 MW ISTS-III, Rajasthan 750 MW (non-solar park), SECI 1200 MW ISTS-IV and GUVNL 700 MW phase III-R - got commissioned in fiscal 2022.

The first 2 months of fiscal 2023 recorded solar capacity additions of ~3.4 GW. MNRE provided a 7.5-months extension for projects impacted by the first and second COVID-19 waves. This delayed commissioning in fiscal 2022, causing a spill over in fiscals 2023 and 2024.

CRISIL Research expects solar power capacity additions of 70-75GW over fiscals 2023-27, as compared with ~38 GW over fiscals 2018-22. Growth in capacity additions will be driven by government support, with an aggressive tendering roadmap outlined and being followed by the government so far. Few external factors such as improvement in technology (floating solar, module efficiency) and low capital costs are also key to enabling additions. However, the additional taxation & revision of GST from 5% to 12% will increase capital costs and consequent willingness of state discoms to offtake.

Figure 38: Solar capacity additions fiscals 23-27P



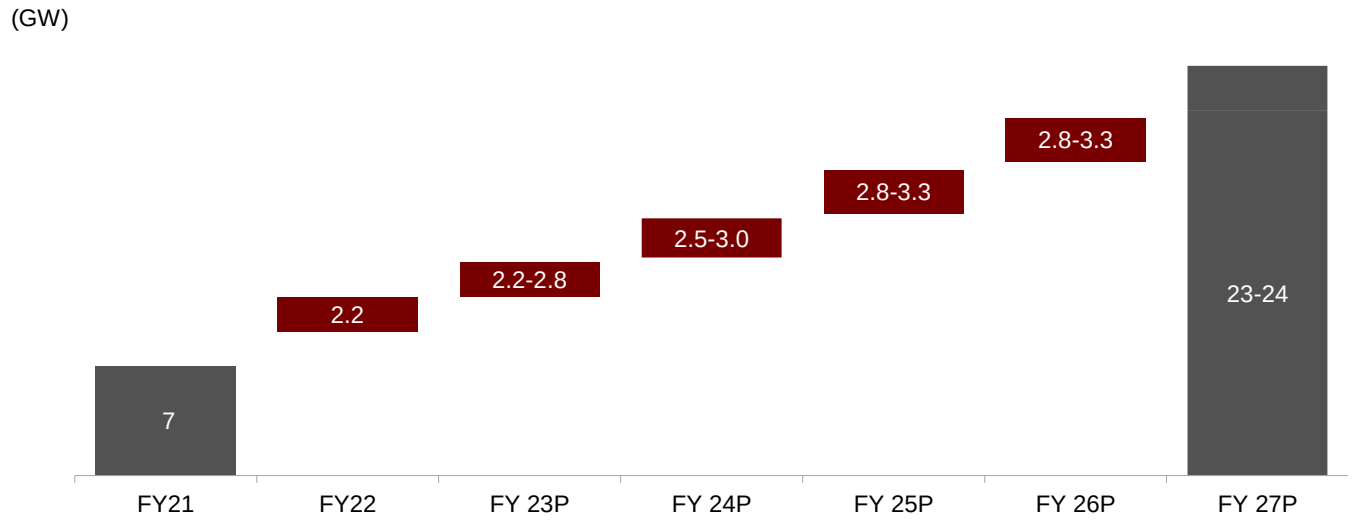
P- Projected

Source: MNRE, CRISIL Research

3.4.2. 14-15 GW solar rooftop capacities expected to be commissioned over next five years (fiscals 2023-27)

We expect 14-15 GW of projects to be commissioned under the solar rooftop segment over the next five years (2023-2027), mainly led by commissioning of capacities by SECI (up to 2000 MW); capacities allocated by state governments (up to 1500 - 2000 MW), commissioning of ~1,000 – 1,500 MW of capacities by government institutions such as metro, railways and airports; and ~2,500-3,000 MW of capacities to be added by industrial and commercial consumers under net/gross metering schemes of various states. Further, Ministry's approval of allowing net-metering upto 500 KW would give much needed fillip to the sector leading to increase in demand for rooftop installations. Also, MNRE provides central financial assistance for all rooftop projects constructed by residential category of consumers: 70% for special category states and for 30% for other states.

Figure 39: Projected rooftop capacity additions over fiscals 2023-27



Note: Historical solar rooftop installed capacity is based on internal estimates.

Source: MNRE; CRISIL Research

Over 50% of the new capacity additions, would be added by Delhi, Gujarat, Maharashtra, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu, which are expected to lead capacity additions. However, these seven states would be able to achieve only 22-23% of their allocated targets Also, recently Andhra Pradesh has announced CFA for residential consumers and a total of 8 MW has been sanctioned by MNRE under Phase II of Rooftop Solar Program.

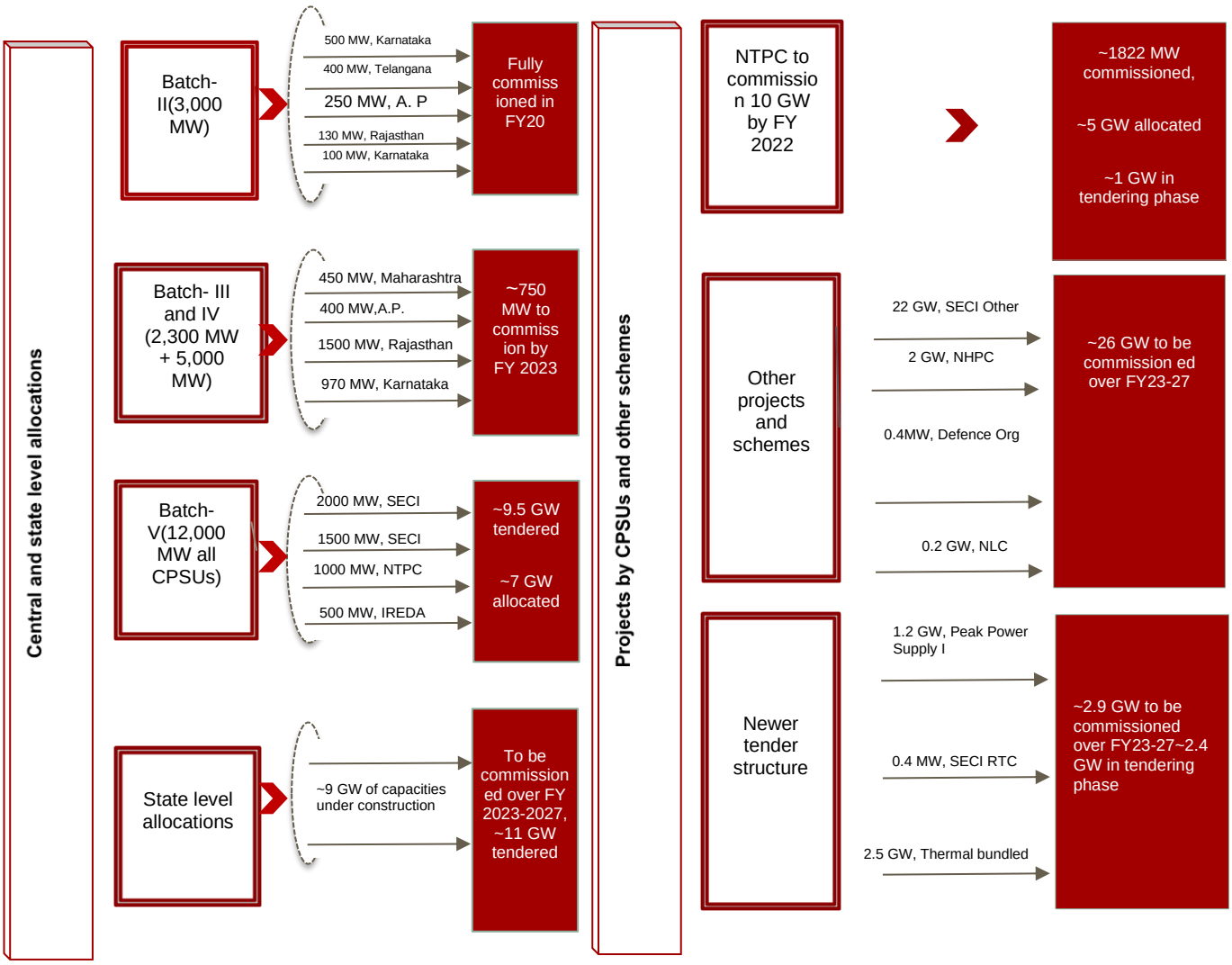
States were analysed on the following parameters. Each parameter was assigned a weight and scored on a scale of 1 to 5. The weighted average score was computed, and a potential achievement rate was assigned to state-wise MNRE targets, to arrive at the outlook.

3.4.3. Potential long term growth drivers and constraints of solar sector in India

i. Large capacity allocations under central and state schemes

In line with the government target of installing 175 GW by December 2022, large-scale central allocations are planned under the NSM. We believe that offtake and payment security under central allocations will be key drivers for additions under this scheme. Moreover, strategies to reduce tariffs through bundling with thermal power (by NVVN) and viability gap funding, or VGF (SECI state-specific VGF schemes) will support additions. NVVN, through its bundling scheme (two units of solar bundled with one unit of thermal power), is expected to allocate ~12 GW under Tranche II and III of the NSM. SECI has also planned to set up 12 GW of projects over fiscals 2020 to 2023 under the VGF scheme, expected to boost capacity additions, going forward.

Figure 40: Central and state level allocations



Source: CRISIL Research

The following policies are likely to drive capacity additions:

- Entire NSM Phase II Batch II Tranche I of 3000 MW has been commissioned.
- Under NSM Phase II, Batch III and Batch IV, Solar Energy Corporation of India (SECI) through its state-specific viability gap scheme (VGF) has tendered out ~7 GW of capacities of which we expect ~750 MW of Kadapa Solar Park capacity to be commissioned over 2022-2023.
- SECI has also tendered capacities under various other schemes where ~22 GW is allocated and under construction while ~8 GW is tendered.
- Under the state schemes, ~9 GW of projects are under construction and are expected to commission over fiscals 2023-2027. Based on tendered capacities by states at the end of May 2022, a further ~11 GW worth of solar projects are expected to be up for bidding over the coming months.

- The government has expanded the 1 GW CPSU program to 12 GW to encourage cash-rich central PSUs to set up renewable energy projects. ~922 MW, 1,104 MW & 5,000 MW got allocated under Tranche-I. II & III of this scheme respectively. We expect 7 GW from this scheme to be commissioned till fiscal 2026

- We expect 14-15GW of projects to be commissioned under the solar rooftop segment over the next five years , mainly led by capacities tendered by SECI (up to 2000 MW); capacities allocated by the state governments (~1,500-2,000 MW), commissioning of ~1,000 – 1,500 MW of capacities by government institutions such as metro, railways and airports; and ~9,500-10,500 MW of capacities to be added by industrial and commercial consumers under net/gross metering schemes of various states

3.4.4. Technical issues and factors that are likely to hinder growth in rooftop bases capacity additions

a) *Bottlenecks to achievement of the 40 GW target*

While solar rooftop project installations are expected to rise significantly, they would still lag the government target of 40 GW significantly by 2022 owing to several issues, as highlighted below.

- Lack of availability of cheap finance

Availability of cheap finance could hinder growth in this segment, particularly given weak credit profile of potential consumers, their ability to provide collateral etc. This could be tackled through providing guarantee and providing access rights of the site. Additionally, the entry of several multi-lateral agencies via public and private banks have assured availability of feasible bank credit for rooftop. World Bank has committed USD 500 million to PNB and USD 625 million to SBI as a multi -tranche facility for funding viable rooftop facilities in the country.

- Uncertainty over enforcement of contractual obligations

Currently there are issues in enforcement of lease agreements and contractual obligations (power purchase agreement) between producer and buyer of solar power generated from rooftop projects. This is critical to be addressed to boost investor confidence and the same could be achieved through measures such as granting access rights to the third party, timely dispute redressal, payment security under centrally allocated capacities and insurance schemes.

- Issues of gird variability in areas with higher RE penetration

Grid variability could arise as an issue over the long-term with rising penetration of rooftop solar as it forms a minigrid. This issue can be handled with battery back-up-based storage solutions, which could minimize grid volatility. With declining battery prices, battery back-up-based systems would be used to provide more firm power to grid, reducing grid constraints.

- Discoms unwilling to provide connections to consumers in industrial and commercial segments

Analysis of the tariff structure of discoms across states reveals that average realisation of revenues from the electricity sold to industrial consumers is 20% to 50% higher than the average cost of supply (ACOS) of discoms in the majority of the leading States in India, and almost twice the realizations of domestic and agricultural consumers. Thus, if discoms allow such high-paying industrial consumers to utilise power generated captively through rooftop solar (particularly as there is no cross-subsidy surcharge on solar connections), cross-subsidisation of residential and agricultural consumers would be challenging, and they would stand to lose considerable amount

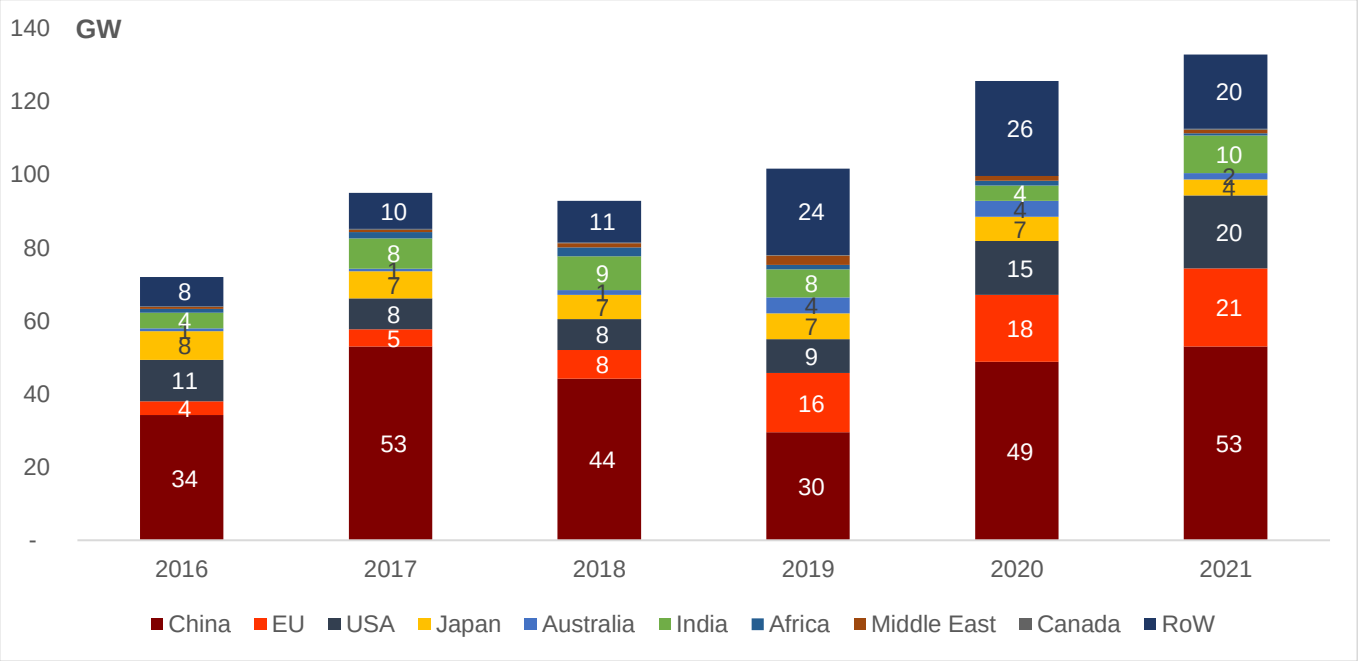
of revenues. Moreover, increasing tariffs of residential and agricultural consumers would be difficult as their demand is price-sensitive.

3.5. Global Solar Market

3.5.1. Review of Global Solar PV capacity additions

The global installed solar photovoltaic (PV) capacity increased by ~19% y-o-y to 843 GW in 2021. Globally, ~133 GW of capacity was added in 2021, led by China, USA, Japan and India which together added ~88 GW or around 66% of total capacity added during the year.

Figure 41: Annual Solar Capacity Additions in major economies

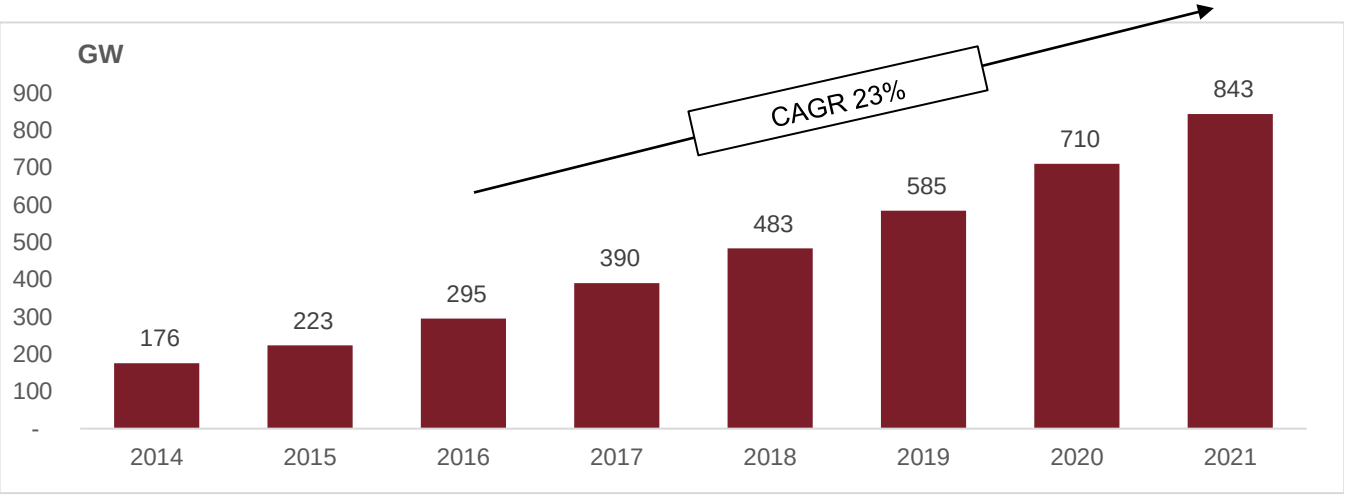


Note: The annual capacity addition numbers are pertaining to calendar year (Jan-Dec)

Source: IRENA Statistics 2022; CRISIL Research

In terms of cumulative installed capacity as of December 2021, China is the market leader with a total installed base of ~307 GW, while USA which is second commissioned ~20 GW of solar projects in 2021, achieving ~95 GW of installed solar base as of December 2021.

Figure 42: Global cumulative installed solar PV power capacity has grown at CAGR 23% between fiscals 2016 and 2021



Source: International Renewable Energy Agency (IRENA), CRISIL Research

3.5.1.1. Key countries with largest capacity addition in the last five years

Figure 43: Solar PV capacity additions and installed base (2021)

Country	Installed Capacity (MW)	Capacity additions (MW)
China	3,06,403	52,985
EU	1,58,061	21,400
USA	93,713	19,899
Japan	74,191	4,427
Australia	19,074	1,732
India	49,342	10,299
Africa	10,302	598
Middle East	7,969	938
Canada	3,630	288
RoW	1,20,401	20,239

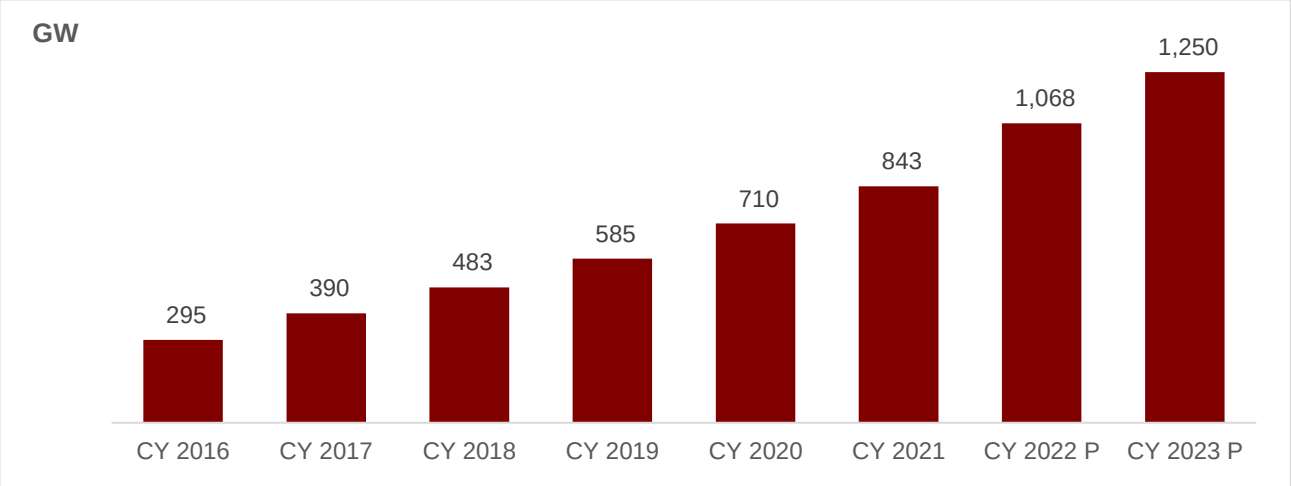
Source: IRENA, CRISIL Research

China continues to dominate the solar PV market and account for about 36 per cent of the global installed capacity while key European countries control about 19 per cent of the total solar PV installed capacity.

3.5.2. Outlook: Global solar capacity additions of ~225 GW expected from CY22

Globally, ~133 GW of solar PV capacity was added in 2021 taking installed capacity to 843 GW which is a ~19% per cent increase over the previous year. China continued to be the market leader with a total cumulative capacity of ~306 GW where USA is second with total cumulative solar capacity of ~94 GW followed by Japan with an installed capacity of ~74 GW.

Figure 44: Growth in Global installed capacity base in solar PV over 2016-2023



Source: International Renewable Energy Agency (IRENA), CRISIL Research

(P): Projected

Following outbreak of COVID pandemic, solar manufacturing was severely disrupted in the last two years. It has also reduced workforces, constrained the supply of critical components for PV modules and made it almost impossible to ship completed products due to the closure or partial closure of transport routes, ports. Most of the large projects originally planned for completion in H1 2020 along with new projects planned to start in H2 2020 have been impacted. Despite persistent pandemic-induced supply chain challenges, construction delays, and record-level raw material and commodity prices, solar energy capacity additions increased by 20 per cent globally in 2021.Global additions of solar PV capacity are on course with an expected addition of ~225 GW in 2022. Solar's growth in China and India is accelerating, driven by strong policy support for large-scale projects, which can be completed at lower costs than fossil fuel alternatives. In the European Union, rooftop solar installations by households and companies are expected to help consumers save money as electricity bills rise. Solar energy is expected to account for ~60 per cent of global renewable capacity.

Solar PV capacity addition rose by 53 GW in 2021, making China the leader in the solar PV market. The total capacity increased 21 per cent y-o-y to 306 GW in 2021 as compared to a growth of 24 per cent to 253 GW in 2020. 2019 was the transformation year for Chinese solar market from 100 per cent subsidy driven to a 100 per cent subsidy free market by 2021- first year of its 14th Five-Year-Plan (2021-2025). A policy halt to subsidized solar projects, as announced by the Chinese government in June 2018, has restricted capacity additions in the country. New policies have not been entirely delineated by the government; however the National Development and Reform Commission (NDRC) and NEA in January 2019 announced the removal of quotas for solar projects developed without central subsidies for next two years. However, there will still be capacity limits on overall project development due to grid instability in several provinces. Similarly, the central government will impose some control on new solar capacity across provinces. But in China, solar capacity additions are mostly subsidy driven and

presently only local government incentives for solar have been permitted with no clarity on central subsidies so far. Overall, considering delayed policies and far-reaching impact of coronavirus, China is expected to add around 130-135 GW during CY2022-23. This would mean China would continue to remain one of the largest solar markets going forward however, its pace would slacken compared to its previous growth.

While USA, Japan and India are expected to remain steady on their course to adding solar capacities, there are some headwinds to the same in the present scenario. In USA, capacity additions showed slowdown in 2019 where it added 9.1 GW of capacity compared to 10.1 GW added in 2018. However, the same been improved in 2020 to about 15 GW and 20 GW in 2021. Capacity additions have been driven by tax credits, renewable purchase obligations (RPOs) and loans and grants by government. Sharp decline in input prices also supported the capacity additions. State mandates for renewable electricity have fuelled growth of utility-scale projects, the largest of which are materializing in western United States, particularly in California, Arizona and Nevada. States of California, Arizona, North Carolina, New Jersey and Nevada are leading the country's solar PV installations. The federal tax credit or Investment tax credit (ITC) allows residential and commercial properties to deduct 30 per cent of the cost of installing solar system from the federal taxes. In 2021, tax credit for residential and commercial owners was 22 per cent of cost of the system and from 2022 onwards, owners of new commercial solar energy systems can deduct 10 percent of the cost of the system from their taxes. However, there is no federal credit for residential solar energy systems.

Japan added 6.7 GW of solar PV capacity in 2018 as against ~7.5 GW added in 2017. The addition has been almost constant for the next 2 years at ~7 GW in 2019 and 2020 but dropped to 4.4 GW in 2021. The growth in PV installations has been driven by introduction of feed-in-tariffs in July 2012. Moreover, significant increase in utility and commercial installations has also led to healthy growth. Due to mounting subsidy burden Japan is planning to move towards competitively bid auctions for renewable energy. Hence, solar projects above 2 MW would be subject to tariffs decided via competitive auctions and would not fall under the FiT scheme. The country's increasing focus towards renewable energy sources is expected to drive growth in the next few years.

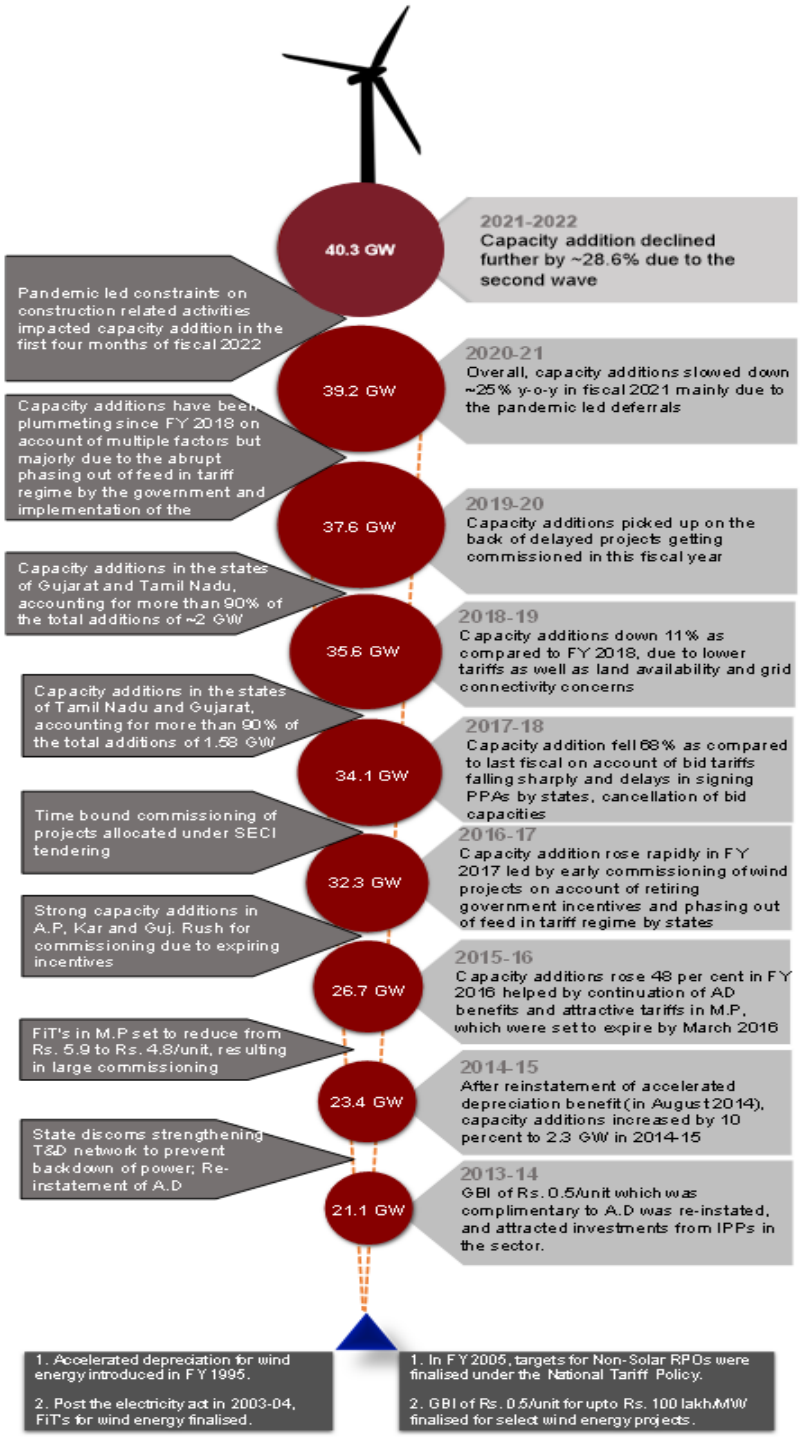
Indian market faced a temporary slowdown in the second half of fiscal 2020. The slowdown was mainly due to several policy issues – additional taxation in the form of imposition of a safeguard duty, higher GST rate, and other policy issues such as cancellations / renegotiation of PPA’s that adversely impacted the developer sentiments. Despite this, India remains a significant market for solar capacity additions.

Substantial solar PV capacities of ~400 GW are expected to be added over 2022-23 led by China, US and India. Other emerging markets in Africa, Latin America, Southeast Asia and the Middle East have also started to grow past the ~1 GW level, further supporting future growth outlook. Key markets include south-east Asia (countries like Malaysia, Vietnam, Indonesia, Philippines, etc.), the Latin American region (Brazil, Venezuela, Chile, etc.) and the MENA region (Egypt, United Arab Emirates, Saudi Arabia), where there is an increasing focus towards renewable energy.

3.6. Wind Power market

3.6.1. Review of Wind energy capacity additions in India (fiscal 2016-2022)

3.6.1.1. Evolution of Wind Power in India



- Rise of Wind energy Power in India (Government support and other key factors)

  Reverse e-auction: In February 2017, the government had conducted the first reverse e-auction for wind power, which led to tariffs falling to Rs. 3.46/unit. This was in fact 17% lower than the lowest wind feed-in tariff (FiT) of Rs. 4.16/unit in the state of Tamil Nadu. With such sharp drop in tariffs, several state discoms like Gujarat, Andhra Pradesh, Rajasthan and Karnataka expressed their unwillingness to buy power under the FiT regime even for approved and under-construction projects as PPAs were not signed.

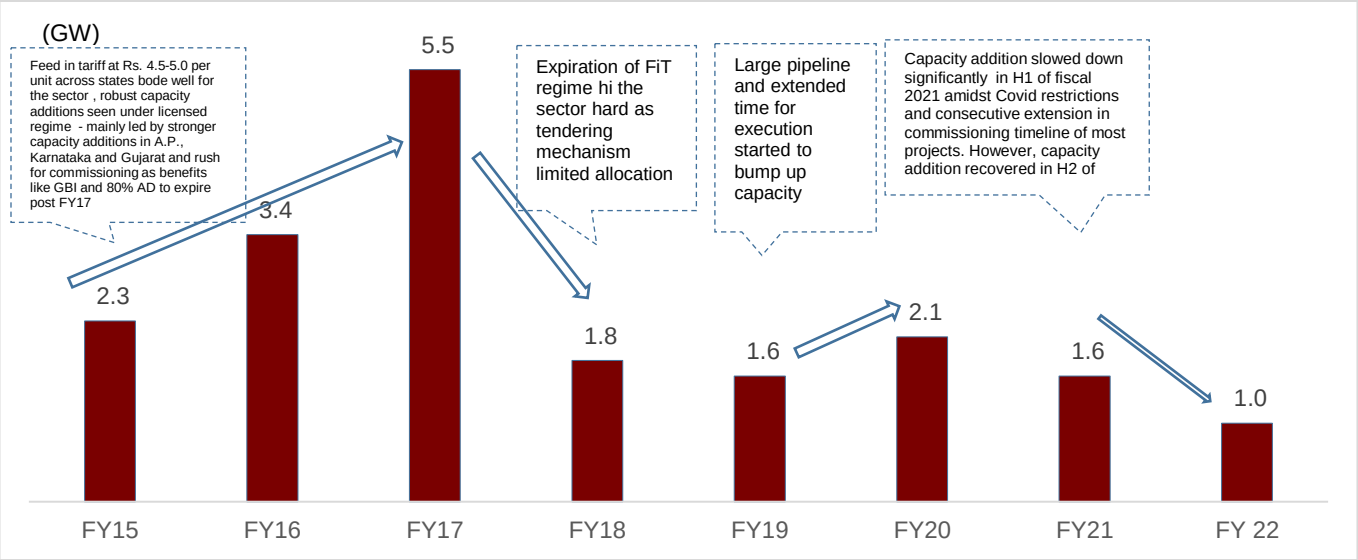
  Accelerated Depreciation: The government has halved the accelerated depreciation benefit (40% from project commissioning post March 2017). This, coupled with competitive bidding, reduces the prospects of higher returns for accelerated depreciation-based players, which has led to a shift in investment focus to other avenues.

3.6.1.2. Review of overall Grid connected wind energy capacity additions (2016-22)

a) Second wave of COVID-19 led restrictions delayed capacity addition fiscal 2022;

As per CRISIL Research, pandemic led constraints on construction related activities impacted capacity addition in fiscal 2022. India added ~1 GW of wind energy capacity during fiscal 2022.Capacity additions declined in the fiscal 2022 compared to fiscal 2021, owing to surge in commodity prices, supply chain disruptions, and challenges in acquiring locations in windy regions, leading to issues of project viability. Additions were weak when also compared with historical long-term trends.

Figure 45: Capacity addition slowdown continued to fall fiscal 2022



Source: MNRE; CRISIL Research

In the previous year (fiscal 2021) as well, ~1553 MW was added, lower than the ~2,068 MW added during fiscal 2020.This comes on the back of a pickup in additions in fiscal 2020 from subdued fiscals 2019 and 2018, post the

FiT regime change. Capacity additions had picked up by 31% y-o-y in fiscal 2020 compared to the 1,580 MW and 1,766 MW added in fiscals 2019 and 2018 respectively.

This increase in fiscal 2020 was largely attributed to the commissioning of delayed projects under SECI Tranche I, II and III as well as state auctions of Tamil Nadu, Maharashtra and Gujarat.

However, the sector continues to face severe delays, grappling with several execution challenges on the ground. Post 2017, SECI has allocated ~121 GW of ISTS connected wind capacities of which ~6.5 GW (31%) has been commissioned and ~3 GW cancelled. With commissioning timelines of 18-24 months, capacities are now lined up for commissioning fiscal 2023 onwards. Fiscal 2023 faces new challenges such as locating land in windy areas, monsoon-related disruptions, surge in prices for cement (4% on-year) and steel (21% on-year). However, momentum is expected to pick up in the second half of fiscal 2023 when commodity prices are expected to stabilize.

To provide relief to the wind developers, the Ministry of New and Renewable Energy (MNRE) had also previously permitted extension in scheduled commercial operation dates for wind projects facing difficulties, subject to certain conditions and adequate proof. Under the same extension may be granted due to:

1. Any change in land policy for a state post bidding or any delay in handing over of land by state government as per policy;
2. Modifications in the land and building rules of Tamil Nadu (for projects with PPAs signed post July 2018);
3. Extension of 60 days post operationalization of the concomitant ISTS infrastructure;
4. Any delays in approval of request from Ministry of Defense (MoD) beyond a period of 60 days and subject to the condition that request to the MoD must have been applied within 30 days of effective date of the power purchase agreement (PPA);
5. Financial closure timelines will also be extended according to the extensions given to the final commercial operational date;
6. Any other extension request which can be sent by SECI to MNRE.

Apart from this, MNRE has granted two and half months' time extension for renewable energy projects which have their scheduled commissioning date on or after 1st April, 2021. In fiscal 2021, MNRE also provided an extension of five months in addition to its initial blanket extension of lockdown plus 30 days amidst the COVID-19 related lockdown, apart from clarifying that any delays from constraints related to the virus outbreak will be treated as force majeure. The latter can be applied for via petitions in front of the respective state regulatory commissions.

CRISIL expects these factors to cause a further deferral in the execution of the delayed pipeline, though some recovery is expected from fiscal 2023.

b) Review of competitive bidding

Tariff of Rs. 3-3.2 per unit required for equity IRRs of ~9-11 per cent for wind power projects

Based on our analysis, we believe that levelised tariff of Rs. 3-3.2 per unit is required for an equity IRR of ~9-11 per cent. Our analysis is based on Rs 75-80 million per MW capital costs (sans land charges) considering surge in commodity prices, PLFs of 35% and an interest rate of 8% p.a. These tariffs are significantly higher when compared to solar tariffs of Rs 2.5 - 2.9 per unit. These and more would constraint wind additions in the medium term. This is also evident from the fact that cancellations have gone up in the sector with only 31% commissioned for existing tenders after the introduction of competitive bidding. OEM-wise market share for wind capacity addition (till fiscal 2022)

According to the Directory Indian Wind Power 2022, Suzlon had the maximum number of turbines supplied accounting for 9,169 turbines followed by Siemens Gamesa, Vestas Wind and Inox Wind. Out of the total (fiscal 2022) 36,538 turbines, 17,290 turbines were supplied by the players that are currently inactive. These turbines pose an opportunity for the O&M service providers as the players in the current market especially the OEMs, which hold the largest share of the O&M services in Indian market. The typical O&M contract period is 2+8 or 2+10 or 2+12 years with initial two years of free service with the purchase of equipment. Therefore, most of the turbines supplied by the inactive players will require renewal of such contracts or newer contracts. The O&M contracts are structured mostly for 2+8 or 2+ 10 years to incorporate the price escalation of the services over the years. Post the tenor the contracts are then renewed for another 8 – 15 years. If the contracts are done for more than 15 years, there are clauses to renegotiate the service cost in between the term.

On the other hand, contracts are sometimes terminated by the parties owing to the following clauses:

- Breach of material supply obligations – this clause is invoked when a O&M service providers is not able to fulfil its obligation to render services and supply replacement equipment resulting in loss of generation
- Payment delays from power producer – This clause is invoked when the power producer is unable to clear the dues of the O&M service provider in the committed time
- Mutual termination – when both parties reach a consensus to terminate the contract for reasons not stipulated in the contract

Usually, the termination of the contract takes 3-6 months to come into effect along with prior intimation to the parties associated.

Figure 46: Market share by no. of turbines, fiscal 2022

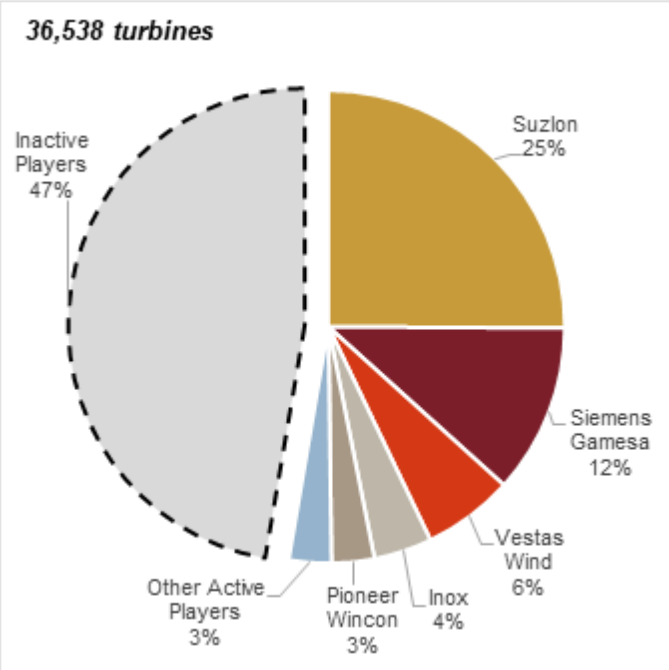
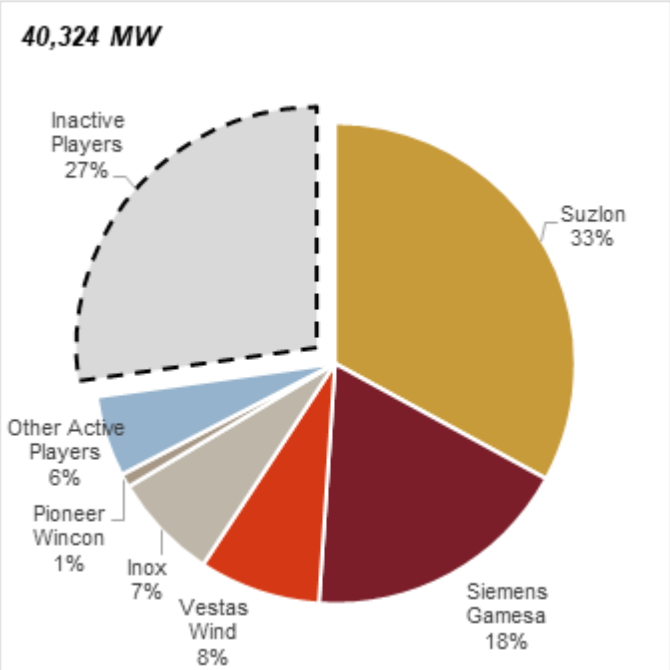


Figure 47: Market share by capacity (MW), fiscal 2022



Source: Directory Indian Wind Power, 2022 (CECL)

Note: The inactive players include turbines supplied by players which do not offer equipment or services as of fiscal 2022. Some of the major players currently inactive included Wind World, Regen Powertech, and NEPC-Micon

In 2022, Suzlon added 160 turbines with a cumulative capacity of 343.5 MW followed by Siemens Gamesa, Inox Wind, Nordex and Vestas Wind with 151 (324 MW), 71 (142 MW), 49 (147 MW), and 47 (97 MW) turbines added. The total additions stood at 509 turbines and ~1.1 GW of capacity.

Table 10: Wind capacity addition by OEM, fiscal 2022

OEM	Number of turbines	Capacity Addition (MW)
Suzlon	160	343.5
Siemens Gamesa	151	324.4
Inox	71	142.0
Nordex	49	147.0
Vestas Wind	47	97.2
GE Energy	15	40.5
Pioneer Wincon	13	9.75
Senvion	3	6.9
Total Addition	**672**	**1494**

Source: Directory Indian Wind Power, 2022 (CECL)

3.6.1.3. Brief on the region-wise generation of Wind energy in India

Capacity additions remain subdued post change in regime, fiscal 2020 was seen as a recovery

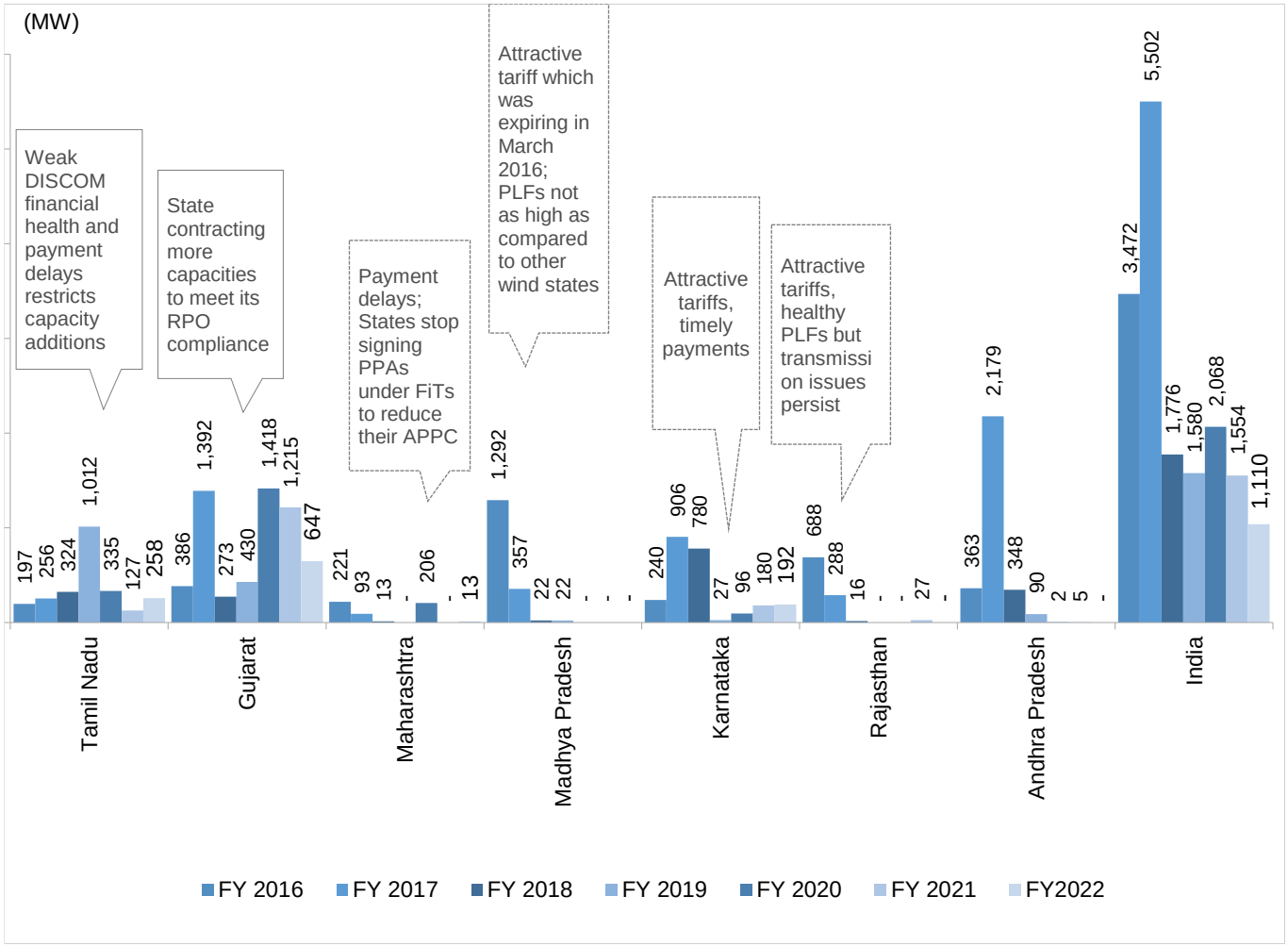
Capacity additions have been plummeting since fiscal 2018 on account of multiple factors but majorly due to the abrupt phasing out of feed in tariff regime by the government and implementation of the competitive bidding mechanism at the end of fiscal 2017. Moreover, halving of the accelerated depreciation benefit (from 80% in fiscal 2017 to 40% in fiscal 2018) and elimination of generation-based incentives (GBI) of Rs. 0.5/unit also reduced investments in the sector from non-IPPs players.

In February 2017, the government had conducted the first reverse e-auction for wind power, which led to tariffs falling to Rs. 3.46/unit. This was in fact 17% lower than the lowest wind feed-in tariff (FiT) of Rs. 4.16/unit in the state of Tamil Nadu. With such sharp drop in tariffs, several state discoms like Gujarat, Andhra Pradesh, Rajasthan and Karnataka expressed their unwillingness to buy power under the FiT regime even for approved and under-construction projects as PPAs were not signed.

Capacity addition stayed muted in most states amidst second wave of COVID pandemic

In the first 2 months of fiscal 2023, Rajasthan and Gujarat added capacities of ~169 MW and ~139 MW respectively. In fiscal 2022, Gujarat added highest wind capacity of ~647 MW followed by Tamil Nadu (~258 MW) and Karnataka (~192 MW). Similarly, in fiscal 2021, most of the wind capacity additions had happened in the states of Gujarat, Karnataka, Tamil Nadu & Rajasthan with Gujarat adding highest wind capacity of ~1200 MW, Karnataka (~180 MW), Tamil Nadu (~120 MW) and Rajasthan (~30 MW).

Figure 48: State wise capacity additions



Source: MNRE; CRISIL Research

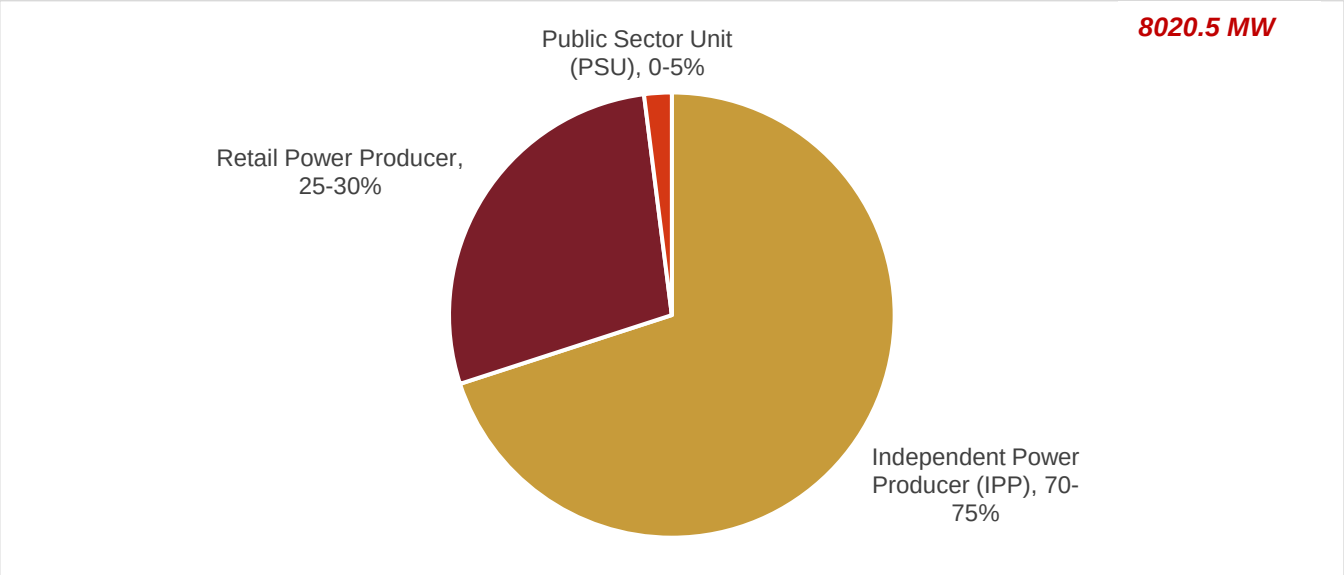
Table 11:State- wise distribution of wind turbines and capacity (till fiscal 2022)

State	Active Players		Inactive Players		Total	
	No. of turbines	Cumulative capacity (MW)	No. of turbines	Cumulative capacity (MW)	No. of turbines	Cumulative capacity (MW)
Andhra Pradesh	1774	3460.50	807	574.54	2581	4035.04
Goa	0	0.00	2	0.11	2	0.11
Gujarat	4207	7600.22	2631	1774.30	6838	9374.52
Karnataka	2241	3788.80	1777	1309.92	4018	5098.72
Kerala	68	68.00	15	3.35	83	71.35
Madhya Pradesh	986	1783.20	676	674.84	1662	2458.04
Maharashtra	2861	3444.85	1736	1550.61	4597	4995.46
Odisha	0	0.00	21	1.19	21	1.19
Rajasthan	1940	3049.10	1600	1295.75	3540	4344.85

Tamil Nadu	5110	6028.70	8018	3785.97	13128	9814.67
Telangana	61	128.10	0	0.00	61	128.10
West Bengal	0	0.00	7	1.75	7	1.75
Total	19248	29351.47	17290	10972.32	36538	40323.79

Source: Directory Wind Power in India, 2022

Figure 49: Capacity distribution of wind generation (fiscal 2018 to 2022)



Source: Directory Wind Power in India, 2022

Slower additions lead to tepid tender and bid momentum

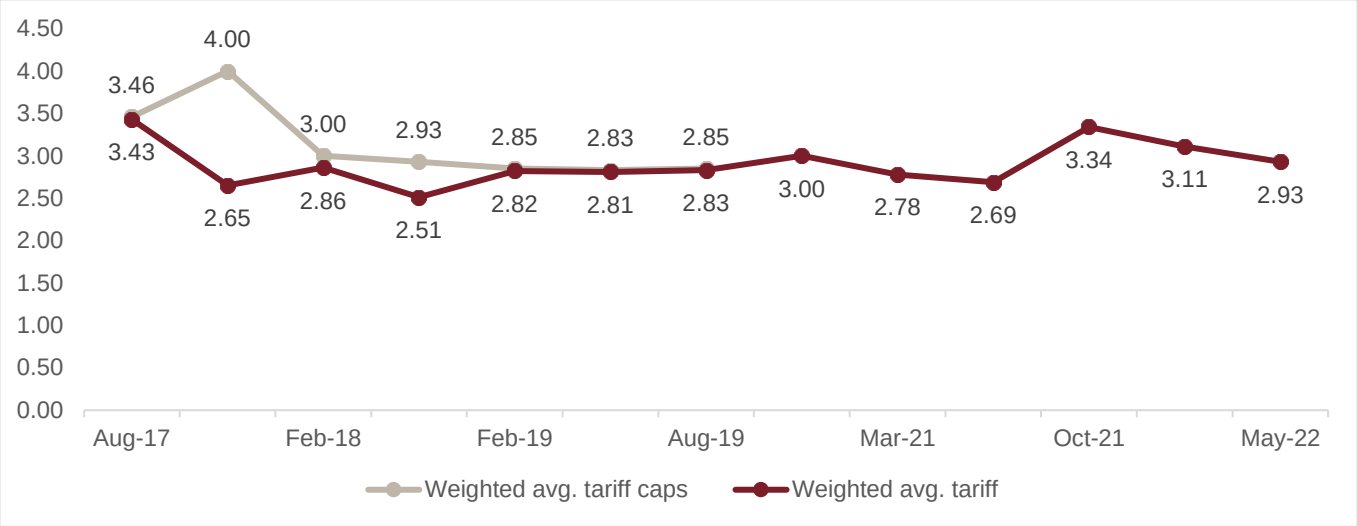
Auctioning has been slow since fiscal 2019 owing to tepid bid response from developers in several large tenders. Developers have been raising concerns regarding lack of adequate grid infrastructure, either due to delay in construction or lack of connectivity due to congestion. Out of 26 substations for wind evacuation, only 6 are viable for new bids as rest of them are either at uncompetitive wind resource sites or are fully occupied by the existing pipeline. Further, lower availability of Type I[1] wind sites in suitable locations is also a cause for concern. Consecutively, projects bid out at low tariffs earlier, are now facing execution challenges as project returns get impacted at increased costs due to delays.

Tariff ceilings were a cause for lower subscription, removal is a positive policy change for the segment

A continuous lowering of tariff ceilings in tenders had left little flexibility to developers who were already coping with execution challenges on the ground.

Figure 50: Tariff caps vs weighted average tariffs (Rs/Unit)

[1] *Type I wind classification sites have high wind power density at various hub heights.*
Type II wind classification sites have medium wind power density at various hub heights.
Type III wind classification sites have low wind power density at various hub heights.



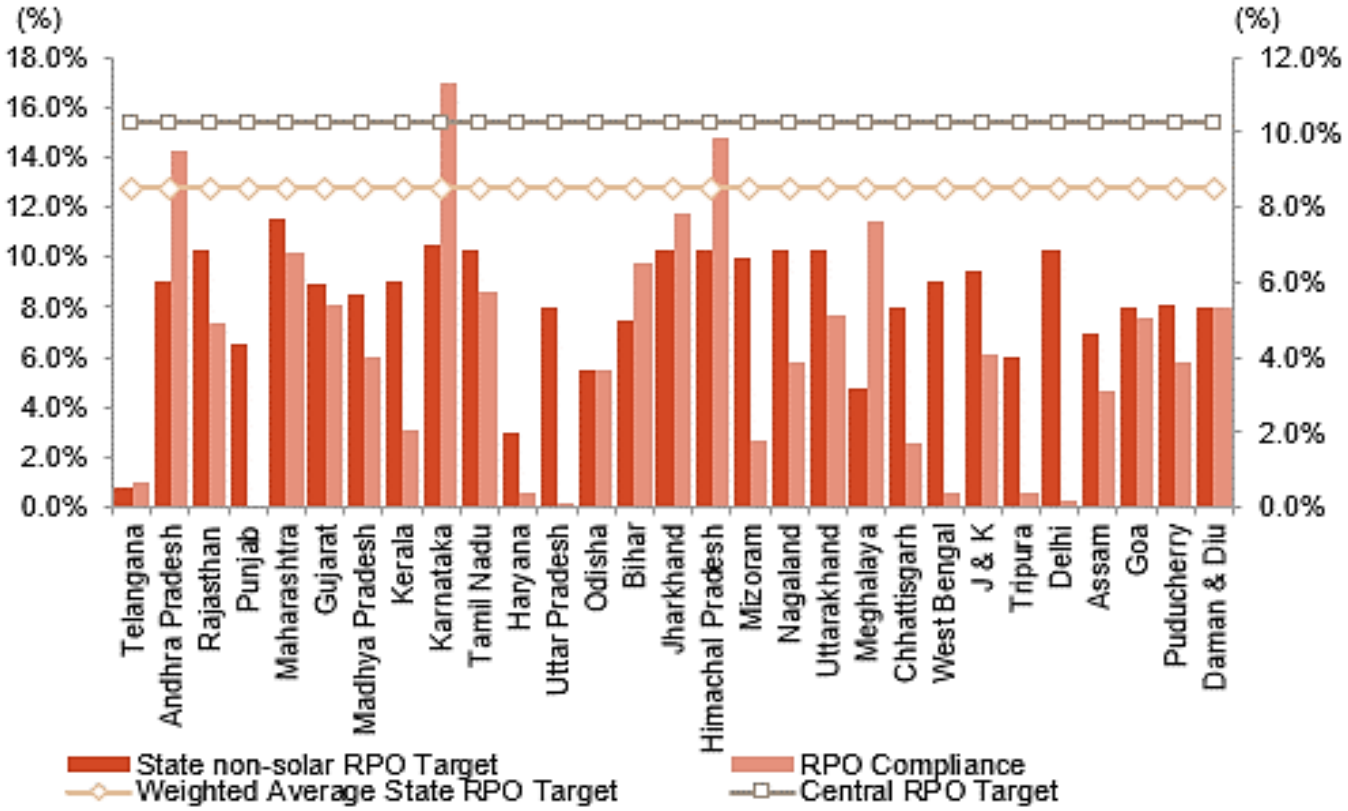
Note: Tariff caps for ~6.1 GW auctioned over the period considered. ~8,5 GW auctioned did not have tariff caps, hybrid tenders excluded here (included in solar energy section).

Tariff caps have been removed by MNRE effective from March 2020, hence no tariff cap is applicable for the auctions post that in above chart

Source: CRISIL Research

3.6.1.4. Lower state targets and concentration of wind projects in fewer states pulls overall compliance to ~65-70%

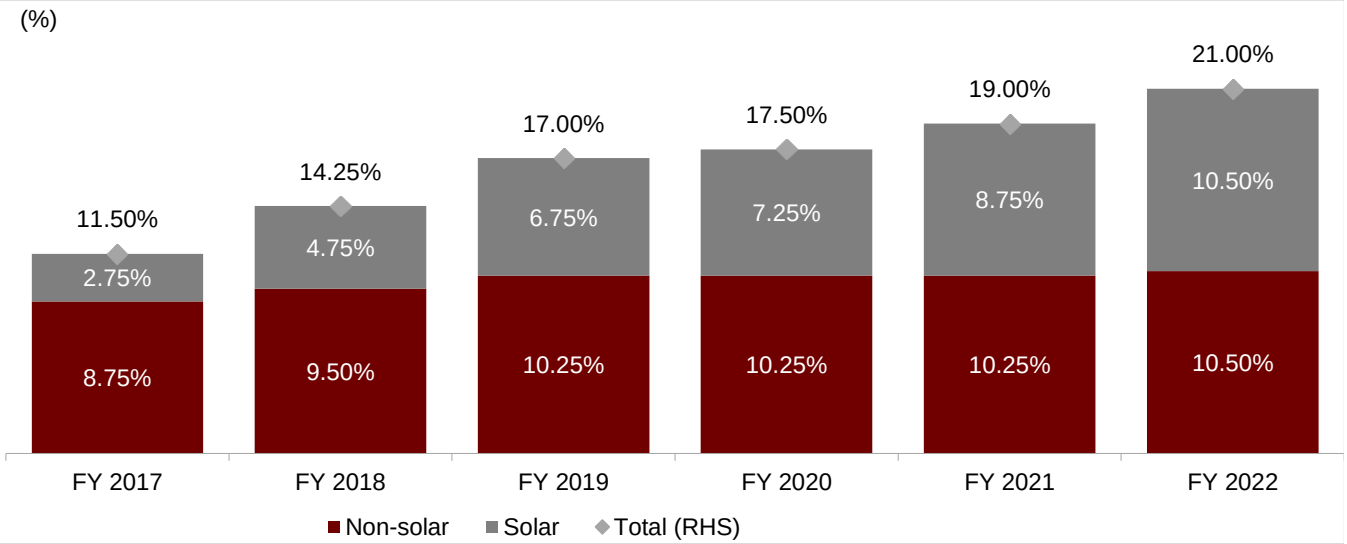
Figure 51: Non-solar RPO targets vs estimated off-take (2021-22)



Source: MNRE; SERCs; CRISIL Research

CRISIL Research estimates that non-solar RPO compliance was ~65-70% per cent in 2021-22 based on the RPO target (weighted average of ~8.3% per cent) set by the respective states. However, as per the notification provided by Ministry of power in June 2018, it had set the Non-Solar RPO target of 10.5% by fiscal 2022 and 10.25% for fiscal 2021.

Figure 52: RPO Trajectory set up the Ministry of Power under its revised Tariff policy



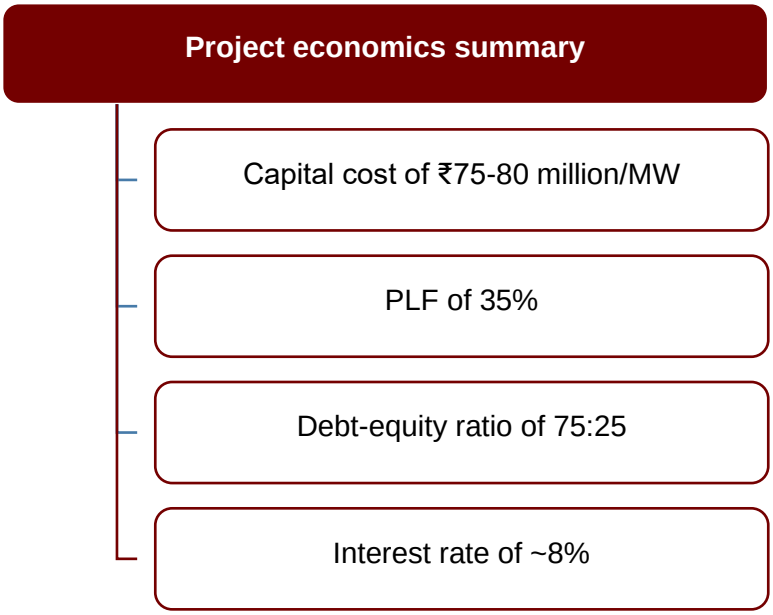
Source: Ministry of Power (Order No. 23/023/2016-R&R; dated June 14, 2018); CRISIL Research

The RPO compliance in 2021-22 was mostly driven by a few states, namely – Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, and Gujarat. This was due to their large installed capacity base, set up on account of attractive wind FiTs, high industrial tariffs and favorable state policies towards renewable energy. On the other hand, despite high renewable energy potential, large states like Uttar Pradesh, Haryana and West Bengal are significantly lagging in terms of RPO achievement owing to low installed base and poor financial health of the discoms.

Despite continuing non-compliance by most states, there has been limited enforcement on obligated entities - distribution companies (discoms) and open access and captive power users - to meet RPO targets. This is primarily on account of the weak financial health of state discoms and lack of uniform imposition of penalties, with imposition cases being far and few. While few states have taken some action, the success has been limited. For instance, in October 2019, state distribution utilities of Delhi were penalized by the Delhi Electricity Regulatory Commission to the tune of Rs 45.9 crores for defaulting on the RPO targets for three financial years, this however, is under dispute currently. Maharashtra Electricity Regulatory Commission (MERC) had directed all obligated entities to meet their solar RPO targets for 2011-15 cumulatively by 2015-16. Despite that, Maharashtra State Electricity Distribution Company Ltd failed to purchase renewable energy certificates (REC) to fulfil its renewable purchase obligations (RPO). Punjab discom earmarked funds of Rs. 800 million and Rs.1 billion for 2012-13 and 2013-14 respectively to buy RECs but utilized the fund to buy non-solar RECs only.

3.6.2. Review of project economics and levelised tariffs for wind power plants in India

Tariff of Rs. 3-3.2 per unit required for equity IRRs of ~9-11 per cent for wind power projects



Source: CRISIL Research

We have assumed a capital cost of Rs 75-80 mn /MW considering the current rise in wind turbine costs due to surge in commodity prices & also in the current scenario of competitive bidding where IPPs are managing most of the activities (such as land selection, approvals from government department, evacuation infrastructure etc.) themselves on which premium used to be charged earlier. Interest rate of ~8% has been assumed due to the current lower interest rate regime.

PLFs of 35 per cent have been assumed given that new projects are deploying higher rated turbines with longer hub height exceeding 100 meters, however, on an average PLFs may vary significantly depending on location and age of machine.

Based on our analysis, we believe that levelised tariff of Rs 3-3.2 per unit is required for equity IRRs of ~9-11 per cent. In our computations, we have not factored in the available accelerated depreciation benefit of 40% as well as generation-based incentives (GBI) [applicability of these benefits varies as per PPA conditions and type of project – FiT or non-FiT].

This tariff range of Rs 3-3.2 unit is also supported by various financial metrics as analysed at different tariff ranges below:

Tariff Range					
Ratio analysis	2.4	2.6	2.8	**3**	**3.2**
ICR	3.9x	4.4x	4.9x	**5.4x**	**5.9x**
Net Debt/EBIDTA	3.9x	2.5x	1.4x	**0.5x**	**0.2x**
DSCR	0.6x	0.7x	0.9x	**1.0x**	**1.2x**
Equity IRR	1%	3%	6%	**9%**	**11%**

Source: CRISIL Research

As highlighted in the above chart, financial metrics are weaker at tariffs below Rs 3 per unit, with Net debt/EBITDA being high, DSCR being below ~1 times and ICR also witnessing a declining trend, coupled with low equity IRRs below Rs 3 per unit.

Further below, we have assessed the sensitivity of equity IRR to two critical factors, PLF and tariffs. IRRs are estimated to be very sensitive to both PLFs and tariffs, where every 20 paise hike in tariff improves equity IRR by 190-200 bps. While, for every 100 bps change in PLFs, equity IRRs improves by 180-190 bps.

Sensitivity of equity IRR to PLF and tariff

PLFs (%)/Tariff (₹ per unit)	2.6	2.8	3	3.2
28%	-3.6%	-1.6%	0.5%	2.6%
30%	-1.7%	0.5%	2.7%	5.1%
33%	1.2%	3.7%	6.3%	8.8%
35%	3.1%	5.9%	8.6%	11.2%

Source: CRISIL Research

We believe, sub Rs 3 per unit projects are viable only at high PLF ranges, above 35%, which is provided by Type I[2] wind sites only. However, currently, lower availability of type I wind sites in preferred locations along with congested transmission infrastructure has forced developers to move to type II wind sites which have a lower average PLF range of 28-32%.

Hence, tariff of Rs. 3.0-3.2 per unit would be required for equity IRRs of ~9-11 per cent for such wind power projects.

According to India's Wind Potential Atlas issued by National Institute of Wind Energy (NIWE) in October 2019, at 120m above ground level (agl), only a handful states have CUF above 35%. The detail list of states and potential for wind (at 120 m) at various CUF is given below:

States	**State-wise detailed Wind Potential at 120m agl (MW)**					
	25-28%	**28-30%**	**30- 32%**	**32- 35%**	**>35%**	**Total**
Gujarat	33655	26900	24662	28502	28841	142560
Rajasthan	98714	27394	1621	27	-	127756
Karnataka	53863	29248	20868	14221	5955	124155
Maharashtra	47324	20597	14131	12526	3635	98213
Andhra Pradesh	33251	14790	10716	11121	5028	74906
Tamil Nadu	30183	11524	7057	7446	12540	68750
Telangana	17987	5057	1369	379	43	24835
Madhya Pradesh	12103	2398	779	124	-	15404
Odisha	6421	1628	287	10	-	8346
Bihar	3469	181	-	-	-	3650
Kerala	366	193	180	359	1213	2311

Source: National Institute of Wind Energy; CRISIL Research

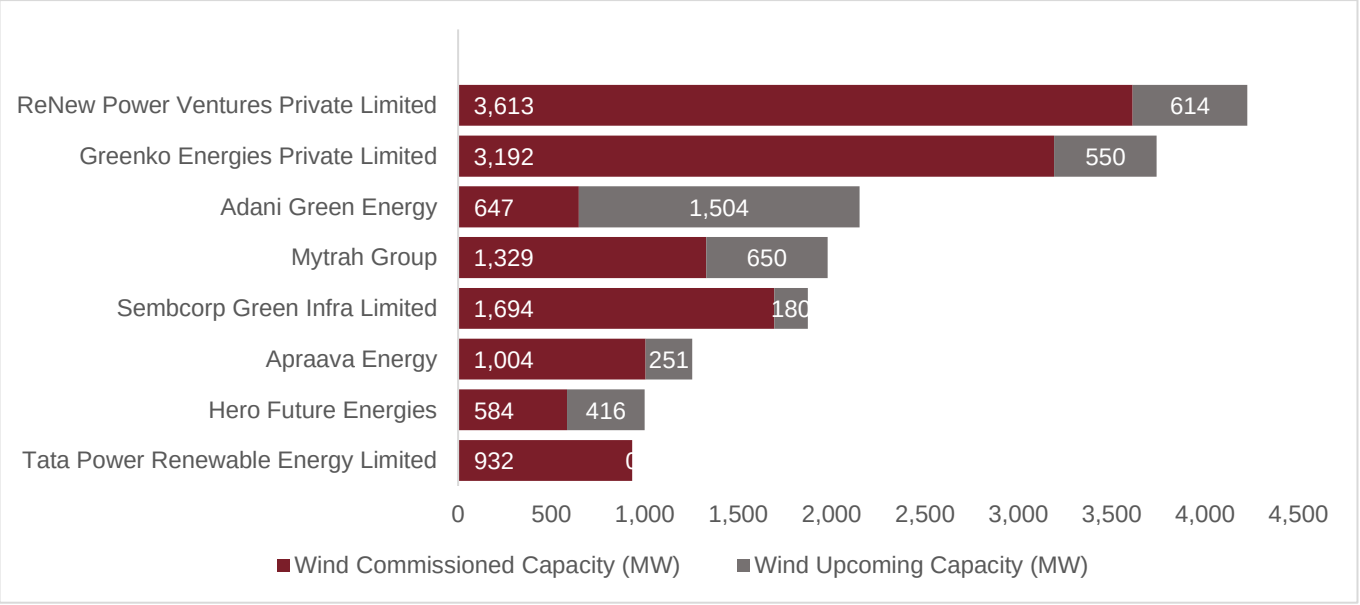
[2] *Type I wind classification sites have high wind power density at various hub heights.*
Type II wind classification sites have medium wind power density at various hub heights.
Type III wind classification sites have low wind power density at various hub heights.

Wind sector witnessed pressure on returns led by competitive bidding; access to high wind density sites and low-cost financing critical

Previously, the discovered tariffs for competitively bid projects reached as low as at Rs. 2.43 / unit as against Rs. 3.0-3.2 / unit tariff required for earning 9-11% equity IRRs. However, post December 2017, when this low benchmark was reached, tariffs have started to rise up back again. For instance, the weighted average tariff of allocations in fiscal 2022 (YTD - April 2021 to February 2022), have averaged at Rs 2.8/ unit, providing an indication that developers are factoring in increased tariffs to adequately manage risks. The latest auction held in May 2022 witnessed tariffs of Rs. 2.92 per unit.

We believe that projects were aggressively bid even when availability of developed land banks (availability of wind micro siting data and proximity to the transmission) with high wind density sites were not tied up prior or finalised before bidding. This has caused execution challenges for several projects in the sector, for e.g. the SECI ISTS III projects were previously not able to acquire required wind sites in the preferred region of Gujarat. This has deterred further interest/ developer response. Additionally, authorities had set pricing expectations near the Rs 2.8 per unit mark, making it difficult for capacities to be auctioned at higher tariff ranges. However, the tariff cap removal in March 2020, provided an opportunity to developers to factor in the added execution challenges, leading to higher bid tariffs in successive auctions.

Figure 53: Competitive Mapping for wind players in India (Capacity Operational & Under-construction) as of March 2022



Source: CRISIL Research

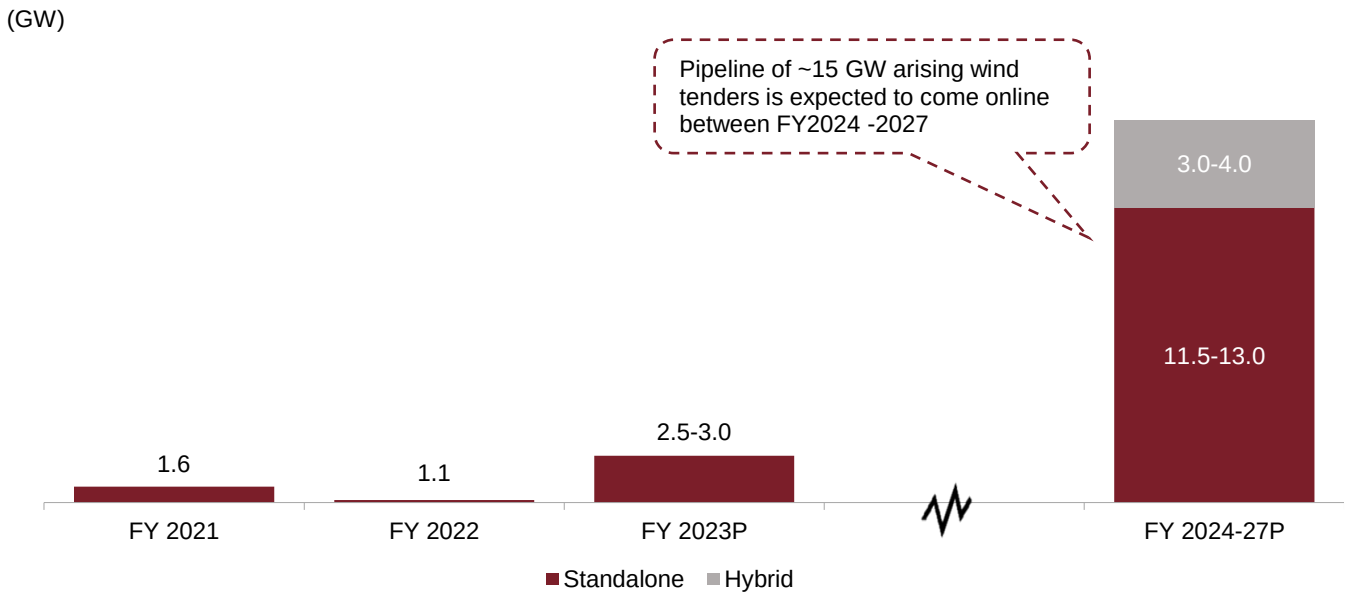
3.6.3. Outlook of wind energy capacity additions in India (fiscal 2023 – 2027)

Capacity addition to witness moderate growth over the next five years

CRISIL Research expects capacity additions to grow, albeit at a slow pace over the next 5 years mostly driven by the allotment of CTU connected capacities. However, the previous change in the bidding mechanism has caused

the entire industry to slow down due to a significant fall in tariffs, where both bid response and profitability for OEMs has dropped. Extended project timelines alongside non-availability of grid and land related challenges would be impacting installations.

Figure 54: Wind capacity addition outlook



Source: CRISIL Research

CRISIL Research expects capacity additions of 17-20 GW over the next 5 years (fiscal 2023-27) entailing investments of ~Rs. 1.43 trillion over the period. Lower interest rate remains a key driver for capacity additions in the near term. ~19 GW in the pipeline is expected to be commissioned by fiscal 2027 factoring in delay due to cost escalation, evacuation infrastructure etc. Owing to 60 GW target by 2022 and a healthy pipeline build-up for the same, fiscal 2023 could witness approximately twice the capacity additions, as compared to fiscal 2022. Additionally, the removal of tariff ceiling has removed the execution hurdles, resulting in faster commissioning of pipeline projects.

Capacity additions over the long term will be driven by increased hybrid tenders coupled with storage, central government (SECI) allocations under relatively stronger off takers like SECI and PTC India Ltd. (PTC), which also reduces risk as compared to direct exposure to state discoms. State auctioning, on the other hand, has slowed as several have instead signed power sale agreements (PSAs) with PTC and SECI for procurement of wind power to help fulfil their non-RPO targets

Mounting challenges have led to a slowdown in additions for wind

Additions have been slow since fiscal 2018 where authorities took time to release competitive bidding guidelines and establish a mechanism in place. Thereafter, gradually auctions took place with only four state auctions so far i.e. by Gujarat (awarded 500 MW wind in Q3 fiscal 2018), Tamil Nadu (500 MW in August 2017), Maharashtra (500 MW in Q4 fiscal 2018) and Gujarat (1000 MW but only 203 MW allocated in Q1 fiscal 2020).

A shift to competitive bidding mechanism in the wind energy sector has caused a slowdown in capacity additions as the participants are yet to adjust. Tariffs had fallen from a range of Rs 4.0-4.5 per unit, under the feed-in-tariff

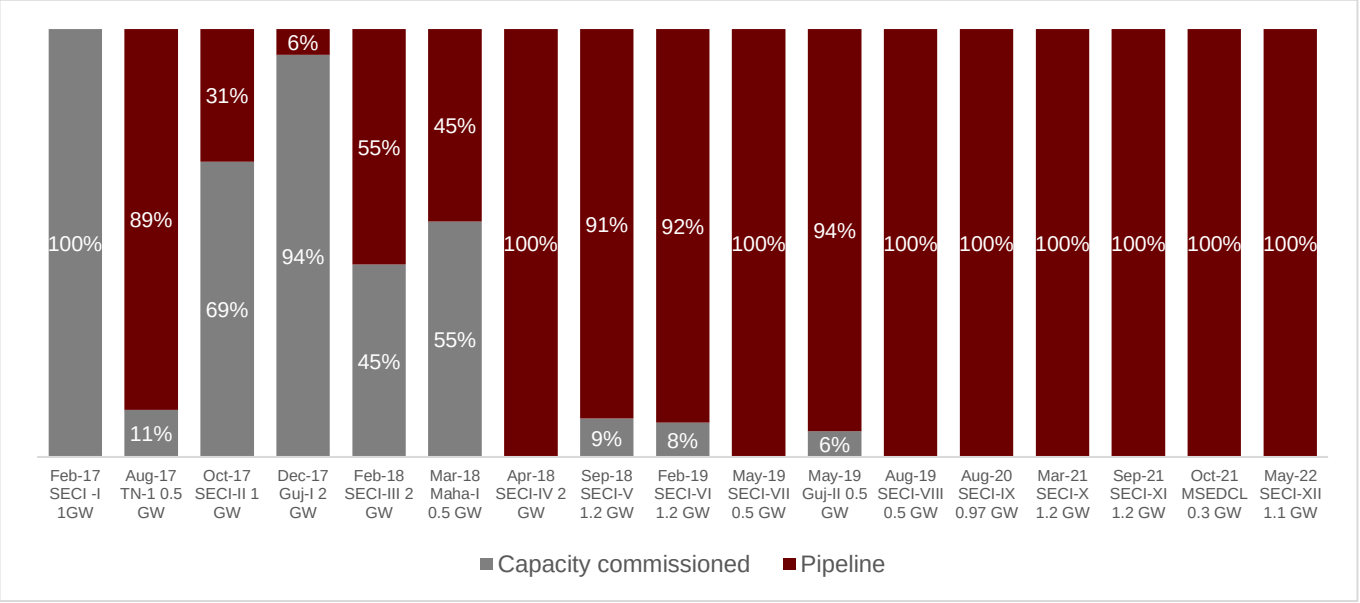
regime to Rs 2.4-2.6 per unit range under competitive bidding mechanism, later correcting to the Rs 2.8-3.0 per unit mark (low returns even at this tariff). Such low realisations remain unviable for the entire value chain at current capital costs of Rs 7.0-7.2 crores per MWdiscussion vision album be very open and unfollow in outlook.

Existing pipeline continues to face bottlenecks

Capacity additions remained weak with ~1,100 MW installations witnessed during fiscal 2022 owing to the second wave of pandemic. Fiscal 2021 had also witnessed a reversal of the slowdown in capacity additions seen over fiscals 2018 and 2019, with ~1.5 GW of additions in the year.

There remain almost 10 tranches of SECI led wind only allocations which have been auctioned but are currently under construction. Most of the capacities were expected to come online over fiscal 2021/22. However they continue to face bottle-necks in the form of delay in receiving regulatory approvals, delays in grid evacuation, land acquisition, transmission LTA, etc.

Figure 55: SECI Tranche wise – commissioning status



Source: SECI, MNRE, CRISIL Research

As a result, only ~1.1 GW was added in fiscal 2022 considering lockdown in most parts of the country during Q1 of fiscal 2022. Moreover, MNRE has announced two and half month extension for projects which have scheduled commissioning date on a case-to-case basis due to monsoon and supply chain disruptions. This would lead to further push back in commissioning of upcoming capacities. However, with ~69% of capacity in pipeline, capacity additions are expected to bounce back in fiscal 2023. Constraints/risks for wind power addition

With regards to this the following constraints/risks have emerged which may be a restraining factor to additions-

1. **Sustainability at low bid tariffs:**

The initial competitively bid wind auctions, which took place in fiscal 2018 and early fiscal 2019, witnessed bid tariffs of ~Rs 2.5 per unit. This had led to regulatory authorities (discoms/SECI) considering those as the

benchmark. However, prevailing market dynamics are not conducive to such realisations. Those tariffs were achievable at low capital costs of Rs 6.3-6.5 crores per MW, which had resulted from an inventory build-up with OEMs.

However, currently capital costs are ranging between Rs 7.5-8 crores per MW, which cannot be supported by tariffs as low as Rs 2.5 -2.8 per unit. While, on the other hand, counterparties were not ready to accept tariffs above a certain mark causing a pricing impasse in the sector. However, the removal of the tariff ceiling as announced by MNRE in March 2020 is a key positive in this regard. Following the same, the auctions held in fiscal 2022, have averaged Rs 2.85/unit, indicating that developers are factoring in increased tariffs to adequately manage risks. The latest auction held on May 2022 witnessed tariffs of Rs 2.93 per unit.

2. **Poor bid response and slow tendering / auctioning activity:**

The sector witnessed an initial spurt of auctions over Feb-2017 - Dec-2017 with tariffs reaching Rs. 2.44 per unit by the end of Dec 2017. Auctions saw a brief lull period post April 2018, with two tenders of NTPC 2 GW and SECI 2 GW delayed over a prolonged period due to poor bid response. These tenders were then revised to 1.2 GW of capacities post which they were allocated. The next wind auction again took place in February 2019 after a brief lull period from April 2018 - September 2018. Post this, three auctions have been held in May 2019, one in August 2019 and one in August 2020, all of which have been grossly undersubscribed. Fiscal 2022 saw allocation of ~1.7 GW with limited allocation activity in Q3 and Q4 of the fiscal. However, fiscal 2023 saw a recovery with ~1.1 GW already allocated under SECI Tranche XII. This is in contrast to the ~50-60 GW of tender and under construction pipeline in solar. The slowdown in tendering/ auctioning would extend the time period for commissioning further, hence, limiting pipeline for the sector.

3. **Concentration of projects in high wind density zones**

The top 5 states make up ~83% of the installed wind capacity (as of May 2022), with particular regions within these states accounting for most of the projects. This leads to lower wind site availability in Type I[3] wind sites or key windy regions (especially with increasing scale of project capacity), rising land costs and problems in arranging connectivity.

For instance, Tamil Nadu with the highest installed wind capacity of 9,866 MW, sees concentration of projects in districts of Tirunelveli, Nilgiris, Erode, Coimbatore and Tirupur. Similarly, for Gujarat with an installed wind base of9,348 MW, most of the projects are located in or near the Rann of Kutch region apart from coastal sites and select locations of Jamnagar, Porbandar, Morbi and Bhavnagar. Similarly, for Karnataka (5,171 MW) - Chitradurga, Bellary, Davengere and Tumkur; Rajasthan (4,496 MW) – Barmer and Jaisalmer; and for Andhra Pradesh (4,097 MW) – Ananthapuramu, Nellore and Kurnool; are the key regions where projects are concentrated.

To be sure, there would be other sites across states which would also be suitable for wind projects, however, they may be of a lower wind density (Type II and Type III wind sites), may not have adequate linked grid infra or may have a paucity of contiguous land parcels as required for the current scale of 200-300 MW of wind installations.

As a consequence, players are finding it difficult to acquire contiguous land with good quality (Type I) wind sites concomitant to adequate transmission connectivity. This has also led to poor bid response.

4. **Adequate transmission infrastructure:**

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[3] Type I wind classification sites have high wind power density at various hub heights.
Type II wind classification sites have medium wind power density at various hub heights.
Type III wind classification sites have low wind power density at various hub heights.

The rapid addition of renewable capacities requires adequate gird infrastructure so as to evacuate incremental power. This has increasingly emerged as a concern, with developers lowering participation in bids (SECI 2 GW, NTPC 2 GW) where this has been a key issue. Specifically, for wind, majority of the best wind sites are concentrated in few states such as Gujarat, Tamil Nadu, AP and Karnataka which causes increased congestion in specific regions of these states. However, nodal agencies (PGCIL, SECI) have planned various schemes to alleviate grid congestion and improve connectivity to RE projects.

The grid capacity additions will come under two main schemes, namely the Green Energy Corridor Scheme and Renewable Energy Zones (REZ), both of which are to be implemented over the medium term. This would add ~80 GW of transmission grid capacity to an existing ~24 GW, taking grid capacity planned for RE integration to ~100 GW.

The Green Energy Corridor (GEC) scheme is aimed at developing specific evacuation corridors for renewable energy in key renewable rich states. Government has planned to integrate renewable energy into the national grid by setting up inter-state and intra-state schemes for evacuation of power from wind and solar projects, termed as 'green energy corridors'. The interstate component of the scheme was completed in March 2020 while the Intra state level is facing delayed execution, which is expected to be completed by 2022. A total of 8,434 km length of transmission lines have been constructed under the intra state scheme as of November 2021 with states like Madhya Pradesh, Tamil Nadu, Andhra Pradesh & Rajasthan leading the execution. PGCIL has also come out with a scheme for setting up grid infrastructure in identified Renewable Energy Zones (REZ). Under this, key areas with concentration of existing / planned renewable energy projects have been identified in the Western and Southern regions of the country. Out of this, 8 GW of grid capacity will be added for wind projects in the Western region and 9 GW in the Southern region. These would be known as wind energy zones.

In conclusion, these schemes give comfort against the estimate of ~17-20 GW of wind to be added by fiscal 2027. However, timely execution of planned capacities is key as renewable energy projects take only 1-1.5 years to come online while transmission capacities would take roughly 2-3 years.

5. **Continued payment delays from state-owned discoms: -**

Payment delays from debt-ridden state-owned discoms continue to remain a major concern for power generators especially renewable energy. Discoms have a total overdue of Rs 210 billion by the end of June 2022, with the seven key states having majority of wind resources witnessing total dues outstanding at ~Rs 173 billion.

3.6.3.1. Drivers for wind power addition

1. **Wind solar hybrid**

Harnessing the potential of renewables in India has resulted in the co-location of wind and solar generation sites. This results round the clock generation thereby leading to higher utilization of the system. The added benefit of consistent power generation compared to standalone wind or solar generation has attracted the central public sector such as SECI to invite capacities for hybrid generations. This could lead to higher adoption of wind in the next five years compared to standalone wind.

Although the exact split of wind vs solar for hybrid projects is based on developer choice and technical design, they tend to have a higher share of solar energy, due to lower capital costs and ease of installation. The minimum required share of technology is 33% for a project to be termed as hybrid. Hence in order to maintain the cost effectiveness of the installation wind contribution is typically 33% of the rated power capacity. Similarly, round-the-clock and peak power supply project also generate substantial demand for wind capacity addition as developers require a good mix of source (solar, wind and/or energy storage) to get maximum possible efficiency.

Solar-wind hybrid tenders are estimated to result in capacity addition of 3-4 GW over the next five years with existing schemes. With fresh hybrid tenders in the industry, additions will increase gradually over the long term.

2. **MNRE's removal of tariff ceiling:**

MNRE in March 2020, notified the removal of a tariff cap from all future tenders, including wind. This bodes well for the segment especially in light of low viability of projects previously bid at tariff below Rs 2.8 per unit and the increasing execution hurdles being faced by developer. Consequently, the removal of the tariff cap would help developers price in the additional risk / cost associated to these challenges, which is also expected to improve subscription rates in the sector. As per CRISIL's analysis, this could provide a fillip of up to 2 GW over the medium term to subscription rates, though only post the impact from COVID-19 related constraints subsides.

3. **Improved technology:**

Newer wind turbines are being launched which have higher rated capacity and higher hub height (over 100 m), which can be set up at low quality wind sites, otherwise considered economically unattractive. Technological advancements have allowed players to set up windmills in states / sites with lower wind density. The higher hub height would not only increase the generation capacity of the turbine but also boost the PLF of the plant considerably. Based on our estimates for every 100-bps change in PLFs, equity IRRs improve by 100-150 bps.

4. **Large scale central allocations:**

Post competitive bidding of 1 GW by SECI in February 2017, SECI has further allocated ~12.4 GW of capacities over March 2017– June 2022. MNRE has outlined further plans to bid out ~5-6 GW of capacities each year, of which majority portion should be expected from SECI/PTC. This bodes well as central sector PPAs have lower counter party risk as compared to PPAs directly with discoms. The latter are known to delay payments to developers and have poor financial ratings while SECI/PTC are better rated and provide various payment security mechanisms (LCs, payment security fund and SECI being part to the tripartite agreement).

5. **Upward revision in RPO targets:**

The discoms are expected to revise their Non-Solar RPO targets and provide a long-term trajectory based on the new Ministry of Power guidelines, which proposes a target of 10.5% of non-solar renewable energy mix by fiscal 2022 for individual states.

Currently, most of the states in India have set lower RPO targets (Pan India avg. non-solar RPO target in fiscal 2022 was 8.4% v/s 10.5% required as per MoP) which resulted in higher compliance vis a vis the set targets. To fulfil the increased targets, states would have to procure more renewable energy either via REC route (which still leads to capacity additions) or via competitively bid out capacities, however, trading on the REC market has been restricted over the past fiscal year. Waiver of ISTS transmission charges by CERC for all projects until fiscal 2025 also provides states with low renewable potential the option to procure renewable power from states with high renewable potential. However, RPO compliance is dependent on strict enforcement by regulatory authorities. Amendment to Electricity Act, 2003 has been proposed to include stricter provisions on penalization for non-compliance, however, this is yet to be passed.

6. **Accelerated depreciation:**

Historically, particularly in 2014-15 and 2015-16, accelerated depreciation (AD) had been a key driver for capacity additions. However, going forward we expect capacity additions under this mode to be restricted only to large conglomerates in other unrelated business but seeking tax breaks. While accelerated depreciation was halved to 40 percent from April 2017 onwards, it will continue to support additions in open access capacities.

7. **High industrial tariffs:**

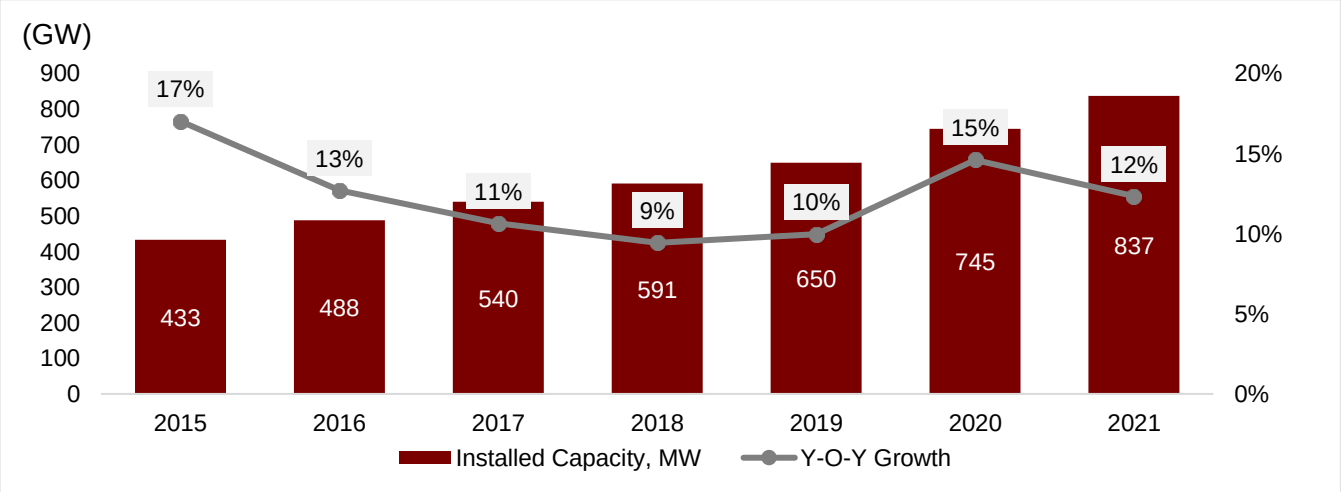
In states such as Maharashtra, Karnataka, Tamil Nadu and West Bengal where industrial tariffs are high in the range of Rs. 6-6.5 per unit, wind power is an attractive option since generation costs are about Rs. 3.0-4.0 per unit. Capacities can be set-up via the open access mode i.e. bilateral agreement directly with consumers such as commercial/industrial entities.

3.7. Global wind power market

3.7.1. Review of Global Wind energy capacity additions

Since 2016, global installed capacity for wind energy has grown at a CAGR of 11.4%, from ~488 GW in 2016 to ~837 GW in 2021. In 2020 in particular, installed capacity grew by ~15 per cent y-o-y led by China, USA, Germany, India and Spain which accounted for ~70% of the new capacity additions in a year. In terms of cumulative installations, China, US, Germany, India and Spain remain the top markets, collectively making up 75% of the total 837 GW of wind power capacity across the world. Offshore wind is playing an increasingly important role in driving global wind installations, with the sector installing a record 21.1 GW in 2021, accounting for a share of 22.9% of new installations. Countries transitioning away from Feed-in-Tariffs to market-based mechanisms and solar wind hybrid models gaining traction have driven wind capacity additions in past few years.

Figure 56: Global cumulative installed wind power capacity

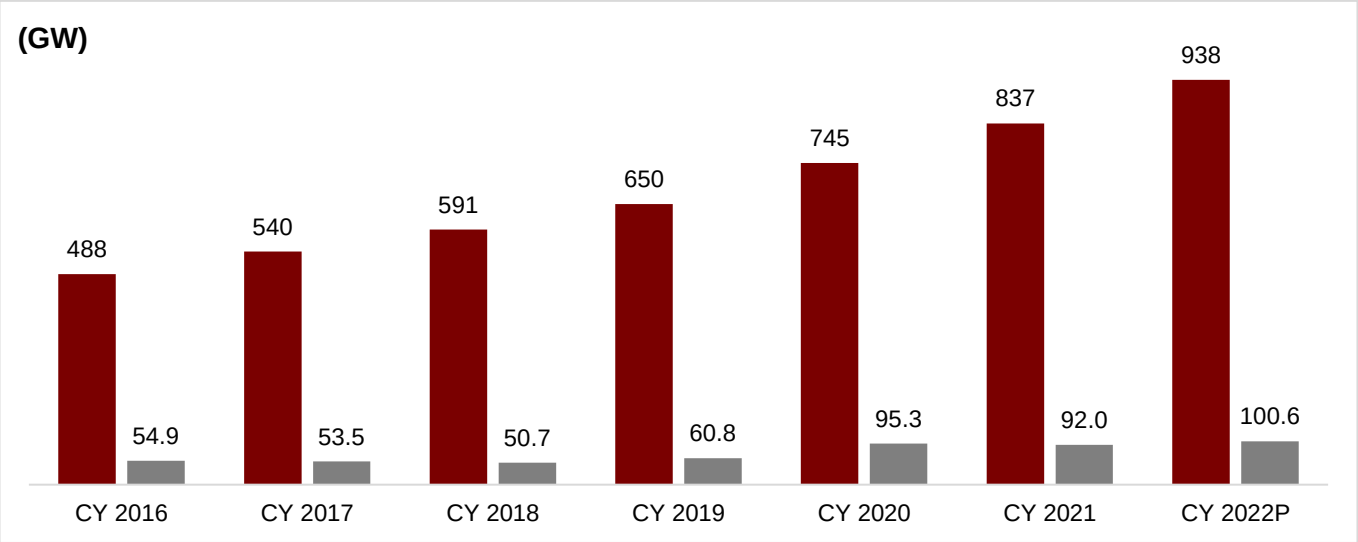


Source: Global wind energy council (GWEC), IRENA, CRISIL Research

Nearly ~92 GW of wind-based power capacities were added in 2021 (Jan-Dec), mainly led by additions made by China (47.6 GW), USA (12.7 GW), Brazil (3.8 GW), Germany (1.9 GW), India (1.4 GW) and France (1.19 GW).

3.7.2. Outlook 2022-2026: Wind energy capacity additions to be driven by China and USA

Figure 57: Growth in Global installed capacity base in Wind energy over 2016-2022 (GW)



Source: Global Wind Energy Council, CRISIL Research

Global wind energy capacity additions have seen robust growth over the 2016-2022 period. This has mainly been driven by China which has remained the market leader in terms of wind energy capacity additions. After witnessing over 3 GW of wind addition in 2020, Chinese onshore wind installations in 2021 will decline significantly due to most of the project pipelines approved before the end of 2019 have already run their course and starting from 2021 all onshore projects have to be subsidy-free. However, onshore wind installations are expected to gradually ramp up again to support China's carbon neutrality target in the coming years to reach new record levels.

According to GWEC, wind power is poised to play a vital role in accelerating the global energy transition. Coupled with growing energy security concerns triggered by Russia's invasion of Ukraine, the mid-term outlook for wind energy is positive. GWEC Market Intelligence expects that 557 GW of new capacity at an CAGR of 6.6% will be added in the next five years – that equates to more than 110 GW of new installations each year until 2026. The CAGR for onshore wind in the next five years is 6.1%, with average annual installations of 93.3 GW. In total, 466 GW is likely to be built in 2022-2026. The CAGR for offshore wind in the next five year is 8.3%. The annual global offshore market is expected to grow from 21.1 GW in 2021 to 31.4 GW in 2026 under current policies, bringing its share of global new installations from today's 22.5% to 24.4% by 2026. In total, more than 90 GW of offshore capacity is expected to be added worldwide from 2022-2026.

3.7.2.1. Onshore and Offshore wind capacity

China led the onshore and offshore wind capacity addition for the year 2021 with 30,670 MW of onshore and 16,900 MW of offshore capacity addition. With this the total installed wind capacity for the country stood at 338,309 MW making it a global leader in overall capacity installed for wind.

Table 12: Wind capacity additions in 2021

Country	MW (Onshore)	MW (Offshore)	Total addition (MW)	% share
China	30,670	16,900	47,570	51%
USA	12,747		12,747	14%
Brazil	3,830		3,830	4%
Sweden	2,104		2,104	2%
Germany	1,431		1,431	2%
India	1,459		1,459	2%
France	1,192		1,192	1%
UK	328	2,317	2,645	3%
Canada	677		677	1%
Others	18,061	1,889	19,950	21%

Source: Global Wind Energy Council, CRISIL Research

3.8. Wind-Solar Hybrid

Wind-solar hybrid (WSH) is fast becoming the preferred renewable energy (RE) option in India. Although the Ministry for New and Renewable Energy (MNRE) has not yet set a generation target for the nascent sector, WSH has received strong support from the central public sector undertaking Solar Energy Corporation of India (SECI) and several state governments.

There are two types of WSH projects – pure-play ones and those with storage. There are also projects that may come up under the government's round-the-clock (RTC) power scheme, which has a mandatory 51:49 blend of RE and thermal.

3.8.1. Constraints in setting up hybrid power plants market in India

- Lack of good sites to set up WSH project

Wind-solar hybrid projects require wind and solar plants to be co-located to inject power into the same pooling station. This means the ideal location should have good irradiation and also experience high wind speeds. But such locations are hard to find, especially as all major windy areas with strong grid evacuation facilities have been saturated. Hence, the industry has demanded that wind and solar plants of a WSH project be allowed to operate from different locations. This will also help bring down tariffs owing to better plant utilisation levels. The only advantage of co-locating is better utilisation of transmission infrastructure. However, CRISIL Research believes the advantage from reduced tariff (when wind and solar units are located separately) is much higher than the benefit of improved transmission capacity utilisation (with co-location).

- Grid balancing requirement poses implementation risks

Developers are required to balance the grid before injecting electricity generated from a co-located WSH plant. This means they need to simulate the ideal wind and solar generation mix from the plant, in order to optimise the hybrid curve. This may lead to additional implementation risks for a developer.

- Higher tariff

The average tariff for WSH projects is Rs 2.6-2.9 per kWh today – higher than solar tariff, which has dropped to Rs 2.5 per kWh in recent bids, and comparable to wind tariff, which has remained sticky at Rs 2.80-2.85 per kWh. And although cross-subsidising costly wind power with low-cost solar will provide some price cushion at the lower end, the pricing needs to be attractive to make WSH competitive.

3.9. Global wind solar hybrid market

Hybrid power generation showcases great opportunities for the electrical grid systems. It helps the achieving the higher efficiency with the help of coupling various renewable generation sources such as wind-solar hybrid, wind-solar-storage hybrid or wind-storage hybrid. Many manufacturers and developers are therefore pursuing hybrid capacity addition actively.

3.9.1. Capacity addition snapshot

Countries such as US, India, Australia, China, and Germany are key countries having hybrid capacity addition. Apart from these other countries are also planning to introduce hybrid renewable generation capacity to boost the implementation of clean energy generation.

- **US**

In US, there were at least 226 co-located hybrid plants more than 1 MW operating across the United States at the end of 2020, totalling more than 30 GW of aggregate capacity.

Table 13: Hybrid capacity installed in US till CY 2020

Installed at end of 2020	# projects	Gen 1* (MW)	Gen 2* (MW)	Gen 3* (MW)	Storage capacity (MW)	Storage energy (MWh)
PV + Storage	73	992	0	0	250	658
Wind + Storage	14	1,425	0	0	198	122
Wind + PV	7	586	267	0	0	0
Wind + PV + Storage	2	218	21	0	34	15

Sources: EIA 860 2020 Early Release

By the end of year 2020 13 GW of wind-hybrid capacity and 159 GW of solar-hybrid capacity was reported in pipeline in US.

- **Australia**

In Australia, the Australian Renewable Energy Agency (ARENA) has funded hybrid projects worth USD 111 million. Hybrid generation projects consisting of battery energy storage had 270 MW of installed capacity by the end of 2020. This included 7 projects as reported by Clean Energy Council. In addition to this, 15 GW of wind/solar hybrid capacity is expected in Western Australia by 2027, while 1,425 MW of new energy storage capacity is under construction.

- **India**

India has introduced round-the-clock (RTC) generation tenders including hybrid tenders to strengthen clean generation combining solar, wind and storage technologies. The Ministry of New and Renewable Energy (MNRE) adopted the National Wind-Solar Hybrid Policy on 14 May 2018. The objective of the policy is to provide a framework for the promotion of large grid-connected wind-solar PV hybrid system for efficient utilization of transmission infrastructure and land. It also aims at reducing the variability in renewable power generation and achieving better grid stability. It is expected that India will witness more than 15 GW of wind solar hybrid capacity in the next five years.

- **China**

China has also initiated construction of renewable plus projects to develop centralized renewable power complexes that are bundled with various energy storage solutions. National Development & Reform Commission (NDRC) and National Energy Administration have issued the guidelines on Wind-Solar-Hydro-Thermal Integration and Generation-Grid-Load-Storage Integration Development that led to the increased interest in the renewable plus projects in the country. The projects include gigawatt size hybrid projects having either battery, hydrogen or gas units coupled with PV or wind generation.

The hybrid projects are typically located at the wind-rich northern provinces such as Inner Mongolia, Hebei, and Xinjiang. However, some emerging production regions like Yunnan and Guangxi also entered the development stage. This is because most of the developers prefer wind as the basis of the hybrid plants while also trying to address the looming fear of renewable curtailment as witness in the past.

4. Operation and Maintenance services for Wind Energy and other renewable

4.1. Evolution of O&M services in India

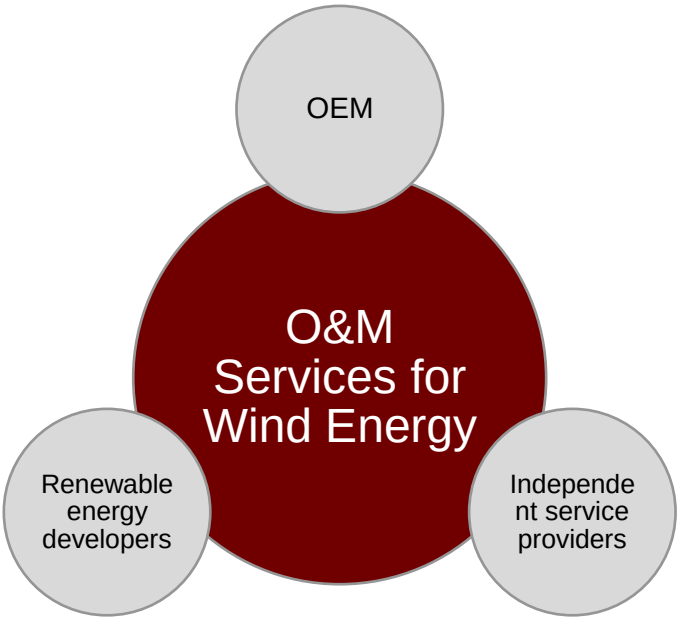
Operations and maintenance cost form a critical component in the Levelized Cost of Electricity (LCOE) of wind energy. Therefore, renewable power producers adopt various strategies to lower this cost and improve the reliability of the services. In order to make the LCOE competitive with other producers and technologies. Typically, the O&M cost account for 20-25% of the LCOE involving 5 categories, namely, Insurance, regular maintenance, repair, spare parts, and administration. These costs generally rise with the years of operation however, with more experience various approaches have been formulated that generators follow to keep a check on the O&M costs.

The industry started with reactive maintenance mostly resulting in downtime and major service or overhaul. The major reason behind this was late detection of the fault or part failure. The cost of service due to this late detection increases compared to early detection and repair. Moreover, with increase in the life of the generation plant the cost of major repairs escalates. Currently, the O&M service providers offer solutions to minimise the major repairs and replacements while moving towards predictive maintenance. As a result of this, the cost of maintenance has decreased by more than 50% for onshore wind and by more than 50% for offshore wind generators in the past 10 years, as reported by IRENA.

Key components of wind turbine that require service includes

- Hydraulic Pitch
- Transformer
- Generators
- Gearbox
- Blades
- Grease oil and Lubricating Oil
- Electrical components
- Contactor/ Circuit Breaker/Relay
- Controls
- Safety
- Sensors
- Pumps/Motors
- Hub
- Heaters/ Coolers
- Yaw System
- Foundation/Tower/Mast
- Power Supply/Converter
- Services

4.2. Value chain for O&M services for wind energy



There are three channels to obtain the operation and maintenance for wind energy generators

1. **Original Equipment manufacturers:** Operation and maintenance services are usually acquired along with the components of the wind turbine generation (WTG) unit. These services are acquired for a time of 2 to 5 years as a part of annual maintenance packages. The key providers of these services are the Original Equipment Manufacturers (OEM), which include guarantees and preventive and corrective maintenance that could be adopted after the expiry of the contract period. These are preferred globally due to ease of procuring spare parts or replacement equipment from OEMs compared to other O&M service providers.
2. **Renewable Energy Developers:** Large renewable energy developers have also started to maintain their own capacity instead of traditionally OEM based O&M contracts. Currently, there is limited capacity from some of the key renewable energy developers being maintained in house. The major reason for this is to increase the control over the operations of the generation and further reduce the dependence on the OEMs. This also reduces the risk of extended periods of shutdowns resulting in no drop in availability of the plant. Moreover, due to financial hurdles for OEMs, Independent Power Producers (IPPs) have opted to carry out O&M activities in-house to avoid dependence on the any other entity
3. **Third-party or Independent Service Providers:** O&M services are also offered by third-party service providers. This is usually taken at the time of warranty expiration the Annual Maintenance Contracts (AMC) with the OEM or when the OEMs are not preferred with the equipment acquisition due to financial constraints.

4.3. Key technological advancements/innovation and trends in O&M services

4.3.1. Predictive maintenance vs reactive maintenance:

Major components such as nacelle, turbine, generator, hydraulics, and electronics require constant monitoring to ensure smooth operability. Traditionally reactive maintenance was carried out when the equipment has shown severe operational faults or complete failure or during scheduled maintenances. The failure or reactive maintenance resulted in longer shutdowns and low availability of the generators.

On the contrary, predictive maintenance accurately forecasts the component failures before they occur based on historical data. This is a critical service in wind generation as it addresses the issues associated with reactive maintenance as described above. Furthermore, the proactive maintenance reduces the operational cost by reducing the wear and tear of the equipment in the system. As a result of implementation of predictive maintenance techniques replacements and major repairs in the wind energy have declined considerably over the past years. Therefore, more and more developers are going for predictive maintenance as compared to reactive and scheduled maintenance.

The disadvantage of solely relying on historical data is that some of the assets will be flagged for maintenance despite being functionally sound and performing well. This drives the maintenance cost of the assets in good operational conditions. Hence it needs another layer of technological intervention that segregates, analyses and prioritize the activities. Thus minimize the unwanted spends on maintenance of asset that are in healthy conditions. AI and IoT enablement can solve this purpose and lead to cost savings especially in the case of power plants having assets spread across large area. For instance, in large solar parks predictive maintenance using AI can lead significant saving of inspection and maintenance planning of the assets. Moreover, it also aids capacity planning and addition over the years. In case of distribution networks, precision mapping of the assets leads to proper identification and location of the assets in the network for maintenance and addition of the consumers.

4.3.2. Condition monitoring

A key element of predictive maintenance suite, condition monitoring is used to monitor the health of the turbine and related electrical systems. Its purpose is to predict maintenance issues so site operators can conduct repairs and replacements only when needed to avoid unnecessary and costly up-tower jobs. Although the intent is to cut time and cost from O&M tasks, condition monitoring system have become rather detailed in accumulating and analyzing data and hence can become expensive. The system can supply the failure rate of the turbine and related equipment for upto 20 years along with simulations to predict the future failures thereby reducing the cost of energy considerably by avoiding major replacements.

4.3.3. Impact of technology implementation on O&M services

Technology driven solutions are constantly evolving and are being deployed across the sector. For instance, the implementation of AI-based predictive analytics solutions can help analyze real-time operational data at scale, identify any underperformance, and recognize failures using machine learning. The most advanced implementation of technology across wind energy includes digital twin. Digital twin is a virtual representation of the actual asset for remote interaction by the trained professional. Digital twin minimises the need of human team diagnosing the faults, instead engineers can analyze and identify problems remotely. Thus, saving the efforts of personnel to specific instances. Applications such as demand response management, hybrid energy storage systems, vehicle-to-grid, virtual power plant etc are being tested across the clean energy sector involving implementation of new

technologies. Machine learning (ML) and artificial intelligence (AI) can also be applied to recognize patterns, predict faults and highlight important variables that could otherwise be missed.

4.3.4. Challenges

- **Overdependence on OEMs**

In India the O&M service space is dominated by the OEM players resulting in delays in accessing valuable data. This, along with spare parts unavailability, impacts power generation and revenues for plant owners. Some of the players have also seen a few cases of bankruptcy in the past on the OEM side. Thus, the industry is leaning towards adoption of technologies to de-risk the operations. Further, the availability of spare parts is very specific to OEMs. There is also the issue of forecasting and scheduling resulting the additional deviation settlement charges to be borne by the generator only in case of unavailability of the system

Moreover, countries ahead in wind energy race such as US have a very buoyant service market with a lot of independent service providers providing alternative services to OEMs. This results in reduction of dependence on OEM and raises the competition among the service providers. gives greater visibility, saves resources and improves the accuracy of prediction. Therefore, for third-party service providers (ISP) and Renewable Energy Developers (RED) the cost of O&M services are expected to remain high until they reach economies of scale and better/efficient spare part availability.

- **Slower adoption of new-age technologies**

The adoption of technologies such as Artificial Intelligence (AI) and Machine Learning (ML) is comparatively slower which restraints the sector from reaping the benefits of the innovations. The implementation of these technologies is likely to scale up in the coming years with increased participation from the Independent Service Providers (ISP) along with the major developers entering the O&M space rather than just limiting to performance monitoring of machines. The standard practices among the wind capacities in the country such as SCADA is not as advanced as AI and ML and hence requires upgradation to minimise the risk exposure pertaining to equipment failure.

4.4. Review of O&M services market for wind energy in India (fiscal 2016-2022)

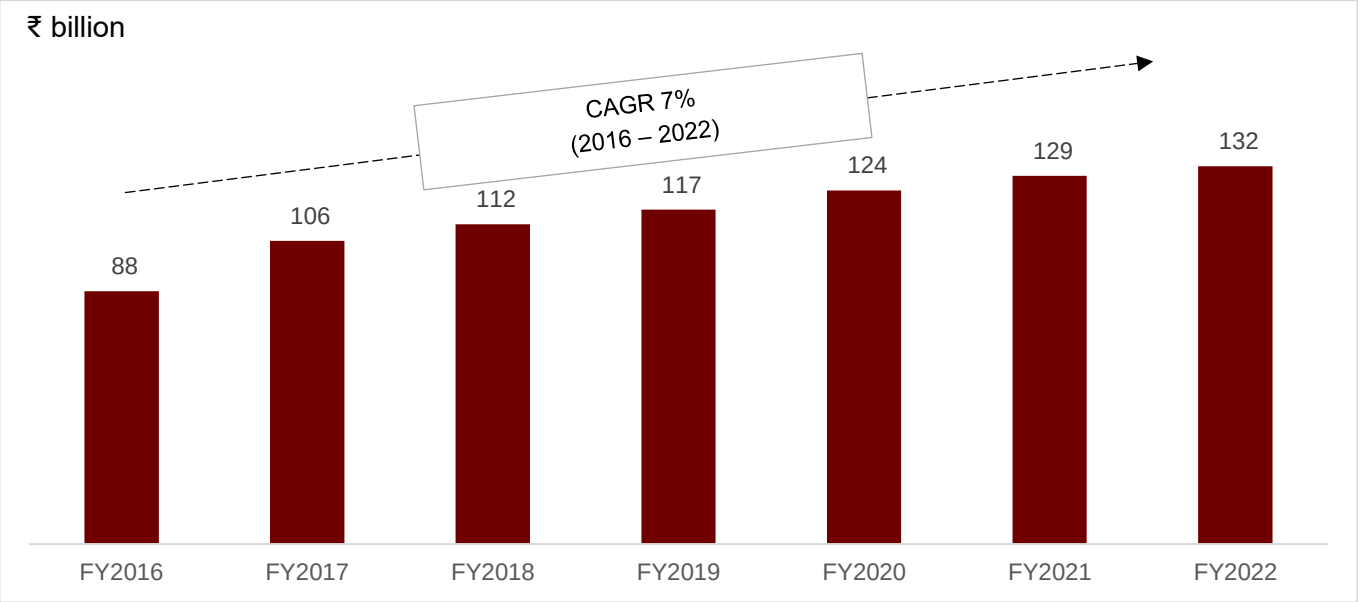
O&M services for wind energy is dominated by the equipment manufacturers in the country. A typical wind turbine O&M cost ranges from ₹2,500-3,500/kW of capacity. The type of services offered as a part of O&M contracts include:

- Supply of equipment
  - Large equipment supply
  - Sundry or small equipment supply
  - Consumables
- Repair services
  - Regular repair and maintenance
  - Major repair or overhaul
  - Equipment replacement

The wind energy market grew at a healthy rate with capacity additions picking up pace in fiscal 2020 after low in 2019 on account of FiT regime change. This has also positively impacted the demand of O&M services which grew from ₹ 84 billion in 2016 to more than ₹ 130 billion in 2022. Capacity additions declined in fiscal 2021 due to

COVID-19 pandemic led lockdowns and mobility restrictions. However, this might have positively impacted the remote monitoring capabilities and technological implementation across the wind energy sector.

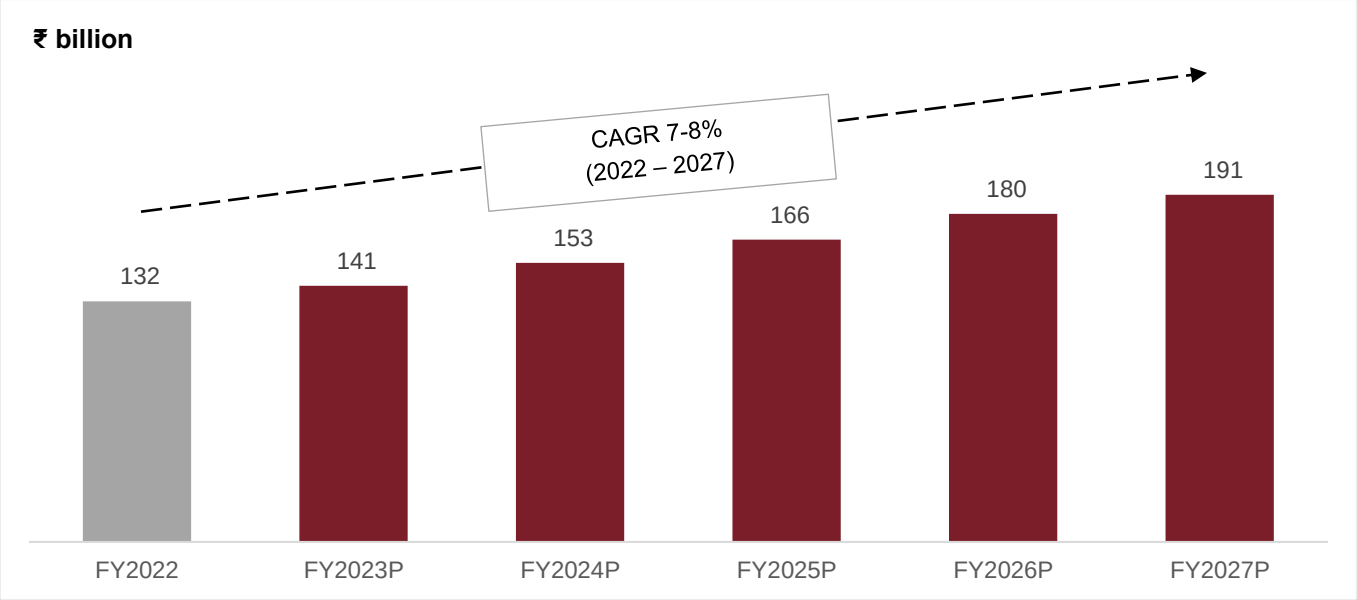
Figure 58: O&M services demand across wind energy, fiscal 2016 to 2022



Source: Industry Publications, CRISIL Research

4.5. Outlook on potential of O&M services market for wind energy in India (fiscal 2022-2026)

Figure 59: O&M services demand forecast across wind energy, fiscal 2021 to 2026



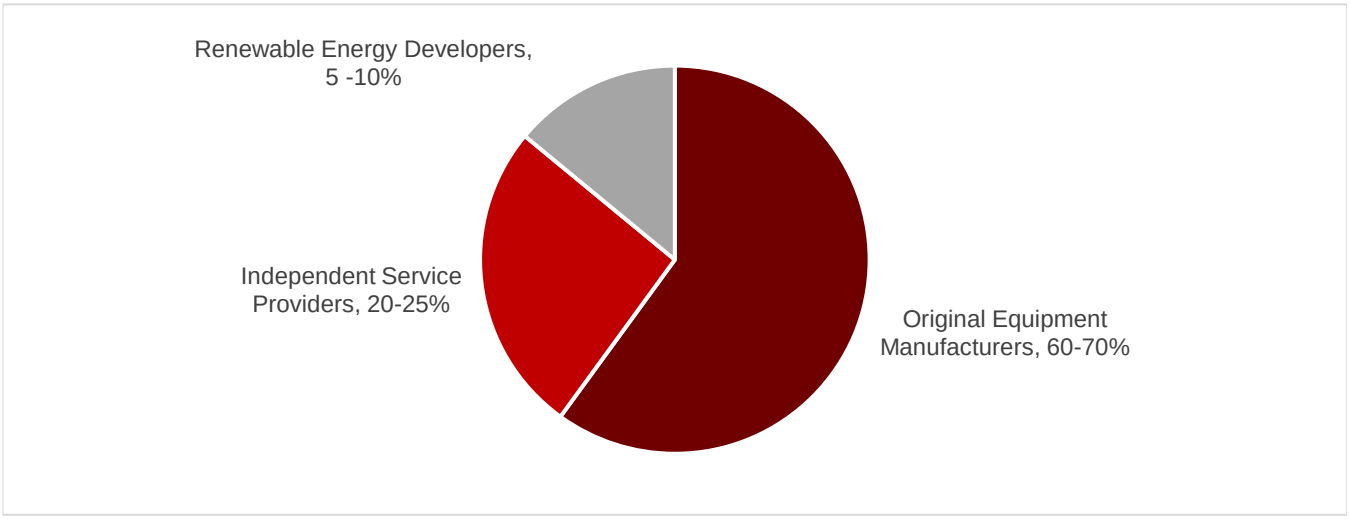
Source: Industry Publications, CRISIL Research

CRISIL Research expects the wind capacity addition to be in the range of 17-20 GW during the forecast period thereby taking the total installed capacity over 50 GW. The growth is likely to be on account of hybrid capacity allocation along with existing pipeline of 10-11 GW for pureplay wind. As a result of this, the demand for O&M services is expected to be in the range of ₹170-210 billion by fiscal 2026.

4.6. Key competitors and comparison of service offerings

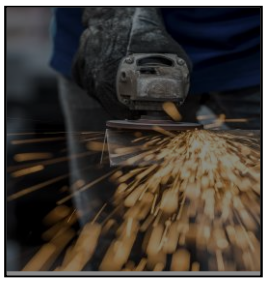
The O&M service offered by the OEM dominated the market with up to 70% of market share. Independent service providers and renewable energy developers contributed to 20-25% and 5-10% respectively in fiscal 2021

Figure 60: Market share of O&M service providers, 2021



Source: CRISIL Research

Figure 61: Advantages of O&M Service Providers

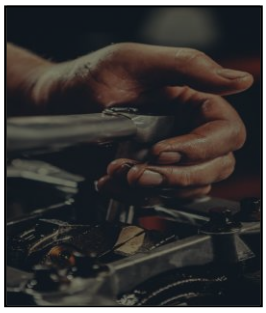


Original Equipment Manufactures (OEM)

- Better availability of spare parts for replacement or upgrade due access to technological advancements and large pool of surplus equipment
- Availability of authorized trained professionals
- Easy warranty claims and extended cover

Renewable Energy Developers (RED)

- Reduced cost of maintenance
- No drop in performance or availability
- Reduced third party risk with dependence on OEM/ISP



Independent Service Providers (ISP)

- Lowered dependence on OEM or building in-house expertise
- Can offer diversified package compared to OEM, however, this can result in increasing the cost of OEM in the country due to limited availability of technology and spare parts with ISPs

Source: CRISIL Research

4.6.1. Equipment provider offering bundled O&M solution

Original equipment manufacturers hold the largest share of wind O&M services in India. Most of the operators or turbine owners prefer OEMs pre and post warranty. This is because OEM have advantage of better spare part availability which is crucial to maintain high generator availability. In addition to this some of the OEM offer upgrades along with equipment acquisition or O&M service contracts. These bundled offerings are what separates the OEM from third party or independent service providers. The bundles offerings are beneficial in case of equipment failure resulting in timely rectification of the faults and easy availability of spares.

On the other hand, the service cost from the OEM sometimes increases the overall operating cost of the generation plant and thereby resulting in higher LCOE. Therefore, RE developers / equipment owners might shift to third party service post warranty to save O&M costs or reduce the dependency on OEMs. However, this shift can result in increasing the cost of O&M due to lack of long-term supply tie ups.

OEMs can target the capacity available from the inactive OEMs. As reported in Directory of wind power in India (2021) more than 14,000 turbines were supplied by the OEM that are out of operations.

4.6.2. O&M service providers

Third-party service providers offer independent service contracts to the wind asset owners and can result in reduction in the fixed O&M services cost. India has seen increase in the independent service providers with multiple instances of OEM filing for bankruptcy. This has resulted in revisions in the O&M strategies of the wind asset owners and shifting the focus towards the ISPs or in-house maintenance by the owners themselves.

Some of the ISPs associate themselves with multiple OEMs to leverage the confidence that the operator/asset owner has built with the OEMs. Traditionally OEMs have been a key stakeholder in the O&M strategies of the asset owners, however, ISP are offer a single point of contact for all the O&M needs thereby eliminating the need to contact various OEMs for each equipment. This will eventually lead to reducing turnaround time and downtime eventually making the O&M more manageable.

Some of the key ISPs and their service offering are described below:

Independent Service Providers	Services Offered
Renom Energy Services LLP	• Remote monitoring and controlling of assets • In-house electronic repair station for electronic components • Asset digitalization and optimization • Spare breakdown maintenance • Technical support and security deployment at the site
SKF Limited	• Performance based monitoring • Condition based monitoring • Spare part management and remanufacturing service • Lubricants and tools for maintenance
Windcare India Pvt. Ltd.	• Equipment replacement – erection or re-erection services • Spare availability • Planned and unplanned service and maintenance
Kintech .	• Performance optimization • Component inspection and replacement • Spare availability and service • Substation operation and maintenance services

Source: Company Website, CRISIL Research

4.6.3. View on technology sourcing by WTG and OEM players operating in India

Most of the WTG and OEM players offering solution in India are global giants having consistent offering across the geographies. The technologies are developed at their global R&D centres and then supplied across the globe. On the other hand, the smaller players having low market penetration develop the equipment based on their experience or by having international tie up. These tie ups are either to utilize the technology and manufacture equipment at domestic locations or to import the manufactured equipment and assemble it with the system in India.

4.7. Opportunities for wind energy O&M service providers in:

4.7.1. Wind-solar hybrid segment

New opportunities have emerged in the wind sector in India with SECI coming up with newer kind of project tenders in the form of hybrid, round-the-clock, and peak power supply projects. Although the exact split of wind vs solar for hybrid projects is based on developer choice and technical design, they tend to have a higher share of solar energy, due to lower capital costs and ease of installation. The minimum required share of technology is 33% for a project to be termed as hybrid. Hence in order to maintain the cost effectiveness of the installation wind contribution is typically 33% of the rated power capacity. Similarly, round-the-clock and peak power supply project also generate substantial demand for wind capacity addition as developers require a good mix of source (solar, wind and/or energy storage) to get maximum possible efficiency.

So far SECI has auctioned 3600 MW hybrid tenders, under ISTS tranche I, II, and III of which ~2800 MW was allocated. Similarly, 1200 MW peak power supply and 400 MW of RTC tender has been allocated with 2500 MW RTC tender in pipeline. As per industry interaction, these new tenders combined are expected to add 1.0-1.5 GW wind capacity. Thus offering new areas for O&M service providers to utilize their existing capabilities for maintaining larger and hybrid capacity.

4.7.2. Aging capacity

Wind turbines are expected to lose 1-1.5% of their output per year thereby requiring consistence optimization, service and upgrades. In India, Tamil Nadu is having the oldest wind energy capacity which require repowering of turbines. Repowering refers to replacement of old high number of smaller turbines with newer high-capacity large turbines. This increases the efficiency of the system and further reduces the generation losses. The aged fleet also boosts the need of condition-based monitoring pre and post repowering. There is already a policy in place for repowering of turbines by Mistry of New and Renewable Energy. Moreover, compared to a new project, repowering would cost less, since existing land and infrastructure are being used. It also reduces risk associated with worn out assets. Thus aged assets and repowering poses a great opportunity for O&M services.

Till fiscal 2002, wind generation accounted for 1,666.8 MW of installed capacity, with Tamil Nadu having more than 50% of this capacity. This capacity had an average service life of 15 years and sizes well below 1 MW. These turbines if replaced with modern day turbines one could easily derive 30% CUF & upwards from the current 10-14% CUF. Furthermore, the capacity addition post 2002, involved low-capacity turbine below 1 MW which are or can become eligible for repowering increasing the overall opportunity of repowering of turbines. States like Gujarat, Andhra, Karnataka, and Tamil Nadu have come up (or is under advisement) with policy for repowering of wind turbines. However, Repowering policies do not address key concerns such as model, mandatory repowering and incentivisation. Therefore the repowering scheme has seen have seen low traction/activity till date.

Moreover, the capacity or turbines supplied by the inactive OEM players accounted for more than 9 GW or 14,633 turbines. These accounted for 41% of the cumulative capacity by the end of fiscal 2021 thereby posing as an opportunity for the O&M service providers in the country.

4.7.3. Solar segment

Wind O&M service providers utilise various techniques for continuous monitoring of the assets. These techniques or technologies can be implemented on other renewable generation assets such as solar or battery systems. In case of hybrid or round the clock systems the monitoring, diagnostics, etc service can be employed. While the

services relating to hydraulics or mechanical parts can be implemented if required. Furthermore, technological driven basic solutions for forecasting and scheduling involving the implementation of AI and ML are common to various sources of generation in the renewable energy space. Hence, wind O&M service providers can enter into solar segment with the help of hybrid capacities and further develop specific service suite for it. Along with this large OEM offering O&M services for wind can utilize their presence and supply chains to target solar capacities as well.

5. Global O&M services for wind energy

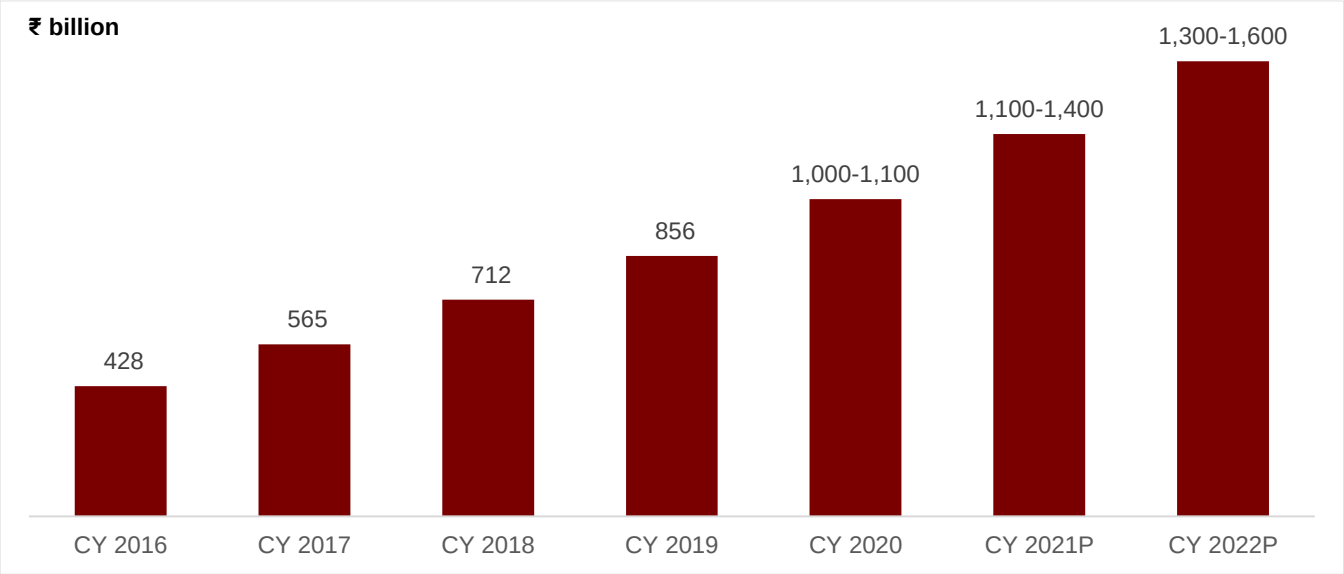
5.1. Global demand for O&M service for renewable energy

5.1.1. Sector-wise demand for O&M services

5.1.1.1. Solar

The typical O&M cost of a ground mounted solar PV ranges between ₹1,500 to ₹2500/kW depending on the size of the system. This cost declines with the increase in the capacity of the system due to increase in the module size, lower service packages for bulk capacities. It includes the regular maintenance cost (covering preventive, predictive and scheduled activities) and unplanned maintenance cost (covering major repairs and replacements). The key activities under these maintenances are cleaning, emergency response, inspection, management, preventive maintenance, testing, and repair/corrective maintenance.

Figure 62: Solar PV O&M service demand, 2016-2022



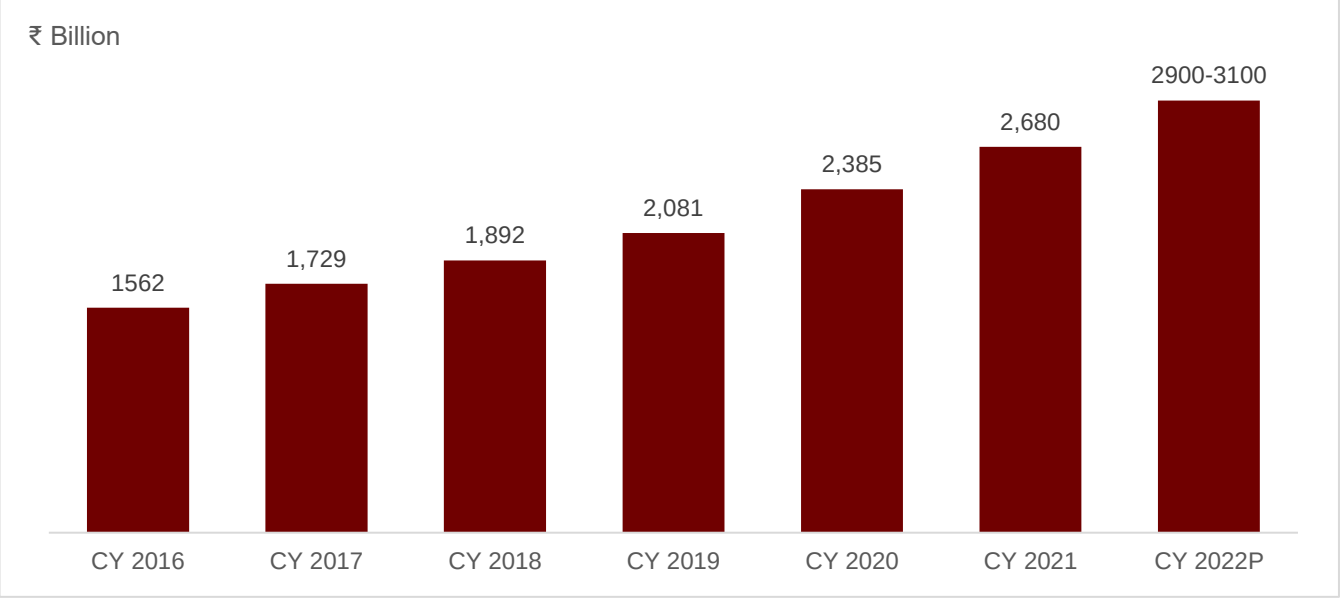
Source: IRENA, National Renewable Energy Laboratory, CRISIL Research

With the global solar PV installed capacity reaching 1,068 GW expected till 2022, CRISIL Research expects the demand for O&M services to reach ₹1,300 – 1,600 billion from an estimated demand of ₹1,100-1,400 billion in the year 2021.

5.1.1.2. Wind

Wind energy generation is likely to reach 938 GW of the installed capacity by the year 2022 globally. Wind generation O&M service demand is likely to follow the same trend to reach ₹2,900-3,100 billion by 2022. Compared to solar PV the maintenance cost of the wind generators is higher due to continuous wear and tear of the movable parts resulting in higher replacement of equipment.

Figure 63: Wind O&M service demand, 2016-2022



Source: Global Wind Energy Council, National Renewable Energy Laboratory, CRISIL Research

5.1.2. Key players & business model adopted: Global vs India

Global O&M service market for renewable consists of independent service providers (ISPs) offering similar services as Original Equipment Manufacturer (OEMs). Easy availability of spare and availability of trained professional has resulted in increasing the ISPs contribution in the service market. Furthermore, OEMs operating the global market offer package deals along with the equipment acquisition. These package offerings include discounted upgrades for equipment covered under the scheme, warranty for the system, and easy availability of replacements.

ISPs usually perform affiliated services and third-party services. Affiliated services are performed with authorization from the OEM resulting in leveraging the supply channels and customers of the OEM, while third party services are performed on assets regardless of brand of OEM. Affiliated services are performed pre and post warranty period; third party services are usually availed after warranty period.

On the contrary, in India OEMs dominate the O&M service market due to tack of the above-mentioned factors and limited number of ISPs present in the market. Moreover, due to the control over the infrastructure, OEM have an upper hand in the market and are likely to remain in the same position in the coming years

Some of the key OEMs offering services in the global market are listed below along with their offerings

Original Equipment Manufacturers	Service Offerings
GE	• Operation Solutions • Monitoring Services • Unplanned Maintenance • Planned Maintenance

Original Equipment Manufacturers	Service Offerings
Siemens Gamesa Renewable Energy, S.A.	• Regular Maintenance • Equipment Upgrades • Diagnostics and Monitoring • Logistics of equipment and spares with high availability Maintaining >33000 turbines worldwide along with multi-brand service capability
Vestas	• Planned and unplanned maintenance services including output management • Repair and replacement service with multi-brand support • Component level inspection and service • Online spare availability across various locations • Fleet optimization and upgrade services Maintaining more than 50000 turbines worldwide
Enercon GMBH	• Installation, maintenance and servicing of ENERCON wind turbines, • Remote monitoring of the turbines, • Maintaining the technical availability as well as • Implementation of service contracts and customer support for all technical and commercial issues

Source: Company website, CRISIL Research

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It is India's foremost provider of ratings, data, research, analytics and solutions, with a strong track record of growth, culture of innovation and global footprint.

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