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India's Renewable Energy Journey: Short-Term Hiccups but Long-Term Trajectory Intact

Analysing the Clean Energy Commitments in India and Comparison with Global Peers

Executive Summary

We believe the long-term trajectory for renewable energy in India is still intact, even though recent global events have pushed policymakers to expand the use of domestic thermal energy. IEEFA and CEF forecast that India will add 35-40GW renewable energy capacity annually through to fiscal year (FY) 2029/30, reaching 405GW. We also forecast that thermal power will progressively lose market share and its generation share will fall to just 53.4% in FY2029/30 from 72.3% in FY2021/22. The ambitious capacity addition targets of the Indian government and commitments by both private and state-owned companies across industries support our projections. Our study of similar clean energy commitments by global majors – NextEra Energy (U.S.), RWE (Germany), Ørsted (Denmark) and Enel (Italy) – offers important learnings for Indian counterparts. We find that the ambitious decarbonisation targets of the four global companies, which do not rely on carbon offsets or carbon capture and storage, have helped their share prices outperform broader equity markets and helped the companies tap a rapidly growing global green bond market.

India has been one of the champions globally in adopting renewable energy as part of its energy transition. Installed renewable energy capacity (including large hydro) rose from a few megawatts (MW) in 2010 to ~163 gigawatts (GW) as of August 2022. India's ambitious renewable energy targets and the associated policy and reform framework have been an important tailwind for the sector's development. Additionally, the transition has also resulted in shunning coal power capacity, with additions hitting rock bottom in FY2021/22. More than 606GW of coal-fired power projects have been cancelled or shelved, and 15.6GW retired in India during the 2010-2022 period.[1]

That said, there have been several headwinds faced by the renewable energy sector lately, along with rapidly rising power demand from across the country. These factors have led to the government taking a re-look at thermal power as a fix against any power crunch in the foreseeable future. NTPC, the country's largest power producer, announced diversifying away from coal in October 2020 but recently awarded its first new coal-fired plant in about six years to meet the country's surging demand for electricity.

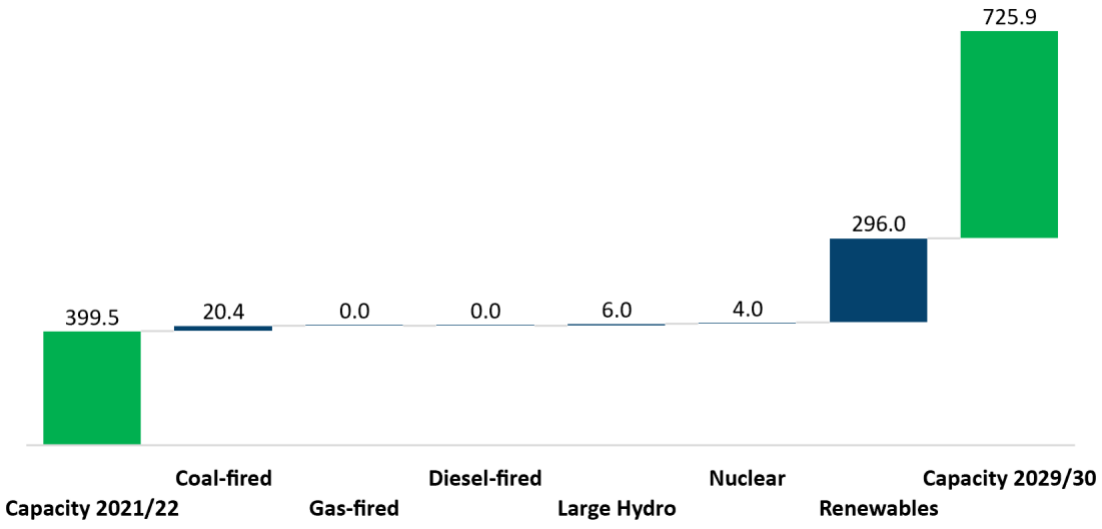
[1] Global Energy Monitor. Global Coal Plant Tracker. July 2022.

Besides having the potential to derail India's energy transition journey, a higher reliance on coal-fired power also exposes the country to the vagaries of global energy markets. Due to a shortage of domestic coal, the country has accelerated its import of the commodity. However, the Russia-Ukraine war has led to imported prices skyrocketing tenfold in the last two years, making use of imported coal expensive and widening India's current account deficit. This high coal price has also fuelled inflation in the country, with the Wholesale Price Index (WPI) crossing double digits (15%) in May/June 2022.

IEEFA and CEF believe that even though there is some renewed momentum building on expanding the use of domestic thermal energy, the long-term trajectory for renewable energy is still intact. IEEFA and CEF forecast India's renewable energy capacity to grow rapidly with 35-40GW of new capacity additions annually through to FY2029/30, reaching 405GW. Due to the competition from variable renewable energy sources, hyperinflation in fossil fuel commodity prices and increased global capital pledges under the US$130 trillion Glasgow Finance Alliance for Net Zero (GFANZ) to align investments with a 1.5°C limit to global warming, we forecast that thermal power will progressively lose market share, with its generation share falling from 72.3% in FY2021/22 to just 53.4% in FY2029/30.

IEEFA and CEF forecast India's renewable energy capacity to grow rapidly with 35-40GW of new capacity additions annually through to FY2029/30, reaching 405GW.

Figure 1: India's Electricity Capacity Addition Forecast Until 2030 (in GW)



Source: CEA, CEF Calculations

Our projections are supported by the ambitious capacity addition targets of the Indian government and commitments by a slew of players, both state and non-state, operating across industries, such as power and oil & gas, to steel and cement through the utility and distributed renewable energy segments.

In the utility-scale segment, the combined additional capacity targets through to 2030 by some of the top players operating in the industry stand at ~231GW. This includes commitments by state-owned NTPC at 60GW, Adani Green Energy at 45GW and Tata Power, ReNew Power and Acme Solar at 25GW each. While these targets seem aggressive, the Indian government seems unbending in ensuring its targets are met through facilitating growth across the renewable energy spectrum. Financially strong investors, such as the Indian government, domestic conglomerates and some of the biggest global investors, back most industry players, lending them the financial firepower needed to fulfil their capacity addition targets.

On the decentralised renewable energy side, several segments have the potential to grow multifold as policy-side reforms streamline current bottlenecks and demand-side drivers provide lucrative returns. Even though the country has been a laggard in rooftop solar, state-level reforms, corporate decarbonisation, and net-zero pledges from commercial and industrial (C&I) customers will accelerate this segment exponentially. Similarly, solar pumps have a target of 30.8GW under the KUSUM scheme. But, the scheme has not made much headway to date due to several bottlenecks. With more than 20 million grid-connected agricultural pumps in India, consuming over 17% of the nation's total electricity, the opportunity for solar pumps is enormous.

Our projections are supported by the ambitious capacity addition targets of the Indian government and commitments by a slew of players, both state and non-state, operating across industries.

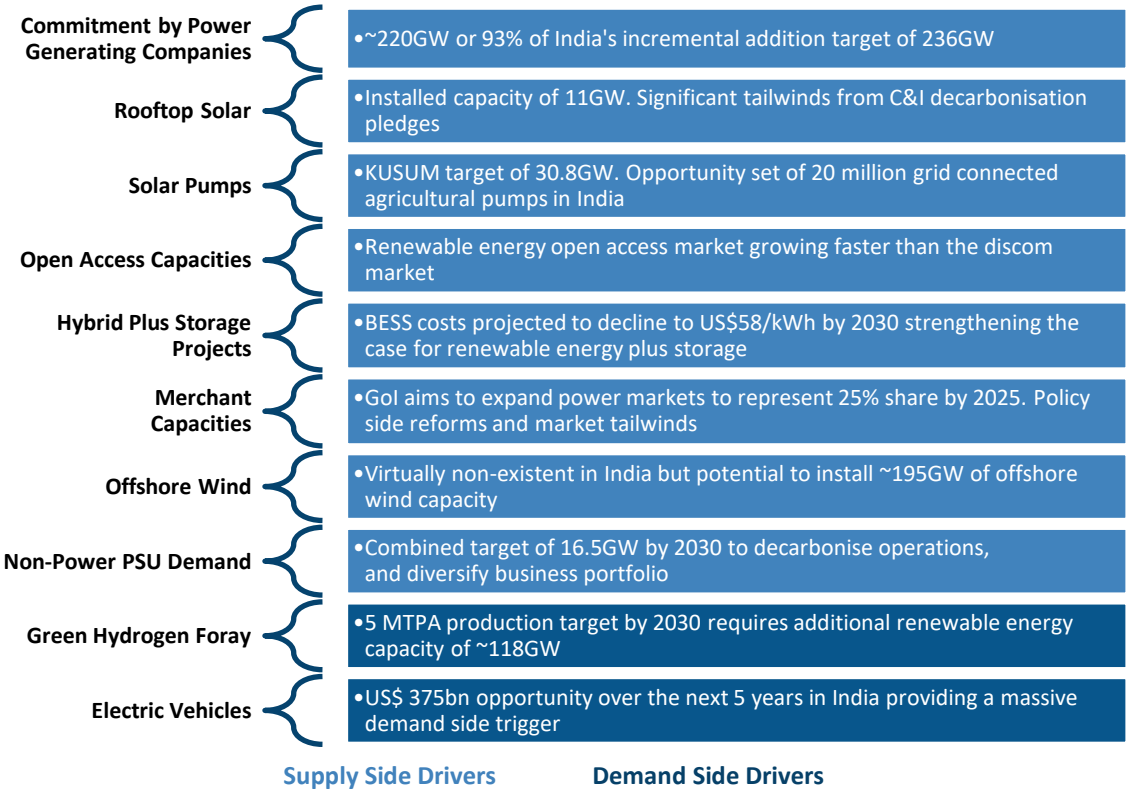
Several Indian public sector undertakings (PSUs) have also been committing to install renewable energy capacity in a bid to decarbonise their operations, diversify their business portfolio and also contribute to the government's renewables plans. Non-power sector PSUs, including Oil and Natural Gas Corporation (ONGC), Indian Oil Corporation (IOC), Bharat Petroleum Corporation Limited (BPCL) and GAIL, have a combined renewable capacity addition target of 16.5GW by 2030.

On the demand side, green hydrogen is a major force that promises to massively drive India's clean energy ambitions. India's green hydrogen target of 5 million tonnes per annum (MTPA) by 2030 will require an additional renewable energy capacity of ~118GW. Corporates, such as the Adani Group and Reliance Industries, have wholeheartedly supported the country's green hydrogen policy, announced in June 2022, and its 5MTPA target, with several major commitments.

Several other upside triggers are also present, which can contribute to the country's clean energy target.

- Open access capacity installations buoyed by higher demand from C&I customers for procuring clean energy.
- Future wind-solar hybrid projects integrated with storage assets will become more competitive than thermal power, with the cost of battery energy storage systems (BESS) projected to keep falling.
- Merchant capacities traded through power exchanges are also projected to grow exponentially. Policy-side reforms and favourable market dynamics will continue to act as a driver for green merchant capacity additions in the foreseeable future.
- Offshore wind, a non-starter in the Indian markets, has been given a new lease of life through recent government reforms and targets. With a coastline of about 7,600 km, offering the potential to install ~195GW of offshore wind capacity, the segment can contribute to India's clean energy target.
- Lastly, electric vehicle uptake, projected to be a multi-billion-dollar opportunity in the country, will be a major demand-side driver for clean electricity generation assets.

Figure 2: Demand and Supply Side Drivers of Renewable Energy Capacity Addition in India



Source: IEEFA & CEF Analysis

Understanding the clean energy commitments of domestic players compared with global counterparts also provides perspective on where India's renewable energy plans stand relative to international developments and what Indian utility players can leverage from the experience of global leaders. An analysis of the clean energy trajectory and plans of four global energy transition utility leaders: NextEra Energy (US), RWE (Germany), Ørsted (Denmark) and Enel (Italy), shows that they are betting heavily on the global energy transition opportunities. Across all the jurisdictions where they operate, a recurrent theme has been accelerating action to progressively reduce fossil fuel-based asset reliance and doubling down efforts in supporting the clean energy sector.

These four majors have accelerated their world-leading investment plans in response to the hyperinflation of fossil fuel commodity prices, reflective of the increasing cost competitiveness of firmed renewable energy (even in the absence of a CO_2 price). Further, all four have clearly articulated ambitious decarbonisation targets, and it is noteworthy that none rely on carbon offsets or the mythical use of carbon capture and storage (CCS). All are tapping into the global green bond market for long-duration funding at very commercial rates.

NextEra Energy's investment plan to deploy US$85-95 billion over four years through to 2025 across solar, wind and storage assets supports its core strategy of expansion in the renewable energy segment. The recently announced Inflation Reduction Act of 2022 in the U.S. will likely accelerate its plans. The company has laid out a detailed decarbonisation target, announcing a Real Zero to eliminate all scope 1 and scope 2 carbon emissions across its operations by 2045. Clearly articulated interim decarbonisation targets set on a five-yearly basis will massively support NextEra's ability to tap global sustainable finance markets, a point that Indian utilities, such as NTPC and Tata Power, should note. The company's green pivot has struck a chord with investors too, with its share price materially outperforming the US equity market (+199%) over the last decade.

RWE of Germany has similar ambitions. The company targets to double to a net 50GW of renewable energy capacity by 2030, which requires a €50 billion (US$50 billion) investment. The German government coalition's objective to accelerate the expansion of renewable energy as a top priority buoys RWE's plans. RWE has doubled down on battery storage too, with a target of 3GW by 2030 up from just 47MW as of December 2021, underpinning the role that storage will play in the transition globally. Another integral part of RWE's strategy is green hydrogen. It targets building 2GW of in-house electrolysis capacity by 2030 across Germany, the U.K. and Netherlands. Similar to NextEra, RWE has also pledged to decarbonise its operations to become climate-neutral by 2040, helping it issue two green bonds totalling €2 billion (US$2 billion) in May 2022.

RWE's share market performance is a study in itself for Indian utilities pivoting towards clean energy. Its shares saw significant underperformance in the first half of the last decade as the fossil fuel heavy utility underestimated the speed of the stranding of thermal power assets, combined with the entirely flawed spin-off of its renewable energy division (Innogy) in 2015/16. But since then, RWE has pivoted to

embrace a planned energy transition, and the company's shares have materially outperformed the German equity market.

Another European player, Ørsted, is the perfect model of a conventional utility transitioning to clean energy and, in the process, creating immense wealth for its shareholders. The company currently has 7.5GW of offshore wind in operation and another 14.5GW of awarded capacity under development. It has a global target of installing 30GW of offshore wind capacity by 2030. After championing offshore wind technology in Europe, Ørsted is now exploring other markets, such as Taiwan, the U.S. and Spain, using its technological know-how and experience to capitalise on government reforms and market tailwinds to fulfil its 2030 capacity targets. This is a credit to its early pivot to clean energy compared to regional peers. Green hydrogen finds an important place in the company's future strategy. Denmark's green hydrogen foray into deep decarbonisation of transport and shipping sectors, along with developments across the Netherlands and Germany, have provided market signals to Ørsted to develop expertise in this nascent technology too.

Lastly, Italy's Enel, with a global portfolio of 55.4GW of renewable energy, including 28GW of hydro, spanning 27 countries, is the world's largest renewable energy company. Enel's gross capex budget for 2021-2030 is a staggering €210 billion (US$210 billion), split between grid modernisation and expansions and renewable energy generation capacity. As of June 2022, Enel had a gross project pipeline of over 400GW of renewables capacity, including 64GW of batteries. This is by far the largest investment program of any company globally in decarbonisation. While betting massively on battery storage, the company has not made many inroads into green hydrogen. On the sustainability front, Enel brought forward its target for Net Zero by a decade to 2040 by driving electrification and ongoing accelerated phase-out of its end-of-life thermal capacity with firmed renewable energy capacity. Unlike most fossil fuel firms, this puts no reliance on carbon removal and is 100% aligned and certified with 1.5°C in accordance with the SBTi. As a leading investor in decarbonisation, Enel has regularly tapped the global sustainable bond markets, being a leader in the issuance of sustainability-linked instruments.

Figure 3: Clean Energy Commitments and Decarbonisation Efforts of Global Utilities

COMPANY	GREEN ENERGY COMMITMENTS	DECARBONISATION EFFORTS
NEXTERA ENERGY	Plan to deploy US$85-95 billion in renewable energy by 2025, adding 8-11GW of new wind, 14-19GW of solar and 5-7GW of energy storage	Real Zero emissions target no later than 2045. Clearly articulated interim decarbonisation targets
RWE	Plans to invest €50 billion (US$50 billion) this decade in phasing out the existing coal-fired fleet and investing in new renewable energy. Battery storage target of 3GW and green hydrogen target of 2GW electrolysis capacity by 2030	Targets being climate-neutral by 2040. Targets confirmed by SBTi and in line with the Paris Agreement
ØRSTED	Global target of installing 30GW of offshore and 17.5GW of onshore wind capacity by 2030 across Europe, Taiwan, the US, and Spain, among others	Frontrunner in sustainability-related disclosures globally. 2040 net zero target confirmed by SBTi
ENEL	Capex budget for 2021-2030 of €210 billion (US$210 billion) across grids modernisation and expansion of renewable energy. Gross project pipeline of over 400GW of renewables capacity, including 64GW of batteries	Brought forward its target for Net Zero by a decade to 2040 by driving electrification and phase-out of thermal capacity

Source: Company Reports; IEEFA & CEF Analysis

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India's Electricity Sector Transformation

India has laid out ambitious plans for renewable energy. As part of its revised Nationally Determined Contribution (NDC), India is committing to meet 50% of installed capacity from non-fossil fuel energy sources and reduce the economy's emission intensity by 45% from 2005 levels by 2030.[2]

While India witnessed high renewable energy capacity growth in the last few months, the pace to decarbonise the electricity sector needs to increase. The renewable energy sector has been facing hurdles because of rising module prices due to supply-led disruptions, imposition of basic customs duty, increase in goods and service tax (GST) rates, higher financing costs etc.

On the other hand, India witnessed heatwaves in March/April this year, which led to high power demand. As India could not meet the power demand with domestic coal, leading to a lower plant load factor (PLF) of thermal power plants, the country has been importing coal to bridge the gap between the requirements and domestic supply. However, the Russia-Ukraine war has led to imported prices skyrocketing tenfold in the last two years, making imported coal expensive and burdening India's current account deficit.

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The high fuel prices are leading to high inflation. India's wholesale and retail inflation are rising due to high prices of crude, gas, and minerals. This is impacting food inflation as well. India's Wholesale Price Index (WPI) crossed double digits (15%), while the Consumer Price Index (CPI) breached the comfortable 6% mark[3] in May/June and remains at 7% now.[4]

India's gross domestic product (GDP) grew by 8.7% in FY2021/22.[5] The Reserve Bank of India (RBI) expects it to grow 7.2% in FY2022/23.[6] Likewise, India's electricity demand is increasing to meet high economic growth, led by a

[2] PIB. Cabinet approves India's Updated Nationally Determined Contribution to be communicated to the United Nations Framework Convention on Climate Change. August 2022.
[3] The Indian Express. WPI Inflation India, June 2022: India's wholesale inflation eases to 15.18% in June, govt data shows. July 2022.
[4] Money Control. August CPI at 7%; how high inflation impacts common man?. September 2022.
[5] PIB. Central Government reduced Central Excise duty on petrol and diesel to boost consumption and keep inflation low. August 2022.
[6] CNBC-TV18. GDP growth projection for 2022-23 is retained at 7.2%: RBI Guv Shaktikanta Das. August 2022.

manufacturing and farming activity surge. For the electricity demand, the International Energy Agency (IEA) has revised upwards India's annual electricity demand from 6% to 7% in 2022[7] due to exceptionally high summer temperatures and the revival of economic activities, leading to a significant surge in consumption. The demand will likely remain high in the coming years, though energy efficiency and demand-side measures will offset some of the increased demand.

The COVID-19 pandemic and Russia's invasion of Ukraine have led many countries, including India, to turn inwards and rely on what is available in the domestic market. India is trying to increase domestic coal production by opening more mines for private production. To address the issue of energy security and protect itself from the price volatility of imported fossil fuels, the strategy is to start exploiting more domestic resources to meet its demand.

India has 770 operating mines, while the government has proposed 300 new mines, out of which 23 projects have been announced. Of the 300 new mines, 239 are in the exploration stage, 35 projects have received permits, and four are under construction.[8]

In May 2022, the government approved ten mine expansions without an environmental assessment. This was after the Ministry of Environment, Forest and Climate Change (MoEFCC) agreed to a Ministry of Coal (MoC) request to lift the assessment-free threshold from 40% to 50% of mine production capacity for projects where the expansion did not require the lease area's extension or additional land acquisition. The ten projects in Chhattisgarh, Maharashtra, Orissa, Madhya Pradesh and Uttar Pradesh have a combined capacity of 9.65 million tonnes per annum (MTPA).[9]

In June 2022, MoC received bids from 31 companies for commercial coal mining for the auction process for 122 coal/lignite mines on 30 March 2022. Well-known companies like Vedanta Limited, JSW Steel Limited, Birla Corporation Limited and NLC India Limited, among others, participated in the auction.[10]

In July 2022, on the other hand, eight public sector companies, because of various reasons such as law and order issues; enhancement in the area of forest from what was declared earlier; the resistance of land-holders against land acquisition; geological surprises in terms of availability of coal resource; submitted requests to surrender 11 non-operational coal mine deposits under an amnesty scheme.[11] This demonstrates growing issues with expansion in coal mining in India, which could lead to delays and cost overruns.

On thermal power production, India has about 27.5 gigawatts (GW) of projects under construction, which could become operational in the next 3-4 years. India

[7] The Hindu Business Line. IEA revises India's 2022 electricity demand upwards. July 2022.
[8] Global Coal Mine Tracker, Global Energy Monitor. Operating Mines and Proposed Projects (1 mtpa+). July 2022.
[9] Rissadiary.com. Ministry Of Coal Requested MoEF&CC To Consider Expansion Of Mine Without Public Consultation Upto 50% Of Their Production Capacity. August 2022.
[10] PIB. Thirty One Companies Submit Bids for Commercial Coal Mining Auction. June 2022.
[11] The Economic Times. 8 PSUs surrender 11 coal mines: Coal Minister Pralhad Joshi. July 2022.

targets to commission ten thermal power units of an aggregate 7GW capacity in FY2022/23, out of which the central government will own 3.5GW, and various states will own 3.4GW.[12] If delivered, this will be the largest addition in thermal capacity since FY2017/18.

NTPC, which announced diversifying away from coal in October 2020, announced that it may add new coal power capacity to meet the country's surging demand for electricity.[13] In July 2022, the company awarded contracts for the first coal-fired plant in about six years.[14] In September 2022, NTPC acquired the 600 megawatts (MW) Jhabua power plant for Rs9.25 billion (US$115 million)[15] as part of the Corporate Insolvency Resolution Process initiated by the National Company Law Tribunal (NCLT).

Other players like Adani[16] and Reliance,[17] who are betting big on clean energy technologies, are also buying stranded thermal power assets. Adani Power is close to acquiring DB Power Ltd, which owns and operates a 2x600MW thermal power plant in Chhattisgarh, at an enterprise value of Rs70.17 billion (US$878 million)[18] for cash consideration. Reliance Industries (RIL) is leading the race to acquire Lanco Amarkantak Power (Lanco), a coal-based power project, with an offer of Rs19.60 billion (US$245 million)[19] cash upfront.

There is some renewed momentum building up on expanding the use of domestic thermal energy, but we believe this needs to be treated with caution. Fatih Birol, Executive Director, International Energy Agency (IEA), busts the myth around the global energy crisis inflicting various countries.[20] He emphasises that the current energy crisis is not because of clean energy but rather not building more of such energy.

India's Current Electricity Mix

As of March 2022, India had 211GW of coal-fired capacity, contributing 52.7% of its total capacity and an unsustainably high 72.3% of total FY2021/22 generation. Renewables provided 110GW capacity, delivering 27.5% of capacity and only 11.5% of total generation.

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[12] Hellenic Shipping News. India expected to commission 10 thermal coal power plants in 2022-23, add 7,010 MW. June 2022.
[13] Bloomberg. India Power Giant Weighs New Plants as Coal Phase-Out Must Wait. June 2022.
[14] Business Standard. NTPC set to award first coal-fired plant in about six years: Report. July 2022.
[15] ET Energy World. NTPC acquires 600MW Jhabua power plant for Rs 925 crore. September 2022.
[16] Bloomberg, The World's Third-Richest Man Sells the World a Green Dream Built on Coal, 9 September 2022.
[17] Reliance Industries Ltd. AGM Speech. 29 August 2022.
[18] Business Standard. Adani Power to acquire DB Power for Rs 7,017 crore enterprise value. August 2022.
[19] Business Standard. RIL inches closer to acquiring Lanco Amarkantak with Rs 1,960 cr cash offer. September 2022.
[20] Financial Times. Three myths about the global energy crisis. September 2022.

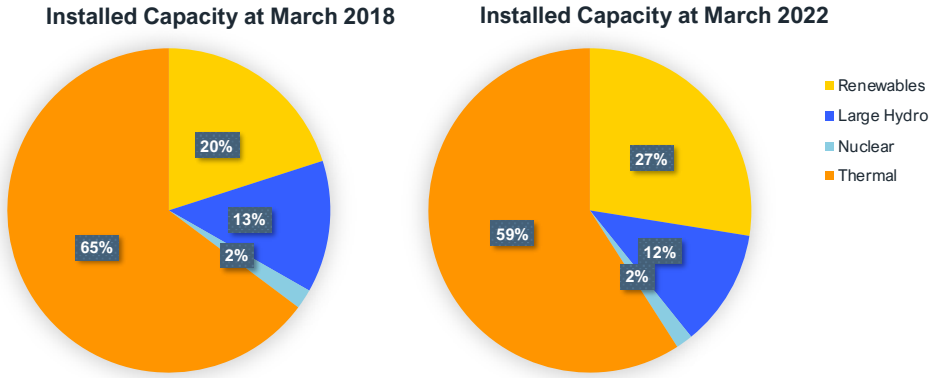
Figure 4: India's Electricity Sector Composition FY2021/22

	---- Capacity ----		-- Generation --		Capacity	Increase
	GW	%	TWh	%	Utilisation	GW rise vs F20
Coal-fired	210.7	52.7%	1,078.6	72.3%	58.6%	1.4
Gas-fired	24.9	6.2%	36.0	2.4%	22.0%	0.0
Diesel-fired	0.5	0.1%	0.1	0.0%	10.0%	0.0
Large Hydro	46.7	11.7%	151.6	10.2%	37.0%	0.5
Nuclear	6.8	1.7%	47.1	3.2%	72.0%	0.0
Renewables	109.9	27.5%	170.9	11.5%	22.0%	15.5
Bhutan (Import)	n.a	n.a	7.5	0.5%	n.a.	
Total	**399.5**	**100%**	**1,491.9**	**100%**		**17.3**
Battery Storage	n.a					
Captive power	51.4					
Total	**450.9**	1.1				

Source: CEA, IEEFA & CEF Estimates

Despite the rapid slowdown in new thermal power capacity adds and the acceleration of investments in renewable energy, thermal still dominates India's installed capacity. The share of thermal capacity fell from 65% in FY2017/18 to 59% in FY2021/22, while renewables increased from 20% to 27% during the same period. But in terms of share of generation, the momentum is less clear, given the lower renewable energy utilisation rates. Large hydro and nuclear shares have remained constant over the years.

Figure 5: India's Installed Capacity Over the Years



Source: CEA

In FY2017/18, India added a record 12GW of renewable energy capacity and 5GW of coal capacity. However, renewable energy capacity addition then slowed down. After a tough three years filled with policy headwinds, policy obscurity, and the COVID-19 pandemic that choked growth in renewables capacity, India saw a record high of 15.5GW of renewables capacity addition in FY2021/22. This includes record solar capacity installations of 13.9GW in a year.

India added 6.2GW of renewable energy capacity from April to August 2022. Its total renewable energy capacity as of August 2022 stands at 116.1GW.[21]

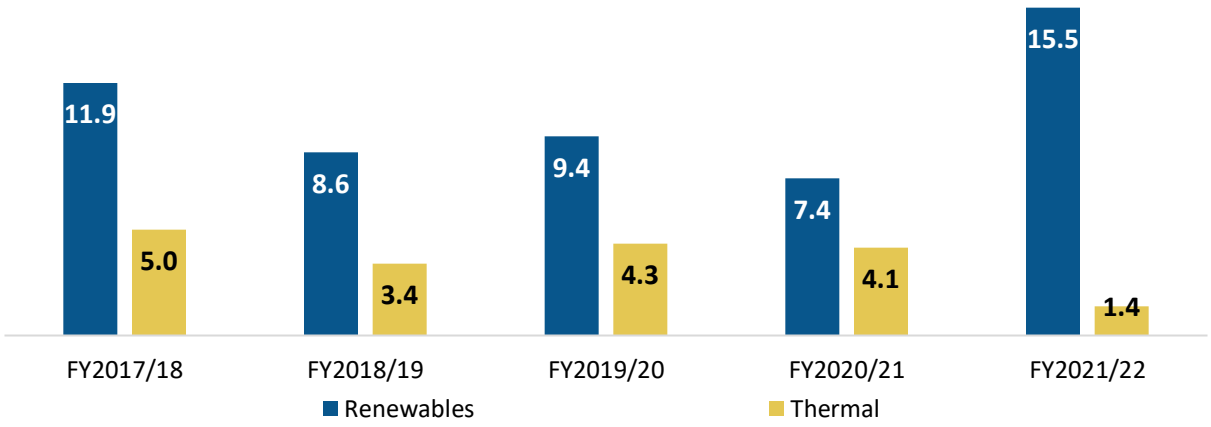
Figure 6: Renewable Energy Addition Change

Renewable Energy	Mar-21	Mar-22	Change (GW)
Wind	39.2	40.4	1.11
Solar	40.1	54.0	13.91
Small Hydro	4.8	4.8	0.06
Biomass/Co-gen	10.1	10.2	0.06
Waste to Energy	0.2	0.5	0.31
Total	**94.4**	**109.9**	15.45

Source: CEA

On the other hand, coal power capacity additions hit rock bottom in FY2021/22, with only 1.4GW of net new coal capacity additions during the year. At the end of the year, the total coal capacity was 211GW. A total of 4.4GW of gross new coal capacity was commissioned, and 1.5GW of end-of-life coal capacity was retired (1.5GW of capacity was converted to behind-the-meter captive use).

Figure 7: Coal Vs Renewables Capacity Adds



Source: CEA

With the acceleration of electricity demand growth and lack of new capacity additions, we have seen PLFs of thermal power plants going up from 55% last year and at the start of this year to 70% now for coal-based power plants from March to June 2022 but had dropped to 60% in July 2022.[22]

[21] CEA. All India Installed Capacity Report. July 2022.
[22] CEA. Executive Summary. July 2022.

India's Future Electricity Mix

IEEFA and CEF model the energy mix in India's electricity sector with reference to the Central Electricity Authority's draft report on the optimal energy mix by 2029/30. However, we attenuate our estimates based on our reading of the current market, finance and policy conditions rather than an extrapolation of the last five-year trends. This is because a period of weak electricity demand, a rapid slowdown in thermal power plant investments, and a noticeable cooling in the government's enthusiasm for underwriting significantly more renewable energy power purchase agreements (PPAs) after the brilliant momentum evident pre-COVID-19, had affected the previous five years.

IEEFA and CEF forecast India's renewable energy capacity to grow rapidly with 35-40GW of new capacity additions annually through to FY2029/30. IEEFA and CEF project renewable energy capacity to be at 405GW (excluding hydro) by FY2029/30, which forms 55.9% of India's total generation capacity and 33.6% of total generation.

Due to the unrelenting and likely ever cheaper competition from variable renewable energy sources, hyperinflation in fossil fuel commodity prices and increased global capital pledges under the US$130 trillion Glasgow Finance Alliance for Net Zero (GFANZ) to align investments with a 1.5°C limit to global warming, we forecast that thermal power will progressively lose market share, taking its generation share from 72.3% in FY2021/22 to just 53.4% in FY2029/30. IEEFA and CEF project new capacity additions to be some 21GW (net of retirement of end-of-life coal power plants), taking coal-fired capacity to 231GW by FY2029/30.

Figure 8: India's Electricity Sector Composition FY2029/30

	---- Capacity ----		-- Generation --		Capacity	Increase	Capacity
	GW	%	TWh	%	Utilisation	GW yoy	GW vs
						FY2030	FY2022
Coal-fired	231.1	31.8%	1,185.4	53.4%	58.7%	1.5	20
Gas-fired	24.9	3.4%	31.3	1.4%	14.3%	0.0	0
Diesel-fired	0.5	0.1%	0.5	0.0%	12.0%	0.0	0
Large Hydro	53.1	7.3%	172.0	7.8%	37.3%	0.8	6
Nuclear	10.7	1.5%	74.1	3.3%	79.2%	0.0	4
Renewables	405.5	55.9%	746.3	33.6%	22.1%	40.0	296
Bhutan (Import)	n.a	n.a	8.7	0.4%	n.a.		
Total	**725.7**	**100.0%**	**2,218.3**	**100.0%**		**42.3**	**326**

Generation growth including EVs	5.4% pa
AT&C loss reduction rate	-0.5% pa
Electricity to GDP growth ratio	90.0%
GDP growth	6.0% pa

Source: CEA, IEEFA & CEF Estimates

Different studies have different projections of India to peak coal demand. In December 2021, NITI Aayog's report mentioned that the coal-based utility

electricity generation capacity in India could peak at 250 GW by 2030.[23] However, coal-based utility electricity generation in the country will slow down but will likely peak and then plateau out by 2040. While coal-based thermal power generation will grow, its share in the total power generation mix of the country will decline to 50-55% from the current 72% over the next decade due to the shifting capacity mix with a growing share of lower-cost domestic renewable energy.

CEA Optimal Generation Mix report predicts that India will have 267GW of coal capacity by 2030.[24] IEEFA and CEF expect India's coal-fired power capacity to peak at a significantly lower 231GW by 2030, with end-of-life closures increasingly offsetting the long-delayed commissioning of under-construction plants. This trend will likely accelerate beyond 2025 as expensive PPAs expire, particularly in light of the evident coal and gas commodity price inflation, especially for imported supply (made even more costly in Indian domestic terms by the ongoing depreciation of the Rs/USD). This contrasts with the financial certainty and declining real price of domestic renewable energy PPAs (fixed flat in nominal terms for the 25-year contract duration).

A study by energy think tank Ember suggests that India's coal capacity could peak before 2025.[25] With the Russia-Ukraine war, timelines are likely to shift because of energy security reasons, global supply disruptions, and, more importantly, the increasing incidences of heatwaves leading to increasing electricity demand. Interestingly, heatwaves and droughts undermine the ability of coal-fired power plants to continue to operate due to the increasingly problematic reliance on water-cooling. Most countries, including India, are trying to meet this demand through increasing coal-based power generation in the near-to-medium term while permanently accelerating reliance on firmed renewables (on and offshore wind farms, utility-scale and rooftop solar, pumped hydro storage, ground heat pumps) and energy efficiency measures (such as stricter building standards[26]).

Reviewing India's Coal-fired Capacity Pipeline

According to Global Energy Monitor's (GEM) data as on July 2022, no new Indian coal-fired power plants were announced in the last few months until recently, when NTPC announced the first coal-fired plant in about six years in Odisha. Also, some long-stranded assets are finding new buyers under NCLT proceedings.

There is a lack of financing for new coal-fired power projects and/or demand for additional power by state electricity distribution companies (DISCOMs). In addition, the continued financial distress in India's power distribution sector makes thermal PPAs even more unbankable in the absence of long-delayed distribution sector reforms.

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[23] Government of India, Economic Diplomacy Division. Coal demand to peak in India by 2030: NITI Aayog. December 2021.
[24] CEA. Report on Optimal Generation Capacity Mix for 2029-30. January 2020.
[25] Ember. Peaking Coal?. February 2021.
[26] ABC. Energy efficiency requirements for new homes will rise in October next year, but building a 7-star home doesn't have to break the bank. 7 September 2022.

GEM's data shows more than 606GW of coal-fired power projects have been cancelled or shelved, and 15.6GW retired during 2010-2022 in India. There are 31.3GW of projects under construction and another 25.7GW of projects that have been announced or have received a permit, but no construction has started on these projects.

Figure 9: India's Coal-Fired Power Project Pipeline

Coal capacity status	Jul-22	Jan-22	Change
Announced	5.3	2.9	2.4
Pre-permit	7.2	8.3	-1.1
Permitted	13.2	12.6	0.6
Pre-construction pipeline	**25.7**	**23.9**	1.9
Underconstruction	31.3	31.3	0.0
Total pipeline	**57.0**	**55.2**	1.8
Operating	233.1	231.9	1.2
Mothballed	1.5	1.5	0.0
Shelved	20.4	20.5	0.0
Cancelled	586.0	587.2	-1.2
Shelved + Cancelled (2010-2021)	606.4	607.7	-1.3
Retired (2010-2021)	15.6	14.9	0.7

Source: Global Energy Monitor, IEEFA Calculations

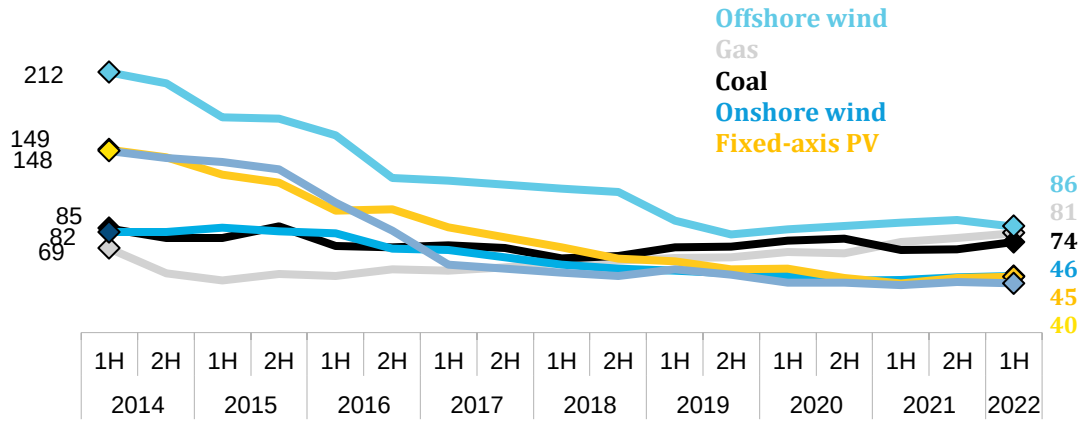
Why Renewables Will Play a Bigger Role

While the COVID-19 pandemic and the increasing geopolitical conditions are pushing many countries, including India, to increase domestic coal mining and coal-powered production, prices are inflationary. India needs to actively pursue a shift to clean energy alternatives to protect itself from the vagaries of high fuel prices and, at the same time, ensure energy security, energy access and meet other social and economic objectives.

Renewables are Deflationary

Prices of renewables have gone down over the years. Wind and solar are complementary, not competitors. Offshore wind is coming fast, but it will not be cost-competitive for another decade. Both solar module prices and battery packs saw a 90% deflation in prices since 2010, whereas onshore wind turbine prices have halved during the last ten years. The decline in prices has led to the increasing deployment of renewable energy.

Figure 10: Global Prices of Different Technologies in US$/MWh



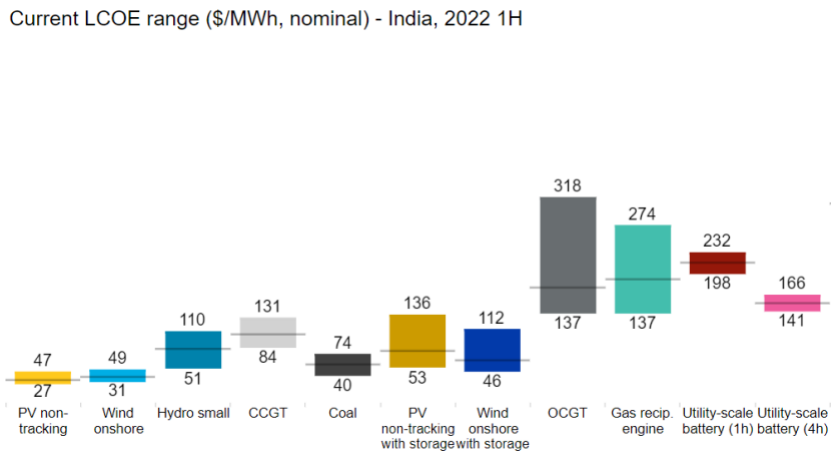
Source: BNEF

Observing the tariff trend over the past six quarters, the L1 tariffs discovered in utility-scale solar tenders have increased by an average of 30-40% above the record-low tariff. Prices have now started rising upwards because of an increase in module and freight costs, which is temporary. We stand by our view that the long-term pricing of solar energy is likely to see a record low of Rs1/kWh by the end of this decade, with the growth in global solar module manufacturing capacity set to treble in the next decade to upwards of 900GW annually.[27] Absent a trebling of global installs, module prices will likely return to oversupply and hence their long-term downward trajectory, particularly as the worldwide fossil fuel-induced energy crisis is progressively resolved.

Further, if we look at the levelised cost of electricity in India, solar PV or onshore wind is now by far the cheapest source of new bulk power and deflationary once built. New solar PV and onshore wind are now competitive with the marginal cost of running existing domestic coal and gas-fired plants. While renewable energy enjoys must-run status, in terms of the merit order stacking, solar and wind will continue to be dispatched first because of zero marginal cost of generation.

[27] Bloomberg. The Supply Chain to Beat Climate Change Is Already Being Built. 7 September 2022.

Figure 11: Levelised Cost of Electricity in India (US$/MWh)

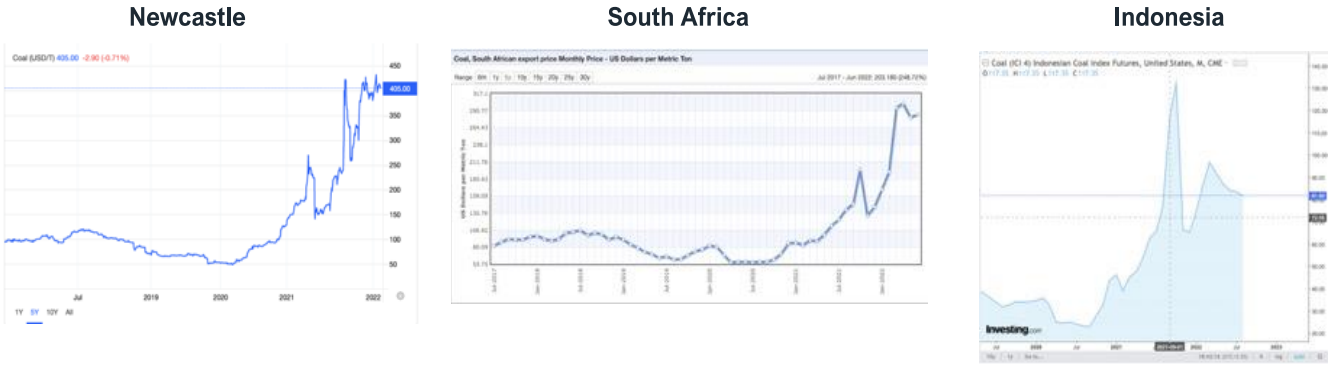


Source: BNEF

Imported Coal Price Volatility

Price volatility seen in imported coal prices has made the use of imported coal for power generation expensive and unreliable. Prices have risen in Australia, South Africa and Indonesia, the main suppliers of imported coal to India. In Australia, prices have gone up from US$100/tonne (T) in 2021 to US$440/T in September 2022; in South Africa, it has gone up from US$80-100/T to US$280-300/T; and in Indonesia, from US$50-70/T to US$80/T, though it touched US$130/T earlier this year – Figure 12.

Figure 12: Imported Coal Price in US$/MT



Source: Trading Economics, Investing, Index Mundi

Coal Divestment

Financing becomes a key for any new coal power development. Globally more than 195 banks and financial institutions have announced coal exit policies. So, the big question is, from where will the financing come? While public sector banks have been supporting the development of thermal power assets so far, recently, the RBI has come out with a paper on climate-related disclosures, an important element to

understanding the risks faced by various stakeholders. Increasingly, raising finance will be difficult and expensive as the risks attached will be higher.

Figure 13: Coal Divestment – Over 100 & Counting

GSFI Category	No. of Coal Exit Policies	Year	No. of Coal Exit Policies
Asset Manager/Owner	34	2015	2
Bank	78	2016	2
Bank/Insurer	3	2017	32
Central Bank	1	2018	9
Development Finance Institution	3	2019	35
Export Credit Agency	19	2020	50
Insurer/Reinsurer	50	2021	54
Multilateral Development Bank	7	2022	11
TOTAL	**195**	**TOTAL**	**195**

Source: IEEFA

Corporate Diversification

While Indian companies have been slow to join the race to net zero, they are starting to get their act together. Some of India's biggest companies, such as Tata, Reliance, Mahindra, ITC, and Dalmia Cement, have made net-zero announcements.

Various government corporations have also committed to achieving net-zero carbon emissions, such as Indian Railways by 2030, Indian Oil Corporation by 2046, GAIL by 2040 and Chhattisgarh Health Department by 2050. While this trend is far less established in the domestic Indian market as a reflection of the common but differentiated responsibilities underlying the Paris Agreement, India is increasingly recognised as a globally significant country. The progressive opening up of the Indian financial sector to global capital brings with it a gradual shift towards global convergence in norms. Any Indian firm seeking to raise capital on Wall Street will

While Indian companies have been slow to join the race to net zero, they are starting to get their act together.

increasingly need to comply with SEC mandates on climate disclosures and commitments.[28]

Many Indian corporates are now getting mandates by their boardroom and shareholders (domestic and global[29]) to diversify into clean energy as it would increase the return on their investment and manage this increasingly evident key financial risk.

A review of the relative share price performance of NTPC, Coal India and Tata Power shows how a materially increasing share of renewable energy in the portfolio has led to the better share price performance of the company. Globally also, we have witnessed the same trends.

Figure 14: Share Price Performance of NTPC, CIL and Tata Power

Source: Google Finance

India has recently announced Energy Conservation Bill 2022, which empowers the government to lay down different consumption thresholds for different non-fossil sources and consumer categories. It also allows carbon trading, which again will boost more renewable energy deployment. Further, India announced the first phase of the green hydrogen policy to give a supply-side push and encourage the development of green hydrogen near the consumption centre. The second phase of the policy is likely to provide the demand side push by mandatory obligations from the industries. The government has further introduced a Production Linked Incentive scheme to boost domestic manufacturing and reduce import dependence on various products and modules for renewable energy deployment.

[28] SEC. Spotlight on Enforcement Task Force Focused on Climate and ESG Issues.
[29] Blackrock CEO Letter 2022. How Effective Stakeholder Capitalism Creates And Sustains Value For Shareholders.

India's Shift to Clean Energy Supported by Ambitious Plans by Industry Players

India's renewable energy sector has witnessed massive growth over the last decade, with many players today operating capacities in the Indian market. To start with, thermal power giants such as NTPC, Tata Power and JSW Energy have lately pivoted towards green energy with ambitious capacity addition commitments. In addition, an entirely new set of independent power producers (IPPs), such as Adani Green Energy, ReNew Power and Azure Power, have entered buoyed by the massive growth potential of the market, tapping into both domestic and increasingly global capital markets. It is needless to say that competition has been rife in the sector, with India witnessing some of the most competitive tariffs in renewable energy auctions globally, helping renewable energy establish firmly as the lowest cost source of power in the country.[30] The clarity and credibility of the Indian government's renewable energy policies and targets, in conjunction with the innovative government-backed 25-year PPAs by the Solar Energy Corporation of India (SECI), have helped developers access the rapidly expanding global infrastructure capital. The US$8.5 trillion global giant asset manager BlackRock has referenced this tectonic shift accelerating.[31]

The country's recently updated NDCs now target the installation of 50% of non-fossil fuel power capacity by 2030.[32]

Figure 15: India's Installed and Target Renewable Energy Capacity (GW)[33]

Total installed non-fossil capacity	170
Non-fossil target 2030	**409**
RE Additions required (including large hydro)	**233**

Source: CEA, PIB, IEEFA Analysis; Non-fossil defined as RE, large hydro and nuclear

The above table lists the renewable energy capacity additions required for India to fulfil its NDCs. The additions required per year on an average until 2030 are ~30GW. A slew of players, both state and non-state, operating across industries such as power and oil & gas to steel and cement through the utility and distributed renewable energy (DRE) segments, will support these additions.

Commitments by Power Generating Companies

The growth in the utility-scale segment defines India's renewable energy journey. This segment has grown significantly through a steady pipeline of state and

[30] BNEF. Levelized Cost of Energy. June 2022.
[31] BCG, A tectonic shift of Capital is Just Beginning. 17 June 2021.
[32] Business Standard. India's updated NDC will be communicated to UNFCCC. August 2022.
[33] Non-fossil installed capacity includes large hydro (46.8GW) and nuclear (6.8GW); CEA estimates installed capacity in 2029-2030 to be 817GW. As per updated NDC's 50% of installed capacity to be non-fossil or 409GW. RE additions (including large hydro) required arrived at by reducing installed RE+large hydro capacity and net additions to nuclear from 409GW.

central-level auctions and government reforms, including 25-year PPAs, transmission charge waivers, effective resolution mechanisms and financial and non-financial incentives. Several top rung players have stated their capacity addition commitments in the renewable energy sector that match government ambitions.

Figure 16: Renewable Energy Installed Capacity and Commitments by Domestic Players

Generation Companies	Installed Capacity (GW)	Target Capacity (GW)	Net Additions (GW)	Promoter/Shareholders
NTPC Limited	5.7	60	54	Government of India (GoI)
Adani Green Energy	5.8	45	39	Adani Group
ACME Solar	2.9	25	22	Acme group
Tata Power	4.9	25	20	Tata Group
Renew Power	7.6	25	17	Goldman Sachs, CPPIB
JSW Energy	4.7	20	15	JSW Group
SJVN	2	17	15	Government of India
Sembcorp Green Infra	1.7	10	8	Sembcorp Industries Singapore
Greenko Group	7.2	22	15	GIC, ADIA
Ayana Renewables	4	10	6	NIIF
NLC India	1	6	5	Government of Tamil Nadu, GoI
Azure Power	2.9	7.4	5	CDPQ Canada
Hero Future Energies	1.6	5	3	Hero Group
Amp Energy India	2	5	3	Amp Energy Canada, CIP
Fourth Partner Energy	1.5	3	2	Norfund, TPG
Radiance Renewables	0.2	2	2	Eversource Capital, NIIF
Net Additions	**56**	**287**	**231**	

Source: Company Reports, IEEFA Analysis

The above lists down the current capacities and commitments by some of the top players operating in the industry, which have publicly stated capacity addition targets. These corporates' combined additional capacity targets until 2030[34] stand at ~231GW, ~100% of the country's incremental addition target of 233GW. Their current capacities stand at 56GW, which translates to a 4x jump to achieve the stated targets.

We note the absence of a formal target from Reliance Industries Ltd (RIL), the largest conglomerate in India, which should further boost this committed target. This is because RIL's stated target is to invest US$10 billion in the next few years in green energy and facilitate the development of at least 100GW of solar by 2030.[35] Another conglomerate which is already a major player in the transmission segment,

[34] Some companies have intermediate targets from 2025-2030; For Greenko and Radiance Renewables, pipeline plus installed capacity is taken as target; Hero Future target is global though majority capacity is in India.
[35] Reliance Industries Ltd, AGM Speech, page 11. 29 August 2022.

Sterlite Power part of the Vedanta Group, recently shared plans to set up a renewable energy company.[36]

This is a significant jump and requires work from the government's side, providing a steady pipeline of renewable energy auctions and continued policy certainty to facilitate growth across other segments. On the other hand, corporates will have to mobilise sizeable capital to fund these commitments. While the government seems unbending in ensuring its targets are met through facilitating growth across the renewable energy spectrum, the key to scaling up capacities remains the ability to mobilise capital.

While the government seems unbending in ensuring its targets are met through facilitating growth across the renewable energy spectrum, the key to scaling up capacities remains the ability to mobilise capital.

The majority of the industry players listed in the above table are backed by financially strong investors, such as the Government of India, domestic conglomerates and some of the biggest global investors, lending them the financial firepower needed to operate in the super-competitive Indian market. Additionally, Indian companies are steadily making inroads in the global sustainable finance markets with policy-side developments, such as mandatory sustainability disclosure standards and work on a sustainable finance taxonomy, supporting that move. This will help domestic players tap into the massive global pool of environment, social and governance (ESG) capital, including green bonds.[37]

The most ambitious target is from the state-owned behemoth NTPC at 60GW by 2030. NTPC has an installed renewable energy capacity of 5.7GW and another 9.5GW capacity in various stages of construction or tendering.[38] Further, NTPC is also building several ultra-mega renewable energy parks (UMREPPs) across various states in the country that will further facilitate the development of future capacities. The company's sovereign backing lends it enough credibility to raise financing from

[36] Business Standard. Sterlite Power forms RE firm for projects serving commercial clients. September 2022.
[37] Climate Bond Institute. Green bonds up 25% in 2nd quarter after volatile start to 2022. 4 August 2022.
[38] NTPC. NTPC Investor Presentation. Pipeline capacity for standalone entity. August 2022.

the most cost-effective domestic and offshore sources of capital. SJVN and NLC India, the other two sovereign-backed entities on the list, are similar to NTPC.

NTPC's private counterparts also have significant pipelines and financial firepower. Adani Green, for instance, has 20.4GW of capacity, including installed, under construction and pipeline. The wider Adani Group has pledged to invest up to US$70 billion in energy transition over the next decade and the renewable energy business will get the lion's share.[39] Others such as JSW Energy and Tata Power have 2.2GW and 1.9GW of pipeline capacity, respectively. Large conglomerates, which have a long history in India, back all three companies. Similarly, the Nasdaq-listed ReNew Power and Azure Power, both majority-owned by global private equity and pension funds, have pipeline capacities of 5.5GW and 4.5GW, respectively.

Other players, such as Acme, have a demonstrable history of bringing in global institutional investors to invest in their projects and recycle capital successfully into pipeline capacities.

Capacity Additions Beyond Utility-Scale Renewable Energy

Utility-scale projects will contribute a large majority of India's renewable energy capacity in the run-up to 2030. But several other segments have the potential to grow multifold as policy-side reforms streamline current bottlenecks and demand-side drivers provide lucrative returns for industry players.

Rooftop Solar

The rooftop solar market in the country has been a laggard compared to the government's targets of 40GW by 2022 and global rooftop solar market leaders like Australia (15GW), California (13GW) and Vietnam (9GW).

The rooftop solar market in the country is lagging compared to the government's targets of 40GW by 2022.

Several issues have hindered the growth of this segment, including net metering limits, unsigned power supply agreements, banking restrictions, financing issues, and delays in or rejection of open access approvals.[40] However, several states have recently started reforming the policy structure facilitating the segment's growth. For instance, Uttar Pradesh, the country's most populous state, recently unveiled its ambitions to install 16GW solar capacity led by rooftop solar, where residential customers will receive net metering

[39] ET Energy World. Adani to invest USD 100 bn across new energy, data centres. September 2022.
[40] IEEFA. Rooftop Solar Lagging: Why India Will Miss Its 2022 Solar Target. April 2022.

approvals.[41] Gujarat also updated its regulations to allow net metering up to 1MW of rooftop solar.[42]

The Government of India has a target of 40GW of installed rooftop solar capacity by 2022. The current installed capacity stands at 11GW,[43] which would require an almost 4x increase in installations. A major growth area for the segment will be the commercial and industrial (C&I) customers. Currently, 70-80% of installed rooftop capacity is already from the C&I segment,[44] which is touted to accelerate exponentially as corporate decarbonisation and net zero pledges increase. Several Indian companies have pledged to reduce greenhouse gas (GHG) emissions under the Science-Based Targets Initiative (SBTi)—a global alliance enabling businesses to establish their own climate pledges. Of 1,703 global signatories, 79 companies in India are committing to science-based targets to date.[45]

Solar Pumps

India has been a pioneer in adopting grid-connected pumps in the agricultural sector. The government has set a target to install 1.75 million solar pumps by 2022 under the KUSUM programme with up to 60% subsidy on the capital cost. The country has the third-largest regional market for water pumps,[46] providing several tailwinds for the sector's growth.

The KUSUM scheme targets to install a combined 30.8GW of solar capacity in the agricultural sector. The below table gives the breakup of the capacity targets.

Figure 17: Component-wise Revised Solar Capacity and Financial Support Under the KUSUM Scheme

Component	Solar Capacity (GW)	Central Financial Assistance (Rs Bn)
Decentralized grid connected solar plants up to 2MW	10	33.2
200,000 standalone solar pumps	9.6	159.1
150,000 grid connected solar pumps	11.2	148.0
Total	**30.8**	**340.3**

Source: MNRE

[41] Mercom. Uttar Pradesh Proposes to Install 16 GW of Solar Capacity in the Next Five Years. August 2022.
[42] Mercom. Gujarat Allows Net Metering for Rooftop Solar Systems of 1 kW to 1 MW. June 2022.
[43] IEEFA. Rooftop Solar Lagging: Why India Will Miss Its 2022 Solar Target. April 2022.
[44] JMK Research. Powering up Sunshine – Untapped Opportunities in India's Rooftop Solar Market. July 2020.
[45] Science Based Targets. How can the Indian corporate sector drive net-zero? April 2022.
[46] Times Now. Delayed Monsoon to increase demand for solar pumps. June 2022.

While transformational, the scheme has not made much headway due to the lack of coordination among state government bodies involved in implementation, financing issues for farmers and different ownership models.[47] The currently installed pumps under the scheme stand at 16,570 as of FY2021[48], showing extremely slow progress. Weeding out state-level issues and finding an appropriate model suiting local conditions will help propel this segment. Further finding innovative financing solutions to fund the capacity uptake will be needed. Entities such as International Solar Alliance (ISA) have solar pump uptake as a key strategy but need to do more to channel financing for this segment.

With more than 20 million grid-connected agricultural pumps in India, consuming over 17% of the nation's total electricity[49], the opportunity set for solar pumps is enormous. With a clear value proposition for farmers and the government alike (for the latter, there is a clear fiscal incentive in replacing reliance on expensive subsidised imported diesel gensets with local, zero emissions distributed energy), this segment holds the promise to drive India's clean energy ambitions massively. Moreover, companies such as Tata Power and Shakti Pumps, two of the biggest solar pump players, have seen installed capacity volumes increase substantially over the last couple of years, indicating an improving scenario.

Non-Power Public Sector Undertaking (PSU) Capacity Targets

In a bid to decarbonise their operations, diversify their business portfolio and contribute to the government's renewable energy capacity addition plans, Indian public sector undertakings (PSUs) have been committing to install more renewable capacities. Several state-owned oil & gas majors, such as Oil and Natural Gas Corporation (ONGC), Indian Oil Corporation (IOC), Bharat Petroleum Corporation Limited (BPCL) and GAIL, have renewable energy addition targets until 2030. This is in line with global trends where oil & gas companies have been foraying into renewable energy generation and green hydrogen production.

Figure 18: PSU Renewable Energy Addition Commitments Till 2030

PSUs	Installed Capacity (GW)	Target (GW)	Net additions (GW)
ONGC	0.2	1.5	2
Coal India	0.01	3	3
IOC	0.24	5	5
BPCL	0.05	1	1
GAIL	0.13	3	3
Indian Railways	0.22	3.7	3
Total	**0.8**	**17.2**	**16.3**

Source: Company Reports, IEEFA Analysis

[47] IEEFA. Powering up solar irrigation effort will support India's renewable energy targets. June 2021.
[48] MNRE. MNRE Annual Report. 2021.
[49] Energy Tracker Asia. Kusum: India's Agriculture Solar Pump Scheme Facing Challenges. September 2021.

The above table lists the renewable energy targets of non-power sector PSUs, which have a combined capacity addition target of 16.3GW by 2030. Indian Railways, which operates one of the world's largest railway networks, has a 3GW target by 2030. To become a net-zero emitter by 2030,[50] it may soon invite mega tenders for 40GW of renewable energy in the next two to three years, although we note significant hype in previous years has seen little action to date.[51] Coal India is another PSU looking towards the clean energy space to diversify its portfolio and reduce dependence on coal, given its structural headwinds.[52]

Green Hydrogen Foray

India announced its green hydrogen and green ammonia policy in June 2022.[53] The policy puts the country among a growing number of nations globally supporting a nascent technology with the potential to decarbonise several hard-to-abate sectors, such as iron & steel, cement and chemicals.

India's green hydrogen target is 5 million tonnes per annum (MTPA) production by 2030. Renewable energy will play an important role in the green hydrogen economy. This is because the production of green hydrogen through electrolysis, the leading green hydrogen production pathway, is an 'opex' heavy business model where renewable power used is 50-70% of the total cost.[54] For India to meet its green hydrogen target of 5MTPA, it requires an additional renewable energy capacity of ~118GW.[55] This in itself is a humungous target and can contribute massively towards the country's renewable energy addition targets.

India's green hydrogen target is 5 million tonnes per annum (MTPA) production by 2030.

Corporates have supported the green hydrogen policy wholeheartedly with several significant commitments to invest in this nascent technology.

[50] Indian Express. Indian Railways sets 'net zero' emission goal for 2030. November 2021.
[51] Mint. Railways to invite tender for 40GW renewable energy projects. December 2021.
[52] Mint. Coal India plans foray into aluminium, solar. 20 June 2022.
[53] Ministry of Power. Green Hydrogen Policy. February 2022.
[54] Financial Express. Making green hydrogen cost competitive. February 2022.
[55] IEEFA Analysis. Solar PV considered as Renewable Energy source.

Figure 19: Green Hydrogen Commitments by Indian Companies

Company	Green Hydrogen Commitment/ Development	Sector
Adani Enterprises	• US$ 50 billion investment in GH along with Total SE with an initial target of 1MTPA by 2030[56] • MoU with South Korean steel company POSOCO for a US$ 5 billion investment in an integrated green steel mill which will make use of GH[57]	Power, Steel, Oil & Gas, Transport
Reliance India Limited	Announced investments of US$ 75 billion in RE infrastructure development including green hydrogen production[58]	Oil & gas, other diversified sectors
Acme Solar	MoU with Telangana government for development of 1.1MTPA of ammonia synthesis powered by a 5GW solar[59]	Diversified
Jindal Stainless	Signed India's first long term offtake agreement with Hygenco for green hydrogen[60]	Steel
GAIL	Awarded contract to set up a 4.3 metric ton per day green hydrogen plant run with a 10MW RE plant[61]	Oil & gas
GIPCL	Invited expression of interest (EoI) for electrolyser based GH projects in Gujarat of 5MW and 10MW capacity[62]	Fertilisers, Oil & gas, chemicals
Greenko	Joint venture (JV) with Belgium's John Cockerill to set up a 2GW electrolyser factory in India[63]	Oil & gas
IOC	• Target to produce 70,000 tonnes a year of green hydrogen by 2030 • Plans to set up a 40 MW electrolyser at Mathura refinery and a 15 MW unit at Panipat unit in Haryana[64]	Oil & gas
Ministry of Ports	Develop and build India's first indigenous Hydrogen Fuelled Electric Vessels[65]	Shipping
NHPC	MoU with the district administration of Chamba (Himachal Pradesh) for developing a pilot green hydrogen mobility project[66]	Transport

[56] Adani. Adani And Total Energies To Create The World's Largest Green Hydrogen Ecosystem. June 2022.
[57] Outlook India. Adani Group Partners With POSCO. January 2022.
[58] PV Magazine. Reliance Industries commits over US$75 billion for green energy projects in India. January 2022.
[59] Economic Times. ACME announces Rs 52k-crore green hydrogen, ammonia project . July 2022.
[60] ET Energy World. Jindal Stainless to set up green hydrogen plant. August 2022.
[61] Swarajya. GAIL Awards Contract To Build India's Largest Green Hydrogen Project. May 2022.
[62] Mercom. Invited for Electrolyzer-Based Green Hydrogen Projects in Gujarat. April 2022.
[63] Mint. Greenko in tie-up for electrolyser plant. April 2022.
[64] Business Today. New policy to cut green hydrogen production cost by 40-50%: Indian Oil. February 2022.
[65] Ministry Ports. India to develop and build first indigenous Hydrogen Fuel Cell Vessel. April 2022.
[66] Business Line. After Leh, Chamba becomes second district to focus on green hydrogen mobility solutions. April 2022.

NTPC	• Awarded India's first hydrogen fueling station project[67] • Inked a pact with Gujarat Gas Ltd for an initiative to blend green hydrogen with the piped natural gas (PNG)[68] • Develop a project of standalone fuel cell based 50 kW microgrid pilot project[69]	Transport, Oil & gas, power storage
Oil India Limited	Green Hydrogen pilot plant with an installed capacity of 10 kg per day installed at its Jorhat Pump Station in Assam[70]	Oil & gas
Avaada	MoU signed with Rajasthan government to build a 1MTPA green hydrogen facility powered by a 6GW RE capacity[71]	Diversified
Indian Railways	The Indian Railways Organization for Alternate Fuels (IROAF) has invited bids to develop a hydrogen fuel cell-based hybrid power train[72]	Transport

Source: Media Updates, IEEFA Analysis

The above table lists several commitments and ongoing developments in the green hydrogen sector in India. Clean energy players and industries have undertaken several other MoUs and partnerships. Many players across various hard-to-abate sectors, such as refining, mobility, chemicals, steel and fertilisers, are also working on green hydrogen production projects. Most of the projects are currently in a pilot or demonstration stage due to the nascent stage of green hydrogen technology globally. But these projects will pave the way for commercial-scale projects in the future.

India is still scratching the surface regarding green hydrogen end-uses in industries. It may revise the 5MTPA target upwards as the country sets deep decarbonisation targets for industries, further boosting the demand for clean energy.

Other Tailwinds for Renewable Energy Additions

There are several pockets of the economy where renewable energy keeps making inroads. With electrification of everything being a key theme globally, supported by the massive global shift towards low carbon energy sources, demand for renewable energy will keep emerging from entirely new pockets providing demand-side triggers. In contrast, new and innovative sources will augment the supply side.

Open Access Capacities

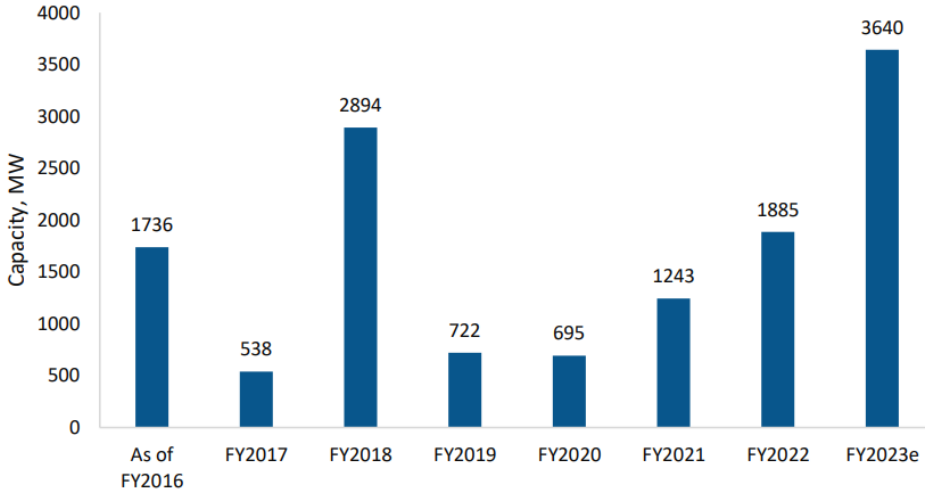
Long-term contracts between generators and distribution companies primarily drive India's electricity market. With higher demand from C&I customers for procuring clean energy, the market is slowly transforming also to accommodate

[67] Economic Times. NTPC awards Amara Raja Group India's first green hydrogen fueling station project. June 2022.
[68] Moneycontrol. NTPC inks pact with Gujarat Gas. April 2022.
[69] ET Energy World. NTPC to develop standalone fuel cell-based microgrid project. March 2022.
[70] The Economic Times. Oil India Limited commissions India's first 99.999% pure Green Hydrogen pilot plant. April 2022.
[71] PV Magazine. Avaada to invest $5 billion in green hydrogen. August 2022.
[72] Green Hydrogen-India. Hydrogen Fuel Cell Train project.

bilateral contracts between generators and end customers directly through open access agreements.

The primary customers here are the C&Is, who require substantial amounts of electricity as part of their operations and cannot fulfil that through rooftop solar capacities alone. Buoyed by corporate decarbonisation pledges, the renewable energy open access market is growing faster than the DISCOM market[73] and is currently at ~10GW.[74]Recently the e-commerce giant Amazon signed three corporate power purchase agreements (CPPAs) with Indian IPPs totaling up to 420MW. This includes a CPPA with ReNew Power for 210MW, one of the biggest such agreements in the Indian markets until date.[75]

Figure 20: Open Access Capacity Installation Trajectory in India



Source: JMK Research

Ministry of Power published the green open access (OA) policy in June 2022. The policy provides several benefits to propel OA installations, including quashing additional surcharges, a major component of OA charges and setting a fixed approval window of 15 days to clear OA applications.[76]

Though other areas still need reforms, such as unfavourable banking provisions and increased penalties for deviation in power schedule, the tailwinds from the increasing C&I demand will keep growing the market exponentially. The C&I segment forms ~50% of the country's total electricity demand. With a growing aversion towards fossil fuel-based sources of power, the share of C&I demand from RE will keep increasing further. In a scenario where DISCOMs cannot guarantee a 100% clean energy supply, the open access market will be a big beneficiary.

[73] ReNew Power. ReNew Power Q1 2023 Results Presentation.
[74] IEEFA. India's Renewable Energy Open Access Market: Trends and Outlook. August 2022.
[75] The Economic Times. Amazon plans 3 solar farms and 23 solar rooftop projects in India. September 2022.
[76] The Economic Times. Govt notifies Green Open Access Rules 2022. June 2022.

Round-the-Clock (RTC) and Hybrid Projects

As India moves towards a policy focused on "reliable electricity" from "providing electricity", energy storage is the next frontier for the renewable energy sector. With incrementally higher renewable energy additions planned until 2030, battery storage will be a vital technology solution as it allows time to shift the dispatch of solar and wind power. Several RTC and Hybrid tenders being rolled out around the country require energy storage capabilities. A hybrid system of solar plus wind plus batteries helps provide RTC supply and complement the intermittency of renewable energy sources.

As India moves towards a policy focused on "reliable electricity" from "providing electricity", energy storage is the next frontier for the renewable energy sector.

In May 2022, Tata Power, AMP Energy, NTPC and SJVN were winners in SECI's 1.2GW Wind-Solar Hybrid Auction, where the discovered price was Rs2.53/kilowatt-hour (kWh). This tariff is very much in line with standalone solar tariffs across the nation.[77] More than 15GW of hybrid and RTC capacity has been tendered to date in the country, of which ~12.5GW has been allocated, and 7.5GW is expected to come online by 2023.[78] We expect the momentum in this segment to accelerate going forward.

The global cost of standalone Lithium-ion battery systems, the dominant chemistry in battery energy storage systems (BESS), has fallen from US$1,220/kWh in 2010 to US$132/kWh in 2021. Notwithstanding significant commodity inflation in 2022, BNEF projects a further decline in the cost to US$59/kWh by 2030.[79] Continued deflation in BESS will help RE plus storage become more competitive than thermal power.

Merchant Capacities

Merchant electricity markets in India, which aim to sell power through power exchanges, are still an evolving segment. There are currently no pure-play merchant capacities in the renewable energy segment in the country. But the scenario is touted to change fast given the country's aim to expand power markets to represent

[77] Mercom. Tata Power, Amp Energy, NTPC & SJVN Winners in SECI's 1.2 GW Wind-Solar Hybrid Auction. May 2022.
[78] HDFC Securities. Shifting energy landscape. June 2022.
[79] BNEF. 2021 Lithium-Ion Battery Price Survey. November 2021.

a 25% share by 2025 from the current 5.5%.[80] Several market-based reforms, such as the Central Electricity Regulatory Commission's (CERC) ancillary services regulations 2022, implementation of the national open access registry (NOAR) and the general network access regulations, will contribute to the growth of power markets in the country.[81] Another landmark order from CERC that will provide massive tailwinds to power markets is the approval to provide up to 3-month long contracts on the exchange.[82]

Besides policy side reforms, there are other tailwinds for this segment's growth. With the integration of the national grid and several projects underway to strengthen the interstate transmission system (ISTS), renewables-rich states are being encouraged to develop capacity beyond their own obligations and offer it for sale in a pan-India market. The payment security offered by the market mechanism addresses the issue of non-payment of dues faced by renewable energy developers. Further, increasing compliance over renewable purchase obligation targets, coupled with voluntary green targets committed by C&I customers, will continue to act as a driver for green merchant capacity additions in the foreseeable future.

IEX, the country's biggest power exchange, has rolled out several products to cater to the growing clean energy market. The exchange's green market, which now comprises green day-ahead, green term-ahead, and renewable energy certificate segments, aligns with India's sustainability aspirations. The company's Managing Director Satyanarayan Goel envisages 25GW of merchant capacities to come up in the next few years.[83]

A major hurdle to the installation of merchant-only capacity is the lack of financing when there is no long-term assured off-takers for a project. However, industry players are developing unique models where part market part long-term capacity models are part of the same project.

Offshore Wind

Offshore wind, a clean energy technology that has been a key growth driver in renewable energy adoption globally, is virtually non-existent in India. India has been bestowed with a coastline of about 7,600 km, which offers the potential to install ~195GW of offshore wind capacity. The country set a target to install 30GW of offshore wind capacity by 2030[84] back in 2015, but there has not been any movement since then as the country is waiting for more cost savings and technology gains. The average turbine size of offshore projects has doubled to 8MW in recent years, with a projected doubling again to 15MW or larger in the coming five years (refer to the International Utilities Section below).

[80] The Economic Times. Power exchanges can trade contracts up to 3 months now. 10 June 2022.
[81] IEX. IEX Annual Report FY 2021-2022.
[82] Central Electricity Regulatory Commission. Order on Petition No. 229/MP/2021 along with IA No. 25/2022. 7 June 2022.
[83] The Hindu Business Line. 25GW of merchant renewable energy capacity will come up in 3 years. March 2022.
[84] Financial Express. Tapping India's offshore wind potential. 13 July 2022.

Several factors have contributed toward offshore wind being a non-starter in India to date, the primary being its significantly higher cost than onshore wind and solar. The government has provided no incentives for developing this segment, something observed with its onshore counterparts, such as generation-based incentives. Further, a high variable renewable energy penetration and associated time-of-the-day pricing advantage must take off in India, as witnessed in newly emerging offshore wind countries such as Australia.[85]

The technology offers much better utilisation factors compared to onshore wind and solar. It is essential in providing round-the-clock renewable energy power with solar, the country's dominant clean energy source. The government has been wary of this fact and has been working on tweaking the defects in the current market. The Ministry of New and Renewable Energy (MNRE) has suggested supporting cost-free evacuation and power transmission from offshore to onshore transmission networks for projects commissioned by 2030.

Any developments fulfilling India's offshore wind targets will significantly contribute to the nation's renewable energy goals.

Electric Vehicle Uptake

Electric mobility is taking the global transport markets by storm. With global electric vehicle (EV) sales growing 103% year-on-year in the calendar year (CY) 2021 and the momentum continuing in 2022,[86] the electrification trend of global transport is accelerating rapidly.[87] India is also betting big on EVs to decarbonise its transport sector. At COP26 in November 2021, India set an ambitious goal to achieve EV sales accounting for 30% of private cars, 70% of commercial vehicles and 80% of two- and three-wheelers by 2030.

The recent battery-swapping policy will benefit EV makers. Further, the FAME-II policy by the Ministry of Heavy Industries (MHI) allocated Rs10 billion (~US$133 million) to set up EV charging infrastructure in India.

The EV sector presents an almost US$375 billion opportunity in India over the next five years.[88] For this opportunity to materialise, there will be a massive requirement for clean electricity assets in the country. While the current and envisaged installed renewable energy capacity in the country will cater to this massive demand-side trigger, there will be a need for incrementally higher capacity additions as the EV story pans out in the country.

[85] RenewEconomy. "Momentous:" Labor begins process to declare Australia's first offshore wind zone. 5 August 2022.
[86] Bloomberg. Electric Vehicles Have China's Massive Middle Market Surrounded. 30 August 2022.
[87] BNEF. EV Sales. March 2022.
[88] CRISIL. Electric vehicles a Rs 3 lakh crore opportunity for India. April 2022.

Other Tailwinds

Besides the growth avenues listed in the previous section, there are other tailwinds which, if materialised, can provide an added boost to India's renewable energy capacity addition trajectory.

Reliance Industries Limited's Mega Pledge in Gujarat

To make Gujarat net-zero and carbon-free, RIL, India's biggest conglomerate, proposes to invest ~US$625 billion in the state over 10-15 years to set up 100GW renewable energy power plants and a green hydrogen ecosystem. While this was just an initial announcement, RIL stated its intent to establish and enable at least 100GW of solar energy by 2030 in its recently concluded annual general meeting.[89]

Global Investors and Oil & Gas Majors Interested in Indian Renewable Energy Assets

Several global oil & gas majors, such as Shell, Total, BP, and Petronas, are vying to get a foothold in India's growing renewable energy market, primarily by buying operational assets or investing primary equity in domestic IPPs.[90] This allows domestic players to recycle their capital from operational into pipeline projects. Similarly, several global investors, such as pension funds, private equity funds, infrastructure investors and sovereign wealth funds, have invested heavily into the Indian renewable energy sector either through investing in local players or rolling out their investment vehicles in the Indian market to set up greenfield and brownfield capacities.

Global Clean Energy Giants Setting Up Domestic Capacities

Lastly, global IPPs, such as Enel, Eden Renewables (EDF), Statkraft and Fortum, have also been scaling up their renewable energy capacities in India and have ambitious goals to expand operations in the country. For instance, EDF has an ambitious target of doubling installed renewable capacity worldwide by 2030 to 50GW, with India playing a key role. Similarly, Enel has set a 129GW renewable energy capacity target globally by 2030, with emerging economies, such as India, also playing a part in it.

The following section delves into global utility leaders' clean energy trajectory and commitments to illustrate where Indian counterparts stand from a global perspective. It also shows how embracing the energy transition investment opportunities can be a winning corporate strategy even as it helps solve India's need for energy security and more sustainable economic growth. Accessing global capital markets will also be significantly enhanced if investment strategies align with the decarbonisation commitments of the US$130 trillion-strong Glasgow Finance Alliance for Net Zero (GFANZ).

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[89] Reliance Industries Limited. Reliance Industries Limited Annual General Meeting 2022.
[90] IEEFA. Global capital mobilising for India's $500bn renewable energy infrastructure opportunity. February 2021.

Global Energy Transition Utility Leaders

In this section, we evaluate four global energy transition utility leaders: NextEra Energy (US), RWE (Germany), Ørsted (Denmark) and Enel (Italy).

All four have demonstrated significant sustained share price outperformance vs their peers/benchmarks.

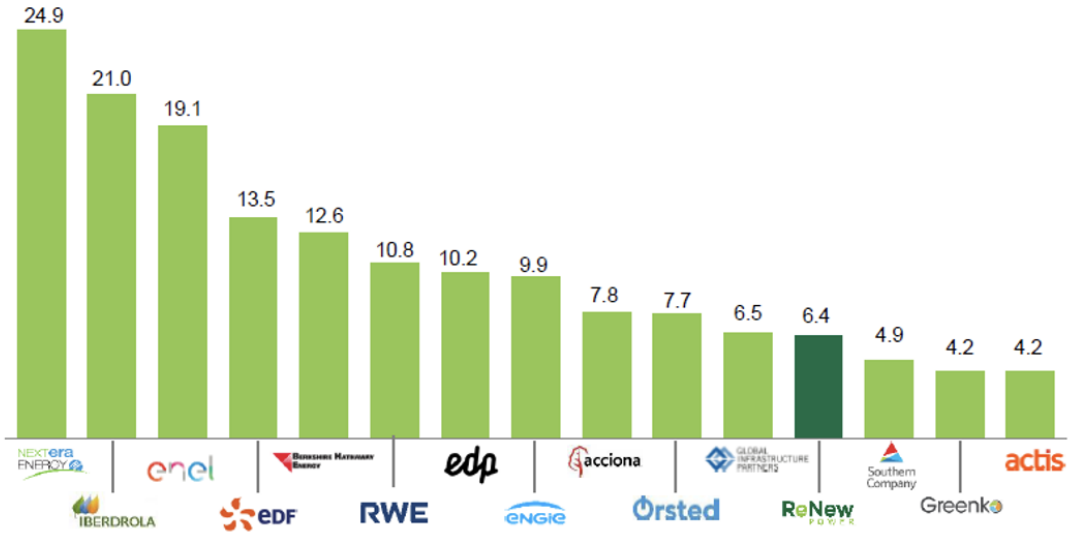
All have dramatic investment plans, with NextEra on track to invest over US$200 billion this coming decade, RWE targeting a €50 billion (US$50 billion)[91] gross investment and Enel a staggering €210 billion (US$210 billion) of capex (gross, including equity partner buy-ins and capital recycling). All have accelerated their world-leading investment plans in response to the hyperinflation of fossil fuel commodity prices, reflective of the increasing cost competitiveness of firmed renewable energy (even in the absence of a CO_2 price).

We examine the rapid scaling up of new investments in batteries and green hydrogen and emerging plans to progressively phase in the use of green hydrogen/renewable gas in methane gas-fired peaking power plants. However, we do not expect it to ramp up commercially for another 1-2 decades.

All four have clearly articulated decarbonisation targets, and it is noteworthy that none rely on carbon offsets or the mythical use of carbon capture and storage (CCS). All are tapping into the global green bond market for long-duration funding at very commercial rates.

[91] EUR/USD Exchange rate taken as 1.0 for forecasted figures.

Figure 21: The World's Leading Variable Renewable Energy Utilities (Excluding China)



Note: This excludes hydroelectricity capacity (Enel is 55GW including hydro)
As of 23rd September 2021, Net Capacity in MW (Operational).
Source: Renew Power Q2 2022 earnings presentation

NextEra Energy (U.S.)

NextEra Energy has continued to deliver excellent growth in sustainable earnings, with second quarter (2Q) CY2022 net profits of US$1.8 billion, on track to deliver 12% earnings per share (EPS) growth in CY2022 overall. NextEra Energy's adjusted earnings per share expectations reflect an impressive 10% compound annual growth rate (CAGR) from 2021 to 2025.[92]

Capital investment of US$85-95 billion over 2022-2025

Core to NextEra Energy's strategy is the continued expansion of its renewable energy and storage development portfolio, with a record capital investment plan to deploy US$85-95 billion into new investments over the four years through to 2025. This rapid expansion saw NextEra add 2.0GW to its pipeline in the last quarter alone to give a 19.6GW pipeline of project proposals, on track to deliver on its 2022-2025 target to add 28-37GW of new zero-emissions capacity (a 30% expansion relative to NextEra's current fleet). This is expected to incorporate adding 8-11GW of new wind, 14-19GW of solar and a record 5-7GW of energy storage.

In conjunction with US President Joe Biden's Inflation Reduction Act of 2022, rapidly rising fossil gas fuel prices, which are feeding into higher US electricity prices and

[92] NextEra Energy. Second Quarter 2022 Earnings Presentation.

making renewable energy even more competitive, underpin the commercial viability of these new investments. NextEra CFO Kirk Crews states:

> *"Renewables are not just the most economic form of generation—they are deflationary and countercyclical. Renewables support energy independence and help stimulate economic growth, including domestic job creation."*

NextEra continues to invest significant capex in its Storm Protection Plan to deliver increased resiliency and faster restoration times in response to increasingly extreme severe weather events, particularly in its home state of Florida, where both sea level rise and escalating extreme heat pressures are already impacting.

Real Zero Emissions by 2045

In June 2022, NextEra announced it would target a Real Zero to eliminate all Scope 1 and Scope 2 carbon emissions across NextEra Energy's operations by no later than 2045. NextEra identified that this pledge would deliver clean energy at zero incremental cost to customers, enhancing reliability and resiliency and substantially eliminating all fuel price volatility while driving US energy independence.

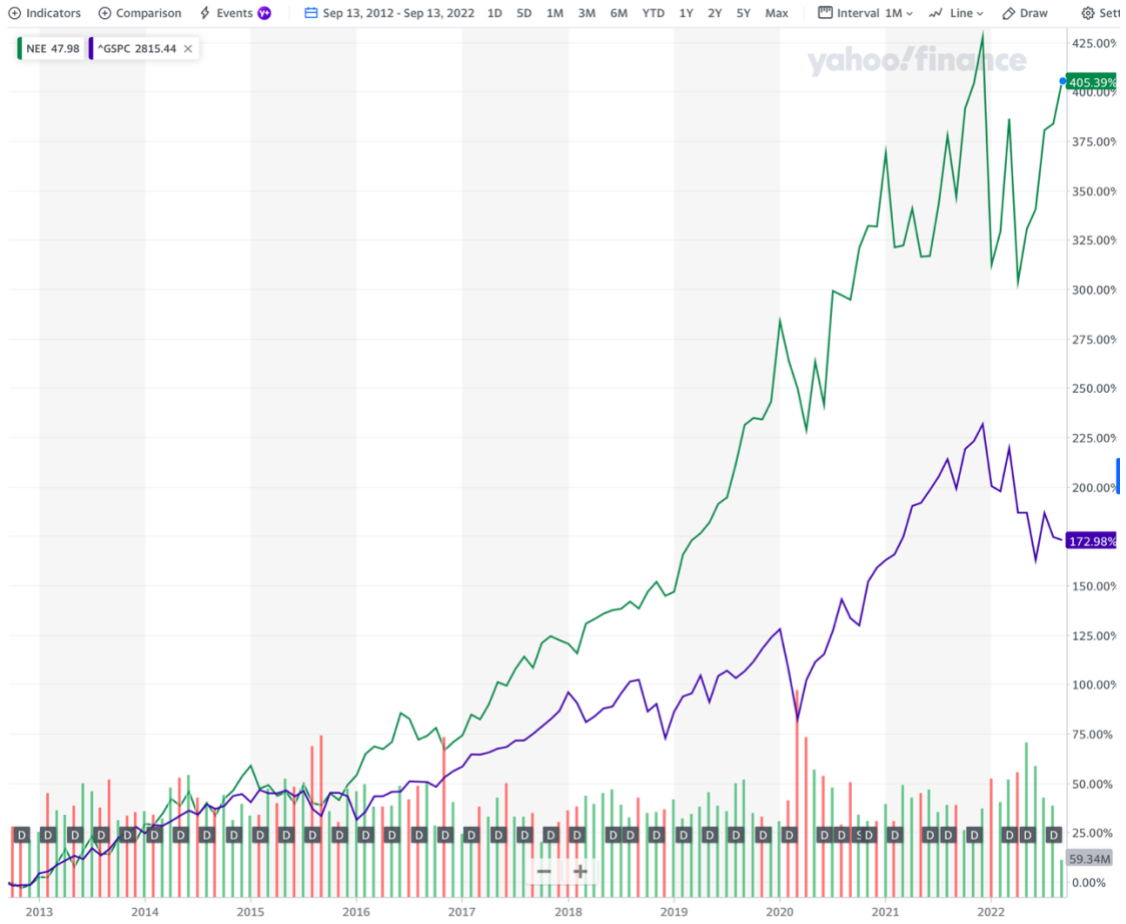
NextEra has set clearly articulated interim targets on a five-yearly basis: 82% by 2030, 87% by 2035, and 94% by 2040. This plan includes long-term plans to retire some of the existing methane gas power plants and convert 16GW of newer gas plants to run on green hydrogen (but not until 2042-45,[93] reflective of the lack of carbon pricing and still yet-to-be-commercially proven economics of hydrogen) and 6GW of renewable natural gas peakers as a key part of this strategy. Additionally, this includes building out a portfolio of 90GW of solar and 50GW of batteries and maintaining its 3.5GW fleet of nuclear power plants. No offsets nor carbon capture and storage (CCS) investments are part of this plan.[94]

Equity Market Performance

NextEra Energy (+405%) has materially outperformed the US equity market (+173%) over the last decade as it has ramped up its investments in zero emissions generation and associated grid infrastructure (see Figure 22).

[93] Bloomberg. NextEra's Plan to Ditch Carbon Is a Huge Bet on Hydrogen. 16 June 2022.
[94] NextEra Energy. NextEra Energy sets industry-leading Real Zero™ goal to eliminate carbon emissions from its operations, leverage low-cost renewables to drive energy affordability for customers. 14 June 2022.

Figure 22: NextEra Energy Equity Market Performance



Source: Yahoo Finance – accessed 14 September 2022

RWE (Germany)

RWE targets to double to a net 50GW of renewable energy capacity by 2030, which requires a €50 billion (US$50 billion) investment, with this anticipated to drive a 9% CAGR in core EBITDA.

July 2022 saw RWE report exceptionally strong earnings trends for CY2022, targeting EBITDA for RWE Group of between €5.0-5.5 billion (US$5.0-5.5 billion) due to skyrocketing European electricity prices on the back of Putin's invasion of Ukraine and associated restrictions on Russian gas exports.[95] While the whole generation portfolio of RWE benefits from hyper-energy price inflation, the coal and nuclear generation arms profits fail to fully benefit given higher fuel input costs and the fixed price long-term offtake contracts, the normal hallmarks of risk management for any integrated utility. RWE also took an €850 million

[95] RWE. RWE raises outlook for fiscal 2022. 27 July 2022.

(US$891 million) write-off of a thermal coal contract in the first quarter CY2022 due to the UK's sanctions against Russia.

€50 billion gross capex this decade on transition

RWE plans to invest €5 billion (US$5 billion) in green technologies in CY2022 as part of its very ambitious target that by 2030, it will double its global renewable energy installed capacity of 50GW, relative to the level at the end of 2021, while coal and nuclear capacity will drop by two-thirds to just 4GW. This includes building 21GW of renewables and batteries (6GW offshore wind, 5GW onshore, 8GW solar, 3GW of batteries (the latter up from just 47MW as of December 2021)), 2GW of gas peakers and 2GW of green hydrogen capacity.

To this end, RWE plans to invest €50 billion (US$50 billion) gross (€30 billion (US$30 billion) net of capital recycling and equity partners) in this decade to continue to progressively phase out its existing coal-fired power plant fleet and invest in new offshore and onshore wind power, solar, batteries and peaking gas generation. This 2030 goal is to achieve an adjusted EBITDA of €5 billion (US$5 billion), an increase of 80% compared to 2021.

It is very interesting to see how RWE considers batteries to be a key part of its investment plans, with the target of 3GW by 2030 up from just 47MW as of December 2021. As of August 2022, RWE details a 4GW battery development pipeline.

RWE's capex program aligns with the German government coalition's objective to accelerate the expansion of renewable energy, a top priority. Their Easter Package on 6 April 2022 stipulates that renewable power generation should account for 80% of gross electricity consumption by 2030. The German government's previous target was 65%. The total capacity of German offshore wind farms shall increase to 30GW over the current decade. This figure is expected to rise again to 70GW by 2045. The law also introduces new targets for onshore wind and solar capacities, which shall increase to 115 GW and 215GW, respectively, by 2030. By the middle of the decade, the German government wants to achieve annual build-out rates for these two technologies of 10GW and 22GW, respectively. To this end, the principle was enshrined in law that renewable energy usage is a matter of significant public interest and contributes to public security.[96]

The U.K. government is similarly introducing measures to reduce dependency on fossil fuel commodity imports, including significantly more ambitious goals for offshore wind and hydrogen. In July 2022, the UK government introduced a bill to Parliament on the improvement of security of energy supply. The law encompasses a series of measures relating to electricity production, grid infrastructure and energy efficiency. An accelerated expansion of renewable energy has also been planned, targeting an increase in U.K. offshore wind capacity to 50GW by 2030 (10GW more than previously envisaged). New floating wind farms are expected to account for a total capacity of 5GW by the same time. The U.K. government is also upping its ambition to grow hydrogen production capacity to 10GW by 2030, double

[96] RWE. Interim report on the first half of 2022.

the previous goal. Nuclear energy will also play a major role in the government's concept, with the generation capacity set to rise to 24GW by 2050. This would account for a quarter of the projected UK demand for electricity.

August 2022 saw RWE acquire Alpha Solar, bringing a 3GW solar development pipeline across Poland, providing a step-change in ambitions versus RWE's current 70MW wind and solar pipeline in the country.[97]

Offshore Wind

Offshore wind is a core part of RWE's global portfolio expansion. At the end of 2021, RWE had an offshore wind power portfolio with a pro-rata capacity of 2.4GW across the UK, Germany, Belgium, Sweden and Denmark. The company targets raising this figure to 8GW by 2030 (RWE's equity share). New projects are underway in Sofia (the UK, 1,400 MW), Kaskasi (Germany, 342MW, the first globally to pilot Siemens Gamesa's 9MW per turbine RecyclableBlade[98]), Thor (Denmark, 1,000 MW) and at F. E. W. Baltic II (Poland, 350 MW).

In Germany, RWE is progressing the development of four offshore wind projects with a total capacity of 1.5 GW – partly together with its Canadian partner, Northland Power, with turbines of up to 15MW each.[99]

February 2022 saw RWE's 73%-owned New York Bight Wind winning six leases that could accommodate up to 3GW of offshore wind as part of New York state's target of bringing 9GW of offshore wind online by 2035 and New Jersey's target of delivering 7.5GW of offshore wind by 2035.[100]

RWE is also working on offshore wind projects in Japan, Taiwan and South Korea.

Green Hydrogen

Hydrogen is an integral part of RWE's green growth strategy, with a target to build up 2GW of in-house electrolysis capacity by 2030 across Germany, the UK and Netherlands. RWE has partnered with numerous corporates in over 30 hydrogen project proposals globally.

April 2022 saw RWE announce plans for Germany's first green hydrogen storage facility at its existing natural gas cavern storage facilities at Kottiger Hook by 2026.[101]

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[97] PV Magazine. RWE buys Polish developer Alpha Solar. 25 August 2022.
[98] RWE. Power on: First turbine commissioned at RWE's Kaskasi wind farm in the German North Sea. 8 August 2022.
[99] OffshoreWind.biz. New German Offshore Wind Farm Planned to Use 15 MW Turbines and Include Hydrogen Production. 14 July 2022.
[100] RWE. RWE successful in New York Bight offshore lease auction in the U.S. 25 February 2022.
[101] RWE. RWE starts approval procedure for construction of hydrogen storage facility in Gronau. 29 April 2022.

May 2022 saw RWE announce a €30 million (US$ 32 million), 14MW green hydrogen pilot due for commissioning in mid-2023 (10MW alkaline, 4MW PEM[102]) with the expectation of three subsequent stages to expand to three electrolysers at the methane gas Lingen power station in the period from 2024 to 2026 of 100MW each, five times the largest 20MW green hydrogen facility currently operating outside of China. China has a 150MW green hydrogen facility it commissioned in December 2021, and Sinopec plans to commission a 260MW facility in mid-2023.[103] RWE targets 300MW by 2026 with the scope to expand green hydrogen at Lingen to 2GW by 2030.

December 2021 saw RWE announce a partnership with Kawasaki Heavy Industries to build and commission a 34MW 100% hydrogen-powered gas turbine at Lingen, Germany, by 2024.[104] This pilot will have global significance to test the assumption that methane gas-fired power plants can be progressively retrofitted to run on green hydrogen.

June 2022 saw RWE announce another 100MW green hydrogen electrolysis plant in partnership with EnBW, RheinEnergie and Rostock Port in North East Germany.[105]

RWE is part of the NortH2 consortium, including Shell, Equinor, Gasunie, Eneco and Groningen Seaports, that is undertaking a feasibility study to bring stage 1 online by 2027 in the Netherlands using 1GW of offshore wind energy for GH2 production, then expanding to 4GW by 2030 and 10GW by 2040 (to produce 1 Mtpa of GH2).[106]

RWE Targets Being Climate-Neutral by 2040

RWE has reduced its CO2 emissions by 60% between 2012 and 2020 "by abandoning electricity generation from fossil fuels and embracing renewables". Further, RWE targets to be climate-neutral by 2040, with a 1.5°C compliant pathway. The Science Based Targets Initiative has confirmed the targets, which are also in line with the Paris Climate Agreement.

RWE has also taken advantage of the global financial markets' increased appetite for ESG investing by issuing two green bonds totalling €2 billion (US$2.1 billion) in May 2022: one with a four-year tenor and a 2.12% annual coupon and another with an eight-year tenor and a 2.75% coupon. In all, RWE has issued five green bonds totalling €3.85 billion (US$3.85 billion). RWE's green bond policy, established in 2020, stipulates that proceeds on issuances be spent exclusively on wind and solar farms. RWE's rules also comply with the generally accepted Green Bond Principles of the International Capital Market Association (ICMA).[107]

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[102] RWE. RWE receives funding approval for 14-megawatt electrolyser test facility in Lingen – construction to start in June. 3 May 2022.
[103] South China Morning Post. China building world's largest 'green hydrogen' factory. 13 August 2022.
[104] RWE. RWE and Kawasaki plan to build one of the world's first 100% hydrogen-capable gas turbines on industrial scale in Lingen, Germany. 9 December 2021.
[105] Renews.biz. RWE, EnBW JV unveils 100MW green hydrogen scheme. 24 June 2022.
[106] RWE. Welcome to the age of hydrogen. accessed August 2022.
[107] RWE. Interim report on the first half of 2022.

RWE Target Internal Rates of Return

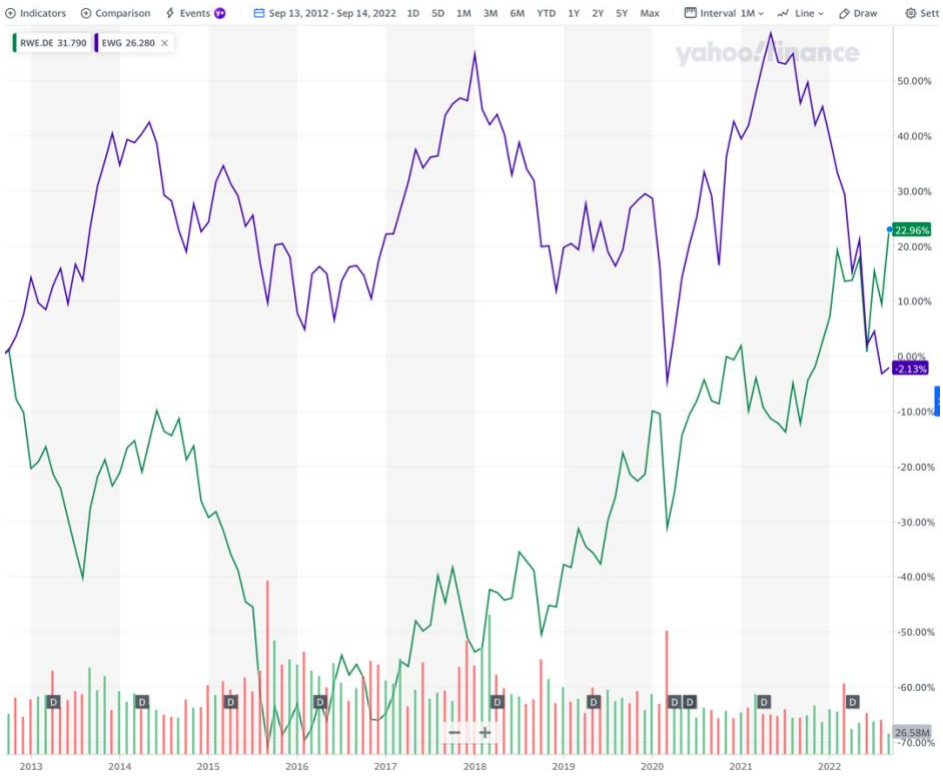
RWE details that its business plan is predicated on an after-tax, unlevered, nominal internal rate of return (IRR) of 5-9% for higher risk offshore wind, 4-7% for onshore wind, solar and batteries and 6-11% for flexible generation and green hydrogen.

The €50 billion (US$ 50 billion) of gross investment adds to €7 billion (US$7 billion) of mine and nuclear rehabilitation costs and €7 billion (US$ 7 billion) of total dividends until 2030 to give a gross €63 billion (US$63 billion) use of funds. This is expected to be funded by €20 billion (US$20 billion) of asset recycling (equity partners buy-in to new projects), €11 billion (US$11 billion) from expanded financial leverage and €32 billion (US$ 32 billion) of net operating cashflow, such that RWE can maintain its investment grade rating.

Equity Market Performance

RWE shares saw a significant, sustained underperformance in the first half of this last decade as the fossil fuel heavy utility underestimated the speed of the stranding of thermal power assets, combined with the entirely flawed spin-off of its renewable energy division (Innogy) in 2015/16. But since RWE has pivoted to embrace a planned energy transition, the company's shares have materially outperformed the German equity market since the trough in 2016 as it has ramped up its investments in decarbonisation (see Figure 23).

Figure 23: RWE vs iShares MSCI Germany (EWG) (2012-2022)



Source: Yahoo Finance – accessed 14 September 2022

Ørsted (Denmark)

August 2022 saw Ørsted increase its full-year EBITDA guidance by DKK1 billion (US$0.13 billion) to DKK20-22 billion (US$2.6-2.9 billion) on the back of a near record first half of CY2022 interim result.[108] Ørsted's green share of heat and power generation amounted to 92%, an increase of three percentage points compared to the same period in 2021, consistent with the steady transformation of this utility from its original fossil fuel base a decade earlier.[109]

Ørsted is one of the top 10 renewable energy firms globally by installed capacity.

Ørsted is one of the top 10 renewable energy firms globally by installed capacity.

Offshore Wind Developments

Ørsted is currently constructing two of the largest offshore wind farms in the world, Hornsea 2 in the UK's North Sea (1.4GW, 165 turbines of 8MW each) and Greater Changhua 1 & 2a offshore of Taiwan (900MW, 111 turbines of 8MW each) with full commissioning in September 2022 and 2023 respectively.

In Taiwan, beyond this first 900MW offshore wind farm, Ørsted won the right to build the 920MW Greater Changhua 2b & 4 Offshore Wind Farm in June 2018 with the aim to fully commission it in 2026. Additionally, Ørsted has started the environmental impact assessments (EIA) of the Xu Feng 1, 2 and 3 projects, with a total potential capacity of 2.1GW, and the Wo Neng 1 and 2 offshore wind projects, with a potential capacity of 3GW. Ørsted will utilise the Xu Feng and Wo Neng projects and the 570MW Greater Changhua 3 project that has already obtained EIA approval to scale up aggressively in line with the Taiwan Government's objective for 15GW of offshore wind by 2035.[110]

July 2022 saw Ørsted awarded a 15-year contract for difference (CFD) for building the Hornsea 3 Offshore Wind Farm in UK's Offshore Leasing Round 4 by the Crown Estate, the world's single biggest wind farm with a proposed capacity of 2,852MW for commissioning by 2027. This is a key new part of the UK Government's target for 50GW of offshore wind to be operational by 2030.[111]

The Hornsea Zone will also include Ørsted's Hornsea 4 project, with a proposed capacity of 2.6GW. Hornsea 4 is currently going through the planning process, with a

[108] Ørsted. Interim financial report First half year 2022.
[109] IEEFA. From Dong to Orsted: A leading utility's green energy transition. 3 September 2021.
[110] OffshoreWind.biz. Ørsted's Two New Offshore Wind Projects in Taiwan Move Forward. 9 June 2022.
[111] Ørsted. Ørsted awarded contract for world's single biggest offshore wind farm. 7 July 2022.

decision expected in early 2023. This builds on Ørsted's existing Hornsea 2 (1.32GW, commissioned in 2022) and Hornsea 1 (1.22GW, commissioned in 2019).

July 2021 saw Ørsted awarded a 1,148MW offshore wind contract by the New Jersey Board of Public Utilities for its project called Ocean Wind 2, working with GE Renewables as a key supplier. The 20-year PPA commences in 2027 at US$84/MWh, with a 2% annual escalator. This builds on Ørsted's proposed Ocean Wind 1, the company's first New Jersey project, which was awarded a 1,100MW contract by the same utility in June 2019. Ørsted's US offshore wind pipeline is over 4GW.[112]

Ørsted currently has 7.5GW of offshore wind in operation, as well as another 3.5GW under construction and another 11GW of awarded capacity under development. Ørsted has a global target of installing 30GW of offshore wind capacity by 2030.

Onshore Wind and Solar Developments

June 2022 saw Ørsted commission its 518MW hybrid onshore wind and solar Helena Energy Center project in South Texas, U.S.[113] Ørsted is building out its U.S. renewables platform with the construction of the 201MW Sunflower Wind project in Kansas.

June 2022 saw Ørsted commission the 62MW phase 1 of its 174MW onshore wind farm at Kennoxhead, Scotland. This project is a key part of the Scottish government's target of 50% of electricity generation from renewable sources by 2030 as part of the wider target of full decarbonisation of Scotland's energy system by 2045.[114]

June 2022 also saw Ørsted enter the Spanish renewables market, establishing a new office and announcing four new partnerships with Glide Energy, Rolwind, ARBA Energías Renovables, and Ereda. The Spanish government has set out to reach 70% renewable generation by 2030, followed by 100% renewable generation by 2050. The country plans to develop 39GW solar PV, 50GW onshore wind, 3GW of floating offshore wind, and 40-60MW of various types of marine energy by 2030, making Spain an absolute front runner in the green energy transition and an attractive market for developers.[115]

In July 2022, Ørsted signed an agreement to acquire the German and French onshore wind and solar platform Ostwind for €689 million (US$704 million) in recognition of the growing investment opportunities for onshore renewable energy.

With a current portfolio of 4.8GW of onshore wind and solar PV projects in operation and under construction across the US and Europe, not counting the Ostwind portfolio of 700MW of commissioned or under construction onshore

[112] Ørsted. Ørsted awarded 1,148 MW offshore wind contract in New Jersey, fully utilizing its Ocean Wind lease area. 7 January 2021.
[113] Ørsted. Ørsted commences construction of largest onshore project to date. 30 March 2021.
[114] Ørsted. Ørsted's first Scottish wind project, Kennoxhead, generates first power. 16 June 2022.
[115] Ørsted. Ørsted enters Spanish onshore renewables market with solar and wind partnerships. 8 June 2022.

assets, Ørsted is on track to meet its goal of reaching 17.5GW onshore renewables capacity globally by 2030.[116]

Green Hydrogen

Green Fuels for Denmark, which aims to produce large quantities of sustainable green fuels for road, maritime and air transport in the Copenhagen area, received IPCEI status from the European Commission in July 2022. When fully developed, the project aims to reach an eventual electrolysis capacity of a multi-phased total of 1,300MW.[117]

The 10MW Phase 1 will supply 1,000 tonnes per annum (TPA) of renewable hydrogen for heavy road transport. The 100MW Phase 2a will produce 50,000TPA of mainly e-methanol for shipping and enough e-kerosene to potentially fuel Denmark's first green domestic air connection. Phase 2b plans to reach 300-350MW of cumulative capacity. When in full operation, phase 2b will produce 100,000TPA in total of e-methanol and e-kerosene, equivalent to more than the total consumption of fuels for domestic aviation in Denmark. Phase 3 – the full 1,300MW capacity – will be able to produce 275,000TPA of renewable fuels. Subject to FIDs, phase 1 could enter commercial operations in 2023, phase 2a in 2025, and phase 2b in 2027.

Ørsted is tendering in 2022 on three other green hydrogen proposals in partnership with Yara, BP and others across Netherlands and Germany.

Equity Market Performance

Despite a significant derating since the peak at the start of 2021, Ørsted (+201%) has materially outperformed the Danish equity market (+53%) since listing in 2016 (see Figure 24).

[116] Ørsted. Ørsted acquires German and French onshore wind platform Ostwind. 23 July 2022.
[117] Ørsted. Green Fuels for Denmark receives IPCEI status. 16 July 2022.

Figure 24: Ørsted A/S vs iShares MSCI Denmark (EDEN) (2016-2022)

Source: Yahoo Finance – accessed 14 September 2022

Enel (Italy)

With a portfolio of 55.4GW of renewable energy capacity globally spanning 27 countries, Enel is the world's largest renewable energy firm, including 28GW of hydro. Enel's total capacity is 88.5GW (including 6.9GW of coal, 15.0GW of gas, 11.7GW of oil and 3.3GW of nuclear).

While Enel targets an 80% growth in annual revenue by 2030 to €34 billion (US$34 billion), this assumes average delivered wholesale electricity prices stay flat at €75 (US$75)/Megawatt-hour (MWh) in real terms, with higher service and grid revenues offsetting a 40% decline in average cost of energy sold by 2030 (leveraging a 50% decline in renewable energy costs per MWh).

Enel targets a 5-6% CAGR in EBITDA over this coming decade, driving a 6-7% CAGR in net income and hence dividends per share. Enel expects CY2022 EBITDA at €19.0-19.6 billion (US$19.0-19.6 billion), flat for the year after absorbing a ~€2 billion (US$ 2 billion) hit from the market turbulence as the spot wholesale price of electricity us quadrupling to €200-250 (US$200-250)/MWh year-on-year.

Ironically, low water availability undermines Enel's ability to fully leverage its 28GW of hydroelectricity.[118]

Enel Targets Net Zero by 2040

In 2021, Enel brought forward its target for Net Zero by a decade to 2040 by driving electrification and ongoing accelerated phase-out of its end-of-life thermal capacity with firmed renewable energy capacity. Unlike most fossil fuel firms, this puts no reliance on carbon removal and is 100% aligned and certified with 1.5°C in accordance with the SBTi.

Enel has set its target scope 1 emissions at 82g/kWh by 2030, down 80% from 414g/kWh in 2017. Enel is well on track with a halving of emissions to 219g/kWh delivered in the four years to 2021. Enel is on track to exit 100% of its coal-fired power fleet by 2027 and exit 100% of its gas fleet by 2040. This means renewable energy will form 85% of Enel's capacity by 2030 and 100% by 2040, up from 58% in 2021. Given one-third of Enel's capex is invested in emerging markets, this is a world-leading commitment.

As a leading investor in decarbonisation, Enel has been able to regularly tap into the global green bond market.

As part of Enel's drive to remain the world's top renewable power utility, Enel targets a partnership share of 10% of all multinationals globally as they drive towards full electrification and Net Zero.

As a leading investor in decarbonisation, Enel has been able to regularly tap into the global green bond market:

- In January 2022, Enel issued a €2.75 billion (US$3.1 billion) sustainability-linked bond with three tranches of 3-13 years duration at fixed rates of just 0.25% per annum rising to 1.25% per annum for the 13-year duration tranche.
- In March 2022, Enel increased by €3.5 billion (US$3.9 billion) the amount of the €10 billion (US$11.1 billion) 4-year Sustainability-Linked revolving credit facility signed in March 2021
- In June 2022, Enel issued a US$3.5 billion sustainability-linked bond with four tranches of 3-30 years duration at fixed rates of 4.25-5.5% per annum.

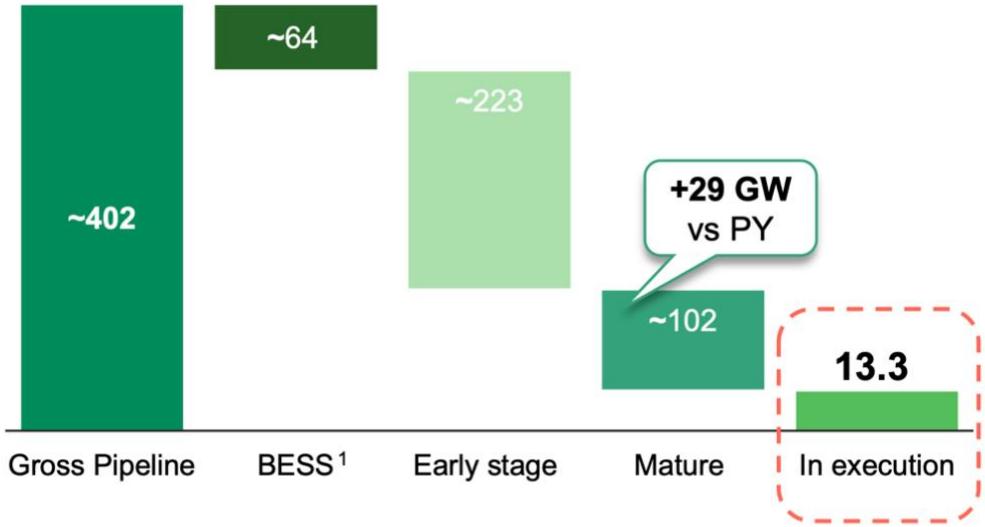
[118] Enel. 5.9 billion euro investments in first half 2022, a 22.4% increase to further accelerate the energy transition. 28 July 2022.

€210 billion gross capex this decade on transition

Enel's capex budget for 2021-2030 is a staggering €210 billion (US$210 billion) gross, with €160 billion (US$ 160 billion) being Enel's equity share, split equally between grid modernisation (€70 billion (US$ 70 billion)) and expansions and renewable energy generation capacity. This plan entails adding 84GW of renewable energy capacity (32GW of wind, 43GW of solar and 9GW of batteries) to take Enel's equity total to 129GW by 2030 (154GW gross), giving a 570TWh pa of electricity generation, supported by 20GW of demand response capacity.

As of June 2022, Enel had a gross project pipeline of over 400GW of renewables capacity, including 64GW of batteries – Figure 25. Enel targets a sixfold expansion in its internally managed, externally owned capacity to 25GW (50 Terrawatt-hours [TWh] per annum) by 2030.

Figure 25: Enel SpA Renewables Capacity Development Pipeline (GW)



1. It includes BESS for around 45 GW in early stage and around 19 GW in mature pipeline
2. It includes both renewables and BESS

Source: Enel Results Briefing, 28 July 2022

Enel targets to have 100% of its customers digitised by 2030, requiring an 80% expansion of its installed smart meter base. Between 2020-2024 alone, Enel targets a 20% grid commercial loss reduction across its global network, a key efficiency target. Enel also targets its customers to operate a collective 20,000-strong fleet of electric buses by 2030, up from 900 today.

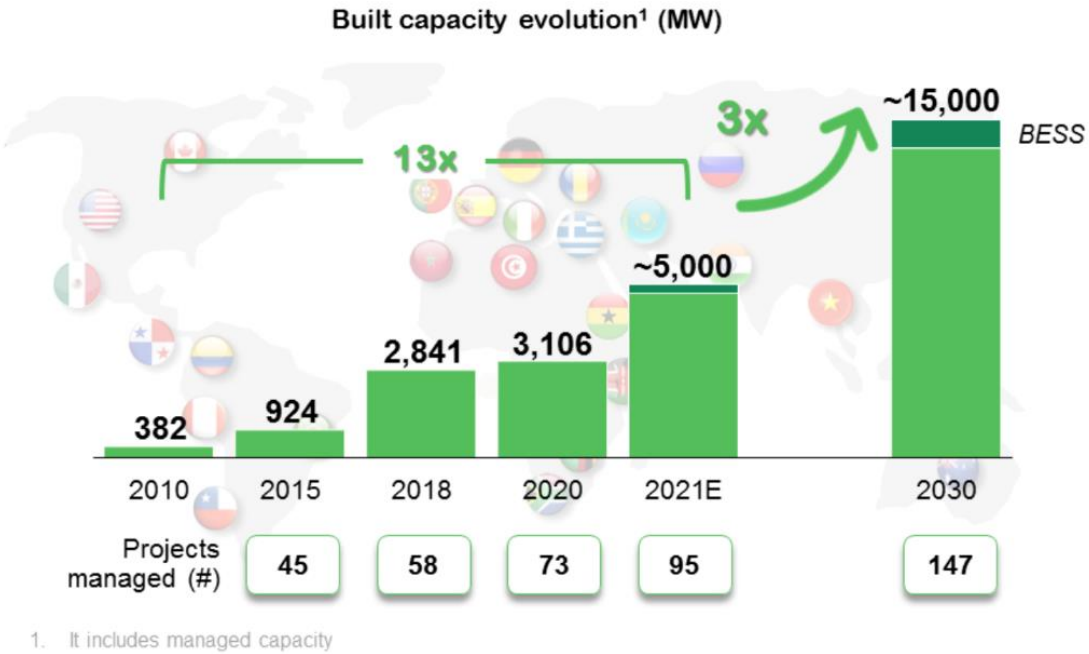
This is by far the largest investment program of any company globally in decarbonisation. Most investments are planned to drive decarbonisation and energy access in emerging markets like Mexico, Brazil, and Chile while also progressively replacing the end-of-life thermal power capacity in Enel's main developed world markets of Spain, Italy, Portugal and the U.S.

Enel's capex budget for 2022-2024 is €52 billion (US$52 billion) (€43 billion (US$43 billion) net), a 12% increase on the previous three-year capex plan to add 23GW of gross new capacity (including 2GW of batteries), with 6GW added in CY2022 alone (including 0.5GW of batteries).

April 2022 saw Enel announce a €600 million (US$ 632 million) investment to expand its 200MW solar module manufacturing plant in Sicily to 3GW per annum of high-efficiency capacity, one of the largest in Europe, with commissioning due July 2024, initially 40% powered by renewable energy.[119]

CY2021 involved investing €6.6 billion (US$7.5 billion) to add 5GW of new renewables capacity, and by CY2030, Enel targets trebling this inhouse installation capacity to 15GW per annum (see Figure 26).

Figure 26: Enel SpA Renewable Energy Capacity Installs (MW pa)



Source: Enel Capital Markets Day, 15 November 2021

Green Hydrogen

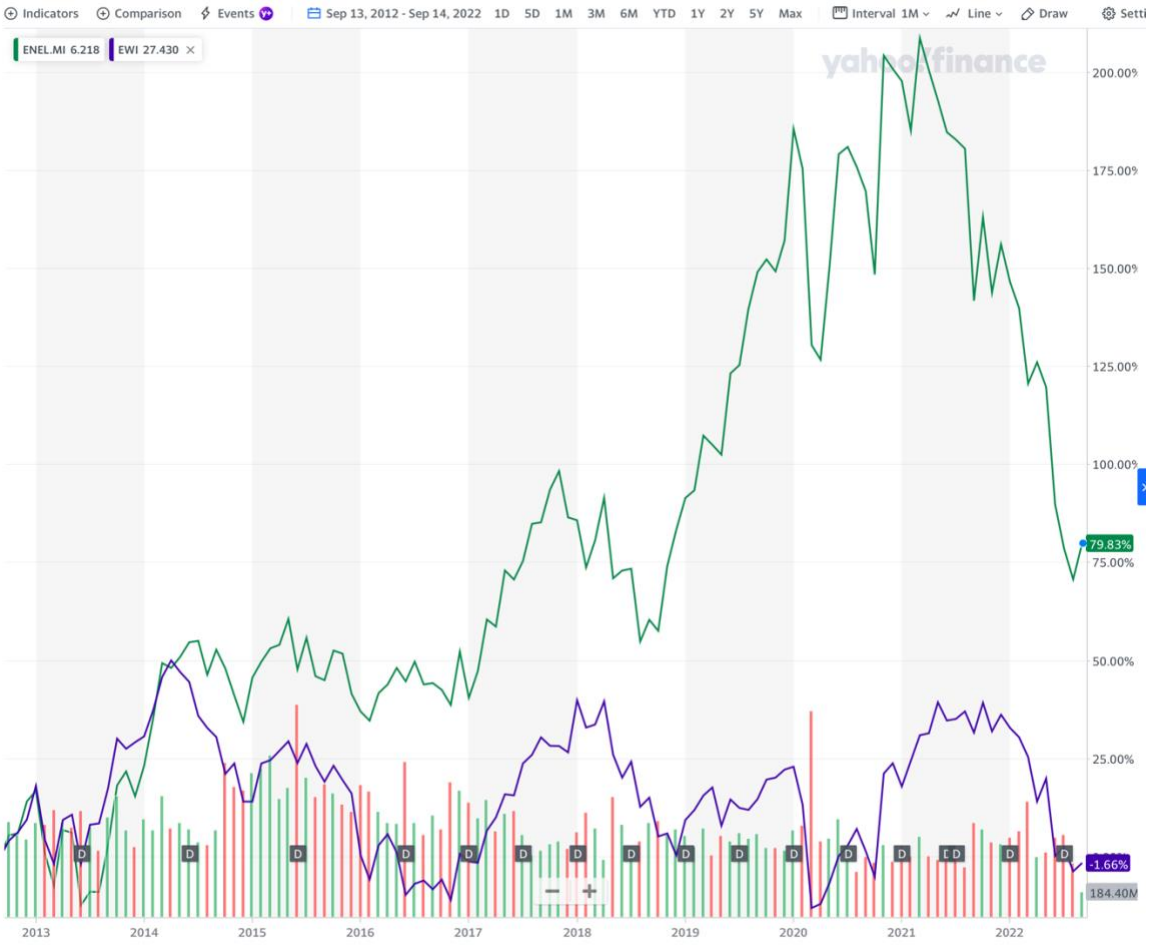
August 2022 saw Enel announce its Hydrogen Industrial Lab in Sicily won IPCEI Hy2Tech European Union funding for developing hydrogen-focused R&D initiatives of strategic interest using a 4MW green hydrogen electrolyser pilot.[120]

[119] Enel. Enel Green Power signs grant agreement with the EU for solar panel Gigafactory in Italy. 1 April 2022.
[120] Enel. Enel Green Power's Hydrogen Industrial Lab wins IPCEI Hy2Tech European funding. 1 August 2022.

Equity Market Performance

Despite a significant derating since the peak in 2021, Enel (+80%) has materially outperformed the Italian equity market (-2%) over the last decade (see Figure 27).

Figure 27: Enel SpA vs iShares MSCI Italy (EWI) (2012-2022)



Source: Yahoo Finance – accessed 14 September 2022

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