

India's Electricity-Sector Transformation: Global Capacity Building

"No power on earth can stop the idea, whose time has come"

Victor Hugo



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and Financial Analysis
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In this briefing paper, the Institute for Energy Economics and Financial Analysis (IEEFA) provides an updated review of India's electricity sector transformation, given the acceleration of momentum that has occurred over 2015. This report analyses key corporates that are developing strategies to implement the Indian Government's US\$200 billion (Bn) target for renewable-energy investments by 2021/22. This report also outlines the global capacity that is rapidly building as new global entrants bring international capital, technology and management expertise to accelerate the deployment of 175 gigawatts (GW) of renewable energy to India.

Executive Summary

IEEFA finds that momentum around India's electricity-sector transformation has accelerated as 2015 has progressed. Key developments:

- In February 2015, 293 companies pledged to build a combined 266GW of renewable-energy projects in India by 2021/22 as part of the major Government of India summit, RE-Invest.¹ At the time, global financial markets were sceptical about whether non-binding intentions could be turned into concrete actions.
- Eight months later, well over US\$100bn of firm commitments have been announced by a multitude of companies at successively lower prices fixed flat for 25 years. These include state-owned enterprises, leading Indian power companies, a number of Indian billionaires new to the power sector, plus a multitude of leading global renewable-energy firms.
- Bridge to India calculates that the Indian solar project pipeline is over 8GW, with another 4GW of tenders under way currently. Given India was installing less than 1GW annually in the last three years, this strongly indicates installations will more than double in 2015/16 to 2-3GW² and double again in 2016/17 to 5-6GW.
- The firm-commitments list is growing daily. In October 2015 alone, India saw the following major moves:
 - Sany Group, China announcing plans to invest US\$3bn in Indian renewables by 2020;
 - Chint Group, China announcing plans to invest US\$2bn of Indian renewables by 2020;
 - Coal India Ltd signing an MoU with Solar Energy Corporation of India to construct 1GW of solar power plants;
 - India's Embassy Group announcing plans to develop 1GW solar and wind parks across the country over the next 5 years and commencing a 200MW project;
 - India's ReNew Power raising US\$265m in new equity from investors, including US\$200m from Abu Dhabi Investment Authority and US\$50m from Goldman Sachs;

¹ <http://www.hindustantimes.com/business-news/293-companies-pledge-266-gw-clean-power/article1-1317191.aspx>

² Press speculation is that installs for 2015/16 might even reach 4GW after 593MW were installed in 1HFY2015/16:
http://www.domain-b.com/industry/power/20151031_capacity.html#sthash.tfbwBt0A.dpuf

- Spanish firm Gamesa receiving orders to install wind projects of cumulative capacity of 140MW (100MW from Hero Group, 40GW from ReNew Power);
 - INOX Wind receiving orders to install wind projects of cumulative capacity of 100MW and commissioning 116MW of new wind (Tata Power, Sembcorp);
 - Orange Renewables of Singapore awarding Suzlon Energy a repeat order for a 101MW wind energy project in Andhra Pradesh;
 - Welspun commissioning the largest solar project to-date in Punjab, a 34MW plant at Bathinda, and signing an MoU for a second 151MW project in Punjab;
 - Neyveli Lignite Corporation announcing its third solar project, that being 25MW in Barsingsar, Rajasthan, and its first 51MW wind power farm, in Tirunelveli, Tamil Nadu;
 - The new SoftBank/Foxconn/Bharti joint venture signing its first US\$2bn memorandum of understanding (MoU) in Andhra Pradesh for 3GW of renewables;
 - Suzlon commissioning a 50MW wind project for Ostro Energy in Rajasthan; and
 - Aditya Birla Nuvo announcing its partnership with Dubai-based private equity investor Abraaj Group to develop 1GW of utility-scale solar power plants in India.
- There was much scepticism when Energy Minister Piyush Goyal announced a target for Coal India Limited to double coal production to 1 billion (bn) tonnes in the six years to 2020/21. However, after five years of 2% annual growth to 2013/14, Coal India Ltd delivered 6.9% volume growth in 2014/15, and in the period of April to October 2015, production growth has accelerated to 9.2%. While this report is about renewable-energy momentum, this example illustrates the across-the-board progress in India's electricity sector transformation.
 - Consistent with domestic coal production accelerating, 2015 is likely to see thermal coal imports peak, as detailed by Minister Goyal in his November 2014 target. In the seven months to October 2015, Indian coal imports have declined 6% year-on-year, culminating in a 27% collapse in the month of September 2015 and a 5% yoy decline in October 2015.³⁴
 - The Reserve Bank of India has cut official interest rates three times in 2015 for a total of 125 basis points, highlighting another tailwind for renewable investment in India. Having almost zero operating costs means the construction capital and financing cost is the key hurdle. The lower the interest rate environment, the more competitive renewables are.
 - In November 2015 the 500MW Solar tender in Andhra Pradesh saw a winning bid of Rs4.63 (US\$0.071)/unit.⁵ The same auction saw bids submitted for 5.5GW by 30 developers.⁶ This puts utility scale solar below the delivered wholesale cost of electricity of Rs5.15/kWh in 2013/14,⁷ with some 5% annual real price declines locked in for the next 25 years.

³ <http://in.reuters.com/article/2015/10/19/india-coal-imports-idINKCN0SD0C920151019>

⁴ <http://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/coal-imports-drop-5-to-14-52-million-tonnes-in-october/articleshow/49721013.cms>

⁵ <http://economictimes.indiatimes.com/industry/energy/power/sunedision-to-supply-cheapest-solar-power-in-india/articleshow/49654469.cms>

⁶ <http://www.bridgetoindia.com/blog/500-mw-of-nsm-bids-in-andhra-pradesh-to-close-below-inr-5-37kwh/#sthash.id4cQNkl.dpuf>

⁷ http://www.pfcindia.com/writereaddata/userfiles/file/Operations/state_performance/Report%20on%20the%20Performance%20of%20State%20Power%20Utilities%202011-12%20to%202013-14.pdf

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Introduction

The government of India has initiated a radical transformation of the Indian coal-mining, renewable-energy, power-generation and electricity-distribution sectors. Minister Goyal has set extremely ambitious targets in regard to increasing Indian energy supply, including adding 175GW of renewable-energy installation by 2022, a US\$50bn modernisation of the electricity grid and a target that could increase India's domestic coal production to 1,500Mtpa. All of these measures are likely to see the cessation of thermal coal imports in the medium term.

Investment in Indian renewables, particularly solar, has seen a step-change in momentum as 2015 has unfolded. Total solar installs had reached 4.57GW by October 2015. Almost every successive tender for new solar projects has resulted in new record low power purchase price agreements (PPA) emerging, with the latest and lowest to date being a 25-year fixed PPA at Rs4.63/kWh (US7c/kWh), already significantly below the cost of new imported coal-fired power projects even before considering the deflationary benefits of zero indexation.

In this report we analyse how global renewable-energy majors are rapidly building up financial and management capacity in India, generally undertaking joint ventures with established renewable-energy firms in India to ensure local industry and regulatory expertise is in place. Global firms bring access to global debt and equity capital, plus the latest technology.

2015 has seen an increasing number of corporates making significant investments:

- Four of the world's largest solar manufacturers advance plans to build Indian solar manufacturing capacity (Trina Solar, JA Solar, Hanwha Q CELLS, LONGi).
- Three of the world's top renewable-energy utilities have each recently acquired top Indian renewable project-development firms (EDF Energies Nouvelles, ENEL Green Power, ENGIE).
- Four of North America's top solar-development companies have accelerated project development in India (Sky Power of Canada, First Solar, SunEdison and SunPower).
- Leading Asian innovators and utilities have targeted Indian renewables (Foxconn of Taiwan, SoftBank of Japan, Sembcorp of Singapore, CLP Group of Hong Kong).
- Most of the leading Indian energy sector conglomerates have initiated multiple new investment programs in renewables (Adani Power (10GW of solar), Tata Power (~4GW), Reliance Power (6GW of solar, 5.2GW of hydro)).
- Several of India's wealthiest companies have entered the power markets to invest in renewables (Aditya Birla Group, the Dilip family, Bharti Enterprises, Jindal Steel and Power).
- India's emerging renewable-development firms have built momentum (Welspun, Azure, Greenko, ACME Solar, ReNew Power, Suzlon Energy, Vikram Solar, Essel Infraprojects Limited, INOX Wind, Ostro Energy).
- Indian State Owned Enterprises (SOE) have diversified into renewables (NTPC Ltd, Coal India Ltd, Neyveli Lignite Corporation, Indian Railways, National Hydro Power Corp.).
- Global development banks and leading equity investors are providing innovative green finance (International Finance Corp, the World Bank, KfW of Germany, Asia Development Bank, Abu Dhabi Investment Authority, GE, Goldman Sachs, Actis Capital).

In October 2015, Indian Prime Minister Narendra Modi challenged Indian state political leaders to make the development progress of solar projects a number-one priority.⁸ Chairing the sixth “*Pro-Active Governance and Timely Implementation*,” Modi used the platform to reaffirm the government’s goal of installing 100GW of solar PV capacity by 2022.

Bridge to India estimates there is now a pipeline of 12GW of new solar projects now under development or tender, up from virtually nothing at the start of 2015. Momentum is building with every month, as is financial, engineering and supply chain capacity.

Also in October, the German government pledged €1.5bn over five years to support India’s solar energy expansion through a German-Indian solar partnership.⁹

A key consideration for India’s electricity sector is the relative speed of project development. While the Modi government has professed a desire to build nuclear capacity, individual projects remain stranded, with a realistic commissioning timeline of over a decade. Large-scale hydro in India likewise has a history of community resistance due to environmental and social issues.

For coal-fired power plants, a three- to four-year planning and construction timetable is best practice, and five to seven is normal. For wind, the timeline is one to two years to commissioning, and solar just 12 months.

Should the Indian economy deliver its target of 7-8% annual economic growth, new renewable energy projects are well placed to deliver 50-60% of the new electricity generation needs of India through to 2021/22, whilst grid efficiency and energy efficiency could deliver 20-30% of the delivered electricity required.

IEEFA has reviewed the development progress of Reliance Power, one of the major private electricity generators in India. Reliance Power is reported to be exiting almost its entire coal and gas-fired generation plant expansion plans that totalled 14GW at the start of 2015/16. Reliance Power has even gone so far as to seek to sell its 4GW Sasan coal-fired UMPP, a project that was only fully commissioned at the start of this year. Reliance Power is now focused on profitable growth, which in India almost entirely revolves around its 6GW solar and 5GW hydro electricity expansion plans.

⁸ http://www.pv-magazine.com/news/details/beitrag/india--pm-modi-calls-on-states-for-proactive-solar-push_100021320/#ixzz3oERmpthz

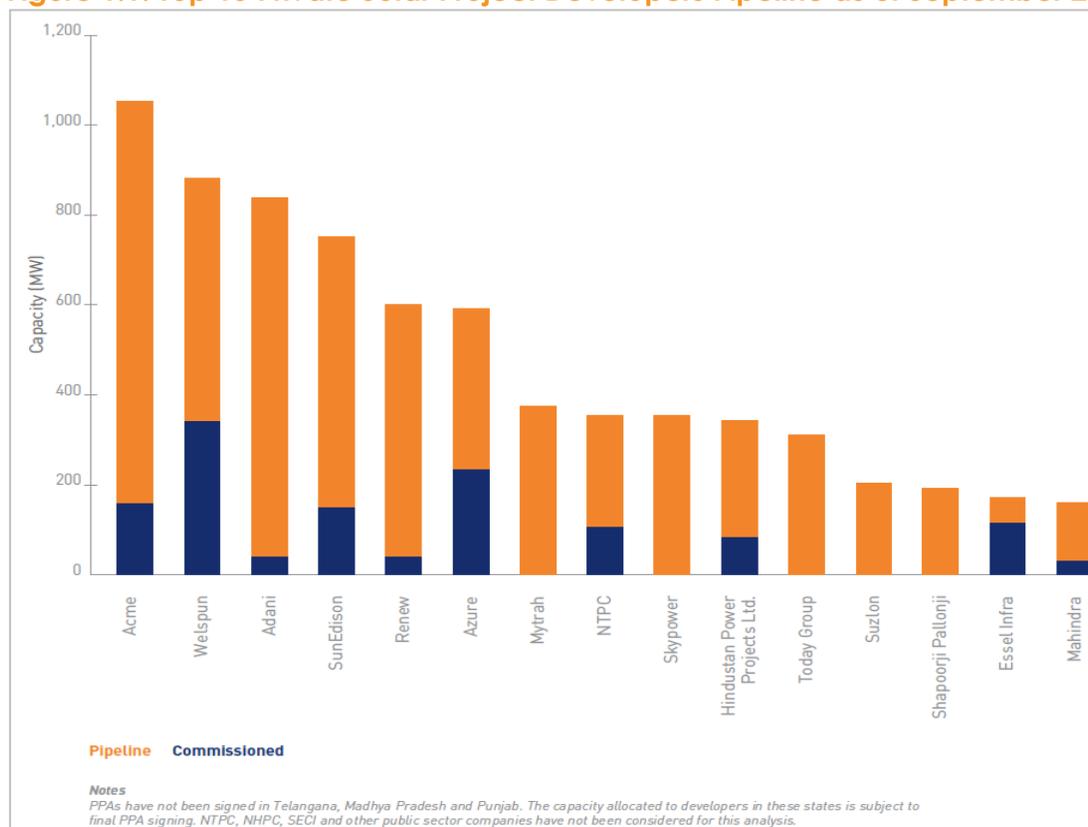
⁹ http://www.pv-magazine.com/news/details/beitrag/german-government-to-invest-eur-15-billion-to-aid-indias-solar-transition_100021392/#ixzz3oF0NGDIr

Section 1 – Overview

Energy Minister Piyush Goyal has set extremely ambitious targets in regard to increasing Indian energy supply, including adding 175GW of renewable energy installation by 2022. Beyond this, there have been suggestions that India consider including a commitment to 350GW of renewables by 2030 in their Intended Nationally Determined Contribution (INDC). Whilst omitted from the final report, an extrapolation of the installation rates implied in the 2015-2022 period suggests to IEEFA that should 175GW be achieved by 2022, 350GW by 2030 could even be considered a conservative objective.

Figure 1.1 details estimates from Bridge to India of the solar development pipeline for the top 15 private project developers in India. This details both the rapid expansion of the Indian solar pipeline, which Bridge to India estimates at over 8GW under development with another 4GW of tenders currently in progress as of October 2015. This is a step change in solar installation activity over 2015, given India's total cumulative installed utility scale solar farms is 4.7GW.

Figure 1.1: Top 15 Private Solar Project Developers Pipeline as of September 2015



Source: Bridge to India Solar Map, September 2015.¹⁰

¹⁰ http://www.bridgetoindia.com/wp-content/uploads/2015/09/india-solar-map-2015_final.pdf

Figure 1.2: Major recent corporate initiatives in Indian renewables (since Jul'15)

Company	Investment	Announced	US\$m	Wind MW	Solar MW
SunEdison	SunEdison bid a record low of Rs4.63/unit in a reverse auction to build a solar power project of 500MW capacity	Nov'2015	500		500
Coal India Limited	MoU signed between the Solar Energy Corporation of India and Coal India Ltd to construct solar power projects totaling 1GW of capacity. CIL plans to finish a 250 MW installation in Madhya Pradesh within twelve months.	Oct'2015	1,000		1,000
SoftBank, Japan / Bharti Enterprises, India / Foxconn, Taiwan	The consortium JV, SBJ Cleantech, signed an MoU with the government of Andhra Pradesh to add solar and wind capacities in the state.	Oct'2015	2,930	1,000	2,000
Sany Group, China	Sany Group, a construction equipment manufacturer, committed to develop 2GW of solar power capacity in India.	Oct'2015	3,000		2,000
Aditya Birla Group	Aditya Birla Nuvo announced partnership with the Dubai based PE investor Abraaj group to develop 1GW of Indian solar	Oct'2015	1,000		1,000
Gamesa, Spain	Gamesa won order to supply turbines for a 100MW wind farm in Madhya Pradesh.	Oct'2015	100	100	
Chint Group, China	Chint Group committed to invest \$2bn in solar projects	Oct'2015	2,000		
Embassy Group	India's Embassy Group has announced plans to develop 1GW solar and wind parks across India over the next 5 years	Oct'2015	1,000		
Renew Power India / Gamesa	ReNew Power awarded Gamesa a 40MW turbine order for its new wind farm in the state of Karnataka	Oct'2015	40	40	
Welspun Energy, India	Welspun inaugurated a 34MW solar power plant in Punjab. Welspun raised US\$617m of equity and debt	Oct'2015	617		34
INOX Wind	INOX Wind won a 50MW wind energy project in Gujarat	Oct'2015	50	50	
Adani Green Energy	Adani Green Energy won the bid to develop 50MW solar power plant in the state of Uttar Pradesh	Sep'2015	50		50
Enel Green Power	In September 2015 Enel Green Power acquired a majority stake in BLP Energy for about US\$34m to enter India	Sep'2015	34	172	
SunEdison Inc. U.S.	SunEdison signed an MoU with the govt. of Tamil Nadu to set up 2GW of solar power and wind energy over the next 5 years. SunEdison bid 500MW into a new solar tender auction in Andhra Pradesh	Sep'2015	2,500		2,500
LONGi Silicon, China	Chinese solar wafer maker Longi signed a MoU with Andhra Pradesh for the construction of a solar cell & module manufacturing facility . MOU includes installation of 500MW of solar power capacity.	Sep'2015	250		500
Essel Infraprojects/ JA Solar, China	JA Solar and Essel formalize agreement to construction of a 500MW solar cell factory in Andhra Pradesh, with a similar-size module factory to follow; completion stage II targeted by mid 2017.	Sep'2015	150		500
Neyveli Lignite Corporation	Neyveli Lignite Corporation Limited (NLC), which comes under Ministry of Coal, to set up solar power plants to produce 4000 mega watt (MW) of power.	Sep'2015	4,300		4,000

Company	Investment	Announced	US\$m	Wind MW	Solar MW
Jindal Steel and Power	Jindal Steel and Power Ltd submitted a 1GW solar proposal to the Government of Jharkhand	Sep'2015	1,000		1,000
Suzlon Energy	Suzlon commissioned a 101MW wind project in Rajasthan. Suzlon also disclosed a technical feasibility study for a 600MW pilot offshore wind energy project in Gujarat	Sep'2015	700	700	
Hindustan Power Projects	Hindustan Power entered the Green Bond market with a US\$58m bond issue	Sep'2015	58.5		
China Light and Power (HK)	CLP Power raised a US\$92m green bond to finance its wind projects of 1GW.	Sep'2015	92.0	1,000	
Sky Power, Canada	Sky Power won 200MW of projects in the state of Telangana with the lowest quotes amongst all bidders	Aug'2015	200	200	
Acme Solar	Acme solar won 445MW of PV tenders in the state of Telangana	Aug'2015	446		446
SoftBank, Japan / Bharti Enterprises / Foxconn, Taiwan	Announced a JV to invest US\$20bn in Indian solar over the next decade, citing high radiation and low install costs.	Jul'2015	20,000		20,000
Sky Power, Canada	Progressing a commitment to build 10GW of solar in India by 2020, Sky Power won a 150MW of solar in MP at a record low Rs5.05/kWh fixed tariff.	Jul'2015	150		150
Renew Power India / Hanwha Q CELLS, Korea	Renew announced an agreement with Hanwha to develop two solar projects in the State of Telangana, totaling 149MW.	Jul'2015	150		149
Renew Power India / Hareon Solar, China	Renew announced an agreement with Hareon to develop a 72MW solar project in the State of Andhra Pradesh.	Jul'2015	72		72
Aditya Birla Group	Aditya Birla Nuvo aims for US\$1bn for 1GW of solar within 5 years.	Jul'2015	1,000		1,000
ENGIE, France / Kiran Energy Solar Power	ENGIE may take a 80% stake in Indian solar project developer Kiran Energy.	Jul'2015	180		85
ENGIE, France / SolaireDirect, France	ENGIE acquired French solar project developer SolaireDirect, who has a stated target of 2GW of solar in India by 2019.	Jul'2015	2,000		2,000
Welspun Energy, India	Welspun commissioned its 52MW solar project in Maharashtra as part of a target to develop 11GW of RE.	Jul'2015	11,000		11,000

Section 2 – SoftBank, Foxconn and Bharti Enterprises

Softbank of Japan is a listed telecommunications conglomerate, with a 32% stake in Alibaba Group of China and an 80% stake in Sprint Corporation of America. Softbank has been a leading developer of solar projects in Japan, and has also undertaken wind energy projects in China.

In October 2014, SoftBank chairman and founder Masayoshi Son pledged to invest at least US\$10bn in Indian Internet and technology companies over the next decade. Progress to date in the technology sector provides clear evidence of the group's drive and aggressive strategy implementation.¹¹

In June 2015, India saw its most exciting and largest investment commitment for its ambitious solar development program in SoftBank Corp. of Japan's announcement of its partnership with India's Bharti Enterprises Ltd and Taiwan's Foxconn Technology Co. Ltd to invest US\$20bn in solar energy projects in India. The joint venture, known as SBJ Cleantech, aims to generate 20GW of electricity.

In October 2015, the state government of Andhra Pradesh and SBJ Cleantech signed a MoU to add 2GW of photovoltaic (PV) and 1GW of wind power capacity in Rayalaseema region.¹² SBJ Cleantech is yet to participate in any auctions since its launch but may be looking to set up projects by signing bilateral agreements with state governments.

In November 2015, SoftBank's first-round bid was reported as Rs5.65kWh into the 500MW National Solar Mission (NSM) tender in Andhra Pradesh, making it one of 30 developers bidding a collective 5GW.¹³ However, it was underbid in the second round by SunEdison.

¹¹ http://www.livemint.com/Companies/nWa8rR4bJb2OP4m4WaMpDJ/SoftBank-shifts-focus-to-mature-startups.html#nav=editor_picks

¹² <http://www.kacharagadla.info/2015/10/ap-govt-signs-pacts-with-sbj-cleantech.html>

¹³ <http://www.bridgetoindia.com/blog/500-mw-of-nsm-bids-in-andhra-pradesh-to-close-below-inr-5-37kwh/#sthash.id4cQNkl.dpuf>

Section 3 – Adani Group – US\$16bn of Solar Projects

Whilst the SoftBank / Foxconn / Bharti announcement was the largest headline development in Indian solar, the Adani Group has probably made the most prominent progress on the ground in India, with an announced US\$16bn of investment intent across eight new solar project proposals so far in 2015. Adani Group has set a target of 10GW of solar projects by 2022.

Adani Power exited 2014 with a single 40MW solar project it commissioned in December 2011 in Kutch district of Gujarat.

In September 2014, the Tamil Nadu government offered a power purchase agreement priced to buy electricity at Rs7.01/kWh flat for 25 years.¹⁴ Subsequently the Adani Group signed an agreement to set up a 648MW solar power park in the Ramanathapuram district. In August 2015, Suntech of China announced it would supply 200MW of solar modules to this Tamil Nadu project. Eric Luo, CEO of Shunfeng International Clean Energy, Suntech's parent company, stated:

*“The Indian government has provided positive incentive policies for solar development as it looks to accelerate its 2020 100GW solar mission. We believe this landmark project will help showcase solar energy's capabilities in providing India with clean and sustainable energy”.*¹⁵

Over 2015, Adani Power has made a number of announcements, proposing a rapid-solar sector entry and its CEO recently said this:

“India has embarked on an ambitious program to become a world leader in power generation from renewable technologies, and [Adani] sees solar as a key part in realizing that goal,”

In February 2015, Adani Enterprises announced a new MoU to develop a joint venture with the Rajasthan government's Rajasthan Renewable Energy Corp for a [new solar park facility](#) with scope to warehouse up to 10GW of solar with a potential investment totalling Rs60,000 crore (US\$10bn or US\$1m per MW). Out of the proposed 10GW Solar Park, Adani Enterprises plans to develop 5GW itself.

In February 2015, Adani Enterprises and SunEdison Inc. announced a MoU for the development of a US\$4bn solar-module manufacturing facility in Gujarat. However, this MOU has fallen over due to the significant balance sheet pressures impacting SunEdison and alternative partners emerging for Adani.¹⁶

In June 2015, Adani Enterprises appeared to have decided to proceed with a new partner in Golden Concord Holdings Limited (GCL).¹⁷ This new JV is planning to leverage GCL's manufacturing expertise and build a fully-integrated PV manufacturing complex within a special economic zone in Mundra, including polysilicon, ingot/wafer, solar cell and module

¹⁴ <http://timesofindia.indiatimes.com/business/india-business/Tamil-Nadus-Adani-deal-under-scanner/articleshow/48119380.cms>

¹⁵ http://www.domain-b.com/companies/companies_a/Adani_group/20150820_solar_power.html#sthash.GzlyHVAL.dpuf

¹⁶ http://www.pv-tech.org/editors_blog/adani_dumps_sunedison_in_favour_of_richer_contenders

¹⁷ http://www.moneycontrol.com/news/business/chinas-gcl-ties-upadani-for-green-energy_3258241.html

production. The pact was signed during Prime Minister Narendra Modi's visit to China. GCL claims to be China's largest non-state-owned green energy holdings company and the world's largest photovoltaic-material manufacturer.

Adani Power was also reported to be considering a [second](#) 1GW solar industrial park in Uttar Pradesh, with an initial solar project of up to [50MW](#) under way there now.

In September 2015, Adani Green Energy Limited won the competitive bidding for a 50MW solar power plant from Uttar Pradesh's New and Renewable Energy Development Agency (NEDA) under its Solar Energy Policy 2013 as part of a tender for 215MW of on-grid solar power projects.¹⁸

In September 2015, Adani Group was reported to have separately sent a proposal to the Jharkhand Renewable Energy Development Agency to set up solar power capacity of 1GW. Jharkhand has only 16MW of installed solar capacity out of the 4.5GW installed across India, and though the has set a target to have 2GW solar power capacity installed by 2020, it is yet to allocate any projects. Alongside Jindal Steel, the Adani Group would be the first developer to set up a large-scale solar power project in Jharkhand.¹⁹

The Adani Group is also reportedly having discussions with Foxconn and SoftBank to set up solar power projects across India.

Section 4 – Enel Green's €9bn Renewable Pipeline

In September 2015, Enel Green Power, the listed renewables subsidiary of the Italian energy group ENEL, entered the Indian market with the acquisition of a majority share in BLP Energy, the wind and solar project development unit of Bharat Light & Power.²⁰ This deal possibly illustrates the ideal scenario for the Indian Government, of a truly global renewable energy player with enormous financial capital (both debt and equity) allying with an Indian company with an established domestic track record.

The €30m transaction represents the first move into the Asia-Pacific region for EGP, which is now present in 17 countries worldwide and has 9.9GW of net installed renewable energy capacity globally—Figure 4.1—with a presence in Europe, North America, Latin America and South Africa.

According to Francesco Venturini, chief executive officer of Enel Green Power:²¹

"This acquisition opens the doors for Enel Green Power to the huge potential of the Indian market and is the gateway to further expansion across Asia ... contribute to the Indian government objective of increasing the share of renewables in the country's energy portfolio. EGP is also interested in participating through BLP Energy in the country's upcoming public solar tenders at both national and state level. India is well positioned for

¹⁸ http://www.business-standard.com/article/companies/adani-group-wins-50-mw-solar-power-plant-in-up-115090101088_1.html

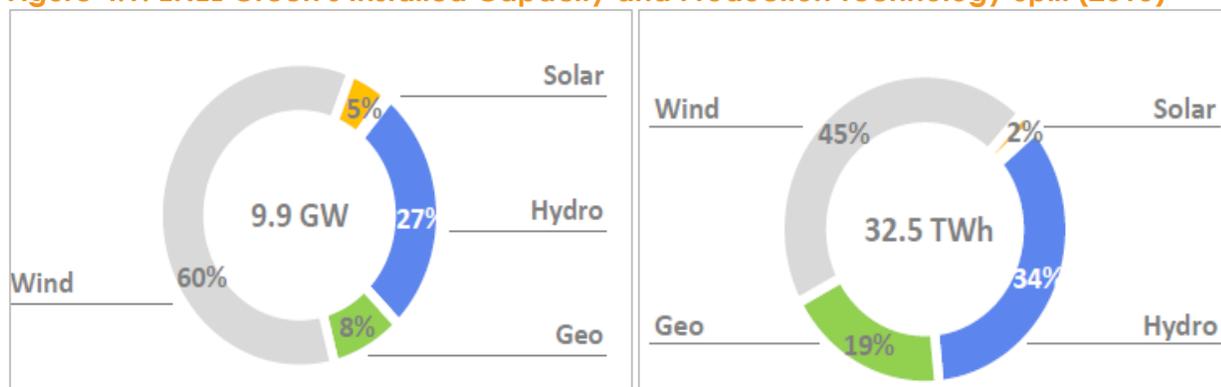
¹⁹ <http://cleantechnica.com/2015/09/15/2-gw-solar-power-capacity-addition-proposed-indian-state-jharkhand/>

²⁰ <http://www.ft.com/intl/fastft/396621/italys-enel-green-power-enters-indian-market?siteedition=uk>

²¹ http://www.enel.com/en-GB/media/press_releases/enel-green-power-enters-indian-market-by-acquiring-a-majority-stake-in-blp-energy/r/1664463

rapid expansion in the renewable energy industry owing to its high population and economic growth.”

Figure 4.1: ENEL Green's Installed Capacity and Production Technology Split (2015)



Source: Enel Green Power Investor Presentation, September 2015

Venturini said this in October 2015:

“There is a huge tide flowing and you can decide in which direction you want to swim. The tide is not in our control - it is the evolution of technology. I think it is crazy if there is someone thinking that he can actually influence this.”²²

Based in New Delhi and Bangalore, BLP is one of the larger renewables companies in India, with plants in the states of Gujarat and Maharashtra with 172MW of projects. Last year, BLP announced plans to increase its operational capacity to 1GW over a period of five years at an investment of US\$1bn.

In September 2015, Enel Green Power announced its global €9bn, 7GW renewable energy program over 2015-2019 to increase installed capacity and expand into new markets.

Enel Green Power in September 2015 was awarded 553MW of new solar projects in its first solar tender in Brazil. Involving capex of US\$600m, making it the largest solar developer in Brazil. This highlights the balance sheet strength of the group, and scope to rapidly expand in emerging markets.²³

²² <http://www.theguardian.com/environment/2015/oct/22/former-foes-greenpeace-and-energy-giant-enel-stand-together-in-low-carbon-push>

²³ http://www.enel.com/en-GB/investors/press_releases/enel-green-power-becomes-brazil-146-s-top-solar-player-with-553-mw-of-new-pv-capacity-in-landmark-tender-award/r/1664305

Section 5 – Sky Power of Canada

SkyPower is a Canada-based firm with 25GW of solar development projects across 60 countries, developed under an Independent Power Producer model.

In February 2015, SkyPower made a commitment to install 9.9GW of solar power in India by 2022.²⁴

In July 2015, Sky Power of Canada [announced](#) it had been awarded 150MW of a total of 300MW of solar PPAs awarded in the state of Madhya Pradesh, securing rights to develop three projects of 50MW capacity each at tariffs ranging from Rs 5.051/kWh (US\$7.95¢/kWh) to Rs5.298/kWh (US\$8.34¢/kWh), a fixed flat rate for 25 years.²⁵ The previous lowest bid in India was placed by First Solar at Rs5.25/kWh (US\$8.27¢/kWh) for a 40MW project in Andhra Pradesh. Sky Power has a solar development pipeline of 25GW globally, including major projects in Kenya and Egypt. Sky Power has set a [target](#) to add 9.9GW solar power capacity in India over the next five to seven years.

In August 2015, Sky Power won 200MW of projects in a 2GW auction in Indian state of Telangana, again with the lowest quote of Rs5.17/kWh (US\$8.13¢/kWh) for one 50MW project, and the other three set at up to Rs5.37/kWh (US\$8.45¢/kWh); all fixed rates for the next 25 years.²⁶

In October 2015, SkyPower signed a PPA to deliver 150MW of solar to the Indian State of Madhya Pradesh.²⁷

In October 2015, SkyPower agreed to a US\$1bn deal to build 500MW of solar in Panama.²⁸ In the same week, SkyPower announced it had signed an agreement to spend US\$440m to develop 200MW of solar PV capacity in the East African nation of Djibouti.²⁹ This followed a March 2015 commitment to invest US\$5bn to develop 3GW of solar in Egypt³⁰ and the July 2015 commitment to develop 1GW of solar projects in Kenya.³¹

²⁴ http://re-invest.in/wp-content/themes/reinvest/pdf/Green_Energy_Commitments.pdf

²⁵ <http://www.skypower.com/news/skypower-global-to-develop-150-mw-of-solar-projects-in-madhya-pradesh-state/>

²⁶ http://www.pv-magazine.com/news/details/beitrag/india--pm-modi-calls-on-states-for-proactive-solar-push_100021320/#ixzz3oETHeRrY

²⁷ <http://www.skypower.com/skypower-signs-power-purchase-agreement-to-deliver-150-megawatts-of-solar-power-to-the-indian-state-of-madhya-pradesh/>

²⁸ http://www.pv-magazine.com/news/details/beitrag/skypower-agrees-1bn-deal-to-build-500-mw-of-solar-in-panama_100021436/#ixzz3oExFCtRS

²⁹ http://www.pv-magazine.com/news/details/beitrag/skypower-announces-440m--200-mw-djibouti-solar-plans_100021344/#ixzz3oExYNZ8Y

³⁰ http://www.pv-magazine.com/news/details/beitrag/egypt-signs-3-gw-solar-deal-with-skypower--igd-_100018660/#ixzz3oEy3jS1G

³¹ http://www.pv-magazine.com/news/details/beitrag/skypower-to-develop-1-gw-of-projects-in-kenya_100020332/#ixzz3oEyYdwG3

Section 6 – Aditya Birla Group targets Solar

In July 2015, Aditya Birla Nuvo Ltd, a US\$4bn equity-capitalised listed division of the US\$41bn Indian conglomerate, Aditya Birla Group announced board approval to enter the Indian solar sector, stating:³²

“With the renewed focus of the Indian government on clean energy and in line with the vision of the company to invest in promising sectors, the company is planning a foray in the solar power business. The board has authorized and approved the formation of special purpose vehicles (SPVs), or subsidiaries, by the company and will evaluate induction of investor(s) in the SPVs and subsidiaries, if required.”

In October 2015, Aditya Birla Nuvo announced³³ its partnership with Dubai-based private equity investor Abraaj Group to develop 1GW of utility-scale solar power plants in India. The new renewable-energy platform, Aditya Birla Renewables Limited, plans to bid for projects tendered in both state and national auctions in India.

The Aditya Birla Group will invest in the platform through Aditya Birla Nuvo Limited, owning 51% of the equity, and Abraaj will hold the 49% balance.

Sev Vettivetpillai, Partner and Global Head of Abraaj’s Thematic Funds Business, said:³⁴

“The gap in energy infrastructure in growth markets translates into a long-term and sustainable investment opportunity. Renewable energy is set for explosive growth, thanks to technological advances, favourable policies and pricing structures that make it a competitive alternative to conventional power generation. At Abraaj, we see significant opportunity in India, one of the world’s biggest energy-consumption markets. The renewable-energy sector in India offers vast potential for growth and can play a transformative role in reducing dependency on fossil fuels and enhancing India’s long-term energy security. We are delighted to partner in this rapidly growing sector with one of India’s leading entrepreneurial groups and together bring our capital and expertise to bear in creating a landmark investment that can address the demands for clean energy infrastructure in the country.”

³² <http://adityabirlanuvo.com/pdf/ABNL%20Outcome%20of%20BM%2009.07.2015.pdf>

³³ http://www.pv-tech.org/news/state_coal_mining_firm_plans_1gw_of_solar_in_india?utm_source=pvtech-feeds&utm_medium=rss&utm_campaign=news-rss-feed

³⁴ <http://www.adityabirla.com/media/press-releases/Aditya-Birla-Group-partners-Abraaj-Group-invest-solar-power-India>

Section 7 – ENGIE of France Acquires SolaireDirect

In July 2015, ENGIE of France (formerly GDF Suez) [proposed](#) acquiring a majority stake in Kiran Energy Solar Power, a solar project developer based in Mumbai. It was reported that ENGIE will invest Rs 1,200 crore (US\$180m) to acquire the stake. In 2010, Kiran Energy sold a 75-80% stake to three private equity investors — New Silk Route, Bessemer Ventures, and Argonaut Ventures, for US\$40m. Kiran Energy operates 80MW of solar power projects. Kiran Energy has several other projects under development. Kiran Energy also owns a 75% stake in another renewable energy project developer, Mahindra Solar One. Like Kiran Energy, Mahindra Solar One operates several solar power projects in India.

Mahindra Solar One, part of Indian conglomerate Mahindra Group, plans to invest Rs4,500 crore (US\$732m) in renewable energy space over the next three to four years. Mahindra Solar One plans to commission 500MW of solar power projects by the end of March 2016.³⁵

In July 2015, ENGIE acquired the French solar power developer, SolaireDirect for US\$222m, establishing ENGIE as the solar market leader in France, with a gross total installed capacity of 383MW. Solairedirect has developed 486MW of capacity across 57 solar parks across the globe.

In India, SolaireDirect has successfully participated in several central government and state-level competitive auctions. They have a combined total of about 5,000MW of capacity in the pipeline including 186MW in train in India. SolaireDirect has a 2GW target for solar in India by 2019. The takeover by ENGIE provides SolaireDirect access to significant capital resources to accelerate this strategy.

³⁵ <http://in.reuters.com/article/2015/01/26/mahindra-renewables-idINKBN0KZ0N320150126>

Section 8 – Renew Power JV with Hanwha Q CELLS

ReNew Power of India has a portfolio of 1,600MW operational and under-construction wind and solar energy projects.

In July 2014, Goldman Sachs, Asian Development Bank (ADB) and the South Asia Clean Energy Fund invested US\$140m into ReNew Power, promoted by former Suzlon Energy CEO Sumant Sinha who is founder and chief executive officer of ReNew Power.³⁶

In July 2015, Renew Power [announced](#) a JV agreement with Hanwha Q CELLS, the flagship company of Hanwha Group, a diversified South Korean conglomerate, to develop two solar projects in the State of Telangana totalling a capacity of 149MW.

This follows the July 2015 [agreement](#) with Hareon Solar, one of China's largest solar energy companies, to jointly develop a solar project of 72MW capacity in the State of Andhra Pradesh. This is Hareon Solar's first investment in India. Hareon Solar will also supply and install its crystalline silicon solar modules to this project. The delivery of 234,161 modules is scheduled to be completed by December 2015 with the solar plant commissioning due in March 2016.

In October 2015 ReNew Power awarded Gamesa a 40MW turbine order for its new Lingsagur wind farm in the province of Karnataka.³⁷

In October 2015 ReNew Power raised US\$265m in new equity from investors, including US\$200m from Abu Dhabi Investment Authority (ADIA). ReNew Power's largest investor, Goldman Sachs Group Inc., made additional commitment of US\$50m in the fourth round of funding, taking its total investment to US\$370m. The Global Environment Fund, another existing investor, added US\$15m, taking its total investment to US\$35m.³⁸ ReNew Power has raised total equity of US\$655m and currently has an asset base of US\$1.5bn and expects to finish 2015/16 with an asset base of over US\$2bn.

Sumant Sinha, chief executive officer at ReNew Power, said:

"We are at an inflection point where the transformational use of natural resources will define our energy future... as we enter a new phase of growth."

³⁶ http://articles.economicstimes.indiatimes.com/2014-11-20/news/56304086_1_tata-power-renewable-energy-300-mw-hydro-power-projects

³⁷ <http://www.gamesacorp.com/en/cargarAplicacionNoticia.do?idCategoria=62&identificador=1305&urlAmigable=gamesa-to-build-a-40-mw-wind-farm-in-india-for-renew-power-under-a-turnkey-arrangement.html>

³⁸ <http://www.livemint.com/Companies/HWsbQf9rlkF9Y1Awhuq92O/ReNew-Power-sells-stake-to-Abu-Dhabi-sovereign-fund.html>

Section 9 – Welspun Renewables

The Welspun Group is a successful listed Indian conglomerate launched in 1985 (market capitalisation US\$440m). In 2015 the group entered the renewable project-development sector.

In January 2015, Welspun signed an agreement with the state government of Gujarat to install 1.1GW of renewable energy capacity, including 500MW of wind energy capacity and 600MW of solar energy capacity.³⁹

In May 2015, as part of the agenda around Prime Minister Modi's trip to China, it was **reported** that the world-leading Trina Solar of China (Trina Solar delivered 2014 sales of US\$2.3bn on the back of 3.7GW of module production⁴⁰) signed a MoU with Welspun to set up a US\$500m, 1,000MW-per-annum solar-cell and module-manufacturing facility in India. However, this MoU was very preliminary and no further details are yet available.

In July 2015, Welspun Renewables **commissioned** a 52MW solar project in Maharashtra as part of Welspun's target to commission 11GW of solar and wind capacity in India. To that end, Welspun Renewables is planning to install 1GW to be commissioned by March 2016. Welspun Renewables is currently active in eight of India's 36 states and union territories.

In July 2015, Welspun Renewables also **announced** a 550MW Indian MoU with iPLON of Germany.

In August 2015, Welspun detailed its plans for 11GW of renewable-energy projects over the next five to seven years across India including 8.7GW of solar power and 2.3GW of wind energy capacity, a significant expansion relative to its current operational solar capacity of 399MW.

In October 2015, Welspun inaugurated the state of Punjab's largest solar project to date, the 34MW PV plant in the district of Bathinda. At the presentation, Punjab's New and Renewable Energy Minister Bikram Singh Majithia said, "We are committed to developing Punjab as a fully sustainable state. Ensuring the state's upward development trend is important and therefore energy security is critical. (The state government had) opted to take an aggressive step by turning to solar energy for fueling energy needs of our industries and farmers. Through projects like these we are ensuring that our immediate future as well as that of our coming generations will be more secure and avert an otherwise polluted future."⁴¹ Welspun has signed a memorandum of understanding to develop a further 151MW of solar in Punjab.

In October 2015, Welspun raised US\$617m, of which two thirds is in form of debt and one third in the form of equity & line of credit. Last year, Asian Development Bank and GE Energy Financial Services had invested equity in Welspun's 151MW solar plant in Madhya Pradesh.

³⁹ http://www.pv-magazine.com/news/details/beitrag/india--welspun-to-develop-87-gw-of-solar-on-back-of-strong-investment-_100020509/#axzz3oDptIM7s

⁴⁰ http://www.pv-magazine.com/news/details/beitrag/trina-boosts-annual-revenue--profit_100018443/#axzz3U9mNNsKf

⁴¹ http://www.pv-magazine.com/news/details/beitrag/punjab-aims-for-full-sustainability_100021474/#ixzz3oDtaEm8o

Section 10 – SunEdison in India

SunEdison, one of the world's largest clean-energy companies, has an ambitious target to add 15.2GW renewable energy capacity with investment of US\$15bn in India over the next five to seven years.

In October 2014, SunEdison signed a memorandum of understanding (MoU) for the development of 5GW of solar with India's Rajasthan government. It also has plans of 5GW capacity through wind and solar power in the state of Karnataka. Earlier this year, SunEdison signed an agreement for an 180MW solar project to be built in the state of Madhya Pradesh. SunEdison already has 50MW of installed PV capacity in the northwestern state and aims to establish a number of mega-solar projects, many as large as 500MW, as part of its 15.2GW target. The SunEdison MoU follows the announcement by the government of Rajasthan of the state's new solar policy, which has earmarked the deployment of 25GW of solar PV capacity over the next few years.⁴² To facilitate the integration of solar and wind into the grid, the Asia Development Bank in September 2014 provided a US\$152m loan package for the Rajasthan government to develop grid capacity.⁴³

In June 2015, SunEdison acquired Continuum Wind Energy, a previously Singaporean-owned company that has 242MW of wind farms in Maharashtra and Gujarat. This expands SunEdison's capacity into wind, and provides an Indian project-development pipeline for SunEdison's emerging-markets-focused Yieldco, the now listed Terraform Global (which sits alongside the separately listed Terraform Power Yieldco covering developed markets).

In July 2015, SunEdison acquired a 102MW wind-farm portfolio in Karnataka and Rajasthan states from Fersa Energias Renovables SA of Spain. Combined with its solar project investments, this move makes SunEdison one of the largest foreign investors in renewable energy in India.

In September 2015, SunEdison signed an agreement with the state government of Tamil Nadu to set up 2GW of solar power and wind energy capacity over the next five years in projects expected to be developed in the utility-scale segment.

In September 2015, SunEdison bid 500MW into a new solar tender reverse auction in Andhra Pradesh. The state government received a reported total of 5GW of project proposals for its 500MW tender.⁴⁴ In November 2015, in the next stage of the auction, SunEdison bid Rs4.63 (US\$0.071) per kWh for 500MW capacity, breaching the previous low of Rs5.05 (US\$0.077) in the country and getting extremely close to the government's reported solar power target cost of Rs4.50/unit (US\$0.068).⁴⁵

⁴² <http://reneweconomy.com.au/2014/sunedison-signs-5-gw-solar-mou-indias-rajasthan-government-88630>

⁴³ http://www.pv-magazine.com/news/details/beitrag/adb-signs-off-152m-rajasthan-loan_100016585/#axzz3HKXHUuoa

⁴⁴ <http://renewables.seenews.com/news/sunedison-bids-for-500-mw-in-oversubscribed-solar-tender-in-india-492831>

⁴⁵ <http://economictimes.indiatimes.com/industry/energy/power/sunedison-to-supply-cheapest-solar-power-in-india/articleshow/49654469.cms>

Section 11 – Suzlon Energy Recapitalises

While Indian-domiciled [Suzlon Energy](#) was one of the top-tier wind turbine blade manufacturers globally in the last decade, its heavily contested €1.35bn [acquisition](#) of REpower of Germany in 2007 proved disastrous as the global financial crisis unfolded. Suzlon has experience of installing a cumulative 14.5GW of wind energy across 17 countries, including an 8.6GW cumulative installation in India. Suzlon Energy has expanded with a new foray into solar this year, offering a wind-solar integrated solution. Suzlon Energy has an agreement with Tamil Nadu government to install 500MW of onshore wind energy, 500MW of offshore wind, and 1,000MW of solar and solar-wind hybrid. Suzlon Energy has committed to build 11GW of wind power and 4GW of solar power in India over the next five years.

2015 has seen Suzlon make significant restructuring progress, starting with the completion of the divestment of REpower. In February 2015, Suzlon attracted a major new cornerstone equity partner, one of the wealthiest men in India and founder of Sun Pharmaceuticals, Dilip Shanghvi, who [invested](#) Rs18bn or US\$290m for a 17% stake in Suzlon Energy.

This necessary restructuring has halved group debt, while allowing Suzlon to resume growth. In October 2015 Suzlon was rated investment grade by Indian rating agency CARE.⁴⁶

In May 2015 Suzlon reported a 98MW order from Mytrah Energy for a new wind project in Telangana scheduled for commissioning in 2016. The order is part of the Business Partnership Agreement with Mytrah struck in May 2010 to purchase 1GW of turbines from Suzlon Group.⁴⁷

In May 2015, Suzlon reported a 90MW wind turbine order from ReNew Power.⁴⁸

In June 2015, Suzlon reported that it had won a 90MW turbine order from ReNew with Suzlon as turnkey EPC partner in Andhra Pradesh. Turbines are 2.1MW each.⁴⁹

In August 2015, Suzlon Energy was awarded a solar project as part of the 2.0GW Telangana auction.⁵⁰

In September 2015, Suzlon commissioned a 101MW wind project for CLP in Rajasthan, India.⁵¹ In the same month Suzlon announced it had won new orders totalling 105MW to be executed in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh and Tamil Nadu for a range of clients.

In September 2015, Suzlon Energy announced that it was progressing a technical feasibility study for a 600MW pilot offshore wind energy project in the Bay of Kutch off the coast of Gujarat. Total expenditure is forecast to be Rs6,000 crore (US\$920m), with construction on the project expected to begin in 2016, with commissioning in three to five years.⁵²

⁴⁶http://www.suzlon.com/images/Media_Center_Press_release/376_CARE%20assigns%20investment%20grade%20rating%20to%20Suzlon%208th%20Oct.pdf

⁴⁷ http://www.suzlon.com/images/investor_stock_exchange/321_Suzlon_18-05-2015.pdf

⁴⁸ http://www.suzlon.com/images/investor_stock_exchange/318_Suzlon_13-05-2015.pdf

⁴⁹ http://www.suzlon.com/images/investor_stock_exchange/325_Suzlon_4-06-2015.pdf

⁵⁰ <http://www.renewableenergyworld.com/articles/2015/08/india-s-largest-solar-power-auction-reflects-further-drop-in-solar-energy-costs.html>

⁵¹http://www.suzlon.com/images/Media_Center_Press_release/374_Suzlon%20commissions%20100.80%20MW%20wind%20power%20project%20for%20CLP%20in%20Rajasthan,%20India.pdf

⁵² http://www.business-standard.com/article/companies/suzlon-s-offshore-windmill-pilot-in-gujarat-to-cost-rs-6-000-crore-115082900445_1.html

In October 2015, Orange Renewable of Singapore awarded Suzlon Energy a repeat turnkey order for a 101MW wind energy project. The project is located in Andhra Pradesh, as part of a larger wind park, and is expected to become operational in 2016/17.⁵³

In October 2015, Suzlon commissioned a 50MW wind power turnkey project for Ostro Energy (owned by Actis). Located in Jaisalmer, Rajasthan, this is Ostro's first wind power project in India.⁵⁴

Suzlon Energy strategic plan aims to install 11GW of wind turbines in the next five to seven years.

⁵³ <http://economictimes.indiatimes.com/industry/energy/power/wind-turbine-manufacturer-suzlon-bags-100-8-mw-repeat-order-from-orange-renewable/articleshow/49239212.cms>

⁵⁴ http://www.suzlon.com/images/Media_Center_Press_release/377_Press%20Release_Suzlon%20commissions%2050%2040%20MW%20wind%20power%20project%20for%20Ostro%20Energy.pdf

Section 12 – NTPC Ltd Diversifies With a 10GW Solar Program

NTPC Limited of India (previously the National Thermal Power Corporation of India), the country's largest electricity producer with 45GW of installed capacity, has proposed investing US\$10bn in the development of 10GW of renewables within the next five years.⁵⁵

By the end of March 2015, NTPC will have a portfolio of 110MW of solar power,⁵⁶ including 35MW added over 2014/15.⁵⁷ NTPC aims to add a further 250MW of solar power capacity in 2016-17 with the commissioning of its Anantpur Solar plant.⁵⁸

About 90% of the proposed new solar capacity to be put forward for auction in the next six months will be under the central government's policies. NTPC will hold auctions of its own solar projects of total capacity of 1.75GW. This will include a large auction of 750MW capacity to be implemented in the western state of Rajasthan and an additional 1GW capacity in Madhya Pradesh and Telangana. NTPC, also acting as nodal agency for Solar Energy Corporation of India, will auction 650MW solar power capacities across 4 states. The power generated from these projects will be bundled with power generated from NTPC's own coal-based projects. The largest of these auctions will have 400MW capacity, which would be commissioned in Telangana. Jammu & Kashmir and Odisha and will have 100MW and 50MW capacity installed, respectively, while the host state for the balance 100MW capacity is yet to be decided.

NTPC is also exploring options to manufacture solar equipment as part of the state-owned power producer's strategy to be present across the green energy value chain. It has plans to set up a manufacturing capacity of 1GW per annum.

In August 2015, it was reported that NTPC Ltd has increased its solar target to 15GW by 2019.

In October 2014, NTPC Chairman Arup Roy Choudhury announced NTPC Ltd had signed a memorandum of understanding to invest Rs 5,000 crore (US\$820m) in a 750MW solar power plant in the Madhya Pradesh district of Rewa. The project would be developed in three tranches of 250MW each.⁵⁹

In February 2015, NTPC proposed to tender for 15GW of solar under three tranches rolled out in 3GW, 5GW and 7GW segments.⁶⁰

In April 2015, NTPC [announced](#) Invitations for bids for 500MW of utility-scale solar at the Ghani Solar Park in Andhra Pradesh under the National Solar Mission Phase-II, Batch-II, Tranche-1. NTPC in May 2015 [announced](#) a 420MW Invitation for bids for the Bhadla Phase-II Solar Park in Rajasthan and a [second](#) for 500MW at the Gani-Sakunala Solar Park in Andhra Pradesh. The maximum tariff to be tendered for is Rs6.35/kWh.

⁵⁵ http://zeenews.india.com/news/eco-news/ntpc-to-build-10-bn-worth-green-energy-projects_1548011.html

⁵⁶ <http://www.ntpc.co.in/en/power-generation/renewable-energy-and-distributed-generation>

⁵⁷ NTPC Ltd annual report FY2015

⁵⁸ <http://www.ntpc.co.in/presentations/4215/ntpcinvestorpresentation-03-08-2015> slide 16

⁵⁹ http://www.pv-magazine.com/news/details/beitrag/ntpc-to-build-750-mw-solar-project-in-madhya-pradesh_100016786/#ixzz3oEF96JbO

⁶⁰ http://www.pv-magazine.com/news/details/beitrag/indian-state-utility-ntpc-given-green-light-for-15-gw-solar-plan_100018354/#axzz3oDptIM7s

In July 2015, NTPC also commissioned the Koldam Hydro Power Project with a combined 800MW of capacity.⁶¹ It has a further 819MW of hydroelectric power plants under construction as part of its strategic plan to rapidly diversify away from a reliance on thermal electricity capacity by adding hydro, solar and nuclear capacity.⁶²

In October 2015, at its interim results briefing, NTPC noted its intention to install 250MW of solar by April 2016 in Anantapur in Andhra Pradesh at an expected capex of Rs1,500 crore.⁶³ NTPC reports that for 2016/17, 1,260MW of solar capacity is under tender process, with a total of Rs4,350 crore of capex planned.

⁶¹ <http://www.ntpc.co.in/en/investors/announcements>

⁶² http://economictimes.indiatimes.com/articleshow/48333832.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

⁶³ <http://www.ntpc.co.in/transcripts/4543/q2fy15-16transcript>

Section 13 – Coal India Ltd targets 1GW Solar

As early as September 2014, state-owned coal mining company Coal India Limited (CIL) had announced plans to use some of the US\$8bn net cash surplus on its balance sheet to develop US\$1bn or 1GW of solar power projects across India. Energy Minister Piyush Goyal described Coal India and power producer NTPC Ltd. as “massive polluters” and said they “must give back to the society.”⁶⁴

Nagendra Kumar, technical director of CIL, in October 2015 reported⁶⁵ that CIL had signed a memorandum of understanding with the Renewable Energy Corporation of India (RECI). CIL plans to complete at least one 250MW project within one year in Madhya Pradesh. Kumar said the entrance into the solar market is “one step” CIL is taking to reduce its carbon footprint.

India Railways has likewise embarked on a 1GW of distributed-solar installations program, using railway station rooftops as an excellent source of untapped, grid-connected space.

Neyveli Lignite Corporation – 4GW Solar Target

Neyveli Lignite Corporation (NLC) is a government owned mining entity that produces 28 million tonnes per annum (Mtpa) of lignite coal in India. NLC is now operating lignite-fired power plants of 4,240MW capacity in Neyveli, Barsingsar in Rajasthan State and Thoothukudi.

In September 2015, NLC announced a target to install 4GW of solar across various states of India, entailing an investment of up to US\$4.6bn.⁶⁶

As the first step in this, NLC has commissioned its maiden 10MW solar farm in Neyveli, Tamil Nadu – completed at a cost of Rs740m (US\$11.3m). Bharat Heavy Electricals Limited, the Engineering, Procurement and Commissioning (EPC) contractor of this project, will operate and maintain the project for a period of three years, after the performance guarantee period of the first year.

NLC is reported to be building a second 130MW solar farm in the Neyveli township in Tamil Nadu.⁶⁷

In October 2015, NLC reported plans for a third 25MW solar Power Project in Barsingsar, Rajasthan at a cost of Rs1.67bn (US\$26m). The project is proposed to be implemented through EPC route and scheduled to be commissioned in 2016-17.⁶⁸

In October 2015, NLC was also reported to be building a 51MW wind power plant in the district of Tirunelveli, in the State of Tamil Nadu due for commissioning in 2015/16.

⁶⁴ <http://www.bloomberg.com/news/articles/2014-09-22/coal-india-said-to-plan-building-1-2-billion-of-solar-projects>

⁶⁵ http://www.pv-tech.org/news/state_coal_mining_firm_plans_1gw_of_solar_in_india?utm_source=pvtech-feeds&utm_medium=rss&utm_campaign=news-rss-feed

⁶⁶ http://www.business-standard.com/article/companies/neyveli-lignite-to-set-up-4-000-mw-of-solar-plants-115092800668_1.html

⁶⁷ <http://cleantechnica.com/2015/10/19/indian-coal-mining-company-sets-4-gw-solar-power-target/>

⁶⁸ http://www.nlcindia.com/index.php?file_name=about_01h

National Hydro Power Corp – Floating Solar

In July 2014, India's leading hydro power generator, National Hydro Power Corporation (NHPC) announced plans to set up a 50MW solar photovoltaic project over the water bodies in the southern state of Kerala. The cost of the project was estimated at US\$64-72m. NHPC stated:

“The ecology of the water body is not likely to be affected much and it will also reduce evaporation, thus helping preserve water levels during extreme summer. Solar panels installed on land, face reduction of yield as the ground heats up. When such panels are installed on a floating platform, the heating problem is solved to a great extent.”⁶⁹

In July 2015, NTPC signed a MoU with the state government of West Bengal and West Bengal State Electricity Distribution Company Limited for the development of four hydro projects with total capacity of 293MW in Teesta Basin. NHPC has already commissioned the 132MW Teesta Low Dam-III in 2013 and the 160MW Teesta Low Dam-IV is under advanced stage of construction and is due for completion in 2016.⁷⁰

In October 2015, NTPC awarded Rays Power Experts an Engineering, Procurement & Construction (EPC) contract to build a 50MW solar power project at Sattur in Virudhunagar district in Tamil Nadu.⁷¹ Rays Power had previously built over 100MW of solar projects in India.

⁶⁹ <http://reneweconomy.com.au/2014/india-plans-50mw-floating-solar-project-worlds-largest-82706>

⁷⁰ <http://nhpcindia.com/press-release.htm?PressId=42>

⁷¹ <http://energy.economicstimes.indiatimes.com/news/renewable/rays-power-bags-rs-300-crore-order-from-nhpc/49576088>

Section 14 – Reliance Power Redirection

Reliance Power operates 5,945MW of power capacity across its projects based on coal (5,760MW), wind (45MW), solar thermal (100MW) and solar PV (40MW) energy.

For almost a decade, Reliance Power has been trying to build three additional massive coal-fired power plants: the 4GW imported-coal-fired Krishnapatnam Ultra Mega Power Project in Andhra Pradesh, the 4GW Tilaiya domestic-coal-fired UMPP in Jharkhand and the 4GW domestic-coal-fired Chitrangi Power Project in Madhya Pradesh. In addition, Reliance Power has the half-built 2.4GW Samalkot domestic gas-fired power plant in Andhra Pradesh. However, it now looks increasingly likely that none of these four thermal-power projects will be undertaken.

Reliance Power's strategic focus has shifted dramatically, such that the new focus is primarily centred on the 5,200MW of hydropower projects pipeline across Northern India and the 6GW of solar proposed for Rajasthan.⁷²

In March 2012, Reliance Power commissioned a 40MW solar PV project in Pokharan, Jaisalmer, Rajasthan.⁷³

In June 2013, Reliance Power commissioned a 45MW wind project in Vashpet, Maharashtra.

In **November 2014**, Reliance Power commissioned the world's largest compact linear Fresnel reflector-based concentrated solar power (CSP) project, a 100MW project at Pokhran in the Jaisalmer district of Rajasthan. Rajasthan Sun Technique Energy, a wholly-owned subsidiary of Reliance Power, was awarded the CSP project in 2010. The project was co-financed by the US Export-Import Bank, the Asian Development Bank, and the development bank of Netherlands.⁷⁴

In February 2015, Reliance Power signed an agreement with Vasundhara Raje, the chief minister of Rajasthan, to set up 6GW of solar-energy parks in Rajasthan over the next 10 years.⁷⁵ The entire project will require an investment of US\$6bn.

Since the late 2014 change of government in Rajasthan, no competitive auction for allocation of solar power projects has taken place even though the capacity addition target has been set at a very aggressive 25GW by 2022. Through the four agreements signed by the Rajasthan government directly negotiated by a MOU with private project developers (Adani Enterprises, (10GW), Reliance Power (6GW), SunEdison (5GW)⁷⁶ and Azure Power (1GW)⁷⁷), a total of 22GW of new solar power capacity is targeted for commissioning over the next 10 years.

In April 2015, Reliance Power terminated its 25-year binding PPA for the 3,960MW Tilaiya UMPP in Jharkhand.⁷⁸ Won by tender in February 2009, Reliance Power's failure to proceed with this US\$4bn investment was explained as a function of the combination of ongoing land acquisition and regulatory delays, failure to secure the development of the captive coal mine allocated to

⁷² http://www.reliancepower.co.in/business_areas/power_projects.htm

⁷³ http://www.reliancepower.co.in/business_areas/initiatives_in_renewable_energy.htm

⁷⁴ <http://cleantechnica.com/2015/02/17/reliance-power-set-6-gw-solar-power-capacity-indian-state-rajasthan/>

⁷⁵ <http://www.dnaindia.com/money/report-after-adani-now-reliance-power-announces-6000-mw-solar-park-in-rajasthan-2060338>

⁷⁶ <http://cleantechnica.com/2014/11/06/sunedison-install-5-gigawatts-solar-power-capacity-indian-state-rajasthan/>

⁷⁷ <http://cleantechnica.com/2014/12/30/indias-azure-power-set-1-gw-solar-power-rajasthan/>

⁷⁸ <http://www.reliancepower.co.in/1100/Tilaiya-Mediarelease-VFINALFINAL-27Apr15-Clean.pdf>

this project, plus Reliance Power's concerns over the financial viability of the coal-fired power project.

In August 2015, it was reported that Reliance Power had approached the Indian government-owned Power Finance Corporation (PFC) asking it to buy Reliance Power's major coal-fired power plant, the fully operational 3.96GW Sasan UMPP, citing a "breach of representation".⁷⁹ Despite two captive mine-mouth coal mines, the project has such a low PPA of Rs1.19/kWh, that IEEFA does not expect that commercial returns are attainable for this project.⁸⁰

In September 2015, Reliance Power announced it would sell its three proposed Indonesian coal mines, strongly indicating their commitment to the associated, proposed 4GW imported coal-fired Krishnapatnam UMPP in Andhra Pradesh has waned as well, reportedly due to the inability to make a commercial return at the prices Reliance Power originally tendered.⁸¹

In September 2015, Reliance Power was reported to have ceased construction of its 2.4GW of gas-fired capacity in Andhra Pradesh due to the non-viability of the project and the ongoing gas-supply limitations in India. The project is being considered for transfer to a new site in Bangladesh.⁸²

In October 2015, it was reported that Reliance Power had effectively scaled back significantly its thermal electricity capacity expansions and under its new chief executive officer was now pursuing a renewable-energy expansion strategy.

⁷⁹ http://www.business-standard.com/article/companies/r-power-asks-pfc-to-buy-out-sasan-umpp-115082900032_1.html

⁸⁰ <http://cleantechnica.com/2015/10/19/indias-reliance-power-plans-sell-coal-mines-shift-solar-power/>

⁸¹ <http://reneweconomy.com.au/2015/indias-reliance-power-plans-to-sell-coal-mines-shift-to-solar-power-74468>

⁸² <http://economictimes.indiatimes.com/industry/energy/power/reliance-power-to-sell-off-three-indonesian-coal-mines/articleshow/49173152.cms>

Section 15 – Tata Power

Tata Power has an installed electricity generation capacity of 8,615MW, of which 1,383MW is from renewables, including: 576MW hydro; 56MW solar; 511MW wind; and 240MW from waste-gas-based generation.⁸³ Tata Solar was founded in 1989, originally as a joint venture with BP Solar, but is now a wholly-owned subsidiary of Tata Power. The group in 2014 expanded its Bangalore solar cell and module manufacturing plant to a 200MW pa capacity.

Tata Power Renewables is one of the major rooftop solar developer in India and was estimated to hold a 12-15% share of the residential, industrial and commercial rooftop solar installation market in 2014 (as estimated by Bridge to India). To date, Tata Power has installed 65MW of distributed generation projects, including distributed solar PV, in India.⁸⁴

Tata Power has drawn up an aggressive plan of generating 18GW power by 2022, with a target of 20-25% contribution from clean energy sources. It is in the process of acquiring suitable land parcels in the states of Maharashtra, Rajasthan, Gujarat, Andhra Pradesh and Karnataka to develop renewable projects. 182MW of wind projects are under construction in the states of Rajasthan (Dalot 100MW) and Maharashtra (Pethshivpur 50MW and at Visapur 32MW).

Tata Power Renewables is currently developing two wind projects in Maharashtra, and a 126MW Dagachhu Hydro Power project in Bhutan in a venture with the Government of Bhutan.

In May 2015, Tata Solar won a 100MW solar power plant project from NTPC, using domestically manufactured cells and modules. The new project is located in Andhra Pradesh and is part of the total 250MW awarded as phase I of a 1,000MW solar complex. 50MW projects were also won by each of Lanco Solar Energy Pvt, BHEL and Sterling and Wilson.⁸⁵

In October, 2015 Anil Sardana, CEO of Tata Power, said:

“We are exploring multiple options, both greenfield and brownfield acquisitions. Further refinement of technology is also in progress and an in-house floating variant using crystalline single axis tracked PV is under development.”

In October 2015, Tata Power Renewables awarded Inox Wind an order for a 50MW wind power project at Lahori, in the state of Madhya Pradesh.⁸⁶

In November 2015, Tata Power's first-round bid was Rs5.49kWh in the 500MW tender in Andhra Pradesh, making it one of 30 developers bidding a collective 5GW.⁸⁷ However, it was underbid in the second round by SunEdison.

⁸³ <http://www.mydigitalfc.com/power/tata-power-plans-generate-18000mw-power-2022-778>

⁸⁴ <http://www.fierceenergy.com/story/bridge-solar-india-net-metering/2015-09-28>

⁸⁵ <http://renewables.seenews.com/news/ntpc-awards-250-mw-pv-job-to-tata-power-solar-others-475722>

⁸⁶ <http://tata.com/company/releasesinside/Inox-Wind-bags-50-MW-order-from-Tata-Power-Renewable-Energy>

⁸⁷ <http://www.bridgetoindia.com/blog/500-mw-of-nsm-bids-in-andhra-pradesh-to-close-below-inr-5-37kwh/#sthash.id4cQNkl.dpuf>

Section 16 – First Solar Builds Presence

With more than 10GW of solar projects installed worldwide, and a 17GW pipeline of new projects, First Solar has developed, financed, engineered, constructed and operates large grid-connected PV power plants across the globe.

In India, First Solar has supplied its thin-film solar panels to over 700MW of PV solar projects to date. First Solar aims to develop 5GW of solar projects in India by 2019, a “commitment” given to Prime Minister Modi at the RE-Invest 2015 in February 2015.⁸⁸ “The overall commitment is of course contingent upon the government providing PPA allocations from utilities by way of enforcing RPO’s as well as the land and evacuation infrastructure under the solar park policy”, said Sujoy Ghosh, Country Head, for First Solar India.

First Solar recently completed its first utility scale project with 20MW capacity in Telangana. This is part of a 200MW project portfolio owned by First Solar across India in different stages of construction. This 20MW project is contracted under a 20-year PPA to sell power to the Southern Power Distribution Corporation of Telangana at a levelized tariff of Rs 6.49/kWh.

In June 2015, First Solar listed on NASDAQ a new YieldCo structure called “8Point3” in joint venture with SunPower Corp. to finance its solar projects. A YieldCo is a separately listed company set up by a parent entity by spinning off its operating renewable-energy assets. The new, asset-owning company - the YieldCo - raises funds from the public for financing the asset purchase. The YieldCo then has operating assets that generate dividends - one distinguishing feature of a YieldCo is that most of the cash it generates is paid off as dividends. Typically, the parent company keeps ‘dropping in’ more assets into the YieldCo as a way of financing its development pipeline, realizing the value of each project development on completion.

In October 2015 First Solar CEO Jim Hughes highlighted excellent momentum in India:

“The largest growth of bookings opportunities since the prior quarter were in India and Latin America. India is a market where we can get paid for being a developer and we are active as a developer. What is different is, there are capital constraints in India that don’t exist in other markets that limit how much development we’re going to be able to do. So, we are very aggressive on the module and module-plus front in India.”

In November 2015, First Solar’s first round bid was Rs5.35kWh in the 500MW tender in Andhra Pradesh, making it one of 30 developers bidding a collective 5GW. However, it was underbid in the second round by SunEdison.

⁸⁸ <http://investor.firstsolar.com/releasedetail.cfm?ReleaseID=897478>

Section 17 – EDF Energies Nouvelles’ Acme Solar

ACME Solar is a joint venture between ACME Cleantech Solutions Private Limited (50%), EDF Energies Nouvelles of France (25%) and EREN Renewable Energy (25%). ACME Solar is an Indian solar developer and operator. EDF Energies Nouvelles is a subsidiary of the EDF Group dedicated to renewable energy, and has a global portfolio of 7.5GW of installed capacity focused for the most part on wind (onshore and offshore) and solar energy.

ACME Solar has an existing portfolio of 200MW in operation plus projects in development to take it to over 1GW by 2017, including 110MW in Punjab, 192MW in Andhra Pradesh and 120MW JNNSM Phase II Projects in Rajasthan.

In November 2014, ACME Solar won 80MW of solar projects in Telangana and in the same month won a bid to develop 160MW of solar power projects in Andhra Pradesh.⁸⁹

In January 2015, ACME Solar committed to develop 7.5GW of renewable energy projects during the five-year period of 2015-19.

In April 2015, ACME signed a PPA for a 30MW solar project with Uttar Pradesh Power Corp. The power plant will be set up at Mahoba District over 150 acres of land with a 12 year fixed tariff of Rs8.93/kWh. The investment is US\$37m, with commissioning due by August 2016.⁹⁰

In June 2015, ACME commissioned 100MW Solar PV across five projects in the Thar Desert of Rajasthan awarded under the National Solar Mission Phase – II in February 2014. These solar projects were partly funded by the International Finance Corporation and a US\$100m loan from the Asian Development Bank.

In July 2015, ACME commissioned the 30MW Odisha solar project.⁹¹

In July 2015, it was reported that Acme Group was all set to operationalise their 100MW solar projects in Mansa district of Punjab by March 2016.⁹²

In August 2015, ACME Solar took the leading role in the 2,000MW Telangana state PV tender, winning 446MW.⁹³ At Rs5.84 (US\$0.09) per kWh, Acme plans to develop solar PV projects in 18 sites.⁹⁴ With this tender, ACME now has project commitments to invest Rs45bn in Telangana.

⁸⁹ <http://www.livemint.com/Industry/DuV5c5TM9ygE5NCKJVvozO/Acme-Group-wins-bid-for-160-MW-solar-projects-in-AP.html>
⁹⁰ http://www.acmesolar.in/upload/mreleases/1429768942_ACME%20Signs%20PPA%20for%2030%20MW%20With%20Uttar%20Pradesh.pdf

⁹¹ http://www.pv-magazine.com/news/details/beitrag/edf-and-eren-fire-up-150-mw-of-solar-in-india_100020349/#ixzz3oEzoxpWU

⁹² <http://timesofindia.indiatimes.com/city/chandigarh/117-MW-solar-projects-become-operational-in-Punjab/articleshow/48106646.cms>

⁹³ <http://www.acmesolar.in/press-releases-detail.php?id=65>

⁹⁴ http://www.pv-magazine.com/news/details/beitrag/acme-solar-wins-446mw-_100020492/#ixzz3ieDy8ug9

Section 18 – Hindustan Power Projects

Hindustan Cleanenergy is a subsidiary of Hindustan Power Projects Private Limited (formerly known as Moser Baer Projects Private Limited) for development of solar projects in India and abroad. It is one of the larger solar-farm developers in India with an installed capacity of 320MW. Hindustan Cleanenergy is working toward reaching India's first 1GW of solar plants.

Hindustan Powerprojects aims to invest over US\$3bn in the Indian solar sector in the next five years. Hindustan Powerprojects Chairman, Ratul Puri, highlights why demand for electricity to run irrigation pumps, fans and air-conditioners makes solar a natural fit for the Indian electricity grid:

“Solar generation perfectly overlays the demand cycle. Can we have 100% energy in India from solar? No. But 15, 20% of our energy from solar: we can easily do this in the very near future.”⁹⁵

In September 2015, Hindustan Power Projects was the first Indian solar firm to enter the Green Bond market having the issue of Rs38bn (US\$584m) fully underwritten by YES Bank Limited of India.

Section 19 – Mytrah Energy Ltd

Mytrah Energy (India) Limited is one of the largest Independent Power Producers in India. Mytrah Energy, based in London, listed in 2010 on AIM (the Alternate Investment Market exchange), a secondary market of the London Stock Exchange. Mytrah Energy was awarded as one of the top three most innovative companies in the world by PWC. As of August 2015, Mytrah Energy had an operating wind portfolio of 543MW across six Indian states – Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Gujarat and Rajasthan and a construction pipeline under way of 200MW due online in 2016, with a second 200MW wind project also under construction.⁹⁶

Mytrah Energy aims to reach 1GW of installed capacity by early 2017, and is on course to complete a cumulative US\$1bn (Rs62bn) investment in India.

In May 2015, Suzlon reported a new 98MW order from Mytrah Energy for a new project in Telangana. It is scheduled for commissioning in 2016. The order is part of the Business Partnership Agreement with Mytrah in May 2010 to purchase 1GW of turbines from Suzlon Group.⁹⁷

In August 2015, Mytrah Energy moved into the solar sector in a dramatic way, being awarded the second largest solar project allocation in the 2.0GW Telangana auction behind Acme Cleantech at 436MW and ahead of SkyPower at 200MW. Mytrah won its bid for 327MW of solar

⁹⁵ <http://www.theguardian.com/news/2015/may/27/why-india-is-captured-by-carbon>

⁹⁶ <http://www.mytrah.com/company-press-releases.php>

⁹⁷ http://www.suzlon.com/images/investor_stock_exchange/321_Suzlon_18-05-2015.pdf

at a PPA of Rs5.75/kWh. A condition of the tender was that the projects have to be started within 12 months.⁹⁸

Section 20 – Gamesa of Spain

Gamesa of Spain is a top-tier global wind turbine manufacturer. Gamesa entered the Indian market in 2009 and has held a leading 32% turbine market share over 2013 and 2014. To date, Gamesa has installed 1,900MW in India.

In April 2015, Gamesa announced new wind turbine orders in India totalling 194MW across six new wind farms slated for commissioning between July 2015 and February 2016.⁹⁹

In July 2015, Gamesa announced a new order for the supply of 250MW to Orange, one of India's emerging independent power producers (IPP). This includes the turnkey construction of a 100MW wind farm in the town of Ananthapur, in Andhra Pradesh, scheduled for commissioning in March 2016. In addition, Gamesa will supply, install and commission 50MW at the Ratlam wind farm and another 100MW at the Agar wind farm, both in Madhya Pradesh. These facilities are slated for commissioning in the first and third quarters of 2016, respectively.¹⁰⁰

In July 2015 Gamesa announced an agreement to develop a 10MW solar power in India. This project, due to be commissioned in September 2015, represents Gamesa's initial foray into solar. Gamesa has entered into an EPC contract encompassing four photovoltaic solar plants in the state of Tamil Nadu, in southeastern India. It will build the facilities for three important textile makers in the region - Best Corporation, Shiny Knitwear and Santhosh Garments.

This statement by Ramesh Kymal, Gamesa's CEO, in India is telling:

*"This début solar contract fits with the strategic goal enshrined in our 2015-2017 plan of exploring opportunities in businesses that complement the wind industry. The solar segment in India offers a potential of 750GW, and the local government target is to reach 100GW in 2022 from 3.8GW today. Gamesa is keen to accompany its customers as they develop solar power projects in India, leveraging its know-how developing and managing renewable energy projects as well as its established and competitive local supply chain."*¹⁰¹

In October 2015, ReNew Power awarded Gamesa a 40MW turbine order for its new Lingsagur wind farm in Karnataka. ReNew Power has also signed a pact with Andhra Government in October 2015, to invest in wind farms and turbine in the state in next five years.¹⁰²

⁹⁸ <http://www.renewableenergyworld.com/articles/2015/08/india-s-largest-solar-power-auction-reflects-further-drop-in-solar-energy-costs.html>

⁹⁹ <http://www.gamesacorp.com/en/communication/news/gamesa-to-supply-turbines-totalling-194-mw-to-six-wind-farms-in-india.html?idCategoria=0&fechaDesde=&especifica=0&texto=&idSeccion=0&fechaHasta=>

¹⁰⁰ <http://www.gamesacorp.com/en/communication/news/gamesa-strengthens-its-position-in-india-with-a-new-order-for-the-supply-of-250-mw-to-orange.html?idCategoria=0&fechaDesde=&especifica=0&texto=&idSeccion=0&fechaHasta=>

¹⁰¹ <http://www.gamesacorp.com/en/communication/news/gamesa-enters-the-indian-solar-power-market-with-a-maiden-10-mw-order.html?idCategoria=0&fechaDesde=&especifica=0&texto=&idSeccion=0&fechaHasta=>

¹⁰² <http://www.gamesacorp.com/en/cargarAplicacionNoticia.do?idCategoria=62&identificador=1305&urlAmigable=gamesa-to-build-a-40-mw-wind-farm-in-india-for-renew-power-under-a-turnkey-arrangement.html>

In October 2015, Gamesa received an order to supply turbines for a 100MW wind power project in Madhya Pradesh being developed by Hero Group with commissioning due March 2016.¹⁰³

In November 2015, Gamesa was contracted by Ostro Energy, to build two 100MW wind farms under a turnkey arrangement in at the Amba and Nimbagallu wind farms in Andhra Pradesh.¹⁰⁴

Section 21 – Greenko Group PLC

An Indian firm based in Hyderabad that was founded 2006, Greenko Group is a London Stock Exchange's Alternative Investment Market (AIM)-listed, renewable-energy independent power producer. Greenko's portfolio has assets totalling US\$1.3bn across 838MW as of June 2015 that spans wind (502MW), hydel (258MW), gas and biomass (78MW). It is on course to nearly double it to 1.6GW by 2016 and is set to foray into solar power generation and has plans to develop 500MW within 12-18 months by co-locating solar and wind farms.

Greenko has pledged to add 5GW of renewable energy capacity by 2020.¹⁰⁵

In September 2015, Greenko reported that the construction of a 300MW of wind farms spread over three locations is well under way. The 60MW Tanot Phase 2 and 100MW Vyshali projects are expected to be operational by December 2015. A further 178MW of hydro assets are also under construction, including the 96MW Dikchu project in Sikkim that is expected to be operational by end of 2015. The other 82MW of hydro investments are smaller in scale and are due to become operational in 2016.¹⁰⁶

Vestas Wind Systems

In July 2015, Vestas announced a 46MW wind-farm order from an unspecified customer in the Indian State of Karnataka.

In August 2015, Vestas announced a new order for the 40MW Khambaliya wind project with Powerica Ltd., a rising power-solutions provider in India.¹⁰⁷

In November 2015, Vestas Wind Systems A/S, the world's largest wind-turbine maker, announced €50m investment plans to build a new blade factory in India as it seeks to expand its presence in this key growth market.¹⁰⁸

¹⁰³ <http://indianpowersector.com/2015/10/gamesa-india-secures-100mw-wind-power-project-with-the-hero-group/>

¹⁰⁴ <http://www.gamesacorp.com/en/communication/news/gamesa-cements-its-leadership-in-india-having-landed-a-contract-for-the-turnkey-construction-of-two-wind-farms-with-total-capacity-of-200-mw.html?idCategoria=0&fechaDesde=&especifica=0&texto=&idSeccion=0&fechaHasta=>

¹⁰⁵ <http://www.greenkogroup.com/docs/press/2015/Greenko%20Group%20plans%20to%20increase%20capacity%20to%205,000MW%20by%202020.pdf>

¹⁰⁶ http://www.greenkogroup.com/docs/news/2015/REG_Half%20Yearly%20Report_2015-09-30.pdf

¹⁰⁷ <https://www.vestas.com/en/media/news#!company-news>

¹⁰⁸ <http://www.bloomberg.com/news/articles/2015-11-05/vestas-winds-plans-to-build-new-blade-factory-in-india>

Section 22 – Inox Wind of India

Inox Wind Limited, 86% owned by the US\$2bn Inox Group, is an integrated player in the Indian wind energy market, with manufacturing plants at Una (Himachal Pradesh) and Ahmedabad (Gujarat).

Inox Wind raised US\$165m through its initial public offering in March 2015 and aims to use these funds to expand generation and manufacturing capacity. Inox Wind reported a March 2015 project pipeline of 1.2GW and expects new orders of 1.0-1.5GW capacity annually.

Inox Wind received a 166MW contract from Green Infra.

In September 2015, Inox Wind won an order for a 100MW wind power project at Lahori, in the state of Madhya Pradesh from Ostro Energy.¹⁰⁹ This is phase I of the Inox Wind Park, which has a total proposed 200MW capacity.

In September 2015, Inox Wind won an order for a 50MW wind power project at Rojmal, in the state of Gujarat from Gujarat Mineral Development Corp. Ltd. (GMDC). A Government of Gujarat undertaking, GMDC is a leading minerals and lignite mining company in India with installed wind capacity of 150MW in Gujarat. The 50MW project will be part of the Inox Wind Park of 400MW capacity at Rojmal.¹¹⁰

In October 2015, the state-owned enterprise Gujarat Mineral Development Corporation awarded a 50MW wind energy project in the western state of Gujarat to Inox Wind.¹¹¹

In October 2015, Tata Power Renewables awarded Inox Wind an order for a 50MW wind power project at Lahori, in the state of Madhya Pradesh.¹¹² Inox Wind had earlier received order for developing 172MW capacity from the project developer.¹¹³

In October 2015, INOX Wind commissioned 116MW of new wind farms, phase 1 of the 400MW Rojmal infrastructure facility in the state of Gujarat. The 116MW of wind farms are owned by Tata Power, Sembcorp Green Infra and Gujarat Alkalies and Chemicals Limited (a government owned entity).¹¹⁴

¹⁰⁹ <http://www.inoxwind.com/inox-wind-bags-100-mw-order-from-ostro-energy/>

¹¹⁰ <http://www.inoxwind.com/inox-wind-bags-50-mw-turnkey-order-from-gmdc/>

¹¹¹ <http://economictimes.indiatimes.com/industry/energy/power/inox-wind-bags-50-mw-wind-power-project-from-gmdc/articleshow/49167078.cms>

¹¹² <http://tata.com/company/releasesinside/Inox-Wind-bags-50-MW-order-from-Tata-Power-Renewable-Energy>

¹¹³ <http://cleantechnica.com/2015/10/13/listed-wind-companies-india-rally-new-orders-improved-credit-rating/>

¹¹⁴ <http://www.inoxwind.com/inox-wind-commissions-220-kv-sub-station-and-116-mw-capacity-in-gujarat/>

Section 23 – Jindal Steel & Power

Jindal Steel and Power Limited (JSPL) is a leading player in the steel, power, mining, oil and gas and infrastructure sectors in India with a turnover of US\$3.3bn. The company produces steel and power through backward integration from its own captive coal and iron-ore mines. JSPL is a part of the roughly US\$18bn diversified Jindal Group conglomerate.

In September 2015, JSPL submitted a 1GW solar proposal in the Godda district in the state of Jharkhand to the Jharkhand Renewable Energy Development Authority. The Jharkhand Renewable Energy Development Authority (JREDA) confirmed that it had received the proposal but said the exact land requirements for the sizeable project were not yet available. This proposal marked the first step of JSPL into the solar power market. The Jharkhand state government recently approved a new solar power policy with a target of 2GW of solar power by 2020 aimed at boosting renewable energy generation in the region to bridge the state's power deficit.¹¹⁵

In November 2015, JSPL's first-round bid was Rs5.71/kWh in the 500MW tender in Andhra Pradesh, making it one of 30 developers bidding a collective 5GW,¹¹⁶ but was unsuccessful in the second-round bidding.

¹¹⁵ http://www.pv-magazine.com/news/details/beitrag/india--adani--jspl-propose-2-gw-of-solar-projects-in-jharkhand_100020979/#ixzz3I5t8QoEW

¹¹⁶ <http://www.bridgetoindia.com/blog/500-mw-of-nsm-bids-in-andhra-pradesh-to-close-below-inr-5-37kwh/#sthash.id4cQNkl.dpuf>

Section 24 – Essel Infraprojects and JA Solar of China

The Essel Group is an Indian conglomerate, established in 1926 and having a presence in entertainment, media, infrastructure and metals businesses. Essel Infraprojects Limited (EIL), part of the Essel Group, announced a commitment in February 2015 to install 12GW of renewable energy capacity by 2022, including 7.5GW of solar, 4GW of wind and 0.5GW others.¹¹⁷

EIL currently has 30MW of completed Indian solar projects in Maharashtra and Karnataka, 80MW of solar under construction in Uttar Pradesh and Punjab, and 82MW of hydro-electricity under development in Nepal, plus a number of energy-from-waste projects under construction.

In February 2015, the Essel Infraprojects signed a Memorandum of understanding with the Government of Rajasthan to develop Solar Park with total investment of Rs40bn.¹¹⁸

In May 2015, Essel Infraprojects Limited of India **announced** a MoU with JA Solar (a China-based, NYSE listed global solar leader with 2014 sales of US\$1.8bn on the back of 2.4GW of module production) to set up a solar cell and module-manufacturing facility in India.¹¹⁹

In September 2015, JA Solar announced it had formalized its agreement with Essel Solar to begin construction in the southern Indian state of Andhra Pradesh of a 500MW solar cell factory in December, with a similar-size module factory to follow, with completion of the second stage targeted by mid 2017.¹²⁰ The facility is expected to be located at the Sri City Industrial Park, with initial investment for the cell-making facility expected to take a year and cost US\$150m.

¹¹⁷ http://re-invest.in/wp-content/themes/reinvest/pdf/Green_Energy_Commitments.pdf

¹¹⁸ <http://www.esselinfraprojects.com/admin/newsroomDownloads/solar%20park%20.pdf>

¹¹⁹ http://www.jasolar.com/News_corporatedetails/566-JA+Solar+and+Essel+Infraprojects+Limited+Sign+MOU+on+500MW+PV+Joint+Venture

¹²⁰ http://www.pv-magazine.com/news/details/beitrag/ja-solar-pens-agreement-to-build-1-gw-fab-capacity-in-andhra-pradesh--india_100020895/#ixzz3oDwwRrRz

Section 25 –China Light & Power (HK)

Hong Kong-based power generation giant China Light & Power Holdings (CLP Holdings) is a leading investor-owned power businesses in Asia, and also the top foreign investors in the Indian power sector with a total committed investment of over Rs145bn (US\$22bn). Its investment in India is spread across a diversified generation portfolio that covers renewable energy, supercritical coal and gas-fired power plants, amounting to over 3,000MW. In 2007, CLP Group set a target to reduce its carbon intensity by 75% by 2050. It is shifting to more efficient coal and matching that investment in renewables such as solar and wind.

CLP entered the Indian power sector in 2002 with the acquisition of a 655MW gas power plant in Gujarat. CLP had plans to expand capacity when it entered India but with uncertainties in the sector, went slow on them over the past three years and decided to focus on wind energy.

CLP Wind Farms India is the largest wind farm operator in India, having commissioned wind-energy capacity across six states of 874MW following the September 2015 commissioning of their latest new addition, a 101MW windfarm in Rajasthan.¹²¹

In September 2015 Rajiv Mishra, Managing Director of CLP India said:

"From having no wind energy projects in India five years back, we... are commissioning two projects a year. We remain keen to invest in wind energy projects even though the government has eased the pedal on wind energy and is focusing more on solar. We are interested in solar projects but the recent bids have been so competitive that it has raised questions if this could be a repeat of what happened in conventional energy due to competitive bids. We will look at projects carefully."¹²²

CLP India in September 2015 raised Rs6bn (US\$92m) through the issuance of corporate green bonds. The proceeds from the bond issue shall be used for financing of its committed new wind projects of over 1,000MW across six states. CLP India became the first Indian power sector company to raise funds through green bonds. Previously, only financial institutions in India had done so. The CLP bonds have a coupon rate of 9.15% pa and maturity spanning 2018-2020.

In October 2015, CLP Group's chief executive Richard Lancaster said:

"If we invest in China and India we know where the policy is heading and we know with some degree of certainty that the policy will stay there. Effort is made to make it clear and transparent."¹²³

¹²¹http://www.suzlon.com/images/Media_Center_Press_release/374_Suzlon%20commissions%20100.80%20MW%20wind%20po wer%20project%20for%20CLP%20in%20Rajasthan,%20India.pdf

¹²² <http://economictimes.indiatimes.com/markets/bonds/clp-indias-wind-energy-arm-raises-rs-600-crore-via-green-bonds/articleshow/48979673.cms>

¹²³ <http://www.afr.com/news/economy/messy-policy-makes-australia-risky-clps-richard-lancaster-20151007-gk3s52#ixzz3oJIAPEjd>

Section 26 – Other Indian Entrants

Azure Solar

Azure Power is an independent Indian solar power producer that commenced in 1997. It commissioned the first MW-scale solar power project in the country by a private sector company, and it also commissioned the first solar power project under the National Solar Mission. Azure Solar also commissioned India's first MW-scale rooftop solar power project, in Gujarat. It has been actively participating in central and state-level solar power auctions since 2009, and has very ambitious plans to expand its footprint in the Indian solar power sector, pledging to install 11GW of solar power capacity over the next 7 years. It currently has a cumulative operational capacity of 142MW with another 150MW in the pipeline.

The Overseas Private Investment Corporation (US) has backed the development of rooftop solar PV systems in India. It provided borrowing of US\$20m to Azure Sunlight, which will be used for the project which comprises development, financing, construction, operation and maintenance of an approximately 19MW portfolio of rooftop solar generation systems across India.

Axis Energy Group

Axis Energy Group is an Independent Power producer in India whose focus is on both wind and solar power projects. In February 2015, Axis Energy Group committed to install renewable power capacity of 12.5GW (5.5GW solar and 7GW wind projects), by 2022. Axis Energy Group made the second largest commitment in the RE- Invest Conference, the first global renewable energy conference in India, an initiative of the Indian Government.¹²⁴

Axis Energy Group plans to install 4GW wind and 2.5GW solar capacity in the state of Andhra Pradesh, 2GW wind and 2.5GW solar capacity in state of Telangana and 1GW wind and 0.5GW solar capacity in the state of Karnataka.

In February 2015, Axis Energy Group signed an MoU with the Andhra Pradesh Government for developing wind-power capacities of 1GW in the state.

In May 2015, during PM Modi's visit to China, Axis Energy signed a tripartite MoU with Chinese companies Mingyang Wind Power (one of the top three wind turbine manufacturers in China) and Global Wind Power for research and development of renewable energy.¹²⁵

Group Today

Group Today, operating in the solar-power sector through its group company Today Green Energy Private Limited (TGEPL), is in the businesses of real estate, hospitality and energy (both thermal and solar). In February 2015, Group Today committed to install 800MW of green power

¹²⁴ <http://axisenergy.in/overview.html>

¹²⁵ <http://www.china-briefing.com/news/2015/05/21/modi-visit-to-fuel-chinese-investment-into-india.html>

capacity by 2022.¹²⁶ In the thermal power sector, Group Today is implementing a 1,320MW coal-fired power project in Madhya Pradesh.

TGEPL is focused on setting up large-scale solar power projects across India. Currently, it has 70MW of solar projects in the pipeline in the state of Rajasthan and Madhya Pradesh.¹²⁷

Raasi Solar Energy Private Limited

Raasi Solar Energy Private Limited (RSEPL), part of Raasi Group founded in 1978, is into solar-power development, solar-power infrastructure and advisory services. In February 2015, at the RE-Invest conference, Raasi Energy committed to develop solar capacity of 10.6GW by 2022.¹²⁸

In July 2013, Raasi Energy embarked on the development of South India's first 100MW Solar Park at Parmakudi, Ramanadapuram district in the state of Tamil Nadu. However, the plant has not been commissioned yet.¹²⁹

Embassy Group

Embassy Property Developments Private Limited, which commenced operations in 1993, has a portfolio in commercial, residential, retail and hospitality segments of the real estate industry. In October 2015, Embassy Group announced its plans to build 1GW of renewable-energy projects, including both solar and wind power, in the next five years through its newly formed subsidiary, Embassy Energy.

Embassy Energy is setting up a 200MW plant in the state of Karnataka. The plant will be built in two phases of 100MW. The first phase is expected to be completed in March 2017.¹³⁰

Hero Future Energies

Hero Future Energies Pvt. Ltd. (HFE), founded in 2012, is part of the US\$5.6bn Hero Group, one of the leading names in the Indian automotive industry. HFE has a presence in nearly 10 states of India with capacity of 220MW of wind, 40MW of solar PV (grid connected) & rooftop plants. The company intends to focus on solar - wind hybrid technology in the near future.

In February 2015, HFE committed to install capacity of 5.15GW, including 2.85GW of solar and 2.3GW of wind power. Currently, HFE has 268MW of generation capacity, including 220MW of wind power and 48MW of solar power.

HFE has 150MW of wind projects (Badnawar, Madhya Pradesh (100MW) and Zahirabad, Telegana (50MW) both due for commissioning in March 2016) plus 90MW of solar projects (under construction stage in the states of Madhya Pradesh (50MW) and Telangana (40MW)). In rooftop solar, HFE has plans to implement 100–200MW by 2018-19.

¹²⁶ http://re-invest.in/wp-content/themes/reinvest/pdf/Green_Energy_Commitments.pdf

¹²⁷ <http://www.todayenergy.co.in/today-green-energy.html>

¹²⁸ <http://www.raasienergy.com/>

¹²⁹ <http://www.raasienergy.com/events.html>

¹³⁰ http://www.pv-tech.org/news/embassy_energy_to_build_200mw_solar_plant_in_karnataka

Ostro Energy

Ostro Energy is an Indian wind energy business with plans to build 800MW of wind projects by 2018. Ostro currently has operational wind capacity of 100MW plus another 200MW of wind projects under construction. These include the 50MW Rajgarh wind project in Rajasthan, a 100MW Lahori wind project due for commissioning in 2015/16 using INOX turbines in Madhya Pradesh and a second 100MW Amba wind project in Madhya Pradesh due for commissioning in 2016/17 using Gamesa turbines.

In February 2015, [Actis Capital](#) committed to fund Ostro's business plan with an equity funding commitment of US\$230m. Actis Capital has US\$7.6bn of funds under management.

In September 2015, Ostro commissioned its first 50MW Tejuva wind power project in Jaisalmer, Rajasthan backed by a 25 year PPA from the Jodhpur Discom.¹³¹

In September 2015, Ostro Energy awarded Inox Wind an order for a 100MW wind power project at Lahori, in the state of Madhya Pradesh.¹³²

Section 27 – China's Indian Expansions

Zhenfa New Energy Science and Technology

In July 2015, Indian solar-module manufacturer Rolta Power signed a memorandum of understanding with Chinese firm Zhenfa New Energy Science and Technology to jointly develop 2GW of solar power projects in India by 2020.¹³³

The deal also means that Rolta India is entering the project-development space, as the government plans to ease limitations on use of cheaper foreign modules. Domestic module manufacturers in India have lost significant market share to foreign companies, like First Solar, over the last few years. Zhenfa Chairman Zhenfa Zha said the partnership would bring its extensive engineering, procurement, and construction skills and advanced technologies to construct utility-scale solar power projects in India.

Zhenfa is a part of the Jiangsu Zhenfa Holding Group, which has developed 3GW of solar projects in the Chinese market accounting for 10% of the country's solar photovoltaic market.

¹³¹ <http://www.ostro.in/wind-project-tejuva/>

¹³² <http://www.inoxwind.com/inox-wind-bags-100-mw-order-from-ostro-energy/>

¹³³ <http://cleantechnica.com/2015/07/24/chinas-zhenfa-enters-indian-solar-market-2-gw-pact/>

XiAn Longi Silicon Materials Corp (LONGi) of China

XiAn Longi Silicon Materials Corp (LONGi) is a China-based solar mono crystalline ingots and wafers manufacturer with an annual capacity to produce 3GW mono crystalline ingots and wafers.

In September 2015, LONGi signed a memorandum of understanding for the creation of a solar cell and manufacturing facility in the Indian state of Andhra Pradesh, as well as a 500MW solar farm proposal. The total investment planned is US\$235m.¹³⁴

Chint Group

In October 2015, China-based manufacturer of Industrial equipment and energy Chint Group announced plans to undertake an investment of US\$2bn in developing solar power and equipment in India. Chint Group, started in 1984 and listed on the Shanghai Stock Exchange, has grown to be one of the leading Chinese manufacturers of the electrical control and transmission equipment and PV modules and systems with 29,000 employees.¹³⁵

Sany Group

In October 2015, the list of new foreign entrants into the Indian renewable energy sector grew to include China-based construction equipment manufacturer, Sany Group. Sany Group is a Hong Kong-listed manufacturer of coal-mining equipment and port machinery.

Sany Group announced an investment target of US\$3bn in developing renewable energy assets in India as part of a wider US\$5bn commitment.¹³⁶ Sany Group aims to develop 2GW of renewable power capacity by 2020 in the states of Maharashtra and Andhra Pradesh. Sany Group has also expressed interest in India's offshore wind energy sector, which is set to take off later this decade.

Sany Group chairman Kiang Wengen said:¹³⁷

"This investment is a significant step in deepening our presence and commitment to India. Green energy industry in India is growing and we see this as a huge opportunity to introduce our wind energy business in the country."

Sany is already carrying out business operations in India. Sany entered India in 2002 with construction-equipment manufacturing plant in Pune.

¹³⁴ http://www.pv-magazine.com/news/details/beitrag/chinas-longi-to-invest-235m-in-1-gw-indian-solar-fab_100021231/#ixzz3oEHR1uGf

¹³⁵ <http://en.chint.com/about/?classid=144960712517615616>

¹³⁶ <http://economictimes.indiatimes.com/industry/energy/power/make-in-india-chinas-sany-group-to-invest-3-billion-in-india-on-renewable-energy-projects/articleshow/49388244.cms>

¹³⁷ <http://cleantechnica.com/2015/10/19/chinas-sany-group-invest-3-billion-renewable-energy-india/>

Chinese Solar Module Imports to India

In 2014/15, Chinese solar-panel manufacturers dominated the Indian solar power market. According to the Ministry of New and Renewable Energy, India imported 161.5 million solar panels in 2014–15. Of these, 113.5 million panels, or 70%, were imported from China.

This marked a significant increase from the 65% share of Chinese modules in financial year 2013–14 when 154 million panels were imported. India is among the few large solar markets that does not impose import duties on Chinese modules.

With the potentially explosive growth in the Indian solar market over the next decade, it is strategically logical for China to expand its presence in the Indian solar market. China is the world's largest solar-module manufacturer and has the largest installed base of solar-farm globally. IEEFA expects China to exit 2015 with over 50GW of solar installed (with 17GW added in 2015 alone), now well ahead of second-place Germany (with 40.7GW) and third-place Japan (34.7GW). India is number nine globally in terms of cumulative solar installs, but has moved into the top five for annual installation activity.

Figure 27.1: Global Solar Installations – 2015 and Cumulative total (GW)

	2015 Estimated Adds	2015 Growth yoy	2015 Share of growth	2015 Estimated Installed base	2015 Estimated Installed base
China	17.0	31%	30%	50.8	21%
Germany	2.1	10%	4%	40.7	17%
Japan	10.0	0%	18%	34.7	14%
US	8.4	20%	15%	28.3	12%
Italy	0.5	-10%	1%	18.6	8%
UK	1.9	-30%	3%	7.4	3%
France	0.9	20%	2%	6.0	2%
Spain	0.4	0%	1%	5.5	2%
India	2.1	93%	4%	5.2	2%
Australia	0.7	-20%	1%	4.8	2%
Belgium	0.2	0%	0%	3.4	1%
Greece	0.4	0%	1%	2.5	1%
Chile	0.7	30%	1%	2.2	1%
Brazil	0.6	200%	1%	0.8	0%
Others	10.0	78%	18%	32.6	13%
Global Total	56.0	22%		243.3	100%

Source: IEEFA Estimates

Section 28 – Aiming for 175GW of New Renewable Energy by 2022

Finance Minister Arun Jaitley in the 2015/16 Indian budget includes a proposed **tenfold** increase in solar installation to 100GW by 2022, trebling to 60GW of wind farms, an additional 10GW of biomass and 5GW of new small-scale, run-of-river hydro.¹³⁸

This is 175GW of additional renewable-energy installations in total, requiring an investment of more than US\$200bn and representing a fivefold increase on the current installed total of 36GW of renewable energy (excluding large scale-hydro) — Figure 28.1.

Figure 28.1: India's Generating Capacity: Breakdown by Fuel Type (GW)

Capacity (GW)	Mar'1997	Mar'2002	Mar'2007	Mar'2012	Mar'2015	Mar'2015
Coal-fired	54.2	62.1	71.1	112.0	164.6	60.6%
Gas-fired	6.6	11.1	13.7	18.4	23.1	8.5%
Diesel	0.3	1.1	1.2	1.2	1.2	0.4%
Hydro	21.7	26.1	36.4	42.6	41.3	15.2%
Small hydro				3.4	3.8	1.4%
Nuclear	2.2	2.7	3.9	4.8	5.8	2.1%
Wind	0.4	0.8	4.1	16.5	24.2	8.9%
Solar	0.0	0.0	0.0	0.6	3.7	1.4%
Biomass & SMP	0.5	0.9	1.9	3.8	4.1	1.5%
Total	85.9	104.9	132.3	203.3	271.7	100.0%

Source: Central Electricity Authority, India, March 2015.

Section 29 – An Indian Electricity Model

The Indian electricity sector faces an increasingly serious energy-security issue rooted in its lack of diversity in generating capacity, and a growing reliance on imported fossil fuels over the past five years. As of the end of September 2015, coal-fired generation capacity of 169.1GW was 60.7% of total installed capacity, and coal is the fuel type that has grown fastest over the past five years. Even with a depressed plant load factor (PLF) at a record low 57.5% in 2014/15 (down from its peak, in 2008/09, of 79%), coal-fired electricity supplied an estimated

Figure 29.1: India's Electricity Capacity & Generation (Sept 2015)

	---- Capacity ----		-- Generation --		PLF %
	GW	%	TWh	%	
Coal-fired	169.1	60.7%	852.0	73.8%	57.5%
Gas-fired	24.1	8.6%	47.2	4.1%	22.4%
Diesel-fired	1.0	0.4%	2.6	0.2%	30.0%
Large Hydro	42.2	15.1%	125.8	10.9%	34.0%
Nuclear	5.8	2.1%	36.1	3.1%	71.3%
Renewables	36.5	13.1%	86.1	7.5%	26.9%
Bhutan	n.a.	n.a.	5.4	0.5%	n.a.
Total	278.6	100.0%	1,155.2	100.0%	

PLF = Plant load factor, otherwise termed the utilisation rate.

Source: Central Electricity Authority, IEEFA estimates using capacity as of 30 September 2015 and estimating TWh generation using the 2014/15 averages.

¹³⁸ <http://indiabudget.nic.in/bspeecha.asp>

73.8% of India's total (Figure 29.1).¹³⁹

While installed gas-fired electricity capacity has doubled over the past five years, a critical decline in domestic gas supply has likewise seen gas PLF drop to a record low 22.4% in 2014-15.

Hydro-electricity is the second largest installed capacity at 42.1GW, representing 10.9% of generation in 2015, albeit operating with a high seasonality tied to monsoon flows.

Section 29.1 – An Electricity Demand-and-Supply Model for India

GDP versus Electricity Growth

IEEFA forecasts gross domestic product (GDP) growth for India of 6-8% annually through 2022.

A key assumption is that net electricity demand in India will grow at 1.15 times the growth in GDP, less 1% pa in energy-efficiency savings—giving net growth of 7% pa (a net ratio of 1.0x). We would consider this a high-end forecast with scope for more moderate electricity demand growth to occur.

In comparison, China has seen electricity growth of 1.0-1.3x GDP growth over the past decade, with this ratio dropping to 0.5x in 2014 and even lower in 2015 at 0.2x as transformation toward a more service-based economy becomes a defining aspect of China.

The Indian Electricity for All rural electrification program should see development of distributed solar and battery systems off-grid, hence external to the 1.0x on-grid system growth.

With GDP growth forecast at 7% per year, IEEFA assumes net electricity demand growth for India is 7% pa. This is marginally ahead of the five year average through 2014/15 of CAGR of 6.6%, but the reported April-September 2015 outcome of electricity demand averaged increases of only 3% yoy. And record-low spot electricity prices suggest the economy and hence electricity demand is still not robust. Overcoming the excessive financial leverage evident across many corporates and state governments is a major constraint on economic growth and will take some time, and efficiency gains are key to sustainability.

Growth in Electricity Demand Through 2022

IEEFA estimates that India's net electricity consumption in fiscal year 2014/15 was about 818TWh. We assume 7% annual real GDP growth through 2022, and we see electricity demand growth in line with real GDP, net of a 1% per annum energy-efficiency gain. This suggests Indian net electricity consumption will grow to 1,318TWh net electricity consumption by 2021/22 (Figure 29.2). We note also that a 1% per annum gain in energy efficiency would deliver a cumulative savings of 75TWh by 2021/22.

If India's transmission grid can achieve a 1% annual reduction in Aggregate Technical & Commercial (AT&C) losses from 26% in 2014/15 to 18% by 2021/22 (still double the global average), India would realize a critical savings. IEEFA is being deliberately conservative here,

¹³⁹ http://www.cea.nic.in/reports/monthly/installedcapacity/2015/installed_capacity-09.pdf

given that Energy Minister Goyal in October 2015 set a target to cut losses to 15% by 2018/19. Gross electricity production (before AT&C losses) is therefore forecast to grow from 1,106TWh in 2014/15 to 1,627TWh by 2021/22 (a CAGR of 4.7%).

Assuming the Gol achieves 75%, or 75GW, of its target for 100GW of solar-capacity additions, India would see 110TWh per annum of new gross electricity production by 2021/22. Interestingly enough, this suggests solar would be contributing 7% of the 1,627TWh of India's gross electricity produced by 2021/22. Put another way, solar could deliver 24% of the required electricity-generation expansion over the next seven years.

Assuming the Gol achieves its 60GW target for new total installed onshore wind farms by 2021/22, the country would be one of the top three nations globally in terms of total wind installations. This would add a further 95TWh per annum of new gross electricity production. A cautious move into offshore wind development starting at the end of this decade could see 5TWh added by 2021/22.

New large-scale and smaller run-of-river hydro-electric generation across India of 1-2GW per annum, plus expanded hydro imports from Nepal and Bhutan, could add a combined 44TWh to India's supply by 2022 and deliver system diversification, increased use of pumped-hydro storage and load-balancing flexibility.

This means renewable energy including hydro should deliver 50-60% of the net increase in electricity demand required from 2014/15 to 2021/22.

Figure 29.2: India's Net Electricity Consumption (2014/15-2021/22, TWh)

Net Electricity consumed in India in 2014/15 (TWh)	818	
Real GDP Growth	7.0% pa	
Electricity to GDP multiplier	1.15 times	
Electricity Demand Growth	8.1% pa	553
Energy Efficiency	-1.0% pa	-75
Growth in gross production losses		136
Reduced grid AT&C losses	-1.0% pa grid efficiency gain	-114
Net Electricity consumed in India in 2021/22 (TWh)	1,318	
<u>The Increase in Net Electricity Demand is met by (TWh):</u>		
Solar expansion	118	24%
Onshore wind expansion	95	19%
Offshore wind expansion	5	1%
Increase in biomass generation	25	5%
Increase in hydro electricity	34	7%
Increase in hydro imports	10	2%
Increase in gas-fired electricity	40	8%
Increase in nuclear generation	30	6%
Change in Coal Use	144	29%
Net expansion in Electricity Demand 2021/22 (TWh)	500	100%

Source: IEEFA estimates

Doubling the utilisation of existing gas-fired capacity from the 22.4% average in 2014/15 on the 24GW of currently installed gas-fired electricity capacity would add 40TWh per annum.

Biomass and nuclear capacity expansions could each add 25-30TWh by 2021/22.

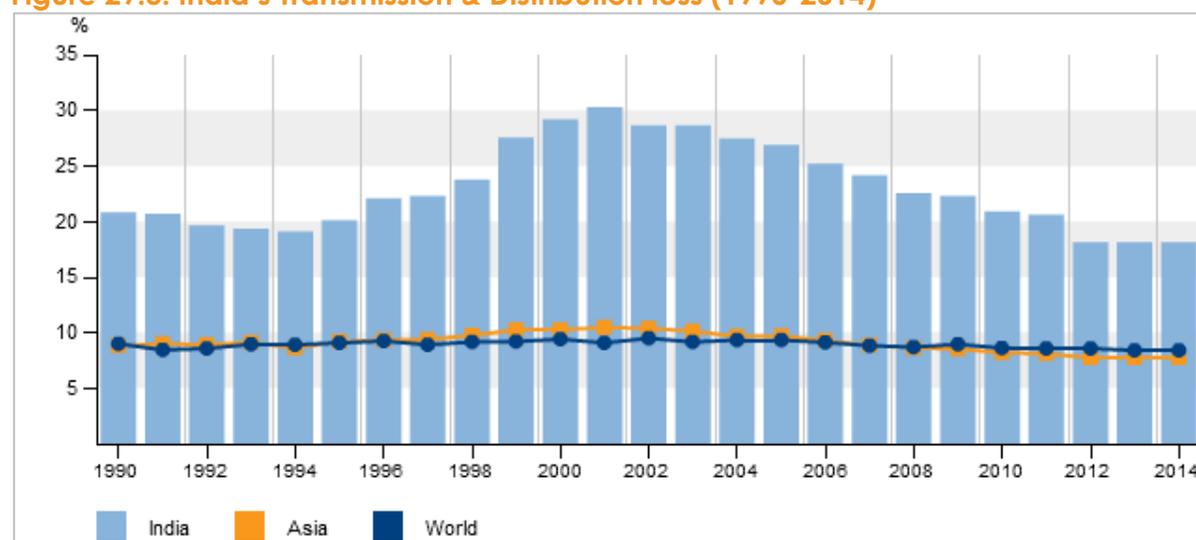
Grid Transmission and Distribution Efficiency

A major constraint on Indian electricity-sector efficiency are AT&C grid losses, which average around 26% annually over the past decade. With a major GoI focus on modernizing and upgrading the electricity grid, IEEFA models an assumption of grid AT&C efficiency gains of 1% annually. If this improved grid efficiency can be delivered, then 7% per annum net electricity demand growth translates to a need for 5-6% per annum growth in gross electricity power-generation growth. Energy Minister Goyal in October 2015 articulated a plan to reduce AT&C losses to 15% by 2018/19, an ambitious target, giving significant upside to our forecasts if this were to be delivered.¹⁴⁰ By global standards, this is still excessive and unsustainable.¹⁴¹

However, even a reduction from 26% to 18% AT&C losses by 2022 would almost offset the grid losses on all new gross electricity production added to the grid, with total AT&C losses rising marginally from an estimated 287TWh in 2014/15 to 309TWh per annum by 2022. Put another way, there are massive system-wide avoided costs that distributed generation like solar with storage would deliver to India, for both on- and off-grid applications.

During 2013/14, Power Finance Corp reports the average Indian electricity cost of supply was Rs 5.15/kWh while the average selling price was Rs 4.00/kWh. Discoms lost an average Rs 1.15/kWh.

Figure 29.3: India's Transmission & Distribution loss (1990-2014)



Source: Enterdata,¹⁴² World Energy Council

¹⁴⁰ <http://economictimes.indiatimes.com/opinion/interviews/indias-investment-thrust-will-be-towards-renewable-energy-piyush-goyal/articleshow/49532254.cms>

¹⁴¹ <https://www.wec-indicators.enerdata.eu/world-rate-of-electricity-T-D-losses.html>

¹⁴² <http://www.enerdata.net/>

Growth in Coal for Indian Electricity Generation of 4-5% Per Annum (2015-2022)

Figure 29.4 details IEEFA's forecast for coal-fired power generation and resulting thermal coal consumption estimates through 2021/22. Relative to 2014/15, coal-fired power generation is forecast to grow at a CAGR of 4-5% to 2021/22. Accelerated energy efficiency, grid efficiency, coal-fired power plant thermal-efficiency gains and greater fuel diversification would see this 4-5% CAGR estimate as materially too high. Figure 29.2 above (showing only 158TWh of additional coal-fired power generation is required) suggests our coal-growth forecasts are considerably too high.

Working on this base assumption, coal-fired power generation will see its market share drop from 74.3% of total Indian electricity generation in 2014/15 to a record low for India of 64.4% in 2021/22. This would reflect the impact of increased diversification into all alternative sources of electricity, similar to that on track to be achieved in China this decade.

IEEFA assumes the thermal efficiency of the average Indian coal-fired power plant improves 1.25% per annum from 32% in 2014/15 to 35% by 2021/22, given the coal industry's emphasis on international banks only providing funding for supercritical and ultra-critical power plants with thermal efficiencies of 38-43%. As such, Indian-coal fired power plants should see a gradual reduction in coal tonnes required per TWh of electricity generated, falling from 0.64Mt/TWh in 2014/15 to 0.59Mt/TWh by 2021/22. By comparison, China has delivered a 1.0-1.5% pa reduction in coal tonnes usage per TWh produced over the last two decades.

Working through these assumptions, we see coal required for the Indian power sector to grow at a CAGR of 4% through 2021/22 to 686Mt, a total consumption increase of 184Mtpa over this seven-year period.

This assumes the average Indian coal energy content of ~4,400kcal/kg remains constant. While India is witnessing the exploitation of progressively lower-grade coal deposits over time, the increased emphasis on coal washing by the Power Ministry should offset this trend, holding constant the delivered coal energy content per tonne.

Figure 29.4: India's Coal-fired Power Generation and Coal Consumption (2013-22, Mt)

Year to March	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Coal fired power generation (TWh)	700	747	829	907	969	1,018	1,071	1,120	1,149	1,169
Coal-fired power - market share	72.2%	72.2%	74.3%	73.3%	72.5%	71.2%	70.0%	68.6%	66.6%	64.4%
Coal-fired power thermal efficiency	31.6%	31.3%	32.0%	32.4%	32.8%	33.2%	33.7%	34.1%	34.5%	34.9%
Tonnes per TWh	0.65	0.66	0.64	0.63	0.62	0.62	0.61	0.60	0.59	0.59
Thermal coal demand - for power (Mt)	455	489	531	574	605	628	653	674	683	686
Thermal coal demand - growth (% pa)	4.9%	7.7%	8.6%	8.0%	5.5%	3.8%	3.9%	3.3%	1.3%	0.4%
Calendar year (Mt)	439	463	500	542	582	611	634	658	676	684

Source: CEA, IEEFA estimates

Section 29.2 – Indian Domestic Coal Production

The analysis above forecasts the total coal required for the Indian power sector to grow at a CAGR of 4-5% through 2021/22 to 684Mt, a total power-consumption increase of 184Mtpa over this seven-year period.

Adding in expanded industrial-sector use of coal suggests a 275-350Mtpa thermal coal demand increase by 2021-22 versus an estimated 704Mt in 2014/15. Assuming that private captive coal-mining sector output rises to 196Mtpa by 2021/22, Singareni Collieries at 73Mtpa and Coal India Ltd at 831Mtpa, India's thermal coal imports could peak at 187Mt in 2015/16 and cease at the latest by 2021/22 (Figure 29.5).

IEEFA's Coal India production forecast assumes growth of 8% per annum, implying it comes in at 719Mt by 2019/20 i.e. delivering only 45% of their targeted 511Mtpa uplift to 1,000Mtpa. Should Coal India Ltd deliver closer to its stretch target, imports would cease well before 2021/22, as first forecast by Energy Minister Goyal in November 2014.

Figure 29.5: India's Thermal Coal Production, Imports and Consumption (FY2013-22, Mt)

Year to March, Mt	Coal Type	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Coal Inda Ltd - Despatches	Thermal + coking	465	472	489	538	579	622	669	719	773	831
Singareni Collieries	Thermal + coking	53	50	53	57	60	62	64	67	70	73
Neyveli Lignite Corporation	Lignite	26	27	27	27	27	27	27	27	27	27
Other lignite producers	Lignite	20	18	18	18	18	18	18	18	18	18
Private / public captive mines	Thermal + coking	51	54	48	58	87	113	136	156	176	196
Less domestic coking coal	Coking	-52	-57	-57	-60	-63	-66	-69	-72	-73	-74
Domestic thermal coal	Thermal + Lignite	564	563	578	638	707	776	844	914	989	1,070
Imported thermal coal	Thermal + Lignite	128	142	180	187	162	132	98	64	30	0
Total coal consumption	Thermal + Lignite	692	705	758	825	869	908	942	978	1,019	1,070
Imports market share		18%	20%	24%	23%	19%	15%	10%	7%	3%	0%

Source: IEEFA estimates

IEEFA notes that relative to the 20-30% compound annual growth rate of Indian coal imports in the five years to 2014/15, the 6% decline in the subsequent seven months to October 2015 suggests a turning point has clearly been reached already. The staggering 27% year-on-year decline in coal imports in the month of September 2015¹⁴³ was followed by a 5% year-on-year decline in October 2015¹⁴⁴ and suggests momentum is accelerating away from imports as domestic coal production surges.

¹⁴³ <http://in.reuters.com/article/2015/10/19/india-coal-imports-idINKCN0SD0C920151019>

¹⁴⁴ <http://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/coal-imports-drop-5-to-14-52-million-tonnes-in-october/articleshow/49721013.cms>

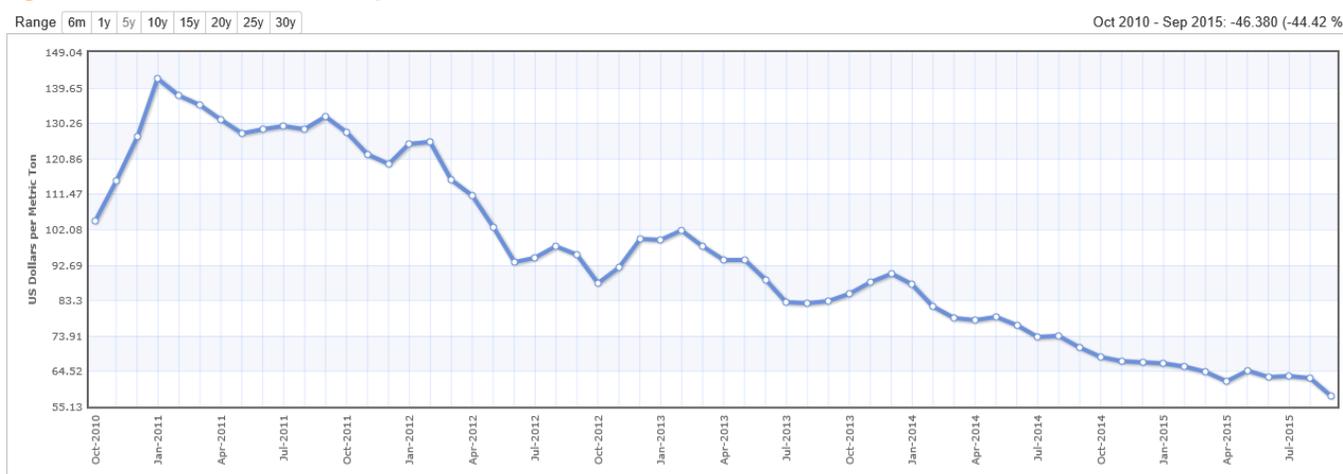
Appendix A - Structural Decline of Seaborne Thermal Coal

IEEFA views the thermal seaborne coal market as having entered structural decline. This reflects IEEFA's forecast that Internationally traded thermal coal demand will fall from its 2013 peak of 1,113Mt to 762Mtpa over 2020-2025. Figure A1 details the >60% decline in coal prices since 2011.

The key driver of this forecast is that China represents 51% of world coal consumption, and in 2014 China's coal consumption declined by 2.9%.¹⁴⁵ China rapidly moved to protect its domestic coal mining operations, resulting in an 11% decline to 290Mt in coal imports in 2014 (of which 240Mt was thermal). The decline in China's seaborne coal imports has accelerated in 2015 to be down 30% yoy in the first ten months. Declining coal consumption reflects economic transitions toward less electricity-intensive sectors, greater energy efficiency and a rapid diversification of electricity generation. Considerably more hydro, gas, nuclear, wind and solar capacity has been installed than has been installed in coal-fired power plants in the past three years, and this trend is accelerating. A structural transition is in progress. China's Intended Nationally Determined Commitment (INDC) of July 2015 aiming to cut its greenhouse gas emissions per unit of GDP by 60-65% by 2030 from 2005 levels will have profound implications for coal demand.

India imported close to 200Mt of coal in 2014/15 (this includes coking and thermal coal imports), up 18% year over year. While many commodity forecasters have assumed Indian imports will continue to grow, rising to upwards of 400Mt in the next decade, IEEFA forecasts a peak in Indian thermal coal imports in 2015, with a rapid ~20% per annum decline thereafter. This is directionally consistent, but more conservative, than Energy Minister Goyal's aim for zero thermal coal imports by 2017.

Figure A1: Thermal Coal Export Price - Newcastle 6,000kcal NAR US\$/t



Source: Index Mundi, Australian thermal coal Monthly Price - US Dollars per Metric Tonne

¹⁴⁵ China Shenhua Energy Company, 2014 Annual Report, page 65.

Appendix B – Falling Import Demand for Thermal Coal

IEEFA forecasts that global import demand for thermal coal peaked in 2013 at 1,113Mt (seaborne plus international rail shipments combined), and is set for a 30% decline by 2020 to 797Mt. This forecast is predicated on the view that Western Europe, Japan and China have already passed peak demand. India is IEEFA's major contrarian call, as per this report.

Should Minister Goyal be successful, seaborne thermal imports will be the first casualty, with a globally material impact. Figure B1 assumes Goyal will be successful, but over five to six years, rather than his hope for cessation of thermal coal imports within two to three years. The 6% year-on-year decline in Indian coal imports in the seven months to October 2015 suggests Goyal's plans are entirely on track.¹⁴⁶

Western Europe is forecast to decline materially over this decade due to European Union policy initiatives for renewables, energy efficiency and the Large Combustion Plant Directive 2001/80/EC.

Japan is forecast to decline due to the combination of four factors: ongoing economic growth headwinds; continued energy efficiency gains; the addition of 10GW pa of new solar installations; and a nuclear facility restart (Japan needs to resolve 42GW of idle nuclear capacity one way or another).

IEEFA forecasts that thermal coal imports peaked into China in 2013, far earlier than most commodity forecasters have anticipated. Thermal coal imports to China declined 9% in 2014, and year-to-October 2015, thermal coal imports have declined a further 30% year-on-year. This is driven by significant ongoing improvements in energy intensity of growth, a gradual slowing of economic growth and continued efforts to diversify away from an excessive reliance on thermal coal (with a significant expansion of wind, hydro, solar, gas and nuclear generation capacity). China ceasing thermal coal imports is an increasingly accepted scenario.¹⁴⁷

Figure B1: Thermal Coal Import Demand (1990 to 2021)

Calendar Year	Actuals				Estimate	Forecasts						
	1990	2000	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021
COUNTRY												
China	11	8	126	264	240	173	142	111	82	56	36	21
India	0	10	81	142	180	189	164	132	98	64	30	0
Japan	42	93	128	142	145	142	139	135	131	128	124	121
Korea	12	45	90	96	98	100	102	104	106	108	111	112
Taiwan	14	40	58	61	63	63	65	66	67	69	70	71
South East Asia (1)	4	14	53	60	63	75	81	87	94	102	111	121
Western Europe (2)	48	80	98	128	114	102	99	95	91	87	83	79
United States	2	10	16	7	7	9	9	10	10	10	10	10
Russia	53	25	24	23	23	21	19	19	19	19	19	19
Rest of world	191	150	172	179	181	184	188	192	196	199	203	208
Total World	378	476	846	1,102	1,113	1,058	1,006	950	895	843	797	762

(1) This includes only Thailand, Philippines, Malaysia, Pakistan and Vietnam
(2) This includes only United Kingdom, France, Germany, Spain and Italy
(3) Note - This is global traded thermal coal including lignite, and inclusive of non-seaborne trade.

Source: IEA database, IEEFA forecasts

¹⁴⁶ <http://ieefa.org/fact-checking-the-iea-the-worlds-three-largest-coal-importers-are-importing-less/>

¹⁴⁷ <http://www.reuters.com/article/2015/10/19/us-china-coal-imports-idUSKCN0SD1VB20151019>

Appendix C – 5-8% Per Annum Solar Cost Deflation

IEEFA forecasts an annual 5-8% decline in the total installed cost of solar projects' delivered cost of electricity in the next two decades. This forecast is predicated on continued double-digit growth in global installations that will drive economies of scale, which combined with technology advances, should continue to progressively lift solar-conversion efficiencies.

As an illustration of this trend, Canadian Solar in May 2015 [announced](#) a plan to double global module manufacturing capacity to 5.5GW pa. Canadian Solar's target is to reduce module manufacture cost from US\$0.47/w in 2014 to US\$0.36/w by 2017. As part of this 25% three-year cost reduction target, Canadian Solar aims to lift its module conversion efficiency from the current 16-17% to 20% by 2020.

A second [illustration](#) of rampant solar deflation was made clear in the tender of 600MW of new solar capacity tenders in Texas in July 2015 that saw bids of over 1.2GW priced at under US\$40/MWh (inclusive of a 30% tax credit). It was only in March 2014 that Recurrent Energy signed a record low 25-year PPA with Austin Energy to deliver electricity from a 150MW solar plant for just US\$50/MWh. U.S. solar electricity prices have fallen 20% in just 15 months.

Beyond the absolute cost of modules, IEEFA forecasts significant scope to reduce balance of system solar costs by 5-10% per annum over the next two decades. Key drivers of this forecast are lower financing costs combined with the module conversion efficiency forecast to nearly double, meaning installation costs [halve](#).

Solar energy still poses a shorter-term challenge of commercial viability even with electricity [costs down](#) to Rs 5/kWh against the average current cost of wholesale electricity in India of Rs3-4/kWh. However, with the fully-installed cost of solar dropping an average 10% per annum over the past six years, the market is increasingly confident that grid parity is rapidly approaching:

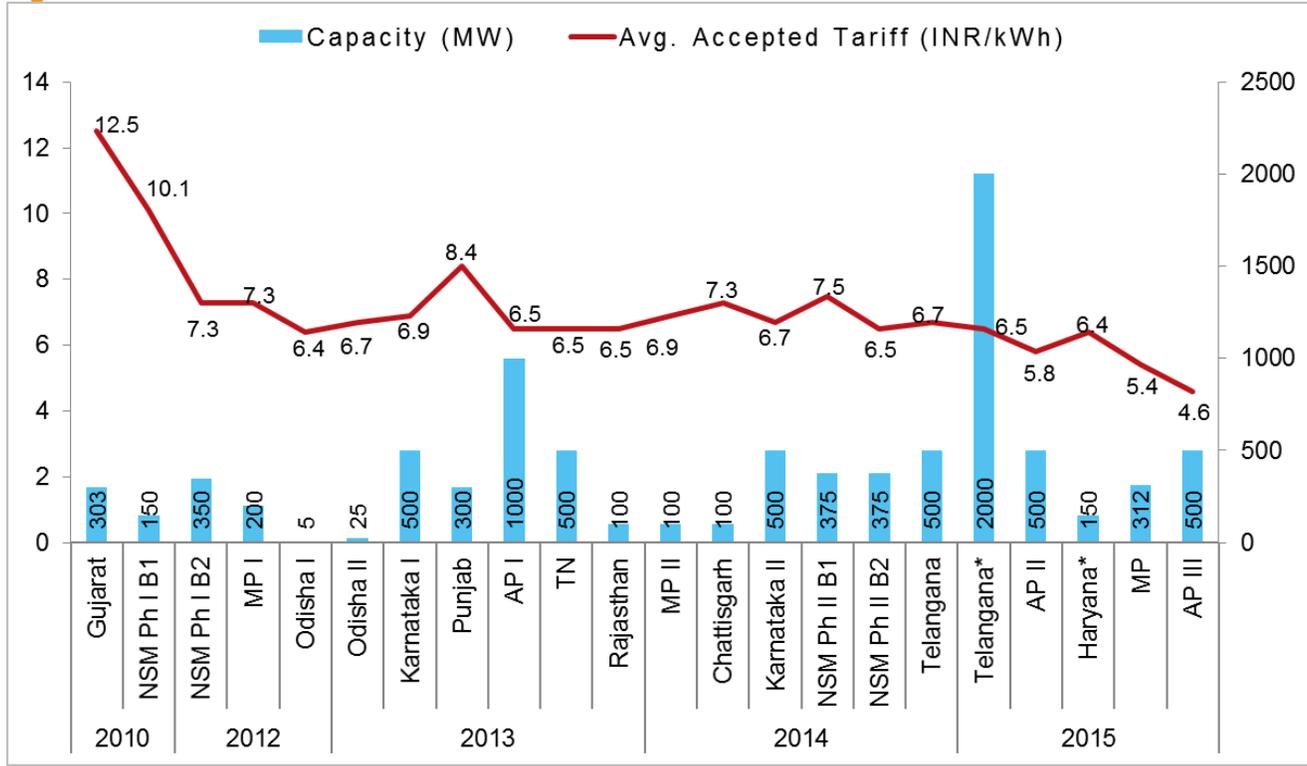
"These calculations are based on the improvement in technology and cell manufacturing cost reduction. But this (tariff reduction) can be done much faster, if the government intervenes by reducing interest rates, allowing dollar-denominated bonds, reduction in capital cost or introduction of other financial instruments," [says](#) Anurag Garg, VP of the solar business at Schneider Electric India.

Energy Minister Goyal in May 2015 [forecast](#) that innovative financing models will drive solar costs from Rs7/kWh to below Rs5/kWh. Prices hit a new record low of Rs5.17-5.35/kWh in July 2015.

For more details on solar, please refer to Jai Sharda's May 2015 [report](#) "*India's Solar Ambitions – Challenges and Options.*"

Figure C1 details the progression of solar feed-in-tariffs across India since 2010, including the latest record low tender result in Madhya Pradesh in July 2015 averaging Rs5.35/kWh fixed flat for 25 years (that is declining each year in real terms). That these FiT are fixed price for 25 years highlights a key aspect of renewable energy, and particularly solar energy, that the systems once they are built have no inflation requirement, so the real price of electricity generation declines over time. With no fuel or foreign currency exchange risk, renewable energy is deflationary. Subsequent to this chart, the latest November 2015 auction was won by SunEdison at a record low Rs4.63/kWh.¹⁴⁸

Figure C1: Solar Tariffs are down 63% since 2010



LHS – Rs/kWh, RHS - Megawatts
 Source: CERC, State ERC, media reports, IEEFA Estimates

¹⁴⁸ <http://www.bloomberg.com/news/articles/2015-11-04/sunedison-wins-500mw-india-solar-project-with-record-low-tariffs>

Appendix D – Additional Hydro Capacity

India has 41GW of operating large-scale hydro capacity but also a significant potential for new hydro electricity. However, we also note significant environmental issues with hydro, not the least being the loss of rich farmlands and forests, risks of seismic activity plus the requirement for large-scale resettlement of traditional owners.¹⁴⁹

India has added 1GW of hydro electricity capacity nationally in each of the past three years.¹⁵⁰ Over the past four five-year plans, India has achieved about 40% of its targeted hydro power capacity addition. IEEFA forecasts net additions of hydro at 1GW pa through to 2021/22.

National Hydro Power Corporation Limited (NHPC Ltd), a listed company majority owned by the Government of India and involved in developing hydro power in the country, is planning to add 490MW of capacity in 2016/17 (160MW Teesta IV and 330MW Kishenganga) and another 2.8GW hydro power by 2018-19 (2.0GW Subansiri (Lower) and the 800MW Parati II).¹⁵¹ NHPC is awaiting clearance for additional hydro projects with capacity of 5GW.¹⁵² Over the last 3 years, NHPC has added a total of 1.2GW of new capacity.

In July 2015, another Public Sector Undertaking (PSU), NTPC Ltd, announced commencement of the Koldam Hydro Power Project with 800MW of capacity. It has a further 819MW of hydro-electric power plants under construction as part of its strategic plan to rapidly diversify away from a reliance on thermal electricity capacity by adding hydro, solar and nuclear capacity.¹⁵³

Reliance Power reports a 5.3GW pipeline of hydroelectricity proposals for projects located in the states of Arunachal Pradesh, Himachal Pradesh, and Uttarakhand in Northern India. At its 2015 annual general meeting of shareholders, Reliance Power noted its 700MW Tato-II and 1,200MW Kalai-II proposals were now in advanced stages of development.¹⁵⁴

GVK Power is commissioning its Shrinagar 330MW hydro-electricity plant on the Alaknanda River in Uttarakhand progressively over 2015.¹⁵⁵

North-East Agra Transmission Link

In September 2015 it was reported by an ABB Group / BHEL joint venture that the first phase of the North-East Agra 800 kilovolt (kv) transmission link was ready to supply hydro-power from northeastern India to a nodal substation in Agra and from there, feed it across North India. This grid expansion project is being built for Power Grid Corp of India.¹⁵⁶

¹⁴⁹ <http://www.theguardian.com/environment/india-untamed/2014/oct/22/indias-largest-dam-given-clearance-but-still-faces-flood-of-opposition>

¹⁵⁰ <http://www.cea.nic.in/hpm.html>, project monitoring, chapter 2.

¹⁵¹ <http://www.ntpc.co.in/transcripts/4169/transcriptq42014-15>

¹⁵² <http://www.nhpcindia.com/writereaddata/Images/pdf/InvestorPresentationMarch15.pdf> page 6.

¹⁵³ http://economictimes.indiatimes.com/articleshow/48333832.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

¹⁵⁴ http://www.reliancepower.co.in/108/AGM_Presentation_2015.pdf

¹⁵⁵ http://articles.economictimes.indiatimes.com/2015-04-11/news/61041528_1_mw-unit-first-unit-330-mw-hydro-project

¹⁵⁶ <http://economictimes.indiatimes.com/industry/energy/power/abb-readies-first-phase-of-north-east-agra-transmission-link-to-supply-hydro-power/articleshow/49138441.cms?prtpage=1>

This completion of Phase 1 of the project enables transmission of up to 1,500MW of electricity along this 1,728 kilometre link. When fully commissioned in 2016, the link will become the world's first multi-terminal UHVDC connection, capable of transmitting enough electricity to serve around 90 million people based on average national consumption. The North-East Agra link will help address the shortage of power in North India by transporting hydropower generated in the mountainous North-East.

This is a critical component of developing a nationally interconnected transmission grid that will facilitate the integration of significant renewable, hydro and thermal electricity generation across the nation, avoiding the current situation of blackouts in one region and generation curtailments in another adjacent state.

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Acknowledgement

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