Institute for Energy Economics and Financial Analysis

Briefing Note

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Gauging Gas-based Power's Role in Meeting India's Peak Electricity Demand

Gas has a limited role in the short-term, which is likely to diminish in the medium-term as energy storage options attain commercial viability and round-the-clock renewables capacity increases

- *Rapidly rising peak power demand has resulted in the Indian government taking proactive measures, including relying on gas-based power, to ensure there is no supply shortfall.*
- *Allocating more domestic gas to gas-based power plants or allowing the blending of liquefied natural gas (LNG) with domestic fuel could improve the affordability of the gas-fired electricity needed to meet peak demand.*
- *Ongoing trends, such as increased deployment of renewable energy assets, improving economies of scale for battery storage and the rise of round-the-clock tenders with more competitive bidding rates for firm and dispatchable renewable energy (FDRE) point to the diminishing role of gas-based power plants for meeting peak power needs in the medium-term.*

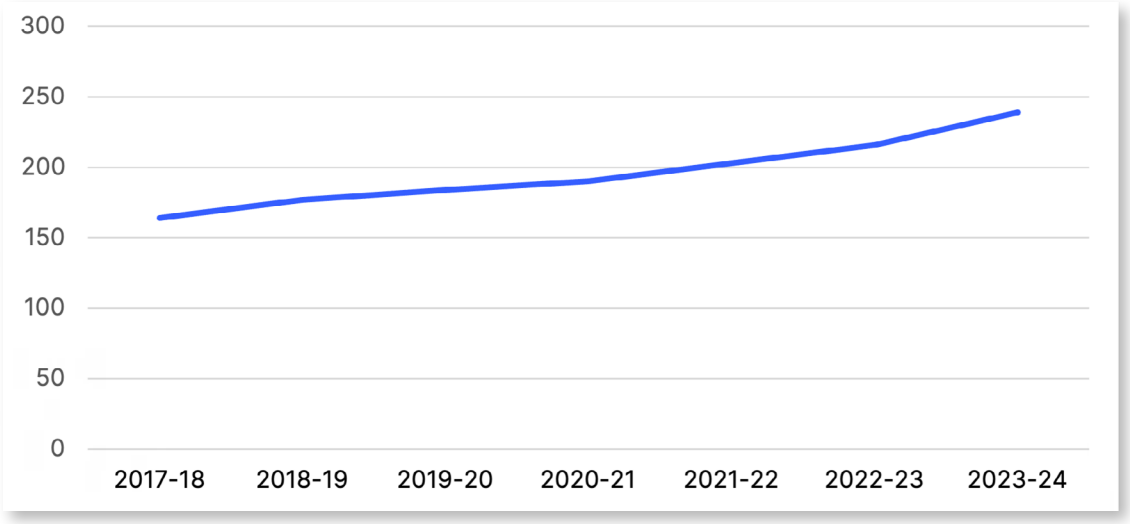
India's peak power demand, which, according to government forecasts, is likely to cross 350 gigawatts (GW) by 2030, has been surging in the past few years on the back of rising urbanisation, increasing industrial activity and erratic weather patterns.

Since recovery started after the COVID-19 lockdowns, India's electricity demand has surged. Peak power demand touched a new high of 240GW in the fiscal year (FY) 2023-24. Figure 1 shows the constant increase in peak demand, which has risen by almost 150% from FY2017-18 to FY2023-24. The government expects it to hit 260GW in FY2024-25. For June, the government forecasts peak demand at 240GW during the daytime and 235GW in the evening. However, soaring temperatures led to peak demand touching 240GW in May itself.

As a result, the government is undertaking several measures in the short to medium term to prevent a peak supply shortfall, especially during the summer. To meet the immediate peakpower demand, the government is shifting the planned maintenance of power plants to the

monsoon season, expediting capacity additions and reducing partial outages of thermal power plants. It is also looking to optimise hydropower generation and has directed power stations to provide surplus energy to energy exchanges. Increasing renewable energy penetration will also help meet peak power demand in the medium term due to the shifting of peak demand to daytime. Above all, the government is ensuring that all available plants are operational, including gas-based power plants that have either been underutilised or non-operational due to fuel constraints.

Figure 1: India's Peak Power Demand FY2017-18 to FY2023-24



Source: Ministry of Power

This note analyses the role that gas-based power has in meeting the peak power demand in India. We find that it has a limited role in the short-term, which is likely to diminish in the medium-term as energy storage options gain commercial viability. We base our findings on emerging trends in the shifting of peak demand hours and the cost-analysis of using gas-based power.

Peak Power Demand Trends and Analysis

Analysing peak demand months and timings from 2019 onwards (see Table 1) indicates a shift of peak demand to daytime when solar power is available. Moreover, the maximum requirement is also shifting to the months when wind power is more widely available. Notably, 70% of the wind power generation in India happens from May to September, coinciding with the southwest monsoon.

Table 1: Peak Demand Analysis (FY2019-20 to FY2023-24)

Fiscal Year	Date of Peak Demand	Maximum Demand Met (in Megawatts (MW))	Time of Maximum Demand Met
2019-20	30 May 2019	181795	15:22
2020-21	31 January 2021	189644	9:53
2021-22	7 July 2021	200570	12:01
2022-23	10 June 2022	211856	14:47
2023-24	1 Sept 2023	239978	12:22

Source: GRID India's Monthly Operation Reports and Daily Power Supply Position Reports

For a more granular observation, we take the data for FY2023-24 into consideration, which also shows a shift of peak to daytime. The highest peak demand registered during the year was 240GW on 1 September 2023.

One of the reasons for shifting of evening peak to daytime or solar hours , according to the Central Electricity Authority (CEA), is due to feeder separation, which has shifted the agriculture load to the daytime. The government is also looking at incentivising the use of daytime power by micro, small and medium enterprises with time of day (ToD) tariffs having come into effect from April 2024.

Table 2: Monthly Peak Demand Analysis (FY2023-24)

Date of Peak	Maximum Demand Met (MW)	Time of Maximum Demand Met
18 April 2023	215882	14:44
23 May 2023	221347	14:50
9 June 2023	223235	14:52
21 July 2023	208825	11:45
31 August 2023	236598	12:11
1 September 2023	239978	12:22
10 October 2023	221627	12:31
3 November 2023	204605	11:43
29 December 2023	213620	10:45
25 January 2024	222327	11:30
23 February 2024	222003	10:30
15 March 2024	221701	10:43

Source: GRID India's Monthly Operation Reports and Daily Power Supply Position Reports

Thus, while in the short term imported coal and gas-based power are helping the government meet peak demand, the shifts highlighted above make solar, wind and storage more viable options in the coming years.

Recent Experience of Using Gas-based Power for Meeting Peak Demand

The peak power high of 216GW in April 2022 was unprecedented for India and it resulted in a shortfall in peak demand met by almost 8,500 megawatts (MW). Consequently, the government took proactive measures in the summer of 2023 by inviting tenders for supplying gas-based power with minimum guaranteed offtake to meet the increase in peak demand.

The first such tender was floated in March 2023 for 4GW of grid-connected gas-based power from non-NTPC plants for the estimated crunch period of 10 April to 16 May 2023. This power was to be offered in the Day Ahead Market (DAM) or the High Price - Day Ahead Market (HP-DAM), which started on 10 March 2023. Alternatively, it was to be offered in other power exchanges, including the tertiary reserve ancillary services (TRAS) mechanism, if not on DAM/ HP-DAM. The price ceiling for HP-DAM was set at Rs50 per unit (US$0.60 per unit), which was later revised to Rs20 per unit (US$0.24 per unit), owing to tepid trade.

Torrent Power emerged as the lowest bidder at Rs13.70 per unit (US$0.16 per unit) price to supply 770MW from two of its gas-based projects in Gujarat. Based on the minimum guaranteed offtake of 233 million units (MUs), this cost NTPC Vidyut Vyapar Nigam Ltd. (NVVN), the

tendering agency, a minimum of Rs4.2 billion (US$50.5 million). During the crunch period of power supply, apart from 17 April 2023, when the market clearing price (MCP) in HP-DAM touched Rs20 per unit (US$0.24 per unit) and on 13 May 2023 when it was Rs13.77 per unit (US$0.17 per unit), the MCP was lower than the quoted gas price with trade being limited due to the unprecedented rains and low temperatures during the period, making it difficult for NVVN to recover the minimum guarantee from the power sale. Gama Infraprop secured a bid for 90MW at Rs14.9 per unit (US$0.18 per unit).

In addition, NTPC had committed to supplying 5GW of gas-based capacity between 15 April and 15 May 2023 with a gas requirement of 248 Metric Million British Thermal Units (MMBtu) to be supplied by GAIL. After the record peak demand of 1 September 2023, a tender was published by NVVN for procuring 4GW of gas-based power with total contracted energy of 1,080MUs and guaranteed offtake of 75% at 810MUs for 20 days between 30 September and 30 November 2023 with maximum generation for six hours and 50% for 18 hours. The highest clearing price during this period was Rs20 per unit (US$0.24 per unit) on 20 October 2023 and it averaged above Rs12 per unit (US$0.14 per unit) in the 10 October to 20 October 2023 period. The total volume was 15.8MUs at an average price of Rs16.95 per unit (US$0.20 per unit). Other than this, no trade took place during the contracted period on HP-DAM.

Annexure 1 shows details of gas-based plants with production targets in the last fiscal and how they performed against those targets. While four plants surpassed the production targets, the rest of the stations were either not operational or could not meet the production target. The total production target was 32,000MUs across 43 plants, which was largely met with total production at 31,295MUs.

Gas-based Power's Role for 2024

To meet the peak summer power demand in 2024, which is expected to touch 260GW, NVVN has again issued a tender inviting gas-based power generation from 16 March to 30 October 2024. The selected gas plants are expected to operate for 72 days between March and June with 50% guaranteed offtake. The operating days for July to October will be communicated by Grid India.

Torrent Power emerged as the lowest bidder for the supply of 770MW with a minimum guaranteed offtake of 388MUs till June 2024 with Rs5.63 per unit (US$0.07 per unit) as the bid for variable charges not linked to gas price. In addition, variable charges are paid on the basis of energy scheduled in the relevant period at Rs8.85 per unit (US$0.11 per unit), indexed to fortnightly prices communicated by GAIL and the applicable exchange rate. Torrent Power expects a minimum revenue of Rs4.4 billion (US$53 million) for the minimum quantity sold. The other bidders included Lanco Power to supply 355MW at Rs7.02 per unit (US$0.08 per unit) and two smaller plants in Uttarakhand to supply a total of 182MW at an average of over Rs7 per unit (US$0.08 per unit) for the variable charges not linked to gas.

Further, to ensure the availability of gas plants to meet peak demand during summer, the government has invoked Section 11 of the Electricity Act for gas-based generating stations (GBSs) during the crunch period of 1 May to 30 June 2024. This means that GBSs must ensure that their operational capacity is made available at all times during the crunch period. The tariff for the power supplied is to be determined by a committee for plants not tied to power purchase agreements (PPAs).

Earlier in the year, the government had also invoked Section 11 of the Electricity Act for imported coal-based stations.

Allocating domestic gas could be more cost-effective

The total gas-based capacity that was operational in FY2023-24 was approximately 16.7GW. According to the Standing Committee on Energy Report on Stressed/Non-Performing Assets in Gas-based Power Plants, the normative gas requirement to operate the 25GW gas capacity at 85% PLF is about 102 Million Metric Standard Cubic Metres a Day (MMSCMD). For the operation of 16.7GW at 85% PLF, it would come down to about 68MMSCMD of gas. In 2023, the domestic gas allocation to the power sector was about 18MMSCMD. The allocation for refinery, petrochemicals and other sectors was 42MMSCMD cumulatively. NVVN committed to a minimum guarantee offtake for the gas-based power capacity bids invited in 2023. For instance, for the April 2023 tender, the cost of the guarantee was approximately Rs4.2 billion (US$50.5 million).

Allocating a higher amount of domestic gas, with flexibility on minimum guarantee obligation (MGO) on gas offtake, could be a more cost-effective and secure solution for meeting increasing peak power requirements and grid balancing needs. According to IEEFA's earlier report, operating 12.5GW gas-based capacity will be sufficient to meet the peak demand estimated by the CEA for 2029-30. For this, the domestic gas requirement at 85% PLF would be 51MMSCMD.

> **"There is a strong case for allocating a limited amount of domestic gas for partially operating gas-based power capacity to cater to peak demand and ancillary services.**

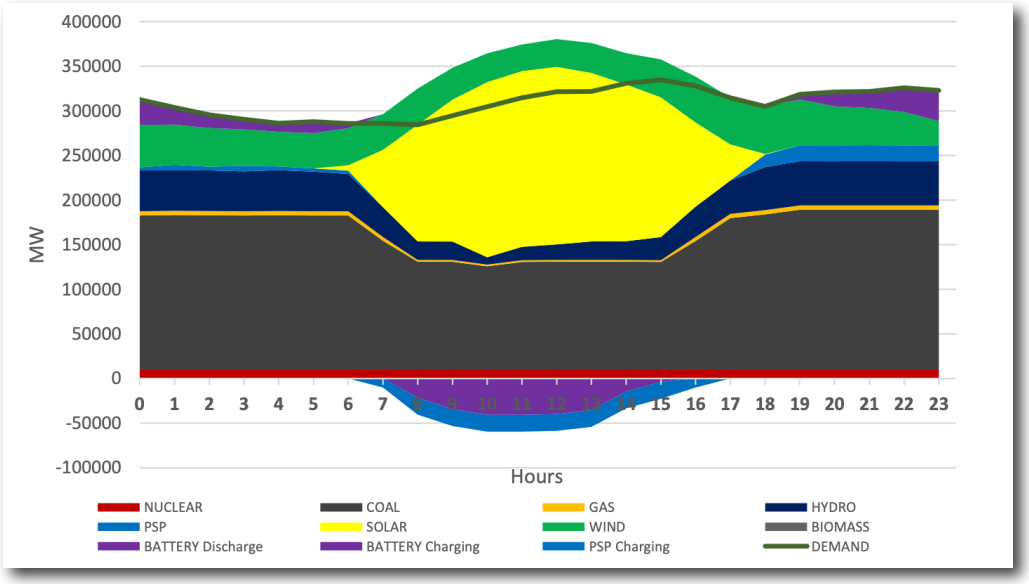
If the prices of short-term traded power, power from domestic gas and that from imported LNG for April 2023 are compared, it would be clear that there is a strong case for allocating a limited amount of domestic gas for partially operating gas-based power capacity to cater to peak demand and ancillary services. At the revised and temporarily fixed domestic gas price of US$6.5/MMBtu (Rs540.34/MMBtu), the energy charge would be around Rs4.4 per unit (US$0.05 per unit). This is much lower than the gas price of Rs13.70 per unit (US$0.16 per unit), which emerged as the lowest bid for gas-based power supply using LNG in April 2023. Moreover, the weighted average price for the month in DAM was Rs5.24 per unit (US$0.06 per unit), HP-DAM was Rs14.59 per unit (US$0.18 per unit) and transacted through traders was Rs8.45 per unit (US$0.10 per unit). Even partial allocation of domestic gas can help lower tariffs. The tariffs can come down to Rs5.83 per unit (US$0.07 per unit) by increasing the allocation of domestic gas (currently costing US$6.5/MMBtu (Rs540.34/MMBtu)) to the power sector, such as to allow 50% blending with LNG (ongoing spot price of US$10.225/MMBtu (Rs850/MMBtu)).

This shows that if there is a more streamlined use of domestic gas and gas procured under long-term contracts, then there is a more economical use of gas-based power in the system, which can also be used for other services during non-peak hours.

Diminishing Role of Gas in the Medium-Term

CEA's Optimal Generation Mix 2030, released in April 2023, notes that pumped storage and battery storage technologies will help in diurnal grid balancing during months when the supply of renewable energy is high. The figure below shows the technology-wise likely generation dispatch on a peak demand day in FY2029-30 in May 2029, which shows the share of gas, pumped storage and battery in non-solar hours. A detailed reading of the graph shows the need for 5GW of gas-based capacity to meet peak demand during non-solar hours.

Figure 2: Technology-wise likely generation dispatch on peak demand day (2029-2030)



Source: CEA's Optimal Generation Mix 2030

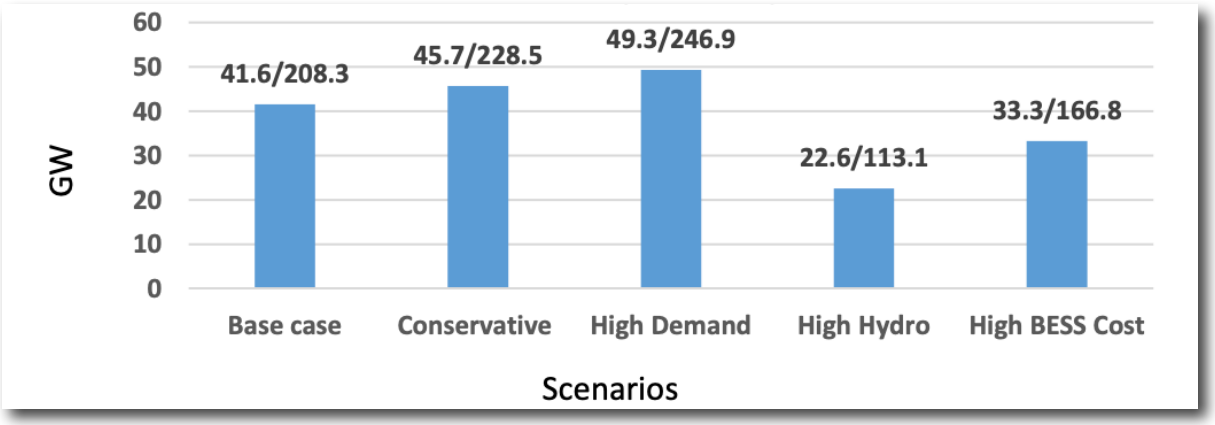
Total energy production at a PLF of 85% for 5GW would require 20.4MMSCMD for a full-year operation and could provide about 37.2 billion units (BU) of electricity. The electricity generation target for FY2023-24 has been set at 1,750BU. Therefore, gas-based plants can be an option at the most in the short-term, until other storage options become increasingly viable.

Any transitional use of gas should be limited to sectors with no competitive alternatives or where gas use supports renewable energy uptake or helps maintain grid flexibility. For instance, until storage options are more widely available and affordable, gas-based power plants could be used to serve peak demand or provide grid-balancing ancillary services.

Battery storage to gain prominence

CEA's Optimal Generation Mix 2030 notes that the installed capacity of battery storage would be 41.6GW. The requirement would vary from 22.6GW to 49.3GW across different demand scenarios modelled in the report, such as conservative, high demand and high hydro, including pumped storage and high battery storage cost.

Figure 3: Likely BESS capacity in different scenarios in 2029-2030 (GW/GWh)



Source: CEA's Optimal Generation Mix 2030

Battery storage is rapidly becoming less expensive and that would further limit the role of gas-based power in the country. In March 2024, Gujarat Urja Vikas Nigam Ltd (GUVNL) concluded a bid for 250MW/500 megawatt-hours (MWh) standalone battery energy storage at a tariff of Rs0.449 million/MW/month (US$5,401.13/MW/month). This indicates plummeting battery costs as it is 58% lower than the tariff of Rs1.08 million/MW/month (US$12,991.58/MW/month) discovered in Solar Energy Corporation of India's (SECI's) 500MW/1000MWh auction in 2022.

More than 22GW of standalone storage tenders (without renewable energy component) were issued in calendar year 2023.

Round-the-clock renewables capacity on the rise

In 2019, SECI announced a tender for setting up 1.2GW Inter State Transmission System (ISTS)-connected renewable energy projects with assured peak power supply in India at a flat (off-peak) tariff payment of Rs2.88 per unit (US$0.04 per unit) and a peak tariff to be quoted by the bidder. The tender was oversubscribed by 420MW. The bid was awarded to Greenko at a peak tariff of Rs6.12 per unit (US$0.07 per unit) and ReNew Power at Rs6.85 per unit (US$0.08 per unit).

SECI issued another tender for 1.2GW hybrid wind-solar projects, paired with energy storage for assured peak power supply. The lowest bid was offered by AMP Energy Green at Rs4.64 per unit (US$0.05 per unit) for 100MW.

Grid-scale Energy Storage Systems (ESS) tenders, including pumped hydro storage and firm and dispatchable renewable energy (FDRE) to ensure 24x7 supply, are helping overcome the variable nature of solar and wind power. According to a report by IEEFA and JMK Research, FDRE tenders dictated the recent surge of the "renewable + ESS" tender segment with FDRE accounting for 17% of the 69GW renewable energy tenders issued in FY2023-24.

The latest discovered tariff for FDRE is already down to Rs4.64 per unit (US$0.05 per unit), as quoted by ABC Cleantech in the most recent tender floated by NTPC in March 2024. The discovered price is 17% lower than the FDRE tender issued by SECI in July 2023.

Conclusion

While tenders for procuring power from gas-based generating stations were invited last fiscal as well, the government went a step further this year by invoking Section 11 for gas-based plants to meet the increasing peak power demand. This is, however, expensive power, which either does not get picked up or is sold at a price lower than the quoted price. During the crunch period from 10 April to 16 May 2023, when the first gas-based power tender was announced, only the market clearing price in the HP-DAM was above the winning bid of Rs13.70 per unit (US$0.16 per unit).

Gas-based power plants have a limited role in meeting peak demand, even in the short term. Their role is likely to diminish in the coming years with the government looking at innovative tendering to ensure round-the-clock availability of renewable energy to facilitate grid integration and enable higher capacity utilisation of renewable energy. According to the CEA, renewable energy round-the-clock (RE RTC) supply is the way forward for achieving 500GW renewable energy capacity by 2030. Further, in the medium- to long-term, the increase in the commercial viability of battery storage and the availability of pumped storage will help eliminate the use of gas.

Annexure 1: Generation Targets of Gas Stations, Actual Production and PLF (FY2023-24)

STATION	SECTOR	Capacity	GENERATION (MU) AND PLF (%) APRIL 2023 - MAR-2024			
			TARGET	GENERATION	PLF	Increase/Decrease from Target
DGEN MEGA CCPP	Private	1200.00	150.00	997.49	9.46	565%
GAMA CCPP	Private	225.00	50.00	251.89	12.74	404%
UNOSUGEN CCPP	Private	382.50	500.00	1332.41	39.66	166%
ANTA CCPP	Central	419.33	140.00	354.52	9.62	153%
SUGEN CCPP	Private	1147.50	1700.00	3707.67	36.78	118%
TROMBAY CCPP	Private	180.00	500.00	981.43	62.07	96%
SRAVANTHI CCPP	Private	439.00	200.00	357.89	10.10	79%
KUTTALAM CCPP	State	100.00	450.00	694.61	79.08	54%
I.P.CCPP	State	270.00	175.00	259.97	10.96	49%
KAWAS CCPP	Central	656.20	430.00	629.53	10.92	46%
AURAIYA CCPP	Central	663.36	480.00	698.05	11.98	45%
UTRAN CCPP	State	374.00	200.00	279.11	8.50	40%
GANDHAR CCPP	Central	657.39	540.00	683.49	11.84	27%
RATNAGIRI CCPP	Central	1967.08	1050.00	1220.38	7.06	16%
MONARCHAK CCPP	Central	101.00	600.00	660.52	74.45	10%
NAMRUP CCPP	State	139.40	775.00	832.08	67.95	7%
ROKHIA GT	State	63.00	300.00	321.43	58.08	7%
TRIPURA CCPP	Central	726.60	4800.00	4573.95	71.66	-5%
KATHALGURI CCPP	Central	291.00	1800.00	1696.52	66.37	-6%
VALUTHUR CCPP	State	186.20	1250.00	1176.71	71.94	-6%
FARIDABAD CCPP	Central	431.59	150.00	137.28	3.62	-8%
KARAIKAL CCPP	State	32.50	250.00	224.10	78.50	-10%
DADRI CCPP	Central	829.78	1040.00	921.47	12.64	-11%
LAKWA REPLACEMENT	State	69.76	560.00	478.90	78.16	-14%
URAN CCPP	State	672.00	2100.00	1769.02	29.97	-16%
DHUVARAN CCPP	State	594.72	360.00	294.96	5.65	-18%
BARAMURA GT	State	42.00	200.00	157.26	42.63	-21%
LAKWA GT	State	97.20	500.00	367.77	43.07	-26%
RAMGARH CCPP	State	273.50	1050.00	761.93	31.72	-27%
PRAGATI CCGT-III	State	1500.00	4100.00	2653.85	20.14	-35%
AGARTALA GT	Central	135.00	1000.00	640.15	53.98	-36%
PRAGATI CCPP	State	330.40	1500.00	841.32	28.99	-44%
PIPAVAV CCPP	State	702.00	500.00	229.85	3.73	-54%
KOVIKALPAL CCPP	State	107.88	200.00	47.27	4.99	-76%
DHOLPUR CCPP	State	330.00	150.00	28.17	0.97	-81%
HAZIRA CCPP EXT	State	351.00	200.00	30.55	0.99	-85%
JEGURUPADU CCPP PH	State	235.40	200.00	2.41	0.12	-99%

GODAVARI CCPP	Private	208.00	400.00	0.00	0.00	-100%
KARUPPUR CCPP	Private	119.80	200.00	0.00	0.00	-100%
P.NALLUR CCPP	Private	330.50	100.00	0.00	0.00	-100%
VIJJESWARAM CCPP	Private	272.00	500.00	0.00	0.00	-100%
HAZIRA CCPP	State	156.10	150.00	0.00	0.00	-100%
YELAHANKA CCPP	State	0.00	500.00	0.00	0.00	-100%

Source: National Power Portal

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