



Maharashtra State Electricity Transmission Company Limited

# PRELIMINARY ASSESSMENT OF DATA CENTRE LOAD PATTERNS IN THE MAHARASHTRA POWER SYSTEM

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Prepared by

**Maharashtra State Load Despatch Centre (MSLDC)**

Airoli, Navi Mumbai

# Preliminary Assessment of Data Centre Load Patterns in the Maharashtra Power system

Prepared By: Maharashtra state Load Despatch Centre  
December 2025

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## Preface

The rapid growth of Data Centres connectivity and projected future demand in Maharashtra marks a shift in the profile of electricity demand served by the State power system. Large, continuous, and geographically concentrated digital loads are emerging alongside traditional industrial and urban demand, particularly in the Mumbai Metropolitan Region and the Pune Metropolitan Region. Recognising the importance of understanding this evolving load segment from a system operation perspective, Maharashtra State Load Despatch Centre (SLDC) has undertaken this preliminary study on Data Centre load behaviour.

This study has been carried out by the SLDC Operations Team, using Data and operational inputs presently available with SLDC. It is intended as a baseline assessment, documenting the current status of grid connectivity, realised loading, and observable operating characteristics of Data Centres connected to the Maharashtra grid. Given the limitations of Data resolution and visibility at this stage, the study deliberately avoids drawing definitive conclusions on dynamic behaviour or system impacts, and instead focuses on describing the current state and identifying areas requiring deeper examination.

I would like to place on record my appreciation for the SLDC Operations Team for proactively initiating this study. Looking beyond immediate operational requirements and examining emerging trends is essential for maintaining grid reliability in a rapidly transforming power system. This effort reflects a forward-looking approach and a strong sense of institutional responsibility towards preparedness and informed system planning.

The study highlights the need for progressive enhancement of Data availability, analytical capability, and coordination among stakeholders as Data Centre penetration increases. Future studies will be required to examine load variability, interaction with system control functions, transmission corridor impacts, and power quality considerations, supported by higher-resolution Data and structured information exchange.

Going forward, effective management of large Data Centre loads will require a clear and enabling framework that supports improved visibility, structured analysis, and coordinated planning, while remaining proportionate to the present stage of load realisation. This report is intended to contribute technical inputs towards such a framework and to support informed deliberation among concerned institutions.



This report should be viewed as a starting point—a foundation for further analytical work and continued engagement as Data availability improves and operational experience evolves. SLDC will continue to build on this initial effort to ensure that system operation and planning frameworks remain aligned with Maharashtra’s expanding digital infrastructure.

A handwritten signature in black ink, appearing to read 'Shashank Jewalikar', written in a cursive style.

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3. **Engineers from MSLDC associated with System Operations, Control rooms, Energy Accounting and regulatory coordination**

## Executive Summary

Maharashtra state has emerged as India's primary hub for Data Centre, driven by rapid digitalization, cloud adoption, financial services, and the growing deployment of AI-driven workloads. These facilities constitute large, continuous, and mission-critical electricity demand, predominantly concentrated in the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR). Recognizing their strategic importance and potential impact on grid operation, this report evaluates the current load behaviour, grid connectivity status, and operational implications of Data Centre connected to the Maharashtra State Grid.

The assessment of grid connectivity reveals that 36 major Data Centre projects in MMR and PMR account for a combined planned demand of approximately 6000 MW, against which about 685 MW has been realized so far. The majority of these facilities are integrated through 220 kV LILLO arrangements on critical transmission corridors, with phased load additions extending up to year 2036. While present utilization remains relatively low, the scale and pace of planned capacity additions underline the need for anticipatory transmission planning, augmentation of 220 kV networks, and strengthening of upstream 400 kV corridors to maintain system reliability.

Operational analysis indicates that commissioned Data Centres exhibit stable and predictable load profiles, high load factors, and near-unity power factor. Case studies, particularly of the CtrlS Data Centre, demonstrate robust performance during grid disturbances, with automatic load transfer to DG supply during voltage stress, thereby supporting grid stability. However, the increasing adoption of AI and high-density computing introduces the possibility of rapid load variations, which may challenge forecasting accuracy, reserve management, and AGC performance in the future.

The concentration of bulk Data Centre load in limited geographic pockets presents specific operational risks, including the impact of sudden bulk load tripping, limited reactive power contribution, and reduced voltage control capability. At the same time, Data Centres offer significant opportunities for grid support, as they are centrally located, remotely controllable loads equipped with redundant power systems and large DG capacities. With appropriate frameworks, Data Centres can participate in demand response, provide controlled load relief during system stress.

Overall, Data Centres connected to the Maharashtra grid are presently operating reliably with limited adverse impact. However, their projected scale and evolving load characteristics necessitate proactive planning, improved real-time visibility, high-resolution Data acquisition, and closer coordination between SLDC, STU, and Data Centre operators. Integrating Data Centres into structured grid support and demand response mechanisms will be essential to ensuring secure, stable, and efficient grid operation as Maharashtra's digital infrastructure continues to expand.



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# Chapter-1: Introduction

In recent years, there has been a major transition from traditional paper-based methods of information storage and management to digital systems. This digital transformation has driven the widespread establishment of Data Centres, which have become essential to the functioning of modern businesses and government operations.

Data Centres are mission-critical facilities that host computing, networking, and storage infrastructure necessary for delivering cloud services, enterprise applications, financial transactions, and digital communications.

A **Data Centre** is a specialized facility designed to house an integrated collection of Information Technology (IT) equipment—such as servers, Data storage devices, and network hardware. These components collectively process, store, and transmit vast volumes of digital information vital to organizational efficiency and operational resilience.

Fundamentally, a Data Centre represents the physical core of an organization’s IT infrastructure. It is equipped with critical systems that ensure uninterrupted functioning, including backup power supplies, advanced cooling and environmental control systems, and robust security frameworks. These systems protect IT assets from electrical disturbances, overheating, and unauthorized access, thereby safeguarding sensitive Data and ensuring uninterrupted service delivery.

As the backbone of today’s digital economy, the power supply behavior and electrical performance of Data Centres hold significant importance. Ensuring reliable, efficient, and stable power operation is essential for maintaining business continuity and meeting global performance and compliance standards.

As enterprises, institutions, and public sectors continue to embrace digitalization, the role of Data Centres has become increasingly strategic. They now serve as the central hubs for managing, processing, and securing digital information, making them essential for sustaining economic growth and supporting India’s expanding digital ecosystem.

## 1.1 Scope and Limitations of the Study

This report presents a baseline assessment of Data Centre load characteristics in Maharashtra based on presently available information with the State Load Despatch Centre (SLDC). The analysis is primarily derived from sanctioned connectivity data, realized loading, 15-minute block-wise energy meter records, and limited site-specific observations.

The findings in this report describe the current observed operating state of Data Centres connected to the Maharashtra grid. Where reference is made to potential operational implications—such as ramping

behaviour, demand response capability, or interaction with grid control functions—these are contextual insights drawn from international studies and literature, and not outcomes directly observed in the Maharashtra power system.

Due to the absence of high-resolution SCADA or PMU Data at Data Centre points of interconnection, the study does not characterize sub-minute load dynamics, fast ramping behaviour, or real-time control interactions. Consequently, conclusions related to dynamic system impacts, AGC response, or frequency regulation are intentionally avoided in this report.

The analysis should therefore be interpreted as a descriptive and preparatory study, intended to inform future monitoring frameworks, analytical studies, and policy deliberations, rather than as a definitive characterization of Data Centre load behaviour under all operating conditions.

## Chapter-2: Current Landscape of Maharashtra’s Data Centre Industry

Maharashtra's Data Centre industry is experiencing rapid and transformative growth, driven by digitalization, rising internet penetration, government initiatives, and increasing demand for cloud services, AI, and big Data analytics.

Maharashtra currently anchors India’s Data Centre industry, with Mumbai and the wider Mumbai–Navi Mumbai (MMR) –Pune (PMR) corridor acting as the country’s primary capacity hub and growth engine.

### 2.1 Scale and geographic concentration

The wider Maharashtra market, including Navi Mumbai, Panvel and Pune, is evolving as a hyperscale corridor, offering land and power for large campuses while offloading growth from saturated core Mumbai locations.

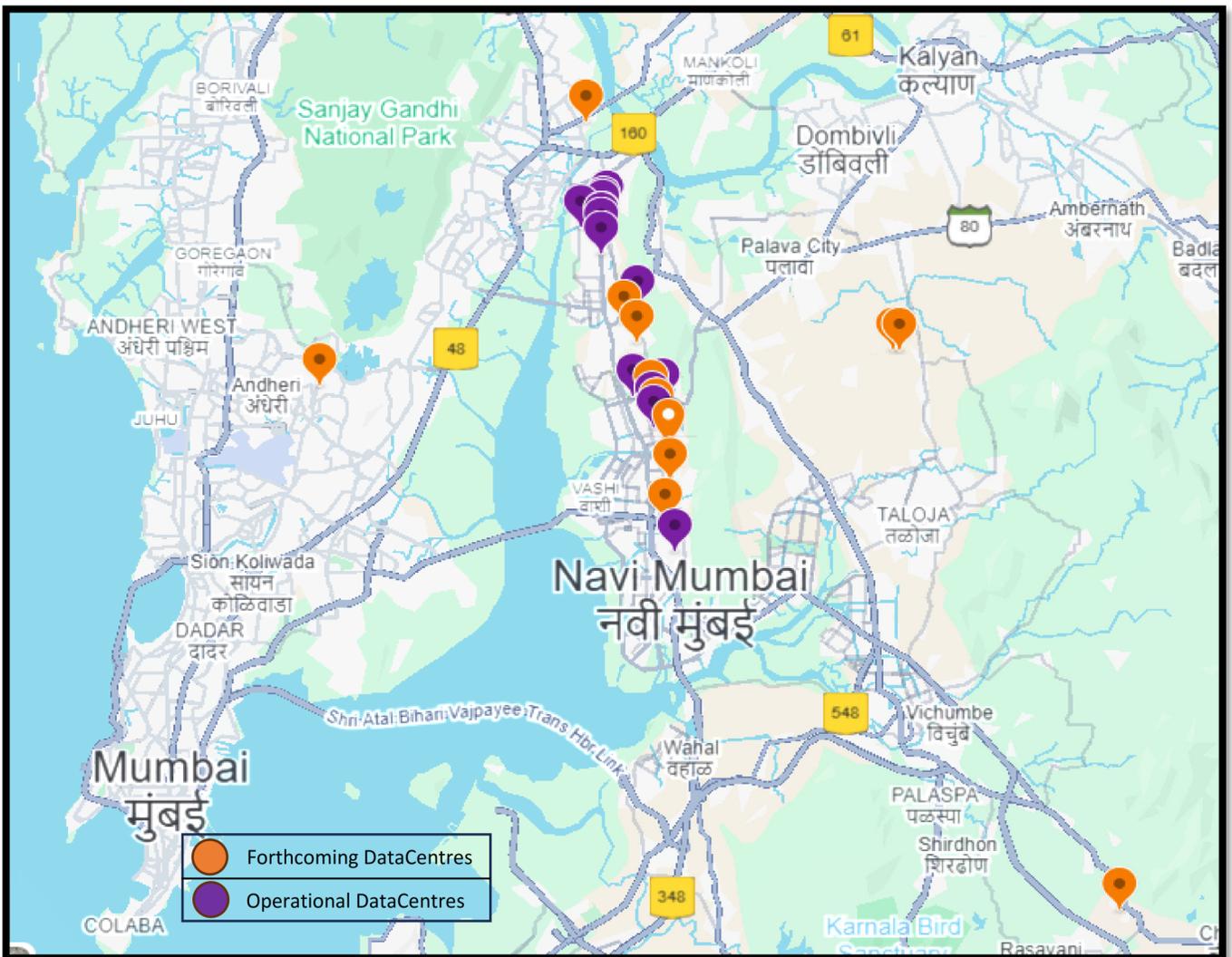


FIGURE 1 GEOGRAPHICAL LOCATIONS OF DATA CENTRES IN MUMBAI METROPOLITAN REGION

Pune is also emerging as Data Centre market with operational IT load crossing about 100 MW and a significant pipeline under construction, especially in Hinjewadi and Pimpri-Chinchwad.

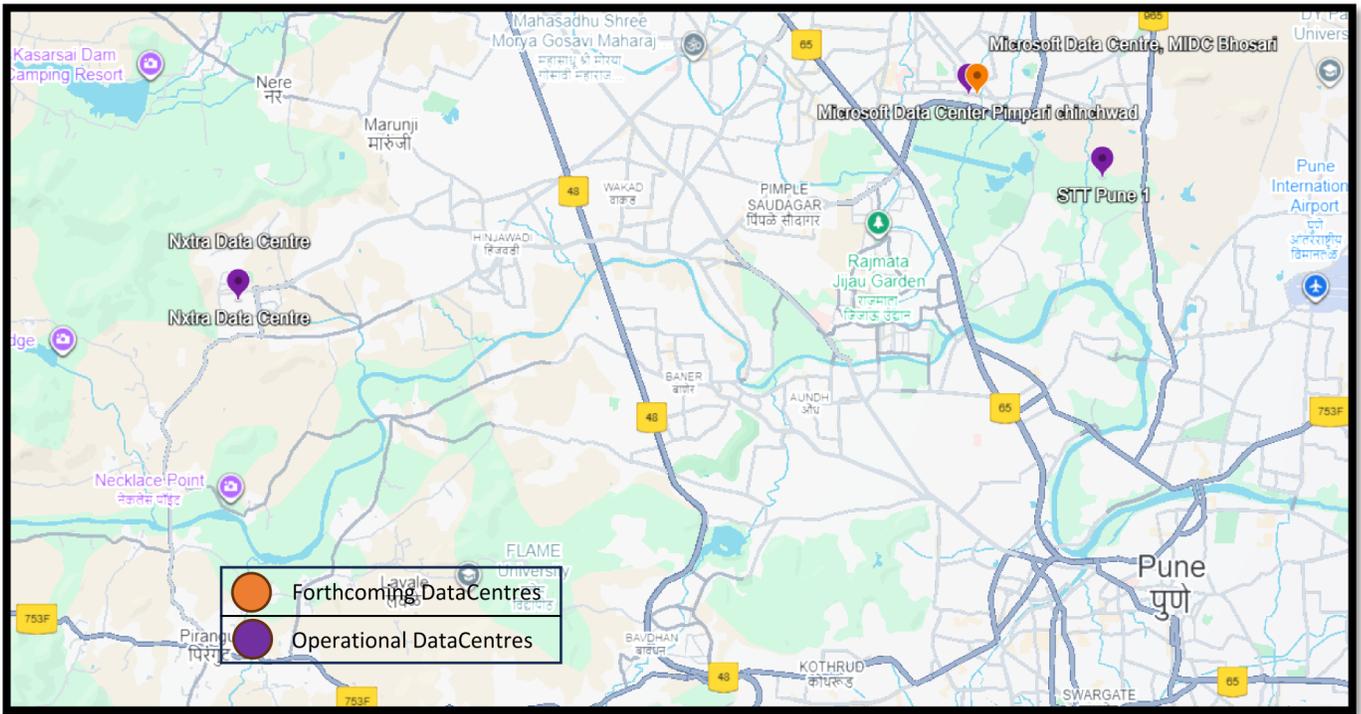


FIGURE 2 GEOGRAPHICAL LOCATIONS OF DATA CETERS IN PUNE METROPOLITAN REGION

## 2.2 Policy environment

Maharashtra’s IT/ITES Policy 2023 explicitly positions the state as a preferred Data Centre destination and grants Data Centres infrastructure status at par with sectors like roads and power. The policy offers stamp duty exemption on land and premises for new and expanding Data Centres, electricity-duty exemptions, single-window clearances, and flexibility to operate Data Centres across zones, significantly reducing entry barriers and project timelines.

MIDC has been tasked with developing dedicated Data Centre parks with ready infrastructure—power, water, roads, and connectivity—around nodes like Navi Mumbai, Pune, and Nagpur, enabling campus-scale developments rather than piecemeal projects. These incentives, combined with status as an “essential service,” strengthen reliability expectations and support 24×7 operations for hyperscale and enterprise workloads.

## 2.3 Demand drivers and ecosystem

Demand is driven by financial services, OTT and content, cloud adoption, fintech and banking financial services and insurances (BFSI) workloads, and more recently AI/ML and edge-driven use cases, all of which concentrate heavily in Mumbai and Pune. International cloud and hyperscale players increasingly prefer Maharashtra for landing zones due to submarine cable landings, large enterprise base, and availability of skilled IT and engineering talent.

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## Chapter-3: Current status of Final Grid Connectivity in MMR and PMR regions

A comprehensive review of Data Centre capacity applications in the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR) reveals substantial growth in energy-intensive digital infrastructure.

The current status of final grid connectivity Data received from STU (Maharashtra) in the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR) is as given below.

Sr. No	Name of Consumer	Address	Grid Connectivity	Phase-wise Load (MW)	Total Load Sanctioned (MW)	Final grid connectivity Granted (Load realized) (MW)
<b>Mumbai Metropolitan Region (MMR)</b>						
1	M/s. ST Telemedia	Thane Belapur Road	LILO on 220 kV Mahape – Tiffil line	40	40	-
2	M/s. Innovative	Khairane MIDC, Navi Mumbai	LILO on 220kV Mahape-Tiffil ckt of 220kV Kalwa-Siemens-Mahape- Tiffil line at proposed M/s. Innovative.	50	50	-
3	M/s CTRLS	TTC MIDC, Mahape, Navi Mumbai	LILO on ckt-I of 220kV Kharghar - Borivali D/C line at M/s. CTRLS s/s D/C line.	Ph-I – 70	295	70
				Ph-II - 2025 – 50		
				2026 - 30		
				2030 – 145		
4	M/s Newfound	TTC Industrial Area, Thane, Navi Mumbai	LILO on 220 kV Kharghar – Sonkhar line at M/s Newfound S/s – 150 mtrs. approx.	Ph-I – 36	250	36
				Ph-II - 2025 – 19		
				2026 – 15		
				2027 – 16		
				2028 – 32		
				2029 – 13		
				2030 – 14		
				2031 – 10		
				2032 – 11		
				2033 – 9		
2034-75						
5	M/s Gigaplex	TTC Industrial Area, Airoli Knowledge Park, Airoli,	LILO on 220kV Kalwa - Bapgaon at M/s Gigaplex-1.2km approx.	Phase-I - 35	285	35
				Ph-II - 2025 -40		
				2026 -50		
				2027 -35		
				2028 - 25		

		Navi Mumbai		2029 - 35		
				2030 - 30		
				2031 - 35		
6	M/s Netmagic	TTC Industrial area, Village – Mahape, Navi Mumbai	LLO on circuit-1 of 220kV Kharghar - Borivali D/C line as M/s. Netmagic S/s -0.35km approx.	Ph-I – 25 Ph-II – 10 Oct-25 – 15 Aug-26 – 10 Jun-27 – 10 Apr-28 – 10 Feb-29 – 10	90	25
7	M/s IMCC	TTC MIDC Zone-A, Ghansoli, Navi Mumbai	LILO on Ckt-I of 220 kV Kharghar – Borivali D/c line at M/s IMCCL S/s – 0.45 km. approx.	Ph-I-20 Ph-II - 2025-20 2026-20 2027-20 2028-26	106	-
8	M/s. Nxtra	TTC Industrial Area, Mahape, Navi Mumbai	LILO on 220 kV Kalwa – Tiffil line at M/s Nxtra Data Ltd. – 600 mtrs. approx.	35	35	35
9	M/s. Estela Mukund (NTT Global)	Bhola Nagar, Kalwa	Interim: LILO on 220 kV Kalwa – Bapgaon ckt at 220 kV NTT Global - 400 mtrs. Final: LILO on one ckt of 400 kV Kalwa - Padghe D/C line	Ph-I - 50 Ph-II - 70 2025- 80 2026- 150 2027- 150	500	50
10	M/s Amantin (Greenscape)	T.T.C. Industrial Area, MIDC, Village – Bonsari, Turbhe, Navi Mumbai	LILO on Existing 220 kV Kalwa – Tiffil line at proposed 220 kV Substation at M/s Amanthin Info Parks Pvt. Ltd. – 0.9 km approx.	Ph-I - 2025- 23 Ph-II - 2026- 21 2027- 21 2028- 23 2029- 22 2030- 20	130	-
11	M/s Estela Coromandal (M/s Garmercy Infopark Pvt. Ltd.)	TTC Industrial Area, Village- Mavli, Ghansoli, Navi Mumbai	Interim (96 MW) LILO on 220 kV Kharghar – Borivali Express Line No. I at existing Loc. No. 57 – 0.3 km overhead + 0.5 km UG cable OR LILO on 220kV Reliance- (Support Proposed)- Mahape line (bottom ckt.) at loc. no. 53- 0.3 km OH + 0.05 km cable. Final connectivity- LILO on one ckt of 400 kV Kalwa -Kharghar Line at loc. no. 176- 5 km	Ph-I - Mar 28- 96 Nov 28- 54 Mar-29- 50 Nov-29- 50 Mar-30- 50 Nov-30- 50 Mar-31- 50 Nov-31- 80	480	-
12				Ph-I- 30	90	30

	M/s Print House (Sify Infinit Spaces Ltd.)	T.T.C. Industrial Area, M.I.D.C., Village – Rabale, Navi Mumbai	LILO 220 kV Apta – Kalwa Ckt. of existing 220 kV D/C Apta – Kalwa & Panchanand – Kalwa line – LILO distance 0.2 km approx..	Ph-II - 2025 - 40 2027- 10 2028- 10		
13	M/s Estela Hindustan Unilever (Gramercy Techpark Pvt. Ltd.)	TTC MIDC Industrial Estaste, Airoli, Navi Mumbai	LILO on 220kV Kalwa-Taloja -Panchanand line - LILO distance-0.5km	Ph-I- 35 Ph-II - 2025- 25 2026- 30	90	35
14	M/s. STT Global	TTC, MIDC, Khairane	LILO on 220kV Mahape-Tiffil line -LILO distance -0.25km approx.	Ph-I- 40 Ph-II - 2026- 20 2027- 20	80	40
15	M/s. Web Werks	TTC Industrial Area, Rabale, Navi Mumbai	LILO on 220 kV Kalwa – Siemens line at proposed 220 kV GIS of M/s Web Werks India Pvt. Ltd.	Ph-I- 25 Ph-II - 2025- 15 2026- 25 2027- 55	120	-
16	M/s. Data Centre Holding	, Kalwa Industrial Area, Village- Dighe, Airoli	LILO on 220 kV Kalwa – Colourchem line – LILO distance 800 mtrs approx.	Ph-I- 10 Ph-II - 2026- 15 2028- 10 2029- 25	60	10
17	M/s. Datascape	, TTC Industrial Area, MIDC, Village – Dighe, Navi Mumbai	LILO on 220 kV Kalwa – Bapgaon line – LILO distance 800 mtrs approx.	Ph-I- 18 Ph-II - 2025- 28 2026- 22 2027- 22 2028- 30	120	18
18	M/s. NTT Global DC-13	TTC Industrial Area Bhola Nagar, Kalwa	LILO on 220 kV Kalwa – Bapgaon line at proposed 220 kV GIS at M/s NTT Global Data Centres NAV2 Pvt. Ltd. (DC-13) S/s – 80 mtrs approx.	Ph-I- 15 Ph-II - 2025- 20 2026- 40	75	15
19	Amazon Data Services Pvt. Ltd., Mumbai	village: Tungwa, Powai, Taluka: Kurla, District: Mumbai Suburban	LILO Arrangement on 220KV Salsette-Sahar line and Salsette-Saki 7 (Proposed reorientation as Trombay-Saki) from Tower No. 22.	Ph-I - 2025- 12 Ph-II - 2026- 54 2027- 36 2028- 48 2029- 42 2030- 24 2031- 9	225	-
20	Amazon DataServices Pvt Ltd, Thane	Village Balkum & Majiwade,	LILO on 220KV Colorchem-Temghar ckt of the 220KV D/C Kalwa-Colurchem-	Ph-I - 2025- 37.5 Ph-II - 2026- 37.5 2027- 37.5	150	-

		Taluka-Thane	Temghar line on loc. No.22	2028- 37.5		
21	M/s. Raiden InfoTech India (P) Ltd.	Turbhe MIDC, TTC Industrial Area, Navi Mumbai	LILO on 220 kV Kharghar – Sonkhar line at M/s Raiden – 1.6 km	Ph-I - May 26 – 20	190	-
				Ph-II - May 27 – 30		
				May 28 – 30		
				May 29 – 30		
				May 30 – 40		
				May 31 – 40		
22	M/s. Amazon, Ambernath	Villages Narhen, Usatane, Burdul & Asode, Taluka-Ambernath, District-Thane	220 kV D/C line from 220 kV Lodha Switching Station (Proposed-MSETCL) to 220 kV Amazon GIS S/s – 100 Mtrs approx.	Ph-I - 2028 -150	475	-
				Ph-II - 2031- 50		
				2032 -25		
				2033 - 75		
				2034 - 50		
				2035 - 50		
				2036 - 50		
23	M/s. STT Global, Ambernath	Villages Narhen, Usatane, Burdul & Asode, Taluka-Ambernath, District-Thane	220 kV D/C line from 220 kV Lodha Switching Station (Proposed-MSETCL) to 220 kV STT Global GIS S/s – 100 Mtrs approx.	Ph-I - Feb 27 – 150	450	-
				Ph-II - Dec 28 – 100		
				Dec-30 – 100		
				Dec 32 – 100		
24	M/s. CTRLS New	Trans Thane Creek, TTC MIDC, Mahape, Navi Mumbai	220kV Mahape- M/s. CTRLS proposed GIS D/C underground cable-1km approx. in addition to Borivali- Kharghar line 1 LILO at Mahape	Ph-I - 2025 - 50	290	-
				Ph-II - 2026- 50		
				2027 -50		
				2028 - 50		
				2029 - 50		
				2030 - 40		
25	M/s. Gramercy Business Hub Private Limited	TTC Industrial Area, Mahape, Navi Mumbai	a) Establishment of 220 kV Gramercy Switching Station b) LILO on 220 kV Kharghar – Netmagic line at Gramercy – 85 mtrs c) 2 nos. of 220kV feeders from Gramercy Switching S/S to M/s. Gramercy Business Hub Pvt. Ltd. S/S	Mar 2024-15	150	-
				Mar 2025-30		
				Mar 2026-30		
				Mar 2027-30		
				Mar 2028-30		
				Mar 2029-15		
26	M/s. Gramercy Infra Realty Private Limited	Plot No IT-1, IT-1 (Part) and IT-2 at Knowledge Park, Navi Mumbai	TFR awaited from field office	Feb 2027-20	180	-
				Feb 2028-30		
				Feb 2029-30		
				Feb 2030-30		
				Feb 2031-30		
				Feb 2032-40		

27	M/s. Digital Edge (AGP)	Mukand Ltd. at Kalwa Village and Digha Village,	LILO on 100 kV Kalwa-BDC-Mukund I & 100 kV Kalwa-Mukund II at 100 kV Digital Edge	Ph-I - Sept 25 – 25	35	25
				Ph-II - Mar 26 – 10		
28	M/s. Digital Edge	Village: Dighe, Thane Belapur Road	LILO of 220 kV DCHI – Colourchem line at M/S Digital Edge S/s.	Ph-I - Aug 2025 - 50	190	-
				Ph-II - Aug 2026 – 35		
				Aug 2027 - 30		
				Aug 2028 - 30		
				Aug 2029 - 45		
29	M/s. Bridge Data Centre	Dighi MIDC, Navi Mumbai	LILO on 100 KV Kalwa - Mukund Ckt-1 at M/s BDC.	32	32	32
30	M/s. Sify Technologies Ltd.	T.T.C. Industrial Area, M.I.D.C., Village – Rabale, Navi Mumbai	LILO of 100kV Reliable-Standard Alkali line	Ph-I- 20	70	70
				Ph-II- 40		
				Ph-III- 10		
31	Yotta Data Services	Hiranandani Fortune City, Panvel			52	
				<b>Total</b>	<b>5385</b>	<b>526</b>

**TABLE 1 CURRENT STATUS OF FINAL GRID CONNECTIVITY DATA RECEIVED FROM STU (MH) IN MMR REGION**

Pune Metropolitan Region (PMR)						
Sr. No	Name of Consumer	Address	Grid Connectivity	Phase -wise Load (MW)	Total Load Sanctioned (MW)	Final grid connectivity Granted (Load realized) (MW)
1	M/s Microsoft - Corporation India Ltd	Bhosari Block, Pimpri Industrial area, village- Bhosari, Pune	220kV D/C Underground cable of suitable capacity from 220kV Century Enka substation to proposed 220 kV M/s Microsoft Substation – 2 km	Feb 2025- 16.1	74	
				May 2025- 33.7		
				Aug 2025- 47.6		
				Nov 2025- 51.5		
				Feb 2026- 74		
2	M/s Microsoft Corporation India Ltd	Pimpri Chinchwad, District – Pune	220 kV D/C Underground cable from 220 kV Bhosari-I Substation to proposed 220 kV M/s Microsoft Substation – 4 km	Feb 2025- 16.1	155	16
				May 2025- 33.7		
				July 2025- 47.6		
				Aug 2025- 61.5		
				Nov 2025- 74		
				Feb 2026- 96		
				July 2027- 112		

				Mar 2028- 128		
				May 2029- 140		
				Jan 2030- 155		
3	M/s. STT Global Data Centres India Pvt. Ltd	Alandi Road, VSNL Old Colony, Dighi, Pune	220kV VSNL-STT Global Ckt-I & 220kV VSNL-STT Global Ckt-II	Existing -100	100	57
				Additional-100		
4	M/s NXTRA Data Ltd-1	MIDC, Plot No. 13/104, 28, Rajiv Gandhi Infotech Park, Hinjewadi-Phase 3, Pune Pin 411057	Via 2 Nos. of 220kV Lines emanating from 400kV Hinjewadi Ph-III	36	36	36
5	M/s NXTRA Data Ltd-2	Rajiv Gandhi Infotech Park, Phase-3, Mann, Hinjewadi Mulshi District-Pune	220kV Underground D/C cable of approx. size from existing 400/220kV Hinjewadi Phase –III S/s to proposed 220kV Switchyard of M/s NXTRA Data Ltd. 0.3km	Ph-I 50 - 2023-24	150	50
				Ph-II -50 - 2026-27		
				Ph-III -50- 2028-29		
				<b>Total</b>	<b>615</b>	<b>159</b>

**TABLE 2 CURRENT STATUS OF FINAL GRID CONNECTIVITY DATA RECEIVED FROM STU (MH) IN PMR REGION**

Maharashtra MMR & PMR	Total Load Sanctioned (MW)	Final grid connectivity Granted (Load realized) (MW)
<b>GRAND TOTAL</b>	<b>6000</b>	<b>685</b>

**TABLE 3 CURRENT STATUS OF FINAL GRID CONNECTIVITY DATA RECEIVED FROM STU (MH) IN MMR & PMR REGION**

Above table provides a comprehensive assessment of grid connectivity arrangements, phase-wise contracted demand, and load realization for major Data Centre developments across the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR). Total 36 Data Centre projects with a combined planned demand of 6000 MW, of which 5385 MW pertains to MMR and 615 MW to PMR. In MMR, the Data Centres are predominantly integrated through 220 kV LILLO configurations on critical transmission corridors including Kalwa–Tiffil, Kharghar–Borivali, Kalwa–Bapgaon, Kalwa–Colourchem, Mahape–Tiffil. The projects exhibit a multi-year load rollout spanning 2024–2036, with a significant concentration of demand expected between 2025 and 2028.

Key hyperscale installations such as CTRLS, Newfound, Gigaplex, Nextra, NTT Global, Amazon, Gramercy, Sify, and Web Werks constitute the majority of the planned additions. The current load realization in MMR stands at 526 MW, representing approximately 10% of the total projected demand.

In PMR, grid integration is predominantly via 220 kV underground double-circuit links connected to substations such as Century Enka, Bhosari, VSNL, and Hinjewadi Phase-III. Major contributors include Microsoft, STT Global, and Nextra, with load increments planned through 2025–2031. The load realization in PMR is 159 MW, amounting to about 26% of the region’s planned Data Centre load.

The aggregated analysis highlights growing stress on the 220 kV transmission network, particularly in the TTC-Mahape-Airoli cluster, along with dependency on upstream 400 kV Kalwa–Padghe and Kharghar corridors. Planned capacities indicate the necessity for targeted network strengthening, creation of new GIS substations, and augmentation of existing EHV infrastructure to ensure reliability and voltage stability under the projected Data Centre load growth.

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## Chapter-4: Current Loading scenario of Data Centres in Maharashtra

The following table outlines the operational loading status of commissioned Data Centres with respect to their granted grid connectivity. It provides a summary of the *Final Grid Connectivity Granted (MW)* for each consumer, along with the *Average* and *Maximum Load* recorded during the last three months.

	Sr. No.	Name of Data Centre	Final grid connectivity Granted in MW	Average Loading During Last 03 Months in MW	Max Loading During Last 03 Months in MW
Mumbai Metropolitan Region	1	M/s Nxtra	35	2.28	3.5
	2	M/s New Found	36	0.42	4.25
	3	M/s DCHIL	10	1.2	1.75
	4	CTRLS-GIS	70	43	45
	5	NETMAGIC-GIS	25	23.19	24.68
	6	PRINTHOUSE-GIS	30	14	19
	7	STT-GIS	40	5	5
	8	M/s. BDC	32	10.93	11.56
	9	M/s. Digital Edge	25	0.97	7.77
	10	M/s DataScape	18	9	10
	11	M/s Gigaplex	35	7	27
	12	M/s NTT Estella (Global)	50	14	15
	13	M/s NTT Neon	15	5	6
	14	M/s Gramercy Techpark	35	5	10
PUNE Metropolitan Region	15	STT	57	STT-1: 21.13 MW STT-2: 20.50 MW	STT-1: 30 MW STT-2: 27.80 MW
	16	Nextra Data1	36	16.88	17.17
	17	Nextra Data2	50	5.02	8.98
	18	Microsoft-2	16	0	0
			<b>Total: 615</b>	<b>Total: 204.52</b>	<b>Total: 274.46</b>

**TABLE 4 LIST OF DATA CENTRES IN MAHARASHTRA WITH THEIR SANCTIONED LOADS**

A review of the loading trends of Data Centres connected in the Mumbai Metropolitan Region (MMR) and the Pune Metropolitan Region (PMR) indicates a cumulative Final grid connectivity of 615 MW, the average recorded demand over the last three months stands at 204.52 MW, representing an overall

utilization of 33 %. Even at peak, the combined maximum loading reached 274.46 MW, which is 44 % of the Final grid connectivity Granted.

#### 4.1 Power requirements in Data Centre Industry

The load composition of a Data Centre is key to understanding its power demand, energy efficiency, and reliability. The electrical load profile is made up of distinct subsystems, each with specific roles:

**IT Load (Critical Load)** (55-65 % of Total Load)

- Includes servers, storage, and networking gear.
- Characterized by steady power draw.
- Highly sensitive to power quality and interruptions.

**Cooling Infrastructure** (30-35 % of Total Load)

- Includes precision air conditioners, CRACs, chillers, pumps, and fans.
- Maintain the optimal thermal environment necessary for equipment performance and longevity.

**Auxiliary Systems** (2-5 % of Total Load)

- Fire protection, lighting, building management systems (BMS), and security systems.
- Support operational safety and facility management.
- Contribute to the overall electrical load but with variable profiles depending on usage.

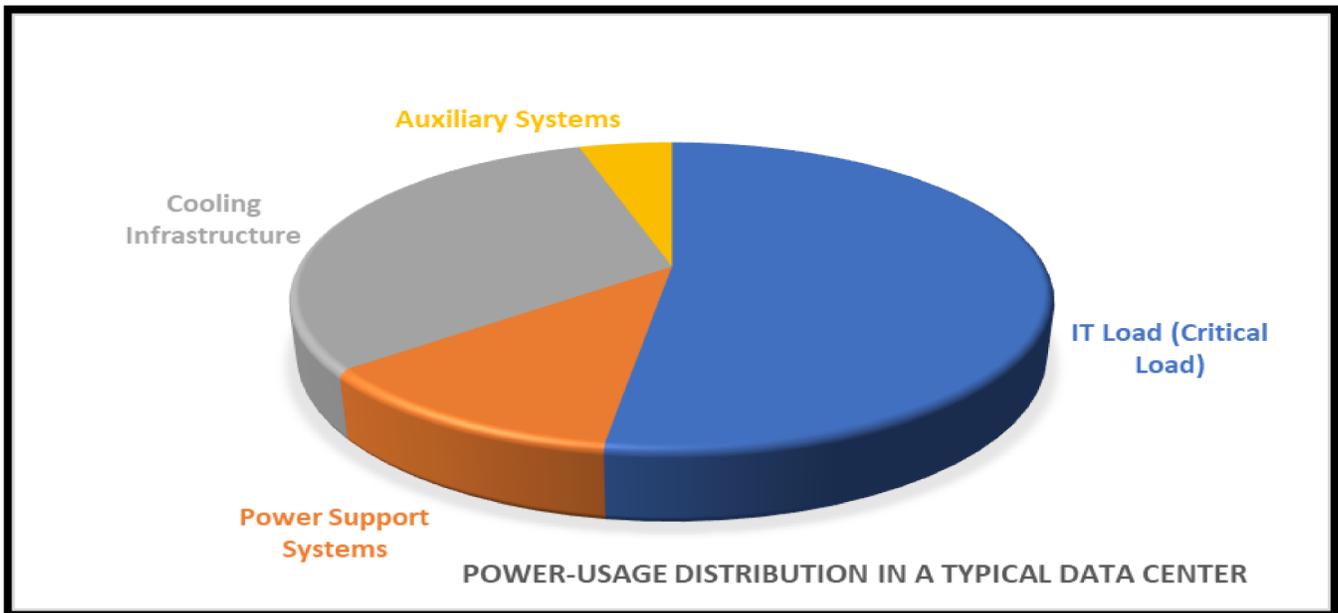


FIGURE 3: THE POWER-USAGE DISTRIBUTION IN A TYPICAL DATA CENTRE

A Data Centre's energy use is dominated by IT equipment, which typically accounts for about 50–55% of total consumption, followed by cooling infrastructure at roughly 30–35%, making it the second-largest load. Because cooling demand scales with IT heat output, any improvement in IT efficiency directly lowers the burden on auxiliary systems such as cooling equipment, UPS units, and power-distribution hardware. Understanding and managing these interlinked subsystems is essential for enhancing energy efficiency, ensuring reliable power delivery, and maintaining overall operational resilience.

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## Chapter-5: M/s CtrlS Data Centre Visit

On 14.10.2025, the MSLDC Data Centre Study Team carried out a visit to M/s CtrlS with the objective of understanding and reviewing its electrical installations.

### 5.1. Purpose of Visit:

A site visit is carried out to understand the grid connectivity, electrical infrastructure, various loads at DC, operational philosophy, grid interface, system reliability, voltage performance, protection arrangements, and future load addition aspects of M/s CtrlS Data Centre.

### 5.2. Grid Connectivity and Power Supply Arrangement:

M/s CtrlS Data Centre is connected to the Maharashtra grid at 220 kV voltage level through a LILO arrangement on the 220 kV Netmagic–Borivali (MSETCL) transmission line. The substation receives power from 220 kV Kharghar and 220 kV Borivali (M) substations.

The LILO arrangement has been implemented using 220 kV, 2000 sq.mm XLPE underground EHV cables, with three runs per circuit laid separately, along with one additional spare cable run. The arrangement provides high reliability and redundancy in line connectivity.

### 5.3. Substation Configuration and Equipment:

The CtrlS DC, 220 kV substation is a GIS installation of GE make comprising two-line bays, one bus coupler bay, and two transformer bays, with a double main bus arrangement. The protection system and SCADA are of Hitachi make.

The installed transformation capacity is  $2 \times 75$  MVA, 220/22 kV transformers, (Ynyn0) with solidly earthed neutrals. The transformers are equipped with OLTCs, and voltage regulation is carried out through AVR and RTCC scheme, which was reported to be in service.

### 5.4. Load Sanction, Present Loading and Distribution:

The STU-sanctioned load is 295 MW, planned to be availed in phases. At present, two phases aggregating to 70 MW are operational. The average and maximum loading of the Data Centre are about 42 MW and 45 MW respectively, and the load has remained largely steady over the past operational year. The GIS substation is located at DC Tower-3, from where 22 kV supply is distributed to other DC towers. The supply is stepped down to 415 V through distribution transformers rated 2500 kVA / 3150 kVA.

Currently, there is no any Special Protection Scheme (SPS) or Load Trimming Scheme (LTS).

### 5.5. Reliability, Backup Supply and Disturbance Handling:

The normal operating voltage range at DC is 390 V to 440 V. The Data Centre is supported by DG sets rated at 2500 kVA, 415 V, with adequate fuel storage to provide 48 hours of continuous backup at the present load level. In the event of grid outages or voltage dips/sags (lasting up to 3 sec), automatic

changeover from EB to DG supply takes place, with the load being supported through UPS systems during transition. The UPS (IGBT based) used are of 500 kVA capacity provided with 730-watt batteries. The batteries provide up to 10 mins of back up time.

The system has reportedly performed satisfactorily during grid disturbance events, including the low-voltage condition experienced in the MMR region on 12.03.2025 due to multiple EHV line tripping in the Western region Gujrat grid. Restoration from DG to EB supply is carried out only after sustained voltage stability, with gradual load transfer through UPS systems.

## 5.6. Power Quality and Harmonics:

Power quality monitoring is carried out using Secure make PQ meters (ProQ100) installed at both 220 kV incomers. Parameters such as Voltage Total Harmonics Distortion (VTHD) and Current Total Harmonics Distortion (ITHD) are monitored. The observed harmonic levels during the visit as follows:

VTHD: L1=1.03%, L2=1.02%, L3=0.93%

ITHD: L1:1.23%, L2=1.30%, L3=1.15%

The power quality parameter Data of P-Q meter Data is available locally and no historical Data is available.

To mitigate harmonics generated by VFD-based cooling equipment, Active Harmonic Filters (AHFs) are installed at chiller pump levels. APFC panels are available to maintain power factor (PF)

## 5.7. Visibility of the Data Centre at SLDC:

The Data visibility of the Data Centre at SLDC is only available for Point of Interface (POI) i.e. 220 kV line LILO arrangement.

## 5.8. Certification, Monitoring and Operational Philosophy:

The Data Centre is certified as a Tier-IV facility by EPI Certification Body, indicating fault-tolerant design 2N redundancy, and high availability. All DC towers are monitored through a centralized Integrated Building Management System (IBMS), covering electrical, mechanical, security and surveillance systems, enabling continuous supervision and control.

## 5.9. Renewable Energy Integration:

M/s CtrlS has access to renewable energy through a 50 MW solar power plant in the Nagpur region, supplying approximately 20–30% of the Data Centre's energy requirement via open access. Additionally, an 863-kW rooftop solar installation is available at DC Tower-2 for captive consumption. No Battery Energy Storage System (BESS) is presently installed.

## 5.10. Load Composition

The load composition of the Data Centre comprises approximately 60–65% IT loads, 35–40% cooling loads, with other auxiliary loads being negligible. The IT load is primarily in the form of rack loads, with a typical rack capacity of around 6 kW, though actual loading varies based on customer requirements.

The major consumers of CtrlS are Enterprise clients, Banking institutions, Hyperscale operators, small scale vendors, utilities,

### 5.11. Future Expansion Plans:

M/s CtrlS informed that the following expansion activities are planned:

- Apart from existing Extra High Voltage installation, one more 220 kV source line from 220 kV Mahape Substation through underground cabling, which will enable the CtrlS DC to be 2N+1 redundant.
- Installation of four additional 75 MVA, 220/22 kV transformers
- Commissioning of DC Towers 6 and 7, currently under construction
- Another 220 kV GIS substation is planned to cater an additional load totaling to 290 MW.

### 5.12. Overall Observations:

Based on the site visit, the existing grid connectivity, substation configuration, protection schemes, and backup arrangements of M/s CtrlS Data Centre appear robust and adequate for the present level of operation. The infrastructure demonstrates high reliability and fault tolerance, with sufficient redundancy to manage grid disturbances.

However, the future expansion plans will significantly increase the load, and accordingly, detailed system studies and coordination with STU/SLDC shall be required prior to further load addition to ensure continued grid security and voltage stability.

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# Chapter-6: Load pattern study of Major Data of M/s. CtrlS, Mahape, in Mumbai region

CTRLS has an extensive presence in Mumbai through its hyperscale Data Centre campus, that houses 5 Data Centre buildings. CTRLS Mumbai Data Centre Campus is the largest Data Centre campus in Mumbai. The CtrlS DC (tier-4 Facility) has Installed capacity as below:

DC tower	Area	Power Capacity	No of Racks
Mumbai DC1 & DC2	3,94,177sq.ft.	42 MW	5,555
Mumbai DC3	<b>1,46,000 sq. ft.</b>	<b>8 MW</b>	<b>1,045</b>
Mumbai DC4	<b>2,65,000 sq. ft.</b>	<b>36 MW</b>	<b>2,936</b>
Mumbai DC5	2,28,482 sq. ft.	30 MW	2,750

TABLE 5 THE CTRLS DC (RATED-4 FACILITY) INSTALLED CAPACITY

- The Data Centre has been connected to state grid through a LILLO arrangement on the 220 kV Net Magic – Borivali (M) transmission line. The Main power sources for DC are 400 kV Kharghar and 220 kV Borivali(M) ss.
- The Total Sanctioned Load for CTRLS Mumbai Data Centre is 295 MW to be commissioned in phased manner. At Present 02 phases of loads 30 MW and 40 MW are operational.
- The transformation capacity of the DC’s EHV s/s (220 kV) is 2\*220/22 kV Power Transformers (located at Dc-3). The 22 kV supply is distributed to the remaining DC towers, where it is stepped down to 415 volts through 2500/3150 kVA distribution transformers for further load utilization.
- A typical Electrical supply arrangement till rack load at DC is shown below

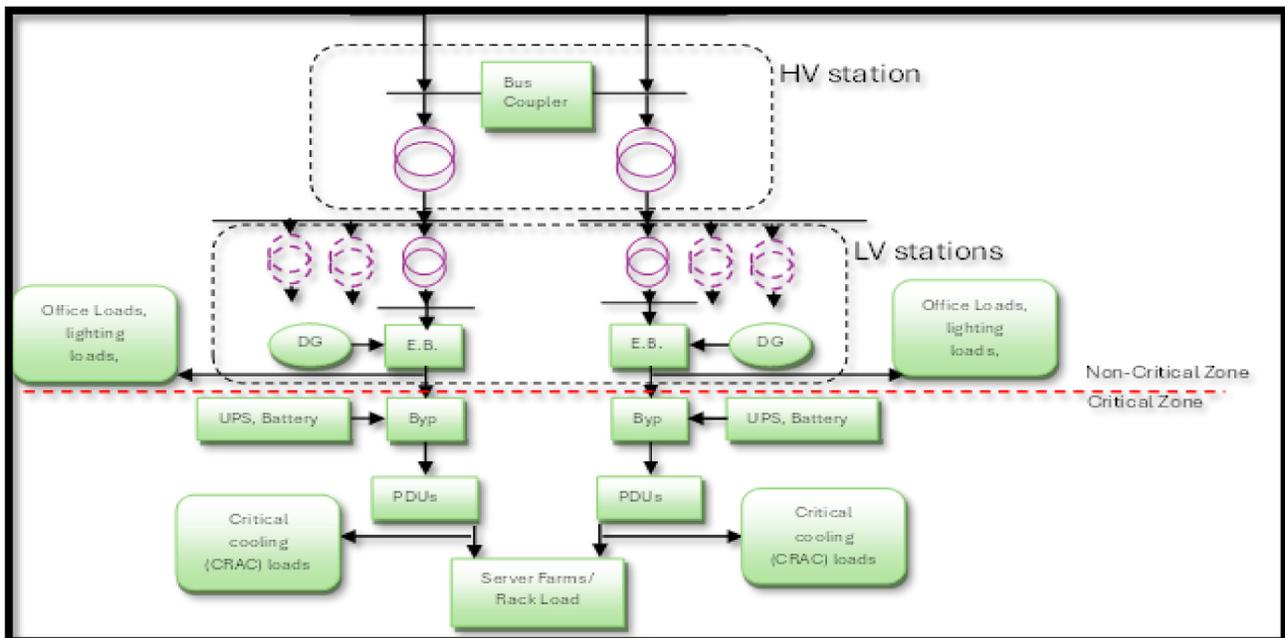


FIGURE 4: ELECTRICAL SUPPLY ARRANGEMENT AT CTRLS

### 6.1 Grid Voltage & frequency Profiles at CtrlS Data Centre

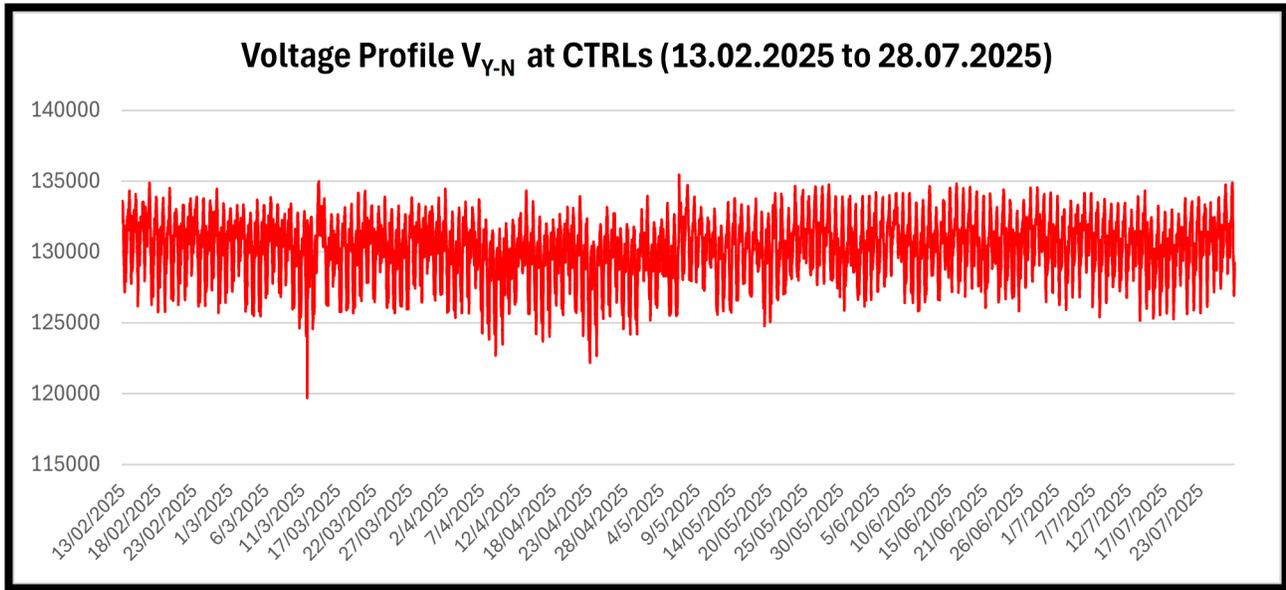


FIGURE 5 VOLTAGE PROFILE  $V_{R-N}$  (13.02.2025 TO 28.07.2025 (SOURCE AMR DATA)

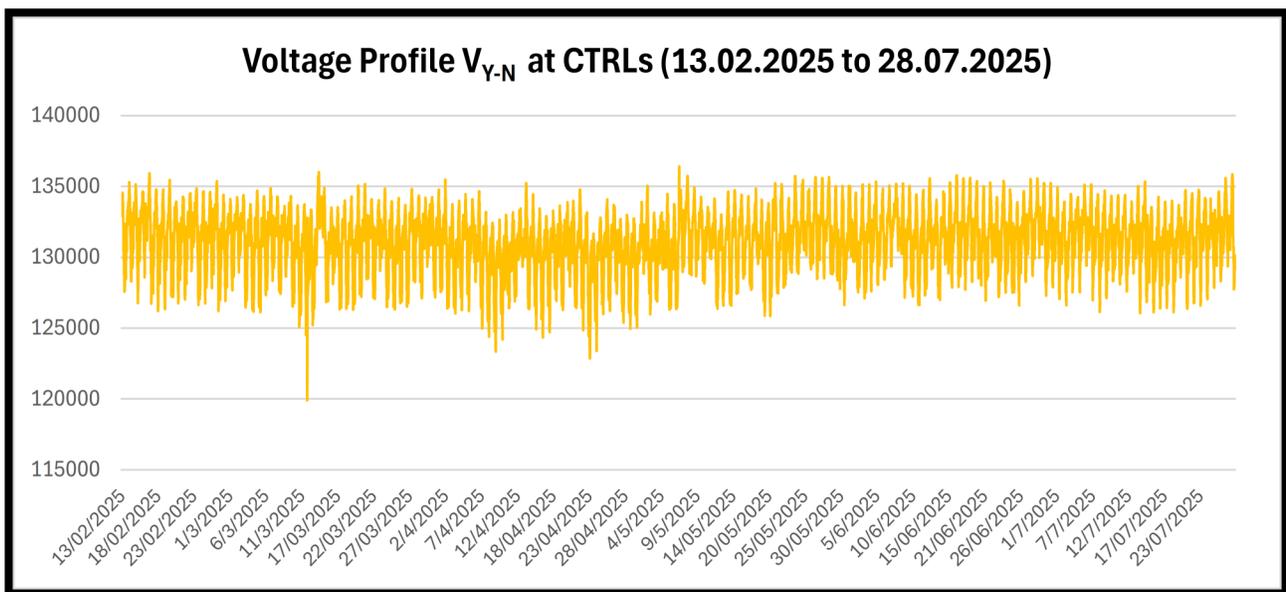
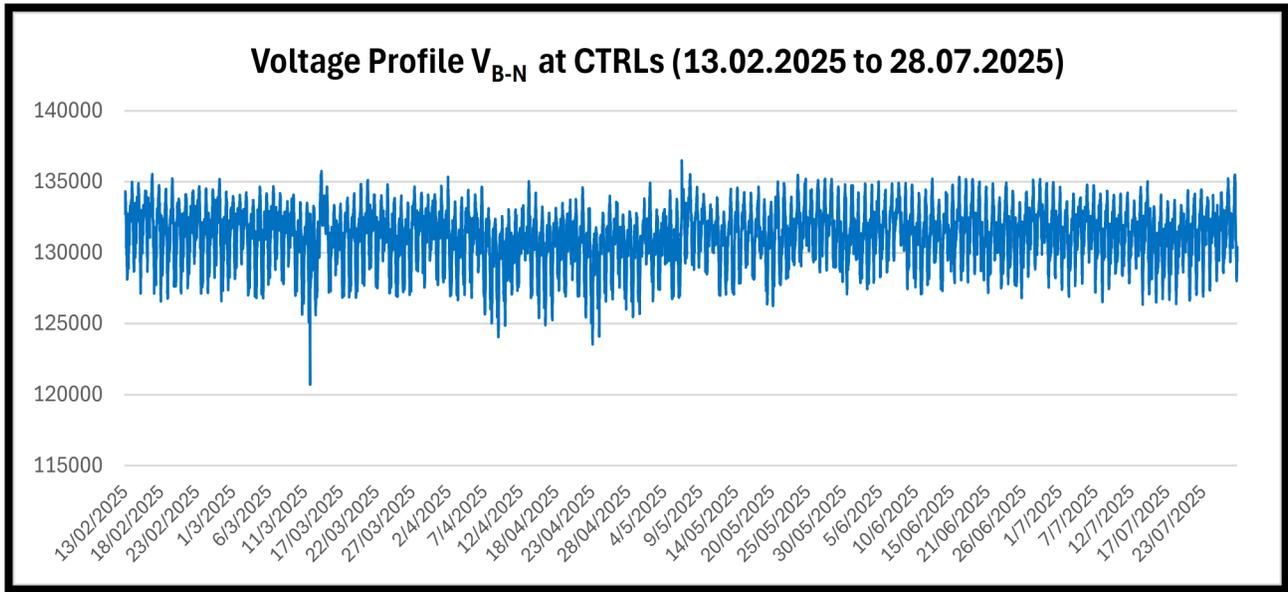
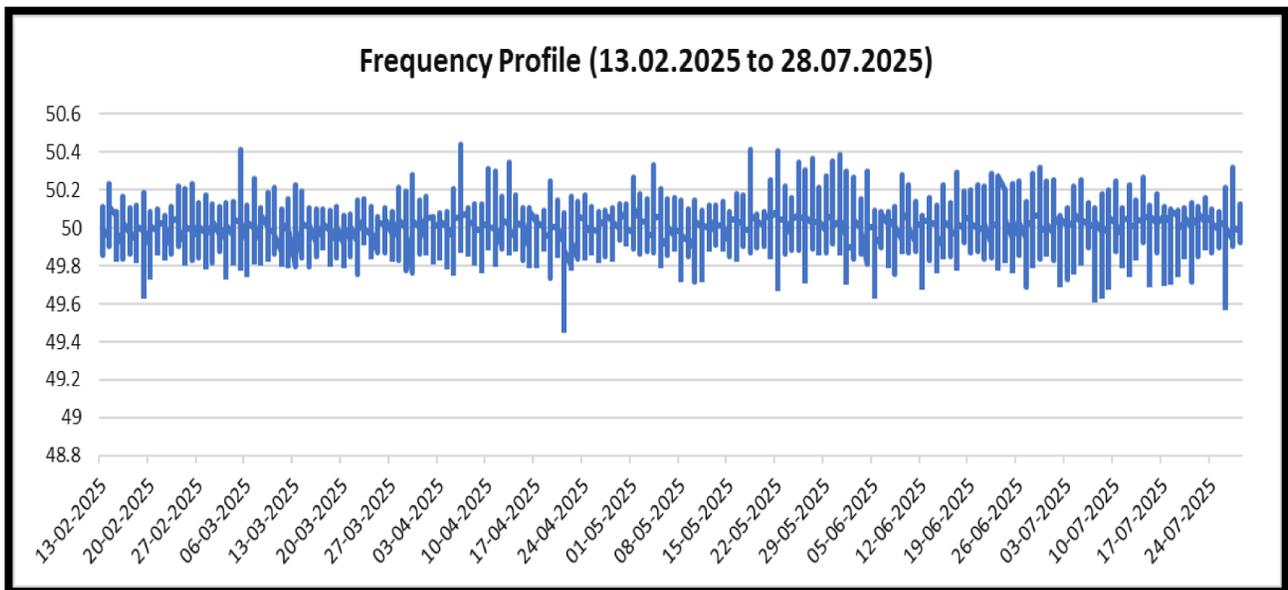


FIGURE 6 VOLTAGE PROFILE  $V_{Y-N}$  AT CTRLS (13.02.2025 TO 28.07.2025) (SOURCE: AMR DATA)



**FIGURE 7 VOLTAGE PROFILE VB-N AT CTRLS (13.02.2025 TO 28.07.2025) (SOURCE: AMR DATA)**



**FIGURE 8 FREQUENCY PROFILE (13.02.2025 TO 28.07.2025) (SOURCE: AMR DATA)**

The voltage profile at CTRLS exhibits that the grid voltages are within the range of 125 kV to 135 kV<sub>(ph-n)</sub>. The substantial voltage dip has been observed on 12.03.2025 which was due to Gujrat Partial Grid failure. Voltages and Frequency parameters of CTRLS DC are found within permissible limits.

## 6.2 Behaviour of CtrlS Load on 12.03.2025

Coinciding with the regional grid disturbance in western region On dated 12.03.2025, the voltages in Maharashtra system collapsed. The Load Behavioral pattern of CtrlS during this period is plotted as below:

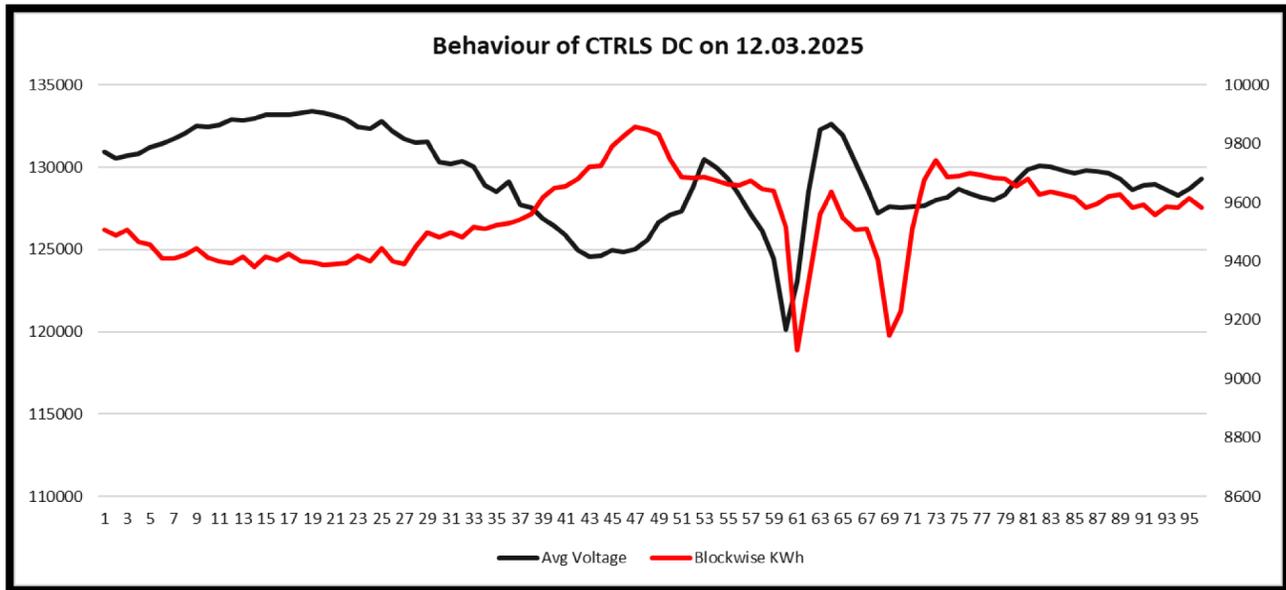


FIGURE 9: BEHAVIOUR OF CTRLS DC ON 12.03.2025

During the voltage dip, the Data Centre drew less power from the grid and shifted the DC load to internal support (i.e. DG sets). However, the pattern within some blocks needs further analysis with more granular data. Once the grid voltages were recovered, the load was again fed through grid.

## 6.3 Power Factor at Data Centres

The observed power factor for CtrlS is plotted below.

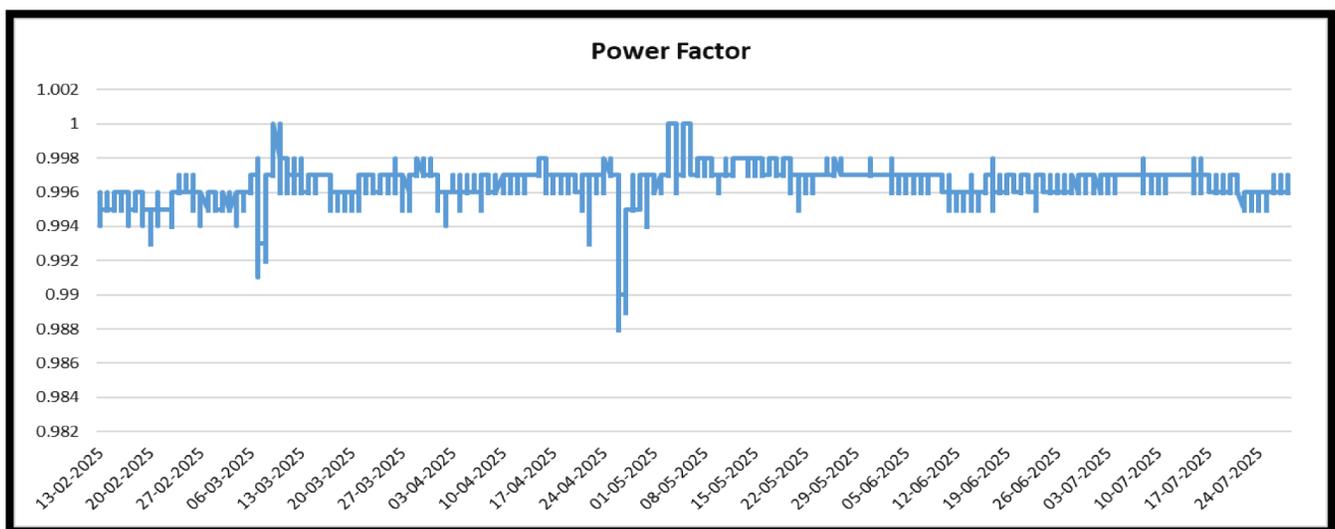


FIGURE 10 POWER FACTOR PROFILE (13.02.2025 TO 28.07.2025) (SOURCE: AMR DATA)

Data Centres typically operates at around unity-power factor (0.98–0.99 lagging) due to modern server power supplies with active PFC, efficient UPS systems, and VFD-based cooling equipment. Although harmonics from nonlinear IT loads can affect waveform quality, they do not significantly degrade the overall PF.

Overall, as per the available data, CtrlS DC generally maintained utility-compliant power factor.

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## Chapter-7: Daily Load Curves of CtrlS Data Centre

The long-term analysis of daily load curves for the CTRLS Data Centre demonstrates stable operational profile, with the majority of days operating consistently in the 9000–10500 kWh (Block wise) range.

Across the assessment period, the Data Centre maintained a high load factor, reflecting efficient utilization of installed capacity and minimal idle operation. Only minor diurnal variations were observed, confirming that the facility operates with near-constant compute and cooling requirements.

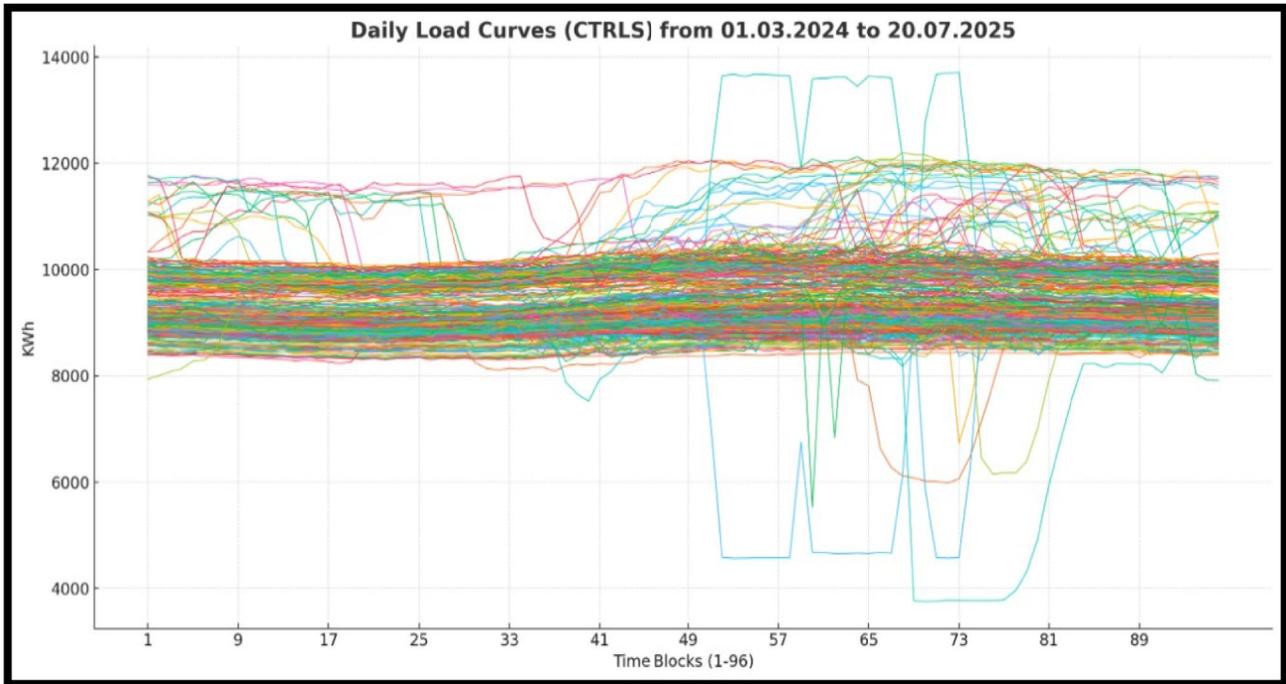


FIGURE 11 DAILY LOAD CURVES FROM 01.03.2024 TO 20.07.2025

A small number of days exhibit major dips or abnormal load patterns. These events may correspond to grid disturbances, operational disturbances such as scheduled maintenance, UPS/transformer isolation, commissioning of new IT/cooling blocks. The exact reasons for these events were not known.

The overall trend shows steady load growth, likely driven by incremental IT hall additions and increased utilization of server racks. Post-mid-2024, the load curves become even more compact and uniform.

## 7.1 Month-Wise Daily Load Assessment

### 7.1.1. Daily Load Curves (CtrlS)-March 2024

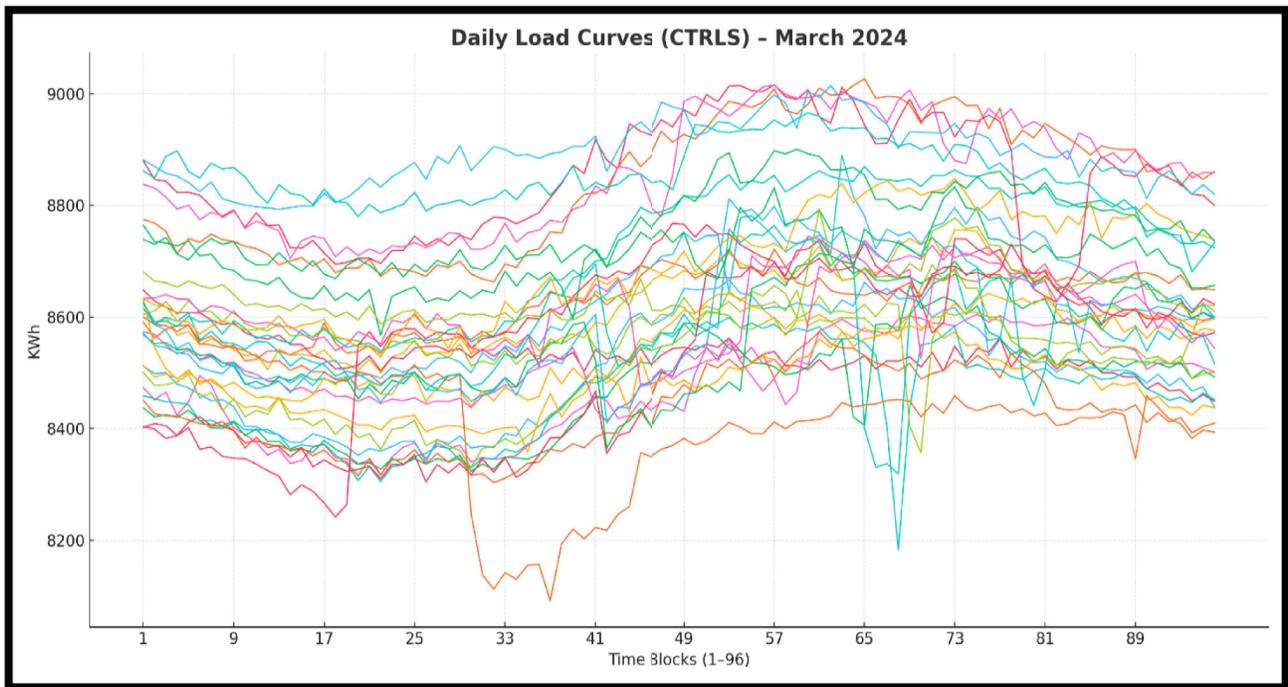


FIGURE 12 DAILY LOAD CURVES (CTRLS)-MARCH 2024

### 7.1.2. Daily Load Curves (CtrlS)-April 2024

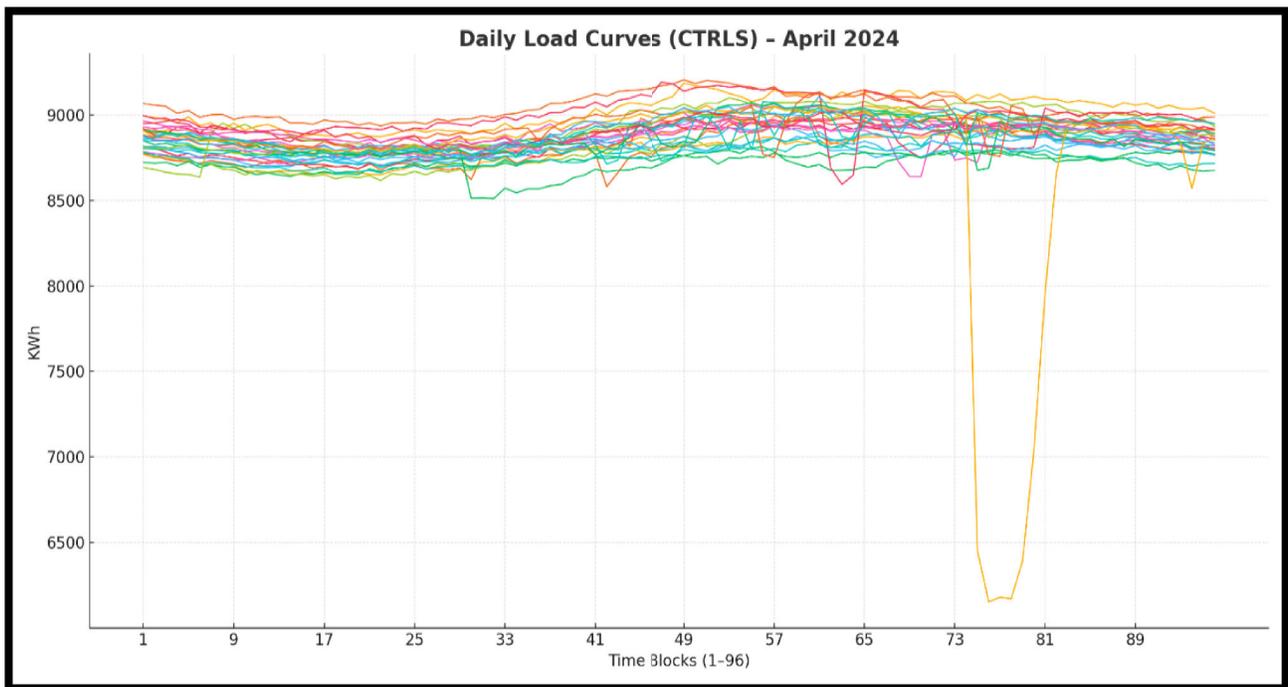


FIGURE 13: DAILY LOAD CURVES (CTRLS)-APRIL 2024

### 7.1.3. Daily Load Curves (Ctrls)-May 2024

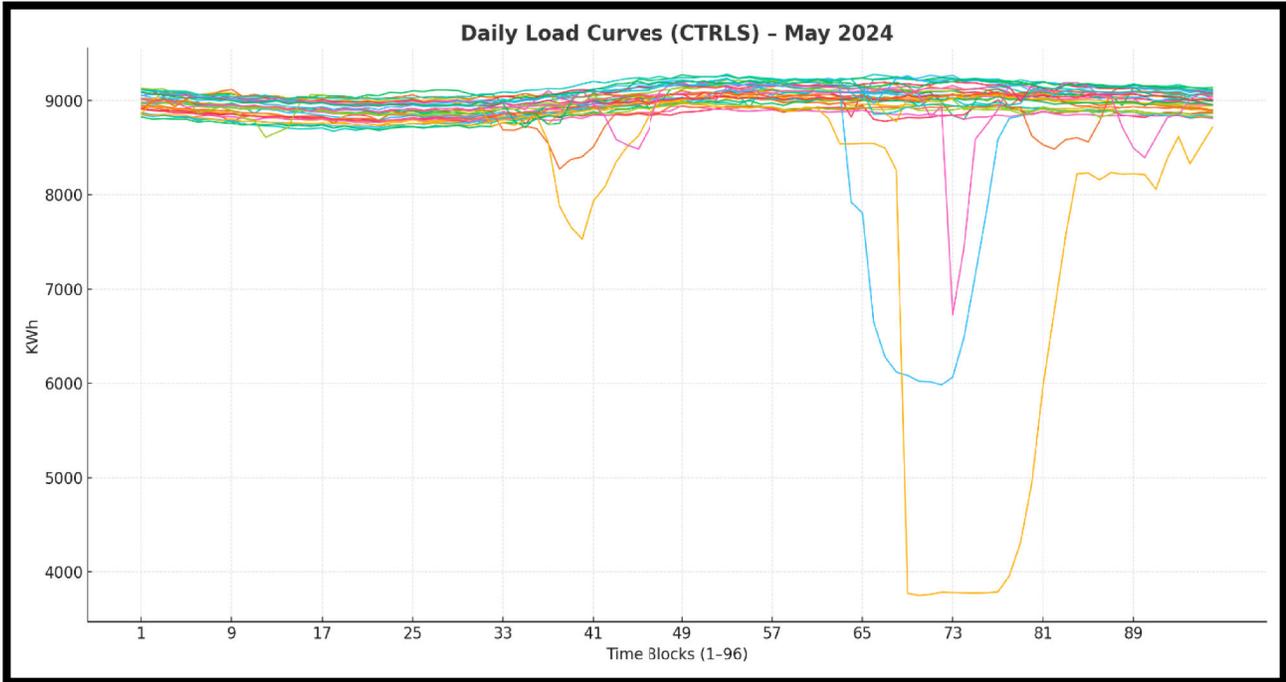


FIGURE 14 DAILY LOAD CURVES (CTRLS)-MAY 2024

### 7.1.4. Daily Load Curves (Ctrls)-June 2024

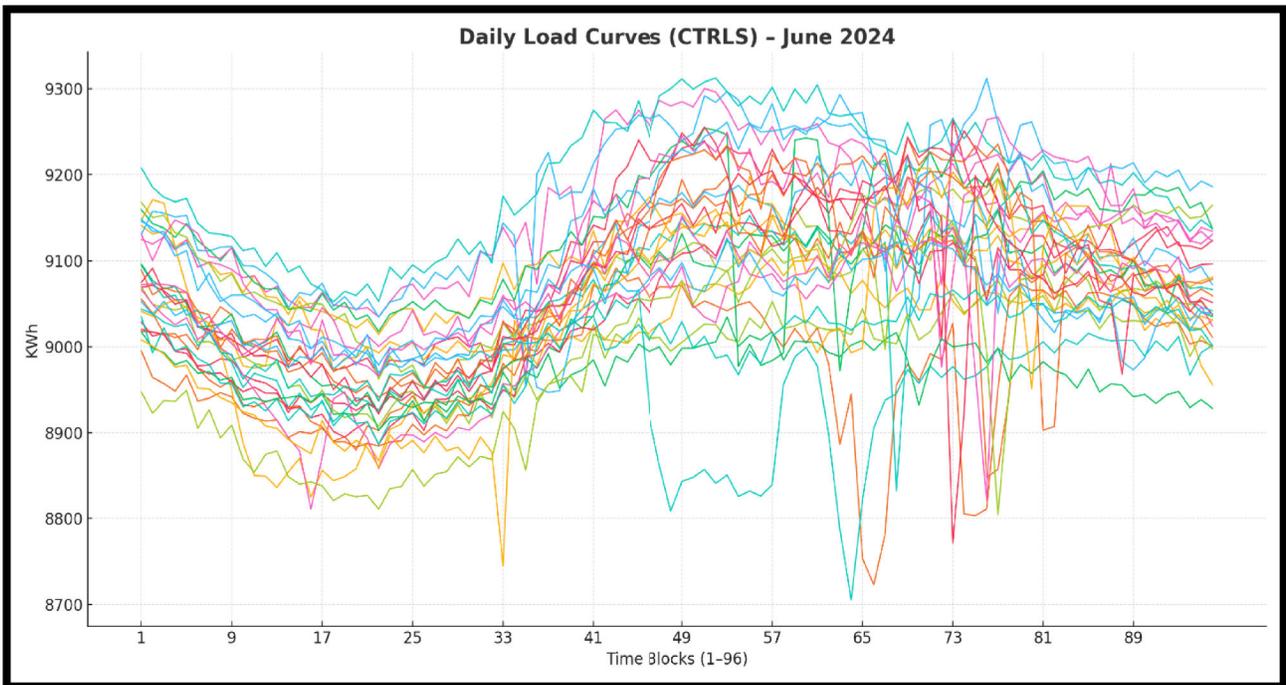


FIGURE 15 DAILY LOAD CURVES (CTRLS)-JUNE 2024

### 7.1.5. Daily Load Curves (CtrlS)-July 2024

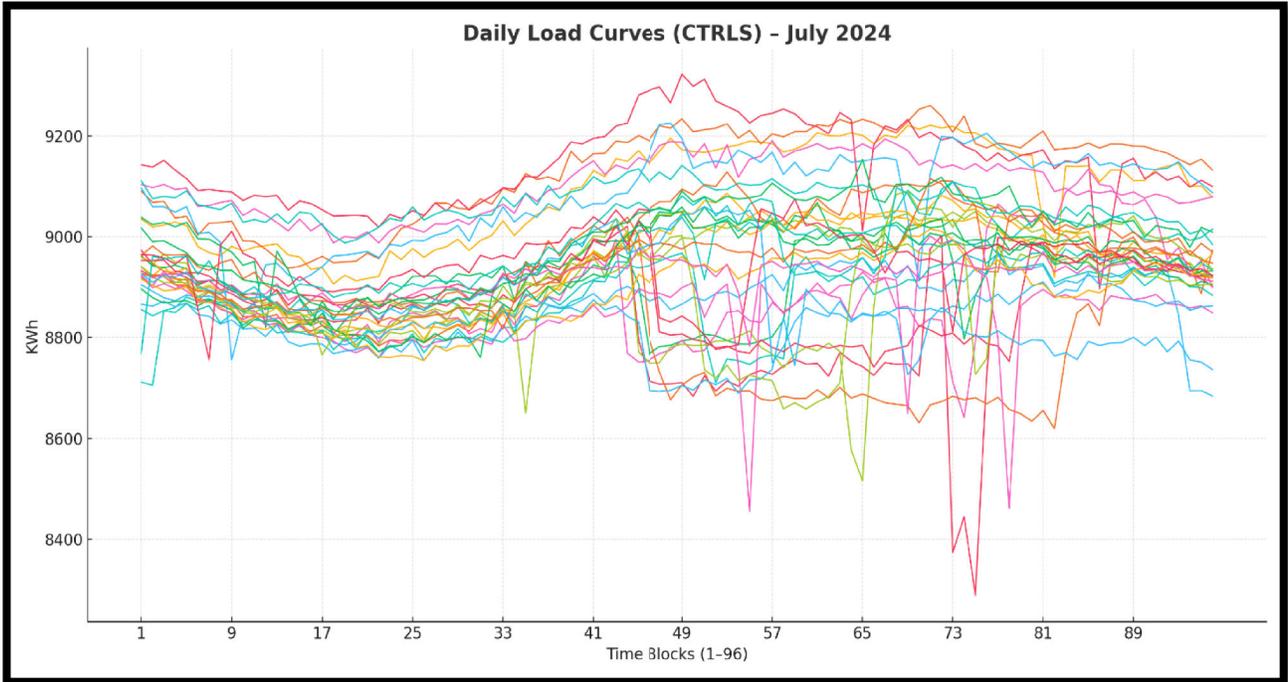


FIGURE 16 DAILY LOAD CURVES (CTRLS)-JULY 2024

### 7.1.6. Daily Load Curves (CtrlS)- August 2024

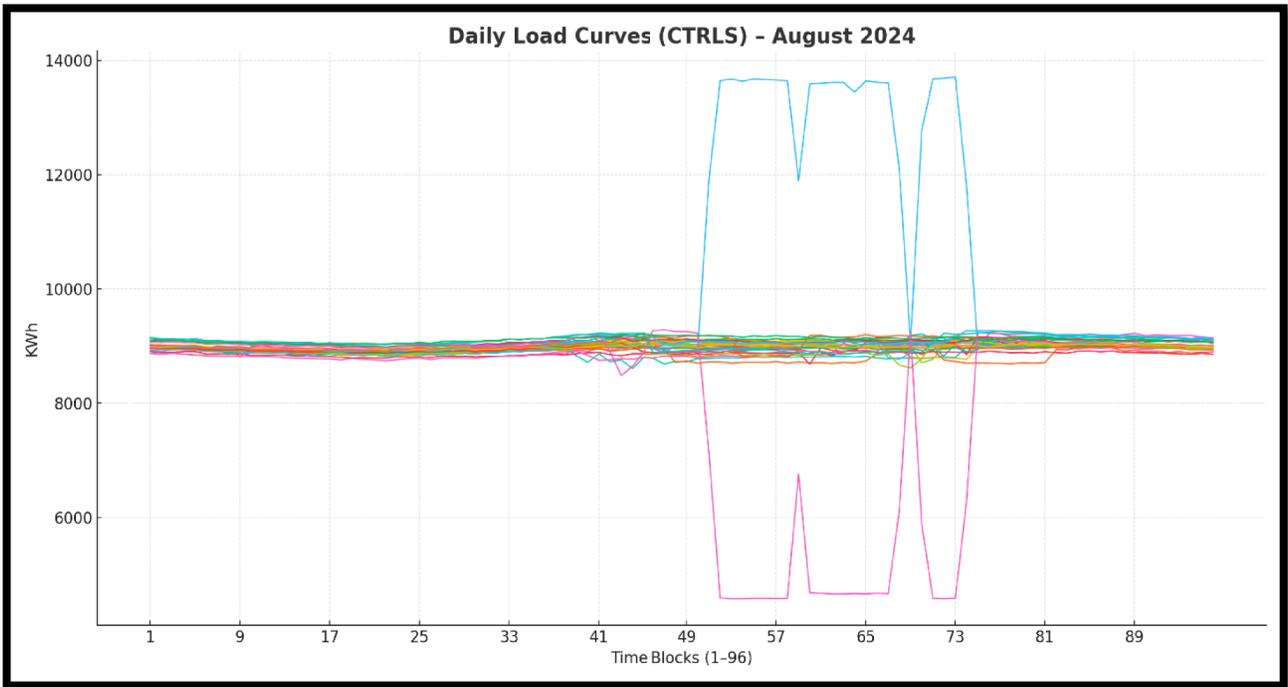
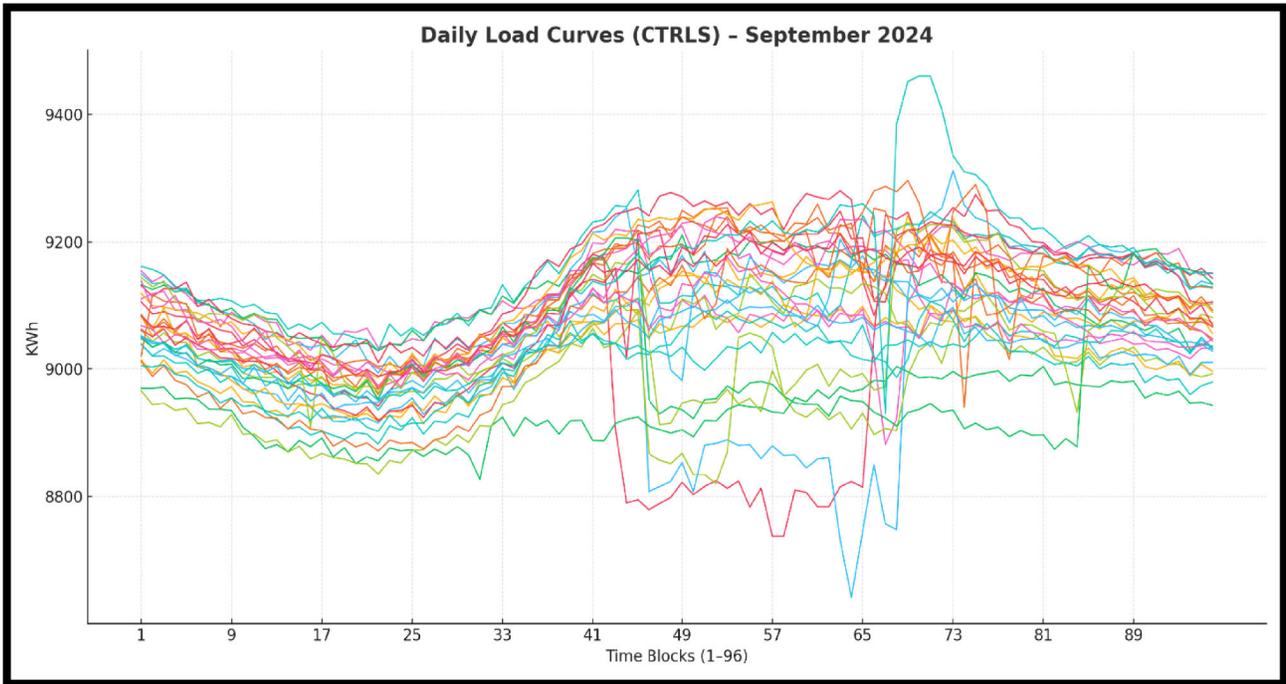


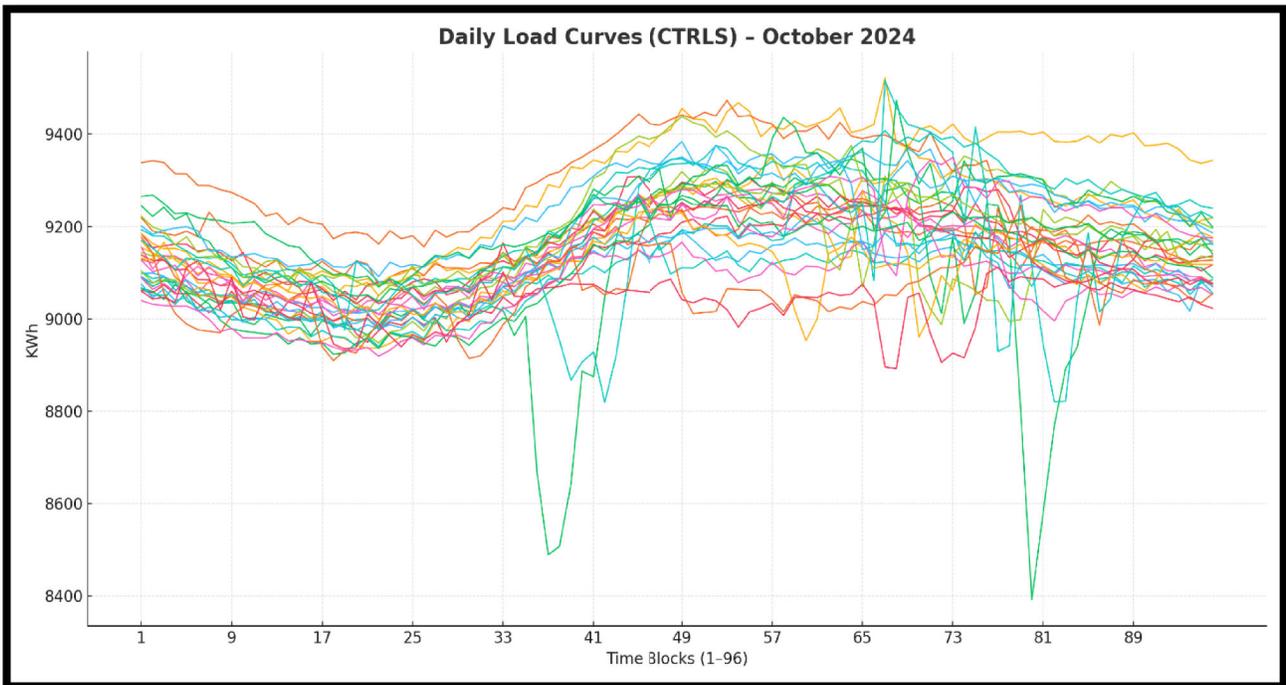
FIGURE 17 DAILY LOAD CURVES (CTRLS)- AUG 2024

### 7.1.7. Daily Load Curves (Ctrls)- September 2024



**FIGURE 18 DAILY LOAD CURVES (CTRLS)- SEPT 2024**

### 7.1.8. Daily Load Curves (Ctrls )- October 2024



**FIGURE 19: DAILY LOAD CURVES (CTRLS)- OCTOBER 2024**

### 7.1.9. Daily Load Curves (Ctrls)- November 2024

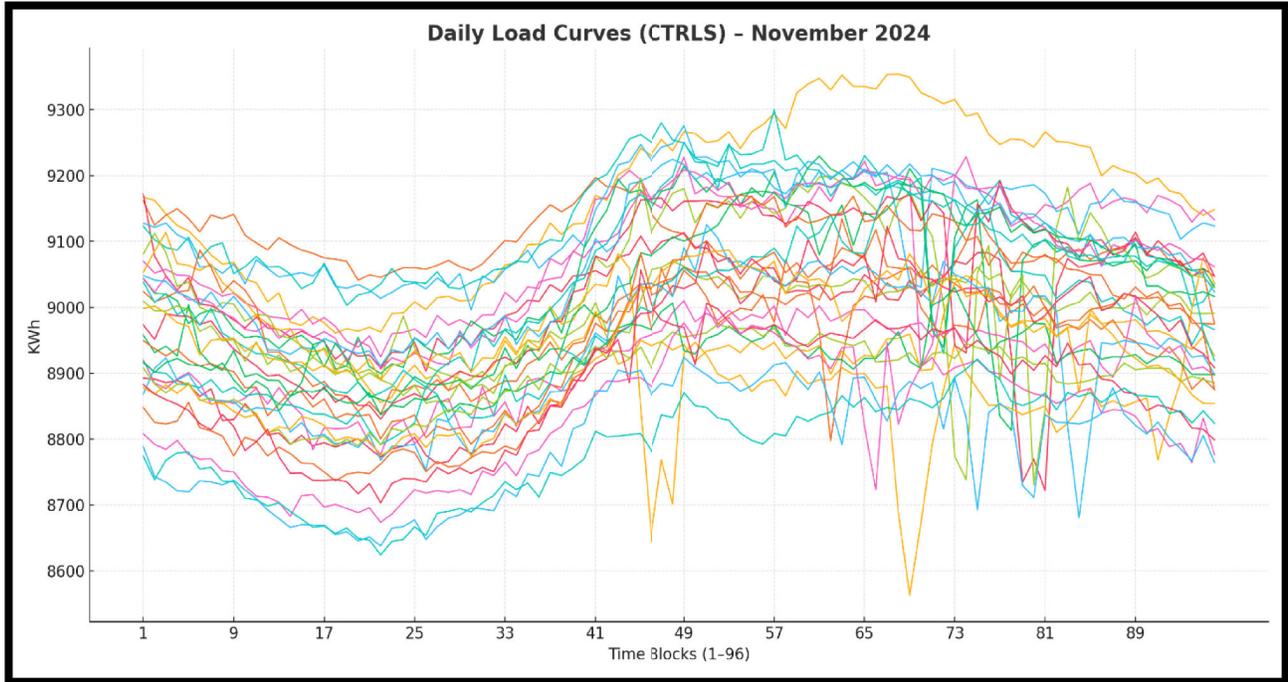


FIGURE 20:: DAILY LOAD CURVES (CTRLS)- NOVEMBER 2024

### 7.1.10. Daily Load Curves (Ctrls)- December 2024

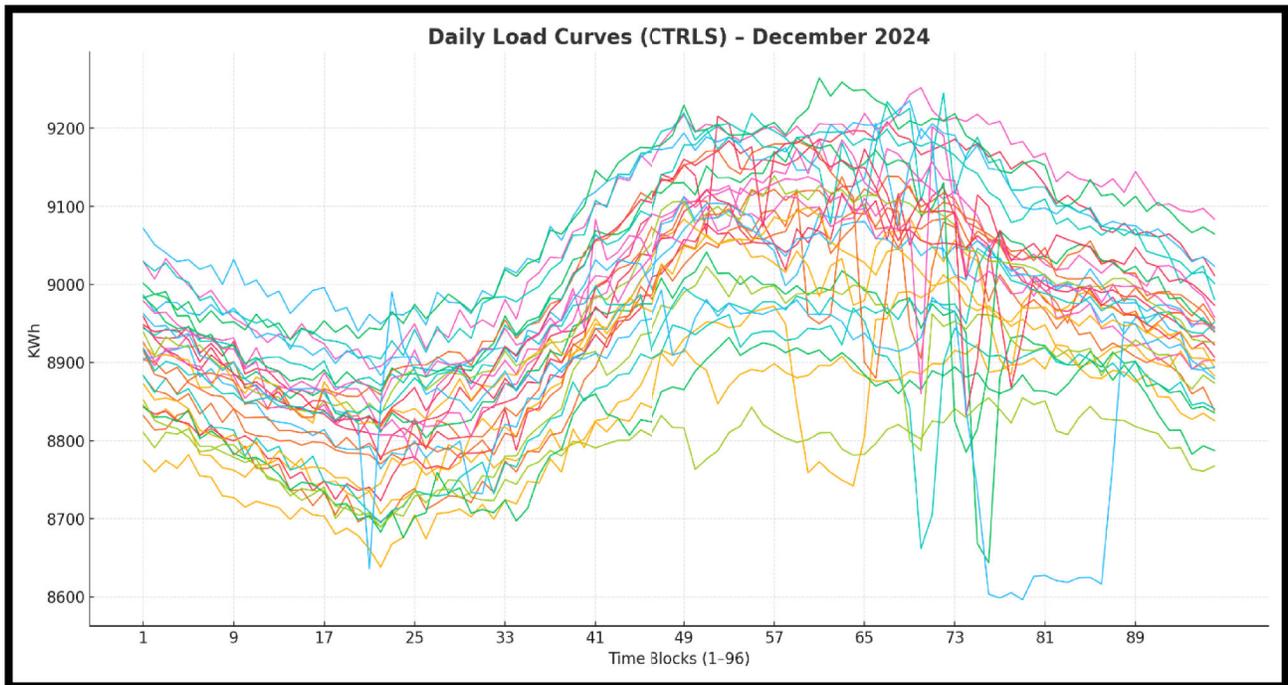


FIGURE 21: DAILY LOAD CURVES (CTRLS)- DECEMBER 2024

### 7.1.11. Daily Load Curves (CtrlS)- January 2025

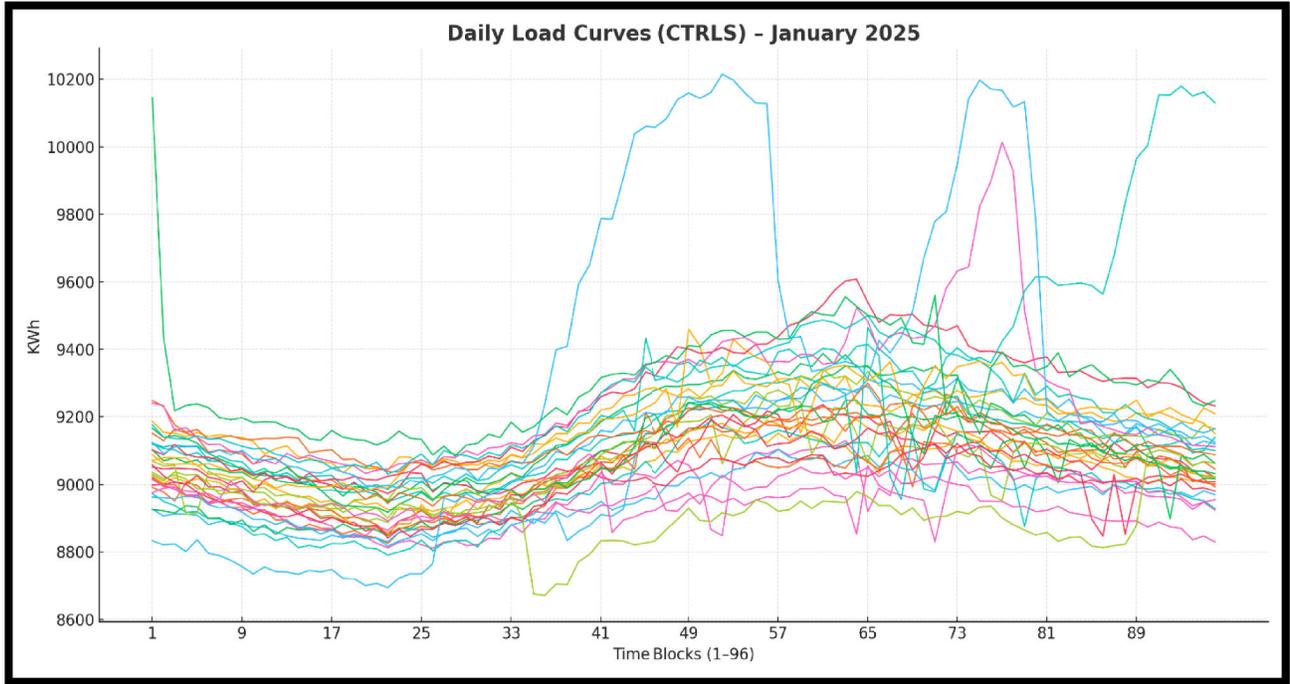


FIGURE 22 DAILY LOAD CURVES (CTRLS)- JANUARY 2025

### 7.1.12. Daily Load Curves (CtrlS)- February 2025

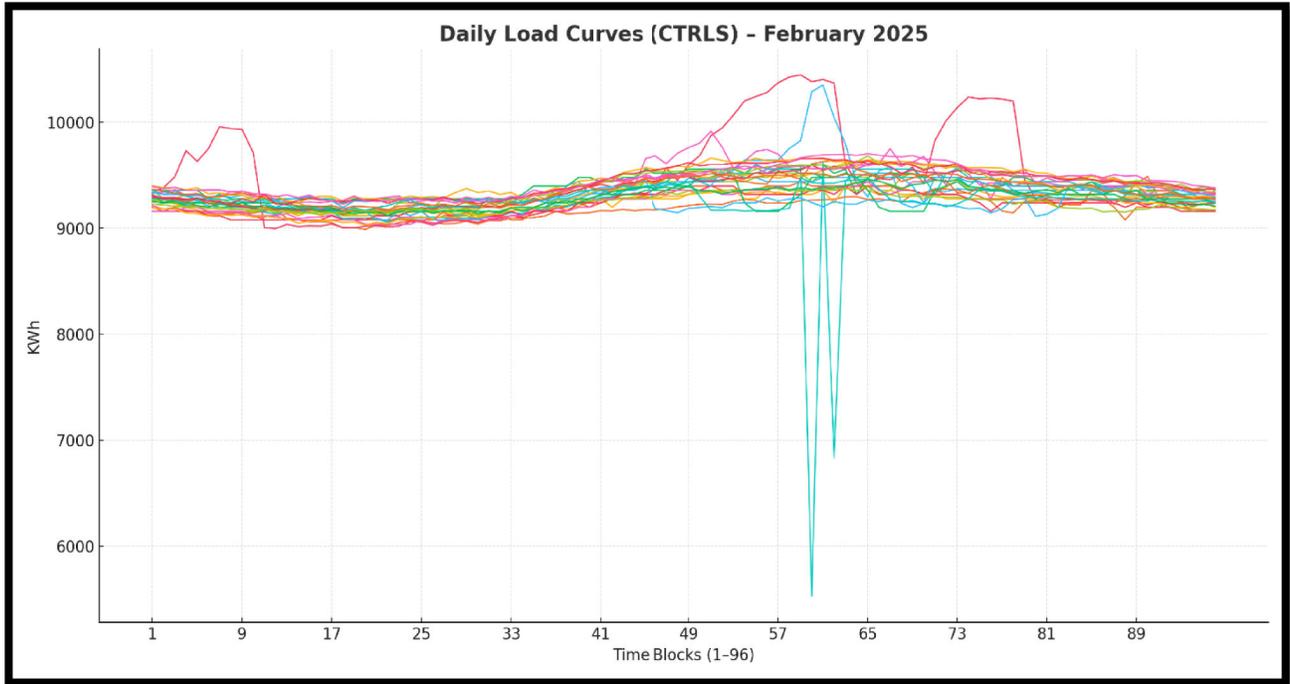


FIGURE 23: DAILY LOAD CURVES (CTRLS)- FEBRUARY 2025

### 7.1.13. Daily Load Curves (CtrlS)- March 2025

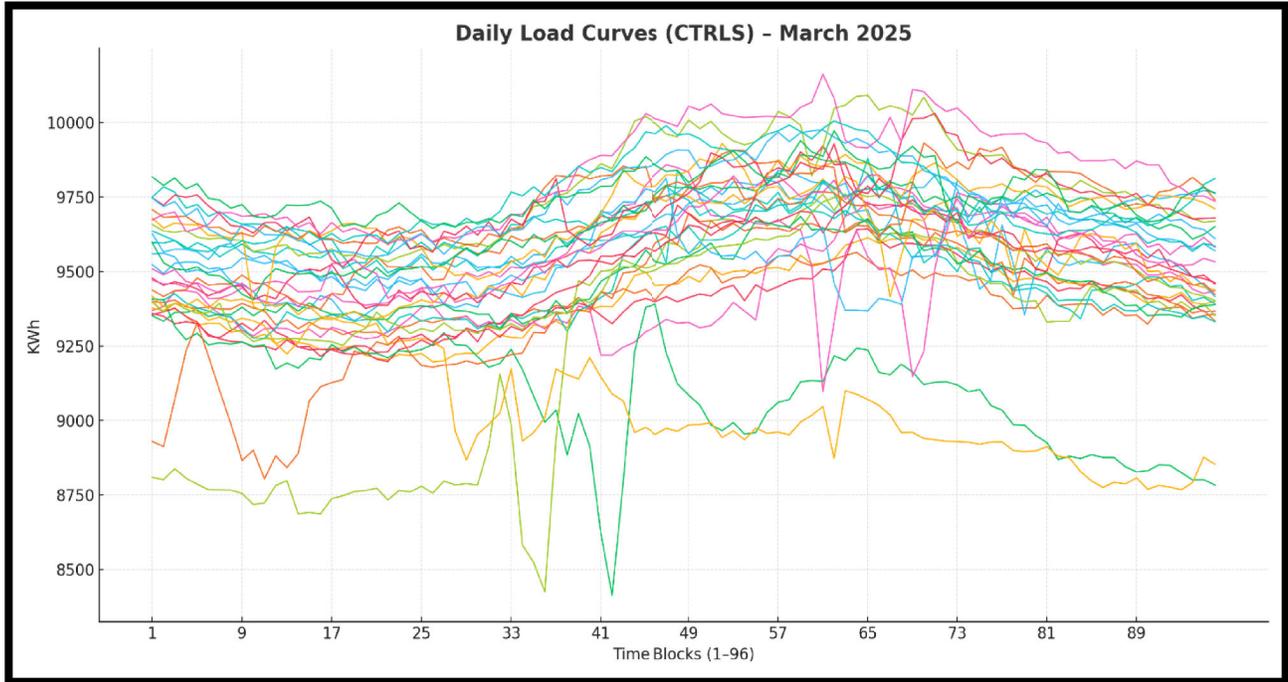


FIGURE 24: DAILY LOAD CURVES (CTRLS)- MARCH 2025

### 7.1.14. Daily Load Curves (CtrlS)- April 2025

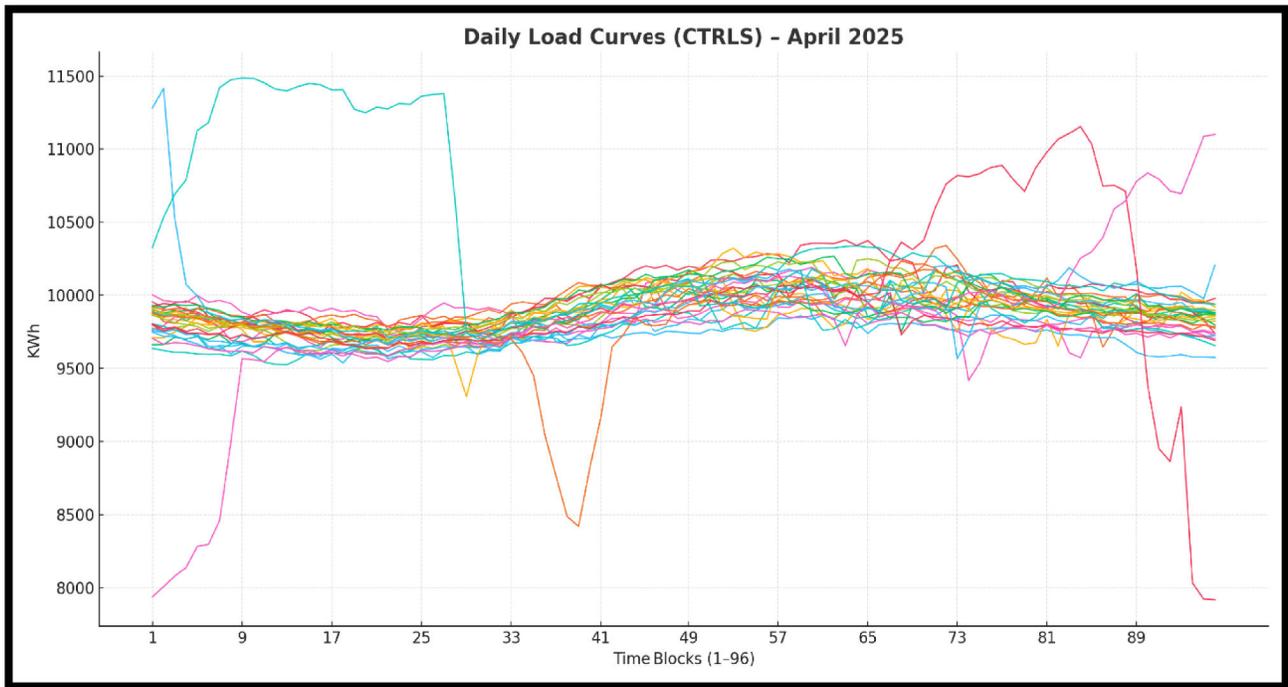


FIGURE 25: DAILY LOAD CURVES (CTRLS)- APRIL 2025

### 7.1.15. Daily Load Curves (CtrlS)- May 2025

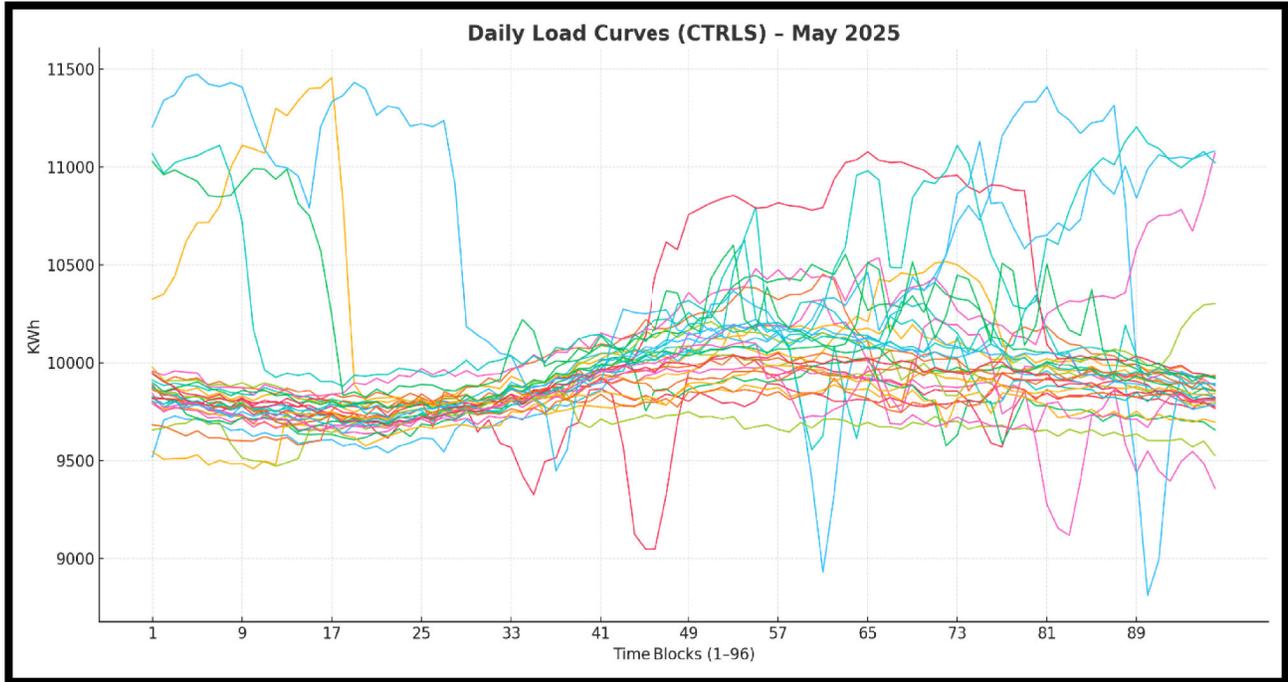


FIGURE 26: DAILY LOAD CURVES (CTRLS)- MAY 2025

### 7.1.16. Daily Load Curves (CtrlS)- June 2025

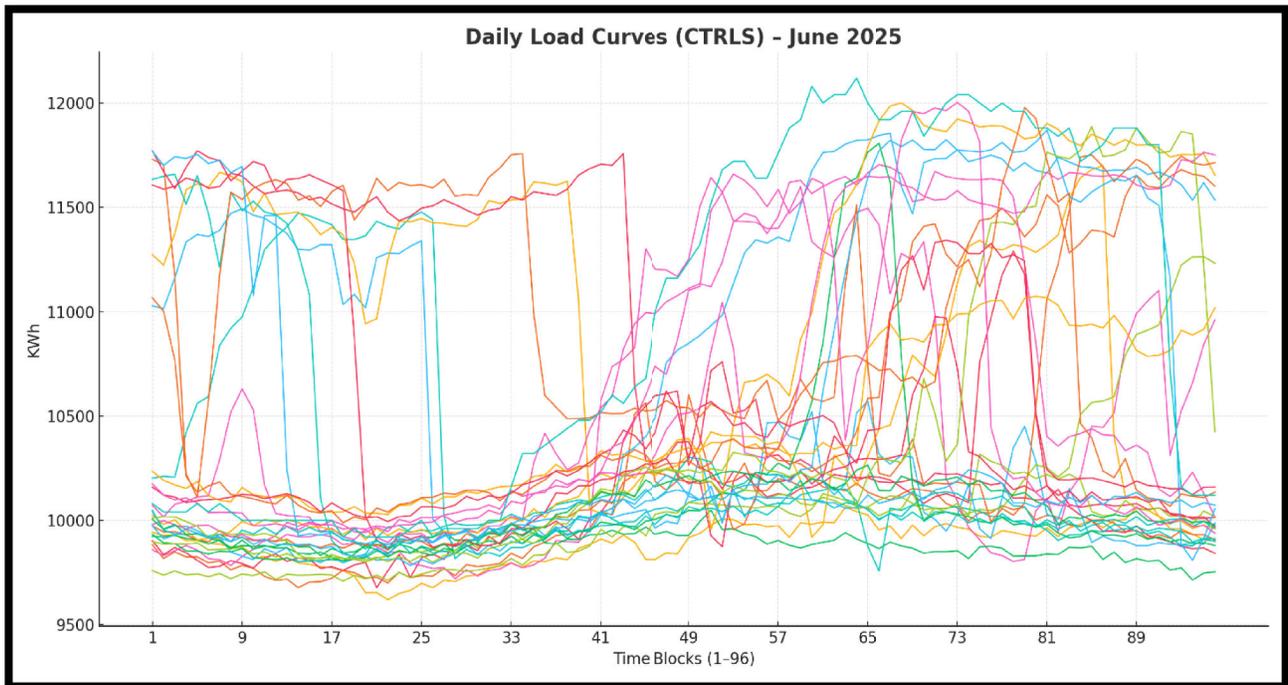
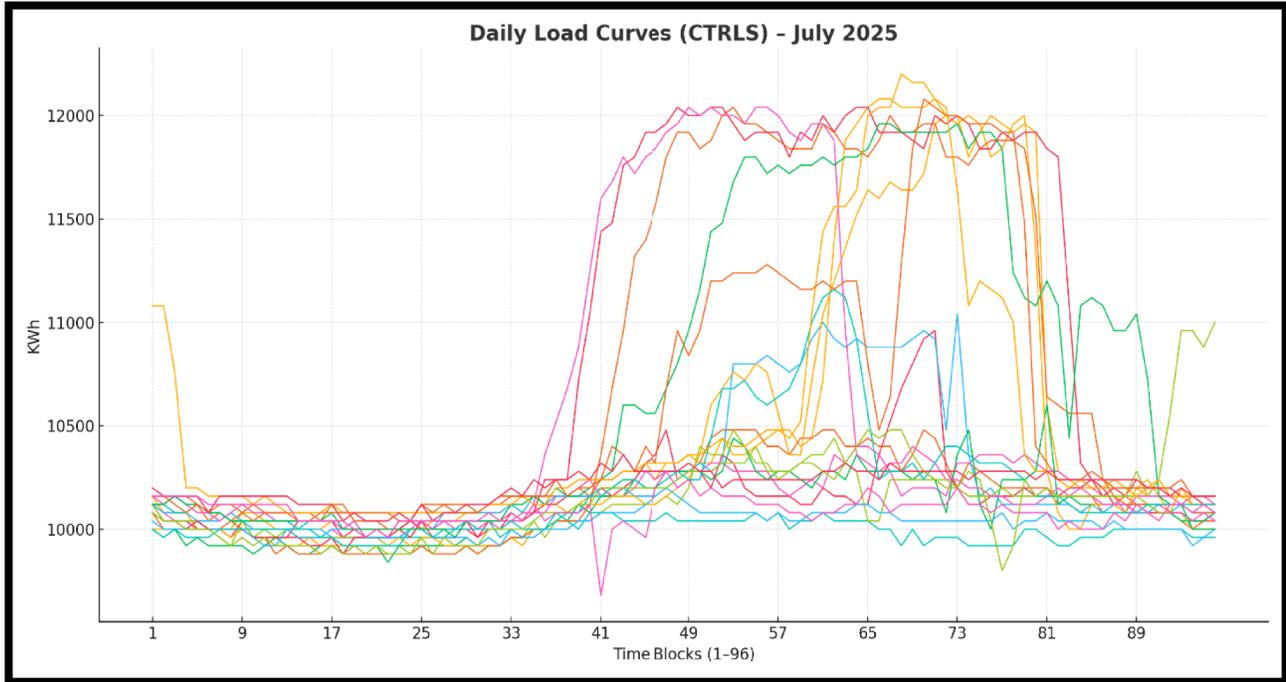


FIGURE 27: DAILY LOAD CURVES (CTRLS)- JUNE 2025

### 7.1.17. Daily Load Curves (CtrlS)- July 2025



**FIGURE 28: DAILY LOAD CURVES (CTRLS)- JULY 2025**

The figures illustrate the month-wise daily load curves of the CTRLS Data Centre, showing that energy consumption generally remains within the 8,000–10,000 kWh range. A few outlier days exhibit sudden spikes or dips. These anomalies appear isolated, and a detailed investigation would be required to confirm their root causes and assess any operational implications.

At present, the CtrlS Data Centre is operating at roughly 20-25% of its sanctioned load, indicating substantial unutilized capacity. As the IT footprint grows and AI adoption accelerates across industries, the facility may experience more dynamic or pulsating demand patterns in the future. Such behaviour has been reported in international literature; it has not been observed in the present Data set. However, the current analysis is based on 15-minute block-wise (daily) average loading data, which smoothens out short-duration fluctuations. Once high-resolution (sub-minute or second-level) Data becomes available, the load behaviour—particularly rapid ramp-ups, transient spikes, and intra-block variations—will need to be reassessed to confirm the true characteristics of the emerging AI-driven load profile.

### 7.1.18. Daily Load Curves (Ctrls)- from March 2024 to July 2025

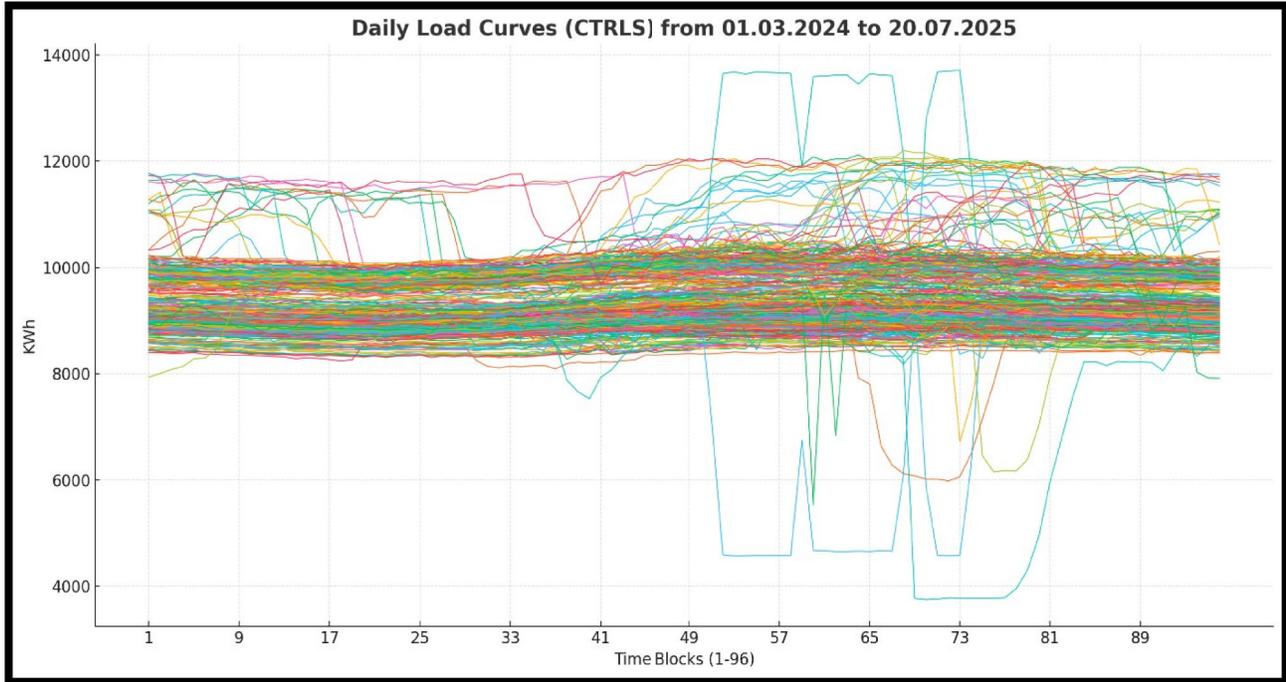


FIGURE 29: DAILY LOAD CURVES (CTRLS) FROM 01.03.2024 TO 20.07.2025

### 7.1.19. Daily Load Factor of Ctrls - from March 2024 to July 2025

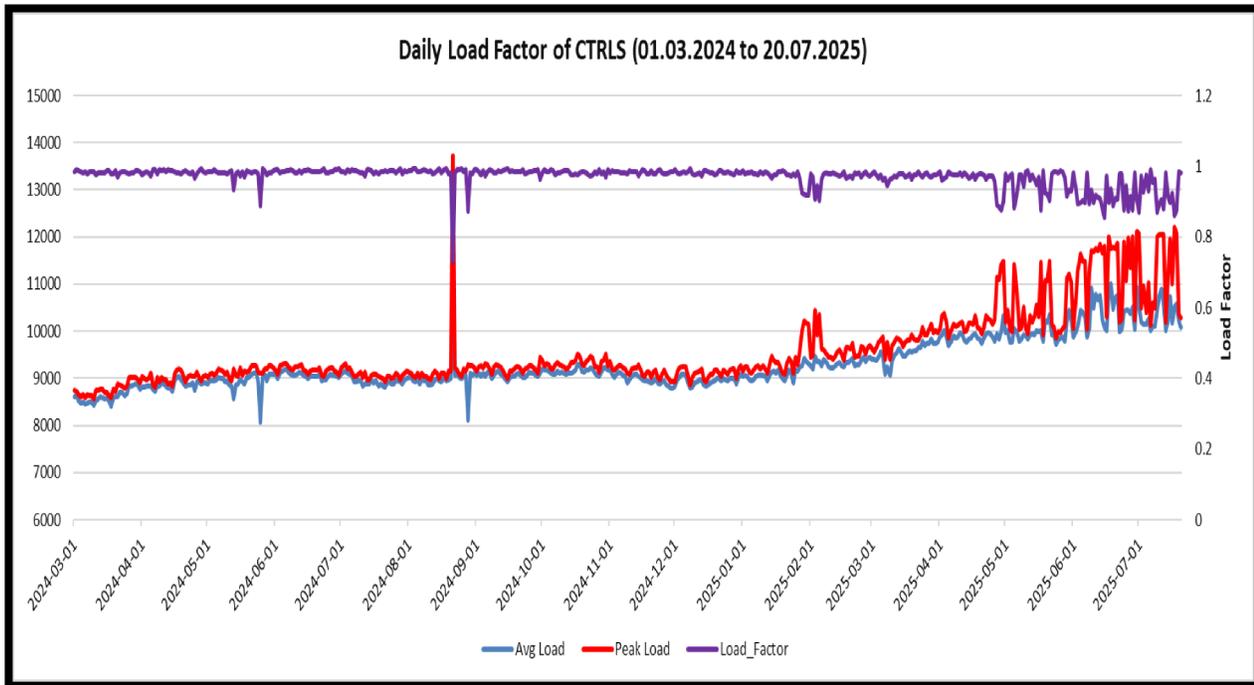


FIGURE 30: DAILY LOAD FACTOR OF CTRLS (01.03.2024 TO 20.07.2025)

Daily load factor remains close to unity, indicating that CTRLS operates near its peak load for most of the day. This reflects stable utilization, consistent IT activity, and efficient infrastructure performance.

7.1.20. Daily Load Factor duration curve of CtrlS - from March 2024 to July 2025

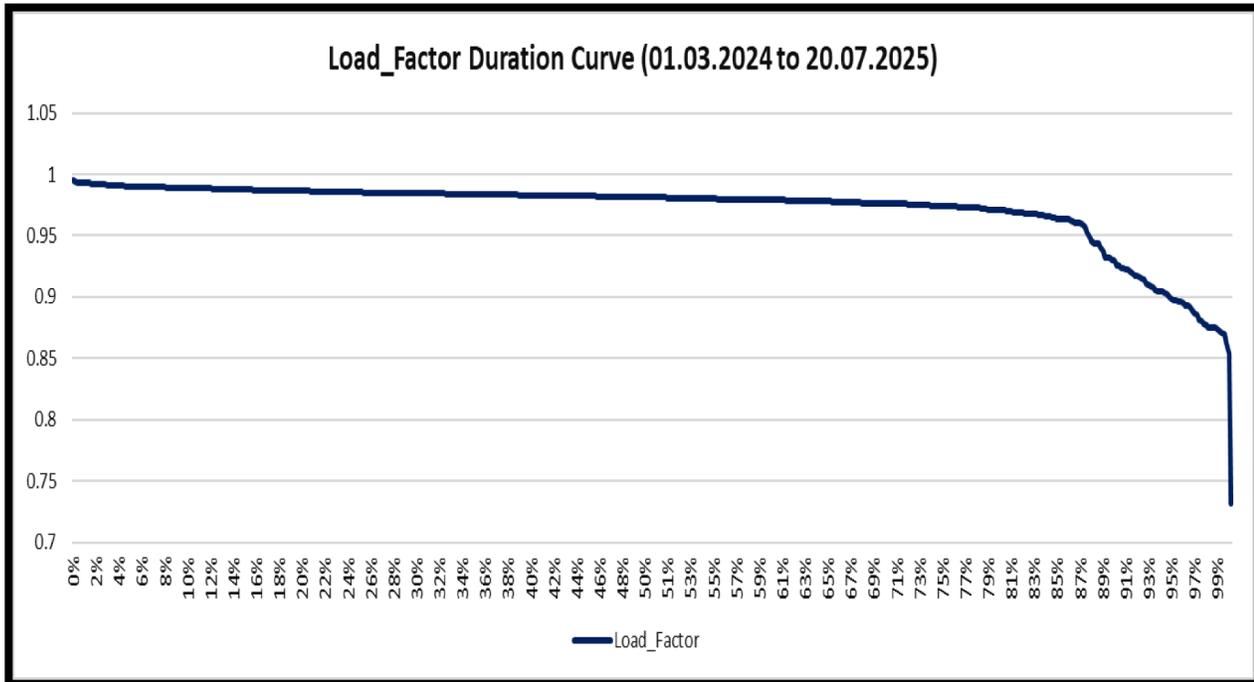


FIGURE 31: LOAD FACTOR DURATION CURVE (01.03.2024 TO 20.07.2025)

The figure indicates that **87% of the time, the CTRLS load factor remains above 0.96**, highlighting consistently high utilization and strong operational stability throughout the assessment period.

7.1.21. Block-wise consumption in kWh of CtrlS - from March 2024 to July 2025

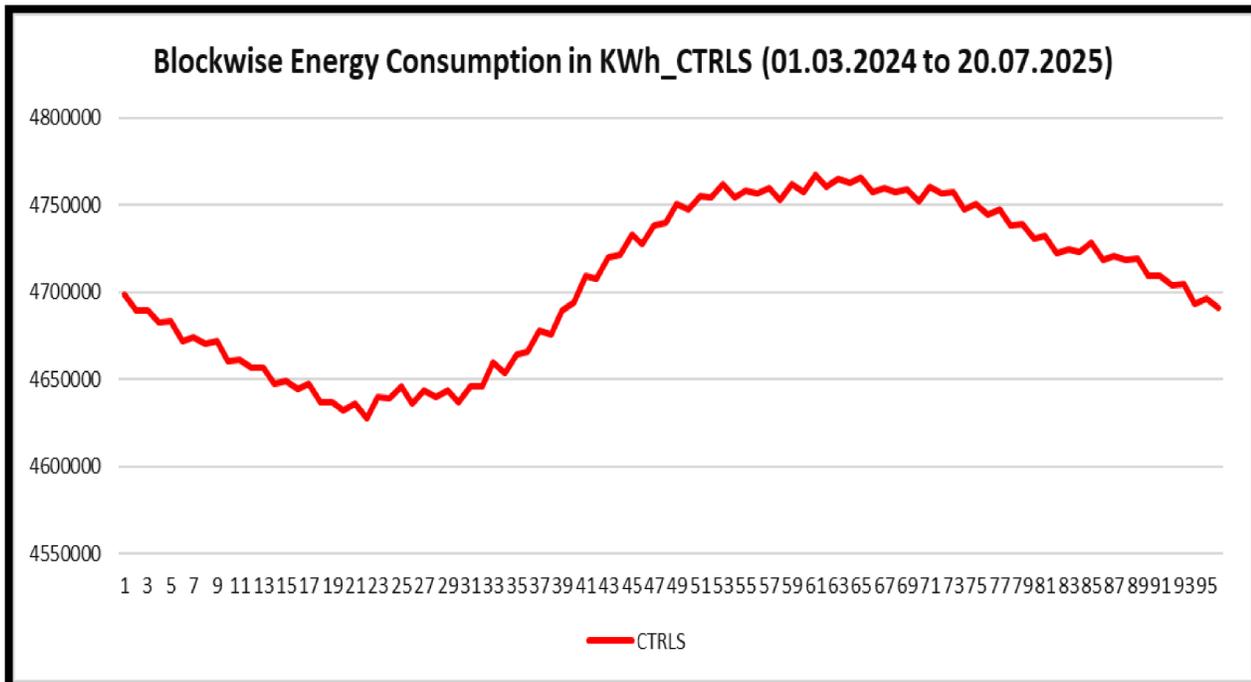


FIGURE 32: BLOCK WISE ENERGY CONSUMPTION\_CTRLs (01.03.2024 TO 20.07.2025)

The Block wise energy consumption of remaining Data Centres is attached in Annexure-1. The block-wise energy consumption profile of the CTRLS Data Centre from 01.03.2024 to 20.07.2025 shows lower usage during the early morning hours, followed by a steady rise as operational activity increases through the day. This pattern can be replicated on any average day, as the load is most likely to follow the same progression of low early-morning consumption, a steady rise through the day, a pronounced peak during the mid-day to evening period, and a gradual decline thereafter.

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## Chapter-8: Checklist of Technical Details of Data Centre

The Annexures shared by NLDC are forwarded with the Data Centre operators. The partial response was received as follows:

### 8.1. Digital Edge Data Centre

Sl. No.	Description	Submission
<b>A. Project</b>		
1	Name of the Project/ Power Station	
2	Name of the Developer	<b>Digital Edge DC India PVT LTD</b>
3	Time taken from planning to operation commencement	Approx 1 year
4	Total Project Capacity (MW)	30.75 MW (Facility load)
5	Peak Sanctioned load (MVA)	35MVA
6	Current Operational Load (MW)	0.1541MW (IT load),
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	Hyperscale
<b>B. General Details</b>		
1	Point of Interconnection (POI) with InSTs grid	100KV Kalwa - Mukand Line 1 and Line 2
2	HV/MV/LV voltage	100kv,11kv, 440V
3	Single line diagram of the power station	Attached
4	Seasonal Ambient Temperature range, Max, Min and Average (2024)	High 32.5, Low 24.9 Deg Cel
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	NA
6	Maximum Ramp during load cycling (% load/sec)	NA
7	No. of distribution transformer (MVA capacity of each)	18x2.25 MVA 11KV / 430V, 2 x 25MVA 100KV/11KV
8	No. of DG sets (MVA capacity of each) including spares	18x2.25 MVA
9	Reactive Compensation Specifications (design study report can be supplemented if available)	<b>NA</b>
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	
11	UPS battery backup capacity (if available)	800KW x 2, 150KW x 14, 100 x 1 with 5Mins battery backup
12	Details of Captive / Behind the meter captive generation	NA
<b>C. Facility Load Details</b>		
1	Composition of Data Centre Loads (Percentage of Total load)	65%
1.a	Server, Network and Storage (IT load)	17.7MW
1.b	Transformer and UPS Losses	400KW

1.c	Lighting	200KW
1.d	Chillers, Fans and Pumps	9090KW
1.e	Any other component	300KW
2	Composition of Electrical Loads (Percentage of Total load)	
2.a	Three phase motors (directly connected)	NA
2.b	Three phase motors with VFD	NA
2.c	Power electronic load	NA
2.d	Single phase induction motor	NA
2.e	Battery storage (if any)	NA
C. Facility Performance Metrics		
1	PUE = Total Facility Energy / IT Equipment Energy	1.6
2	REF = Renewable Energy Used / Total Energy Consumed	NA
3	Load factor (measured on peak sanctioned load)	Current LF is 37%. Loading is in progress. It will reach to 85% in next 6Months
4	Load power factor range (measured at POI)	0.9
D. Protection Related Details		
1	Details of Protection philosophy implemented within facility	GIS with CRP. Feeder and Transformer protection.
2	Operating voltage range & frequency range of IT load & other motor loads	400 - 415 at 50 Hz
3	Disconnection time delay from grid when voltage goes beyond operating range	0.2 Sec
4	Time for which IT Load is operated on UPS battery before shifting to DG set	30 to 45 Secs
5	Disconnection ramp rate of load after fault detection (% of load/sec)	Immediate
6	Reconnection time delay when voltage comes back within operating range	Reconnection is done manually after checking the system is stable for 30Mins and confirmation from MSETCL
7	Reconnection ramp rate of load (% of load/sec)	3000KW/sec
G. Capability of Grid Support Services		
1	Reactive Power Capability	
2	Voltage Control Demand Response (If yes, specify control characteristics)	
3	Frequency Control Demand Response (If yes, specify control characteristics)	
4	Minimum SCR for stable operation	
5	Voltage/Frequency Ride through capability details	
6	Disturbance recorder facility, if any for protection (e.g. PMU etc.)	

TABLE 6 CHECKLIST OF TECHNICAL DETAILS OF DIGITAL EDGE DATA CENTRE

## 8.2. NTT DC-13 Data Centre

Sl. No.	Description	Submission
<b>A. Project</b>		
1	Name of the Project/ Power Station	<b>NTT NAV2 DC13 Neon GIS</b>
2	Name of the Developer	Siemens
3	Time taken from planning to operation commencement	---
4	Total Project Capacity (MW)	75
5	Peak Sanctioned load (MVA)	17.968
6	Current Operational Load (MW)	7
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	Hyperscale
<b>B. General Details</b>		
1	Point of Interconnection (POI) with InSTS grid	NTT Estela Line (220kV Bapgaon Source) & Datascape Line (220kV Kalwa Source)
2	HV/MV/LV voltage	220kV
3	Single line diagram of the power station	---
4	Seasonal Ambient Temperature range, Max, Min and Average (2024)	Max: 33.9°C, Min: 17.7°C, Avg: 26.6°C.
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	Daily
6	Maximum Ramp during load cycling (% load/sec)	Not applicable
7	No. of distribution transformer (MVA capacity of each)	200kVA-1 No.
8	No. of DG sets (MVA capacity of each) including spares	250kVA DG Set-1 No.
9	Reactive Compensation Specifications (design study report can be supplemented if available)	<b>No</b>
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	Not available
11	UPS battery backup capacity (if available)	---
12	Details of Captive / Behind the meter captive generation	No
<b>C. Facility Load Details</b>		
1	Composition of Data Centre Loads (Percentage of Total load)	
1.a	Server, Network and Storage (IT load)	70%
1.b	Transformer and UPS Losses	8%
1.c	Lighting	Included in Other Component
1.d	Chillers, Fans and Pumps	14%
1.e	Any other component	8%

2	Composition of Electrical Loads (Percentage of Total load )	
2.a	Three phase motors (directly connected)	NA
2.b	Three phase motors with VFD	---
2.c	Power electronic load	---
2.d	Single phase induction motor	---
2.e	Battery storage (if any)	---
C. Facility Performance Metrics		
1	PUE = Total Facility Energy / IT Equipment Energy	1.42
2	REF = Renewable Energy Used / Total Energy Consumed	Not applicable
3	Load factor (measured on peak sanctioned load)	0.86
4	Load power factor range (measured at POI)	0.98
D. Protection Related Details		
1	Details of Protection philosophy implemented within facility	Earth Fault, SPD, Breakers & Relays
2	Operating voltage range & frequency range of IT load & other motor loads	415V to 430V, 50+/- 1
3	Disconnection time delay from grid when voltage goes beyond operating range	---
4	Time for which IT Load is operated on UPS battery before shifting to DG set	UPS Less design however load shifts in 18 Secs from EB to DG
5	Disconnection ramp rate of load after fault detection (% of load/sec)	---
6	Reconnection time delay when voltage comes back within operating range	30 Mins
7	Reconnection ramp rate of load (% of load/sec)	---
G. Capability of Grid Support Services		
1	Reactive Power Capability	<b>Not applicable</b>
2	Voltage Control Demand Response (If yes, specify control characteristics)	<b>Not applicable</b>
3	Frequency Control Demand Response (If yes, specify control characteristics)	<b>Not applicable</b>
4	Minimum SCR for stable operation	---
5	Voltage/Frequency Ride through capability details	<b>Not applicable</b>
6	Disturbance recorder facility, if any for protection (e.g. PMU etc.)	Yes (IED)

TABLE 7 CHECKLIST OF TECHNICAL DETAILS OF NTT DC-13 DATA CENTRE

### 8.3. SIFY Data Centre

Sl. No.	Description		
A. Project		<b>T4</b>	<b>T5</b>
1	Name of the Project/ Power Station	<b>220/22kv GIS SIFY Rabale</b>	<b>220/22kv GIS SIFY Rabale</b>
2	Name of the Developer	SIEMENS	SIEMENS
3	Time taken from planning to operation commencement	24 months	24 months
4	Total Project Capacity (MW)	82 MVA	82 MVA
5	Peak Sanctioned load (MVA)	30MVA	30MVA
6	Current Operational Load (MW)	15MW	15MW
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	Banking, Hyperscale, AI, Cloud Computing	Banking, Hyperscale, AI, Cloud Computing
<b>B. General Details</b>			
1	Point of Interconnection (POI) with InSTs grid	LILO (KALWA-GTPL)	LILO (KALWA-GTPL)
2	HV/MV/LV voltage	220kV /22kV/415V GIS	220kV /22kV/415 V GIS
3	Single line diagram of the power station	Available	Available
4	Seasonal Ambient Temperature range, Max, Min and Average (2024)	low of ~17.5 °C in winter to a high of ~34.4 °C in summer, with moderate and stable temperatures during the monsoon and post-monsoon periods.	low of ~17.5 °C in winter to a high of ~34.4 °C in summer, with moderate and stable temperatures during the monsoon and post-monsoon periods.
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	---	---
6	Maximum Ramp during load cycling (% load/sec)	---	---
7	No. of distribution transformer (MVA capacity of each)	2Nos. Of 90MVA Power Transformer(220/22KV) & 7nos of 3150 KVA distribution transformer(22KV/415V)	2 Nos. Of 90MVA 220 kV/22 kV Transformer & 35Nos of 2.75 MVA 22kV/ 400V distribution Transformer

8	No. of DG sets (MVA capacity of each) including spares	7 Nos of 3.5 MVA DGs	35 Nos of 3 MVA DGs
9	Reactive Compensation Specifications (design study report can be supplemented if available)	---	---
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	---	---
11	UPS battery backup capacity (if available)	10 min back up for Full load on UPS	10 min back up for Full load on UPS
12	Details of Captive / Behind the meter captive generation	NA	---
<b>C. Facility Load Details</b>			
1	Composition of Data Centre Loads (Percentage of Total load)	---	---
1.a	Server, Network and Storage (IT load)	19.37%	61.43%
1.b	Transformer and UPS Losses	1%	0.35%
1.c	Lighting	NA	0.39%
1.d	Chillers, Fans and Pumps	NA	35.51%
1.e	Any other component (CRAC)	20.94%	1.68%
2	Composition of Electrical Loads (Percentage of Total load)	---	---
2.a	Three phase motors (directly connected)	NA	NA
2.b	Three phase motors with VFD	NA	0.69%
2.c	Power electronic load	NA	NA
2.d	Single phase induction motor	NA	NA
2.e	Battery storage (if any)	NO	NA
<b>C. Facility Performance Metrics</b>			
1	PUE = Total Facility Energy / IT Equipment Energy	1.65	1.63
2	REF = Renewable Energy Used / Total Energy Consumed	---	0.22
3	Load factor (measured on peak sanctioned load)	95%	94%
4	Load power factor range (measured at POI)	0.99	0.999
<b>D. Protection Related Details</b>			
1	Details of Protection philosophy implemented within facility	SCCS attached	SCCS attached
2	Operating voltage range & frequency range of IT load & other motor loads	440 V 50 Hz	440 V, 50 Hz
3	Disconnection time delay from grid when voltage goes beyond operating range	3 sec	3 Sec
4	Time for which IT Load is operated on UPS battery before shifting to DG set	1 sec	1 sec to 15 sec (different for different line-up)

5	Disconnection ramp rate of load after fault detection (% of load/sec)	---	---
6	Reconnection time delay when voltage comes back within operating range	240 sec	min.240 sec - max. 30 min (different for different line-up)
7	Reconnection ramp rate of load (% of load/sec)	---	---
<b>G. Capability of Grid Support Services</b>			
1	Reactive Power Capability	---	---
2	Voltage Control Demand Response (If yes, specify control characteristics)	NA	NA
3	Frequency Control Demand Response (If yes, specify control characteristics)	NA	NA
4	Minimum SCR for stable operation	---	---
5	Voltage/Frequency Ride through capability details	---	---
6	Disturbance recorder facility, if any for protection (e.g. PMU etc.)	---	PM 8000

**TABLE 8 CHECKLIST OF TECHNICAL DETAILS OF SIFY DATA CENTRE**

#### 8.4. STT Global, Navi Mumbai Data Centre

Sl. No.	Description	Submission
<b>A. Project</b>		
1	Name of the Project/ Power Station	<b>STT Global Data Centres India Pvt. Ltd.</b>
2	Name of the Developer	L&T
3	Time taken from planning to operation commencement	---
4	Total Project Capacity (MW)	100
5	Peak Sanctioned load (MVA)	40
6	Current Operational Load (MW)	3.79
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	Hyperscale
<b>B. General Details</b>		
1	Point of Interconnection (POI) with InSTs grid	LILO
2	HV/MV/LV voltage	220kV/11kV/415V
3	Single line diagram of the power station	Available
4	Seasonal Ambient Temperature range, Max, Min and Average (2025 )	low of ~17.5 °C in winter to a high of ~34.4 °C in summer, with moderate and stable temperatures during the monsoon and post-monsoon periods.
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	---
6	Maximum Ramp during load cycling ( % load/sec)	---
7	No. of distribution transformer (MVA capacity of each)	2nos. Of 75 MVA Power Transformers & 25 nos. of 2500 KVA Distribution TF
8	No. of DG sets (MVA capacity of each) including spares	17 nos. of 2750 KVA & 8 nos. of 2500 KVA
9	Reactive Compensation Specifications (design study report can be supplemented if available)	NA
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	NA
11	UPS battery backup capacity (if available)	10 min back up for Full load on UPS
12	Details of Captive / Behind the meter captive generation	
<b>C. Facility Load Details</b>		
1	Composition of Data Centre Loads (Percentage of Total load )	
1.a	Server, Network and Storage (IT load)	43%
1.b	Transformer and UPS Losses	0.968%
1.c	Lighting	2.64%

1.d	Chillers, Fans and Pumps	19.50%
1.e	Any other component (PAHU, FWU)	33.88%
2	Composition of Electrical Loads (Percentage of Total load )	
2.a	Three phase motors (directly connected)	NA
2.b	Three phase motors with VFD	NA
2.c	Power electronic load	NA
2.d	Single phase induction motor	NA
2.e	Battery storage (if any)	NO
C. Facility Performance Metrics		
1	PUE = Total Facility Energy / IT Equipment Energy	2.3
2	REF=Renewable Energy Used / Total Energy Consumed	NA
3	Load factor (measured on peak sanctioned load)	77%
4	Load power factor range (measured at POI)	0.99
D. Protection Related Details		
1	Details of Protection philosophy implemented within facility	SCCS already implemented
2	Operating voltage range & frequency range of IT load & other motor loads	440V & 50Hz
3	Disconnection time delay from grid when voltage goes beyond operating range	3 sec
4	Time for which IT Load is operated on UPS battery before shifting to DG set	20 sec
5	Disconnection ramp rate of load after fault detection (% of load/sec)	---
6	Reconnection time delay when voltage comes back within operating range	600 sec
7	Reconnection ramp rate of load (% of load/sec)	---
G. Capability of Grid Support Services		
1	Reactive Power Capability	---
2	Voltage Control Demand Response (If yes, specify control characteristics)	NA
3	Frequency Control Demand Response (If yes, specify control characteristics)	NA
4	Minimum SCR for stable operation	---
5	Voltage/Frequency Ride through capability details	---
6	Disturbance recorder facility, if any for protection ( e.g. PMU etc.)	---

TABLE 9 CHECKLIST OF TECHNICAL DETAILS OF STT GLOBAL, NAVI MUMBAI DATA CENTRE

## 8.5. STT Global, Pune Data Centre

Sl. No.	Description	Submission
<b>A. Project</b>		
1	Name of the Project/ Power Station	220KV /11 kV GIS Substation Pune
2	Name of the Developer	STT Global Data Centres India Private Limited
3	Time taken from planning to operation commencement	2 years
4	Total Project Capacity (MW)	200 MV
5	Peak Sanctioned load (MVA)	140
6	Current Operational Load (MW)	45
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	Banking, Hyperscale, Cloud Computing
<b>B. General Details</b>		
1	Point of Interconnection (POI) with InSTs grid	220 KV VSNL Substation
2	HV/MV/LV voltage	220KV/11KV/440V
3	Single line diagram of the power station	Yes
4	Seasonal Ambient Temperature range, Max, Min and Average (2024)	37°C /20°C /30°C
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	hourly
6	Maximum Ramp during load cycling (% load/sec)	---
7	No. of distribution transformer (MVA capacity of each)	3.75 MVA - 6 2.5 MVA - 4 750 KVA -1 3.5 MVA -20 3.5 MVA -20 1.5 MVA -4 3.1 MVA -18 2.5 MVA -10 120 MVA -2 60 MVA -1 50 MVA -1
8	No. of DG sets (MVA capacity of each) including spares	2.25 MVA, qty -72
9	Reactive Compensation Specifications (design study report can be supplemented if available)	<b>NA</b>
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	NA
11	UPS battery backup capacity (if available)	8 min
12	Details of Captive / Behind the meter captive generation	Open access
<b>C. Facility Load Details</b>		

1	Composition of Data Centre Loads (Percentage of Total load)	---
1.a	Server, Network and Storage (IT load)	27 MW
1.b	Transformer and UPS Losses	0.213 MW
1.c	Lighting	0.5 MW
1.d	Chillers, Fans and Pumps	10.8 MW
1.e	Any other component	2.487 MW
2	Composition of Electrical Loads (% of Tot load)	---
2.a	Three phase motors (directly connected)	NA
2.b	Three phase motors with VFD	NA
2.c	Power electronic load	NA
2.d	Single phase induction motor	NA
2.e	Battery storage (if any)	NA
C. Facility Performance Metrics		
1	PUE = Total Facility Energy / IT Equipment Energy	1.519
2	REF = Renewable Energy Used / Total Energy Consumed	0.301
3	Load factor (measured on peak sanctioned load)	NA
4	Load power factor range (measured at POI)	0.999
D. Protection Related Details		
1	Details of Protection philosophy implemented within facility	Busbar Protection, Transformer Protection, Backup Protection
2	Operating voltage range & frequency range of IT load & other motor loads	401 V AC, 50 Hz
3	Disconnection time delay from grid when voltage goes beyond operating range	-
4	Time for which IT Load is operated on UPS battery before shifting to DG set	24 hrs.
5	Disconnection ramp rate of load after fault detection (% of load/sec)	-
6	Reconnection time delay when voltage comes back within operating range	-
7	Reconnection ramp rate of load (% of load/sec)	-
G. Capability of Grid Support Services		
1	Reactive Power Capability	-
2	Voltage Control Demand Response (If yes, specify control characteristics)	-
3	Frequency Control Demand Response (If yes, specify control characteristics)	-
4	Minimum SCR for stable operation	-
5	Voltage/Frequency Ride through capability details	-
6	Disturbance recorder facility, if any for protection (e.g. PMU etc.)	DR- MiCOM Agile V1

TABLE 10 CHECKLIST OF TECHNICAL DETAILS OF STT GLOBAL, PUNE DATA CENTRE

## 8.6. New found Data Centre

Sl. No.	Description	Submission
<b>A. Project</b>		
1	Name of the Project/ Power Station	<b>ADSIPL Data Centre, (New found) Plot No. 2/1/F in MIDC, TTC Industrial Area, Bonsari, Kukshet &amp; Shirvane, Navi Mumbai, Tal. &amp; Dist. Thane</b>
2	Name of the Developer	ADSIPL
3	Time taken from planning to operation commencement	4.5 years
4	Total Project Capacity (MW)	150 MW
5	Peak Sanctioned load (MVA)	23 MVA
6	Current Operational Load (MW)	To be provided later
7	Catering to Load Type: Banking, Hyperscale, AI, Cloud Computing	To be provided later
<b>B. General Details</b>		
1	Point of Interconnection (POI) with InSTS grid	NPLPL Juinagar 220kV Substation / LILO at Loc. No. 20 220 kV Kharghar - Sonkhar
2	HV/MV/LV voltage	220/33kV
3	Single line diagram of the power station	Attached
4	Seasonal Ambient Temperature range, Max, Min and Average (2024)	34.2 C (max), 17.1 C (min), 26.9 C (avg.)
5	Description of load cycling (random, price-sensitive, hourly, daily, seasonal, etc.)	To be provided later
6	Maximum Ramp during load cycling (% load/sec)	To be provided later
7	No. of distribution transformer (MVA capacity of each)	2x 150MVA, 220/33kV ONAN/ONAF Transformer
8	No. of DG sets (MVA capacity of each) including spares	To be provided later
9	Reactive Compensation Specifications (design study report can be supplemented if available)	To be provided later
10	Automatic Harmonic Filters Specifications (design study report can be supplemented if available)	To be provided later
11	UPS battery backup capacity (if available)	To be provided later
12	Details of Captive / Behind the meter captive generation	To be provided later
<b>C. Facility Load Details</b>		
1	Composition of Data Centre Loads ( Percentage of Total load)	
1.a	Server, Network and Storage (IT load)	To be provided later
1.b	Transformer and UPS Losses	To be provided later
1.c	Lighting	To be provided later
1.d	Chillers, Fans and Pumps	To be provided later
1.e	Any other component	To be provided later
2	Composition of Electrical Loads (Percentage of Total load)	

2.a	Three phase motors (directly connected)	To be provided later
2.b	Three phase motors with VFD	To be provided later
2.c	Power electronic load	To be provided later
2.d	Single phase induction motor	To be provided later
2.e	Battery storage (if any)	To be provided later
C. Facility Performance Metrics		
1	$PUE = \text{Total Facility Energy} / \text{IT Equipment Energy}$	To be provided later
2	$REF = \text{Renewable Energy Used} / \text{Total Energy Consumed}$	To be provided later
3	Load factor (measured on peak sanctioned load)	To be provided later
4	Load power factor range (measured at POI)	To be provided later
D. Protection Related Details		
1	Details of Protection philosophy implemented within facility	To be provided later
2	Operating voltage range & frequency range of IT load & other motor loads	To be provided later
3	Disconnection time delay from grid when voltage goes beyond operating range	To be provided later
4	Time for which IT Load is operated on UPS battery before shifting to DG set	To be provided later
5	Disconnection ramp rate of load after fault detection (% of load/sec)	To be provided later
6	Reconnection time delay when voltage comes back within operating range	To be provided later
7	Reconnection ramp rate of load (% of load/sec)	To be provided later
G. Capability of Grid Support Services		
1	Reactive Power Capability	To be provided later
2	Voltage Control Demand Response (If yes, specify control characteristics)	To be provided later
3	Frequency Control Demand Response (If yes, specify control characteristics)	To be provided later
4	Minimum SCR for stable operation	To be provided later
5	Voltage/Frequency Ride through capability details	To be provided later
6	Disturbance recorder facility, if any for protection (e.g. PMU etc.)	To be provided later

TABLE 11 CHECKLIST OF TECHNICAL DETAILS OF DIGITAL EDGE DATA CENTRE

The above information has been compiled based on the received Data from Data Centres. The technical parameters reflect the present configuration and operating status of the respective Data Centre facilities.

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## Chapter-9: Data Availability Gaps and Monitoring Limitations for Data Centres

Accurate assessment of Data Centre load characteristics and their interaction with grid operations is fundamentally dependent on the availability of high-quality, granular, and reliable data. A review of the Data presently available with SLDC indicates that, while basic demand accounting is feasible, there are significant limitations in the depth, resolution, and scope of information required for advanced operational analysis and planning.

### 9.1 Temporal Resolution of Load Data

At present, SLDC has access primarily to 15-minute block-wise energy meter Data for Data Centres. While this level of granularity is adequate for energy accounting, demand tracking, and basic load profiling, it is insufficient for analyzing fast load variations, short-duration ramping behaviour, or transient responses during grid disturbances.

International experience indicates that assessment of large digitally controlled loads requires higher-resolution Data (typically 10-second or faster) over extended periods to reliably characterize dynamic behaviour. The absence of such Data in the Maharashtra system limits the ability to undertake dynamic studies, AGC impact assessment, and contingency analysis related to large Data Centre loads.

### 9.2 Power Quality and Harmonic Data Limitations

Comprehensive evaluation of the impact of Data Centre loads on grid power quality requires access to voltage and current harmonic measurements at the point of interconnection. At present, P–Q meters are not installed at most Data Centre POIs. Even in cases where such meters exist, historical harmonic Data is generally not archived or retrievable in a structured manner.

As a result, assessment of long-term harmonic trends, correlation with loading levels, and cumulative impact on the EHV network cannot be carried out. The available harmonic observations are limited to isolated snapshots and do not support system-level power quality evaluation.

### 9.3 Limited Visibility Beyond the Point of Interconnection

SLDC's operational visibility of Data Centres is presently restricted to the point of interconnection at the transmission level. Internal Data related to EHV power transformers, MV distribution, and load segmentation within the Data Centre campus is not available.

While such internal details are not required for routine system operation, their absence constrains analytical studies related to internal load composition, transformer loading patterns, and the response of different subsystems (IT load, cooling load, auxiliary load) during grid events.

## 9.4 Absence of Event-Based Load Reporting Mechanisms

There is currently no defined mechanism for real-time or post-event reporting of significant load changes, bulk load tripping, or automatic transfer to backup supply at Data Centres. Consequently, SLDC does not receive structured information on the timing, magnitude, or duration of such events.

This limits post-event analysis, disturbance investigation, and correlation of system events with load behaviour, particularly in cases involving large, concentrated demand. This doesn't presently affect the system operation much, however if volumes of such loads increase, it will be necessary.

## 9.5 Lack of Load Segregation Information

Detailed segregation of Data Centre load into IT load, cooling load, and auxiliary components is not presently available with SLDC. This restricts the ability to assess demand composition, identify potentially flexible components, or understand how different subsystems respond to external grid conditions.

Such information is increasingly used by system operators internationally for analytical studies, even where no operational control is envisaged.

## 9.6 Absence of High-Resolution Dynamic Measurement Infrastructure

High-resolution dynamic measurements, such as those provided by Phasor Measurement Units (PMUs), are not available at Data Centre POIs. PMU Data is valuable for studying fast load behaviour, voltage sensitivity, and response during grid disturbances under both steady-state and transient conditions.

Without such measurements, any assessment of rapid load dynamics remains speculative and outside the scope of the present study.

## 9.7 Limited Availability of Efficiency and Performance Metrics

Year-wise Data on Power Usage Effectiveness (PUE) and related efficiency metrics is not uniformly available. While such parameters are not directly linked to real-time system operation, their analysis provides insight into trends in internal power utilization and the evolving nature of Data Centre demand.

The identified Data gaps highlight that the present understanding of Data Centre load behaviour in Maharashtra is constrained by limitations in Data resolution, visibility, and event reporting. While existing Data is sufficient to describe current operating conditions at a high level, it does not support detailed dynamic analysis or forward-looking system studies.

Addressing these gaps through phased enhancement of monitoring, Data archiving, and information exchange will be essential for enabling informed operational planning, robust analytical studies, and evidence-based policy development as Data Centre penetration in the Maharashtra grid continues to increase.

# Chapter 10: System Interaction of Data Centres with Grid Operations

This section examines the interaction of large Data Centre loads with grid operations in Maharashtra, based on current observed conditions, design characteristics of Data Centres, and international experience. The discussion is intended to identify areas requiring further study and preparedness, and does not imply the existence of operational grid-support services from Data Centres at present.

## 10.1 Concentration of Data Centre Load and Network Planning Considerations

Data Centre development in Maharashtra is presently concentrated in the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR). These areas already host dense urban and industrial demand and are served by heavily utilized Extra High Voltage (EHV) 220 kV and 400 kV transmission corridors. The addition of large, continuous Data Centre loads in such pockets necessitates careful and forward-looking transmission planning to maintain system reliability and operational margins.

The observations in this report are limited to the current level of load realization, which remains significantly lower than the planned capacities. Accordingly, while no adverse operational impacts have been observed at present, the projected scale of future additions underscores the importance of proactive grid planning.

## 10.2 Behaviour of Bulk Data Centre Loads During Grid Disturbances

Large Data Centres are typically connected as single bulk loads at EHV voltage levels. In the event of grid disturbances or any grid event resulting in voltage dips or outages, Data Centres are designed to protect internal equipment through automatic transfer of load to UPS systems and on-site diesel generators.

This behaviour is primarily intended for internal reliability and continuity of IT services. From a system perspective, such load transfer results in a temporary reduction in grid demand during stressed conditions. However, this response is incidental and uncoordinated, and there is presently no mechanism by which SLDC can anticipate, signal, or rely upon such behaviour for operational planning. Accordingly, this should not be interpreted as an assured or Despatchable grid-support function.

While such events have not been systematically observed across Data Centres in Maharashtra, international system operators have highlighted the need to understand and account for bulk load disconnection and reconnection behaviour as part of contingency analysis and reserve management studies. In the Maharashtra context, such understanding is presently limited by the availability of only 15-minute resolution data.

### 10.3 Load Variability and Advanced Computing Workloads

International studies have reported that certain advanced computing applications, including AI and high-performance computing workloads, may exhibit faster and less predictable changes in power consumption compared to traditional IT loads. Such behaviour has implications for short-term demand estimation and system balancing.

Based on the Data presently available with SLDC, including detailed observations from the CTRLS facility, Data Centre loads in Maharashtra exhibit largely stable and continuous demand profiles when observed at 15-minute resolution. No fast ramping or correlated load behaviour across multiple sites has been observed in the Maharashtra system to date. Assessment of such characteristics would require higher-resolution telemetry and dedicated analytical studies.

### 10.4 Reactive Power and Voltage Control Characteristics

Most Data Centres presently operate with near-unity power factor at the point of interconnection, primarily due to internal power conditioning equipment such as UPS systems, APFC panels, and modern power electronic interfaces. Reactive power control and voltage regulation are largely managed internally through transformer-level AVR and RTCC schemes.

As a result, Data Centres do not presently function as active providers of reactive power or voltage control to the grid. Their interaction with grid voltage conditions is primarily passive and designed to protect internal equipment rather than to support external system regulation.

### 10.5 Demand Response – Contextual Considerations

Data Centres are equipped with advanced automation, monitoring, and redundant power supply systems that distinguish them from conventional industrial consumers. International experience indicates that these characteristics have prompted system operators in certain jurisdictions to examine the potential role of Data Centres in demand response or system support frameworks.

In the Maharashtra context, no demand response participation by Data Centres currently exists, and no such capability has been assessed or validated. Any consideration of demand response would need to be approached cautiously and should be understood strictly as a subject for future study rather than an operational expectation. It also needs to be noted that no demand response framework presently exists in Maharashtra. However, the evolving nature of these bulk loads in less geographic area creates opportunities for consideration of these loads in demand response. This needs to be considered while framing a demand response framework for the state.

International practice suggests that exploration of demand response from large Data Centres has typically been undertaken through voluntary, pilot-based frameworks, with clearly defined safeguards to ensure that critical IT services, cybersecurity, and equipment integrity are not compromised. Such pilots are preceded by extensive Data collection, offline analysis, and regulatory clarity.

## 10.6 Need for Structured Evaluation and Avoidance of Operational Assumptions

It is emphasized that the aspects discussed in this section represent system interaction considerations, not established operational capabilities. Premature assumptions regarding grid support or controllability of Data Centre loads can lead to unrealistic expectations and operational risk.

Accordingly, any future exploration of Data Centre participation in grid support mechanisms in Maharashtra should proceed only after:

- Enhanced Data visibility and monitoring,
- Detailed analytical studies based on high-resolution data, and
- Clear regulatory and policy guidance defining scope, roles, and limitations.

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# Chapter-11: Concluding Remark and Way Forward

## 11.1 Concluding Observations

This report presents a structured, baseline assessment of Data Centre loads in Maharashtra, with particular focus on the Mumbai Metropolitan Region (MMR) and Pune Metropolitan Region (PMR), where Data Centre development is presently concentrated. The analysis is based on sanctioned connectivity data, realized loading, 15-minute block-wise energy records, and limited site-specific observations available with SLDC at the time of the study.

The assessment establishes that, under current operating conditions, Data Centres in Maharashtra function as large, continuous, and predominantly stable electricity consumers from a grid operation perspective. The realized loading of operational Data Centres remains significantly lower than the sanctioned and planned capacities, reflecting the phased nature of IT infrastructure deployment rather than constraints in grid connectivity or electrical infrastructure.

Observed voltage, frequency, and power factor performance at Data Centre points of interconnection have remained within permissible limits under normal system conditions. In isolated disturbance events, Data Centres have demonstrated internal protection-driven responses—such as automatic transfer to backup supply—designed primarily to ensure service continuity. These responses are incidental to grid operation and should not be interpreted as deliberate or assured system support.

The study further highlights that the present visibility of Data Centre operations at SLDC is limited in both temporal resolution and depth of observability. While existing Data is adequate for high-level demand accounting and descriptive analysis, it does not support characterization of fast load dynamics, assessment of short-term ramping behaviour, or evaluation of interactions with real-time grid control functions. Consequently, this report does not draw conclusions regarding dynamic system impacts, frequency control interaction, or demand response capability of Data Centres in Maharashtra.

Accordingly, the findings of this report should be viewed as a **baseline description of the current state**, rather than as a definitive characterization of future Data Centre behaviour. As Data Centre loading increases and technologies evolve, the nature of interaction between such large digital loads and the power system may change, warranting periodic reassessment supported by improved Data availability.

## 11.2 Way Forward:

The findings of this study indicate that Data Centres are emerging as a significant category of large, continuous electricity demand in Maharashtra, while also highlighting current limitations in Data visibility and analytical capability. As Data Centre penetration increases over time, a structured and phased approach will be required to strengthen operational preparedness, analytical understanding, and planning frameworks, without imposing premature operational expectations.

In this context, the following way forward is suggested:

**1. Phased Enhancement of Data Visibility**

Priority to be given for improving the depth and resolution of Data available at SLDC for large Data Centre loads. This may include enhanced SCADA integration, higher-resolution telemetry at selected points of interconnection, and systematic archival of power quality and disturbance records. Initial efforts should focus on improving observability.

**2. Development of a Standard Data-Sharing and Event Reporting Framework**

A standardised technical information and data-sharing framework may be evolved in coordination with STU, SLDC, and Data Centre operators. Such a framework could cover operational load data, power quality parameters, and structured reporting of significant events such as bulk load tripping, rapid load changes, or automatic transfer to backup supply. This information would support post-event analysis and improve understanding of system response without creating operational obligations.

**3. Analytical Assessment of Load Variability and Control Interactions**

Once high-resolution Data becomes available, detailed analytical studies may be undertaken to examine load variability, ramping characteristics, and the potential interaction of large Data Centre loads with system control functions. In particular, studies may evaluate the implications of sudden load changes on Area Control Error (ACE), Automatic Generation Control (AGC) performance, and short-term balancing requirements. Such assessments should be conducted offline and used to inform system preparedness rather than immediate operational action.

**4. Demand Response – System Operation Perspective**

At present, there is no regulatory or market-based demand response mechanism in force in Maharashtra, and Data Centres do not participate in any form of demand-side response under SLDC control. Accordingly, Data Centre loads are presently treated as passive demand from a system operation standpoint.

As Data Centre penetration increases, it may become necessary for system operators to analytically examine whether large, concentrated, and digitally managed loads introduce any implications or can play role for operational balancing, contingency management, or reserve deployment. Any future consideration of demand response concepts should therefore originate from system operation requirements, considering the possible consumer-side flexibility.

Introduction of any operational or incentive-based mechanism would require a clearly defined regulatory framework, explicit policy direction, and comprehensive safeguards.

**5. Integration into Long-Term Transmission and Operational Planning**

Projections of Data Centre load growth should be systematically incorporated into long-term transmission planning studies as well as medium-term operational planning. This includes assessment of transmission corridor loading, voltage stability margins, reserve requirements, and balancing needs as load realisation increases in concentrated regions.

## **6. Regulatory and Policy Preparedness**

As part of future regulatory evolution, consideration may be given to provisions related to large demand facilities in grid codes. These may include enhanced visibility requirements, structured event reporting, and non-binding declarations of grid-relevant characteristics. Any such measures should aim to support informed planning and operational preparedness.

### 11.3 Closing Note:

This report has been prepared as a baseline technical study to document the current status of Data Centre loads and their interaction with the Maharashtra power system, based on the information presently available with SLDC. The observations and analyses herein are intended to support improved understanding, informed planning, and future analytical work as Data Centre penetration increases. As system conditions, Data availability, and regulatory frameworks evolve, the subject will require periodic review and refinement to ensure continued grid reliability and operational preparedness.

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# Annexure

## 1. Daily Load Curves (01.03.2024 to 20.07.2025) – BDC

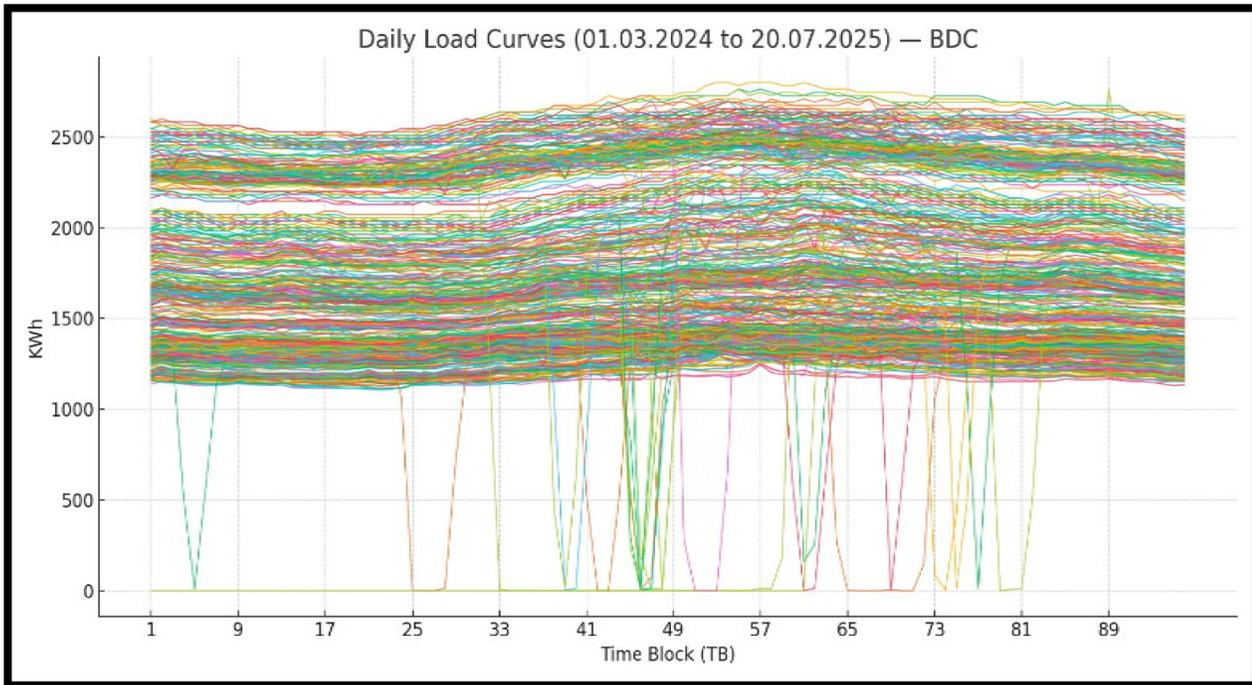


FIGURE 33 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – BDC

## 2. Daily Load Curves (01.03.2024 to 20.07.2025) – DATASCAPE

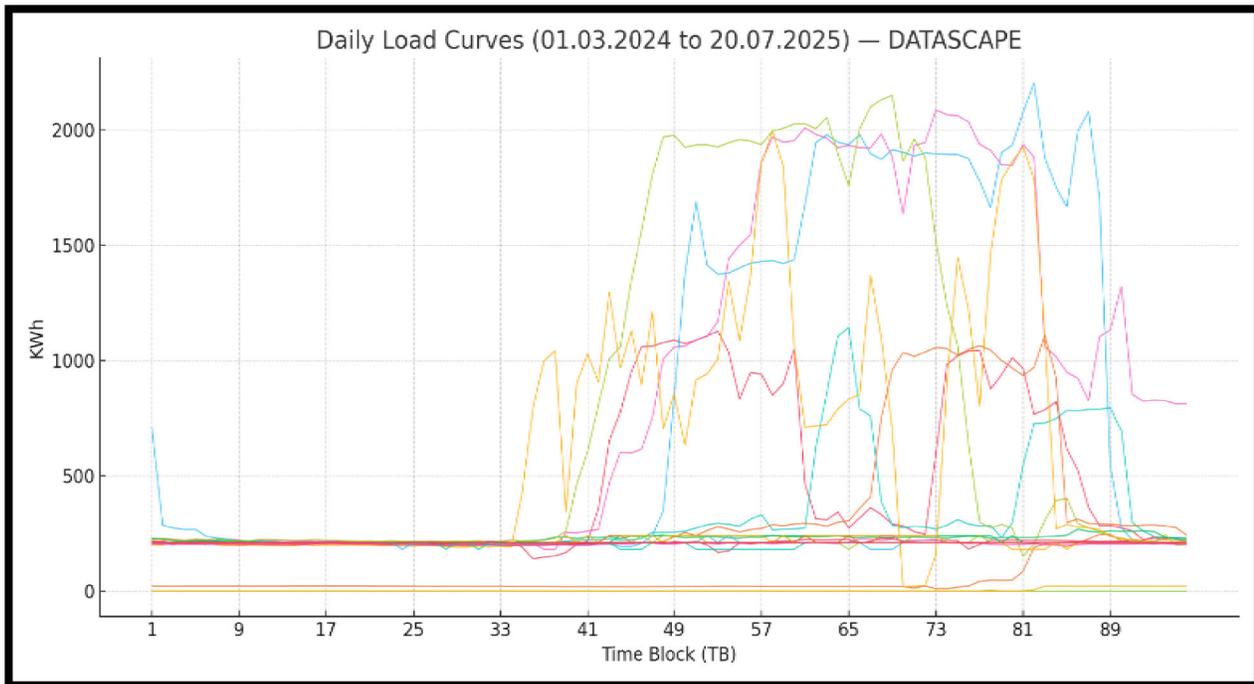


FIGURE 34 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – DATASCAPE

### 3. Daily Load Curves (01.03.2024 to 20.07.2025) – NTT ESTELLA

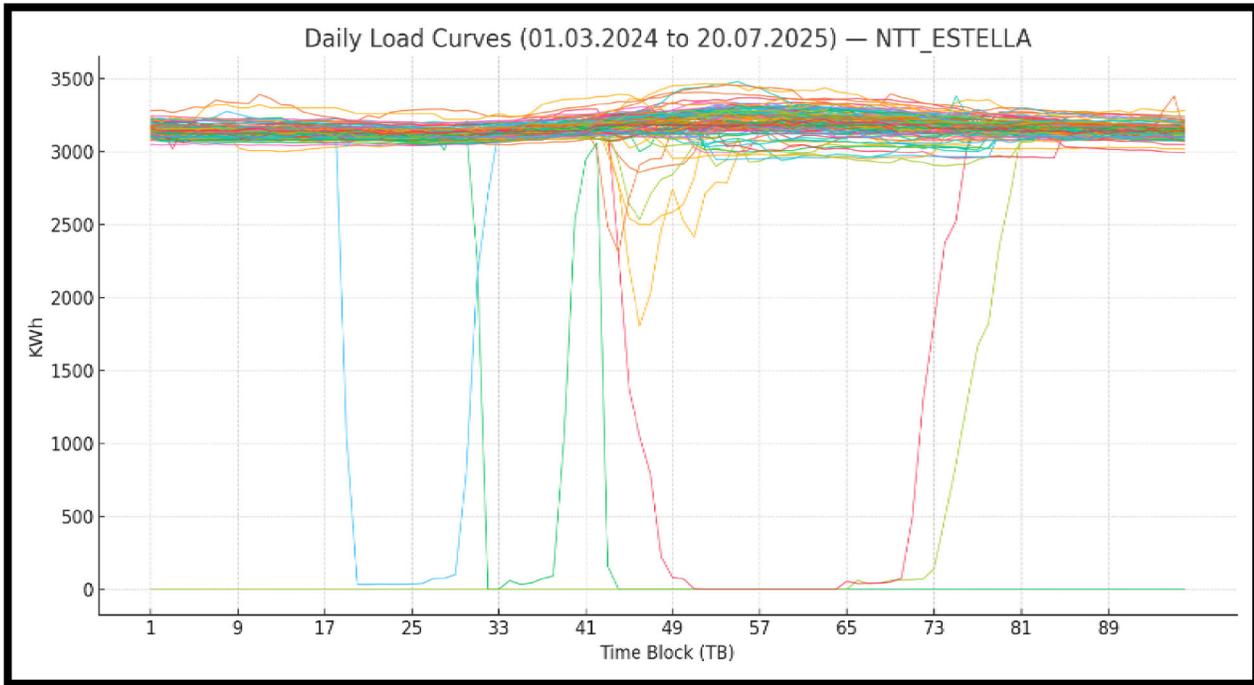


FIGURE 35 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NTT ESTELLA

### 4. Daily Load Curves (01.03.2024 to 20.07.2025) – NET MAGIC

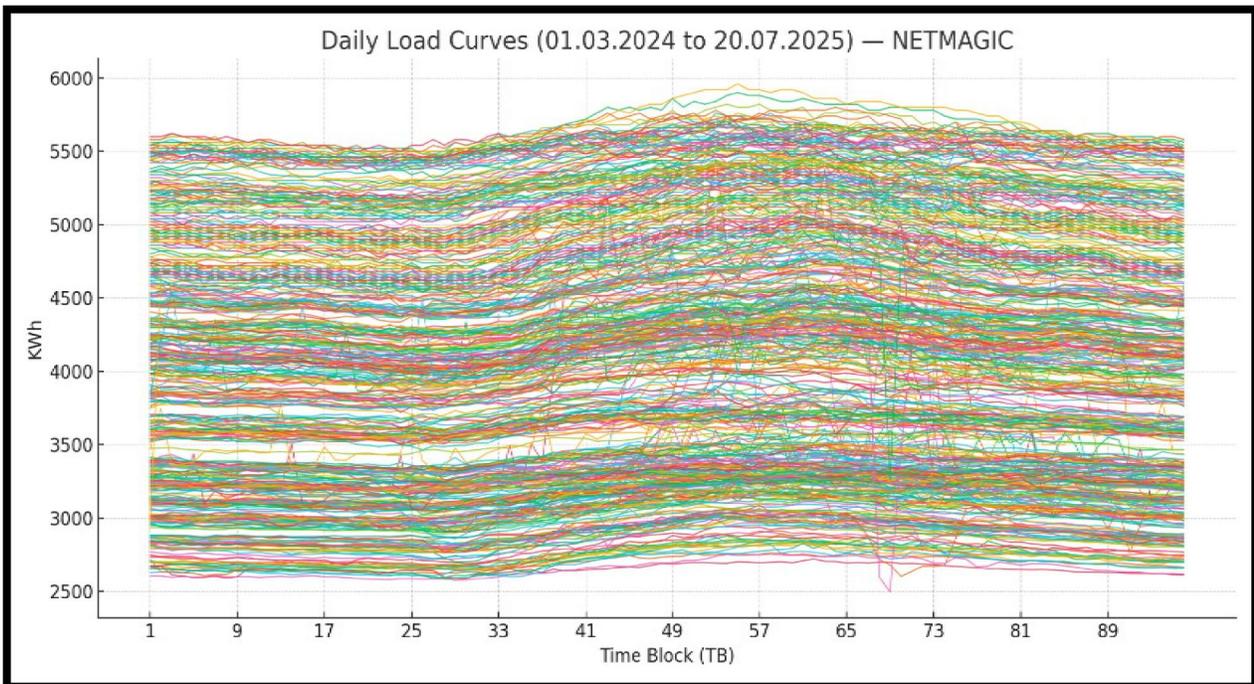


FIGURE 36 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NET MAGIC

5. Daily Load Curves (01.03.2024 to 20.07.2025) – NTT NEON

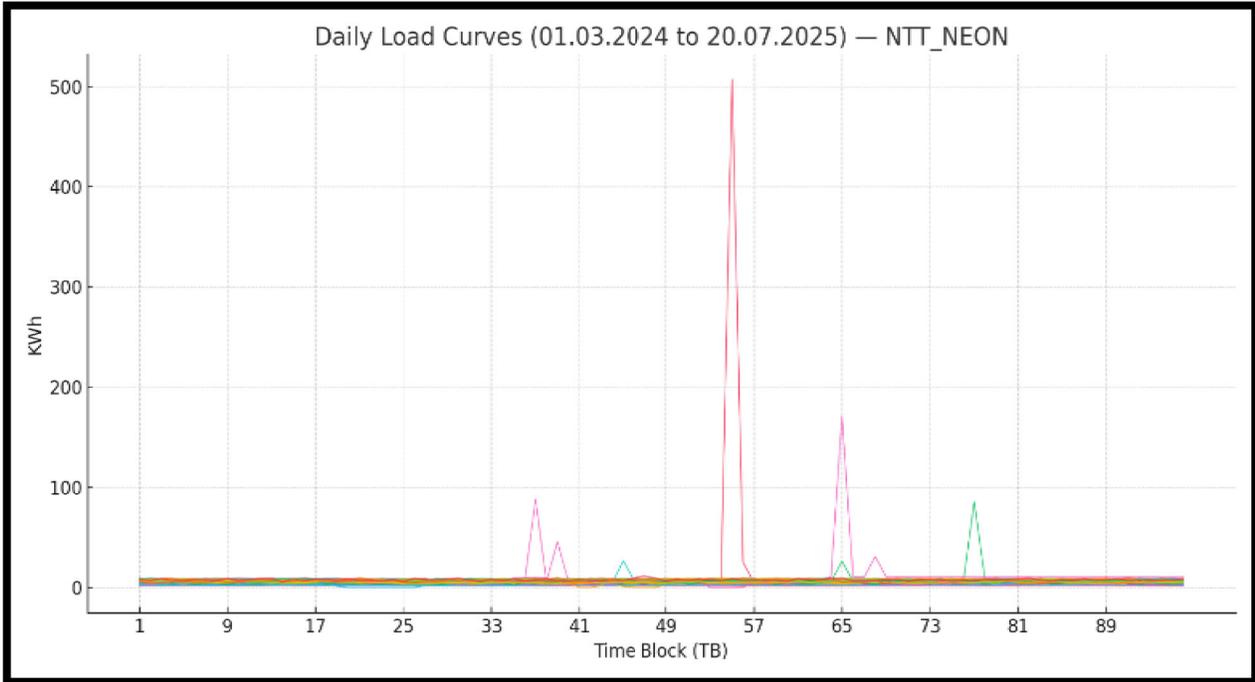


FIGURE 37 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NTT NEON

6. Daily Load Curves (01.03.2024 to 20.07.2025) – PRINTHOUSE

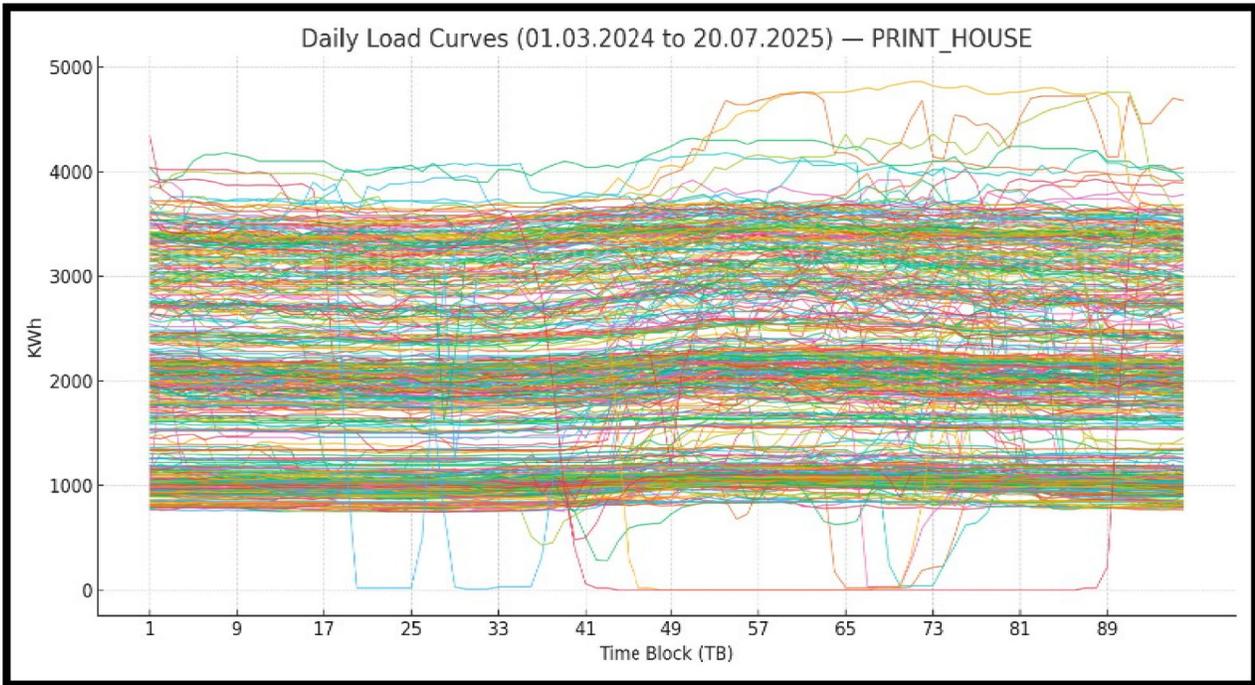


FIGURE 38 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – PRINTHOUSE

7. Daily Load Curves (01.03.2024 to 20.07.2025) – GIGAPLEX

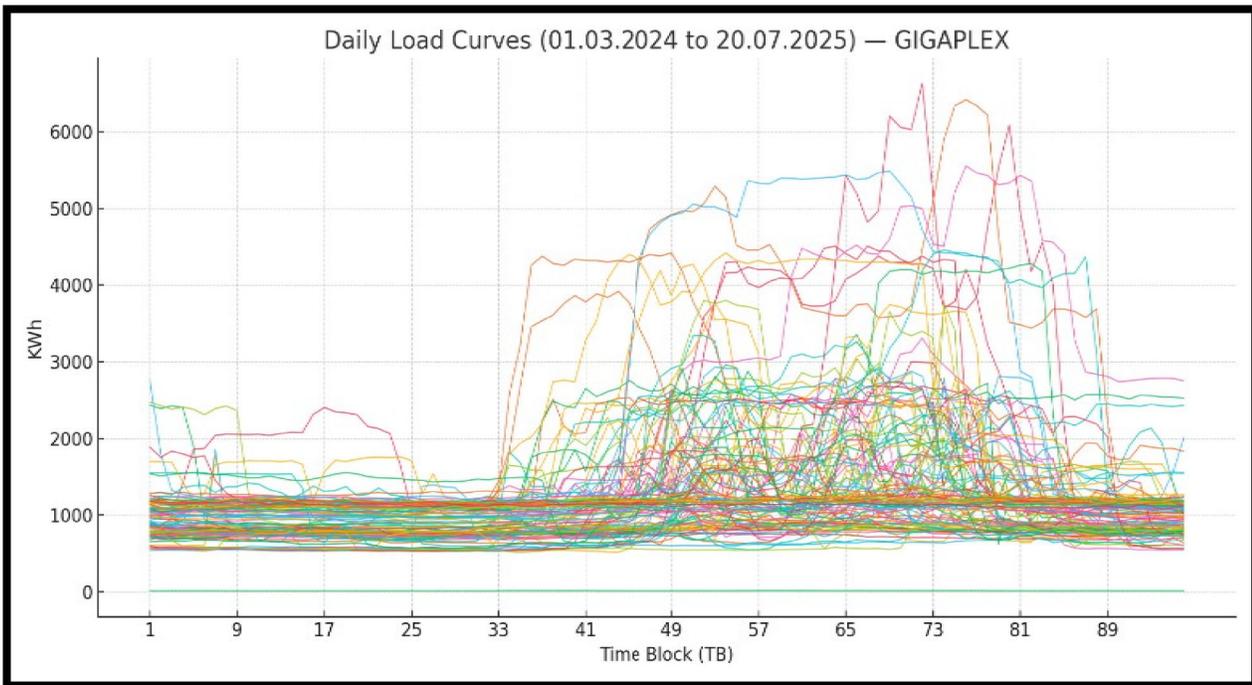


FIGURE 39 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – GIGAPLEX

8. Daily Load Curves (01.03.2024 to 20.07.2025) – DIGITAL EDGE

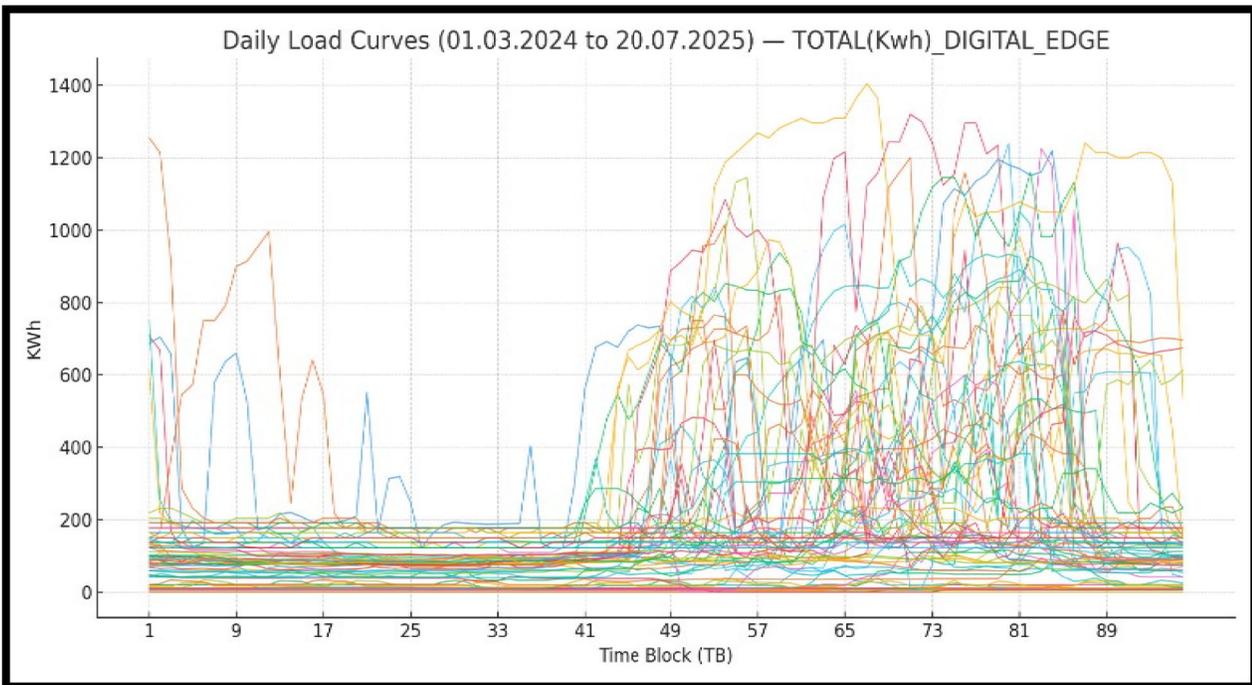


FIGURE 40 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – DIGITAL EDGE

9. Daily Load Curves (01.03.2024 to 20.07.2025) – STT GLOBAL

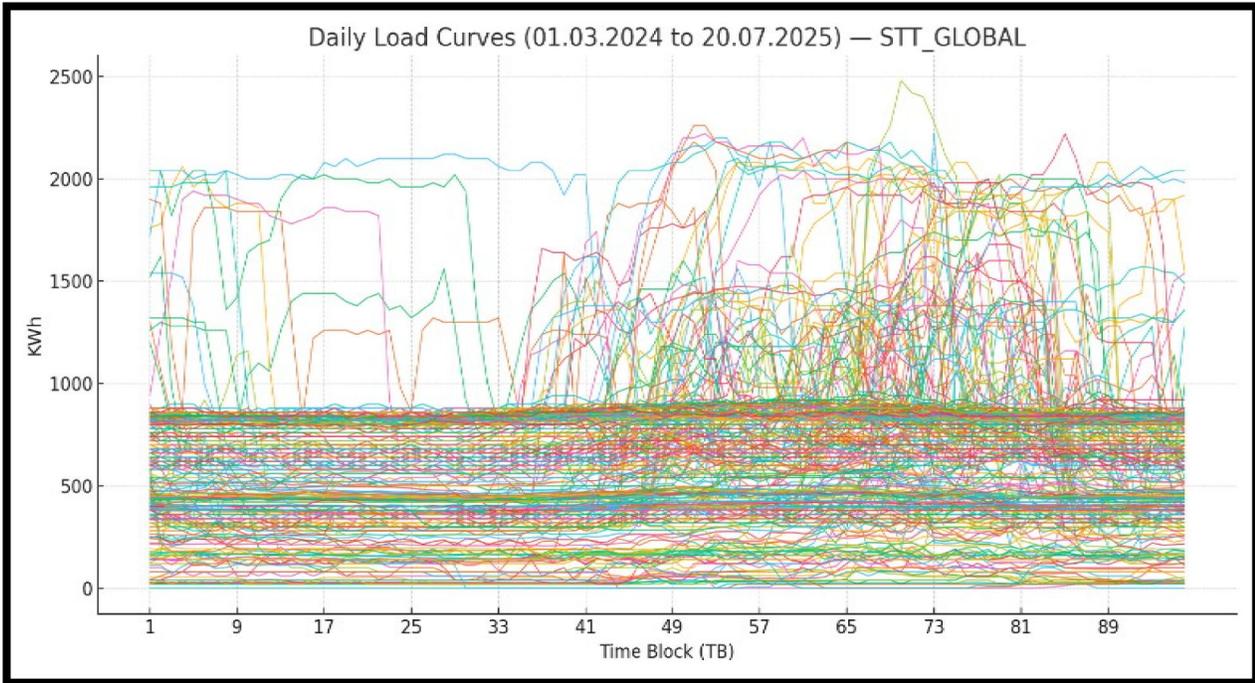


FIGURE 41 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – STT GLOBAL

10. Daily Load Curves (01.03.2024 to 20.07.2025) – NET MAGIC

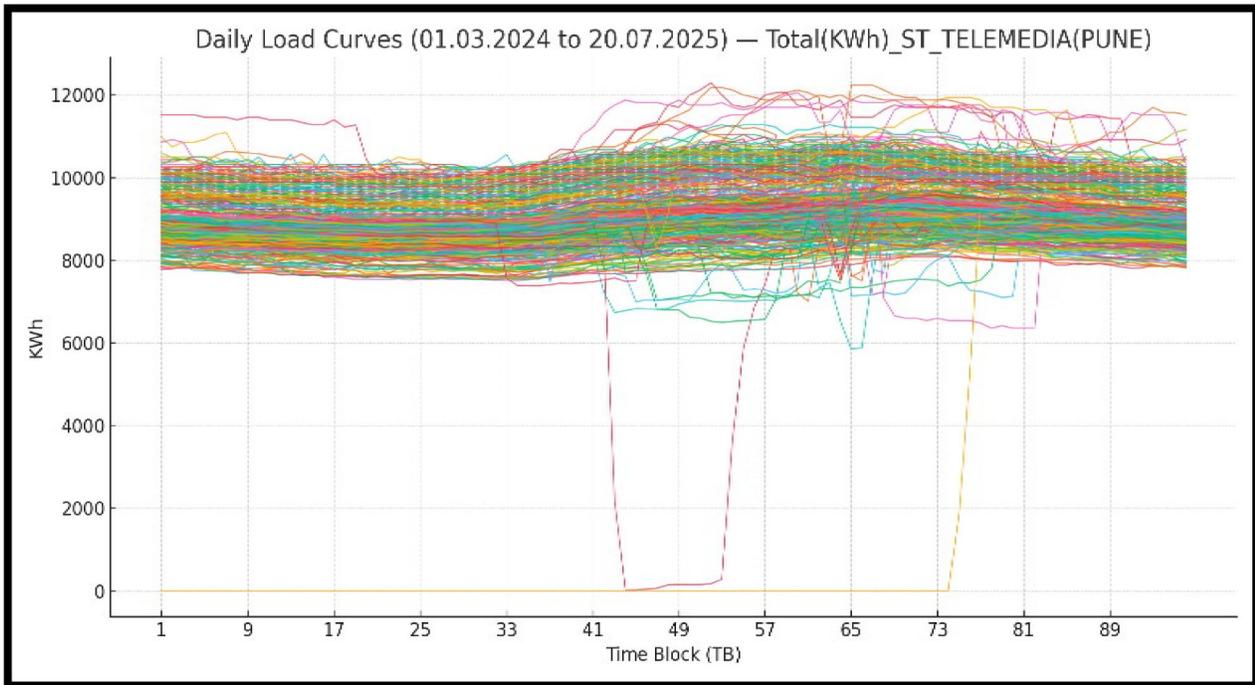


FIGURE 42 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NET MAGIC

### 11. Daily Load Curves (01.03.2024 to 20.07.2025) – DCHI

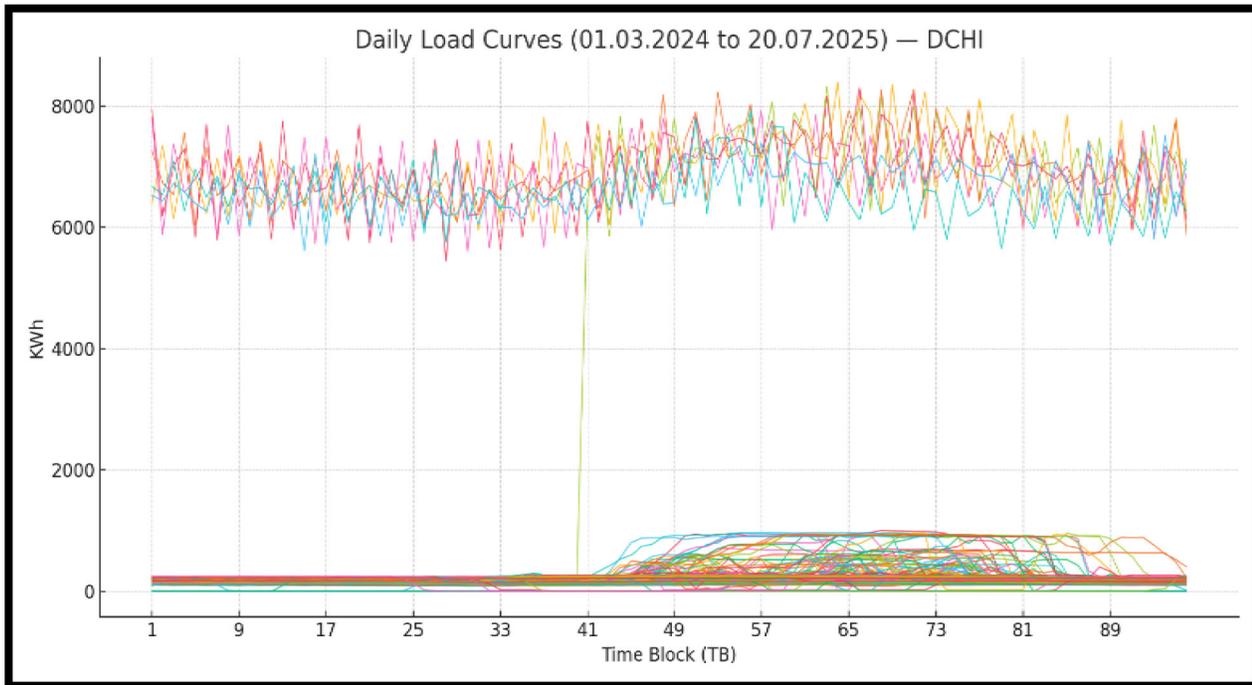


FIGURE 43 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – DCHI

### 12. Daily Load Curves (01.03.2024 to 20.07.2025) – NEXTRA

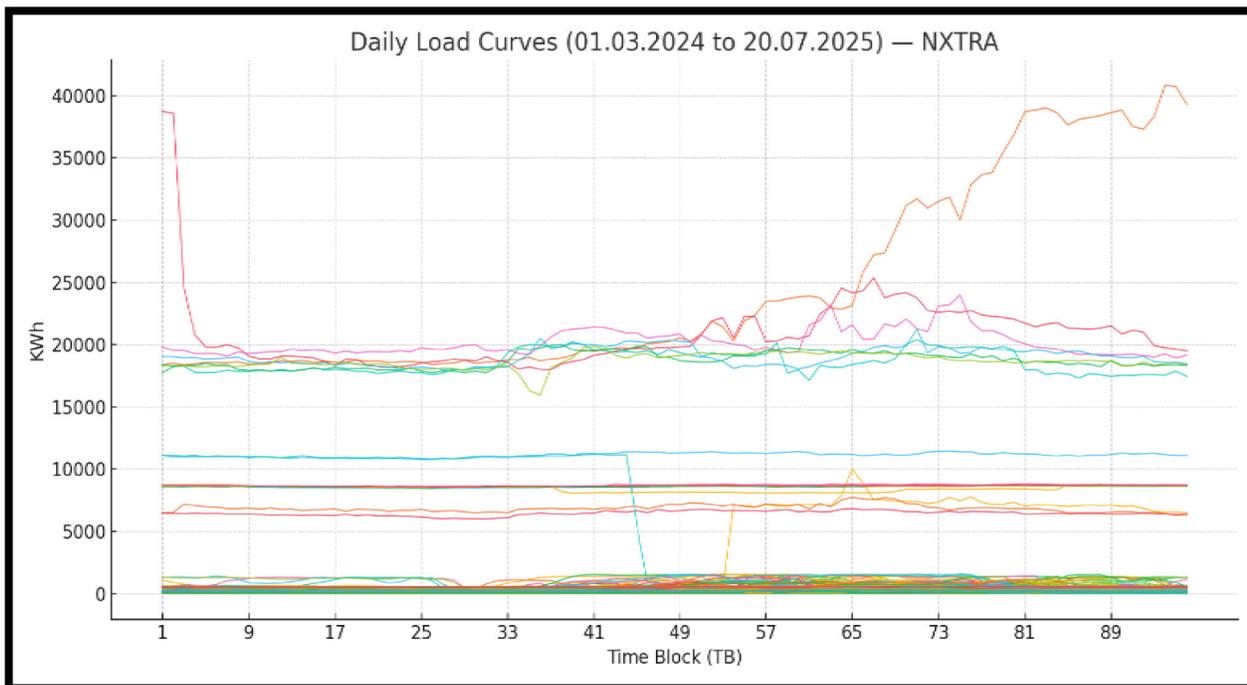


FIGURE 44 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NEXTRA

### 13. Daily Load Curves (01.03.2024 to 20.07.2025) – NXTRA PUNE

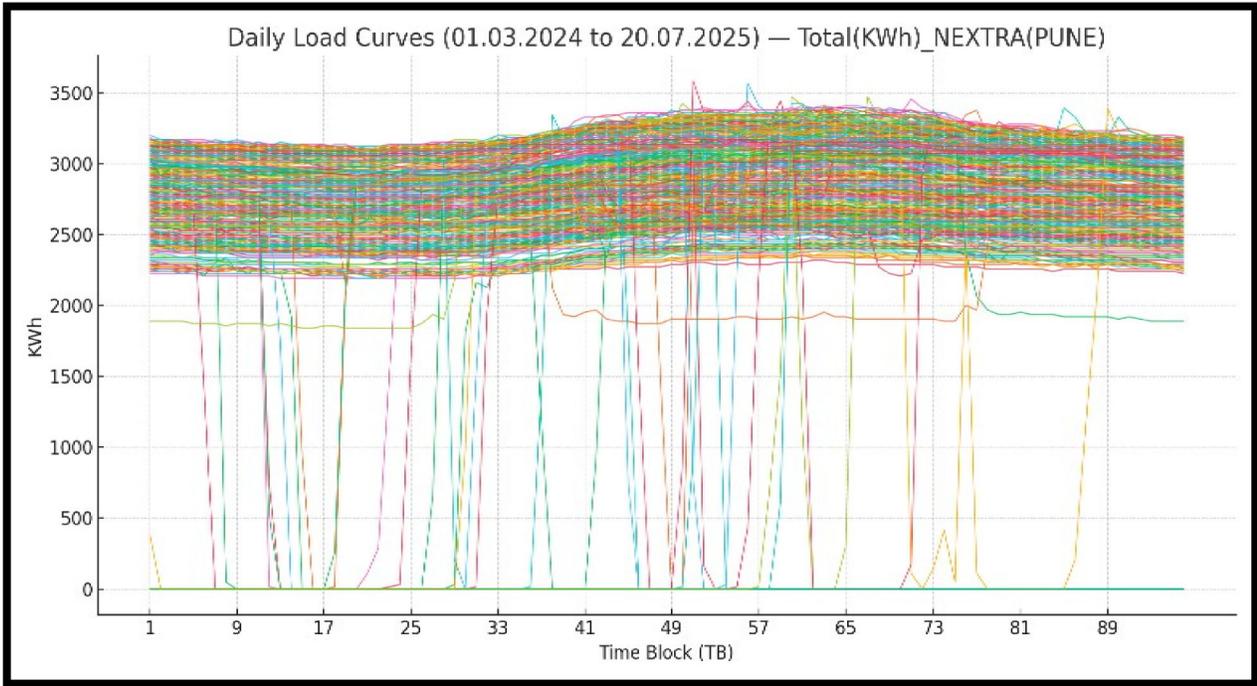


FIGURE 45 DAILY LOAD CURVES (01.03.2024 TO 20.07.2025) – NXTRA PUNE

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[Maharashtra State Load Despatch Centre](#)



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