India

Overweight *(no change)*

Power

Data centre boost to power, cooling tech

- India's data centre capacity is set to grow from 1.07GW in FY24 to 3.29GW by FY28F.
- Artificial intelligence or AI workload is boosting power demand, with Nvidia chips in servers requiring up to 107kW per rack.
- Liquid cooling systems will require US$1.12bn in infrastructure investment by FY28F. India's data localization bill can create demand for 30GW of power.

India's data centre surge is driven by AI and massive internet usage

India's data centre industry is rapidly expanding, with the capacity of 1.074GW in FY24 expected to touch 3.29GW by FY28F, at a 30% CAGR (Source: Cushman & Wakefield). The country's substantial internet user base of over 880m, combined with the rising need for data localization, is driving this growth. Currently, India generates 20% of the world's data, yet its data centre capacity represents only 3% of the global capacity. With a per million internet user data centre capacity of just 1MW, far below China's 4MW, India's market is set for significant expansion.

Soaring power demand

AI is transforming data centres, driving power consumption, as GPUs (graphics processing units) demand higher power densities of up to 107kW per rack, compared to the traditional 10-20kW. This has contributed to a 30-40% year-on-year increase in power demand. India's AI market is expected to grow from US$8bn in CY23 to US$20bn by CY26F, further intensifying the need for energy-efficient data centres.

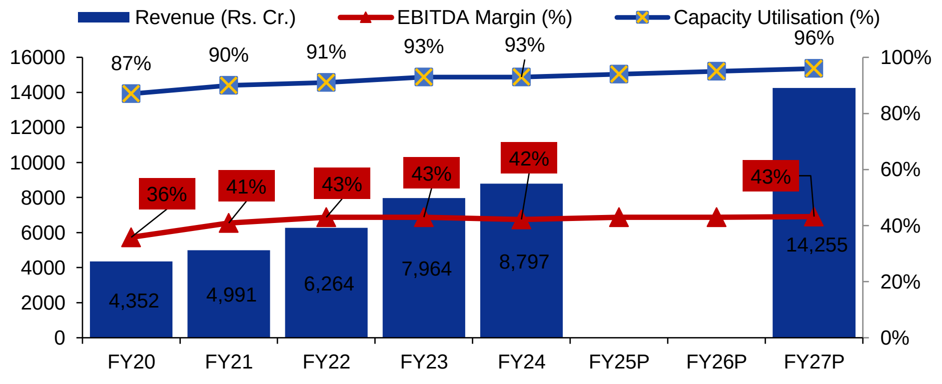
The cooling revolution - liquid cooling tech takes centre stage

Cooling is critical for maintaining optimal conditions at high-performance data centres. As power densities exceed 30kW per rack, traditional air-cooling systems are becoming inefficient. Liquid cooling technologies, growing at a 20% CAGR globally, are emerging as the solution. In India, cooling infrastructure costs are projected to reach US$1.12bn by FY28F, including liquid cooling systems, CDUs, pumps, and other necessary components. These systems improve energy efficiency by up to 40% and reduce PUE from 1.7 to as low as 1.02, significantly lowering operating expenses as the country meets the rising demand from AI and hyperscale data centres.

Data localization bill fuels the need for an additional ~30GW of power

India's digital transformation is driven by the government's data localization push, which mandates local storage of transaction and social media data. This initiative is expected to increase power demand by nearly 30 giga watt or GW, fueled by data from platforms like the Unified Payments Interface or UPI (13bn monthly transactions) and social media giants like Facebook and Instagram. With data consumption projected to grow at a 22% CAGR, scalable, energy-efficient data centres are critical. This shift could result in investments amounting to US$210bn in data centres and US$16bn in cooling technologies, underscoring the need for robust data infrastructure to support India's digital ecosystem.

Figure 1: Data centre companies enjoy a 40-45% EBITDA margin



* PLAYERS RATED BY CRISIL SOURCES: INCRED RESEARCH, COMPANY REPORTS

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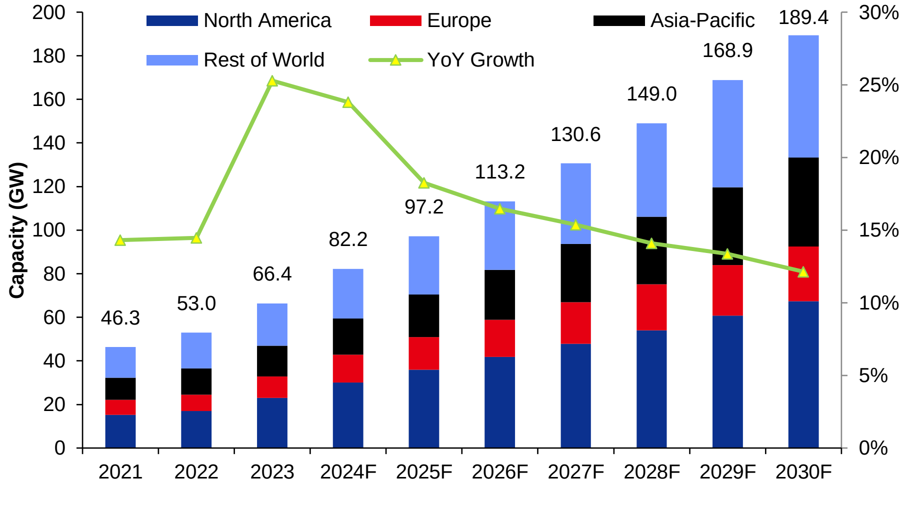
Data Centres

Global market

The global data centre industry continues to witness robust growth, driven by hyperscale expansions, rising data consumption, and the increase in artificial intelligence or AI-driven applications. Global data centre capacity stood at 66.4 GW and is expected to touch 190GW by CY30F (CAGR 16.15%). In the US, data centre absorption has touched 4.5GW across top markets, while Europe saw nearly 1GW of capacity being leased. Vacancy rates in both these regions have plummeted to just 1-3%, from over 10% a few years ago, highlighting the immense pressure on supply. As a result, rents for wholesale data centres have increased more than 80% since 2021, as new constructions struggle to keep pace with demand.

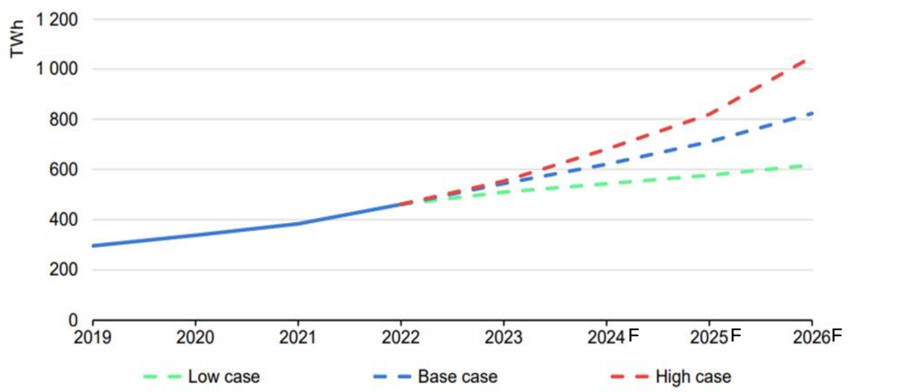
Figure 2: Global data centre capacity



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Power consumption is a critical concern for the industry, with global electricity demand from data centres expected to rise to 800-1,050TWh (terawatt hour) by 2026F, up from 460TWh in 2022. This growth is particularly notable in emerging markets like India, where affordable land and power have fuelled rapid data centre expansion. India now ranks 14th globally in data centre capacity, driven by a surge in data usage and regulatory support, positioning it as one of the most sought-after markets for hyperscalers. As data centre power density increases, driven by GPU deployment for AI workloads, the industry will require significant investments in power generation and grid infrastructure to meet the rising demand.

Figure 3: Global electricity demand for data centres & AI in 2019-26F



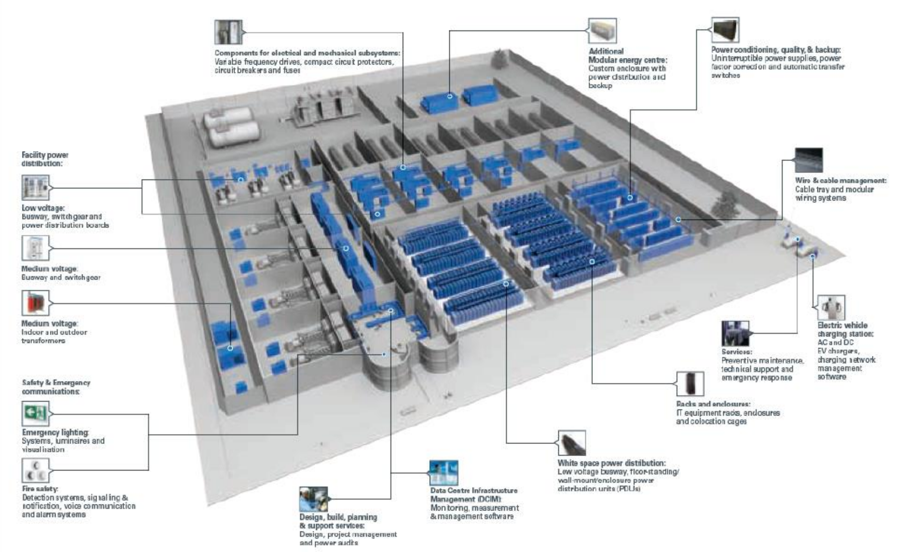
SOURCE: INCRED RESEARCH, IEA

The working of data centres

Data centre architecture is highly complex, with dozens of elements working in tandem. We can broadly divide a data centre's physical infrastructure into four broad categories:

- Computing and processing infrastructure
- Storage and data management
- Network infrastructure
- Support infrastructure

Figure 4: Data centre architect



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Computing and processing infrastructure ›

The core function of any data centre is to power and cool high-performance servers responsible for data processing. These servers handle critical tasks such as managing databases, processing user requests, running applications, and executing machine-learning algorithms. Key server types include:

- **Rack servers**: The most common server form factors found in data centres. They come in various shapes and sizes and can be stacked on top of one another to maximize space. Each rack server has its own power supply alongside network switches, ports and cooling fans.
- **Mainframe servers: T**hey are robust, high-performance systems designed for intensive, real-time processing, known for their reliability and multitasking capabilities. That said, the evolution of the cloud means on-premises mainframes aren't as standard as they once were.
- **Blade servers:** They are even more compact than rack servers. Each independent blade fits into a shared chassis that accommodates multiple servers. While blade servers are easily scalable and hassle-free to manage, it's important to note that their processing power is comparatively limited compared to rack or mainframe servers.

The choice of server depends on the workload, whether it's general-purpose processing or real-time computing, and the proximity to end-users for latency-sensitive applications.

Storage and data management ›

Data storage infrastructure serves as the backbone for a data centre's ability to store, retrieve, and manage large volumes of information. Modern storage systems are fast, efficient, and scalable, allowing businesses to access critical data quickly and recover information instantly in the event of loss or compromise. The integration of these systems ensures data integrity and optimizes operational performance.

Network infrastructure

Data centre networking equipment is comprehensive and highly reliable. Switches, routers, and cables connect each of the servers together and provide communication with end-user locations. When everything is set up correctly, these networks can transmit high volumes of traffic with little to no latency or drop in performance.

Support infrastructure

Support infrastructure ensures that all systems within the data centre remain operational and perform efficiently. Key components include:

- **Cooling infrastructure**: Comprising computer room air-conditioners (CRAC), computer room air handlers (CRAH), chillers, and in-row cooling systems, this infrastructure maintains the optimal temperature to prevent server overheating. Advanced systems like rear-door heat exchangers and liquid cooling are also used in high-density computing environments.
- **Uninterruptible power supply (UPS) and back-up generators**: These provide emergency power during outages, ensuring the continuous operation of the data centre.
- **Airflow management systems**: Hot aisle/cold aisle containment and other airflow systems direct cool air where needed and expel hot air, improving energy efficiency and system reliability.

Types of data centres

Figure 5: Comparing business models of data centres

	Third party service providers				Captive
	Hyperscale	Colocation	Managed Services	Edge	
Planning					
Location	Well-planned and located in hubs on outskirts where land is cheaper	Well-planned and located in hubs on outskirts where land is cheaper		Located within cities near business hubs which are the customers of Data Centers	Location at the clients' premises
Building type	Well-planned and located in hubs on outskirts where land is cheaper	Dedicated buildings with Physical infrastructure with Plug and play	Dedicated buildings with fully-integrated support including servers etc.	Smaller buildings or parts of a building co-located with other offices, Data Centers etc.	Smaller buildings compared to co-located and managed services
Proximity to end users	Located on outskirts of cities, usually far from the business areas	Located on outskirts of cities, usually far from the business areas		Located very close to end-users	On-premises
Latency	Low to medium latency based upon distance from the end-user	Low to medium latency based upon distance from the end-user		Very low latency	Low latency
Server Design					
Visibility	High visibility for end-users on critical Data Center parameters	High visibility for end-users on critical Data Center parameters such as peak server load, power consumption etc.		Low visibility for end-users on critical Data Center parameters	High visibility for clients
Size	At least 50K servers	Less than 50K servers		Less than 10K servers	Less than 10K servers, however some large captive Data Centers exist
Customer types	Large organizations with heavy data storage requirements	Medium-to-large scale organizations bringing their own servers	Medium-to-large scale organizations with end to end requirements	Organizations with very high requirement for lowest-possible latency.	Organizations with less requirement but low latency

SOURCE: INCRED RESEARCH, PRAXIS

Data centres need to be reliable and are routinely tested for reliability

Data centres are heavily regulated and routinely assessed for reliability, redundancy capabilities, and efficiency. The ANSI/TIA-942 standard for data centres is the most common method for assessing infrastructure. The Uptime Institute uses this standard to categorize data centres into four tiers, with 'I' being the lowest tier and 'IV' being the highest.

Figure 6: Understanding data centre tiers

Parameters	Tier 1	Tier 2	Tier 3	Tier 4
Category	Non-Redundant Capacity	Redundant Capacity	Concurrently Maintainable	Fault Tolerant
Uptime per annum (Downtime per annum)	99.67% (28.8 hours Per annum)	99.74% (22 hours Per annum)	99.98% (1.6 hour per annum)	99.995% (0.4 hour per annum)
Capacity components to support the IT Load	N	N+1	N+1	2N+1
Power Outage Protection	-	-	72 hour protection	96 hour protection
Cooling	Single cooling path	Single cooling path	Multiple cooling paths	Multiple cooling paths (Continuous cooling)
Months to implement	3	3-6	15-20	18-24
Target customer	Small Business	Small Enterprise	Large Enterprise	Very Large Org/MNC
Key players in India	Small Scale Data Centers	Small Scale Data Centers	Reliance Communications, STTelemedia Global Data Centres, netmagic, NTT, nxtra	Pi, YOTTA

SOURCE: INCRED RESEARCH, PRAXIS

Indian data centre market to witness rapid growth

The Indian data centre market will experience rapid growth in the near future, as the installed data centre capacity is 93% lower than that of the Western world for each petabyte (PB) of data generated. With data localization becoming a reality, India needs to rapidly expand its data centre capacity.

Indian data centre market experiencing exponential growth ➤

Figure 7: Digital India is growing

Population	~1,450 million	~333 million	~1,412 million	~742 million
Internet users	~63%	~92%	~76%	~90%
E-commerce shoppers	~270 million	~268 million	~845 million	~326 million
OTT subscriptions	~119 million	~400 million	~350 million	~567 million
Mobile data traffic per active smartphone (GB/month)	24-25 GB	19-20 GB	13-14 GB	15-16 GB
DC capacity (MW/million internet users)	**~1.1**	**~50.5**	**~3.5**	**~12.4**
Cloud spending (as a % of worldwide cloud spend)	**~1%**	**~48%**	**~10%**	**~4%****

Source: Industry reports. ** This pertains to the UK only.
Note: The above data pertains to 2023; OTT: over-the-top

5

CRISIL Ratings

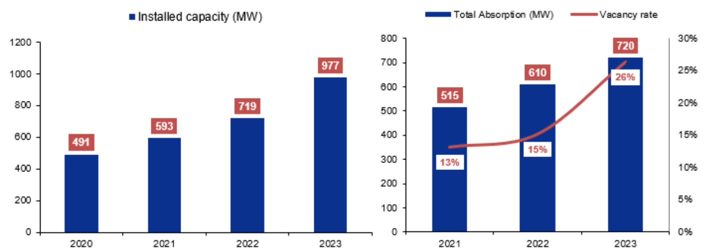
SOURCE: INCRED RESEARCH, CRISIL RATINGS

India's data centre market is witnessing rapid growth, propelled by its substantial internet user base of over 880m—nearly twice that of the US and 12 times higher than that of the UK. Despite accounting for approximately 20% of the world's data generation, India's data centre capacity remains significantly underdeveloped, representing only 3% of the global capacity. With the current data centre capacity of 977MW across the top seven cities, India's capacity per million internet users is just 1MW, far lower than China's 4MW per million users. Going ahead, India's data centre capacity is expected to expand substantially, with 1.03GW currently under construction and plans for an additional 1.29GW, bringing the total capacity to 3.29GW by 2028F—at a projected 30% CAGR (Cushman & Wakefield).

Data localization is the key driver behind this growth

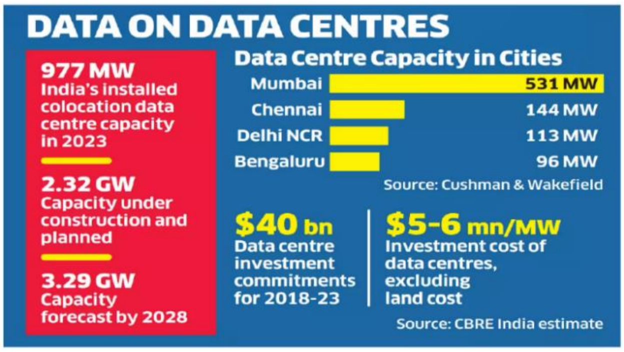
Key drivers behind this growth include the rising demand for data localization, which has become a regulatory mandate, and the country's soaring mobile data consumption, which is the highest globally. An average Indian mobile user consumes over 19GB of data per month, driving the need for advanced data storage and processing facilities. The availability of affordable land and power, coupled with robust global connectivity through submarine cables, is attracting global data centre operators to India, positioning it as a crucial market for future data centre business expansion.

Figure 8: India's data centre capacity & vacancy rate



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 9: Data on data centres



SOURCE: INCRED RESEARCH, ET

India's data centre capacity per petabyte of data genetated is 93% lower compared to the western world

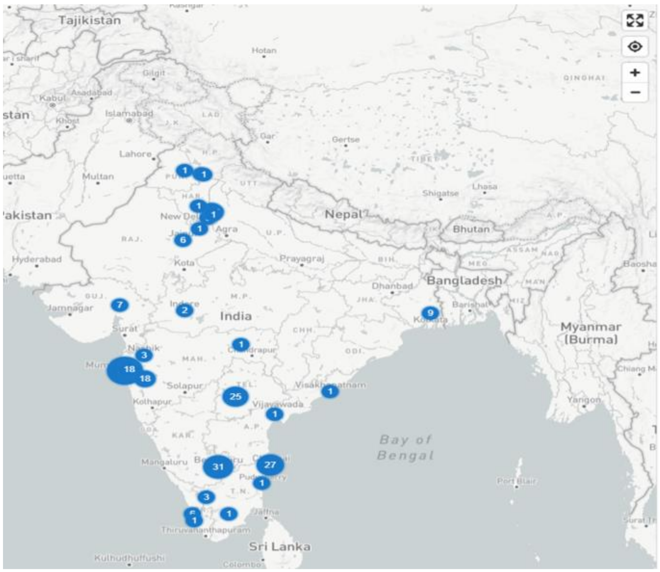
India's data generation per 1MW of installed data centre capacity stands at a remarkable 13.2 petabytes (PB), far exceeding the less than 1PB per MW generated in mature markets like the US, UK, and Singapore. This highlights India's immense potential and the critical need for capacity expansion to support its rapidly growing digital ecosystem. In 2023 alone, 258MW of capacity was added, surpassing the 126MW added in 2022, and reflecting a significant increase in investment. As the country continues its digital transformation, India is on track to become a key global data centre hub, with a strong focus on increasing storage capacity, ensuring data security, and implementing energy-efficient technologies.

Data centres in India

India has over 132 data centres distributed across the country, with Mumbai accounting for 45 percent of them. Chennai, while ranking a distant second, is rapidly emerging as the next prominent data centre hub. Other prominent data centre hubs in India are Bengaluru, Hyderabad, Noida (Delhi-NCR), Pune, and Kolkata. As most data centres in India are situated in Tier- 1 cities, there are huge untapped prospects for Tier-2 and Tier-3 cities. Tier-2 cities are also expected to increase investments in edge data centres to ensure` seamless customer digital experience in these rapidly growing markets.

Mumbai is the prime hub for data centres in India, attracting demand from BFSI (banking, financial services, and insurance), media, and IT/ITeS sectors. To support this, the Maharashtra government offers incentives for integrated data centre parks and includes data centres under the purview of the Essential Services Maintenance Act, 1968. According to Mordor Intelligence, the Mumbai data centre market was estimated at 411.9MW in 2022. It is projected to grow at a CAGR of 13.44 percent over 2023 to 2029F, touching a substantial capacity of 1,491.38MW.

Figure 10: India's data centre map



Market	Data Centers
Mumbai	39
Hyderabad	25
Bangalore	31
New Delhi	17
Chennai	27
Madurai	1
Gurgaon	5
Noida	16
Coimbatore	3
Cochin	6
Ahmedabad	7
Kolkata	9
Navi Mumbai	18
Pune	18
Jaipur	6
Nashik	3
Indore	2
Bhubaneswar	1
Guntur	1
Mohali	1
Panchkula	1
Pondicherry	1
Alappuzha	1
Alwar	1

SOURCE: INCRED RESEARCH, DATACENTERMAP.COM

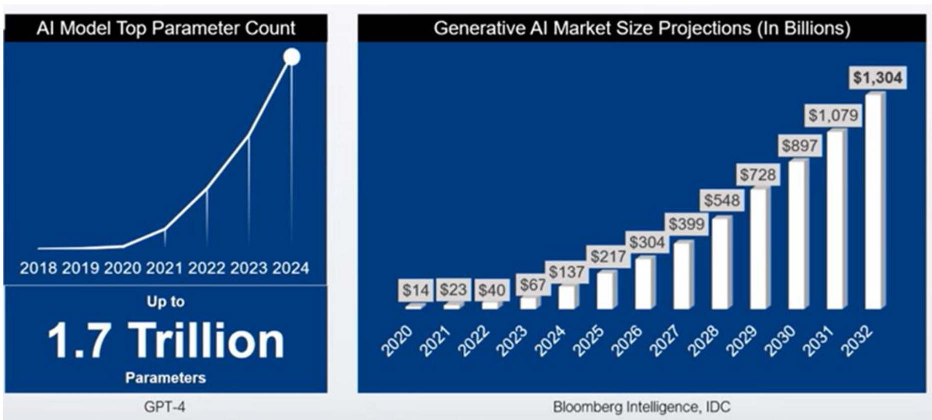
Rapid addition of capacity and changing operator landscape over the next five years

In the most recent period, enterprises dominating India's Colo data centre market have included NTT, STT, Nxtra, Sify, and CtrlS. These five entities together account for almost 77% of the overall Colo capacity. However, a few new entrants have been expanding quite aggressively, and soon we will witness entities such as CapitaLand and BAM Digital Realty making deep inroads into the Indian market. There will be immense capacity addition shortly, and the market is poised to witness changes in the operators' landscape. New entrants will help the market to diversify and bring in the much-needed volume of inventory.

Drivers of Indian data centre market's success - AI and cooling technologies

India's data centre market, already on a fast growth trajectory, is being reshaped by two critical trends: the rise of artificial intelligence (AI) and advancements in cooling technologies. These trends are poised to redefine the operational economics of data centres while creating significant investment opportunities. How these emerging trends are driving exponential growth, altering power demand dynamics, and ushering in new technologies to address infrastructural challenges?

Figure 11: AI market in numbers



SOURCE: INCRED RESEARCH, BLOOMBERG INTELLIGENCE

The rise of AI and surge in demand for power

AI's power consumption dynamics

Artificial intelligence (AI) is the single most transformative force hitting the data centre market, with implications for power demand, infrastructure investments, and operational costs. Electricity use is staggering and headed upwards. Data centres account for about 1-1.5% of global electricity consumption. The average rack density has more than doubled since 2017, from less than 6kW in 2017 to ~12kW in 2023, whereas the typical rack density among hyperscale facilities is ~36kW and is expected to continue rising.

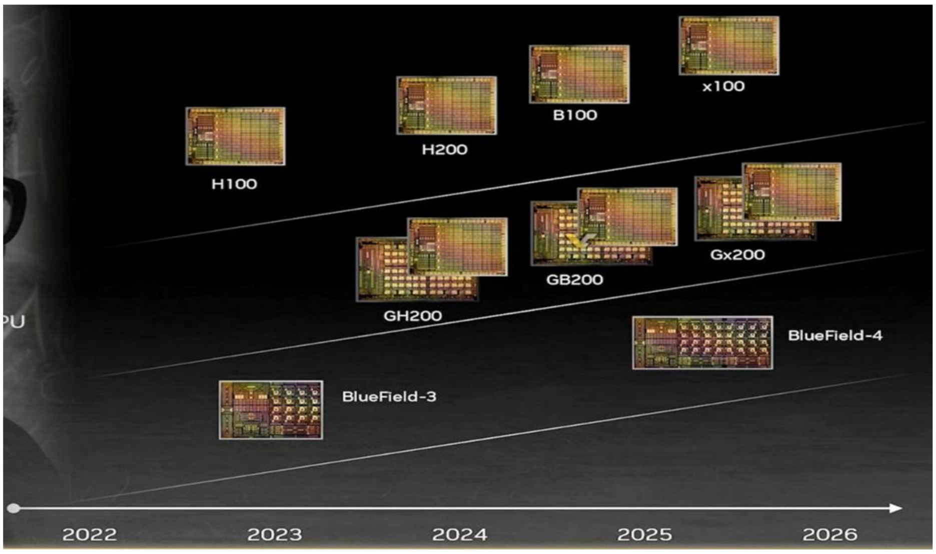
Nvidia chips have exponentially raised the power demand of AI data centres

In traditional set-ups, a standard six-foot rack is divided into 42 rack units and a rack typically houses 21 servers, each equipped with two central processing units or CPUs drawing 160 watts, resulting in an overall power consumption of 10kW per rack, including 3kW for storage and networking.

However, with Nvidia's current-generation AI chips, such as the H200 (Hopper architecture), a rack configuration comprises five servers, each with eight GPUs and one CPU. Each GPU draws 700watts, with the CPU drawing 350watts, and thus overall drawing a total of 33kW per rack.

Going ahead, the next-generation Nvidia GB200 (Blackwell architecture) will further elevate power density. Nvidia's NVL72 rack configuration with 18 servers per rack, each server containing four GPUs (1,200 watts per GPU) and two CPUs (500watts per CPU), bring the total power consumption to a substantial 107kW per rack, highlighting the rising need for advanced cooling solutions at high-performance data centres.

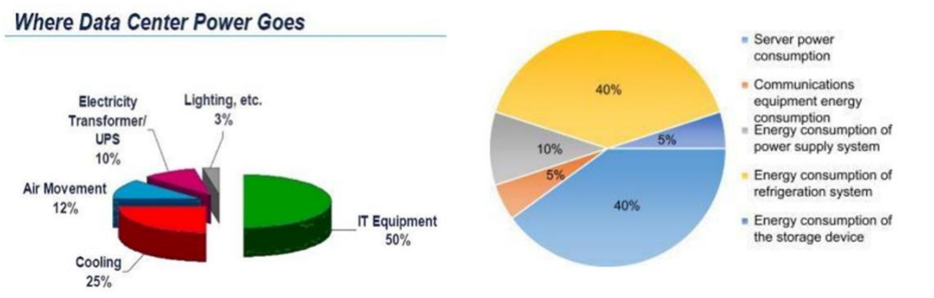
Figure 12: Evolution of chips



SOURCE: INCRED RESEARCH, COMPANY REPORTS

As hyperscalers like AWS, Google Cloud, and Microsoft Azure race to train increasingly complex AI models, this has led to a 30-40% YoY increase in power demand at data centres. In India, which ranks fourth in the Asia-Pacific region in terms of data centre capacity, this demand growth is particularly pronounced as global AI workload shifts to cost-effective regions.

Figure 13: Most power consumption in data centres is for IT infrastructure and cooling



SOURCE: INCRED RESEARCH, CTRLS

India's AI market to grow exponentially from US$8bn in CY23 to ~US$20bn by CY26F

India's AI market is expected to grow from US$7-9bn in 2023 to US$17-22bn by 2026F, driving the need for data centres with higher power density. The operational capacity in India, currently at 1,074MW, is projected to more than double to 3,290MW by FY28F. Much of this growth will be fuelled by AI workload that demand massive computational and energy resources. The cost of setting up a new data centre in India has increased to Rs0.6-0.7bn/MW, against Rs0.4-0.45bn earlier, mainly due to incremental land, equipment and other soft costs. The cost break-up typically is as follows: 40% real estate, 40% electrical/tech and 20% for heating ventilation and cooling systems. But despite increased costs, this business remains lucrative as the capital expenditure for setting up a data centre in India is roughly 45% lower compared to the global average.

Who can benefit from this growth - established power and electrical equipment companies

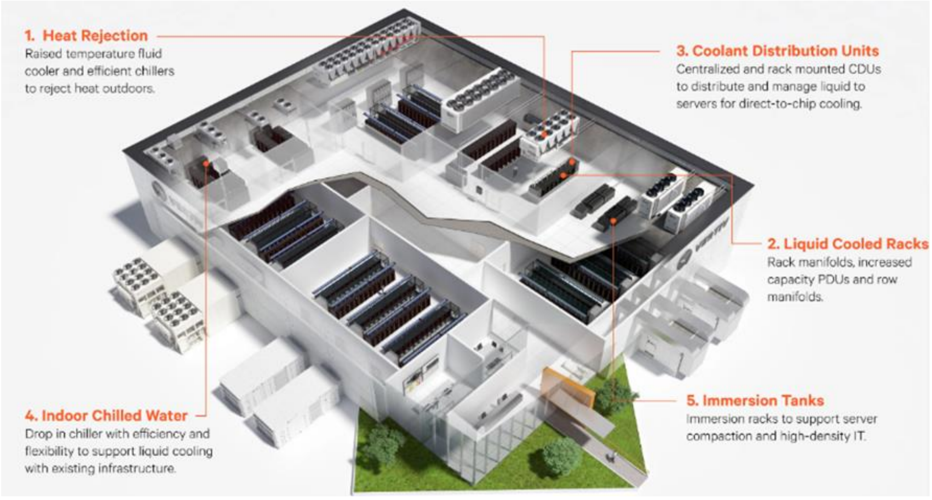
Capitalizing on AI's growth, the focus is on hyperscalers, energy utilities, and capital goods companies that are well-positioned to meet the infrastructure and energy demands. **ABB India, Schneider Electric**, and **Cummins India** are key players offering solutions for electrification, power management, and data centre cooling systems. As AI ramps up, they are poised to capture a significant market share in data centre-related capital expenditure.

Cooling technology revolution – a critical shift for operational efficiency

Why cooling matters now more than ever? India's hot climate requires tremendous power for AI

The unprecedented rise in power demand due to AI is pushing traditional air-cooling systems to their limits. At the same time, India's hot and humid climate, especially in key data centre markets like Mumbai, Delhi-NCR, and Hyderabad, presents unique challenges that call for innovation in cooling technology.

Figure 14: Liquid-cooled data centre architect

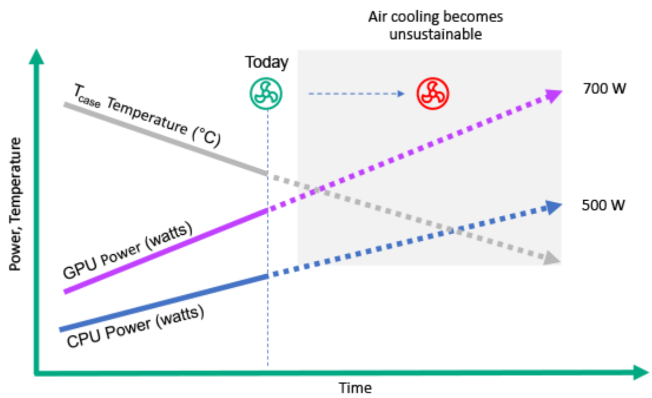


SOURCE: INCRED RESEARCH, VERTIV

Air cooling cannot solve cooling requirements of modern data centres

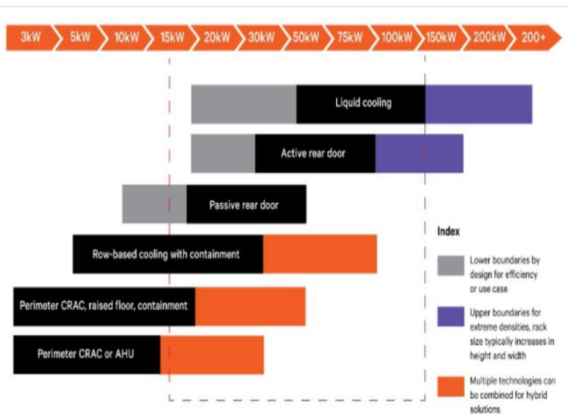
As rack densities exceed 30kW, air cooling can no longer adequately maintain the working temperature and hence, liquid cooling is the only option for removing heat efficiently.

Figure 15: Air cooling is becoming unsustainable as component TDPs increase



SOURCE: INCRED RESEARCH, HPCWIRE

Figure 16: Thermal management capabilities at various rack densities



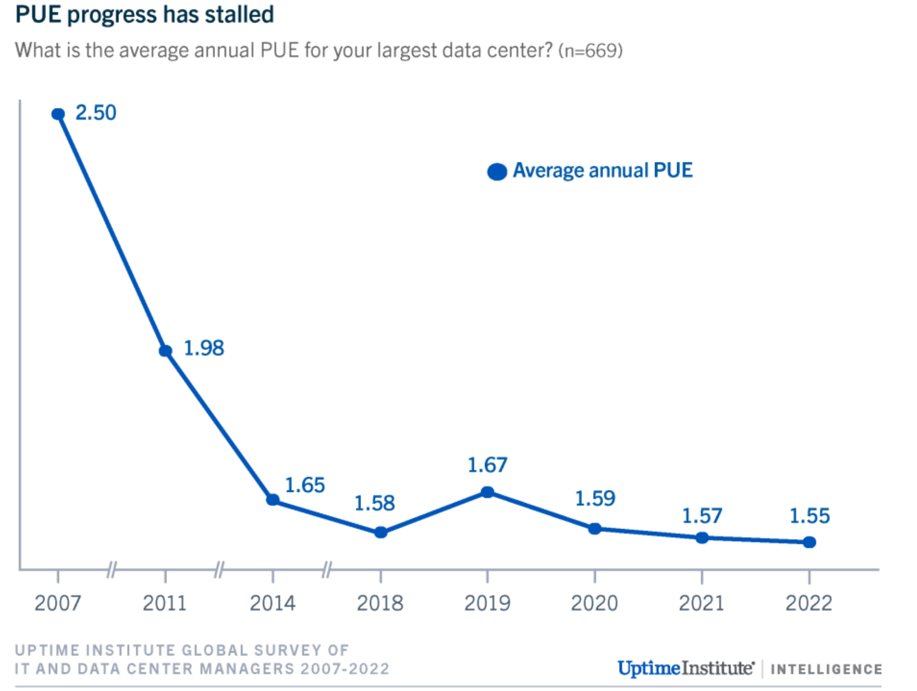
SOURCE: INCRED RESEARCH, VERTIV

One solution to reduce data centres' cooling requirement is reduction of PUE

PUE is determined by dividing the total amount of power entering a data centre by the power used to run the IT equipment within it. For example, a PUE of 1.3x means for every 1kW of processing equipment, it requires 300watts power for cooling. So, if we reduce the PUE, the head load will be reduced.

However, the reduction in PUE has stalled

Figure 17: PUE progress has stalled



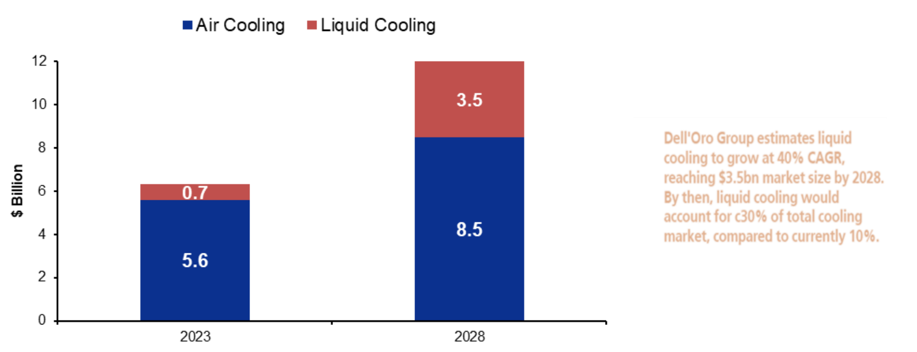
SOURCE: INCRED RESEARCH, UPTIME INSTITUTE

In the last five years, PUE has remained flattish, which necessitates the use of new technologies. The relationship PUE and Moore's Law highlights the rising need for efficient cooling solutions as processor power doubles approximately every two years, leading to higher energy demand at data centres. Traditional air-cooling systems, achieving a PUE of around 1.7, are being outpaced by liquid cooling methods, which can lower the PUE to about 1.02, indicating that nearly 98% of energy usage is directed towards IT equipment.

Liquid cooling is emerging as the new technology for data centres- its demand will grow at a 20% CAGR

Liquid cooling is emerging as the go-to-solution for next-generation data centres, which is expected to grow at a **20% CAGR** globally over the next five years. In India, hyperscalers and co-location providers are expected to accelerate their adoption of liquid cooling solutions, especially as power costs rise and sustainability becomes a core focus area. Liquid cooling systems can reduce energy consumption by up to 40%, significantly lowering operating expenses.

Figure 18: Cooling market size in India

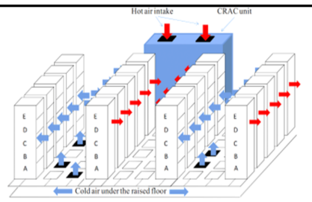
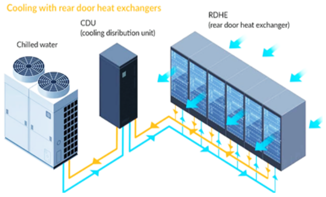
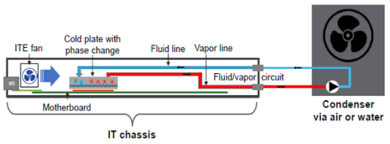
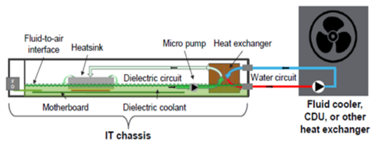


SOURCE: INCRED RESEARCH, DELL'ORO

Several cooling technologies are available in the market ➤

Several liquid cooling technologies, including **immersion cooling**, **cold-plate cooling**, and **rear-door heat exchangers**, are leading the charge in optimizing data centre cooling efficiency. Each of these methods provides targeted cooling for high-performance computing environments, significantly reducing energy consumption and improving power usage effectiveness (PUE).

Figure 19: Different cooling techniques

	Illustration	Description	Power Utilization Effectiveness (PUE)
Air Cooling		The most common method for cooling data centers is air cooling, where Computer Room Air Conditioning (CRAC) units are typically used to circulate cool air. This is often combined with a raised floor system, which allows cool air to flow beneath the servers and be distributed more effectively throughout the room	1.5x
Rear-door Heat Exchanger		Radiator-like systems mounted on the back of server racks, equipped with coils or plates that facilitate direct heat dissipation. These exchangers can either utilize chilled water or other coolants to efficiently absorb and remove heat from the servers, enhancing cooling performance while minimizing airflow disruption	1.3x
Direct-to-chip		Circulating a coolant through a cold plate that makes direct contact with critical heat-generating components, like CPUs and GPUs, efficiently drawing heat away from these sources to maintain optimal performance and prevent overheating	1.15x
Immersion Cooling		Enables servers and computing components to be fully submerged in a dielectric liquid, efficiently dissipating heat even in operating environments up to 50°C. This advanced cooling method eliminates the need for traditional data center air conditioning systems, significantly reducing energy consumption and optimizing thermal management	1.02x

SOURCE: INCRED RESEARCH, COMPANY REPORTS

What are the components of a liquid cooling system? ➤

A comprehensive liquid cooling system comprises several key components, with each playing a critical role in ensuring effective heat removal and system efficiency:

Coolant distribution unit (CDU): The CDU is the core of the system, managing the coolant flow, temperature, and pressure. It adjusts dynamically to maintain optimal conditions for heat transfer, ensuring the even distribution of coolant across the system.

Heat exchangers and pumps: Heat exchangers transfer heat from the coolant to a secondary fluid, usually water, which is cooled externally. Pumps ensure the coolant circulates consistently, maintaining efficient heat removal. The performance of the system depends on the design and efficiency of these components.

Liquid-cooled server racks: These racks are designed to seamlessly integrate with liquid cooling systems. They allow direct-to-chip or immersion cooling, with features for leak prevention, optimized airflow, and easy maintenance access.

Cooling fluid: The choice of cooling fluid depends on its thermal conductivity, electrical resistance, and chemical compatibility. Common fluids include water, glycol mixtures, and synthetic oils, each chosen based on operational requirements.

Figure 20: Direct-to-chip cooled rack

SOURCE: INCRED RESEARCH, VERTIV WEBSITE

Figure 21: Rear-door heat exchanger

SOURCE: INCRED RESEARCH, VERTIV WEBSITE

Figure 22: Air vs. water

Characteristics	Air	Water
Thermal conductivity[2] under 25°C (W/(m·K))	0.026	0.6089
Density (kg/m^3)	1.29 (1atm, 0°C)	1,000 (4°C)
Specific heat capacity - C_p (kJ/(kg·K))	1.004	4.2
Thermal capacity per unit volume[3] (kJ/(m^3·K))	1.30	4,200
Comparison	Benchmark	3,243

SOURCE: INCRED RESEARCH, SCHNEIDER ELECTRIC

Figure 23: Fluid compatibility with liquid cooling architectures

Liquid cooling method	Water based	Oil based	Engineered fluids
Direct to chip (single-phase)	Yes	No	Yes
Direct to chip (two-phase)	No	No	Yes
Immersive – chassis (single-phase)	No	Yes	Yes
Immersive – tub (single-phase)	No	Yes	Yes
Immersive – tub (two-phase)	No	No	Yes

SOURCE: INCRED RESEARCH, SCHNEIDER ELECTRIC

Notable examples of data centre liquid cooling initiatives in India include:

1. **The Nippon Telegraph and Telephone Public Corporation (NTT),** one of the top three global data centre service providers, has deployed liquid immersion cooling (LIC) and direct contact liquid cooling (DCLC) technologies in India, marking for the first time these technologies have been deployed in a production environment in the country. This deployment has resulted in ~30% improved energy efficiency.
2. **Yotta Group**, one of the top Indian data centre operators, also claims that Indian data centres with a PUE of between 1.5 and 1.6 can bring down the PUE level to 1.1 by adopting liquid cooling methods.
3. **Equinix** is now set to use liquid cooling in 100 data centres across the globe, including India. The company has also started constructing its upcoming data centres that are suitable for liquid cooling methods.
4. **CtrlS** recently launched a new AI-ready liquid cooled, data centre in Hyderabad with a 13MW capacity spread over 1,30,000 sq.ft. The company currently manages 15 data centres across eight markets with a total capacity of over 250MW and 120MW under construction.

Economics of cooling – capex and opex considerations

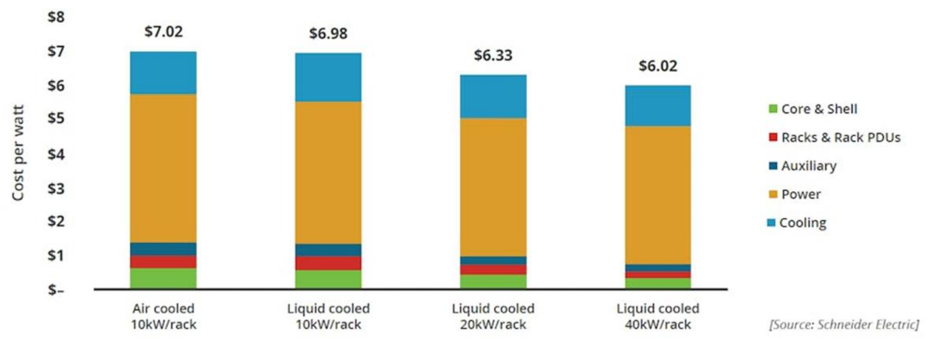
Low density liquid cooling doesn't offer any advantage

In a study by Schneider Electric, we see that for like densities (10kW/rack), the cost of an air-cooled and liquid-cooled data centre is roughly equal. When you go to liquid cooling, you remove the chillers, you remove the CRAHs, and you save on switchgear & UPS because the load is smaller without the server fans. But, if you add dry coolers and CRACs, you have an additional pump and piping cost, and you add a premium for the liquid cooling technology at the server and rack level (sealed chassis, dielectric fluid, liquid heat sinks, micro pumps, etc.).

However for higher density (increased compaction) liquid cooling offers a significant advantage

Immersion cooling also enables IT compaction; with compaction, there is an opportunity for capex and opex savings. Compared to the traditional data centre at 10 kW/rack, a 2x compaction (20 kW/rack) results in first-cost savings of 10%. When 4x compaction is assumed (40 kW/rack), savings go up to 14%.

Figure 24: Capex overview



SOURCE: INCRED RESEARCH, SCHNEIDER ELECTRIC

If high density racks are replaced with immersion, then the payback is as low as two years

These technologies deliver significant opex savings over time, primarily through reduced energy consumption. The top drivers of opex are rising equipment service and personnel costs, followed by rising energy costs. For example, liquid cooling systems for high-density racks (30-50+ kW per rack) with a PUE of 1.03 result in 95% opex savings due to lower energy demand.

Figure 25: Cooling tech opex & payback comparison

Metric	Air Cooling	Rear-Door Heat Exchanger	Liquid Cooling
Opex savings	Baseline	40-60% reduction	60-95% reduction
Payback Period	-	2-3 years	1.5-2.5 years

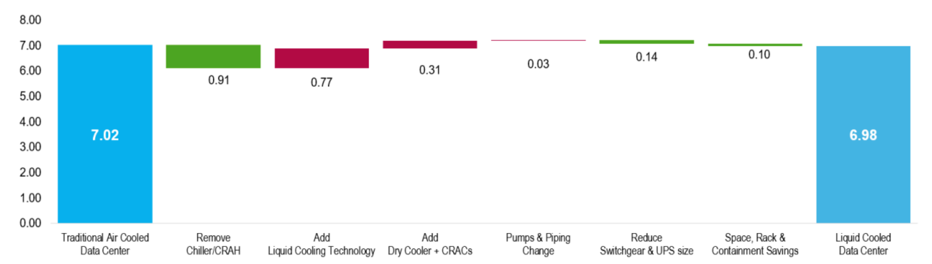
SOURCES: INCRED RESEARCH, COOLIT SYSTEMS

Setting the stage for cooling costs

Calculating cooling equipment costs, we start with the assumption that the overall cost per watt for cooling infrastructure in data centres is US$7.02 per watt. This figure includes all the various cooling components needed to support high-density racks.

- **Liquid cooling technology**: A premium of US$0.77 per watt is allocated specifically for liquid cooling technology. This cost accounts for all the specialized components required, including sealed chassis, dielectric fluids, liquid heat sinks, micro pumps, heat exchangers, and rack manifolds. These technologies are essential in maintaining cooling efficiency for high-performance workloads.
- **Dry coolers + CRACs**: Traditional air-based cooling systems, consisting of dry coolers and CRAC units (computer room air-conditioners), add US$0.31 per watt. These systems are still commonly used in lower density or hybrid set-ups where some heat can be rejected without the use of compressors.
- **CDUs + pumps and piping**: Coolant distribution units (CDUs), along with pumps and piping, add US$0.23 per watt to overall cooling costs. CDUs manage the coolant flow and maintain the temperature and chemistry of the water, which is crucial for liquid cooling systems. Pumps and piping ensure that the warm water is circulated effectively to remove heat from the servers.

Figure 26: Cost/watt difference of air-cooled vs. liquid-cooled data centre at 10kW/rack



SOURCE: INCRED RESEARCH, SCHNEIDER ELECTRIC

Demand analysis for data centres: Capacity growth (FY24 to FY28F)

India's data centre market is on a steep growth trajectory, In FY24, the total data centre capacity stood at 1.074GW, and by FY28F, this capacity is expected to rise to **3.2GW**. This translates into an incremental capacity of 2.126GW.

- **Incremental liquid-cooled capacity**: Of the 2.12GW of new capacity, 850 MW (40%) is projected to be cooled using liquid-cooling technologies, reflecting a shift towards the more energy-efficient cooling solutions as power densities rise.
- **Power density per rack**: The average power density is projected to increase to 40kW per rack. This highlights the rising demand for efficient cooling systems capable of handling high-density racks, especially in AI-driven environments.

Cooling equipment cost breakdown (FY28 forecast)

The incremental growth in data centre capacity brings with it significant costs associated with cooling infrastructure. Here's a detailed cost breakdown based on the assumptions:

- **Total cost**: The overall cost for the incremental 2.12GW of data centre capacity is estimated at US$15bn.
- **Liquid cooling technology**: The cost of deploying liquid cooling technologies for 850MW is projected to be US$655m. This includes all the necessary components, such as chassis-level cooling systems, heat exchangers, and other specialized infrastructure to handle liquid-cooled racks.
- **Dry coolers + CRACs**: The cost for deploying traditional air-based cooling systems, such as dry coolers and CRACs, is estimated to be US$264m. These systems are expected to be deployed in less dense or hybrid data centre environments.
- **CDUs + pumps and piping**: The infrastructure required to support liquid cooling, including CDUs, pumps, and piping, is projected to cost US$200 m. CDUs play a critical role in ensuring proper coolant flow and maintaining water quality, while pumps and piping ensure efficient heat transfer.

Companies who are present in cooling technology

Cooling technology players are critical to the future of the data centre industry. Focus on companies that specialize in high-efficiency cooling systems, such as Schneider Electric, Vertiv, etc. which have made significant inroads into data centre cooling infrastructure. These companies stand to benefit as AI and other high-power workloads become the norm, increasing the demand for advanced cooling solutions.

- **Schneider Electric India:** Precision air-conditioning, in-row cooling systems, and air economizers. The company's EcoStruxure data centre solutions focus on improving energy efficiency and power usage effectiveness (PUE). Schneider is a global leader with its sales exceeding €25.2bn globally in 2020, and India serves as one of its four international hubs.
- **Delta Electronics India:** InfraSuite Precision Cooling Solutions, including chilled water systems and immersion cooling. Delta Electronics India aims to capture a significant market share in the data centre cooling segment, bolstered by its investment in local manufacturing in India.
- **Mitsubishi Electric India:** The company provides air-cooled chillers, water-cooled chillers, and precision cooling solutions. These products are focused on delivering energy-efficient cooling for data centres across India.
- **Vertiv Group Corporation:** The company's cooling solutions include precision cooling, heat management, and humidity control systems suitable for hyperscale and enterprise data centres. The company has a broad global footprint, providing advanced infrastructure solutions.
- **Kirloskar Chillers Private Limited:** The company provides both air-cooled and water-cooled chillers optimized for energy-efficient cooling in data centres. The focus is on operational efficiency and sustainable solutions.

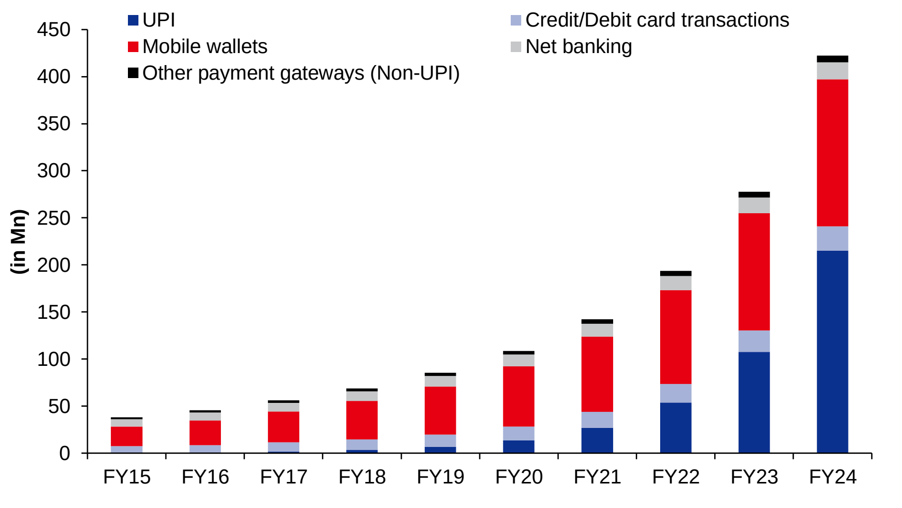
Data localization in India: A critical analysis of power, cooling, and data consumption

India's digital ecosystem has rapidly evolved, with digital transactions and social media usage reaching unprecedented levels. As the government plans to mandate the storage of transaction data within the country, understanding the implications on power and energy consumption, and data storage requirement becomes crucial.

India's digital transactions skyrocket at ~33% CAGR and the UPI platform leads with 430m transactions daily

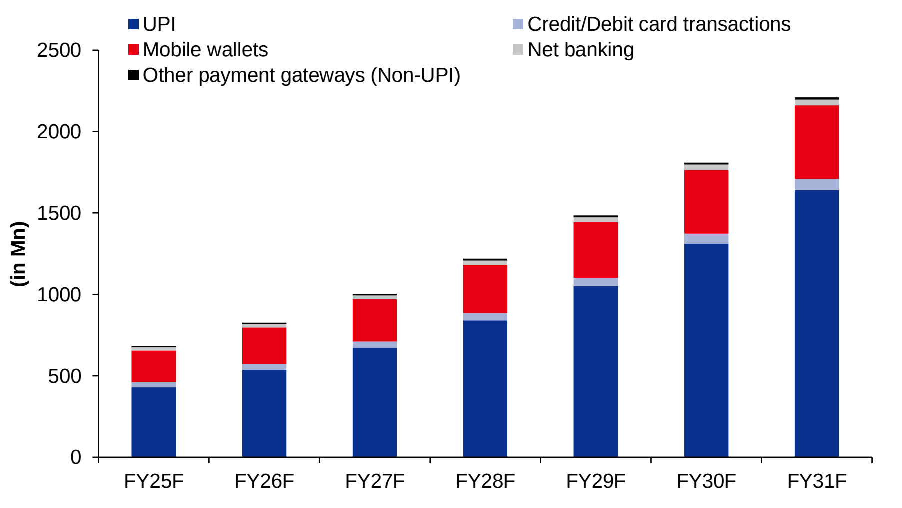
Over the past decade, India's digital transaction platforms have experienced explosive growth, growing at a compounded annual growth rate (CAGR) of approximately 33%. UPI alone processes around 13bn transactions monthly, translating to approximately 430m transactions daily. Credit and debit card transactions, including both Point-of-Sale or PoS and online, account for around 27-30m transactions per day, while mobile wallets like Paytm and Google Pay handle about 190-200m transactions daily. Collectively, these platforms facilitate between 668-695m digital transactions daily, reflecting India's rapid shift towards a cashless economy.

Figure 27: Historical transaction volume of different interfaces/day



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 28: Projected transaction volume of different interfaces/day

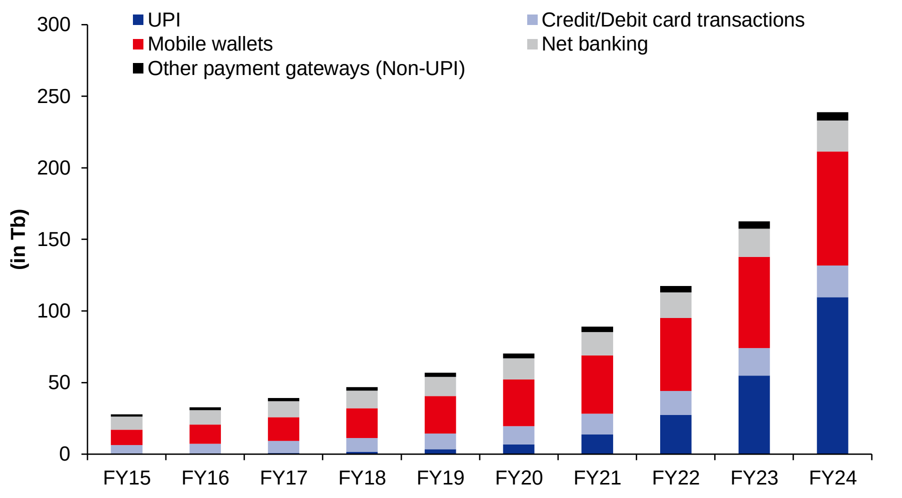


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Data consumption booms as India's digital transactions drive 375TB annually and is projected to post a 22% CAGR

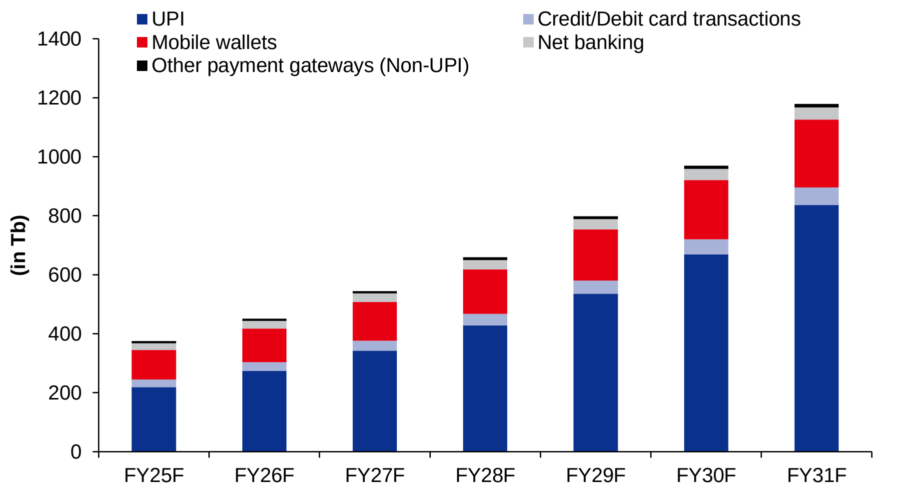
The massive volume of digital transactions and social media activity in India generates immense data annually. Platforms like UPI, credit/debit cards, and mobile wallets collectively consume between 360TB (terabyte) to 412.7TB of data annually. Future projections indicate continued expansion at a 22% CAGR over the next five-to-seven years. This growth highlights the critical need for scalable data infrastructure as India embraces the digital age.

Figure 29: Yearly historical data consumption of different interfaces



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 30: Yearly projected data consumption of different interfaces

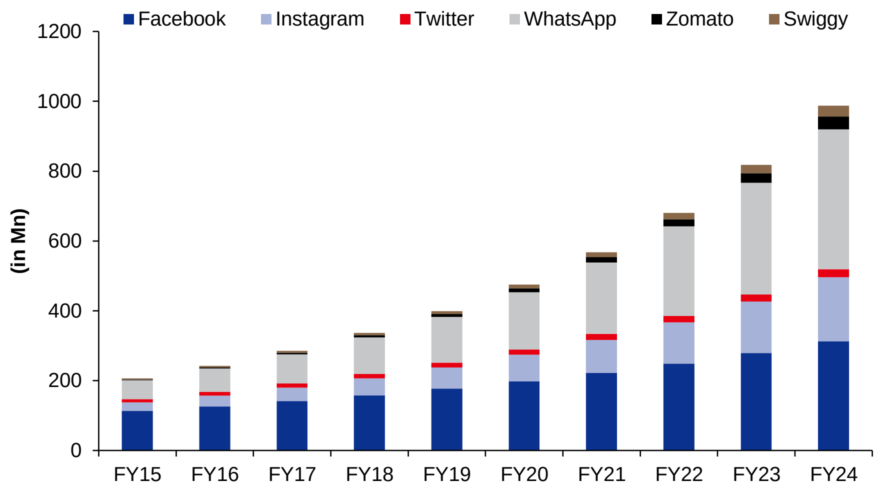


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Social media user base expands at a 19% CAGR, driving India's digital engagement

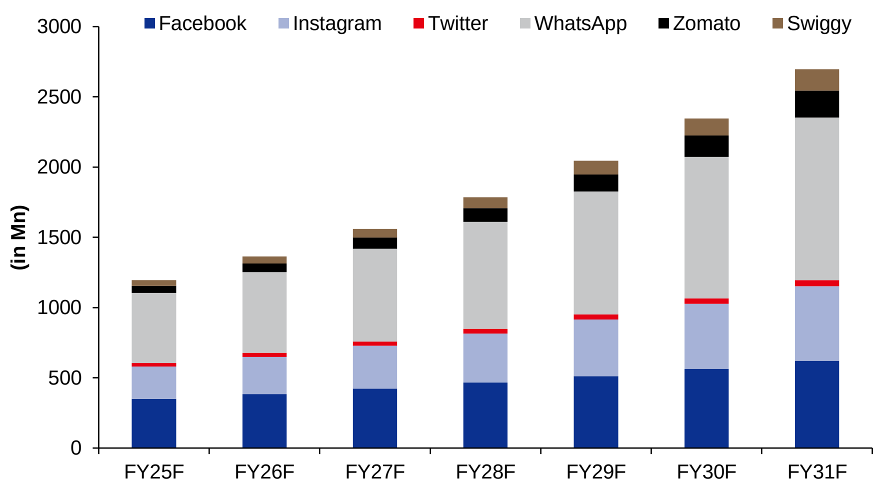
India's social media landscape has experienced significant expansion over the past decade, with platforms like Facebook, Twitter, Instagram, WhatsApp, and Zomato witnessing a combined annual growth rate (CAGR) of approximately 19%. Facebook leads with around 350m users, followed by WhatsApp with 500m users, and Instagram with 230m users. These platforms have become integral to daily life, driving a substantial increase in user engagement and data consumption as more and more Indians come online and interact through these digital channels.

Figure 31: Historical average user base of different digital interfaces



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 32: Projected average user base of different digital interfaces

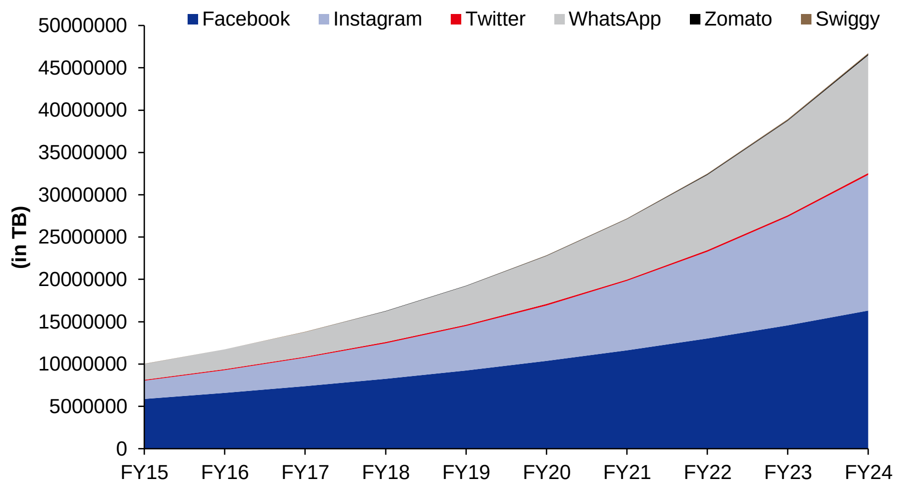


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Data consumption set to surge with a 15% annual growth as India's social media usage escalates

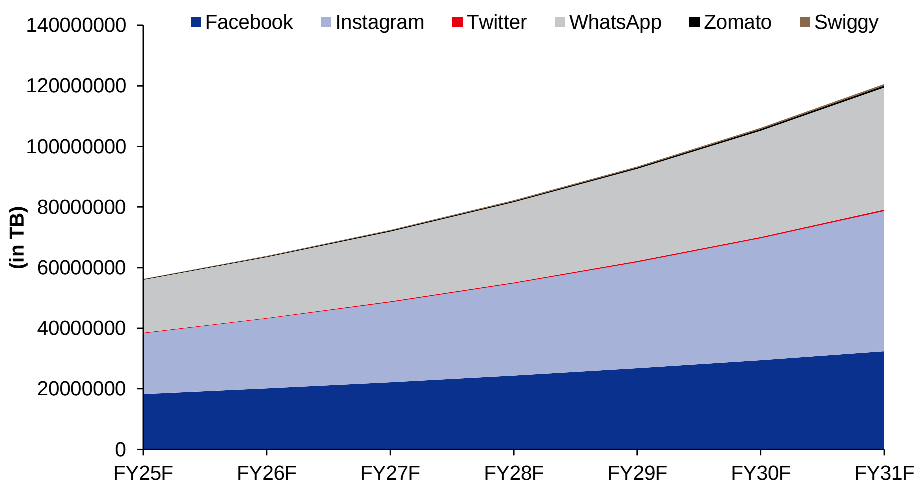
The rising number of social media users has directly contributed to a massive surge in data consumption across platforms like Facebook, WhatsApp, and Instagram. Currently, these platforms collectively consume around 58.2EB (exabyte) of data annually. With a projected growth rate of 15% CAGR over the next five-to-seven years, data consumption is expected to continue its upward trajectory, driven by increased user activity, richer media content, and the ongoing expansion of India's digital ecosystem. This highlights the critical need for scalable and efficient data storage solutions to accommodate future growth.

Figure 33: Yearly historical data consumption of different interfaces



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 34: Yearly projected data consumption of different interfaces



SOURCE: INCRED RESEARCH, COMPANY REPORTS

India's data localization bill to create additional power demand of ~30GW as digital transactions and social media data soar

Data centres are the powerhouses that will sustain India's data localization efforts. However, the energy requirement to store and manage transaction data is immense. For instance, storing just 1TB of data in active SSDs (solid state drives) requires approximately 262kWhr of power annually. When scaled to the volume of transaction data and digital media data, the energy and power demand escalates to around ~6.2GWh per year for historical and future transaction data, which includes interfaces such as UPI, credit & debit cards, Amazon Pay, G-Pay etc., and ~30GW for historical and future digital media data which includes Facebook, Twitter, Instagram, Zomato, etc. These figures underscore the importance of investing in energy-efficient data centres to support the growing digital economy while minimizing the environmental impact.

Cooling equipment cost breakdown for 30GW

The incremental growth in data centre capacity necessitates significant investment in cooling infrastructure. Based on the assumptions, here's the breakdown:

- **Total data centre cost**: For 30GW incremental capacity, the total cooling cost is projected to be around US$210.6bn.
- **Liquid cooling technology**: To support 12GW of liquid-cooled data centre capacity, the projected cost is US$9.24bn. This investment includes all components of liquid cooling systems, such as chassis-level cooling systems, heat exchangers, and other specialized infrastructure required for liquid-cooled racks.
- **Dry coolers + CRACs**: For air-cooled and hybrid environments (handling the remaining 18GW), the cost for dry coolers and CRACs is projected to be US$3.72bn. These systems will still be used in lower-density data centres where cooling needs are less demanding.
- **CDUs + pumps and piping**: The infrastructure for liquid cooling (including CDUs, pumps, and piping) will require an investment of US$2.76bn. These components are critical for ensuring that the coolant is distributed evenly across the system and that the necessary maintenance processes are in place.

Figure 35: Power required for storing historical transaction data (FY15-24)

Total historical data (TB)	**882**
Power required/TB (W)	8.5
Energy required/TB (kWh/yr)	74
No of required copies	3
PUE	1.5
Total power required (kW)	33.7
Total energy required (MWh/yr)	295

SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 36: Power required for storing future transaction data (FY25F-31F)

Total future data (TB)	**4,978**
Power required/TB (W)	30
Energy required/TB (kWh/yr)	263
No of required copies	3
PUE	1.5
Total power required (kW)	672
Total energy required (GWh/yr)	5.9

SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 37: Power required for storing historical digital media data (FY15-24)

Total historical data (TB)	**23,93,71,258**
Power required/TB (W)	8.5
Energy required/TB (kWh/yr)	74
PUE	1.5
Total power required (GW)	3.1
Total energy required (GWh/yr)	26,735

SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 38: Power required for storing future digital media data (FY25F-31F)

Total future data (TB)	**59,46,92,422**
Power req./TB (W)	30
Energy req./TB (kWh/yr)	263
PUE	1.5
Total power req. (GW)	27
Total energy req. (GWh/yr)	2,34,428

SOURCE: INCRED RESEARCH, COMPANY REPORTS

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Hold	The stock's total return is expected to be between 0% and positive 10% over the next 12 months.
Reduce	The stock's total return is expected to fall below 0% or more over the next 12 months.

The total expected return of a stock is defined as the sum of the: (i) percentage difference between the target price and the current price and (ii) the forward net dividend yields of the stock. Stock price targets have an investment horizon of 12 months.

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Underweight	An Underweight rating means investors should be positioned with a below-market weight in this country relative to benchmark.