WRI INDIA

CONFERENCE PROCEEDINGS

Emerging AI Technologies for a Sustainable Future: Prospects and Challenges

KEY INSIGHTS FROM THE WORKSHOP

11 April 2026 | IIT Tirupati, Andhra Pradesh | Compiled by: Dr. Varun Jyothiprakash, Ananya Srinivasan, Dr. Shaurya Rahul Narlanka, Tarandeep Kaur, Sweta Bhushan and Professor Chandra Sekhar Bahinipati

Introduction

India stands at the cusp of an artificial intelligence (AI) revolution. However, this transformation risks reinforcing existing inequalities, such as disparities in digital access, connectivity, affordability, skills, language inclusion and representation, particularly among rural, low-income and marginalised communities. The rapid expansion of AI data centres could place additional pressure on India's energy system and complicate its long-term decarbonisation ambitions. Under current trends, electricity consumption from data centres is projected to reach 700 terawatt-hour (TWh) by 2070 (NITI Aayog 2026a). The data centre industry's growing water footprint presents another critical challenge, as nearly 75 per cent of India's data centres are located in water-stressed states, such as Maharashtra, Tamil Nadu, Karnataka, Telangana and Uttar Pradesh, where the pressure on water supplies is expected to intensify as the capacity of data centres expands (Kuzma et al. 2023).

Yet, AI also offers an opportunity to address India's long-standing labour market challenges: nearly 90 per cent of the workforce is employed in the informal sector, often characterised by low wages, limited mobility and weak job security (ILO and IHD 2024). If deployed within a comprehensive, inclusive and equitable policy framework, AI could support transitions towards more productive and higher-quality employment, particularly in emerging green industries and the AI sector.

To identify the key challenges and opportunities associated with the rising adoption of AI in India and discuss methods for reliably quantifying AI's resource-use impacts, the Indian Institute of Technology (IIT) Tirupati and WRI India organised 'Emerging Artificial Intelligence (AI) Technologies for a Sustainable Future: Prospects and Challenges', a one-day hybrid workshop on 11 April 2026 that brought together experts, researchers, academicians and students.

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Prof. K. N. Satyanarayana, Director of IIT Tirupati, delivered an opening statement that set the tone for discussions at the conference. He highlighted the rapid growth of investment in AI data centres across states such as Andhra Pradesh and emphasised the urgent need to address their significant resource demands, particularly in terms of water and energy consumption.

Building on these concerns, the keynote speaker, Ulka Kelkar, Executive Director of the Climate, Economics and Finance programme at WRI India, highlighted the wider economic, energy, financial, supply-chain, and labour risks associated with the rapid growth of AI infrastructure in India.

The opening statements were followed by three panel discussions, two presentations, and one participant discussion session that sought to assess how AI could be aligned with India's climate mitigation and just transition goals.

Summary of panel discussions

The following sections describe each of the panel discussions in detail and distil their key takeaways. Insights from the participant discussions are included where relevant.

Panel 1: Energy use and AI

The panel discussed the technological implications of AI growth for India's energy infrastructure, focusing on how growing demand from data centres could affect the reliability, planning, and decarbonisation of the country's power system.

As AI adoption increases, concerns are emerging about how land, water and minerals can be used more efficiently so that the electricity grid can meet the resulting growth in energy demand. To help identify feasible pathways, panellists emphasised the importance of technological efficiency, grid planning, and consumer-level accountability.

Estimating data centre electricity demand

The discussion began by highlighting the first step towards energy optimisation in data centres: estimating data centre energy demand, which can be achieved through bottom-up and top-down approaches.

The bottom-up approach estimates electricity demand by examining the hardware and infrastructure specifications of a data centre. It begins at the level of components (servers, cooling systems, storage and power systems) and then aggregates these estimates into total energy demand.

In contrast, the top-down approach uses broader market indicators and historical trends to project future energy demand. These indicators may include the pace of AI adoption, growth in AI-related research and workforce capacity, investment flows, and expansion trends observed in more advanced AI economies. Such benchmarks can then be used to estimate the likely trajectory of data centre electricity demand in India.

However, the discussion highlighted that neither approach is sufficient on its own. A bottom-up approach may provide technical detail but may not fully capture market-driven growth. A top-down approach may reflect broader trends but may overlook infrastructure-level variations. Therefore, combining both methods could provide a more robust projection of India's future data centre electricity demand.

Hardware and software optimisation for energy efficiency

To reduce the environmental and resource footprint of AI data centres, a panellist suggested three measures: edge computing,[1] model compression using quantisation and distillation,[2] and a reduced dependence on imported graphics processing units (GPUs) by shifting suitable workloads to central processing units (CPUs) to lower total system costs.

Panellists also highlighted the importance of generating more granular insights into power surges and temperature fluctuations. Because average values can mask short-term fluctuations that affect system performance, panellists proposed training AI models on data collected at five- to ten-minute intervals to capture these fluctuations more precisely and improve output accuracy. To bring these parameters within a single framework, a speaker proposed a 'Multimodal AI' design in which a unified model processes sensor readings, text information, and historical records (McKinsey Co. 2025). This integrated approach could improve accuracy while reducing computational load and energy consumption.

From a software perspective, a primary challenge in defining the AI growth pathway is that AI no longer operates as a stand-alone tool but is increasingly embedded in the back end of almost all devices and applications. Its rapid integration

into smartphones, in particular, is emerging as a significant driver of energy demand. As improvements in hardware efficiency may not be sufficient to offset this growth, it is important to distinguish between the intentional use of AI and applications that continuously operate in the background. To improve software efficiency, panellists recommended techniques such as model pruning and quantisation[3], which can reduce the computational requirements and energy consumption of AI models (Rajan 2025).

Renewable energy integration

Along with discussing the rising demand for data centres in India, experts emphasised the need to increase the use of cleaner electricity and reduce the country's dependence on thermal power, mainly to reduce greenhouse gas emissions. In this context, state-level green-tariff incentives and the revised Nationally Determined Contributions (NDC) target of achieving 60 per cent of the installed electricity capacity from non-fossil sources by 2035 could strengthen the country's pathway towards net zero emissions by 2070 (Government of India 2026).

The adoption of renewable energy (RE) in the power sector was attributed to the falling economic costs of solar and wind energy relative to coal, as well as falling battery costs (Kapoor and Chalamalasetty 2023). Therefore, to better understand the rate of adoption, required capacities, and costs incurred for each energy source and generate reliable projections of electricity demand and supply, energy-economy models must be used that incorporate the relevant national and subnational policies while accounting for the distinct electricity-use patterns of AI data centres. In particular, the models should differentiate between flat training loads and fluctuating inference peaks. Effective long-term modelling must also be supported by policy certainty at both the national and subnational levels, enabling institutions to align incoming investments with anticipated growth in electricity demand. Further, the panellists identified demand-side management as an important component of this transition. Modelling can help identify opportunities to shift flexible AI workloads away from peak hours and reduce dependence on thermal backup for power (Song 2025).

However, shifting AI-related electricity demand towards cleaner energy sources also presents important technical and financial trade-offs. The speakers noted that achieving uninterrupted operation without thermal backup may require substantial oversizing of RE capacity and storage systems. Although this could improve reliability and reduce emissions, it may also increase system costs and contribute to stranded assets as fossil fuel–based power plants lose value, retire earlier than expected, and generate financial losses. At the same time, the high financial penalties associated with data-centre downtime may encourage operators to prioritise redundancy and uninterrupted supply over energy efficiency. Therefore, experts emphasised that high-cost RE and storage configurations need to be balanced with reliability requirements and the global competitiveness of India's data-centre industry.

Responsible AI use and its energy implications

The panellists broke the topic down into four major themes: model overuse; the sustainability paradox in AI; dynamic volatility; and policy governance.

Model overuse

Users employ high-energy models for executing relatively simple tasks (generating minor text commands or standard 'Hello World' coding scripts). Model overuse makes it difficult to project the energy demands of AI.

Sustainability paradox in AI

While AI-based sensors and monitoring systems can improve the operational efficiency of data centre infrastructure, their deployment may itself require additional energy. In some cases, the energy consumed by AI-enabled optimisation systems may offset, or even exceed, the energy savings generated through the optimisation process. To address this sustainability paradox, energy demand models should consider need-based and behavioural patterns of AI use rather than assuming a linear increase in adoption.

Dynamic volatility

Panellists explained that energy demand during AI training is highly unpredictable, even on a millisecond timescale, as peaks can shift almost instantly. These shifts are too rapid and abrupt for utilities to manage; data centres must therefore rely on on-site storage systems such as batteries. As AI becomes increasingly embedded across software applications, the aggregation of these short-duration demand spikes can place substantial stress on the power system. As a result, average load alone may not adequately capture the infrastructure requirements of AI data centres, highlighting the need to consider peak load and short-term demand variability in system planning.

Policy governance

Effective policy governance can help moderate the growth of AI-related energy demand by prioritising its use for essential and high-value applications. At the same time, flexible and domain-specific models are needed to keep pace with rapid technological change and produce more reliable projections. Therefore, cross-sectoral adaptability, supported by consistent software standards, will be important for ensuring that AI governance remains both responsive and effective.

Reporting and sustainability metrics

Data centre efficiency helps to reduce resource use and environmental impacts. Government mandates influence data centre efficiency, and a panellist highlighted their importance by drawing parallels with other countries that have power usage effectiveness[4] (PUE) mandates for all data centre facilities. For example, upcoming facilities in Germany must meet a maximum PUE of 1.2, while existing facilities must meet a maximum PUE of 1.3 (Telyatnykov et al. 2023). Countries in West Asia and Africa tend to have higher PUE values because more energy is required for cooling, so climate variables such as heat stress play an important role in estimating this standard.

Integrating PUE with another parameter, water usage effectiveness[5] (WUE), can improve the credibility of a reporting framework. The framework could also incorporate a water scarcity factor that gives higher weightage to resource use in water-stressed areas and lower weightage in water-abundant areas, thereby supporting regional equity. Panellists added that India could adopt a two-step approach that involves setting national mandates for new facilities (PUE < 1.25) while requiring mandatory retrofitting for inefficient existing facilities (Deng et al. 2026).

As India is at an early stage of AI growth, achieving a PUE as low as 1.25 may be difficult. The current mandates in the country aim for a PUE of 1.5 (Bajpai and Mothkoor 2025).

Panel 2: AI and the Indian economy

In India, the use of AI is burgeoning, as is evident from the current pace of adoption. As dependence on AI increases across sectors, questions arise about the implications for different parts of the Indian economy.

The panel discussed AI's effects on the economy, jobs and marginalised communities, as well as the policy approaches needed to minimise the unintended consequences of AI expansion. The panel examined the guiding design principles necessary to ensure that consumption of AI is sustainable and equitable. The discussion explored how the potential of AI can be realised in sectors such as agriculture and disaster management.

AI's impact on jobs, inequality, and the need for frameworks to ensure marginalised communities remain unaffected

The notion that the increasing integration of AI causes job losses is common. The discussion began by challenging that notion.

To understand the shift towards AI-based workstreams, panellists suggested that changes in job roles, rather than job losses alone, should be emphasised. Sector-specific reskilling is important; however, lower digital literacy levels among unskilled workers are likely to make this challenging.

Training programmes are required to enable the creation of new job roles. In addition to such training programmes, awareness is crucial in addressing uncertainty around employability. Moreover, to safeguard against job losses due to AI, labour laws should be integrated with AI policies.

In the context of inequality, preliminary results from a speaker's study revealed that the Gini coefficient (a statistical measure of economic inequality) increased by 0.04 from the baseline for state-level AI platforms (AI systems developed or deployed by individual state governments to support public services and administration) and by 0.03 for big-platform AI models (AI technologies created and operated by major private technology companies with broad, cross-regional or national reach). These effects were most pronounced in Karnataka and Maharashtra, largely because most data centres are currently concentrated in these two states, suggesting that the economic benefits and risks associated with AI may be unevenly distributed across states.

The speaker also described examples of marginalised groups, such as visually impaired students and digital novices, being unable to interact with AI and other digital applications. They highlighted the need to identify and acknowledge different types of imbalance within the system so that more inclusive frameworks can be developed.

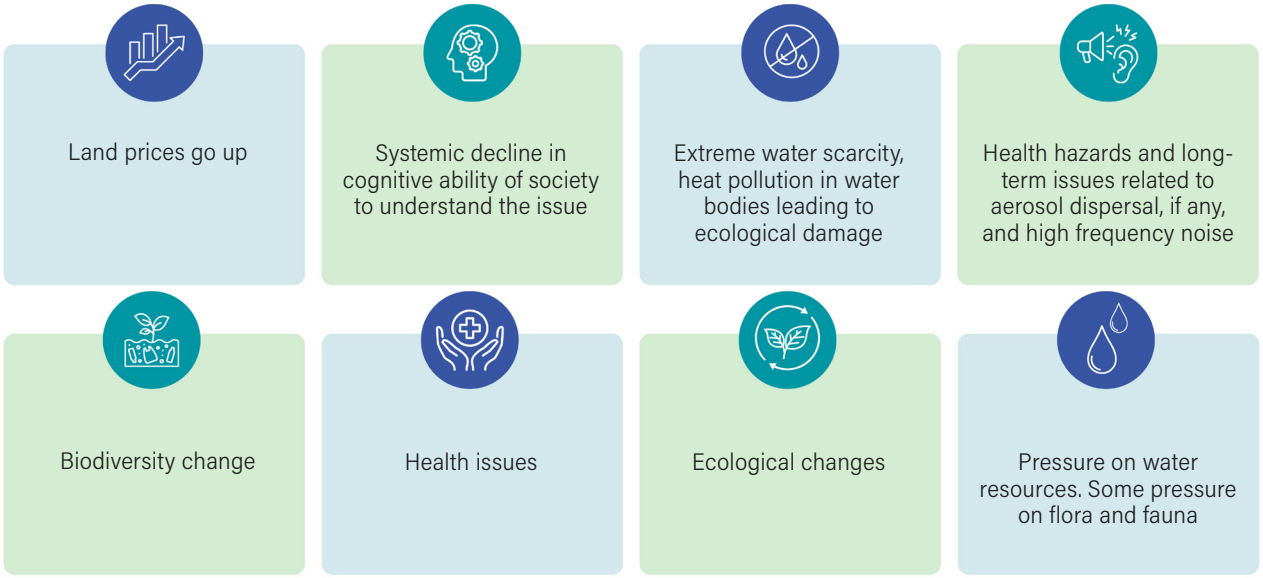
Moreover, basic questions, such as what constitutes marginality, need to be clearly defined and documented before policies are designed to minimise the negative impacts of AI on marginalised communities.

Participant responses on the social impacts of data centre expansion

In an interactive session, workshop participants discussed the social implications of the expansion of data centres, including water scarcity and heat pollution in water bodies, ecological and biodiversity changes, health hazards and rising land prices (Figure 1).

FIGURE 1 | Participant responses on social implications of data centre expansion

What social impacts can arise due to the scaling of AI data centres aside from noise pollution, heat dissipation, e-waste generation and land price changes?



Source: Responses collected from participants through Mentimeter.

Systems needed to ensure that AI use is fair, efficient and accessible

AI development is progressing rapidly. Recognising this, the panellists suggested that guiding principles are needed to support sustainable development. A panellist identified three considerations for AI governance: safety, economic impacts and environmental impacts.

In terms of safety, algorithmic accountability (the ability to trace decisions made by algorithms) is essential for identifying biases that could otherwise undermine the reliability and fairness of their outputs. Panellists also stressed the importance of retaining human expertise and oversight, particularly in critical applications where errors may have serious consequences. Two panellists pointed out that AI systems can have difficulty with inverse mathematical problems, which involve working backwards from results to determine the original inputs or causes. Such limitations can contribute to inaccurate or fabricated outputs, commonly referred to as hallucinations. Human validation should therefore remain an integral part of AI-assisted decision-making, especially in high-risk contexts.

Sector-wide AI integration can lead to recurring job losses. To address this risk, panellists referred to the OECD AI Principles, which emphasise inclusive growth, equitable access and preparation for labour market change.

On the environmental front, the discussion stressed the need to prioritise efficiency parameters, which are often treated as a compromise in algorithm design. These include battery and water use, alongside optimality and accuracy.

With respect to governance, a panellist emphasised that the starting point should be raising awareness of AI systems and introducing AI literacy in the early stages of education. The panellist also noted that legal frameworks such as Intellectual Property Rights (IPR) can play an important role in ensuring that AI is accessible. They further highlighted the role of evaluation frameworks in minimising inaccuracies in outputs caused by data outliers and algorithmic biases.

Given that AI technologies are at a relatively early stage of development, the panel stated that India is well-positioned to effectively implement safeguards within AI systems. For future policy frameworks, an expert identified guiding principles: transparency; reliability and safety; and accessibility.

Transparency requires AI-generated outputs to be explainable and interpretable. Reliability and safety depend on the system's ability to recognise when the available input data are insufficient and to communicate these limitations rather than generate unsupported outputs. Accessibility requires AI systems to be easily integrated into existing workflows, including through compatibility with multiple languages, voices and speech patterns, while minimising biases related to race, gender, culture and other factors.

The panellists therefore emphasised the need for a policy framework that consolidates principles to guide, evaluate and harmonise AI design among the players within the system. Such an integrated framework is currently lacking.

AI's impact on economic productivity, growth, sustainability, and climate change

A speaker noted that several global studies suggest AI will make a significant contribution to productivity gains in the coming decades, but comparable sector-specific studies for India remain limited. One study predicts that, through integration into workstreams, AI could contribute 10–12 per cent in sectors such as software development and up to 66 per cent in other sectors between 2030 and 2035 (EY 2025).

The panellist referred to opportunities such as inclusive digital public infrastructure and India's AI digital stack. For instance, Bhashini, an AI-powered multilingual platform launched by the Government of India, was cited as a case in which AI could help create economic opportunities for 490 million informal workers by overcoming language barriers to employment and improving digital inclusion (PIB 2025). Other examples of AI's emerging role in improving agricultural productivity and creating an enabling environment for farmers include Bharat VISTAAR (PIB 2026b), a multilingual agricultural advisory service, and AgriStack (PIB 2026a), which provides a unified digital identity for farmers and their farm-related data.

In discussing AI's role in climate resilience, the speaker noted that AI could greatly enhance disaster management, particularly by helping to quantify indirect losses, such as supply-chain disruptions, lost livelihoods and reduced well-being, that are otherwise difficult to estimate. These losses can be several times greater than direct losses, such as infrastructure damage and casualties, underscoring the broader resilience dividend. The discussion concluded by highlighting India's potential to use digital AI infrastructure to empower workers, create enabling platforms across sectors and strengthen resilience from the grassroots up.

Panel 3: AI and resource use

The panel on AI and resource use discussed how the new wave of data centre expansion requires a nuanced understanding of the implications of resource use across space and time. Competing demands on land, water and energy infrastructure are expected to intensify as data centre capacity expands. Data centres must be planned in accordance with economic, technical and emissions constraints and situated within a broader, systems-wide approach. For power-intensive facilities like data centres, energy use must be understood not only in terms of electricity consumption but also through its links to land, water, rights of way and the environment.

Supply planning for data centre expansion

The panellists noted that data centres represent a lucrative load for electricity utilities having high load factors (around 80-90 per cent), which enable optimum utilisation of the transmission and distribution (T&D) assets. Moreover, these are usually creditworthy customers who pay their electricity bills on time and shoulder the cross-subsidy burden. While AI data centre load may be commercially viable for utilities, they also need to consider technical parameters such as resource adequacy and load characteristics. The quantum of energy required cannot be understood solely through national-level averages in electricity demand growth.

From the perspective of the grid, electricity demand is expected to be experienced locally at specific locations, across particular voltage levels, during certain times of the day, and within the constraints of the existing T&D network. Supply planning requires an assessment of technology availability, load concentration and profile, reliability requirements, and grid interactions. The panel raised concerns over the ongoing urban-centric expansion that risks exacerbating pressure on infrastructure in a handful of cities. Considering that India is yet to build a substantial portion of its AI infrastructure, panellists suggested that strategies for locating these AI data centres need utmost attention.

Water use implications of AI data centres

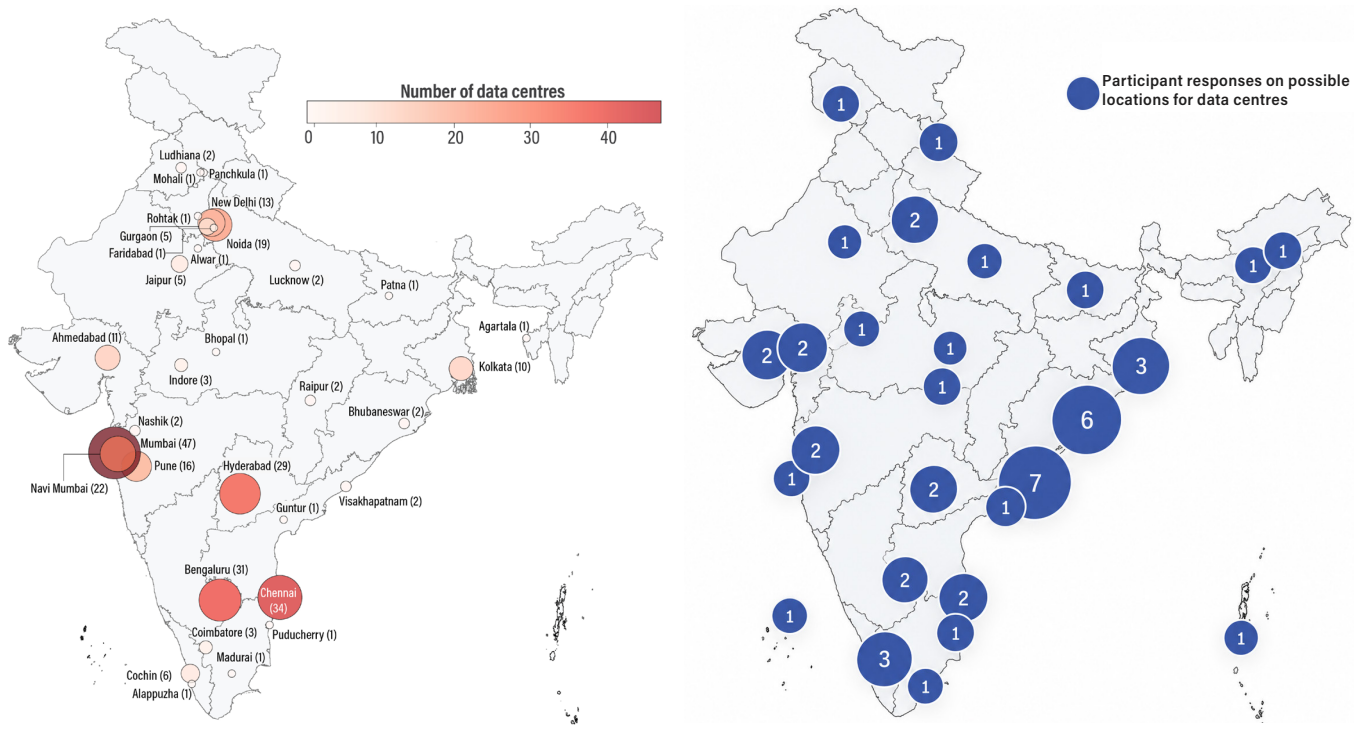
One panellist noted that rising water demand from data centres presents a dual problem. On the one hand, it raises concerns over access to water for local communities and the environmental impact due to potential groundwater depletion. On the other hand, it threatens the operational and financial viability of data centre business models, with potentially cascading effects on downstream sectors. For example, the financial sector increasingly relies on digital services, and access to banking will depend on the seamless operation of data centres. If data centres' cooling requirements are not met, banking services may be severely affected, with financial consequences for people and businesses.

Although unrestricted water use can support short-term viability, it is unsustainable over the long term. Inadequate water supplies could result in stranded assets and financial losses for investors. Additionally, cooling demand is expected to increase because of extremely high summer temperatures and unusually high temperatures at other times of the year. At the same time, urban expansion creates an opportunity to reuse city wastewater for data centre cooling.

Participant responses on future data centre expansion

Data centre capacity is highly concentrated, with just five states accounting for almost 75 per cent of the total load. When asked to identify ideal locations for AI data centres, based on parameters such as state policies, energy reliability, land availability, and water sufficiency, participants agreed on existing data centre hubs such as Mumbai, Chennai, Hyderabad and Bengaluru. Cities such as Visakhapatnam, where data centre projects have been announced recently, were preferred, too (Figure 2). Expressing concerns over the concentration of data centres in a few cities, participants said that upcoming data centres should be planned across India, in states such as Gujarat, Odisha, Andhra Pradesh, Kerala, and Tamil Nadu, where seawater could also be used for cooling, although data centre capacity is limited as of 2025.

FIGURE 2 | Existing locations of data centres in India (left) and participant responses on possible locations for AI data centres in the future (right)



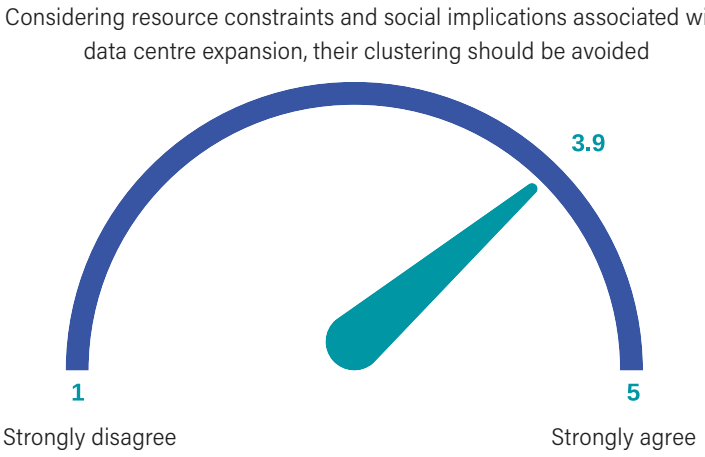
Source: www.datacentermap.com

Disclaimer: Maps are for illustrative purposes and do not imply the expression of any opinion on the part of WRI India, concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

Note: The blue circles represent the possible location of upcoming data centres identified by the participants. The numbers inside the circle represent the number of participants choosing the same location for future data centres.

Considering the constraints on resources (land, energy and water) and the social implications of those constraints, participants agreed that data centres should not be clustered; instead, a hybrid model combining hyperscale and micro data centres should be promoted (Figure 3).

FIGURE 3 | Participant responses on the question of clustering of AI data centres



Source: Responses collected from participants through Mentimeter.

Note: Responses are based on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A total of 62 participants responded to this question with the average response score being 3.9.

AI's role in energy and water efficiency improvements

The discussion explored AI's role as a major consumer of electricity and water, and as an enabler of resource efficiency.

By using weather data, AI can improve forecasts of potential solar and wind generation by 15–20 per cent. This can help address the duck-curve problem by shifting electricity demand to daylight hours, in line with solar generation. This could facilitate better load management, reduce curtailment, alleviate grid congestion and reduce Deviation Settlement Mechanism (DSM) penalties.

Artificial intelligence can also help microgrids participate in electricity markets based on pricing signals, weather information, and electricity demand. At the consumer level, AI-enabled smart devices could optimise energy use by making decisions based on factors such as temperature, time of use, electricity prices and energy-efficiency requirements. However, one panellist cautioned that AI systems may not fully capture the complexity and diversity of the Indian market. The panellist further explained that despite this limitation, the same data-driven optimisation used in electricity markets can extend to carbon markets, as improved measurement and forecasting of energy use and emissions enable more accurate valuation of carbon reductions. In this way, AI can support carbon-price discovery by linking real-time energy consumption patterns with emissions data, thereby informing the design and implementation of effective carbon-pricing mechanisms.

AI-enabled modelling can provide insight into near-term water availability and help align water supply and demand. Its effectiveness, however, is limited by the quality of the underlying data, model design and specific use case. AI can also help optimise city water operations by consolidating the water balance, improving the planning of freshwater use, greywater reuse and wastewater management, and strengthening water-quality monitoring through faster, more robust and scalable assessments.

Critical mineral demand of AI data centres

The new wave of AI data centres has raised the demand for critical minerals: the production of semiconductors, chips, and heat sinks requires gallium, germanium, and silicon; and the RE systems powering these facilities will trigger demand for nickel, lithium, cobalt, and copper.

The panel observed that India depends on Taiwan, South Korea and China for both critical minerals and high-value components because of domestic constraints, including limited resource availability, the absence of mining development strategies, long lead times for mine development and limited processing capacity. India could prioritise domestic manufacturing of AI hardware through sustained investment across the supply chain, including the Production Linked Incentive (PLI) and the India Semiconductor Mission, while diversifying procurement channels through friendshoring.

The circular economy and recycling approaches were also discussed as important mechanisms for reducing future mineral demand, although recycling was noted to be capital-intensive, with challenges related to cost competitiveness, processing infrastructure, stringent purity requirements, and the varying ease of recovery across materials.

Sustainable AI and data centre regulation

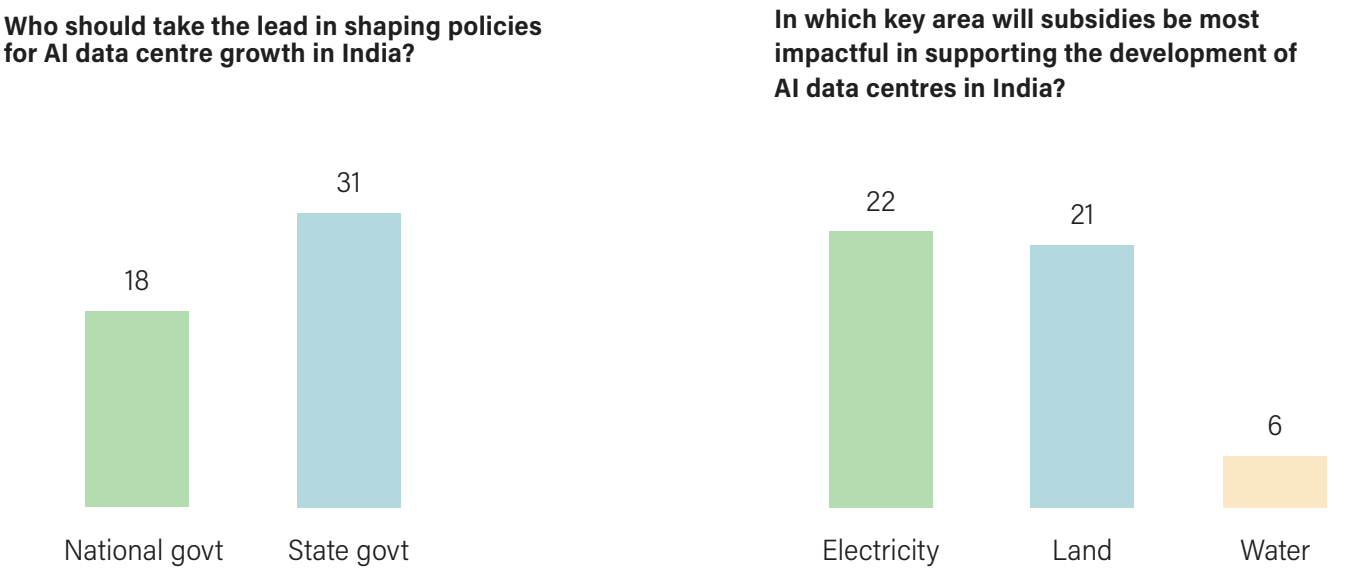
Finally, the panel discussed the possibility of balancing AI growth with environmental sustainability and having regulations for 'green AI'. It noted that existing policies largely emphasise the business case for AI with limited focus on water, energy use, emissions and other environmental parameters.

Another notable gap is the lack of transparent and standardised reporting on resource use. Panellists also noted that there is scope for regulations governing AI data centres similar to those governing water consumption by power plants or energy consumption by green hydrogen plants. This is particularly important in a context characterised by socio-economic disparities and increasing resource stress. Although a separate data centre policy may have merit, its effectiveness will depend on the scale at which it is developed and the extent to which it is integrated with policies on renewable energy, climate change and emissions. Translating policy into action will also require customisable, context-specific design and provisions for staggered implementation.

Participant responses on data centre regulation

Most participants underscored that state governments should take the lead in shaping policies for AI data centre growth as India aims to become an AI data centre hub (Figure 4).

FIGURE 4 | Participant responses on who should make policies to govern AI data centres



Source: Responses collected from participants through Mentimeter

Participants' views on the role that subsidies have to play in attracting companies to establish data centres in India differed. While the subsidies related to land and energy were identified as the most effective drivers, participants also emphasised the need to assess associated resource demands, environmental impacts, and the broader distribution of economic benefits, advocating for evidence-based policymaking (Figure 5).

Workshop presentations

The following presentations showcase two perspectives on the implications of growing electricity demand from data centres. The first presentation examines how AI-driven solutions can be strategically used to enhance smart grid resilience, while the latter outlines the supply-side impacts, economic costs, and environmental implications of meeting this demand.

Securing the smart grid: AI-driven resilience in an era of data centre growth

The presentation examined the relationship between data centres, AI, and grid stability. The key message was that while data centres are creating new challenges for power systems, AI can also support better grid management and security.

Power grids were designed for predictable loads. As AI training workloads can create sudden and unpredictable load spikes (sometimes reaching ramp-up rates of 10-45 MW for a single hyperscale data centre), conventional mechanical generation sources cannot respond quickly enough (NERC 2025).

Two additional major grid-related concerns are load volatility and grid stability. Sudden power fluctuations from data centres can trigger nuisance trips, in which grid protection systems mistakenly shut off power even when there is no real fault. In addition, equipment such as UPS systems, high-powered GPUs, and other power electronics, distort electricity demand and create harmonics, reducing power quality and increasing the risk of equipment damage or wider grid disturbances. In 2024, for example, a minor voltage dip caused data centres in Virginia to switch to UPS systems. This led to a sudden drop in grid load and a dangerous rise in frequency and the risk of a major blackout.

The presentation concluded that AI's impact on the grid is a double-edged sword. Unlike inference workloads, which are steadier, AI training makes electricity demand volatile and difficult to predict. AI can also be part of the solution by improving data centre load forecasting through advanced models such as transformers and long short-term memory networks, detecting false data injection attacks and supporting frequency and voltage control. Overall, the presentation emphasised that AI can either increase grid stress or strengthen grid resilience, depending on how it is implemented.

Methodology for assessing electricity demand for data centres

Building on earlier discussions on data centres, AI, and grid stability, the presentation examined how the rising electricity demand from data centres can be met through RE sources. Highlighting the scale of growth in digital infrastructure in the future, data centre electricity demand is projected to increase from 13 TWh in 2024 to 400 TWh in 2050 and 700 TWh in 2070 (NITI Aayog 2026b; Kang and Chauhan 2025).

To assess how this demand can be met sustainably and cost-effectively, the study uses insights from the Indian Zero Carbon Energy Pathways (IDEEA) model. The model adopts a 2×2 factorial scenario framework that combines two electricity demand trajectories and two policy pathways. One electricity demand trajectory excludes projected data centre demand growth; the other includes it. One policy pathway is the business-as-usual (BAU) scenario; the other is a net-zero scenario targeting zero electricity sector emissions by 2070.

The modelling results show that meeting future data centre demand will require India to substantially expand its electricity generation capacity. Under the net-zero scenario, this additional capacity will be met largely through RE sources while thermal-based capacity gradually declines and is phased out by 2070. This transition is important because the increase in data centre demand not only creates a supply challenge but also raises questions about how the additional electricity will be generated and balanced while ensuring grid reliability.

As RE sources such as solar and wind account for a larger share of the electricity mix, battery energy storage systems (BESS) will become essential for maintaining grid stability and ensuring a reliable demand-supply balance. In the net-zero scenario, BESS will be required to supply 2,209 GW. By contrast, if the BAU pathway is used to meet that increase in data centre demand, the power sector will continue to rely on fossil-fuel-based electricity and generate significantly higher emissions.

The difference between the two pathways becomes more evident when emissions and costs are compared over the long term. By 2070, emissions in the BAU scenario would exceed those in the net-zero scenario by 400 million tonnes. This shows that the way data centre electricity demand is supplied is as important as the scale of the demand itself. In the long term, the net-zero pathway is favourable both environmentally and economically. Although the upfront investment in the net-zero scenario (for RE, storage, and grid-supporting infrastructure) is higher, it will be offset over time by lower fuel costs, reduced dependence on coal, and more efficient system operation: by 2070, the total system cost including data centre demand is estimated to be 25 per cent lower than in the BAU scenario. The Levelised Cost of Energy analysis further supports this conclusion. Across the scenarios, net-zero scenario values remain consistently lower than BAU scenario values, with differences ranging from approximately ₹0.5/kWh to ₹1.3/kWh. While this difference may appear small at the unit level, it becomes highly significant when applied to national-scale electricity generation over several decades. Even

a modest reduction in the cost per kilowatt-hour can translate into savings of crores of rupees at the system level. Overall, the presentation showed that India's growing data centre demand can be met more sustainably and cost-effectively through a net-zero pathway, provided that planning prioritises renewable capacity expansion, reduced coal dependence, storage deployment, and improved grid flexibility.

Conclusion

The themes emerging from the workshop conversations, and insights from panel and participant discussions and presentations highlight that the expansion of AI is not only a digital evolution but also an energy, economic, and social transition that requires rigour and responsible governance.

The discussions identified three interconnected priorities shaping the current outlook: economic growth versus sustainability; efficiency versus total consumption; and innovation versus social inclusion. The speakers also emphasised that resource footprints are important and should be made visible through granular metrics such as PUE and WUE. Additional key considerations that could shape the future of this transition are the circular economy and supply chain protection; mitigation of stranded asset risks; infrastructure for high-frequency loads; and the sociotechnical readiness of workers.

Circular economy and supply chain protection

AI hardware typically has a relatively short life cycle, while India remains dependent on imports for several critical minerals used in digital and computing infrastructure. In this context, speakers emphasised the need to strengthen circular resource use and reduce pressure on both material and water resources. Key priorities identified included enhancing the recovery and recycling of critical materials from electronic waste, strengthening domestic e-waste collection and processing systems, and promoting the use of treated or recycled water for data centre cooling.

Mitigation of stranded asset risks

Captive power plants and decentralised energy systems bear financial risks. Institutions need to consider these risks. Redundancy can prevent the high costs of power failures. Systems are needed that emphasise redundancy rather than efficiency and can coordinate between rural RE sources and urban infrastructure centres.

Infrastructure for high-frequency load

Conventional 'mean load' estimation models are becoming less relevant when applied to the dynamic nature of AI computing.

Speakers recommended that next-generation power systems focus on handling peak loads while remaining flexible enough to include buffer storage, such as batteries, at data centre sites.

Sociotechnical readiness of workers

Workshop participants pointed out that this transformation could have socio-economic repercussions, particularly because technology is advancing faster than parts of the workforce can adapt. A significant share of India's low-skilled workforce may be at risk of displacement, even though AI can improve productivity in the service sector. Panellists therefore emphasised adopting a 'just transition' strategy in which respect and identity take precedence over training programmes. They added that this strategy should go beyond basic skills development to help local workers understand AI well enough to identify bias and flaws in algorithm-based tasks.

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Appendix

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Abbreviations

AI	Artificial intelligence
BAU	Business-as-usual
BESS	Battery energy storage system
CPU	Central processing unit
DSM	Deviation Settlement Mechanism
GPU	Graphics processing unit
IDEEA	Indian Zero Carbon Energy Pathways
IEA	International Energy Agency
IIT	Indian Institute of Technology
IPR	Intellectual property rights
NDC	Nationally Determined Contributions
PLI	Production Linked Incentive
PUE	Power usage effectiveness
RE	Renewable energy
WUE	Water usage effectiveness

Endnotes

1. The process of bringing data processing closer to the source that created the data to improve efficiency.
2. Machine learning models use model compression (utilising the optimisation techniques of quantisation and distillation) to address constraints like limited memory and computational power.
3. Optimisation techniques like model pruning and quantisation reduce the size and complexity of models by eliminating unnecessary parameters based on their level of contribution.
4. The efficiency of power consumption in data centres, calculated as the ratio of the total energy used by a facility to the energy used by the information technology (IT) equipment.
5. Water usage effectiveness measures how efficiently a data centre uses water, reported in litres per kilowatt-hour for a time period.

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About WRI India

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