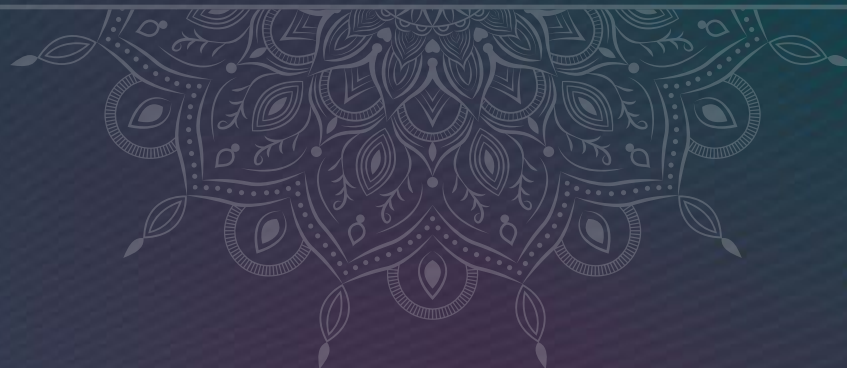# 09 | Green growth: Powering sustainability in energy and agriculture

India's unique pursuit of green growth is built around energy innovation and sustainable farming, thereby driving economic progress at various levels while preserving environmental integrity for future generations.

India's ambitious journey towards achieving sustainable development encompasses key sectors of energy and agriculture, aligning with its overarching vision of *Viksit Bharat 2047*. This chapter synthesises insights gathered from various panel discussions, and *Manthans* focused on green growth, emphasizing the need for a delicate balance between economic development and environmental sustainability as India confronts the dual challenges of climate change and increasing energy demand.

Panel discussions highlighted the importance of technological innovation in fostering climate resilience, with speakers discussing transformative approaches within the textile, coal and agricultural sectors. These discussions underscore a significant opportunity for India to harness renewable energy sources, improve soil health and enhance water management practices. The focus on inclusive development highlights essential strategies that mitigate environmental impacts and prioritise social equity, creating a sustainable framework for stakeholders.

In the agricultural domain, the session titled *"Sustainable Agri Network: Empowering Agriculture with Sustainable Supply Chain"* shed light on the integration of technology into traditional practices. The participants spoke about the construction measures of the watersheds and the urgent need for market integration to enhance the agricultural supply chain. By harnessing technological innovations, farmers can access other important commodities and markets as they continue to fight the effects of climate change. The promotion of sustainable practices is essential for enhancing agricultural resilience, reducing dependency on fertilisers and improving long-term productivity.

For example, project VISTAAR under the Ministry of Agriculture & Farmers Welfare, considers a vision to create a federated structure to share agriculture-related information and consultancy. Through the implementation of AI-driven platforms, farmers are empowered with localised, reliable data that assists in decision-making. Emphasis on digital tools and the creation of a transparent governance model signify a shift towards a modernised agricultural ecosystem. By bridging knowledge gaps and enhancing crop planning, VISTAAR envisions a resilient future for Indian agriculture, ensuring that farmers remain competitive and sustainable.

Furthermore, the discussions on the Unified Energy Interface (UEI) reflect a strategic transition in managing India's energy resources. The *Manthan* highlighted the necessity of an interoperable framework akin to the Aadhaar system, which aims to facilitate seamless energy transactions among diverse stakeholders. Implementing such a model is critical for fostering a decentralised energy marketplace, enhancing customer choices and connecting otherwise siloed energy networks. This transition is vital for integrating renewable energy solutions while ensuring the stability of the energy supply amid the growing peak demand.

The challenges posed by increasing energy demand require a more extensive approach that addresses both the supply and demand sides of the equation. The exploration of various interventions, such as enhancing conventional power plant capacity and deploying energy storage solutions, marks a proactive approach towards meeting rising energy requirements. Additionally, demand-side measures such as dynamic pricing and integrated agricultural load shifting can effectively reduce peak demand, steering the country closer to its net-zero goals.

In summary, India stands at a pivotal juncture in its journey towards sustainable development. The effective adoption of new technologies across the energy and agricultural domains is vital as they help solve existing problems and unlock new economic frontiers. Through collaboration between government organisations, industry stakeholders and local communities, India can create an inclusive and resilient environment that thrives in the face of climate change.

9a. Facing the climate crisis with green technology

Rupinder Brar
Additional Secretary
Ministry of Coal

Sanjay Garg
Additional Secretary, DARE & Secretary, ICAR

Amit Kumar Ghosh
Additional Secretary, Ministry of Social Justice & Empowerment

Rohit Kansal
Additional Secretary, Ministry of Textiles

India is steadily advancing towards its vision of *Viksit Bharat 2047*, a goal marked by sustainable development and economic resilience. Green growth, which integrates economic progress with environmental sustainability, has become a central pillar of this vision. At the national and state levels, India is increasingly adopting green technologies and strategies to mitigate the effects of climate change, protect natural resources and build a future-ready economy. This commitment reflects a collective effort to reduce dependency on fossil fuels, increase renewable energy use and establish ecologically balanced infrastructure.

The Government of India is fostering collaborations with private enterprises, innovative start-ups and multinational organisations to position green technology at the centre stage. Projects such as renewable energy grids, water management and smart agriculture highlight India's dedication to balancing development with environmental sustainability.

Green growth is no longer a vision; it has become a strategy that strengthens India's position in the global economy while maintaining ecological balance.

In the panel discussion, *"Green Growth Technology: A Pathway to Sustainable Development,"* leaders from the government and private sectors explored how green technology is reshaping industries, the challenges hindering sustainable progress and the collaborations required for success. India strives to achieve green growth in diverse areas, such as textiles, agriculture and energy, emphasizing quality-driven contamination control methods. These comprehensive initiatives position India for a more secure and integrated future driven by sustainable development.

Panel: Green Growth - Technologies for Energy Innovation and Climate Resilience
Participants:
Rupinder Brar, Additional Secretary, Ministry of Coal; Sanjay Garg, Additional Secretary, DARE & Secretary, ICAR; Amit Kumar Ghosh, Additional Secretary, Ministry of Social Justice & Empowerment; Rohit Kansal, Additional Secretary, Ministry of Textiles and Will Symons, APAC Climate & Sustainability Leader, Deloitte

Moderator:
Viral, Thakkar, Partner and Sustainability and Climate Leader, Deloitte South Asia

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Green growth is not only an environmental necessity but also an opportunity to redefine India's global leadership.

Sanjay Garg
Additional Secretary, DARE & Secretary, ICAR

According to the Indian Council of Agricultural Research (ICAR), agriculture, an important sector of the Indian economy, has several climate risks triggered by changing weather patterns and declining cultivable land area. To address this, initiatives such as the Soil Health Card were launched, which offer farmers critical information on nutrient levels, enabling better crop management. More than 14.5 crore health cards have been distributed, advising farmers on efficient fertiliser usage and soil restoration methods. Alongside these initiatives, the *Pradhan Mantri Krishi Sinchai Yojana* focuses on water conservation and irrigation efficiency, bringing millions of hectares under micro-irrigation.[38]

Innovative and sustainable practices in agriculture can secure food systems and protect resources for future generations.

ICAR's research into climate-resilient seed varieties marks another leap towards sustainable agriculture, with drought-resistant crops ensuring productivity despite weather uncertainties. While food security has been achieved, the next challenge is ensuring nutritional security. To tackle this, Biofortification efforts are being implemented to enhance grains with essential nutrients, aiming to fight malnutrition and improve overall health.

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The shift to coal gasification will allow us to produce clean energy without traditional mining, marking a transformative step for the coal industry.

Rupinder Brar
Additional Secretary, Ministry of Coal

The coal industry has been a cornerstone of India's energy landscape and is undergoing a significant transformation to align with sustainable goals. Current strategies to foster a sustainable coal sector while transitioning to greener alternatives focus on three key areas, including improving mining processes, optimising transportation logistics and enhancing afforestation efforts.

The ministry endorses better mining practices that integrate advanced machinery to minimise environmental impacts. This commitment extends to developing thermal power plants close to coal mines, aiming to reduce transportation distances and their associated environmental challenges. Restoring coal mines is part of a broader strategy, with plans to develop green clusters and promote ecotourism in these regions.

Green growth represents a path where economic development and sustainability coexist. Empowering communities through sustainable practices is key to achieving inclusive green growth.

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[38] https://pib.gov.in/PressReleasePage.aspx?PRID=2043789#:~:text=by%20PIB%20Delhi-,Soil%20Health%20&%20Fertility%20Scheme%20is%20being%20implemented%20by%20Government%20since,reply%20in%20Rajya%20Sabha%20today.

Among the major employment generators of the Indian economy is the textile industry, which is gradually gearing up to install sustainable industrial standards. Apparel and textile industries employ one-third of manufacturing industries' employees and contribute about 10 percent to the export business, making sustainability efforts essential.[39]

> *The textile industry's potential for sustainable practices is vast, especially among smaller clusters and MSMEs.*

Rohit Kansal
Additional Secretary, Ministry of Textiles

These initiatives are built on the four pillars of efficiency, which are material, water, energy and governance. For example, large textile companies increasingly source more than half of their energy from renewable sources such as solar power. Innovations from smaller clusters and MSMEs, such as Tiruppur, the largest knitwear export cluster, highlight these efforts, with the region successfully treating 95 percent of its wastewater and sourcing a significant portion of its energy sustainably.

The Samana cluster in Punjab, with 70 percent of its workforce comprised of women, demonstrates how sustainable development can drive inclusive economic growth. To further enhance sustainability, the textile sector is adopting solar power, optimising material usage and innovating wastewater treatment.

Inclusive strategies in green growth ensure that no community is left behind in the transition to a sustainable future.

Climate change's socioeconomic impact extends beyond environmental risks, disproportionately affecting vulnerable communities. The need for inclusive strategies to address this disparity was emphasized, with initiatives aimed at economically supporting marginalised groups, including waste pickers, sanitation workers and rural communities facing water scarcity.

The ministry has recently focused on waste pickers, ensuring their compliance with waste management systems and capacity building to allow productive employment. In addition, the ministry has been working hand in hand with the Ministry of Agriculture to help neglected farmers gain access to sustainable agricultural programmes.

> *Inclusivity is essential; without it, social justice remains an incomplete vision.*

Amit Kumar Ghosh
Additional Secretary, Ministry of Social Justice & Empowerment

The ministry is committed to creating frameworks that address social disparities, ensuring no one is left behind in the shift to a green economy.

Technology plays a key role in driving green growth across agriculture, energy and waste management. Innovation, especially in renewable energy and carbon capture, is crucial, with advancements in solar, wind and battery storage essential for a cleaner, self-reliant energy grid. Additionally, the government's focus on hydrogen production supports India's goal of becoming a leading exporter of green energy.

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[39] https://pib.gov.in/PressReleasePage.aspx?PRID=2117470#:~:text=Overview%20of%20India's%20Textile%20Industry,MSME)%20clusters%20in%20the%20country.

> **"**
> *India has ambitious plans for green hydrogen and sustainable aviation fuel, using agricultural resources to drive decarbonisation.*

Will Symons
APAC Climate & Sustainability Leader, Deloitte

India's transition to net-zero emissions hinges on three key strategies, including decarbonising electricity grids, removing carbon from the atmosphere and using hydrogen as a sustainable energy source.

Technological advancements, such as drones for assessing coal quality and reserves, help reduce environmental impact in the coal industry, with institutions such as IITs leading the way. Such advancements underscore the government's commitment to reducing the carbon footprint of traditionally high-pollution sectors through innovative technologies.

Institutional collaboration and policy support are vital in ensuring that green growth initiatives are effective and inclusive. Regulatory frameworks, such as the Business Responsibility and Sustainability Reporting (BRSR) mandate, require companies to disclose sustainability practices, promoting transparency and accountability.

PPPs in green technology are vital to achieving a large-scale environmental and economic impact.

Collaborations among the government, the private sector and international organisations have led to the creation of CoEs, such as IIT Kanpur's AI-driven entrepreneurship centre, which supports start-ups across sustainable technology sectors. These collaborations also drive the development of green infrastructure, such as renewable energy facilities, green hydrogen plants and Electric Vehicle (EV) manufacturing hubs.

India's journey towards green growth is marked by innovation, collaboration and inclusivity. The collective efforts of the government, the private sector and research institutions set a foundation for sustainable development, prioritising resilience and equity.

Resource efficiency, from water conservation to clean energy, defines India's approach to a balanced, green economy.

As India strives to become a developed nation by 2047, addressing climate change alongside socioeconomic challenges remains central to national discussions.

Key takeaways

- **Green growth goals:** The Government of India is steadfast in turning its vision of *Viksit Bharat 2047* into reality. Addressing climate change challenges while identifying opportunities for sustainable transformation is essential for this vision.

- **Impact of climate change on GDP:** Potential GDP losses from climate change could reach US$15 billion by 2070, highlighting the urgent need for sustainability measures across sectors.

- **Textile sector innovations:** The Ministry of Textiles emphasizes sustainability through initiatives focused on material, water, energy efficiency and governance, showcasing successful examples from large companies and MSMEs.

- **Coal sector transition:** The Ministry of Coal advocates a balanced approach between energy security and sustainability, enhancing mining processes, optimising transportation and promoting afforestation efforts.

- **Agriculture resilience:** ICAR highlights sustainable agriculture practices, emphasizing soil health through initiatives such as the Soil Health Card scheme and promoting organic farming to improve agricultural resilience.

- **Social justice initiatives:** The Ministry of Social Justice and Empowerment addresses climate change impacts on marginalised communities by integrating waste pickers and urban sanitation workers into sustainable development frameworks.

- **Technology and innovation in sustainability:** The discussions highlight the role of technology, focusing on renewable energy, carbon removal and hydrogen production as key areas for India's transition to net-zero emissions.

- **Inclusive growth strategies:** The necessity for marginalised populations to benefit from sustainable development efforts is emphasized, advocating for targeted programmes and financial support.

GREEN GROWTH – TECHNOLOGIES FOR ENERGY INNOVATION AND CLIMATE RESILIENCE

OUR RACE to NET ZERO

CLUSTERS of MSMEs are AIDING AND ACCELERATING

the SCOPE is NOW DIFFERENT

RURAL TOURISM

CLIMATE FUEL EFFICIENCY SDG TECH.

SUSTAINABILITY GROWTH

PROCESS
PRACTICES
POLICIES
PEOPLE

COAL as FUEL

"GASIFICATION"

SOIL HEALTH.

ORGANIC AND NATURAL FARMING

HUMAN HEALTH INNOVATION

WATER USE

NUTRITIONAL SECURITY
CLIMATE RESILIENT SEEDS

POLICIES to SUPPORT GROUPS that are FALLING BEHIND
→ PRODUCTIVITY → DIGNITY
→ SKILLING

DECARBONISE
... AGRI-FUEL

EXPORTING DECARBONISATION

NEW TECH AND TOOLS

R&D

AIDING SUSTAINABLE PRACTICES

INCLUSIVE policies AND SKILLING

RISK
TECH
INNOVATION
SOCIAL WELFARE REDESIGNING
CONSERVATION

INTERVENTIONS

PUBLIC PRIVATE

- BRIDGING PRICE-COST GAP
- RULEBOOK
- SCALING AND EXECUTION
- INVESTMENTS

9b. Sowing the seeds for India's smart and sustainable agriculture

Faiz Ahmed Kidwai
Additional Secretary,
Ministry of Agriculture
& Farmers Welfare

Ranjit Singh Deol
Principal Secretary,
Food & Civil Supplies,
Government of
Maharashtra

Nitin Khade
Joint Secretary,
Department of
Land Records

By ensuring that sustainability is embedded in every stage of agricultural production, India can create a more resilient and inclusive agri-economy that empowers farmers while ensuring food security for the nation.

With a greater focus on digital innovation and sustainability-focused networks, India is transforming its agriculture sector into a resilient ecosystem for farmers. AgriTech refers to applying agriculture, horticulture and aquaculture technology to improve various input and output processes. To meet the industry's critical challenges, digital frameworks, such as the Sustainable Agri Network, provide novel solutions by focusing on efficient supply chains, watershed management and optimised storage, all of which are geared towards nurturing sustainable farming practices and farmer income generation.

AgriTech further adds to this by giving farmers market access to various digital tools and platforms, helping them reduce post-harvest losses, access financing and respond to consumer demand.

Open AgriNet and VISTAAR complement these efforts with federated, AI-driven networks that understand a farmer's needs and help deliver localised, real-time advisory and input, agri equipment and other services to farmers across regions. Such open networks connect farmers with tailored insights, transparent resources and a trusted, standardised governance model, ensuring that they benefit from reliable guidance and seamless market integration. Together, these initiatives create a digitally empowered and sustainable framework for Indian agriculture, ready to meet the demands of a dynamic future.

Panel: Sustainable Agri Network – Empowering Agriculture with Sustainable Supply Chains
Participants:
Faiz Ahmed Kidwai, Additional Secretary, Ministry of Agriculture & Farmers Welfare; Ranjit Singh Deol, Principal Secretary, Food & Civil Supplies, Government of Maharashtra and Nitin Khade, Joint Secretary, Department of Land Records

Moderator:
Srinivas Kuchibhotla, Partner, Deloitte India

Sustainability in agriculture is the key to long-term resilience, empowering farmers while ensuring food security for future generations.

Being far more than just the backbone of India's economy, agriculture is intrinsically rooted in the nation's DNA, intertwining deeply with rural livelihood and food security. However, for Indian agriculture to thrive in the 21st century, it needs to be sustainable by promoting economic growth while also protecting the environment. The Sustainable Agri Network seeks to empower Indian agriculture in this regard by achieving the following:
• Addressing critical challenges in the supply chain
• Fostering inclusive growth
• Integrating sustainable practices
• Bolstering productivity and long-term resilience

This panel discussion will provide greater insights into themes such as watershed management, Farmer-Producer Organisations (FPOs) and how technology and digitisation will help improve agricultural practices.

Watershed development and agricultural sustainability

Through watershed management, we have raised water tables and increased farmer incomes by 70 percent, proving that sustainable practices lead to economic growth.

Faiz Ahmed Kidwai
Additional Secretary, Ministry of Agriculture & Farmers Welfare

One of the primary themes emphasized during the session was the importance of watershed management in promoting sustainable agricultural practices. Various initiatives have led to the restoration of degraded lands, boosting agricultural productivity, raising water tables, and increasing farmer incomes by up to 70 percent. By introducing integrated farming, such as mixed crops and agri-horticulture, India can maintain soil health and reduce the environmental burden on farming ecosystems.

Moreover, new technologies involving climate resource management and hydrology studies are also being introduced to effectively manage water resources and protect against drought risks in states such as Karnataka and Odisha. Ultimately, the goal is to develop resilient and climate-adaptive agricultural systems that can sustainably support local communities and ensure that they are no longer at the mercy of environmental hazards.

Digital tools for market integration and efficiency

By integrating technology into supply chains, India's farmers are gaining access to fairer markets and more efficient distribution systems.

Ranjit Singh Deol
Principal Secretary, Food & Civil Supplies, Government of Maharashtra

A significant challenge for Indian farmers is the disparity in market access and pricing, often leading them to sell at wholesale prices while purchasing inputs at retail prices. To address this, the expansion of specialised platforms can be a potential solution for integrating agricultural markets, offering better pricing transparency and market reach.

Digitisation also plays a crucial role in enhancing food distribution systems. The use of Aadhaar to streamline procurement processes in the Public Distribution System (PDS) has reduced inefficiencies,

saving up to 40 percent in logistics costs through route optimisation. Additionally, Aadhaar's integration in beneficiary identification ensures that food reaches those who need it most, making the supply chain both efficient and inclusive.

Farmer producer organisations and market access

> *Farmer Producer Organisations (FPOs) are revolutionising market access for small and marginal farmers, giving them the power to negotiate better prices.*

Nitin Khade
Joint Secretary, Department of Land Records

FPOs are emerging as critical players in helping small and marginal farmers gain bargaining power and access better market opportunities. India now has over 40,000 FPOs, which are working collectively to reduce market barriers and standardise agricultural products. By organising into FPOs, farmers can aggregate produce, access higher-value markets and engage directly with industries that require quality-assured goods.

The growth of FPOs is also instrumental in achieving price consolidation, allowing farmers to bypass intermediaries and secure higher returns on their produce. As India continues to develop a central registry for FPOs, these organisations will play a pivotal role in supply chain efficiency and market integration.

Manthan: AgriTech
Participants:
Dr K Guite, Economic Advisor, Department of Consumer Affairs; Nipun Mehrotra, Co-founder and CEO, TAC; Sanjiv Rangrass, Co-founder, TAC; and Siddhartha Sinha, Chief Technology Officer, NeRL

Guru:
Srinivas Kuchibhotla, Partner, Deloitte India

> **AgriTech is transforming Indian agriculture by reducing inefficiencies and empowering farmers with data-driven insights and direct market access.**

While agriculture has been rightfully lauded as the crown jewel of India's economy, the sector has had its potential dramatically limited by supply chain inefficiencies, lack of market transparency and post-harvest losses. The solution to overcoming many of these challenges lies in AgriTech, which involves integrating digital technology to boost productivity, reduce waste and streamline agricultural supply chains. AgriTech can empower Indian farmers through digital marketplaces and real-time data collection to achieve sustainable and profitable agricultural standards.

During this *Manthan*, critical issues such as price variation, data challenges and storage inefficiencies were addressed. Additionally, Indian agriculture's readiness to transform and create a more transparent, efficient and resilient system for farmers and consumers was at the forefront of discussion, with technology as the catalyst for this change.

Addressing price variations and post-harvest losses

With the right technology, post-harvest losses can be minimised, boosting farmer incomes and streamlining the agricultural supply chain.

Nipun Mehrotra
Co-founder and CEO, TAC

Price variations after harvesting have been a significant challenge in Indian agriculture, as this issue has arisen mainly due to the inefficiencies of supply chains. Consequently, this has resulted in catastrophic yearly losses in terms of logistics and warehousing, estimated to be more than INR1.2 lakh crore annually. The uneven distribution of storage facilities across India exacerbates this issue, with less than 50 percent of the required capacity available compared with developed countries, where storage exceeds demand.

AgriTech solutions focus on minimising post-harvest losses by improving storage infrastructure and traceability. Digital platforms can ensure real-time monitoring of produce, allowing for better decision-making on when and where to sell, reducing waste and ensuring better price realisation for farmers.

Data challenges in the value chain

Without timely data on market prices and stock levels, farmers are left in the dark: AgriTech is lighting the way with real-time insights.

Sanjiv Rangrass
Co-founder, TAC

AgriTech is also poised to make a sizable impact on the availability and quality of agricultural data. However, one of the current limitations to this endeavour is that the available data on market pricing, production and consumption is very limited and often outdated. For example, while production data is available, stock availability and consumption data are rarely published, creating a gap in understanding real-time market dynamics.

DPI for agriculture is vital to closing this gap. AgriTech can offer more accurate insights to farmers and policymakers by building platforms with real-time data on stock levels, price fluctuations and consumer demand. With these insights on hand, farmers will then be able to make the best possible decision regarding when to sell their produce and at what price and eventually obtain the maximum profit in the current market.

Quality standardisation and financing

Standardising quality through digital assaying systems will ensure that farmers get fair prices while building trust in the agricultural value chain.

Siddhartha Sinha
Chief Technology Officer, NeRL

One of the longstanding challenges in Indian agriculture is the lack of quality standardisation for domestic produce. While imports are subject to strict quality standards, domestic produce often suffers from inconsistencies, leading to transactional inefficiencies across the supply chain. AgriTech platforms can help standardise quality by offering assaying services, where produce is graded and certified based on specific parameters. This ensures that farmers get fair prices for quality produce and builds trust within the value chain.

Additionally, AgriTech is driving change in financial accessibility. These digital platforms use Electronic Warehouse Receipts (EWR), allowing farmers to store their produce in accredited warehouses and use them as collateral to access funds. This eases the pressure on farmers, who are often forced to sell quickly after harvest at lower prices and provides them with the liquidity to wait for better market conditions.

Consumer insights and market integration

> *By aligning agricultural production with consumer demand, AgriTech can reduce price fluctuations and bring stability to both farmers and consumers.*

Dr K Guite
Economic Advisor, Department of Consumer Affairs

AgriTech also enables farmers to access information on consumer demand and prices, thus stabilising prices between farmers and consumers. Data collection about retail prices and consumer purchasing patterns allows farmers to align their production with market demand. This leads to better farmers' prices and benefits consumers by keeping prices stable through more efficient supply chain management.

Additionally, the proliferation of digital marketplaces such as the Electronic National Agriculture Market (ENAM) allows for the seamless sale of produce to buyers directly, reducing dependency on intermediaries and encouraging greater value for pricing. Finally, these platforms provide greater market transparency, enabling farmers to access national markets and ensure they receive fair prices for their produce.

Manthan: Open AgriNet and VISTAAR
Participants:

Samuel Praveen Kumar, Joint Secretary, Extension, Ministry of Agriculture & Farmers Welfare; Ramesh MC, CEO, COSS; Vivek Garg, Vertical Leader for Agriculture, AWS; Akanksha Nagpal, Senior Data Architect, CABI; Bhavika Nanawati, GIZ Advisor - AI, GIZ; Kirti Pandey, Advisor AI, GIZ; Reuben Swamickan, Deputy Director, USAID; Asha Chandra, Assistant General Manager, NABARD; Sumit Kumar, Product Leader, ONDC; Yuvraj Ahuja, Program Coordinator, IFC; Rob Strey, Co-Founder & CTO, Plantix; Vikas Kanungo, Senior Digital Transformation Expert, World Bank; Mamta Kohli, Regional Gender, Social Inclusion, and Adaptation Specialist, Climate Finance Network, Bureau for Asia and the Pacific, UNDP; Ankur Bansal, Founder and CEO, GDI Partner; Ruby Pathania, Programme Manager, Wadhwani AI; Ashutosh Pant, Programme Manager, Wadhwani AI; Dr Sujeet Kumar Jha, Principal Scientist, ICAR; Pankaj, AWS; Niyati Joshi, Director (Fisheries Statistics, Fisheries Economics), Department of Fisheries; Anchal Garg Karanth, Senior Economic Officer, ADB; Punith, Climate Collective; Anirban Sarma, Director, Digital Societies Initiatives, ORF; Savita Muley, Haqdarshak; M Dhar, WFIndia; Amitabh Nag, CEO, DIBD (BHASHINI) and Director IndiaAI; Ketav Mehta, Investor and Lead, Unified Krishi Interface, Nasik

Guru:

Sreeram Ananthasayanam, Partner, Deloitte India

Open AgriNet and VISTAAR are transforming Indian agriculture by connecting farmers to a digital ecosystem of trusted, real-time advisory and resources.

Inspired by the Beckn protocol, open networks can play a transformative role in fostering sustainable agriculture by connecting farmers with essential resources and services.

Open AgriNet and VISTAAR, two innovative open networks aimed at building a strong interconnected ecosystem for farmers, advisors and market stakeholders, are set to elevate Indian agriculture to new heights. Open AgriNet is a federated network aimed at enhancing accessibility to agricultural knowledge, practices and digital tools. VISTAAR is an initiative focused on creating a dynamic, AI-driven advisory network. It provides farmers with access to a curated repository of information on best practices, government schemes and real-time advisory services.

These platforms represent a shift from isolated, region-specific support to a unified digital framework, empowering farmers with greater market access, transparency and advisory resources. By connecting farmers to an extensive digital ecosystem, Open AgriNet and VISTAAR are set to foster sustainable growth, bridge information gaps and address the varied needs of India's agriculture sector.

Federated and decentralised structure for information flow

A federated, AI-driven approach ensures that every farmer, regardless of region, can access tailored, localised insights for better decision-making.

Open AgriNet and VISTAAR employ a federated structure, allowing decentralised governance while maintaining a consistent information flow across different states and platforms. This design ensures that each state can customise its VISTAAR system to meet local needs while adhering to a central protocol that standardises data exchange. As with UPI's unified payments protocol, this structure enhances reliability, ensuring that stakeholders, from state governments to local farmer groups, operate within a shared information framework.

Such a decentralised setup enables local adaptations while promoting a seamless flow of information across regions. By decentralising content vetting and policy review, each state can exercise autonomy in implementing tailored governance mechanisms, creating a system that can accommodate diverse agricultural needs and capacities.

AI-driven advisory and seeker platforms for personalised support

With VISTAAR's AI-enhanced advisory, farmers can access real-time, personalised advice, enabling them to adopt best practices based on specific crops, seasons and local conditions.

Samuel Praveen Kumar
Joint Secretary, Ministry of Agriculture & Farmers Welfare, Government of India

A standout feature of VISTAAR is its use of AI-driven advisory systems to provide real-time, tailored information to farmers. VISTAAR's seeker-side platform connects directly with farmers, acting as a user-friendly interface where they can access information relevant to their specific crops, local conditions and seasonal patterns. Through this AI-enhanced network, VISTAAR personalises advice, helping farmers make informed decisions based on localised insights and curated data.

This approach allows the seeker and provider platforms to support year-to-year learning, where farmers can adopt best practices shared by peers in similar climates or crop cycles. For example, a farmer in Karnataka could learn about drought-resistant techniques successfully implemented in Gujarat, fostering cross-regional knowledge sharing that builds resilience against climate variability.

Standardised, transparent to build trust

Standardised governance ensures that farmers can rely on the accuracy and quality of the information, building trust across the agricultural ecosystem.

Rajeesh Menon
Head- Global Programmes, FIDE

Transparency and trust are paramount in ensuring farmers' full engagement with these digital networks. To this end, Open AgriNet and VISTAAR emphasize standardised governance protocols, including content verification, fulfilment network vetting and feedback loops. Farmers' trust in these systems is built through reliable, verified information, which is achieved by setting clear guidelines and ensuring compliance across various fulfilment and advisory networks.

Furthermore, the standardised approach across platforms provides visibility into transactions and information exchanges, allowing farmers to verify the sources of their inputs, advisory services and market data. With well-defined vetting structures, farmers receive consistent quality across services and can make confident decisions on crop management, pricing and input selection.

Interoperability and compatibility across platforms

Interoperability with other digital platforms makes Open AgriNet and VISTAAR seamless, integrating public and private resources for holistic farmer support.

Samuel Praveen Kumar
Joint Secretary, Ministry of Agriculture & Farmers Welfare, Government of India

VISTAAR and Open AgriNet are designed to be interoperable with other digital networks, including the Open Network for Digital Commerce (ONDC) and Aadhaar-linked platforms. This interoperability ensures that information from government databases, market advisories and private sector solutions can flow seamlessly across the digital agriculture ecosystem.

By establishing a shared standard, these platforms simplify the user experience, eliminating the need for farmers to manage multiple incompatible systems. This interconnectedness enhances efficiency and enables greater resource sharing among stakeholders, from small cooperatives to state government bodies, thus driving a more cohesive agricultural network.

Key takeaways

- **Watershed management:** Sustainable agriculture starts with adequate water and soil conservation practices, as demonstrated by successful initiatives that have increased farmer incomes and agricultural productivity in degraded lands.

- **Technology for supply chain efficiency:** Digital platforms and Aadhaar-based systems are improving market access, increasing transparency and optimising logistics to make the agricultural supply chain more inclusive and efficient.

- **FPOs and farmer empowerment:** FPOs are critical to giving small farmers collective power, enabling them to access better markets, negotiate higher prices and integrate into global supply chains.

- **Climate resilience through innovation:** Investments in new technologies, such as hydrology studies and climate resource management, are key to creating resilient agricultural practices that can withstand climate change and drought conditions.

- **Nutrition security:** Encouraging the cultivation of millets and other sustainable crops supports food security and environmental sustainability by promoting water-efficient, nutritious alternatives to traditional grains.

- **Minimising post-harvest losses:** AgriTech solutions address inefficiencies in logistics and storage that lead to substantial post-harvest losses, saving farmers significant amounts and improving price realisation.

- **Data-driven agriculture:** Digital platforms are essential for collecting and sharing real-time data on stock levels, market prices and consumer demand, allowing for more informed decision-making.

- **Quality standardisation:** AgriTech platforms help ensure farmers receive fair prices for their produce while building trust in the agricultural value chain by offering grading and assaying services.

- **Improved access to finance:** Electronic warehouse receipts give farmers access to credit, enabling them to store their produce and wait for favourable market conditions without financial pressure.

- **Enhanced market access:** Digital platforms such as eNAM allow farmers to sell directly to buyers, reducing their dependence on intermediaries and improving market transparency.

- **Decentralised, federated open networks:** Open networks for agriculture, built on decentralisation, interoperability and inclusivity, can drive sustainable farming, empower farmers and enhance food security. Open AgriNet and VISTAAR use a federated model to ensure local relevance while maintaining a unified network across regions.

- **Personalised AI-driven advisory:** VISTAAR's AI-enhanced network offers farmers tailored, real-time advisory services, helping them make informed decisions based on regional data, crop needs and peer insights.

- **Standardised governance for trust:** By implementing standardised content vetting and feedback mechanisms, VISTAAR builds trust among farmers, ensuring they receive accurate, reliable information and services.

  - **Inclusive, interoperable networks:** Open AgriNet and VISTAAR connect seamlessly with digital platforms, lowering access barriers for smallholder farmers and enabling rural entrepreneurs to offer services within a self-sustaining ecosystem.

- **AI-powered insights:** Using local data, the networks deliver tailored, sustainable farming advice, addressing pests, weather and soil conditions.

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AgriTech

DATA AVAILABILITY, QUALITY AND DIGITAL TRANSFORMATION
- PROCESS STREAMLINING VIA BLOCKCHAIN, AI AND IoT
- IMPROVE TRACEABILITY
- FACILITATE FINANCIAL INCLUSION
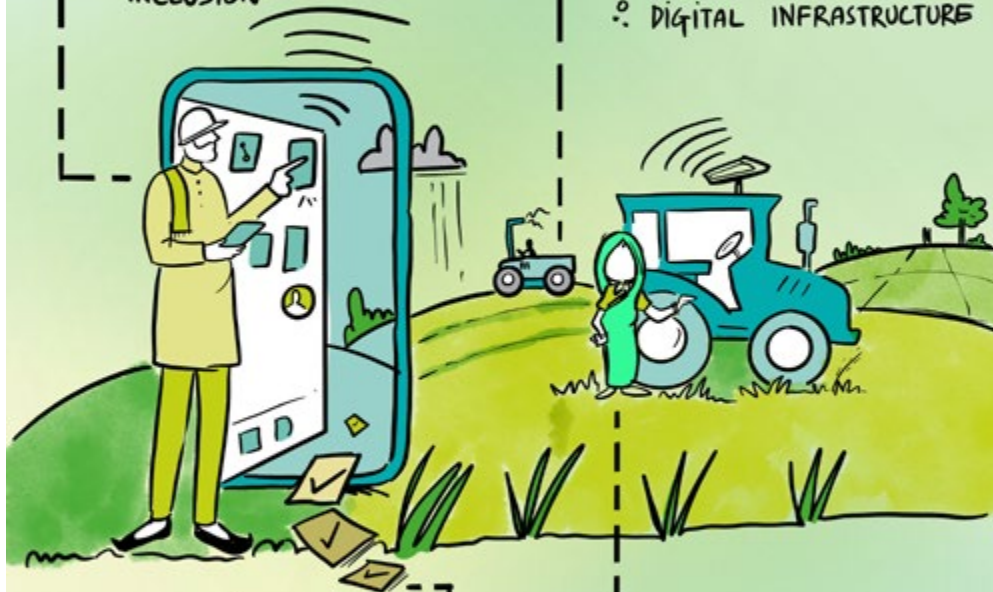
INFRASTRUCTURE DEVELOPMENT
- STORAGE FACILITIES
- TRANSPORTATION NETWORKS
- DIGITAL INFRASTRUCTURE

POLICY AND REGULATORY FRAMEWORK
- IMPLEMENTATION OF INNOVATIVE SOLUTIONS
- ADDRESSING EXISTING BOTTLENECKS

COLLABORATION AND PARTNERSHIPS
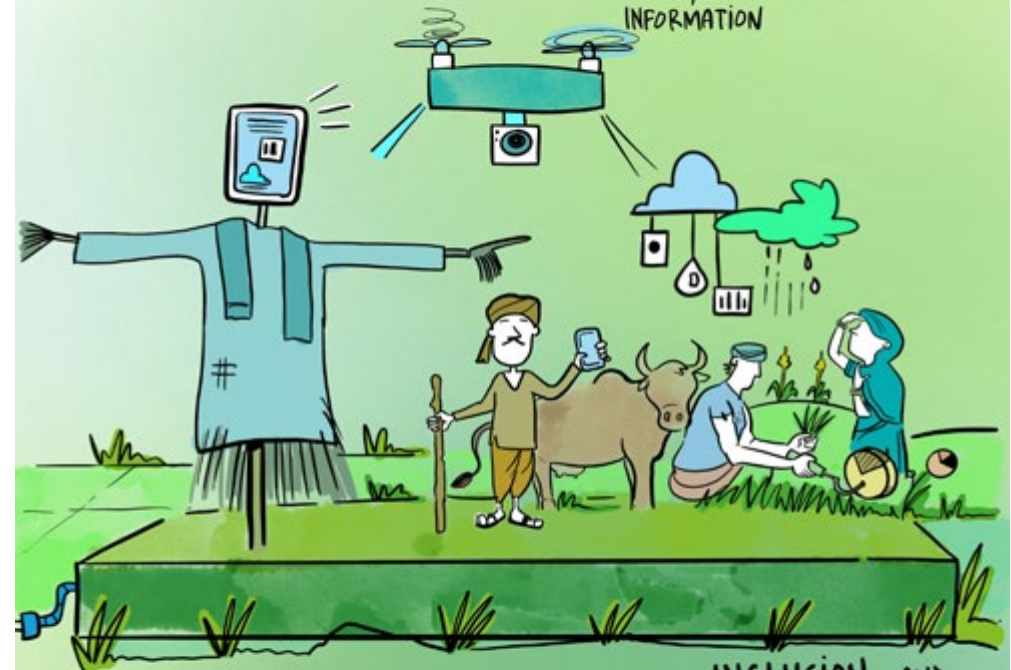- GOVERNMENT AGENCIES, PRIVATE SECTOR AND FARMERS

OPEN AgriNet AND VISTAAR

GOVERNANCE FOR FLEXIBILITY
- FEDERATED GOVERNANCE MODEL
- CUSTOMISING OPERATIONS

AI-POWERED ADVISORY SYSTEMS
- PERSONALISED SERVICES FOR FARMERS
- TIMELY, ACCURATE AND CONTEXTUALISED INFORMATION

FOSTERING A COLLABORATIVE ECOSYSTEM
- PUBLIC AND PRIVATE STAKEHOLDERS
- UNIFIED PLATFORM FOR SERVICE DELIVERY, MARKET ACCESS AND KNOWLEDGE SHARING

INCLUSION AND ACCESSIBILITY
- ONLINE AND OFFLINE DIGITAL SOLUTIONS

BUILDING TRUST THROUGH TRANSPARENCY
- RIGOUROUS VETTING AND FEEDBACK MECHANISM

SCHEMES
- ECONOMIC FRIENDLY
- ECO-FRIENDLY
- INTEGRATED FARMING
- DIVERSIFY
WATERSHED

FARMER
- LOGISTICS
- TRUE PRICING
- AGRICULTURE MARKETING FRAMEWORK
- PROGRAMMES

BANK A/c
ROUTE OPTIMISATION
AADHAR
AIDING DIGITISATION

SUSTAINABLE AGRI-NETWORK: EMPOWERING AGRICULTURE with SUSTAINABLE SUPPLY CHAIN

- AS a STORAGE
FAIR PRICE
WIN WIN
EASE
ACCOUNTABILITY
WATER EFFICIENT FARMING SUPPORT
the FPO MOVEMENT
COMPANY
NUTRITION SECURITY
INTEGRATION of FARMERS, SCHEMES, INFRA AND TECHNOLOGY
THIS IMPORTANT CONNECTION will HELP FARMERS FINANCIALLY with APPROPRIATE PRICING

9c. Nature-first initiatives

The vision for *Viksit Bharat 2047* places a strong emphasis on sustainable urban development. The government is focused on creating resilient cities while also improving the quality of life for its residents. Urban development, focusing on energy-efficient, water-conserving infrastructures, incorporating renewable energy sources and developing intelligent transportation systems, is being prioritised to ensure sustainable urban growth.

The *Manthan* on sustainability was structured in two parts, with a focus on India's resilience to challenges, urban vulnerabilities and infrastructure issues. It highlighted the importance of corporate disclosure, ecosystem collaboration and inclusive development. Esteemed speakers discussed issues such as socioeconomic inequalities, climate change impacts and urban design flaws, offering strategies to overcome these challenges.

Manthan: Resilient Cities
Participants:
Parikshat Kadan, IFS, GoI; Aanchal Garg Karanth, Senior Economics Officer, ADB; Karan Shah, COO (India), Artha Global; Priya Vedavalli, Principal, Artha Global; Neelanjan Sircar, Director, Centre for Rapid Insights, Artha Global; Dr Gyanendra Badgaiyan, Resident Senior Fellow, Artha Global; Santosh Tiwari, Chief Accountant, Vadodara Municipal Corporation; Anup Kumar, Head - Channels, Alliances & Inside Sales - India, ESRI; Sakshi Gudwani, Senior Programme Officer, Gates Foundation; Dr Aniruddha Roy, CTO, Genesys; Arturo Cadena, Advisor, Sustainable Urban Development - Smart Cities II, GIZ; Nicholas Boehlke, Cluster Advisor, GIZ; Samrat Banarjee, ICT and Digitalisation Advisor, GIZ; Shriman Sai, Technical Expert, Sustainable Urban Development - Smart Cities II, GIZ; Punit Gandhi, Policy and Research Lead, India Climate Collaborative; Prof. Vishal Garg, Plaksha University; Sathyanarayanan Shankaran, Urban Strategy Lead, Rainmatter Foundation; Chandra Kishore Yadav, RITES; Dr Anshu Sharma, Co-Founder, STS Global; Jasmeet Khurana, Lead, India for Climate Tech, WEF; Colonel Vijay, Indian Army; Kuntal Shah, Director, Deloitte India; Vikash Chandra, Director, Deloitte India; Sumit Mishra, Executive Director, Deloitte India; Sudeep Kumar Sinha, Partner, Deloitte India; Vivek Mittal, Executive Director, Deloitte India; Murali Thimmapuram, Director, Deloitte India

Gurus:
Viral, Thakkar, Partner and Sustainability and Climate Leader, Deloitte South Asia; Debashish Biswas, Partner, Deloitte India

This *Manthan* focused on overcoming challenges to build a resilient and future-proof India. It was divided into two parts, with participants discussing urban vulnerabilities and infrastructure challenges based on surveys by Artha Global.

Part 1: Addressing urban vulnerabilities
The first session focused on urban vulnerabilities. The Artha Global survey on trends in Asia-Pacific and global regions highlighted the importance of corporate disclosure and ecosystem collaboration.

> *By pooling resources and working together, neighbouring communities and organisations can share the costs of climate adaptation more effectively.*

Karan Shah
COO (India), Artha Global

The survey revealed that urban areas are becoming more vulnerable due to infrastructure gaps, socioeconomic disparities and poor governance, often shaped by pre-existing conditions, such as poverty, poor health and inadequate access to resources.

The survey on urban vulnerabilities highlights the impact of heat stress on productivity. It reveals that 60 percent of people missed work in May due to heat, with 40 percent missing over five days.

Preexisting socioeconomic disparities, poor planning and lack of preparedness exacerbate urban flooding. In public transport, short commutes (less than 30 minutes) were typical, while walking or cycling and longer commutes were not considered problematic.

Below are the highlights of the first session.

Socioeconomic disparities and lack of preparedness

As citizens, we need to take responsibility and lead efforts to better prepare ourselves, contribute to development and mitigate the impacts of climate change.

Socioeconomic status, urban design and governance are critical to understanding vulnerabilities. Socioeconomic inequalities, poor urban planning and lack of information or preparedness amplify disaster impacts. A lack of policy participation persists. Additionally, ineffective implementation of disaster response often adds to the problem. The marginalised and underprivileged groups suffer the most from these vulnerabilities. To address the issue, there should be a focus on inclusive development. Marginalised and vulnerable communities must be empowered with knowledge to better respond to the consequences of climate change.

We need to create more human-centred projects. It is essential to establish conditions that facilitate effective responses to climate-related challenges.

Health issues
An individual's health plays a crucial role in their ability to respond to vulnerabilities and climate-related changes. Health and urban planning must be linked, with access to nutritious food, greenery and open spaces integrated into urban infrastructure.

A gender-responsive approach is crucial to ensure that no one is left behind. If we plan cities or open infrastructures without involving disadvantaged groups, we won't create resilient systems.

Rapid migration and increased susceptibilities
Rapid migration from rural to urban areas leads to other vulnerabilities. Efforts must be made to increase employment opportunities in rural areas. Enhanced awareness and planning are needed across levels, from individuals to communities to government bodies. Rural employment opportunities can lead to reverse migration.

Strengthening institutions at each level, including individual, community and government, is crucial for addressing migration-related issues.

Part 2: Overcoming infrastructural challenges
The second session focused on infrastructural challenges. Based on surveys by Artha Global, the following points were highlighted.

Water management and road connectivity
Over 60 percent of India's population now has piped water, yet many households still rely on supplemental sources due to inadequate supply or poor water quality. Additionally, more than 50 percent of people with limited access to transportation commute for less than 30 minutes, reflecting economic constraints.[40]

Bangalore has the highest percentage of people who commute short distances. Meanwhile, cities such as Delhi and Kolkata often report longer commutes due to different infrastructural setups.

About 60 percent of respondents had not adopted energy-saving technologies, with the highest disinterest found among the most vulnerable groups, often linked to a lack of knowledge rather than refusal.

Procurement and project efficiency
A well-defined technical scope is critical to avoid issues later in the project lifecycle. Material procurement must be prioritised based on quality rather than price. More attention must be given to the planning and design phases rather than rushing into implementation. Prioritising maintenance is of utmost significance.

In our country, resources often lead us to prioritise low costs at the expense of quality, which is critical.

City resilience plans and climate adaptation
The implementation of resilience plans needs to be more robust. As cities can only be modified by 10–20 percent, designing escape models for current threats and raising public awareness is essential. Guidance

on eco-friendly construction materials and ensuring climate resilience features in urban projects is important.

Climate budgeting is essential. Regular audits of climate budgeting and its impact should be performed.

Financing and nature-based solutions
Municipalities must play an important role in infrastructure planning and should have easy access to finance. Adopting nature-based solutions and low-cost green infrastructure is crucial for climate resilience.

Multilateral banks and financial institutions should consider projects contributing to climate adaptation and mitigation rather than just focusing on traditional funding models.

Key takeaways

- **Climate adaptation:** Corporate disclosure and ecosystem collaboration are needed to address climate adaptation.
- **Urban vulnerabilities:** These vulnerabilities are increasing, particularly in infrastructure, socioeconomic disparities and governance, with heat stress and urban flooding significantly affecting productivity.
- **Health-centred resilience:** A health-centred approach and inclusive development are essential to improving resilience, especially for marginalised communities.
- **Water access gaps:** Issues persist, with many relying on supplemental water sources.
- **Commuting challenges:** These issues were highlighted in the survey, showing that limited transportation options result in shorter commutes.
- **Energy-saving technologies:** Adoption of energy-saving technologies remains low, particularly among the most vulnerable populations, due to a lack of awareness.
- **Procurement efficiency:** Improving procurement processes, project efficiency and city resilience plans are critical.
- **Municipal funding:** Direct access to funds for municipalities is essential to implement nature-based climate solutions.

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[40] Data obtained from discussions during the "Ārohaṇa: Growth with Impact," in September 2024

RESILIENT CITIES

SUSTAINABLE INFRASTRUCTURE

- INVESTMENT IN
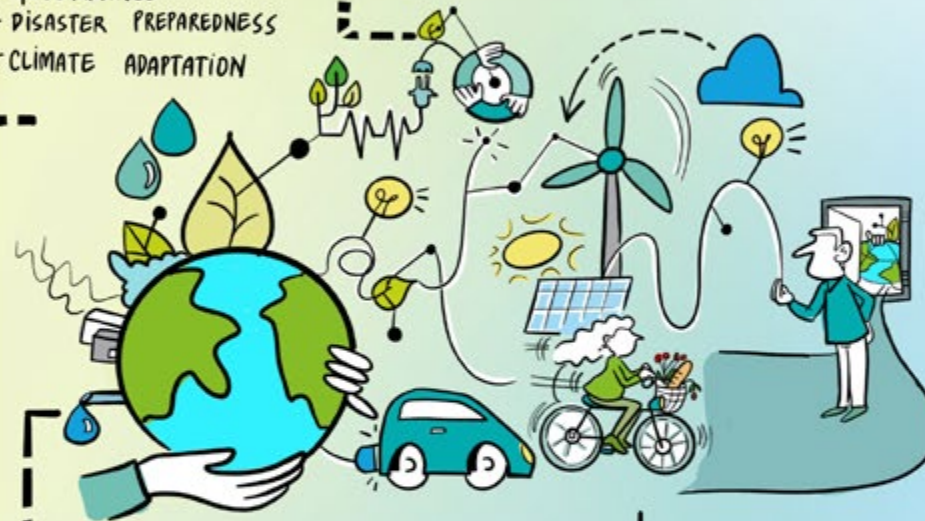 - ECO-FRIENDLY MATERIALS
  - GREEN INFRASTRUCTURE SOLUTIONS

INCLUSIVE DEVELOPMENT

- ADDRESSING SOCIO-ECONOMIC INEQUALITY
- ACCESS TO CLEAN ENERGY, SAFE HOUSING AND CLIMATE RESILIENT SERVICES

COMMUNITY PARTICIPATION

- ENGAGING CITIZENS
  - GOVERNANCE
  - DISASTER PREPAREDNESS
  - CLIMATE ADAPTATION

WATER MANAGEMENT

- EFFICIENT WATER USE
- RAINWATER HARVESTING
- EQUITABLE ACCESS TO CLEAN WATER

URBAN RESILIENCE

- CLIMATE-ADAPTIVE INFRASTRUCTURE

ENERGY TRANSITION

- INCREASED ADOPTION OF RENEWABLE ENERGY
- ENERGY-SAVING TECHNOLOGY
- INCENTIVES AND EDUCATION

9d. Energy efficiency

India's energy sector stands on the brink of transformative change, spurred by increasing demand, clean energy goals and advancements in digital infrastructure. Innovative solutions such as the Unified Energy Interface (UEI) and strategies for managing energy transition are paving the way for a resilient, inclusive energy ecosystem.

Designed on an open, interoperable protocol created by the foundation of interoperability in the digital economy, UEI connects various energy services and resources. These include EV charging, peer-to-peer trading and the discovery of energy units that are to be shared among DISCOMS and consumers. This approach enables real-time access, flexibility and control over energy usage.

By decentralising control and increasing market access, UEI empowers consumers, democratises energy access and fosters market-driven

innovation, propelling India closer to its clean energy goals. Simultaneously, the challenge of managing the energy transition requires a modernised approach to utilities. With urbanisation and energy-intensive sectors growing rapidly, peak demand has become increasingly complex to manage. Together, UEI and peak demand management strategies are driving India's energy transition, building a sustainable future that supports the nation's growth and green energy objectives. UEI tries to bring the energy ecosystem together and focuses on market expansion, in which more and more energy and energy service providers, big or small, can contribute to and fulfil the ever-increasing energy demand for consumers and countries.

Manthan: Unified Energy Interface
Participants:

Sainath Bandhakavi, Head - Solutions Architecture for EdTechs & Prototyping - Public Sector, Amazon Web Services; Col. Sunil Kumar, Engineer-in-Chief, IHQ, MoD (Army); Reena Suri, Executive Director, ISGF – India Smart Grid Forum; Gowtham Injamuri, Senior Product Manager, Pulse Energy Technologies Pvt Ltd; Ankit Mittal, Co-Founder and CEO, Sheru; Abhishek Modi, Lead for Digital Platforms at SKI (UEI Alliance Member), Sattva Knowledge Institute (SKI); Arjun Gupta, Manager, RMI India Program (DER Policy), Rocky Mountain Institute (RMI); Mirambika Sikdar, AI & Energy Policy - Data Scientist, Council on Energy, Environment and Water (CEEW); Dr Sumit Choudhury, Founder, CEO, Green EarthX; Milind Deore, Secretary, Bureau of Energy Efficiency, Girja Shankar, GM, Corporate Driven Programmes, Energy Efficiency Services Limited (EESL); Prateek Aggarwal, Programme Lead, CEEW; Vishal Tripathi, Consultant, CEEW; Avinash Dubedi, World Resources Institute (WRI), Prashant Kumar, Chief General Manager (Technical) - Corporate Driven Programmes, EESL; Soumya Garnaik, India Country Representative, Global Green Growth Institute (GGGI); Vivek Goel, Chief Engineer - Distribution Planning

and Technology Division, Central Electricity Authority; Arturo Cadena, Advisor Smart Cities for Sustainable Urban Development, GIZ GmbH; Punit Gandhi, India Climate Collaborative, India Climate Collaborative

Gurus:
Sreeram Ananthasayanam, Partner, Deloitte India; Viswanathan Ravichandran, Partner, Deloitte India; Anujesh Dwivedi, Partner, Deloitte India

UEI is transforming energy access in India, creating an open, interoperable network where consumers have the power to choose and transact seamlessly.

India's move to cleaner, greener energy needs a solution that can be made more accessible, more affordable and more attuned to the needs of India's rural population. Conceived as a decentralised, interoperable energy network within India, the UEI, often compared to the Open Network for Digital Commerce (ONDC), is a much-lauded undertaking in this sphere of digital expansion. The UEI is built on open protocols, which foster smooth energy transactions and empower consumers and providers alike to enter the energy market through a unified system. With UEI, India is moving closer to a flexible, resilient energy system that democratises energy access for millions.

Decentralisation and interoperability
The key feature of UEI is its open, decentralised framework that promotes interoperability and the discovery of various energy services. These services include EV charging stations, peer-to-peer energy trading and others within the demand response system. The platform allows demand to be addressed by multiple service providers, giving the end consumer the freedom to choose from available options. Using the Beckn Protocol, UEI connects multiple energy service providers, allowing consumers to access various options. This decentralised structure empowers consumers by giving them choice and flexibility while reducing dependency on singular, monopolistic platforms.

Real-time energy trading and access
UEI supports real-time energy trading, enabling consumers and providers to buy and sell energy as an asset. This feature helps balance demand and supply more efficiently and promotes renewable energy usage through microtransactions. SMEs especially benefit from UEI, as they gain access to hyperlocal markets to engage in last-mile transactions. This shift creates a more resilient energy market, encouraging smaller players to enter and innovate within the sector.

Government and policy support

Bridging the gap between policy and technology, UEI promotes clean energy accessibility by uniting government support with innovative digital infrastructure.

For UEI to realise its full potential, supportive government policies and regulatory frameworks are essential. By fostering an open energy ecosystem, government entities at both the central and state levels play a critical role in enabling UEI to scale. Policies promoting clean energy, data sharing and PPPs will be essential in bridging technological and regulatory gaps. A national registry to track energy transactions could further enhance transparency and support the evolution of a sustainable, decarbonised energy system.

Manthan: Managing the Energy Transition through a Period of Surging Peak Demand
Participants:

Ghanshyam Prasad, Chairperson, CEA; Gaurav Angira, Director, Deloitte India; Anujesh Dwivedi, Partner, Deloitte India; Anish Mandal, Partner, Deloitte India; Shubranshu Patnaik, Partner and GPS Industry Leader, Deloitte India and others

Guru:
Eashwar Rao, Director, Deloitte India

> ❝
> *Considering current commitments and anticipated trends, we explored a projection of India's energy landscape in 2070. This analysis focused on future electricity demand and the strategies needed to meet it.*

Anujesh Dwivedi

India's energy demand is rising rapidly, with peak consumption increasingly putting pressure on the existing power grid. With urbanisation, economic growth and a surge in cooling demands, managing this energy landscape is critical for ensuring a stable and reliable power supply. The push for clean energy adds to the challenge as utilities struggle to balance intermittent renewable sources, such as solar and wind, with surging peak demands, especially during non-solar hours.

To meet these demands, India's energy sector is modernising its utilities. This involves using data-driven strategies, investing in innovative energy storage utilities and enhancing the coordination between state and central agencies. This *Manthan* session discussed at length the foundational tenets driving this modernisation imperative and the strategic interventions required to meet India's energy challenges head-on.

The peak demand challenge

Time-of-Day (ToD) pricing models empower consumers to reduce costs while helping utilities manage demand surges more efficiently, creating a win-win situation for India's energy landscape.

One of the most pressing challenges for utilities today is managing surging peak demand, particularly as energy-intensive sectors grow and urbanisation accelerates. Cooling demands are a significant driver, especially when solar power generation is unavailable at night. In recent years, India's peak demand has exceeded general energy demand growth, indicating a shift in consumption patterns. For example, experts project a 35–40 GW shortfall during non-solar hours by 2032, highlighting the need for robust solutions to stabilise the grid.

The rising energy demand highlights the importance of ToD pricing and demand response programmes, both of which encourage consumers to shift their usage away from peak hours. By offering incentives or dynamic pricing, utilities can better manage grid stress and flatten the load curve, leading to a more stable and efficient energy system.

Energy storage solutions

Energy storage has emerged as a game-changer for balancing intermittent renewable sources with consistent peak demand. With the integration of technology such as lithium-ion and pumped hydro storage, utilities can store excess energy produced during off-peak hours, which can then be discharged when demand is at its peak. These storage solutions act as a buffer during high-demand periods, allowing renewable sources to support grid stability even when solar or wind generation is low.

However, scalability remains a challenge. Large-scale storage solutions require substantial investment and policy support. A shift towards decentralised energy storage systems, where storage assets are distributed across the grid, can help utilities achieve the necessary capacity without overburdening any single infrastructure.

Enhanced coordination and planning

The key to sustainable energy management lies in enhanced coordination, structured planning and predictive insights, which are essential ingredients for a reliable power grid.

Effective demand management requires coordination among government bodies, state electricity regulators and private entities. The absence of consistent planning frameworks has historically hampered the ability of utilities to respond to peak demands efficiently. To address this, the central government has introduced the Renewable Purchase Obligation (RPO) framework, mandating states to procure a certain percentage of energy from renewables. However, implementation varies widely, with states facing challenges related to financing, regulatory oversight and infrastructure.

Capacity planning at the state level, backed by robust demand forecasting, is essential for scaling renewable energy while avoiding supply shortfalls. The Regulatory Asset Securitisation (RAS) model offers a structured approach for states to manage peak demand by incentivising investments in renewable generation and storage. As this model gains traction, state-level planning can become more standardised, fostering a national energy framework that is both resilient and adaptable to future growth.

Advanced data and demand forecasting

From real-time smart metering to AI-powered demand forecasting, modern utilities are becoming smarter and more responsive to shifting consumption patterns.

Data-driven approaches are crucial for accurately forecasting demand patterns and predicting surges. AI and ML technologies are being integrated into the energy sector to enhance demand forecasting capabilities. These tools can analyse historical consumption data, weather patterns and other relevant variables to provide predictive insights. Such granular data helps utilities better understand the nuances of peak demand, enabling more precise load forecasting and reducing the likelihood of unexpected shortfalls.

For instance, smart metering technology provides real-time data on consumption, allowing utilities to implement targeted demand response strategies. As smart meters become more prevalent, utilities can better manage peak loads by deploying tailored incentives and programmes to consumers, ensuring grid stability.

Policy and regulatory support

Policy plays a pivotal role in supporting utility modernisation efforts. From renewable energy targets to incentives for energy storage, regulatory frameworks are necessary for driving investments and innovation. The Indian government has recently been exploring ToD tariffs, designed to reflect the actual cost of energy supply during peak hours. By shifting consumption to off-peak times, TOD tariffs help alleviate grid stress, making it easier for utilities to handle peak demand surges.

Another regulatory intervention under consideration is providing states with greater autonomy to set and manage energy pricing based on local demand and supply dynamics. Such policies can encourage states to adopt dynamic pricing models, which could significantly reduce peak demand by promoting flexible consumption patterns among industrial and commercial consumers.

Key takeaways

- **Decentralised open network:** UEI provides a decentralised, interoperable network that enables seamless interaction among diverse energy providers and consumers and brings demand and supply together. This can further help allow the data to predict and manage demand and supply availability.

- **Real-time trading capabilities:** UEI allows real-time trading, increasing market flexibility and providing opportunities for SMEs and local providers to enter the energy market.

- **Government policy collaboration:** Supportive government policies are crucial for scaling UEI, from regulatory frameworks to data-sharing protocols and PPPs.

- **Clean energy accessibility:** UEI promotes sustainable energy practices, supporting the clean energy transition by making renewable energy more accessible and affordable.

- **Time-of-Day (ToD) pricing:** Implementing TOD pricing incentivises consumers to shift their energy use away from peak times, helping flatten demand spikes and easing grid stress.

- **Energy storage:** Investment in both centralised and decentralised energy storage solutions is essential to balance intermittent renewable generation with surging peak demand.

- **Coordination and planning:** Improved coordination among central and state entities, along with structured frameworks such as the RPO and RAS models, is vital for standardised capacity planning across states.

- **Data-driven demand forecasting:** AI and ML technologies, alongside smart metering, provide actionable insights, allowing utilities to predict and manage peak demand more effectively.

- **Policy support:** Regulatory frameworks, such as TOD tariffs and dynamic pricing models, are instrumental in reducing peak demand and driving investments in utility modernisation.

MODERNISING THE UTILITIES (MANAGING THE ENERGY TRANSITION THROUGH A PERIOD OF SURGING PEAK DEMAND)

POLICY INNOVATIONS AND COLLABORATION
- CENTRAL PROCUREMENT
- DYNAMIC PRICING
- COLLABORATION AMONG STAKEHOLDERS

NEED FOR CAPACITY BUILDING IN STATE REGULATORS
- DEMAND FORECASTING
- MARKET UNDERSTANDING
- POLICY IMPLEMENTATION
  - RPO : GREEN HYDROGEN MISSION

CHALLENGES IN RENEWABLE ENERGY PROCUREMENT
- INVESTMENT IN GRID INFRASTRUCTURE

RISING DEMAND AND PEAK LOAD
- TIME-OF-DAY PRICING