Sustainability Stack: DPI Architecture for India's Sustainability Leap

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India's has redefined scalable governance and orchestration at population scale with its successful Digital Public Infrastructure experiences from authenticating 1.4 billion[i] citizens with Aadhaar to powering 16 billion[ii] monthly transactions with UPI. Indian Institute of Management Bangalore's Center for Digital Public Goods (CDPG) is now expanding these proven approaches with its proposed Sustainability Stack, a sector-agnostic DPI framework that integrates fragmented Economic, Environmental and Social (EES) data into unified digital system.

CDPG is pushing boundaries even further by proposing a Sustainability Stack grounded in Digital Public Infrastructure (DPI) principles. This framework intends to integrate economical environmental and social governance (EES) data into a unified, interoperable system, with the potential to redefine effective sustainability efforts by corporations, governments, and communities.

India is dealing with complex sustainability issues with systemic voids which needs to be addressed with promising approach to achieve Nation's net-zero commitment by 2070[iii]. Regulatory complexity amplifies this ambiguity leading to inefficient decision making and false reporting. The vast datasets collected by government departments such as water boards, electricity boards, pollution control boards, and municipal corporations keep getting stuck in departmental silos.

JICA-BCG's Forest Stack, a layered DPI architecture for ecological management and governance has inspired the inception of Sustainability Stack's DPI blueprint. The Forest Stack validated the registries-based orchestration approach to address siloed forest data into a decision-intelligence system. Contrary to Forest Stack, the Sustainability Stack expands this DPI approach by integrating-fragmented data in urban water, energy, waste, and land use systems.

Analysis and solution provision:

The proposed Sustainability Stack introduces a dashboard-based sustainability assessment for Urban systems along with sustainability urban ecosystem entities identification to address departmental data silos. The major advancements proposed include:

- Comprehensive ecosystem mapping across seven layers: grassroots (households, RWAs), institutional/market (utilities, industries), ecological (lakes, parks), systemic/governance (municipal bodies), ESG-focused (rating agencies), social/NGO (SHGs, community groups), energy-transition (DISCOMs, renewables), and quasi-government (pollution boards, SPVs).
- Role-based entity selection links actors to EES impacts, capturing non-traditional influencers like delivery platforms and informal vendors whose behaviors drive outcomes.
- Unified performance metrics, standardizing indicators like per-capita energy use, waste segregation rates, and service equity for cross-entity comparability.
- Systemic entity inclusion, explicitly tracking quasi-government authorities (e.g., water boards, development authorities) often ignored in reporting frameworks.

These advancements facilitate investigation from aggregate (city totals) to disaggregate (entity/ward-level) data, exposing losses, inefficiency, and systemic disparities. Sustainability planning often involves Jevons' efficiency paradox [iv], which states that efficiency gains stimulate rebound through additional units or longer hours usage, raising total consumption. The Sustainability Stack provides for monitoring and evaluation using real-time metering, nudges (peer comparisons), and time-of-day pricing, ensuring that technology adoption results in net savings.

Sustainability Ecosystem: 42 Entities Mapped Across Seven Functional Layers

The primary differentiator of the Sustainability Stack design is its entity-based ecosystem mapping. Instead of focusing exclusively on government departments, it deals with 42 sustainability entities across seven functional categories, each with granular Economic, Environmental, and Social (EES) performance metrics, capturing the true essence of public-private partnership through the DPI approach. This mapping encompassed seven categories, as indicated in Table 1.

Entity Category	Key Examples
Grassroots	Citizens/Households, RWAs, Street Vendors, Urban Animals, SHGs, Personal Vehicles
Institutional	Public Transport, Industries, Utilities, Financial Institutions, eCommerce/Delivery
Ecological	Water Bodies, Parks/Gardens, Urban Forests
Systemic	Government Departments, Municipal Leadership
ESG-Focused	ESG Rating Agencies, CSOs, SEBI Regulators, Auditors
Social/NGO	NGOs, SHGs, CSR Foundations, Community Groups
Energy	DISCOMs, RE Developers, Grid Operators, EV Charging, Rooftop Solar, Smart Meters
Quasi-Government	Lake Authorities, Water Boards, Pollution Boards, SPVs, Energy Regulators

Table 1: Seven Categories for Sustainability stack Ecosystem entities Mapping

Sustainability Stack's Layered DPI Architecture

The proposed Sustainability Stack's six-layered DPI architecture is built on QUADs DPI design principles[v]. Quad Principles for DPI were jointly established by Quad countries (Australia, India, Japan and United States) in 2024 to define design principles required for development and deployment of DPI. These principles emphasize interoperability, modularity, extensibility, scalability, collaboration, intellectual property protection, security, privacy, governance for public benefit, trust, transparency, sustainability, grievance redressal and sustainable development goals.

The sustainability Stack's Layer 1 consists of master data systems (e.g., utility databases); Layer 2 comprises of registries for orchestration Layer 3 offers APIs and standards; Layer 4 manages analytics and decision intelligence; Layer 5 provides stakeholder dashboards; and Layer 6 delivers applications with feedback loops. The schematic illustration for six-layered DPI architecture is indicated in Figure 1.

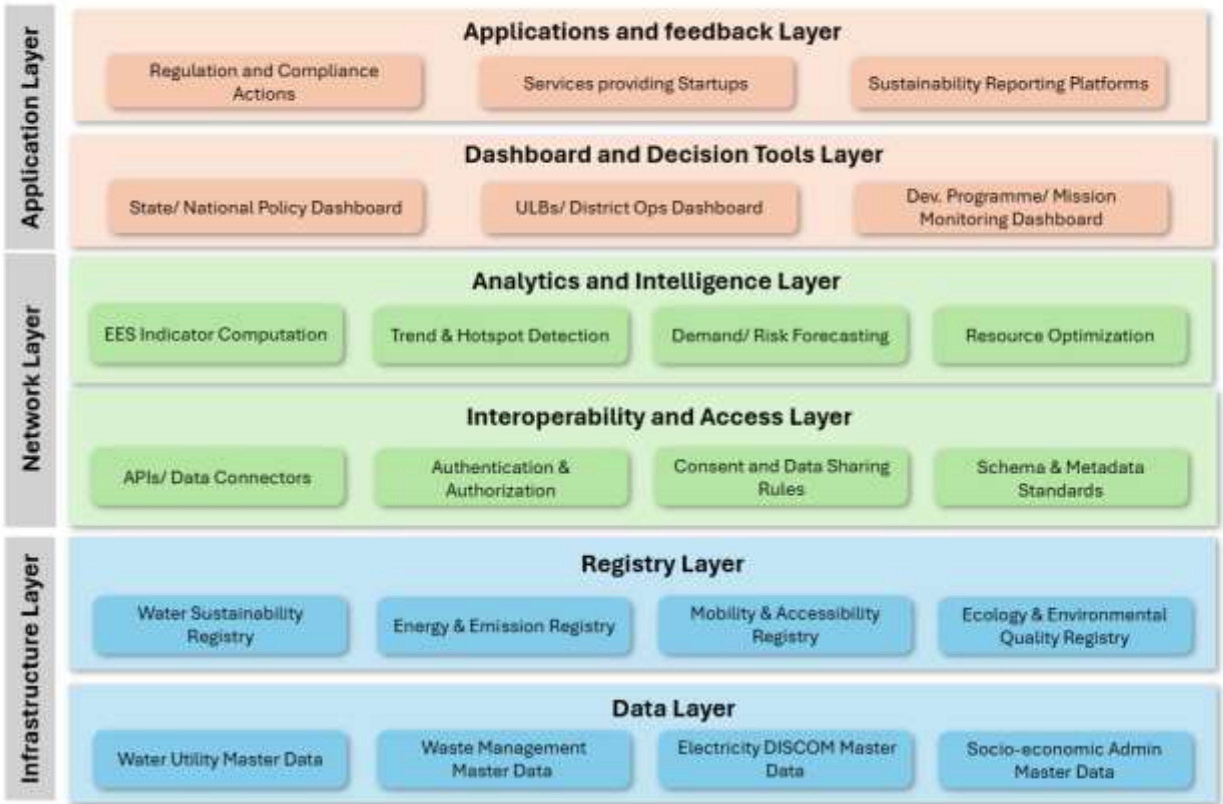

Figure 1: Schematic Illustration for Six-layered DPI Architecture of Sustainability Stack

The proposed Sustainability Stack positions registries as its core innovation distinguishing them from departmental databases. This was essential for addressing fragmented data silos and facilitating interoperability across the regions and ecosystem entities. It proposed the minimum viable registries (water, energy, ecology) working across EES domains, enabling decisions like leakage targeting or demand management could potentially transform reactive reporting into anticipatory governance.

Sustainability Stack's Governance Framework

The stack proposes citizen-centric governance framework where registry-based orchestration is integral. For pilot-scale adoption, Nodal authority (e.g., municipalities and ULBs); and registry custodians (e.g., water boards) need to be established. The stack leverages data stewardship through DEPA-compliant agreements, citizen-centric engagement activities and ensures equilibrium between economic and ecological outcomes. Citizens engage with the stack through multiple means: as data principals (providers of data), data consumers, application development and provide services. For-profit corporations will benefit from the deployment of stack in multiple ways such as creating dashboards for measuring and monitoring impact of their sustainability initiatives, realign their sustainability strategies and allocate resources accordingly. State governments, ULBs/ municipalities and government departments/ agencies will leverage the Sustainability Stack in designing policies, ensuring regulatory compliance, and aligning with development goals (UN SDGs).

Conclusion

The proposed Sustainability Stack intends to potentially transform fragmented sustainability data systems into a sector-agnostic, registry-based Digital Public Infrastructure (DPI) with decision intelligence across economic, environmental, and social (EES) dimensions. The stack contributes with the development of (a) Sustainability ecosystem entity mappings (from grassroots to quasi-government), (b) unified EES entity performance metrics, (c) a six-layer DPI stack architecture built on QUADs DPI principles, and (d) redefining aggregated/ disaggregated sustainability data for minimum viable registries. The Sustainability Stack could be globally scaled in diverse contexts including developing and advanced economies. The DPI design principles will enable Sustainability Stack to scale and deploy globally ensuring sovereignty at all levels.

IIMB CDPG invites academics, practitioners, startups, and governments entities to engage and share feedback on the Sustainability Stack (Full report available on IIMB CDPG website).

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