INDIA ENERGY STACK

Strategy Document

The Ministry of Power is reimagining the digital backbone for India's Power sector by creating a Digital Public Infrastructure (DPI) for the Power sector through the India Energy Stack (IES). The IES is being advanced under a whole-of-ecosystem approach through a phased programme of design, pilot implementation, and national rollout.

Note: The India Energy Stack documents are currently in draft form, going through various revisions, and will be released regularly as the idea evolves for public consultation and review. The contents of these documents should currently be seen purely as a draft.

Glossary of Terms

Acronym	Expanded form	What it refers to in this context
AGC	Automatic Generation Control	Automated control of generator output to support frequency control
AMI	Advanced Metering Infrastructure	Smart metering system including meters, communications, and head-end
AS	Ancillary Services	Grid support services like reserves and frequency response
ATC	Available Transfer Capability	Transfer capacity available for transactions after reliability margins
CIS	Customer Information System	Utility customer and account management system
CMMS	Computerized Maintenance Management System	Maintenance planning and work order management tool
CEMS	Continuous Emissions Monitoring System	Continuous monitoring of emissions at generation units
CPO	Charge Point Operator	Entity that owns or operates EV charging stations
CRM	Customer Relationship Management	Customer engagement, complaints, and service management tool
DEEP	Discovery of Efficient Electricity Price	India's e-bidding and reverse auction procurement portal
DER	Distributed Energy Resource	Distributed generation/storage like rooftop solar and batteries
DERMS	Distributed Energy Resource Management System	System for monitoring and managing DERs and aggregations
DISCOM	Distribution Company	Electricity distribution utility
DRMS	Demand Response Management System	System to run demand response programs and event dispatch
EAM	Enterprise Asset Management	Asset lifecycle management system for utilities and grid owners
EMS	Energy Management System	Control-room system for monitoring and operating the grid
ERP	Enterprise Resource Planning	Enterprise finance, procurement, inventory, and operations system
GENCO	Generation Company	Power generation entity or utility
GIS	Geographic Information System	Spatial asset and network mapping system
HVDC	High Voltage Direct Current	DC transmission technology and associated corridor assets

IAM	Identity and Access Management	Identity, authentication, authorisation, and access control tooling
KPI	Key Performance Indicator	Performance metric used for monitoring outcomes and compliance
LiDAR	Light Detection and Ranging	Remote sensing used for corridor and right-of-way monitoring
MDMS	Meter Data Management System	System that stores, validates, and provides meter data
MERIT	Merit Order Dispatch of Electricity for Rejuvenation of Income and Transparency	Public transparency portal for merit order and procurement insights
MIS	Management Information System	Reporting and compliance information system
N-1 / N-2	Contingency criteria	Planning/operational checks for one or two element outages
NPP	National Power Portal	National portal providing power sector data and dashboards
OTC	Over-the-Counter	Bilateral contracting outside an exchange platform
PMU	Phasor Measurement Unit	Synchrophasor device for wide-area monitoring and stability analysis
REC	Renewable Energy Certificate	Tradable certificate representing renewable generation attributes
RPO	Renewable Purchase Obligation	Regulatory requirement to procure a share of electricity from renewables
SCADA	Supervisory Control and Data Acquisition	Real-time monitoring and control system for grid assets
SEM	Special Energy Meter	High-accuracy meter used for settlement and energy accounting
SIEM	Security Information and Event Management	Central security monitoring, logging, and alerting system
SOC	Security Operations Center	Team and function monitoring and responding to cyber incidents
TARANG	Tarang portal (commonly referenced as a Ministry/NPP-linked dashboard for generation and projects)	Public dashboard for generation/project information in the Indian power sector
TRANSCO	Transmission Company	Entity owning or operating the transmission network
TTC	Total Transfer Capability	Maximum transfer capacity before applying reliability margins

UFLS	Under Frequency Load Shedding	Automatic load shedding to arrest frequency decline
UVLS	Under Voltage Load Shedding	Automatic load shedding to arrest voltage collapse
V2G	Vehicle-to-Grid	EVs discharging power back to the grid as a flexibility service
WAMS	Wide Area Monitoring System	PMU-based monitoring for grid stability and oscillation detection
WFM	Workforce Management	Crew dispatch, work orders, and field operations management

1. PREFACE

1.1 PURPOSE OF THIS DOCUMENT

The strategy document offers a comprehensive overview of how the India Energy Stack (IES) will be developed, implemented, and expanded within the power sector. It articulates the reasoning behind establishing a cohesive digital infrastructure, outlines the fundamental principles guiding the design, and sets clear expectations for stakeholders involved in its execution. The goal is to transition the sector toward interoperable, standards-based interactions that enhance reliability, transparency, and efficiency. Additionally, the document delineates the roadmap for rolling out the IES through the Architecture, Adoption, and Accelerator tracks, providing policymakers and technical bodies with a shared reference for informed decision-making.

1.2 IES AS PART OF INDIA'S DIGITAL PUBLIC INFRASTRUCTURE JOURNEY

India's Digital Public Infrastructure (DPI) journey has consistently focused on building population-scale public goods that establish shared digital frameworks for identity, payments, and data exchange. Examples such as Aadhaar, UPI, DigiLocker, eKYC and eSign have demonstrated how open standards and trusted governance can transform entire sectors. The India Energy Stack builds upon this concept within the power sector, where reliable, verifiable, and interoperable data flows are crucial for both operational stability and sector-wide innovation. Although the energy system is distinct from previous DPIs due to its nature as a cyber-physical network constrained by real-time demands, the core philosophy remains: establish open standards, foster trust and accountability, and allow a diverse ecosystem of public and private entities to engage on equal footing. The IES represents the next phase in this evolution, enabling the power sector to leverage digital public infrastructure while acknowledging its operational challenges.

2. VISION & MISSION

Vision: To enable an energy ecosystem where every consumer can choose, participate, and earn in a clean, digital, and resilient power economy. IES envisions a new energy economy driven by energy entrepreneurs who can effectively use their energy agency for collective benefit of the society.

Mission: To build open, interoperable, and secure digital public infrastructure for the power sector that enables seamless participation, innovation, and efficient coordination among consumers, utilities, markets, and energy assets at scale

3. INDIA ENERGY STACK: A TRUST BRIDGE FOR THE POWER SECTOR

As India grows into a $5 trillion economy with an ambition to reach $30 trillion by 2047, the per capita energy consumption is set to increase manifold, while meeting the nation's Net Zero commitments by 2070 (MEA, 2024) (PIB, 2023) (PIB, 2018). Thus, our power sector needs to be able to ramp up to support this growth while maintaining the momentum for exponentially growing renewable generation. Over the next decade, the challenges in managing our generation mix and grid will become increasingly complex. The growing adoption of renewable energy has led to the emergence of prosumers, households and businesses that both consume and produce electricity through rooftop solar installations, further exemplifying this transformation.

3.1 NEED FOR A DPI IN THE POWER SECTOR

Although India has invested heavily in operational technologies such as smart meters and SCADA, the sector lacks an integrated digital framework that connects these systems. Past programmes like RAPDRP created valuable digital assets but did so in pockets, reflecting the fragmented roles of GENCOs, TRANSCOs and DISCOMs across states. The result is a set of digital islands rather than a unified national ecosystem, limiting the sector's ability to manage rising demand and coordinate an increasingly diverse generation mix. This fragmentation creates significant operational challenges that impede the energy sector's ability to meet India's growing energy demands efficiently (Ravi Kumar, 2025). To address these systemic issues, it is essential to first understand the specific challenges currently plaguing the energy sector.

1

Absence of Unique Identification
There is currently no verifiable, unique identifier for consumers, assets, or stakeholders within the power sector. This gap prevents accurate tracking of individual energy transactions.

2

Information Asymmetry
Decision-making among stakeholders throughout the energy value chain is often limited by the availability of harmonised and real-time data.

4

Interoperability Issues
- Unlike financial infrastructures (e.g., NPCI's UPI), the energy sector lacks standardised platforms for seamless integration and cross-DISCOM transactions.
- Existing digital solutions have not been developed with interoperability as part of the design and have limited scalability
- Redundant efforts and elevated costs result from these shortcomings.
- Integrated systems typically lack cross-regional communication.
- Demand-side management possibilities are limited despite the availability of machine-readable data.

3

Dependency and Cost
Solution providers struggle to achieve economies of scale and depend heavily on utilities' proprietary digital systems and platforms.
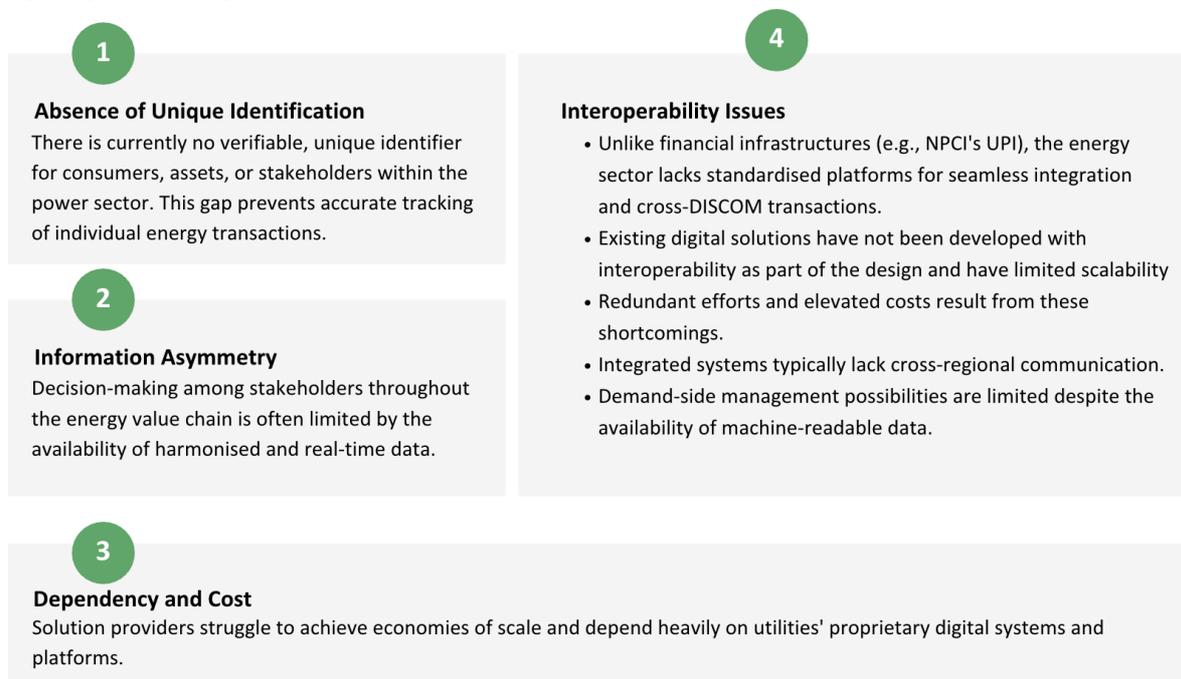
Figure 1 Key Challenges in the Energy Sector (Ravi Kumar, 2025)

These challenges collectively point to a fundamental need for a unified digital architecture that can serve as the backbone for India's energy transformation. The solution lies in adopting a Digital Public Infrastructure (DPI) approach, which has proven successful in other sectors of the Indian digital economy.

The power system is a complex network where digital data and the physical flow of electricity directly influence each other. This two-way coupling between digital data and physical processes, where each continuously affects the other, makes the design of Digital Public Infrastructure (DPI) challenging. In such a system, information from each stakeholder should be complete, consistent, and reliable to improve grid operations, market settlements, and overall system stability.

3.2 IES DEFINITION

India Energy Stack (IES) is a digital public infrastructure to identify and connect stakeholders and assets, thereby facilitating open data exchange and interoperability in the power system through uniform specifications and standards, unlocking transparent, reliable, inclusive, efficient, and affordable access to energy.

3.3 SCOPE OF IES

IES is...

- **A set of protocols/specifications** that makes **interoperability** between grid entities/stakeholders **uniform, reliable, verifiable and trustworthy**. Essentially, IES defines how entities (DISCOM-Apps; DISCOM-GENCO; DISCOM-Transco; Genco-Transco; EV charger- Charger booking apps; consumer-producer etc.) interact with one another
- **A set of services** (API definitions and calls) **plus a data model/taxonomy** (how components are identified, organised and relate to each other, i.e., how the specified services are used together).

Therefore, IES is a **foundational digital layer** combining a common interaction framework, standardised **taxonomy/data models**, **assurance** mechanisms for **trust and validation**, and baseline technical standards. This enables the development of scalable solutions for the energy sector.

IES is NOT...

- A centralised database/data lake.
- **A centralised service** that pulls or receives data from various entities.
- A software package.
- **Dependent on a strict hierarchy.** It does not presume a hierarchical structure of the energy sector to function.
- A set of specifications and standards whose sole purpose is to integrate internal systems of any stakeholder/entity/utility.

3.4 HOW IES SERVES DIFFERENT STAKEHOLDERS IN THE ENERGY ECOSYSTEM

Stakeholder	Core Problems	Possible IES Approach
GENCOs	Limited telemetry, no carbon tracking, no market visibility	Open telemetry APIs, digital maps, and carbon accounting APIs
TRANSCOs	Asset data silos, no DER integration, limited external data access	Open asset registries, infrastructure maps, grid-edge integration ssa
DISCOMs	Fragmented billing/data systems, vendor lock-in, poor demand visibility	Smart meter integration, unified registries, analytics, and openness KPIs
Regulators	Reliance on static reporting, low digital skills, unavailability of tools for policy making	Real-time dashboards, sandboxes to test new tariffs/market, automated compliance monitoring
System Operators (SO/DSO)	Disconnected grid levels, DER blind spots, no coordination framework	Shared nodal data views, DSO-TSO APIs, grid connectivity maps
Market Operators (Exchanges, OTC platforms)	Fragmented market data, no standard APIs, limited grid visibility for market operations	Standard APIs, real-time grid-linked market data, integrated participant registries, and a common carbon marketplace
Consumers	Limited real-time usage/ billing data, no carbon footprint visibility, Limited participation in energy markets	Consented data sharing, real-time dashboards, unified energy accounts, P2P exchange (trading)
Startups/Tech Providers	No sandbox, data access barriers, redundant integrations across utilities	Common registries, Open APIs , innovation sandboxes, Data marketplace (Open Datasets)

Figure 2 Benefits for different stakeholders

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3.5 IES AS AN ENABLER FOR ENERGY AGENCY, LIVELIHOOD AND ENTREPRENEURSHIP

IES will enable the shift from energy access to energy agency by building interoperable digital foundations that let consumers participate in the power system with confidence and at scale. Energy agency means consumers can choose services, participate in markets, and monetise their assets or actions, rather than remaining passive recipients of electricity. This is a core delivery objective for the sector, because a future power system with high volumes of distributed transactions requires participation that is trustworthy, measurable, and settleable at scale.

IES enables agency by reducing the practical friction that prevents most consumers from participating today. It standardises onboarding through verified credentials so consumers do not need to repeat documentation or technical integration for each utility or service provider, enabling seamless participation across services, vendors, and geographies. It also enables consent-based data sharing so consumers can selectively share data with providers of their choice, unlocking competition in advisory, billing support, efficiency services, EV charging, and demand response, while avoiding lock-in into a single vendor workflow.

The economic impact comes when participation becomes monetisable at scale. Small and distributed assets and flexible actions translate into income only when measurement, verification, and settlement are reliable. With use cases implemented at scale, households, MSMEs, and agricultural consumers can monetise actions such as off-peak EV charging, reduced cooling loads, or temporary load curtailment. IES enables verification and settlement at scale, allowing millions of small actions to be bundled into dependable grid support. This creates a new class of energy micro-entrepreneurs who earn not only by generating power, but also by providing flexibility and related services.

IES also provides a direct pathway to inclusive growth. The same participation and settlement rails can align with women-led livelihood programmes, enabling women's self-help groups to collectively own rooftop or community solar assets, trade surplus electricity, and power micro-enterprises in activities such as food processing, tailoring, dairy, and agri-allied services. For these self-help groups, reliable and affordable electricity improves productivity through mechanisation and cold-chain access, while participation in digital energy platforms strengthens financial inclusion, digital literacy, and leadership within local institutions.

3.6 HOW IES WORKS IN PRACTICE

IES defines the **rules for interaction** between federated systems, ensuring that whenever data is exchanged, it does so in a **secure, standardised, and verifiable** manner. IES does

not enter or control the internal processes of the stakeholders' federated systems. Each utility, market operator, or participant continues to manage its own platforms.

A **federated system** is an independent IT/OT system that maintains its control over its local data and operations.

In any interaction, IES provides the **common information rails** that enable transparent, unified, and interoperable exchange among federated participants. It only defines the **specification for data exchange**, not the control logic itself. By standardising these interactions rather than internal systems, IES is reinforcing its role as a trust bridge across the energy ecosystem.

IES provides this data exchange specification for all kinds of digital transactions in the power sector. These transactions may also have an impact on the actual physical flow of energy.

To operationalise this, IES will function as a suite of protocols and standardised APIs that builds on the sector's existing technical foundations and introduces new specifications where necessary. Interactions can draw on established frameworks such as IEC 61850, ICCP, IEEE 1547 and IEEE 2030.5, OpenADR, Beckn, OCPI, . All of these sit on harmonised data models from IEC 61970, IEC 61968, IEC 62325, other existing core primitives and grid data models, creating a consistent and interoperable structure for every interaction.
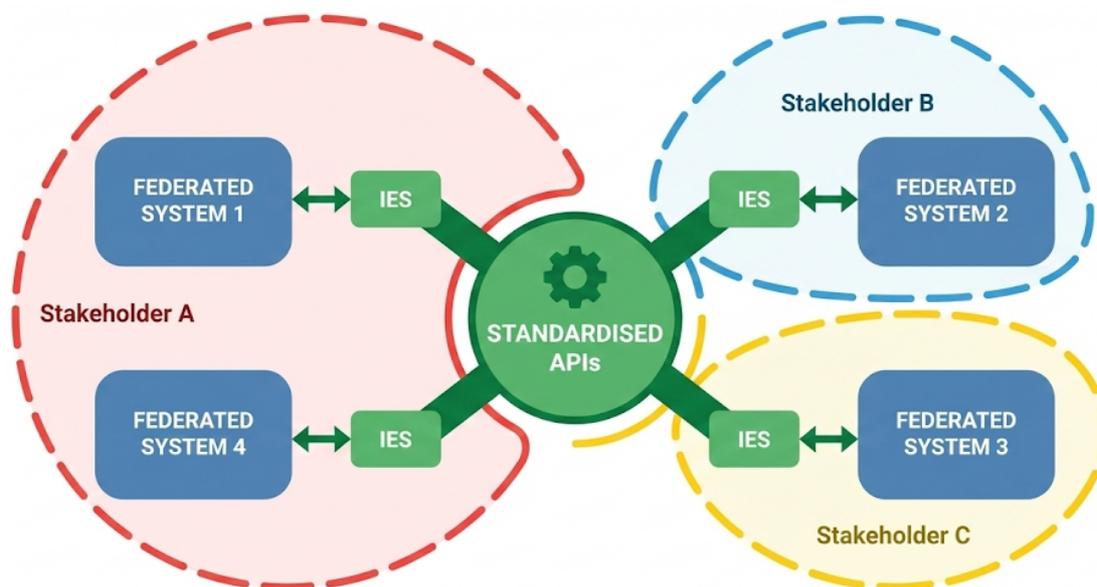

Figure 3 IES Interactions across federated systems/stakeholders

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4. IES DELIVERABLES

IES will be rolled out through three tracks (AAA):

4.1 IES ARCHITECTURE
Defines the technical blueprint for the IES ecosystem. It sets the common rules that let different power-sector actors exchange data and execute digital interactions safely and consistently, including shared data models, identifiers, APIs, registries, and assurance requirements.

Refer to the IES Architecture Document and the IES GitHub Repository for more details

4.2 IES ADOPTION STRATEGY
Defines how the sector moves from the architecture to real implementation. It maps stakeholder readiness, identifies incentives and barriers to adoption, and outlines programs and policy or regulatory actions needed for uptake. It includes phased pathways, pilots, capacity building, integration with legacy systems, and practical compliance or certification approaches so organisations can become IES-ready and IES-compliant.

4.3 IES ACCELERATOR
Builds the practical enablers that speed up adoption of the architecture. It provides sandbox environments, testing tools, and reference solutions so utilities, system operators, market participants, and innovators can validate IES-aligned use cases under controlled conditions. The accelerator generates evidence on interoperability, performance, safety, and regulatory implications to inform scale-up, without compromising reliability, security, or consumer trust.

5. GUIDING PRINCIPLES

- Transparency & Efficiency – all transactions should be verifiable, tamper-evident, and machine-readable.
- Data Federation – data remains where it is generated; IES provides standardised interfaces for secure exchange.
- Interoperability – stakeholders should be able to join or exit with minimal friction, enabled by open APIs and specifications.
- Functional Scope – defines functions (standards, governance, services), not rigid technology forms.
- Scalability & Resilience – decentralised architecture (UPI-like) avoids central bottlenecks; systems must scale to population-level usage.
- Open Innovation – provides core data and services for private and public actors to build applications on top of them, including AI-readiness.
- Inclusivity & Accessibility – smaller stakeholders with limited capacity can use common shared infrastructure; larger ones may self-deploy.

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- Privacy & Trust: Mandate secure data exchanges, privacy protection, and robust compliance frameworks.
- Cybersecurity by Design – ensure authenticated nodes, strong access controls, and continuous monitoring across all interactions.
- Deterministic Reliability – requires timing guarantees and full auditability for critical, cyber-physical interactions.
- Ecosystem Neutrality – maintain technology- and vendor-neutral standards that prevent lock-in and support open participation.
- Sovereignty & Regulatory Alignment – align with national priorities on data sovereignty, security, and compliance.
- Leveraging Existing Systems – build on current infrastructure, standards, and operational workflows to ensure seamless adoption and preserve sector investments.
- Minimalism – define the baseline set of standards, registries, and interfaces needed for interoperability and trust; avoid over-prescribing technology or data beyond what is necessary.
- AI Readiness – Design such that data, identifiers, and governance are AI-consumable by default, enabling safe automation, auditability, and continuous learning across power-sector workflows.

6. MAPPING OF EXISTING DIGITALISATION EFFORTS

The methodology for mapping existing digital efforts was initiated through primary consultations with key stakeholders to define priority areas for digitalization. These insights served as the directive for targeted secondary research, enabling a focused review of relevant documentation to identify and map the digital systems currently in operation. An exhaustive list of existing digital systems and initiatives can be found in Annexure 3.

7. THE IES ARCHITECTURAL FRAMEWORK: BUILDING BLOCKS FOR A MODULAR ECOSYSTEM

IES is designed as a modular suite of shared digital building blocks that collectively eliminate the need for repeated, bespoke integrations across the power sector. The core strategic intent is to achieve interoperability at the workflow level rather than through a single, centralised platform. By adopting common rules for identification, discovery, exchange, and policy execution, utilities and system operators can maintain their own sovereign systems while participating in a seamless, decentralised ecosystem. This modularity and scalability capabilities ensure that solutions can be deployed across institutions and jurisdictions simply by meeting defined conformance requirements and significantly reducing the cost and time of innovation.

7.1 FOUNDATIONAL BUILDING BLOCKS

IES developed its building blocks by working backwards from priority operational, market, and regulatory use cases. For each use case, the design process examined where fragmentation, ambiguity, or manual intervention currently creates cost, delay, or risk. Common patterns were identified across utilities, system operators, regulators, and service providers, and distilled into minimum shared capabilities that could apply across contexts. The focus was on defining what must be standardised to enable coordination, while allowing local systems and workflows to continue. The result is a set of technology-neutral building blocks that are grounded in real sector needs rather than abstract architecture.

The current foundational IES building blocks are:

Identity and Addressing

- **Overview:** Identity and Addressing provides a common reference system for the power sector. It assigns unique, standard identifiers to consumers, connections, meters, and grid assets so every data exchange and transaction is unambiguously attributed. It covers persistent unique IDs, standard attributes, and mapping rules that link local or legacy identifiers to common references.
- **Interoperability rail**: By creating a single reference layer across systems, Identity and Addressing eliminates ambiguity and manual reconciliation. Data from different utilities and vendors can be aligned consistently, enabling solutions to be reused and scaled across geographies.

Registries and Directories

- **Overview:** Registries and Directories are records that establish who is authorised to act in the ecosystem and where their digital endpoints can be discovered. They include role-based registries capturing authorisation status, scope, and validity for institutions and service providers, and directories that provide machine-readable discovery of services and interfaces. Governance arrangements define who can publish, update, and query these records.
- **Interoperability rail:** This building block replaces bilateral onboarding and manual verification with a shared, trusted source of legitimacy and discovery. Systems can verify counterparties and locate services automatically, enabling plug-and-play participation.

Transaction Protocols

- **Overview**: Transaction Protocols define standardised rules for exchanging requests, data, and responses across systems, including common message structures and

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data semantics. IES specifies versioned protocol definitions covering message envelopes, data models, interaction patterns, and error handling. The protocols are extensible and designed to sit above heterogeneous legacy and vendor systems without prescribing internal architectures.

- **Interoperability rail**: Transaction Protocols decouple applications from underlying systems. A service built for one utility can interoperate with another without custom integration, reducing cost and accelerating replication.

Energy Credentials

- **Overview:** Credentials are verifiable digital proofs that establish eligibility, authority, or status for actors and assets, aligned with regulatory and institutional requirements. The framework supports issuance, verification, and revocation of standard credential types such as consumer consent, asset certification, and licences.
- **Interoperability rail**: Standardised credentials embed trust directly into transactions. Systems can verify permissions automatically, reducing fraud risk, strengthening compliance, and improving auditability across the ecosystem.

Policy as Code

- **Overview**: Policy as Code converts regulatory and policy logic into machine-readable rules that can be evaluated consistently and transparently by systems. Policies are expressed in executable formats with defined inputs, outputs, versioning, and governance. Human-readable intent remains linked to the code to ensure explainability and oversight. Policy packs can be configured for different states or programmes.
- **Interoperability rail**: By standardising how policies are packaged and applied, Policy as Code ensures uniform accessibility and understanding across utilities and applications while allowing jurisdiction-specific variation.

7.2 LEVARAGING BUILDING BLOCKS FOR USE CASE ILLUSTRATIONS

The power of the IES framework lies in the composability of the building blocks.

Listed below are illustrative use cases that show the use of building blocks:

Consumer onboarding

- Identity and Addressing: links the consumer, connection, and meter to a common reference.

- Registries and Directories: verifies authorised utilities and service providers and enables endpoint discovery. Registries would also contain credential revocation information (if any)

- Credentials: captures and verifies consumer consent and eligibility.

- Transaction Protocols: standardises onboarding requests, confirmations, and acknowledgements.

- Policy as Code: applies eligibility rules, consent scope, and consumer protection logic.

Peer-to-peer trading

- Identity and Addressing: links buyers, sellers, assets, and settlement accounts to common references.

- Registries and Directories: registries will act as ledger that will contain trade information updated by the trading platforms as well as export – import information updated by the DISCOMS .

- Credentials: validates trading permissions, consumer consent, and platform authorisations.

- Transaction Protocols: handles trade offers, matching, execution, and settlement exchanges.

- Policy as Code: applies trading constraints, price limits, consumer protections, and settlement rules via policy packs.

Regulatory data exchange

- Identity and Addressing: ensures traceability of reported data to verified entities and assets.

- Registries and Directories: confirms reporting roles, obligations, and authorised reporting channels.

- Credentials: establishes authority and authenticity of data submissions.

- Transaction Protocols: standardises submission, acknowledgement, validation, and correction workflows.

- Policy as Code: defines reporting thresholds, formats, and compliance checks.

8. CYBERSECURITY, PRIVACY, AND TRUST FRAMEWORK

The India Energy Stack aims to establish a robust cybersecurity and privacy framework that prioritises protecting sensitive energy data and fosters trust among all stakeholders. The approach embeds security and privacy by design, applying proven tools such as encrypted data exchange, consent-based sharing, and trusted digital identity frameworks. The architecture is modular and scalable, enabling large volumes of devices and data to interoperate securely through open, standardised APIs.

The framework will apply methods such as data encryption, secure data enclaves, and role-based access controls in line with national cybersecurity standards. It will evolve through coordinated engagement with utilities, operators, regulators, and technology partners to strengthen threat detection and maintain resilience against emerging risks. By giving consumers control over how their data is used, the framework aims to establish trust as a core property of the digital energy ecosystem.

9. STAKEHOLDER ROLES & RESPONSIBILITIES

IES requires coordinated participation across institutions that shape policy, operate the grid, deliver services, innovate digitally, and ultimately engage as users. Mapping the stakeholder ecosystem clarifies who contributes to standards, adoption, governance, and service development. This section presents the key actors and their roles in enabling sector-wide interoperability and long-term adoption.

9.1 CORE IES STAKEHOLDERS

Stakeholder	Role in IES
GENCOs	Participate in IES via platform integration, generation data sharing, forecasting, and market participation
TRANSCOs	Implement IES via platform integration, transmission network data sharing, asset registries, and grid visibility enhancement
DISCOMs	Implement IES via platform integration, data sharing, consumer service enhancement, and retail market enablement
System Operators (SO/DSO)	Coordinate grid operations, integrate real-time data flows, enable balancing and ancillary services through IES protocols
Market Operators	Facilitate market clearing, settlement, and trading platforms aligned with IES standards and APIs
Regulators (CERC, SERCs, etc.)	Frame regulatory guidance, support innovation, ensure frameworks enable IES adoption

Stakeholder	Role in IES
Consumers (Residential, Commercial, Industrial)	Participate in IES-enabled services; benefit from transparency, improved access and empowerment
Startups/Tech Providers	Develop IT/OT solutions conforming to IES standards, ensure interoperability; build, pilot, and scale new solutions leveraging IES APIs; integrate and manage smart metering (AMISPs); access and disseminate data securely through IES-standard APIs

9.2 SUPPORTING ECOSYSTEM STAKEHOLDERS

Stakeholder	Role in IES
Ministry of Power	Leads conceptualization, sets policy direction, conducts stakeholder engagement and ecosystem design
Banking Corporations (e.g., REC, PFC)	Provide financial support and credit enhancements for IES rollout and innovation projects. REC also serves as the nodal agency for the IES project
Standard Setting Bodies (e.g., BIS, IEC)	Define, publish, and maintain technical standards to promote uniformity, interoperability, and safety
International Bodies (ISA, IEA, etc.)	Help replicate the IES model in other regions and provide guidance for global adoption

10. SUCCESS METRICS & KPIS

The India Energy Stack will be evaluated on whether it becomes the shared digital foundation for the power sector and whether it delivers measurable improvements in system performance and consumer value. Progress will be tracked across the following dimensions.

Dimension	KPI / Success Metric
Adoption and Coverage	% of utilities, system operators, market bodies, and providers aligned with IES specs
	% of sector interactions routed through IES-compliant interfaces
Ecosystem Development & Consumer Value	Number of 3rd-party apps/services leveraging IES
	Improved consumer access and choice (surveyed)

Table 1: Success Metrics

11.NEED FOR A NATIONAL POWER SECTOR DATA POLICY

11.1 CONTEXT AND STRATEGIC IMPERATIVE

The Indian power sector is currently navigating a "Triple Transition" defined by decarbonization, decentralisation, and digitalisation. To meet the national target of 500 GW of non-fossil fuel capacity by 2030, the grid must manage high variability from renewable sources, requiring real-time visibility into data (Ministry of Power, 2023). Simultaneously, the Revamped Distribution Sector Scheme (RDSS) is driving a massive digital overhaul, with a target to install 250 million smart prepaid meters. As of December 2025, over 20 crore meters have been sanctioned, and approximately 4.76 crore have been installed (Ministry of Power, 2025).

However, the sector's financial viability remains precarious, with state-owned distribution companies (DISCOMs) accumulating losses of nearly ₹6.77 lakh crore by FY23 (Josey et al., 2024). While digitalisation offers a pathway to operational efficiency, the current data landscape is fragmented across state lines and proprietary silos. The absence of a unified governance framework risks turning these digital investments into "data swamps" rather than assets. The **National Power Sector Data Policy (NPSDP)** will serve as the governance "constitution" for the **India Energy Stack (IES)**, ensuring that data flows securely and interoperably to support grid stability and financial turnaround (Kumar, 2025).

11.2 THE POLICY FRAMEWORK: FOUR PILLARS

The proposed policy framework is designed to reconcile the conflicting demands of open innovation, consumer privacy, and critical infrastructure security. It rests on four conceptual pillars:

1. **Cyber-Physical Specificity:** Unlike purely digital sectors, data in the power grid often controls physical assets. The policy distinguishes between *Informational Data* (billing, commercial) and *Operational Data* (control commands). It mandates "Zero Trust" architectures and strict IT-OT segmentation for operational data to prevent cyber-threats from causing physical kinetic damage (Central Electricity Authority, 2021).
2. **Federation over Centralisation:** Recognising India's federal structure, the policy rejects a central data warehouse. Instead, it adopts a federated architecture where data remains with custodians (DISCOMs, SLDCs) but is accessible via unified APIs. This aligns with the India Energy Stack's vision of a decentralised, interoperable network (Mercom India, 2025).
3. **Taxonomy and Criticality:** The policy introduces a functional taxonomy (Operational, Asset, Market, Consumer, Planning) and overlays it with a criticality assessment. Non-critical, non-personal data is "presumed open" to foster

innovation, while critical operational data is restricted. This classification supports the broader goals of the National Data Governance Framework Policy (MeitY, 2022).

4. **Role-Based Entitlements:** Access is democratised but governed. Entitlements are based on the entity's role (e.g., Regulator, Researcher, Market Participant) rather than commercial negotiation, ensuring a level playing field for startups and researchers.

11.3 ARCHITECTURAL DESIGN: THE INDIA ENERGY STACK (IES)

This policy puts the India Energy Stack into action as the sector's shared digital foundation. The IES architecture is organised into four building blocks. (Kumar, 2025):

- **Data Layer:** Distributed systems of record exposed via standard adapters.
- **Identity Layer:** Unique registries for assets (transformers, meters) and entities to enable seamless interoperability.
- **Exchange Layer:** Adoption of the Common Data Model to ensure semantic consistency across utilities.
- **Consent Layer:** A consent mechanism that lets consumers approve, limit, and revoke sharing of their smart meter data with specific third parties for specific purposes, with clear audit trails and legal compliance (NITI Aayog, 2020; Government of India, 2023).

The National Power Sector Data Policy is not merely a regulatory requirement but a prerequisite for India's energy transition. By standardising data governance, India can unlock the value of its physical infrastructure investments, ensuring a grid that is secure, financially viable, and ready for a decarbonised future.

A detailed zero-draft policy paper on the same will be presented alongside the IES Strategy Document V 0.3.

12. IES CERTIFICATION

Why certification is needed

IES is intended to enable plug and play interoperability across utilities, system operators, regulators, and service providers. That only works when readiness is machine verifiable, not negotiated case by case. Certification provides a credible signal that a participant can exchange data and transact safely using IES specifications, with predictable behaviour under defined edge cases. It reduces bilateral integration effort, lowers vendor lock in risk, and increases regulatory confidence because conformance can be audited against published criteria.

Certification also functions as the core programme management and measurement tool for IES adoption. It allows grid entities to set clear milestones for participation and to report progress transparently using a common yardstick. In practice, certification becomes the measurable unit of adoption: it enables IES to report "percentage adoption" as the share of identified entities, systems, and priority interfaces that have achieved certification for the relevant building blocks and use case profiles.

This makes tracking consistent across utilities, states, and vendors, and avoids reliance on self declaration or proxy indicators. It also supports operational accountability by enabling metrics such as the proportion of priority systems and processes certified, the number of certified interfaces running in production, and reductions in time and cost to onboard new service providers. These indicators can be embedded directly into institutional KPIs, programme milestones, and digitalisation scorecards

Guiding principles for the certification model

- **Modularity**: Certification is defined at the level of IES building blocks and their interfaces, not at the organisation level. An entity can be certified for one building block and not others. This keeps compliance proportional to role and avoids forcing full stack upgrades for participants who only need limited capabilities.
- **Use case context**: "IES Ready" should be defined as readiness for a specific use case, expressed as a required subset of building blocks and conformance profiles. A participant may hold multiple certifications, each tied to a different use case. This avoids the false binary of certified versus not certified and supports phased adoption.
- **Continuous and agile**: Certification should be designed for frequent iteration as specifications evolve, versions change, and new risks emerge. Conformance must be repeatable through automated test vectors and regression testing, rather than one time attestations. Recertification triggers should be explicit, such as a major version change of a protocol, a material change in system architecture, or expansion into a higher risk use case.
- **Outcome aligned**: Certification should test behaviour that matters for system performance, consumer protection, and cybersecurity. This includes correct identity resolution, valid consent and credential handling, secure transaction flows, and policy enforcement. Where possible, certification otputs should be machine readable so they can be used in automated onboarding and access control.

What certification covers

Each IES building block should publish conformance criteria and test vectors. These should define mandatory and optional requirements, edge case behaviour, error handling, security controls, and interoperability constraints. Certification should result in a clear statement of what was tested, what version was certified, and what scope the certification covers.

Institutional arrangement and operating model
Certification will be implemented using IES architecture itself. In particular, certification status and eligibility can be expressed as machine readable rules through the Policy as Code building block, enabling digital platforms to verify whether an entity is certified for a given profile and version before allowing specific data exchanges or transactions. This converts certification from a static approval into an enforceable trust control within day to day interoperability.

The detailed governance model, including the designation of certifying authorities, accreditation of assessors, and institutional roles and liabilities, will be specified in the governance section and expanded in subsequent versions of the strategy document.

13. **IES GOVERNANCE** (to be elaborated in V0.4)

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Note: All annexures are populated based on ongoing discussions and, therefore, will be updated with every version.

ANNEXURE 1: ILLUSTRATIVE IES USE CASES

The following is a detailed deep dive into the following 7 illustrative usecases:
1. Inter-Discom P2P Energy Trading
2. Regulatory Data Exchange
3. Energy Policy As Code
4. DER Visibility
5. Consumer Side Flexibility
6. Digital Consumer Lifecycle Management
7. EV Charging

INTER-DISCOM P2P ENERGY TRADING

1. Problem statement

Inter-DISCOM P2P trading is emerging, but execution today relies on ad-hoc platform agreements, non-standard contract and meter evidence formats, and weak traceability from trade intent to delivery and billing. This creates disputes on delivered quantity, wheeling/charges, and timelines, and blocks scale beyond small pilots. A unified, verifiable interaction layer is needed so many trade platforms and many DISCOMs can interoperate without bespoke integrations.

2. Use case definition

Enable a buyer and seller (prosumers) on different DISCOMs to place a P2P contract via any compliant trade platform, record it in a shared trade ledger, deliver energy in a scheduled window, and use signed meter evidence to support settlement and DISCOM billing adjustments. Computable vs discretionary: trade contract, delivery window, metered quantities, and charges computations are computable; enforcement/penalties and dispute adjudication are discretionary.

3. IES applicability

IES is needed to make cross-DISCOM trades interoperable and auditable: standard participant IDs, verifiable consumer-connection credentials, a common trade contract envelope, policy-as-code for wheeling/charges constraints, and receipts binding each step (contract -> delivery -> meter evidence -> settlement). DISCOM internal billing and grid security checks remain local; IES standardizes the handshake and evidence.

Minimum artifacts: TradeContract + MeterEvidence + ReceiptTrail.

4. Current landscape and readiness

India has enabling policy direction for prosumers and increasing AMI coverage, and Beckn-based trading semantics exist, but cross-DISCOM operationalization is nascent. Readiness is medium: the core flow can run with limited scope (few feeders, defined windows, selected consumers). Top blockers: (1) inconsistent consumer/asset identifiers across DISCOMs, (2) missing standard for signed meter evidence and reconciliation, (3) policy uncertainty on wheeling/settlement handling across jurisdictions.

5. Stakeholder roles and impact

- Buyer (consumer): discovers and accepts trade; shares credential proof; pays/receives settlement statements.
- Seller (prosumer): offers energy blocks; shares credential proof; receives payment and DISCOM bill adjustments.
- Trade Platform(s): user experience, matching, contract signing, settlement orchestration.
- Trade Exchange / Ledger operator: tamper-evident trade record, versioned updates, audit queries.
- Seller DISCOM: grid security check, records injected energy evidence, applies wheeling/billing.
- Buyer DISCOM: grid security check, records consumption evidence, applies wheeling/billing.
- Regulator/SLDC (optional in pilot): oversight, reporting, policy constraints for safe operation.

Appetite is high where prosumers and platforms already exist, but DISCOMs will require low-risk onboarding, bounded pilots, and strong auditability to manage disputes and revenue protection.

6. Adoption and expansion

Start with a bounded corridor: one buyer DISCOM and one seller DISCOM, narrow time windows, and a small set of verified participants. Expand by adding more platforms and DISCOM pairs once evidence and billing integration are repeatable. Adoption levers: conformance kit + sandbox, standardized meter evidence profile, regulator-endorsed policy packs for charges.

7. Techno-socio-economic and power system impact

Power system: improves visibility into scheduled prosumer injections/withdrawals, enabling better local planning and reducing unaccounted energy when reconciled with AMI evidence; requires guardrails so P2P does not violate feeder constraints. Socio-economic: enables consumer choice and local energy markets, reduces transaction costs for small trades, and can create new income streams for prosumers; must protect vulnerable consumers from opaque pricing and platform lock-in.

8. Policy and regulatory mapping and recommendations

Existing provisions around prosumers, net/gross metering, and open access create partial foundations, but inter-DISCOM P2P needs clear treatment of wheeling, loss factors, taxes, and consumer protection.

Recommendations below assume a phased approach.
Recommendations (N=National, S=State, I=Institutional)

- [N] Define a model inter-DISCOM P2P settlement and wheeling treatment with standard charge components and disclosure.
- [S] Notify sandbox/pilot orders allowing limited inter-DISCOM P2P with defined caps, windows, and reporting.
- [I] Require signed meter evidence and standardized reconciliation rules for P2P billing adjustments.
- [I] Mandate minimum consumer protections: transparent fees, opt-out, dispute SLAs, and data minimization.
- [I] Publish policy-as-code packs for wheeling/loss factors used in pilots, versioned with effective dates.
- [S] Define treatment for cross-utility dispute resolution and escalation path (platform -> DISCOM -> regulator).

REGULATORY DATA EXCHANGE

1. Problem statement

Regulatory filings are repeatedly recreated across proceedings, formats vary by utility and consultant, and evidence trails (source, transformations, approvals) are weak. This increases time, cost, and disputes, and limits cross-utility benchmarking and AI-ready datasets. A reusable, machine-verifiable filing primitive is needed so the same accepted filing can be referenced many times.

2. Use case definition

Enable a utility to publish one signed, machine-verifiable Filing Object per filing type and period; enable regulator validation and issuance of an acceptance receipt; enable authorized parties to reuse the accepted filing by reference and optionally publish a derived Disclosure Object. Computable vs discretionary: schema/rulebook checks and receipt issuance are computable; acceptance with observations, confidentiality classification, and discretionary clarifications remain discretionary.

3. IES applicability

IES provides the trust fabric: participant registry + keys, versioned rulebooks (policy-as-code), Filing/Receipt/Disclosure profiles, and conformance kits so multiple vendors can produce identical validation outcomes. Utility internal data production remains local; IES standardizes packaging, signatures, receipts, and reuse.

Minimum artifacts: FilingObject + Receipt + RulebookVersion.

4. Current landscape and readiness

Many regulators already collect structured spreadsheets and PDFs; utilities hold data in ERP/CIS/SCADA/MDMS but exports are inconsistent. Readiness is high for a pilot because it can start with Excel-as-source mapped into canonical JSON.

Top blockers: (1) institutional adoption of digital signatures/keys for filings, (2) agreement on rulebook scope and tolerances, (3) confidentiality/disclosure governance for reuse.

5. Stakeholder roles and impact

- DISCOM filing team: constructs Filing Objects from internal exports; signs and submits.
- Regulator (SERC/CERC): publishes requests/rulebooks; validates; issues receipts; governs reuse/disclosure.
- Auditor/Consultant: reuses accepted filings by reference; reduces rework; focuses on analysis.
- Technology provider/implementer: builds adapters, validators, and conformance reports.
- Market/system operator (optional): consumes filings for planning/benchmarking.
- Public/civil society (optional): consumes Disclosure Objects where permitted.

Regulators gain faster validation and stronger non-repudiation; utilities reduce duplication; external parties gain consistent, reusable datasets with provenance.

6. Adoption and expansion

Begin with 2-3 filing types (energy balance, power purchase portfolio) for 2-3 years, then expand across years and additional filing types. Add disclosures once governance is stable. Adoption levers: regulator-issued rulebooks, automated validator + test vectors, reuse-by-reference mandate in proceedings.

7. Techno-socio-economic and power system impact

Power system: improves reliability of planning inputs (procurement portfolio, losses, availability) and enables faster audits; does not directly affect real-time operations. Socio-economic: reduces regulatory compliance cost, improves transparency where disclosures are enabled, and creates a clean substrate for analytics and AI across states.

8. Policy and regulatory mapping and recommendations

Fits within existing filing requirements; the change is the digital form and evidence chain (signatures, hashes, receipts) plus explicit disclosure governance aligned to DPDP. **Recommendations (N=National, S=State, I=Institutional)**

- [N] Publish a model 'digital filing + receipt' framework with minimum cryptographic requirements and retention.
- [S] Amend filing procedures to accept Filing Objects as primary submissions (PDF as human-readable companion).

- [I] Define disclosure classes and reuse permissions; require disclosure-by-reference to accepted filings.
- [I] Standardize rulebook versioning and tolerance policies; publish conformance test vectors.
- [I] Require every filing decision to produce a signed receipt with machine-readable validation report.
- [S] Establish a lightweight dispute workflow where evidence bundles are the source of truth.

ENERGY POLICY AS CODE

1. Problem statement

Tariff and program rules are published as natural-language orders, interpreted differently across billing systems and vendors, and changes propagate slowly. This causes inconsistent bills, disputes, and slow rollout of new tariffs or incentives. A deterministic, versioned policy artifact is needed so multiple implementers can execute the same computable core and produce auditable outputs.

2. Use case definition

Publish a versioned Policy Pack for one tariff's bounded computable core; validate and attest it; allow multiple consumers (DISCOM and vendor) to retrieve and execute it; require conformance tests and produce clause-level execution traces and receipts; demonstrate amendment with effective-date handling.
 Computable vs discretionary: computable parts include eligibility checks and charge computations; discretionary parts include interpretive/legal judgement and exceptional relief handling.

3. IES applicability

IES supplies trust anchors (directory/keys), pack and versioning profiles, execution semantics, receipts/traces, and conformance kits so independent implementations match. Internal billing systems remain local; IES standardizes the policy artifact and its verification.
 Minimum artifacts: PolicyPackVersion + ConformanceVectors + ExecutionReceipt.

4. Current landscape and readiness

Several utilities already maintain tariff spreadsheets and vendor-specific rule engines; interoperability and verification are missing. Readiness is high for a single-tariff pilot with constrained scope.
 Top blockers: (1) agreeing the computable boundary and canonical variables/units, (2) discipline of versioning and clause references, (3) adoption of conformance as a gate before production rollout.

5. Stakeholder roles and impact

- Policy owner (DISCOM/SERC cell): authors pack inputs; manages version chain and effective dates.
- Regulator/Authority: defines attestation requirements; recognizes pack versions for compliance.
- Technology provider/implementer: converts policy inputs to pack; implements executor; runs conformance.

- DISCOM billing/MDMS teams: consume pack version; integrate outputs into billing determinants.
- Auditors/consumer grievance teams: verify receipts and traces for disputes.
- Developers/innovators: reuse packs to build simulators, consumer bill explainers, and planning tools.

Adoption improves when packs reduce production risk: deterministic outputs, traceable clauses, and easy rollback via versioning.

6. Adoption and expansion

Start with one widely used tariff and a small set of test vectors; then add more tariffs, ToD overlays, and rebates; finally extend to program rules (subsidies, flexibility incentives). Adoption levers: mandatory conformance gate, reference validator + SDK, regulator recognition of attested pack versions.

7. Techno-socio-economic and power system impact

Power system: indirect but important - faster rollout of time-of-day and flexibility-aligned pricing improves peak management and investment signals. Socio-economic: reduces billing disputes, improves transparency (bill explainability), and lowers implementation cost for new policies; enables innovators to build consumer-facing tools safely.

8. Policy and regulatory mapping and recommendations

Maps to tariff orders, notifications, and circulars; requires procedural acceptance of an attested digital pack as the authoritative computable representation (alongside the legal text). **Recommendations (N=National, S=State, I=Institutional)**

- [N] Define a common envelope for policy packs (identity, jurisdiction, effective dates, signatures).
- [S] Permit/encourage publication of tariff computable cores as attested packs with clause references.
- [I] Establish a validation + conformance gate before billing systems can activate a new version.
- [I] Require execution receipts with policy_version_id, triggered clauses, and trace_id for audits.
- [I] Maintain a public catalogue of pack versions and change summaries (with access controls where needed).
- [S] Create a transition protocol for amendments (effective dates, supersedes chain, rollback rules).

DER VISIBILITY
1. Problem statement

Behind-the-meter DER adoption is rising, but utilities and system operators lack consistent, trusted visibility of DER installations, capabilities, and linkage to premises/meters. Data sits across portals, installers, CIS/MDMS, and OEM systems, leading to duplicates, missing attributes, and slow reporting. This weakens planning, settlement, and policy compliance.

IES – Strategy Document

2. Use case definition

Register rooftop solar (and later other DERs) in a standardized registry with unique identifiers and location binding; issue consumer energy credentials with consent; exchange schedule/settlement-relevant data between DISCOM and SLDC; produce standardized regulatory reports.

Computable vs discretionary: registration validation, schedule exchange, and reporting schemas are computable; enforcement actions and exceptions (e.g., disputed commissioning) are discretionary.

3. IES applicability

IES enables federated registries + verifiable credentials so many DISCOMs, installers, and SLDCs can share consistent DER facts without centralizing data. Policy-as-code validates net metering/export rules and reporting completeness, and receipts provide auditability. Minimum artifacts: DERRegistryEntry + EnergyCredential + ScheduleSubmissionReceipt.

4. Current landscape and readiness

Rooftop solar portals and net-metering processes exist in many states; data models and IDs are inconsistent, and cross-utility sharing is limited. Readiness is medium-high for a pilot focused on selected circles and one SLDC. Top blockers: (1) data quality/standardization of installation attributes, (2) consent and privacy workflows at scale, (3) integration timelines with SLDC settlement systems.

5. Stakeholder roles and impact

- Prosumer: provides consent; receives credential; benefits from faster onboarding and portability.
- Installer/OEM: supplies certified device attributes; can be verified via credentials.
- DISCOM solar/CIS teams: register DERs, maintain linkage, use data for billing and planning.
- MDMS/AMI systems: provide metering linkage and (later) performance evidence.
- SLDC: consumes schedules/portfolio data for planning and settlement.
- Regulator: consumes standardized reports and can benchmark utilities.

Stakeholder incentives align when the registry reduces manual reconciliation and improves compliance reporting with minimal additional operational burden.

6. Adoption and expansion

Start with rooftop solar and limited attributes needed for settlement and reporting; then add batteries/EV chargers and richer telemetry references; finally enable aggregator participation for flexibility markets. Adoption levers: standardized registry schema + IDs, consent/credential reuse across use cases, conformance kit for registry and schedule exchange.

7. Techno-socio-economic and power system impact

Power system: improves hosting capacity planning and reduces forecasting errors by knowing where DERs are and their limits; supports safer dispatch planning as DER penetration rises.

Socio-economic: speeds prosumer onboarding, reduces paperwork, and improves trust in subsidy and renewable claims; enables innovation on top of reliable DER datasets.

8. Policy and regulatory mapping and recommendations

Aligns with net metering/gross metering regulations, interconnection standards, and reporting requirements; requires explicit acceptance of digital registry + credential artifacts for compliance and reporting.

Recommendations (N=National, S=State, I=Institutional)

- [N] Publish a national DER registry minimum dataset and identifier profile (technology-agnostic).
- [S] Require new DER commissioning to produce a registry entry + credential linkage + receipt.
- [I] Adopt consent templates and minimal disclosure rules for DER data sharing aligned to DPDP.
- [I] Standardize DISCOM-SLDC schedule exchange formats for prosumer portfolios with traceability.
- [I] Provide conformance tests for registry completeness, duplicates, and policy rule validation.
- [S] Define reporting cadence and acceptance criteria using signed submissions and receipts.

CONSUMER SIDE FLEXIBILITY

1. Problem statement

Peak demand and local constraints are rising, but consumer flexibility programs are hard to scale because enrolment and eligibility checks are manual, device/control interfaces are fragmented, and verification/settlement is disputed due to opaque baselines and missing evidence. This increases program cost and reduces consumer trust.

2. Use case definition

Publish a standardized flexibility program catalogue; enable consented enrolment using wallet-based consumer-connection credentials; dispatch events with acknowledgements and opt-out handling; verify impact using MDMS interval extracts and a versioned baseline rulebook; generate settlement statements and bill credits.
Computable vs discretionary: enrolment validation, event logs, baseline/M&V computations, and settlement are computable; dispute adjudication and exceptional consumer relief remain discretionary.

3. IES applicability

IES standardizes identities, consent artefacts, program objects, dispatch event envelopes, rulebook-based verification, and receipts that bind decisions to data and method versions. Device control implementations remain local to aggregators/OEMs; IES standardizes the interoperable evidence and interaction patterns.
Minimum artifacts: EnrolmentReceipt + DispatchEvent + VerificationResultReceipt.

4. Current landscape and readiness

Pilot DR programs exist in pockets; AMI rollout is accelerating, and device ecosystems are growing, but standard enrolment, consent, and M&V artefacts are missing. Readiness is medium for a bounded peak-curtailment pilot with AMI consumers.
Top blockers: (1) reliable device reachability/control integration, (2) timely access to interval data extracts, (3) agreement on baseline rulebook and consumer protections.

5. Stakeholder roles and impact

- Consumer: enrols with explicit consent; can opt out/override; receives settlement statement and credit.
- Consumer app / aggregator: enrolment UX, device capability registry, dispatch execution, participation logs.
- DISCOM DRMS/operations: defines events, targets, monitoring, and operational constraints.
- MDMS/AMI provider: provides interval extracts with quality flags and provenance refs.
- Billing system: posts credits/payout references linked to settlement statements.
- Regulator (optional in pilot): approves program parameters, consumer protection rules, and baseline method.

Consumers participate when terms are clear and payout is reliable; DISCOMs adopt when evidence reduces disputes and operational risk.

6. Adoption and expansion

Start with one program type (residential AC curtailment) and a limited device class; expand to more devices (EV chargers, water heaters), more feeders, and multi-program operation; later connect to markets.
Adoption levers: standardized program catalogue, baseline rulebook + test vectors, automated evidence bundles with trace_id.

7. Techno-socio-economic and power system impact

Power system: reduces peak and improves feeder reliability; creates a measurable flexibility resource that can defer capex and reduce expensive peak procurement.
Socio-economic: offers bill savings and incentives, improves inclusion if enrollment is simple, and reduces transaction costs vs manual programs; must avoid unfair penalties and ensure privacy-preserving data use.

8. Policy and regulatory mapping and recommendations

Aligns with DSM/DR guidelines and tariff incentives; requires clear rules on consent, consumer protection, baseline methods, and settlement timelines.
 Recommendations (N=National, S=State, I=Institutional)

- [N] Define minimum interoperability profiles for DR programs (catalogue, dispatch, verification, settlement).

- [S] Approve baseline/M&V rulebooks for pilot programs and require method version disclosure to consumers.
- [I] Mandate consent artefacts with revocation and minimal disclosure for meter data use.
- [I] Require event and settlement evidence bundles with trace_id for every payout/penalty decision.
- [I] Set settlement SLAs (e.g., verification <72h, credit <7 days) for consumer trust.
- [S] Establish program governance for opt-out rights, comfort constraints, and dispute handling.

IES – Strategy Document

DIGITAL CONSUMER LIFECYCLE MANAGEMENT

1. Problem statement

Many downstream services depend on accurate linkage of identity, premise, connection, meter, and role, but today these linkages are fragmented across CIS/GIS/MDMS and are updated via manual workflows with overwritten history and weak evidence trails. This creates duplicates, delays, and disputes during onboarding, transfers, and meter swaps, and forces repeated KYC across services.

2. Use case definition

Issue a portable Energy Credential to the consumer (wallet-held) that binds verified identity to premise/connection/meter linkage; manage lifecycle changes as versioned linkage records with reason codes and effective dates; capture consent for data sharing and enable downstream reuse. Computable vs discretionary: verification steps, linkage versioning, consent artefacts, and receipts are computable; field feasibility checks and exceptional approvals remain discretionary.

3. IES applicability

IES brings identity/addressability, verifiable credentials, consent, and receipts to make linkage portable and auditable while systems of record remain local. The key architectural value is versioned linkage as a shared, verifiable reference for many services. Minimum artifacts: EnergyCredential + LinkageRecord(v) + ConsentArtefact.

4. Current landscape and readiness

Most DISCOMs have portals, CIS, GIS, and MDMS, but linkages are inconsistent and rarely consumer-controlled. Readiness is medium: a pilot can integrate with one DISCOM stack and demonstrate credential issuance and one lifecycle update. Top blockers: (1) integration access to CIS/GIS/MDMS, (2) governance on who can issue/attest credentials, (3) operational change management for versioned linkage and evidence capture.

5. Stakeholder roles and impact

- Consumer/prosumer: holds credential; shares proofs under consent; benefits from fewer repeated checks.
- DISCOM portal/CIS team: creates/updates connection; consumes/updates linkage versions.
- GIS team: resolves premises and geo-binding; supports match-or-create workflows.
- MDMS/AMI team: assigns/commissions meters; provides metering linkage evidence.
- Verification provider (eKYC/doc): supplies verification results with traceable evidence.
- Wallet/consent provider: stores credentials, manages consent grant/revoke.
- Auditors/grievance teams: use receipts and linkage history to resolve disputes.

High impact on service speed and data quality; adoption improves when credential reuse reduces workload across multiple downstream programs.

6. Adoption and expansion

Start with new connection and prosumer activation flows for one DISCOM; add transfer and meter swap as version increments; then enable multi-DISCOM portability and reuse across programs (DER registration, flexibility, subsidies).
 Adoption levers: standard credential/linkage schemas, consumer wallet UX, and a conformance kit for linkage versioning rules.

7. Techno-socio-economic and power system impact

Power system: improves data quality for planning and loss analytics by reducing duplicates and ensuring correct meter-connection mapping; supports safer DER and flexibility participation through verified linkage.
 Socio-economic: reduces onboarding time and paperwork, improves inclusion via assisted flows, and empowers consumers with portable proofs; requires privacy-by-design and clear consent.

8. Policy and regulatory mapping and recommendations

Maps to consumer service regulations, KYC norms (where applicable), and DPDP requirements. The key regulatory need is acceptance of digital credentials and receipts as valid evidence in processes.
 Recommendations (N=National, S=State, I=Institutional)

- [N] Define a national Energy Credential profile and minimum disclosure/consent rules for common services.
- [S] Recognize digital credential + receipt evidence for onboarding and lifecycle updates (transfer, meter swap).
- [I] Establish issuer roles and signing key governance for DISCOMs and authorized agents.
- [I] Require versioned linkage records with reason codes/effective dates (no overwriting history).
- [I] Provide assisted pathways and grievance processes using the same evidence trail.
- [S] Align eKYC/document verification pathways with state practices and privacy requirements.

EV CHARGING INTEROPERABILITY
1. Problem statement

EV charging networks are expanding, but discovery, reservation, and payment experiences remain fragmented across apps and charge point operators (CPOs). Lack of interoperable APIs and inconsistent station/connector semantics increases user friction, limits utilization, and complicates DISCOM load management and program design.

2. Use case definition

Enable any EV user app to discover nearby charging stations across multiple CPOs, reserve a slot where supported, start and track a charging session, and complete payment and rating through standardized protocol interactions.

Computable vs discretionary: discovery filters, reservation rules, and session telemetry are computable; outage handling, refunds, and customer support escalations include discretionary elements.

3. IES applicability

IES can adopt EV charging interaction patterns (e.g., Beckn/OCPI-aligned) and add IES trust anchors: participant registry, keys, credentials for CPO/operator authorization, policy-as-code for grid-aware constraints (caps, ToD incentives), and receipts for booking/session evidence. CPO operations and charger control remain local.

Minimum artifacts: ChargerCatalogue + Reservation/Order + SessionReceipt.

4. Current landscape and readiness

India has multiple charging networks, emerging roaming/interoperability efforts, and DISCOM interest in managed charging. Readiness is medium: discovery and reservation interoperability can be piloted quickly; deeper grid integration depends on DISCOM capabilities. Top blockers: (1) inconsistent station/EVSE identifiers and metadata quality, (2) fragmented payment and roaming agreements, (3) limited real-time coordination with distribution constraints.

5. Stakeholder roles and impact

- EV driver: discovers, reserves/starts session, pays, and receives receipts.
- EV app / mobility platform: provides unified discovery and user experience across CPOs.
- CPO / station operator: publishes catalogue and availability; fulfills sessions; handles exceptions.
- Charger OEM/backend: exposes telemetry and control APIs to operator systems.
- DISCOM (optional in pilot): publishes ToD incentives and load caps; consumes aggregate demand signals.
- Regulator/transport authority (optional): sets interoperability and consumer protection expectations.
Interoperability increases utilization and competition; DISCOMs benefit when charging sessions are measurable and can be influenced via transparent incentives rather than ad-hoc controls.

6. Adoption and expansion

Start with discovery + basic order flow across 2-3 CPOs and 1-2 apps; add reservations and standardized receipts; then add grid-aware policies (ToD pricing, local caps) and demand response for charging hubs. Adoption levers: common semantic model for stations/EVSEs, certification of APIs, and a shared sandbox with test stations.

7. Techno-socio-economic and power system impact

Power system: better visibility of charging demand supports planning; grid-aware incentives can reduce peak stress and local overloads when widely adopted. Socio-economic: improves EV user experience, reduces range anxiety, increases charger utilization, and lowers integration costs for new apps and CPOs; requires consumer protection around pricing transparency and refunds.

8. Policy and regulatory mapping and recommendations

Aligns with national EV charging guidelines, open access to public charging, and distribution codes for managed charging where applied. Interoperability needs both technical standards and minimal consumer protection   norms.
  Recommendations (N=National, S=State, I=Institutional)

- [N] Define a national interoperability profile for EV charging discovery, booking, and session receipts.
- [N] Standardize station/EVSE/connector identifiers and minimum metadata quality requirements.
- [S] Enable DISCOM-to-CPO digital interfaces for ToD incentives and local capacity constraints where needed.
- [I] Require transparent pricing display, cancellation/refund rules, and receipt evidence for disputes.
- [I] Publish policy-as-code packs for incentives/caps used in managed charging pilots (versioned).
- [I] Create a certification program for CPO and app conformance to reduce roaming friction.

ANNEXURE 2: POWER SECTOR PAIN POINTS AND WHAT IES ENABLES

The list generated below is based on various inputs from stakeholder consultations and expert working groups of IES.

Lifecycle stage	Critical pain points	What IES can enable
Planning and investment	Planning inputs are fragmented and lagged across utilities, SLDCs, generators, and regulators. Asset lists, demand baselines, losses, and constraints are inconsistent. Forecasts and studies are hard to reproduce because data and assumptions are not traceable.	Standard identifiers and registries for consumers, meters, feeders, substations, generators, and contracts. Common data models for topology, outages, metering, and forecasts. Provenance and audit trails so planning inputs are comparable and defensible.
Build, commissioning, and onboarding	Onboarding of new assets and connections is manual, duplicated across systems, and inconsistently named. Commissioning evidence and configuration metadata are missing or not linked. Field and enterprise records diverge over time.	Standard onboarding and registration workflows at the interface level. Consistent naming and metadata requirements. Ability to link commissioning evidence and configuration to an asset identity, improving downstream consistency across systems.
Operations, control rooms, and reliability	OT and IT systems exchange events inconsistently. Time alignment, latency, and data quality vary across vendors.	Authenticated, auditable exchange patterns for operational interactions between systems and entities.

	Outage workflows and incident analysis face weak end-to-end traceability across systems.	Standard event definitions and time-stamping. End-to-end logging to support incident reconstruction and accountability without replacing control systems.
Scheduling, dispatch, and renewables integration	Forecast and telemetry exchanges are inconsistent. Baselines and time-series alignment differ across participants. Disputes persist because the data trail from inputs to outcomes is not consistently auditable.	Standard interfaces for forecast submission, telemetry exchange, and time alignment backed by verifiable credentials. Traceable provenance from input data to reported outcomes, improving transparency and reducing reconciliation friction.
Metering, billing, and revenue assurance	Meter data formats, event codes, and mapping between meter, consumer, and tariff context are inconsistent across AMI vendors and utility systems. Exception handling is weak and disputes rely on manual checks.	Common metering data models and event taxonomies. Strong linkage between consumer, meter, location, and tariff metadata. Assurance levels and audit trails that support automated validation, consistent exceptions, and evidence-based dispute handling.
Consumer service and participation	Consumer data is not portable and service channels are fragmented. Third-party services require bespoke integrations. Consent and purpose limitation are not consistently implemented across providers.	Standard consented data sharing with purpose limitation and audit logs. Predictable APIs that reduce bespoke integrations and allow consumer-authorised services to operate with consistent permissions and accountability.
DER, EVs, and flexibility participation	DER registration, measurement, and verification are inconsistent. Aggregation is constrained by unclear baselines and weak verification. Utilities and regulators lack a standard way to verify performance and compliance across providers.	Registries and identifiers for DER and flexibility providers. Standard measurement and verification data flows. Credentialed participation and auditable performance records that support scalable programs under regulatory oversight.

Settlement, payments, and dispute resolution	Settlement and reconciliation are slow because actors rely on different data versions and limited traceability from events to obligations. Disputes escalate due to weak evidence trails.	Contract reference resolution and provenance linking events, identities, and obligations across the transaction chain. Machine-readable, time-stamped audit trails that narrow disputes and reduce reconciliation overhead.
Compliance, reporting, and governance	Reporting is duplicative and inconsistent across institutions. Cyber, privacy, and access controls are unevenly implemented. Accountability for who accessed what data, for what purpose, is often weak.	Standard governance primitives for access control, purpose limitation, assurance tiers, and continuous auditability. A practical split between critical and non-critical exchanges, with consistent compliance evidence across actors.
Cross-cutting systemic issue	Core coordination failure across actors due to missing identifiers, inconsistent definitions, and low-trust exchanges. High integration cost across legacy systems and vendors.	A shared sector trust layer that standardises identities, interfaces, data models, assurance, and audit. Lower coordination and integration cost without centralising all sector data or replacing existing systems.

ANNEXURE 3: MAPPING EXISTING DIGITALISATION EFFORTS

Digital Systems in Indian Power Sector (The Tools)
Definition: The software, hardware, and platforms used for real-time operations, data collection, and transactions.

A. Grid Operations & Planning Systems

Digital System	Description	Deployment Status
SCADA/EMS	**Supervisory Control and Data Acquisition**; the core software for real-time monitoring and control of the transmission grid.	Operational at NLDC, all 5 RLDCs, and 33 SLDCs; upgrades ongoing for RE integration.
REMC	**Renewable Energy Management Centres**; AI-driven forecasting and scheduling hubs co-located with LDCs to manage variable solar/wind power.	**11 Operational** (1 National, 3 Regional, 7 State) managing 55GW+ of RE.

ADMS	**Advanced Distribution Management System**; integrates SCADA, DMS, and OMS for holistic distribution network control.	Deployed by private DISCOMs (TPDDL, Adani); piloting in select public utilities.
OMS	**Outage Management System**; software to predict outages and coordinate faster restoration crews.	Integrated with ADMS in urban centers; standalone pilots in others.
GIS	**Geographic Information System**; spatial mapping of electrical assets (poles, transformers) and consumer indexing.	Widely deployed; essential for asset management and fault location.
Digital Twin	Virtual real-time replica of the physical grid for simulation and predictive analysis.	Pilots by Powergrid (transmission) and JVVNL Rajasthan (distribution).

B. Metering & Distributed Energy Systems

Digital System	Description	Deployment Status
AMI	**Advanced Metering Infrastructure**; smart meters with 2-way communication for real-time billing and monitoring.	~22.9 million installed; 222 million sanctioned under RDSS.
MDMS	**Meter Data Management System**; central software that validates, stores, and analyzes the massive data flow from smart meters.	Deployed alongside AMI projects.
DERMS	**Distributed Energy Resource Management System**; software to manage grid-edge assets like solar, storage, and EV chargers.	Early pilot stage (e.g., BRPL Delhi).
UEI	**Unified Energy Interface**; open network protocol (Beckn-based) for interoperable energy transactions (like UPI for energy).	Pilot stage (EV charging in Kochi/Delhi); UEI Alliance formed.

C. Market, Settlement & Scheduling Platforms

Digital System	Description	Deployment Status
NOAR	**National Open Access Registry**; centralized platform for short-term open access (STOA) to the interstate transmission system.	**Active**; reduced processing time from days to hours.
SAMAST	**Scheduling, Accounting, Metering & Settlement of Transactions**; state-level software for intra-state scheduling and billing.	Operational in MP, Delhi, Gujarat, Maharashtra; implementing in others.
PUShP	**High Price Day Ahead Market & Surplus Power Portal**; allows DISCOMs to display and trade surplus power capacity.	**Active**; launched March 2023.

DEEP	**Discovery of Efficient Electricity Price**; e-bidding portal for short/medium-term power procurement by DISCOMs.	**Mandatory** for transparent price discovery.
PRAAPTI	**Payment Ratification And Analysis in Power procurement**; portal tracking invoicing and payments between GENCOs and DISCOMs.	**Active**; brings transparency to sector overdues.
LPSC Portal	**Late Payment Surcharge** portal; tracks EMI payments for liquidating legacy dues under LPS Rules 2022.	**Active**; critical for financial discipline.
MERIT	**Merit Order Despatch**; portal displaying marginal costs and source-wise purchase to optimize procurement.	**Active**; helps states minimize power purchase costs.
REC Registry	**Renewable Energy Certificate Registry**; digital ledger for issuing and trading RECs.	**Active**; managed by GRID-INDIA.

D. Consumer, Solar & Transparency Portals

Digital System	Description	Deployment Status
National Portal for Rooftop Solar	Single-window digital interface for **PM Surya Ghar** scheme applications and subsidies.	**Active**; primary channel for residential solar.
National Power Portal (NPP)	Centralized database and dashboard for all power sector data (generation, transmission, distribution).	**Active**; the "Single Source of Truth" for sector data.
Vidyut PRAVAH	Real-time dashboard displaying power availability, demand, and market clearing prices.	**Active**; public transparency tool.
TARANG	**Transmission App for Real Time Monitoring**; tracks status of transmission projects and delays.	**Active**; project monitoring tool.
Urja Mitra	Outage notification platform sending SMS/email to consumers about scheduled outages.	**Active**; integrated with many DISCOMs.
e-Amrit	One-stop portal for Electric Vehicle information, charging, and investment policies.	**Active** (NITI Aayog initiative).
ICED	**India Climate & Energy Dashboard**; open-data platform for energy and climate statistics.	**Active** (NITI Aayog).

Digital Initiatives in Indian Power Sector (The Drivers)
Definition: The schemes, policies, and missions that fund, mandate, or drive the adoption of the systems above.

Digital Initiative	Objective	Status & Key Focus
RDSS	**Revamped Distribution Sector Scheme**; primary funding vehicle for grid modernization.	**Active**; funds AMI (250M meters) and IT/OT integration.
PM-KUSUM	Solarization of agriculture; **mandates digital adoption** via Remote Monitoring Systems (IoT) for pumps.	**Active**; created a massive distributed IoT network.
SMNP	**Smart Meter National Programme**; the specific target to replace 250M conventional meters.	**Active**; largely subsumed under RDSS implementation.
NSGM	**National Smart Grid Mission**; fosters pilots, standards, and capacity building for smart grids.	**Active**; completed 11 pilots; Knowledge Centre established.
Green Energy Corridor (GEC)	Transmission infrastructure for RE; includes **digital communication backbone** (OPGW) for telemetry.	**Active**; Phase-II ongoing (20GW integration).
CSIRT-Power	**Computer Security Incident Response Team**; institutional body for power sector cyber defense.	**Active**; established April 2023 at CEA.
AI/ML Mission	Strategic initiative to adopt AI for load forecasting, predictive maintenance, and theft detection.	**Ongoing**; Centers of Excellence (CoE) at PSUs; regulatory sandbox discussions.
FOLD	**Forum of Load Despatchers**; institutional initiative for training operators in digital systems (SCADA/REMC).	**Active**; ensures workforce readiness for digital tools.
CCTS	**Carbon Credit Trading Scheme**; creating a domestic carbon market (requires a digital registry).	**Development**; BEE finalizing framework; Registry built by Grid-India.
One Sun One World One Grid	Transnational grid vision requiring complex **digital scheduling** across time zones.	**Concept**; technical studies on digital handshakes ongoing.
UDAY	**Ujwal DISCOM Assurance Yojana**; financial turnaround scheme that *first mandated* smart metering (Legacy).	**Closed**; set the foundation for current digital push.

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VERSION 0.3 | FEBRUARY 2026