



विद्युत मंत्रालय  
MINISTRY OF  
POWER

# INDIA ENERGY STACK

## Strategy Document

VERSION 0.4

MARCH 2026



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.

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Published in March 2026 by the Ministry of Power

India Energy Stack (IES) Strategy Document: Version 0.4

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Recommended citation:

Ministry of Power (2026). India Energy Stack (IES) Strategy Document: Version 0.4

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.

## Executive Summary

India's power sector is digitising rapidly - 250 million smart meters, renewable energy at scale, distributed generation on every rooftop. But the digital systems being built cannot talk to each other. Every utility, regulator, and technology provider operates in isolation, creating redundant integrations, locked data, and barriers to innovation.

The India Energy Stack (IES) is a suite of shared digital specifications that enables any two systems in the power sector to exchange data, verify participants, and settle transactions without custom integration. It does not replace existing systems. It standardises the interface between them, much like core banking standardised how banks coordinate with each other while each bank retained its own internal systems.

IES is currently built from five building blocks: identity, registries, interaction protocols, energy data exchange, and energy credentials. Together, these enable use cases ranging from peer-to-peer energy exchange and DER visibility to consumer data portability and machine-readable regulatory filings.

The programme follows a three-stage deployment pathway - build and validate, calibrated deployment, and scale - with clear gate criteria before any use case advances. An accelerator provides the technical support infrastructure: reference implementations, conformance testing, training ecosystems, and capacity building to bridge the gap between specifications and real-world adoption.

This document sets out the strategy: the coordination gap that IES addresses, what IES is and how it works, the building blocks and use cases, who benefits and how, and the delivery pathway from architecture through acceleration to adoption at scale.

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## Glossary of Key Terms

The following terms are used throughout this document.

Term	What it means
AMI	Advanced Metering Infrastructure. Smart meters with two-way communication that record energy use at frequent intervals and transmit data automatically.
CERC	Central Electricity Regulatory Commission. The national regulator for the electricity sector.
CIS	Customer Information System. Utility software for billing, payment collection, and consumer service management.
DER	Distributed Energy Resource. Generation or storage installed at homes and businesses, such as rooftop solar, batteries, and EV chargers.
DISCOM	Distribution Company. The utility that delivers electricity to consumers and sends the bill.
DPI	Digital Public Infrastructure. Shared digital frameworks, such as Aadhaar, UPI, and DigiLocker, that enable population-scale services.
DPDP Act	Digital Personal Data Protection Act, 2023. Indian law mandating consumer consent, data portability, and purpose limitation.
FOR	Forum of Regulators. A body that facilitates coordination among CERC and all SERCs.
GENCO	Generation Company. An entity that generates electricity.
MDMS	Meter Data Management System. Software that collects, validates, stores, and analyses data from smart meters.
NSGM	National Smart Grid Mission. A government initiative fostering pilots, standards, and capacity building for smart grids.
Open access	A mechanism allowing large consumers to buy power directly from generators, bypassing the local distribution utility.
Prosumer	A consumer who also produces energy, typically through rooftop solar.
RDSS	Revamped Distribution Sector Scheme. The primary central government funding scheme for grid modernisation, including 250 million smart meters.
SCADA	Supervisory Control and Data Acquisition. Real-time monitoring and control system for grid operations.
SERC	State Electricity Regulatory Commission. The state-level regulator for electricity.
SLDC	State Load Despatch Centre. The entity that manages real-time grid operations at the state level.

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Term	What it means
Smart meter	A digital meter that records energy use every 15-30 minutes and can transmit data automatically.
Tariff	The price structure for electricity, including per-unit charges, slabs, subsidies, and surcharges.
TRANSCO	Transmission Company. An entity that owns or operates the high-voltage transmission network.

# 01

## Introduction

India's power sector is at an inflection point. The country is targeting 500 GW of non-fossil fuel capacity by 2030 (Ministry of Power, 2023), deploying 250 million smart meters under the Revamped Distribution Sector Scheme (Ministry of Power, 2021), and integrating millions of distributed energy resources - all while supporting an economy on track from \$5 trillion to \$30 trillion by 2047 (PIB, 2018). The sector has invested heavily in the digital systems needed for this transformation - smart meters, SCADA, billing platforms, solar portals, scheduling software. These systems work. But they were built in isolation, and they cannot exchange data in a standard way. The result is not a failure of technology - it is a missing layer of coordination between systems that already exist.

*The sector has digital tools. What it needs is digital coordination - a shared layer that lets these tools work together.*

## The Coordination Gap

Here is what that gap looks like in practice:

### Scenario 1: The Prosumer Who Can't Trade Freely

A homeowner in Mumbai has rooftop solar and wants to sell surplus energy to a neighbour served by a different DISCOM. Today, there is no standard way to verify her identity, confirm her generation capacity, match her with a buyer, and reconcile the settlement across two utility billing systems. Every step requires ad-hoc agreements and bespoke integrations. Peer-to-peer energy exchange remains stuck in small pilots.

### Scenario 2: The DISCOM That Can't See Its Grid Edge

A distribution company has over 50,000 rooftop solar installations, but data sits across four systems with inconsistent identifiers. When a feeder faces overloading, the DISCOM cannot quickly determine how much distributed generation exists on it.

### Scenario 3: The Consumer Locked Out of Their Own Data

A consumer with a smart meter wants to share their usage history with a solar company for an accurate savings estimate, or with a bank to qualify for a green loan. But their data is locked inside the utility's MDMS. There is no standard, consent-based way for consumers to access their own granular data, package it as a verifiable credential, and share it with a third party of their choice.

### Scenario 4: The DISCOM Trapped in Integration Loops

A DISCOM is working with multiple technology service providers - one for smart metering, another for billing, a third for solar net metering, a fourth for demand response. Each vendor requires a bespoke integration with the DISCOM's internal systems. There is no common API, no shared data model, no

standard way for these systems to exchange information. Every new vendor means a new custom connector, new testing, and new maintenance overhead. The DISCOM's IT team spends more time managing integrations than improving services. When a vendor is replaced, the cycle starts again from scratch.

## What These Scenarios Tell Us

Each of these scenarios asks the same question: why can't two systems in the Indian power sector exchange data, verify a participant, or settle a transaction without building a custom solution every time?

The answer is not that the technology is missing. Smart meters, SCADA, billing platforms, solar portals - all of these exist and work. What is missing is the connective tissue between them: a shared set of specifications for how these systems identify each other, exchange data, and establish trust.

The cost of this missing layer is real and compounding. Every technology provider that wants to serve multiple DISCOMs faces a fresh integration effort for each one. Every startup entering the energy space faces lengthy negotiation just to access data. Every regulatory filing cycle begins with weeks of data cleaning because no two utilities submit in the same format. Every consumer with a smart meter has no standard way to share their granular energy data with a lender or solar company - verifiably, on their own terms. Multiply this across 36 states and union territories, over a hundred utilities, and thousands of energy service providers - and the price of inaction is not just inefficiency. It is a barrier to the energy transition itself.

*IES provides that connective tissue for coordination at scale.*

## 02

## What IES Is

### Definition

#### **India Energy Stack (IES)**

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.

### In Simple Terms

Think of IES as the core banking network for the energy sector. Before core banking, every bank ran its own isolated system. Transferring money between banks meant manual processes, incompatible formats, and days of delay. Core banking created a common backbone: a shared way to identify accounts, process transactions, and settle balances. Each bank kept its own internal systems and continued to innovate independently. But when they

needed to talk to each other, they used the shared network. This did two things - it encouraged innovation because it did not interfere with each bank's internal systems, and it enabled interoperability and coordination at scale because it established a common taxonomy and a common way of exchanging information.

IES does the same for the power sector. Today, if a DISCOM wants to share meter data with a regulator, or a prosumer wants to exchange energy with a neighbour, or a startup wants to build an energy app - each requires a custom, point-to-point integration. IES replaces that with a common suite of specifications that any system can implement. The analogy is not exact - the power sector is a cyber-physical system where digital decisions affect the physical flow of electricity, which demands higher safety and reliability standards than financial transactions. But the principle is the same: standardise the interface, not the systems behind it.

IES is a suite of protocols and specifications. It defines how entities and consumers in the power sector interact with each other. It provides a common data model, standard APIs, verifiable credentials, and audit trails. Data stays where it is generated. Each utility keeps its own systems. IES only standardises the interface between them.

*IES is not a centralised database, not a software product, and not a replacement for existing systems. It is the connective tissue - a shared suite of specifications that enables coordination without centralisation.*

## IES in India's DPI Journey

Digital Public Infrastructure (DPI) refers to shared, open, interoperable digital systems that operate at a population scale to deliver essential services. India has pioneered this approach: Aadhaar for identity, UPI for payments, DigiLocker for verifiable documents, and the Account Aggregator framework for consent-based data sharing. Each of these created a shared protocol layer that enabled an ecosystem of applications and services on top. India's DPI journey has transformed sectors through these shared frameworks. IES extends this approach to the power sector.

## Vision and Mission

### Vision

To enable a resilient and interoperable power system that coordinates reliably at scale, and where every consumer can choose, participate, and earn in a clean, digital energy economy, and where a new generation of energy entrepreneurs can build trusted services on a shared digital foundation for the collective benefit of society.

### Mission

To build open, interoperable, and secure digital public infrastructure for the power sector that enables consistent system coordination and seamless participation at scale across consumers, utilities, markets, and energy assets, while accelerating innovation through shared specifications, interfaces, and trust mechanisms.

## Guiding Principles

The following principles guide every design decision in IES:

Principle	What It Means
Transparency & Efficiency	All transactions are verifiable, tamper-evident, and machine-readable.
Data Federation	Data stays where it is generated. IES provides standardised interfaces for secure exchange.
Interoperability	Stakeholders join or exit with minimal friction via open APIs and specifications.
Scalability & Resilience	Decentralised architecture avoids bottlenecks. Systems scale to population-level usage.
Open Innovation	Core data and services available for public and private actors, including AI-ready data.
Inclusivity	Smaller stakeholders use shared infrastructure; larger ones may self-deploy.
Privacy & Trust	Secure data exchanges, privacy protection, and robust compliance frameworks.
Cybersecurity by Design	Authenticated nodes, access controls, and continuous monitoring across all interactions.
Ecosystem Neutrality	Technology- and vendor-neutral specifications that prevent lock-in.
Sovereignty	Aligned with national priorities on data sovereignty, security, and compliance.
Leverage Existing Systems	Build on current infrastructure, standards, and operational workflows.
Minimalism	Define only the baseline specifications, registries, and interfaces needed.
AI Readiness	Data, identifiers, and governance are AI-consumable by default.

## 03

### The Building Blocks

IES is built from a small set of shared capabilities called building blocks. They were designed by working backwards from real use cases: for each scenario, the design identified where coordination breaks down and distilled the minimum shared capability needed to fix it.

Building Block	What It Enables
Identity & Addressing (WHO)	Every consumer, connection, meter, or asset can identify themselves and share address as per need.
Registries & Directories (WHERE)	Shared records of who is authorised to act and where their digital endpoints are - like a phone directory for the energy sector.
Interaction Protocols (HOW)	Standard rules to discover, place requests, receive responses, fulfil, settle, and resolve disputes - replacing bespoke point-to-point integrations with common specifications.
Energy Data Exchange - (WHAT)	<p>Public: Translates deterministic and objectively verifiable policy provisions into machine-readable rules that any system can consume and compute. Provisions involving discretion or interpretation are excluded.</p> <p>Permissioned: consent-based data flows - meter data, trade records, compliance filings - shared with permission and audit trails.</p>
Energy Credentials (PROOF)	Verifiable digital proofs of identity, eligibility, or status - tamper-evident credentials that embed trust directly into every transaction.

## How Building Blocks Compose Across Use Cases

The same building blocks combine differently for different use cases. Some need all six; others need only two or three. The matrix below shows which blocks are core dependencies, which play a supporting role, and which are not required. A detailed interactive version is available in the companion Building Blocks to Use Cases Matrix document.

*Two patterns stand out. Identity and Interaction Protocols are core in almost every use case - they are the foundational infrastructure. And use cases cluster by type: Exchange and operational cases are protocol-heavy; consumer empowerment cases are credential-heavy. This informs which blocks to prioritise first.*

**Legend:** ● Core dependency    ◐ Supporting role    ○ Not require

Use Case	WHO Identity	WHERE Registries	HOW Protocols	WHAT Public	WHAT Private	PROOF Credentials
P2P Energy Exchange	●	●	●	○	●	●
DER Visibility	●	●	●	○	●	◐
Demand Side Flexibility	●	●	●	◐	●	◐
Consumer Energy Passport	●	●	◐	○	◐	●
My Energy Digest	●	◐	◐	○	◐	●
Tariff Intelligence (Public Data)	○	●	◐	●	○	○
DISCOM-Regulator Data Exchange (Permissioned Data)	●	◐	●	○	●	◐
Open Access (NoAR)	●	●	●	◐	◐	◐

## 04

### Use Cases: How IES Works in Practice

The best way to understand IES is to see it in action. The accelerator currently demonstrates select use cases. These use cases are not the boundaries of IES. They are the validation set - chosen because together they exercise building blocks, test various types of interaction (consumer-to-utility, utility-to-regulator, peer-to-peer, generator-to-transmission utility, SLDC-to-discom), and span the full range of complexity from a single credential lookup to a multi-party cross-DISCOM trade. As the ecosystem matures and new needs emerge - EV charging interoperability, carbon credit settlement, community microgrids, virtual power plants - they are expected to compose from the same building blocks. Where they cannot, the architecture will evolve. The use cases are open-ended, and the building blocks will grow with them.

Below is a brief overview of each. Detailed use case descriptions are in Annexure 1.

#### Key Distinctions

Consumer Energy Passport = what you are (your verified profile: address, sanctioned load, generation capacity, storage).

My Energy Digest = what you did (your actual usage history, shareable as a verifiable credential).

Use Case	User Journey
Peer-to-Peer Energy Exchange	A prosumer with rooftop solar has surplus energy. She opens an exchange app, which verifies her identity and credentials via IES. She lists her surplus. A buyer on a different DISCOM finds and accepts the offer. IES enables the trade contract, meter evidence, and settlement reconciliation across both DISCOMs.
DER Visibility	A DISCOM engineer needs to know how much distributed generation sits on a specific feeder. IES enables a federated registry that links every installation to its premise, meter, and owner using standard identifiers - giving a single, trusted view across systems.
Demand Side Flexibility	A consumer with a smart AC enrolls in a peak-reduction programme. When the grid signals a peak event, the device responds. IES enables verification of the impact using interval meter data and a standard baseline method. The consumer receives a bill credit backed by a verifiable evidence trail.
Consumer Energy Passport	A consumer moving to a new city carries a digital credential binding her identity to her connection, meter, and assets. She shares this with her new DISCOM for faster onboarding - no repeated KYC, no lost paperwork. IES enables this portable, verified credential.
My Energy Digest	A small business owner wants a green loan. He authorises his utility to issue a verifiable energy usage digest. The bank receives a tamper-evident summary of his consumption - no PDFs, no manual verification. IES enables this consent-based, credential-backed data sharing.
Tariff Intelligence (Public Data)	A solar developer evaluating investment across three states retrieves machine-readable tariff orders. Her model auto-computes net metering economics without manually interpreting PDF tariff schedules. IES enables this through standardised Policy Packs.
DISCOM-Regulator Data Exchange (Permissioned Data)	For instance, in an ARR filing, a DISCOM submits its cost data, power purchase details, and loss assumptions as a structured, digitally authenticated Filing Object using standardised data models. The regulator reviews and validates the submission through system-assisted checks aligned with regulatory rules. Each submission is time-stamped, versioned, and traceable, enabling consistent audit trails and reuse across proceedings. IES enables more reliable, comparable, and reusable regulatory filings.
Open Access (NoAR)	A validation check that maps the multi-party open access workflow to IES building blocks, stress-testing interoperability across many actors simultaneously.

## 05

### Who Benefits and How

IES is not something delivered to the ecosystem - it is built by the ecosystem. Each stakeholder has a structural role, a way to participate, and a clear reason to do so.

Stakeholder	Role in the ecosystem	How to participate	What you gain
DISCOMs	The primary interface between the grid and over 300 million households (Energy Statistics India, NSO, 2024). Where digital specifications meet physical operations.	Implement IES specifications on existing platforms. Connect CIS, MDMS, and registries to the shared layer.	Common specifications that reduce vendor integration cost. Unified registries. Faster onboarding of technology providers.
State and Central Regulators	The authority that sets rules of engagement. Specifications become operational within a regulatory framework.	Endorse sandbox provisions. Recognise IES-compliant filings. Test new tariff structures in the sandbox before going live.	Machine-verifiable filings in consistent formats. A safe environment to test policy. Cross-utility benchmarking.
System Operators (SLDC / NLDC)	The real-time view of the grid. The actors who validate that digital protocols work under live conditions.	Validate IES protocols against real-time grid conditions. Share operational data through standard APIs.	DER visibility at the grid edge. Standard DSO-TSO data exchange. Grid connectivity maps backed by verified data.
Consumers and Prosumers	The end user of every specification, protocol, and credential in the stack.	Opt in. Share data under consent. Engage with new services as they become available.	A portable energy credential. Consent-based data sharing. Access to P2P exchange, flexibility programmes, and green loans.
Startups and Technology Providers	The application layer. Shared specifications become products and services people use.	Build on IES APIs. Test in the sandbox. Get certified once and deploy across DISCOMs.	Common APIs that work across utilities. A sandbox to develop and test. Certification that travels.
GENCOs and TRANSCOs	The supply side. Generation and transmission data on the shared layer completes the grid-wide picture.	Expose generation and transmission data through IES-standard interfaces.	Open asset registries and telemetry APIs. Digital maps. Carbon accounting interfaces.
Market Operators	The marketplace. Where supply meets demand through standardised and auditable transactions.	Align platforms with IES specifications for participant registration, clearing, and settlement.	Standard APIs for market data and settlement. Real-time grid-linked data. Integrated participant registries.

## From Energy Access to Energy Agency

*IES enables the shift from receiving electricity passively to actively choosing services, participating in markets, and earning from your assets and actions.*

IES enables standardised onboarding through verified credentials, consent-based data sharing, and the measurement, verification, and settlement infrastructure that makes millions of small actions - off-peak charging, reduced cooling loads, surplus solar - bankable at scale. This creates a new class of energy micro-entrepreneurs and provides a pathway to inclusive growth.

## 06

### How IES Gets Delivered

IES is delivered through three parallel tracks: Architecture, Accelerator, and Adoption. These are not sequential phases; they run concurrently and reinforce each other.

#### Architecture

Defines the technical blueprint: shared data models, identifiers, APIs, registries, and assurance requirements.

#### Accelerator

Builds practical enablers that speed up adoption: sandbox environments, testing tools, conformance kits, and reference solutions.

#### Adoption

Defines the institutional conditions that make each stage succeed: certification to verify readiness, incentives to motivate participation, data policy, and success metrics.

### 6.1 Architecture

The IES architecture defines the technical blueprint for the ecosystem. It sets the common rules that enable different power-sector actors to exchange data and execute digital interactions safely and consistently. This includes shared data models, identifiers, APIs, registries, and assurance requirements.

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 any stakeholder's systems. Each utility, market operator, or participant continues to manage its own platforms. IES only defines the specification for data exchange, not the control logic itself.

To operationalise this, IES functions as a suite of protocols and standardised APIs that build on the sector's existing technical foundations and introduce new specifications where necessary. IES builds on existing standards and adds new specifications for identity,

credentials, and data exchange where gaps exist. All of these sit on harmonised existing data models, creating a consistent and interoperable structure for every interaction.

The architecture is detailed in the separate IES Architecture Document and the IES GitHub Repository.

## 6.2 Accelerator

Architecture and adoption strategy alone are not enough. Between writing specifications and achieving national-scale deployment, there is a gap that requires deliberate intervention. The IES Accelerator exists to fill that gap.

### What the Accelerator aims to provide

**Reference implementations.** Working deployments that demonstrate how IES specifications translate into running systems. These lower the barrier for new participants: instead of interpreting a specification document from scratch, they can see how it works, test against it, and build on it.

**Conformance testing and tools.** Automated test suites that validate whether a system correctly implements IES specifications. These are the foundation for certification - a system that passes conformance tests can be trusted to interoperate with others.

**Technical support and advisory.** Hands-on support for DISCOMs, technology providers, and system integrators implementing IES for the first time. This includes architecture guidance, integration troubleshooting, and specification clarification.

**Test environments.** Controlled environments where use cases can be validated with real or synthetic data before going live. These test environments evolve into staging and then production infrastructure - they are not throwaway.

**Training and capacity building.** An empanelled ecosystem of trainers and system integrators who can support implementation at scale. In the early stages, the core team provides this directly. As adoption grows, certified training partners extend the reach.

**Developer ecosystem.** Toolkits, documentation, hackathons, and community forums that enable startups and technology providers to build applications on IES specifications.

*The Accelerator is not a phase. It is a permanent function that evolves as IES matures - starting with hands-on support for early adopters and transitioning to a self-service ecosystem at scale.*

## 6.3 Adoption

Adoption defines how IES moves from specifications to national-scale implementation. This is the core of the strategy document. The adoption strategy has the following components: a three-stage scaling pathway, governance, funding, certification, incentives, and evolution of policy and regulation. Each is addressed in the sections that follow. Annexure 2 details existing initiatives to learn from and leverage.

# 07

## Scaling Up

Every IES use case follows a graduated deployment pathway - from build and validate, to calibrated deployment, to scale - with clear criteria that must be met before any use case advances to the next stage. This staged approach exists for the following reasons:

First, it manages risk. The power sector cannot afford to deploy untested digital infrastructure at scale. Each stage increases the scope and stakes incrementally, with evidence gathered at each step.

Second, it builds institutional confidence. DISCOMs, regulators, and system operators need to see a use case work under controlled conditions before committing resources to field deployment.

Third, it generates evidence for scale. Each stage produces data on cost, performance, and consumer impact that builds the case for broader investment and informs the governance and funding mechanisms needed for national rollout.

Stage	What happens	How to advance
Stage 1: Validation (3 months)	Architecture design and validation. Testing with simulated or limited real data. 2-10 DISCOMs and relevant stakeholders participate under controlled conditions. Deliverable: validated technical specification and reference implementation.	End-to-end functionality demonstrated. 2+ DISCOMs confirm readiness for field deployment. CERC/SERC provisions active. Stage 2 funding secured.
Stage 2: Calibrated deployment (3-6 months, 2-4 states)	Real consumers and prosumers on production workloads. Live data exchange with SLA tracking. Operational processes in place: support, monitoring, escalation. This is not a pilot - it is live infrastructure with no planned end date.	Reliable under production load for 3+ months. 5+ additional states express formal intent. Advisory or discussion paper issued by regulator. State cost-sharing confirmed for Stage 3.
Stage 3: Scale (6-24 months, ongoing)	All-India deployment across states and union territories. Cross-state interoperability validated at volume. CERC/SERC regulatory mandate or national directive. Permanent institutional home established. Continuous improvement.	National interoperability standards published. All states have dedicated teams and budgets. Regulatory order for national adoption. Self-sustaining cost model operational.

*Governing principle: no use case advances unless gate criteria are met and funding for the next stage is pre-committed. P2P Energy Exchange serves as the pathfinder; its deployment lessons inform the operational playbook for all subsequent use cases.*

## 08

### Funding Needs for IES

Scaling IES to a national rollout would require sustained, multi-layered funding across its lifecycle, from initial platform development and stakeholder onboarding to long-term maintenance and iterative upgrades. Funding may flow from a combination of public sources, including central and state government allocations, multilateral development finance, and existing sector schemes, complemented by private sector co-investment where appropriate. A sustainable financing model would ideally embed cost-recovery mechanisms that align incentives across all ecosystem participants, ensuring the platform remains a sovereign public good while remaining financially viable over time.

## 09

### Certification

Certification provides a credible, machine-verifiable signal that a participant can exchange data and transact safely using IES specifications. It is also the core measurement tool for adoption - enabling the programme to track “percentage adoption” consistently.

Principle	What It Means
Modular	Certification is at the building block level. An entity can be certified for one block and not others.
Use-case-scoped	“IES Ready” means ready for a specific use case. No false binary of certified vs not certified.
Phased	Compliance with IES specifications shall be self-declared by participants, with automated test suites available for verification. If a participant's systems cannot interoperate within the IES ecosystem, non-compliance becomes self-evident; empanelled certifiers may be invoked only where systemic risk warrants independent validation.
Outcome-aligned	Tests behaviour that matters: identity resolution, consent handling, secure transactions, policy enforcement.
Machine-readable	Certification status expressed through Policy as Code for automated compliance verification.

## 10

### Incentives for Adoption

Stakeholder	Incentive	Existing Programme Leverage
DISCOMs	Accelerator access and support. Reduced integration cost. Visible adoption ranking.	RDSS milestones: IES conformance for disbursements. NSGM smart grid funding tied to IES readiness.
Regulators	Accelerator to test tariff and market rules. Machine-verifiable filings reduce workload.	FOR coordination: IES evidence informs model regulations. CERC sandbox provisions.
Startups / Tech	Common APIs across DISCOMs. Developer toolkits, reference implementations, hackathons.	Startup India / DPIIT: sandbox participation as innovation credential. MeitY Digital India alignment.
System Operators	Federated DER registries and grid visibility APIs reduce coordination overhead.	Grid-India modernisation: IES-compliant APIs for DSO-TSO exchange.
Consumers	Portable credentials, consent-based sharing, access to new markets and services.	PM Surya Ghar: IES-aligned DER registration. RDSS AMI: consumer data access via IES APIs.
GENCOs / TRANSCO	Open asset registries and telemetry APIs reduce bilateral effort.	Green Energy Corridor: IES data standards for RE integration. CCTS registry alignment.

## 11

### Evolution of Policy and Regulation

As IES scales from a pilot accelerator to a nationwide programme, the existing regulatory landscape must keep pace. Statutory timelines for the adoption of IES specifications should be established, giving DISCOMs and other ecosystem participants a clear horizon to plan and execute system upgrades. Regulations governing peer-to-peer energy exchange, open access procedures, and data sharing must also be revised to formally recognise IES-compliant digital processes as legally equivalent to their manual counterparts.

#### Learning from Global Precedent

International experience offers a compelling model. The United Kingdom's RIIO framework — Revenue = Incentives + Innovation + Outputs — deliberately rewarded utilities for embracing digital infrastructure and innovation, rather than simply allowing it (Ofgem, 2018; Utility Dive, 2019). Adopting a similar philosophy in India, where regulatory frameworks actively incentivise adoption rather than merely tolerate it, would meaningfully accelerate IES uptake across states.

## Leveraging Sovereign Digital Infrastructure

IES specifications could be anchored in India's sovereign digital public infrastructure. Open-source code and specifications may be hosted on OpenForge, while APIs involving a government entity could be published through API Setu (Digital India, 2024a; Digital India, 2024b). This approach would help ensure the ecosystem is built on trusted Indian digital public goods, while potentially preserving the flexibility for private innovation to flourish (APISetu, n.d.).

## National Power Sector Data Policy (subsection of evolution)

The Ministry of Power is developing a National Power Sector Data Policy (NPSDP) as a complementary initiative. The NPSDP will serve as the governance framework for data in the power sector, addressing classification (operational vs informational), federation (data stays with custodians, accessible via unified APIs), role-based access entitlements, and consumer consent aligned with the Digital Personal Data Protection Act, 2023.

# 12

## Governance

IES specifications are only as durable as the institutions that govern them. A governance framework determines who sets specifications, who certifies compliance, who resolves disputes, and how IES evolves as the sector changes. The full governance framework will be elaborated in the next version of this strategy document. This section outlines what it must address and the key risks to anticipate as IES scales.

### What governance must address

- 1. Decision-making authority.** Who approves specifications, and who decides when a use case advances from sandbox to field deployment to national rollout?
- 2. Operational ownership.** Who runs the sandbox and production infrastructure at each stage? Who staffs and funds the technical team as operations grow?
- 3. Certification and quality control.** Who designates certifying bodies, accredits assessors, and ensures compliance is consistent across states and vendors?
- 4. Financial sustainability.** How does IES move from fully centrally funded to a sustainable model where states and market participants share costs?
- 5. Regulatory consistency at scale.** How are cross-state inconsistencies in adoption resolved? What regulatory instruments - model regulations, FOR advisories, or national directives - provide the backing for national rollout?
- 6. Dispute resolution.** When two participants disagree on a transaction, a data exchange, or a compliance finding, how is it resolved? What is the escalation pathway, and who arbitrates?

### Risks to watch as IES scales

- 1. Institutional readiness.** Some DISCOMs may need additional support for enhancing their technical capacity to implement specifications

**2. Uneven AMI deployment.** Smart meter rollout timelines vary across states, which could create uneven readiness for data-dependent use cases.

**3. Regulatory fragmentation.** Cross-state differences in adoption pace and regulatory frameworks could slow national rollout.

**4. Consumer trust.** Willingness to share energy data cannot be assumed. Consent fatigue and privacy concerns need to be addressed proactively.

**5. Quality at scale.** In a federated model, consistency depends on correct implementation by every participant. At national scale, this is hard to enforce.

**6. Funding continuity.** Sustained funding beyond Stage 1 depends on demonstrating measurable value to secure state and market cost-sharing.

## 13

### Success Metrics

Dimension	Metric
Adoption and Coverage	Percentage of utilities, system operators, market bodies, and providers aligned with IES specifications.
Adoption and Coverage	Percentage of sector interactions routed through IES-compliant interfaces.
Ecosystem & Consumer Value	Number of third-party apps and services leveraging IES.
Ecosystem & Consumer Value	Improved consumer access and choice (surveyed).

## Annexures

### Annexure 1: Use Case Specifications

This annexure provides detailed specifications for each of the eight sandbox use cases.

#### A1.1 Peer-to-Peer Energy Exchange

**What it does:** Enables prosumers to buy and sell energy directly with each other, even across different DISCOMs.

**Why it matters:** Rooftop solar is growing rapidly. Millions of households will soon generate more electricity than they consume during daylight hours. Without a way to trade that surplus, the value is lost. P2P exchange turns passive consumers into active market participants.

**How IES enables it:** IES provides a common identity for buyers and sellers, a registry to discover exchange counterparties and verify credentials, standard protocols for trade offers and settlement, and verifiable meter evidence to back every transaction. The DISCOM's billing and grid checks remain local; IES standardises the handshake between platforms and utilities.

**Building blocks used:** Identity (core) • Registries (core) • Protocols (core) • Private data exchange (core) • Credentials (core)

#### A1.2 DER Visibility

**What it does:** Gives utilities and system operators a consistent, trusted view of all distributed energy resources (rooftop solar, batteries, EV chargers) connected to the grid.

**Why it matters:** India is adding distributed generation faster than utilities can track it. Without visibility into where DERs are, what their capacity is, and who owns them, grid planning, safety, and loss reduction are compromised. DISCOMs today often discover DER installations only when feeders overload.

**How IES enables it:** IES enables a federated DER registry with standard identifiers that link each installation to its premise, connection, meter, and owner. Credentials verify commissioning and compliance status. System operators receive standardised schedule and performance data.

**Building blocks used:** Identity (core) • Registries (core) • Protocols (core) • Private data exchange (core) • Credentials (supporting)

#### A1.3 Demand Side Flexibility

**What it does:** Enables consumers to reduce or shift their electricity usage in response to grid signals or price incentives, and be verifiably compensated for doing so.

**Why it matters:** Peak demand is rising. Expensive peaker plants and load shedding are costly responses. Consumer flexibility, such as adjusting AC, EV charging, or water heating during peak hours, is a cheaper, cleaner alternative. But scaling demand response requires standardised enrolment, dispatch, measurement, and settlement that today's fragmented systems cannot deliver.

**How IES enables it:** IES standardises the flexibility programme catalogue, consented enrolment using verifiable credentials, event dispatch with acknowledgements, and baseline-

referenced impact verification using interval meter data. Settlement statements are machine-verifiable and linked to evidence.

**Building blocks used:** Identity (core) • Registries (core) • Protocols (core) • Public data exchange (supporting) • Private data exchange (core) • Credentials (supporting)

### A1.4 Consumer Energy Passport (Composite Energy Credential)

**What it does:** Creates a verified, portable digital profile for each energy consumer, binding their identity to their premise, connection, meter, sanctioned load, generation capacity, and storage.

**Why it matters:** Today, consumer information is scattered across CIS, GIS, MDMS, and solar portals with inconsistent identifiers and no consumer control. Every new service (subsidy claim, DER registration, flexibility programme, transfer) requires consumers to prove who they are and what they have from scratch. The Energy Passport is 'what you are', a credential you hold and can share on your terms.

**How IES enables it:** IES issues a verifiable credential that binds identity to connection, meter, and asset linkage. The credential is wallet-held and consent-governed. Lifecycle changes (meter swap, transfer, new DER) are recorded as versioned updates with evidence trails, not overwrites.

**Building blocks used:** Identity (core) • Registries (core) • Protocols (supporting) • Private data exchange (supporting) • Credentials (core)

### A1.5 My Energy Digest

**What it does:** Gives consumers a portable, verifiable proof of their energy usage behaviour that they can share with anyone, such as lenders, landlords, or service providers, on their own terms.

**Why it matters:** Energy usage data is locked inside utility systems today. A consumer applying for a green loan, renting a property, or switching service providers has no standard way to prove their consumption history. The Energy Digest is 'what you did', a verifiable summary of your actual energy behaviour, shareable via DigiLocker or equivalent.

**How IES enables it:** IES enables a credential-backed digest derived from meter data, signed by the issuing utility, and shared under consumer consent. The digest is tamper-evident and can be verified by any recipient without calling back to the utility.

**Building blocks used:** Identity (core) • Registries (supporting) • Protocols (supporting) • Private data exchange (supporting) • Credentials (core)

### A1.6 Tariff Intelligence (Public Data)

**What it does:** Converts tariff orders, subsidy schemes, and regulatory policies into machine-readable formats that any system can consume and compute.

**Why it matters:** Tariff orders today are published as PDF documents in natural language. Different billing systems interpret the same tariff differently, causing billing disputes. Investors cannot easily compare tariff structures across states. Subsidy eligibility checks are manual. Machine-readable tariffs unlock automation, transparency, and innovation.

**How IES enables it:** IES defines a Policy Pack format: a versioned, machine-executable representation of a tariff's computable core (eligibility checks, charge computations, slabs), with clause-level traceability back to the original order. Multiple billing systems running the same Policy Pack produce identical results. Conformance testing ensures consistency before production rollout.

**Building blocks used:** Registries (core) · Protocols (supporting) · Public data exchange (core)

### A1.7 DISCOM-Regulator Data Exchange (Permissioned Data)

**What it does:** Enables DISCOMs and other reporting entities to submit regulatory filings as signed, machine-verifiable digital objects, and enables regulators to validate, accept, and reuse them.

**Why it matters:** Regulatory filings are currently recreated for every proceeding, submitted in inconsistent formats, and lack evidence trails. This increases cost, delays proceedings, and prevents cross-utility benchmarking. A standardised, reusable filing primitive saves everyone time and improves analytical capacity.

**How IES enables it:** IES defines a Filing Object format with digital signatures, a versioned rulebook for validation, and machine-readable receipts for acceptance. Once a filing is accepted, it can be referenced in future proceedings without recreation.

**Building blocks used:** Identity (core) · Registries (supporting) · Protocols (core) · Private data exchange (core) · Credentials (supporting)

### A1.8 Open Access Validation (NoAR)

**What it does:** Validates open access workflows against IES protocols to test whether the building blocks can support the complex, multi-party processes involved in open access transactions.

**Why it matters:** Open access involves multiple entities (buyer, seller, trader, system operator, DISCOMs) and requires coordinated scheduling, NOC issuance, and settlement. It is a useful stress test for IES interoperability across many actors and building blocks simultaneously.

**How IES enables it:** IES maps the open access workflow to its building blocks: identity for all participants, registries for eligibility and discovery, protocols for applications and approvals, public data exchange for tariff and charge computation, and credentials for verification.

**Building blocks used:** Identity (core) · Registries (core) · Protocols (core) · Public data exchange (supporting) · Private data exchange (supporting) · Credentials (supporting)

## Annexure 2: Mapping Existing Digitalisation Efforts

The Indian power sector has a substantial base of digital systems and ongoing digital initiatives. This annexure maps the key systems currently in operation and the programmes driving their adoption. IES builds on this foundation rather than replacing it.

### A2.1 Digital Systems in the Power Sector

#### Grid Operations and Planning

System	Description	Deployment Status
SCADA / EMS	Supervisory Control and Data Acquisition; 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.	11 operational (1 National, 3 Regional, 7 State) managing 55GW+ of RE.
ADMS	Advanced Distribution Management System; integrates SCADA, DMS, and OMS for distribution network control.	Deployed by private DISCOMs (TPDDL, Adani); piloting in select public utilities.
GIS	Geographic Information System; spatial mapping of electrical assets 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).

#### Metering and Distributed Energy Systems

System	Description	Deployment Status
AMI	Advanced Metering Infrastructure; smart meters with two-way communication for real-time billing and monitoring.	Approximately 4.76 crore installed; over 22 crore sanctioned under RDSS (Ministry of Power, December 2025).
MDMS	Meter Data Management System; central software that validates, stores, and analyses smart meter data.	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).

System	Description	Deployment Status
UEI	Unified Energy Interface; open network protocol (Beckn-based) for interoperable energy transactions.	Pilot stage (EV charging in Kochi/Delhi); UEI Alliance formed.

### Market, Settlement, and Scheduling Platforms

System	Description	Deployment Status
NOAR	National Open Access Registry; centralised platform for short-term open access to the interstate transmission system.	Active; reduced processing time from days to hours.
SAMAST	Scheduling, Accounting, Metering and Settlement of Transactions; state-level software for intra-state scheduling.	Operational in MP, Delhi, Gujarat, Maharashtra; implementing in others.
DEEP	Discovery of Efficient Electricity Price; e-bidding portal for short/medium-term power procurement.	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.
MERIT	Merit Order Despatch; portal displaying marginal costs and source-wise purchase.	Active; helps states minimise power purchase costs.
REC Registry	Renewable Energy Certificate Registry; digital ledger for issuing and trading RECs.	Active; managed by Grid-India.

### Consumer, Solar, and Transparency Portals

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)	Centralised database and dashboard for all power sector data.	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.	Active; project monitoring tool.

System	Description	Deployment Status
Urja Mitra	Outage notification platform sending SMS/email to consumers about scheduled outages.	Active; integrated with many DISCOMs.

## A2.2 Digital Initiatives Driving Adoption

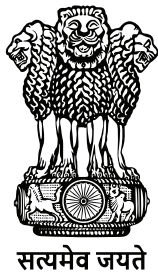
Initiative	Objective	Status
RDSS	Revamped Distribution Sector Scheme; primary funding vehicle for grid modernisation. Funds AMI (250 million meters) and IT/OT integration.	Active.
PM-KUSUM	Solarisation of agriculture; mandates digital adoption via Remote Monitoring Systems for pumps.	Active; created a massive distributed IoT network.
SMNP	Smart Meter National Programme; target to replace 250 million conventional meters.	Active; largely subsumed under RDSS.
NSGM	National Smart Grid Mission; fosters pilots, standards, and capacity building for smart grids.	Active; completed 11 pilots; Knowledge Centre established.
Green Energy Corridor	Transmission infrastructure for RE; includes digital communication backbone (OPGW) for telemetry.	Active; Phase-II ongoing (20GW integration).
CSIRT-Power	Computer Security Incident Response Team for power sector cyber defence.	Active; established April 2023 at CEA.
AI/ML Mission	Strategic initiative to adopt AI for load forecasting, predictive maintenance, and theft detection.	Ongoing; Centres of Excellence at PSUs.
CCTS	Carbon Credit Trading Scheme; creating a domestic carbon market requiring a digital registry.	In development; BEE finalising framework; registry by Grid-India.

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**IES STRATEGY DOCUMENT**

**VERSION 0.4 | MARCH 2026**