

Rs 100

INDIA'S FIRST POWER MAGAZINE

VOLUME 30 • NO. 6 FEBRUARY 2026

POWERLINE

www.powerline.net.in

IES Blueprint **16**

India Energy Stack seeks to create an interoperable electricity ecosystem



Special Issue

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IES Blueprint

India Energy Stack seeks to create an interoperable electricity ecosystem

Marking a significant step towards creating a digital public infrastructure (DPI) for the power sector, the Ministry of Power has released Version 0.3 of the India Energy Stack (IES) architecture and strategy documents. The strategy outlines how the IES will be developed and scaled, while the architecture sets out the technical blueprint to enable interoperability, trust and seamless coordination across the electricity ecosystem.

The IES aims to build open, interoperable and secure DPI for the power sector that would enable seamless participation, innovation and efficient coordination among various stakeholders, including consumers, utilities, markets and energy assets. It builds on the concept of DPI within the power sector, similar to Aadhaar, unified payments interface, DigiLocker, eKYC and eSign.

At the core, IES will identify and connect stakeholders and assets, as well as facilitate open data exchange and interoperability in the power system through

uniform specifications and standards. Essentially, IES will redefine how power sector entities (such as discoms, gencos, transcos, charger booking apps and consumer-producers) interact with one another, which would be facilitated by a set of services (application programming interface [API] definitions and calls), along with a data model/taxonomy.

IES architectural framework: Building blocks for a modular ecosystem

The IES framework is built on several core components that are essential for enabling large-scale coordination across the energy sector. These building blocks are summarised below:

Identity and addressing

Identity and addressing will provide a common reference framework for the power sector. It will assign unique, standardised identifiers to consumers, connections, meters and grid assets so that every data exchange and transaction is unambiguously attributed. It will cover persistent unique IDs, standard attributes and mapping rules that link local

or legacy identifiers to common references. By creating a single reference layer across systems, identity and addressing would eliminate ambiguity and reduce manual reconciliation. Data from different utilities and vendors will be aligned consistently, enabling solutions to be reused and scaled across geographies.

Registries and directories

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

Registries and verifiable credentials also allow participants to securely validate identities, claims and actions without centralising sensitive data. For instance, a rooftop solar installer with a digitally verified licence can be authenticated instantly by a utility during onboarding. Such capabilities will become increasingly important as energy markets grow more decentralised.

Transaction protocols

Transaction protocols define standardised rules for exchanging data across systems, including common message structures and data semantics. The IES specifies protocol definitions covering message envelopes, data models, interaction patterns and error handling.



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	Coordinate grid operations, integrate real-time data flows, and enable balancing and ancillary services through IES protocols
Market operators	Facilitate market clearing, settlement and trading platforms aligned with IES standards and APIs
Regulators	Frame regulatory guidance, support innovation and ensure frameworks enable IES adoption
Consumers	Participate in IES-enabled services, and benefit from transparency, improved access and empowerment
Start-ups/Tech providers	Develop IT/OT solutions conforming to IES standards and ensure interoperability; build, pilot and scale new solutions leveraging IES APIs; integrate and manage smart metering (advanced metering infrastructure service providers); and access and disseminate data securely through IES-standard APIs

These protocols are extensible and designed to operate above heterogeneous legacy and vendor systems without prescribing internal architectures. Transaction protocols decouple applications from underlying systems. A service built for one utility can interoperate with another without custom integration, reducing costs and accelerating replication.

Energy credentials

Credentials are verifiable digital proofs that establish the eligibility, authority or status of actors and assets, in alignment with regulatory and institutional requirements. The framework supports the issuance, verification and revocation of standard credential types such as consumer consent, asset certification and licences. Standardised credentials enable systems to verify permissions automatically. This reduces fraud risks, strengthens compliance and enhances auditability across the ecosystem.

Policy as code

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, while the human-readable intent remains linked to the code to ensure explainability and oversight. Policy packs can be configured for different states or programmes. By standardising

how policies are packaged and applied, Policy as code ensures uniform interpretation and accessibility across utilities and applications, while still allowing for jurisdiction-specific variation.

Use case illustrations of the 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 a 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 the 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.

Need for a national power sector data policy

While digitalisation offers a clear pathway to operational efficiency and improved service delivery, the sector's data landscape remains fragmented across state boundaries and locked within proprietary silos. In the absence of a unified governance framework, ongoing digital investments risk degenerating into "data swamps" rather than strategic assets. The proposed National Power Sector Data Policy is envisaged as the governance "constitution" for the IES, ensur-

Reference use cases built on IES architecture

Across all the use cases, the intent is to reuse the same core primitives (identity, registries/credentials, policy as code, standard APIs and interaction patterns) rather than building bespoke protocols or patterns per use case.

- **Inter-discom peer-to-peer (P2P) energy trading:** Cross-state, cross-discom P2P trading involves buyers and sellers operating under different utilities, while contracting, delivery verification, wheeling and billing, and dispute resolution span multiple organisations without a central coordinating authority. At present, identities and connection-meter linkages do not translate seamlessly across boundaries, evidence is generated in disparate formats, and verification and settlement processes remain slow and fragile.

IES enables repeatable P2P trading by standardising discovery and contracting interactions, and by defining common evidence and receipt artefacts (such as signed meter-derived actuals) that all participants can rely on while platforms, exchanges and discoms remain autonomous. This ensures interoperable platforms, consistent discom visibility into scheduled versus actual trades, and evidence-based reconciliation and dispute resolution through shared protocol receipts and versioned records.

- **Energy policy as code:** Policies issued as PDF documents often lead to inconsistent interpretation, slow and uneven implementation, and disputes over whether the correct rules were applied in billing and operations. Utilities and vendors frequently re-implement the same policy logic with variations, increasing complexity and risk.

IES enables a shift to machine-readable, digitally signed and versioned policy packs with clear provenance and deterministic evaluation. Systems can automatically identify the applicable policy version and generate explainable outputs linked to the source, making policy implementation consistent, portable and verifiable at scale.

- **Distributed energy resources (DER) visibility:** DER scale is

ing that data flows securely, seamlessly and interoperably across the ecosystem. By standardising data governance and embedding trust into digital interactions, the policy can unlock greater value from physical infrastructure investments and lay the foundation for a grid that is secure, financially sustainable and future-ready in a decarbonising economy.

The policy operationalises the IES as the sector's shared digital foundation. The IES architecture is structured around four foundational layers:

- **Data layer:** Distributed systems of record, exposed through standardised

adapters to enable secure and interoperable data exchange.

- **Identity layer:** Unique registries for assets (such as transformers and meters) and entities, providing a common reference framework to support interoperability.
- **Exchange layer:** Adoption of a common data model to ensure semantic consistency and uniform interpretation of data across utilities.
- **Consent layer:** A robust consent mechanism enabling consumers to approve, limit or revoke the sharing of their smart meter data with designated third parties for specified purposes,

constrained by fragmented registries and weak linkages between the consumer, premises, connection, meter and DER set. This results in discom-specific portals, inconsistent identifiers, repeated verification, spreadsheet-based exchanges, limited comparability for regulatory or market reporting.

IES enables federated registries and canonical DER schemas, supported by strong identity linkages, credentials and interoperable exchanges with built-in validation and receipting. DER data becomes consistently discoverable and auditable, reducing reconciliation effort, improving planning and enabling aggregators and programmes to scale across utilities.

- **Consumer-side flexibility:** While technically feasible, flexibility remains difficult to scale due to fragmented enrollment, consent, despatch, measurement and settlement processes. Weak discoverability, non-portable consent, varying despatch semantics and disputed baselines often delay settlements and undermine trust.

IES standardises the full lifecycle – from programme discovery and reusable consent to despatch events, policy-as-code rulebooks, verification and settlement receipts. This makes flexibility programmes repeatable across discoms and service providers, with faster onboarding, verifiable outcomes and itemised settlements, while retaining a federated architecture.

- **Electric vehicle (EV) charging:** EV charging is inherently multi-operator, making interoperability critical. Currently, discovery, access, reservation and session management vary across networks, leading to fragmented user experiences and high integration costs.

IES establishes common semantics for discovery (location, connector type, availability), reservation and charging sessions. This shared interaction framework allows multiple providers to participate seamlessly. Drivers can discover, reserve, charge and pay across networks through interoperable applications, while charge point operators retain operational autonomy and the ecosystem scales without bespoke integrations.

es, supported by clear audit trails and legal compliance.

To conclude, the IES has been designed to address the gaps in the sector by creating a shared digital foundation. Rather than replacing existing platforms, it establishes common protocols, data models and interaction standards to facilitate secure and standardised data exchange across stakeholders. By enabling interoperability and improving coordination, the IES is expected to strengthen system efficiency, market development and the delivery of reliable, and affordable electricity. ■

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