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Original Article

SAP S/4HANA Transformation in the Electric Power and Grid Utility Sector: Combination Migration Strategy and Customer-Managed Deployment A Practitioner's Analysis

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Abstract - *The global electric power and grid utility sector faces a dual transformation imperative: the approaching SAP ECC 6.0 maintenance deadline of December 2027 and the accelerating demands of energy transition, grid modernization, and regulatory compliance. This paper presents a comprehensive practitioner analysis of a large-scale SAP S/4HANA transformation program executed for a major vertically integrated electric utility operating across transmission, distribution, and generation asset portfolios. The program employed a combination migration strategy, Greenfield reimplementation for the enterprise core covering Finance, Asset Management (IS-U/PM), Work Order Management, and Grid Operations, paired with brownfield system conversion for three regional subsidiary instances deployed on a customer-managed S/4HANA private cloud architecture. The analysis examines utility-specific architectural considerations, including SAP Industry Solution for Utilities (IS-U) migration, Plant Maintenance and Enterprise Asset Management (EAM) transformation, regulatory compliance, and NERC-CIP cybersecurity requirements, and grid operations integration. Program outcomes include a 61% reduction in the custom ABAP estate, a 42% improvement in asset maintenance scheduling efficiency, full IS-U migration with zero customer billing interruption, and a projected five-year total cost of ownership reduction of $16.8 million against a $44 million program baseline. The paper provides an integrated decision framework for utility enterprises navigating S/4HANA strategy selection, with dedicated attention to IS-U/S4HANA Utilities migration, EAM transformation, and regulatory compliance architecture.*

Keywords - *SAP S/4HANA, ERP Migration, Electric Utility, Greenfield, Brownfield, Combination Migration, IS-U, SAP Utilities, Enterprise Asset Management, Plant Maintenance, NERC-CIP, Grid Modernization, Work Order Management, Clean Core, Total Cost of Ownership, Customer-Managed Deployment.*

1. Introduction

Electric power and grid utilities occupy a uniquely complex position within the SAP S/4HANA migration landscape. Unlike enterprises in commercial sectors, electric utilities combine the operational complexity of capital-intensive asset management spanning generation plants, transmission infrastructure, and distribution networks, representing decades of capital investment, with the customer-facing complexity of regulated retail energy billing, demand response programs, and smart meter integration. SAP's industry-specific solution for utilities, IS-U (Industry Solution for Utilities), has been deeply embedded in large electric utility operations since the late 1990s, and its migration pathway to SAP S/4HANA represents one of the most technically demanding transitions in the SAP ecosystem.

The convergence of the 2027 ECC maintenance deadline with the energy industry's accelerating transition driven by renewable integration, distributed energy resources (DER), Advanced Metering Infrastructure (AMI), and increasingly stringent grid reliability mandates creates a forcing function for SAP transformation programs that is qualitatively different from other industries. Utilities cannot defer transformation without compounding both technical debt and grid modernization opportunity cost simultaneously.

This paper documents a large-scale S/4HANA transformation program delivered for a vertically integrated electric utility operating in multiple U.S. service territories, with regulated transmission and distribution assets, merchant generation, and approximately 3.2 million retail customers. The program's combination migration strategy, Greenfield for the enterprise core and brownfield for regional subsidiary instances, was selected through a rigorous transformation architecture assessment that balanced the utility's clean core ambitions against IS-U migration complexity and NERC-CIP cybersecurity compliance obligations. Customer-managed S/4HANA deployment on a private cloud architecture was selected in preference to RISE with SAP, driven by cybersecurity sovereignty requirements and existing hyperscale enterprise agreements that the utility's technology governance framework required to remain under direct organizational control.

The paper is structured as follows. Sections II through IV establish the utility-specific SAP architectural context. Section V presents the migration strategy analysis framework. Section VI details the combination migration rationale. Section VII

documents the large-scale implementation use case. Section VIII presents an integrated decision framework for utility enterprises. Section IX provides conclusions and practitioner lessons of broad applicability.

2. The Electric Utility SAP Landscape and Migration Context

2.1. SAP IS-U: Architecture and Migration Complexity

SAP's Industry Solution for Utilities (IS-U), integrated within the FI-CA (Contract Accounts Receivable and Payable) and CS (Customer Service) modules, provides the foundational customer-to-cash architecture for electric utilities: customer master data management, service connection management, meter reading and billing, dunning, and customer interaction management. The IS-U architecture in SAP ECC embeds utility-specific logic rate determination, consumption billing, time-of-use calculations, and regulatory surcharge management through deeply customized configurations and ABAP developments that reflect each utility's rate structure, service territory, and regulatory jurisdiction.

In SAP S/4HANA, IS-U transitions to SAP S/4HANA Utilities (formerly IS-U within S/4HANA), retaining core billing and customer service functionality while introducing the S/4HANA Universal Journal architecture and Fiori-based customer service interfaces. The migration pathway requires specific technical attention: FI-CA document structures require migration assessment distinct from standard FI, meter-to-cash process flows must be remapped to the S/4HANA device management architecture, and custom rate determination logic must be evaluated for compatibility with the S/4HANA billing engine. The complexity of IS-U migration is a primary driver of the extended program timelines characteristic of electric utility S/4HANA programs, typically 24 to 42 months for large integrated utilities, versus 18 to 30 months for comparable non-utility enterprises.

2.2. Enterprise Asset Management in Electric Utilities

Electric utility asset portfolios, including generation plants, substations, transmission lines, distribution infrastructure, and increasingly, renewable generation and battery storage assets, represent the most capital-intensive asset bases in the SAP ecosystem. SAP Plant Maintenance (PM), extended Enterprise Asset Management (EAM) capabilities and integrated with SAP EAM linear asset management for transmission and distribution infrastructure, forms the operational backbone of grid reliability management. Work order management, preventive and predictive maintenance scheduling, regulatory maintenance compliance documentation, and integration with SCADA/EMS grid operations systems are core PM/EAM dependencies that S/4HANA transformation must preserve and, where possible, enhance.

S/4HANA introduces the SAP Asset Intelligence Network (AIN) and predictive maintenance capabilities through integration with SAP Asset Performance Management (APM) on the Business Technology Platform (BTP). For electric utilities pursuing grid modernization objectives, S/4HANA EAM transformation represents an opportunity not merely to maintain existing maintenance operations but to establish the data foundation for condition-based maintenance, drone inspection workflow integration, and regulatory compliance automation that ECC's architecture cannot support [1].

2.3. NERC-CIP Cybersecurity Compliance and Customer-Managed Architecture

The North American Electric Reliability Corporation Critical Infrastructure Protection (NERC-CIP) standards impose cybersecurity requirements on bulk electric system (BES) assets and associated electronic systems, with direct implications for SAP S/4HANA deployment architecture. CIP-007 (Systems Security Management), CIP-010 (Configuration Change Management and Vulnerability Assessments), and CIP-011 (Information Protection) establish controls for cyber assets that connect to or communicate with BES cyber systems controls that electric utilities must maintain continuously and document for FERC compliance audits.

The customer-managed S/4HANA deployment model, in which the utility retains direct ownership of the hyperscaler tenancy, SAP Basis operations, and network segmentation architecture, was selected over RISE with SAP's managed infrastructure model specifically to maintain NERC-CIP compliance sovereignty. Under RISE, SAP's management of underlying infrastructure would require the utility to qualify SAP as a vendor under its NERC-CIP compliance program and establish SAP infrastructure personnel in the Electronic Security Perimeter (ESP) access control framework a governance overhead the utility's Compliance and Regulatory Affairs function assessed as operationally untenable given its regulatory audit posture. Customer-managed deployment, with the utility's existing AWS GovCloud tenancy serving as the infrastructure foundation, preserved the established NERC-CIP compliance architecture without introducing new regulatory qualification dependencies.

3. The 2027 Deadline and Utility Sector Transition Imperatives

Industry surveys conducted in 2022 indicate that approximately 35% of large electric utilities globally had initiated or completed S/4HANA migration planning, with fewer than 12% having reached production. This adoption lag more pronounced than in other industries reflects the specific complexity barriers that electric utilities face: IS-U migration risk, NERC-CIP compliance architecture requirements, 24/7 operational continuity obligations (unlike most commercial enterprises, electric utilities cannot schedule extended system downtime for go-live activities), and the deep integration between ERP systems and operational technology (OT) environments, including SCADA, Energy Management Systems (EMS), and Advanced Metering Infrastructure (AMI) platforms.

The energy transition compounds this complexity. Utilities are simultaneously managing S/4HANA transformation programs while deploying Advanced Metering Infrastructure, integrating distributed energy resources into their operational models, and complying with evolving state and federal renewable portfolio requirements. The SAP ECC landscape that supported traditional generation-focused utility models is architecturally insufficient for the DER integration, real-time demand response, and AMI data volume management that utilities require through 2030 and beyond. S/4HANA's architecture with its real-time analytics foundation, BTP extensibility model, and S/4HANA Utilities evolution path toward smart grid integration provides the platform foundation for this modernization. The 2027 deadline, for electric utilities, is therefore not merely a maintenance cutoff but a strategic forcing function for a grid modernization capability investment that is independently justified.

4. Migration Strategy Analysis for Electric Utilities

4.1. Greenfield Migration

Greenfield migration in a utility context deploys S/4HANA as a new system, re-implementing IS-U, Finance, Asset Management, and all modules against the S/4HANA architectural baseline. Business processes are redesigned against SAP Best Practice content and SAP S/4HANA Utilities standard configurations; custom ABAP is not carried forward, and only selective historical data open work orders, active assets, customer master, billing history within regulatory retention requirements is migrated. Greenfield offers the highest ceiling for IS-U modernization, EAM transformation, and clean core attainment, but requires full IS-U re-implementation a program within a program for utilities with complex rate structures and multi-service-territory billing configurations.

The strategic case for greenfield in a utility context is strongest when: (a) the existing IS-U implementation carries years of custom rate logic that has drifted materially from standard billing engine capabilities; (b) AMI integration and smart meter data management require architectural re-design that brownfield cannot accommodate without major post-migration remediation; or (c) a strategic objective to adopt SAP Customer Experience (CX) or SAP Energy Data Management (EDM) for advanced metering requires a clean architectural foundation incompatible with brownfield's legacy configuration inheritance.

4.2. Brownfield Migration

Brownfield system conversion in a utility context executes an in-place technical conversion of the existing ECC/IS-U system to S/4HANA using SAP's Software Update Manager (SUM) with Database Migration Option (DMO). Existing IS-U configurations, FI-CA document structures, PM object hierarchies, and custom code are retained through conversion, with automatic adaptation to the S/4HANA data model where standard mappings exist. Brownfield represents the lowest technical execution risk and shortest path to production critical for utilities with 24/7 operational continuity requirements but inherits the full custom code estate and IS-U configuration complexity of the existing ECC landscape.

The specific risk of brownfield in utility contexts is the perpetuation of legacy IS-U customizations particularly custom rate determination exits, meter reading interface adaptors, and FI-CA posting routines that prevent adoption of S/4HANA Utilities' native billing engine improvements and smart meter data management capabilities. Brownfield programs that do not include a committed post-conversion IS-U optimization program frequently trade an ECC billing complexity problem for an S/4HANA billing complexity problem.

4.3. Combination (Hybrid) Strategy

The combination strategy Greenfield reimplementation for the enterprise core, paired with brownfield conversion for subsidiary or regional instances, is analytically optimized for large vertically integrated utilities with heterogeneous ECC landscapes. It enables Greenfield's transformation depth in the modules where architectural debt is most material (Finance, EAM, Grid Operations integration) while applying Brownfield's execution risk advantage to subsidiary instances where the transformation value case is lower and operational continuity risk is higher. The governance challenge is defining scope boundaries and designing integration architecture across heterogeneous instances during the program's parallel execution phases.

Table 1: Comparative Analysis: Sap S/4hana Migration Strategies Electric Utility Context

Dimension	Greenfield	Brownfield	Combination (Hybrid)
IS-U migration approach	Full re-implementation on S/4HANA Utilities baseline; custom rate logic redesigned	In-place conversion; custom IS-U exits and rate routines carried forward	IS-U greenfield in enterprise core; retained in subsidiary brownfield instances
EAM / PM transformation	Full EAM redesign against S/4HANA PM/EAM; linear asset management re-architected	Existing PM hierarchy retained; EAM enhancements require post-conversion projects	EAM greenfield in core instance; PM carried forward in subsidiary instances
Typical duration (large utility)	28–42 months	14–22 months	22–36 months

Billing continuity risk	High full IS-U cutover required; meter-to-cash disruption risk elevated	Low-Medium IS-U config retained; go-live risk concentrated in FI-CA data conversion	Medium managed by phasing IS-U brownfield in high-risk subsidiary territories
Custom code outcome	Eliminated by design; BTP side-by-side for genuinely required utility extensions	Carried forward; ABAP remediation required for S/4HANA API compatibility	Retired in core scope; selectively retained/remediated in brownfield subsidiaries
NERC-CIP compliance architecture	Re-established from baseline; compliance architecture designed natively for S/4HANA	Inherited from ECC compliance posture; change impact assessment approach	New compliance architecture for core; change impact assessment for subsidiaries
5-year TCO profile	Lowest long-term: clean core reduces upgrade/maintenance cost	Higher long-term: IS-U and custom code debt drives ongoing remediation	Moderate: core clean core advantage partially offset by subsidiary technical debt
Best-fit scenario	Heavily customized IS-U; AMI integration mandate; strategic clean core objective	Stable IS-U billing; risk-averse organization; compressed program timeline	Heterogeneous ECC landscape; transformation value concentrated in the enterprise core

Note: *Duration estimates reflect large vertically integrated utilities with IS-U, PM/EAM, and regulatory compliance requirements. Programs without IS-U may be 20–30% shorter.*

5. Customer-Managed S/4hana vs. Rise with Sap: Utility Sector Evaluation

The commercial model decision customer-managed S/4HANA deployment versus RISE with SAP carries specific implications for electric utilities that differ materially from the general enterprise evaluation. Three utility-specific factors dominate the analysis: NERC-CIP cybersecurity compliance architecture, existing hyperscaler enterprise agreements, and 24/7 operational continuity requirements that impose constraints on SAP-managed infrastructure change windows.

Table 2: Customer-Managed S/4HANA vs. RISE with SAP: Electric Utility Decision Factors

Evaluation Factor	Customer-Managed S/4HANA	RISE with SAP
NERC-CIP compliance	Full compliance sovereignty; utility controls ESP boundaries and cyber asset classification	SAP infrastructure management requires CIP vendor qualification and ESP access governance; operationally complex
Hyperscaler strategy	Utility selects and manages hyperscaler; existing enterprise agreements and GovCloud tenancies fully leveraged	Hyperscaler selected at contract; existing discount portability may be constrained
Upgrade cadence control	Utility governs upgrade scheduling, maintenance windows, and change freeze periods aligned to grid operations calendar	SAP manages upgrade cadence under contracted SLA; utility change freeze periods require contractual negotiation
Infrastructure cost	Utility bears full hyperscaler and SAP Basis operational cost; higher steady-state infrastructure management overhead	SAP manages hyperscaler tenancy and Basis; infrastructure management cost consolidated in subscription
OT / SCADA integration governance	Full utility control over integration architecture between ERP and OT systems; no third-party dependency in control path	Integration governance maintained by utility; managed infrastructure boundary requires network segmentation documentation for CIP audits
Typical adopter profile	Regulated utilities with NERC-CIP obligations; utilities with established GovCloud tenancies; organizations with mature SAP Center of Excellence	Unregulated or lightly regulated utility subsidiaries; commercial energy retailers; utilities without bulk electric system cyber asset obligations

Note: *RISE with SAP may be appropriate for non-BES utility operations (customer operations centers, back-office functions) where NERC-CIP obligations do not apply.*

6. Combination Migration Strategy: Decision Rationale

The combination migration strategy documented in this use case was selected through a 14-week transformation architecture assessment that evaluated three candidate approaches against a utility-specific scoring framework. The assessment produced a quantified evaluation across eight dimensions IS-U migration risk, EAM transformation depth, NERC-CIP compliance architecture, billing continuity risk, custom code remediation cost, five-year TCO, organizational change management capacity, and program governance maturity for each of the three migration approaches.

Greenfield-only was analytically superior on clean core attainment and five-year TCO but was assessed as unacceptable on billing continuity risk for the utility's two largest service territories: the IS-U configurations governing billing for approximately 2.1 million customers in those territories contained 18 custom rate exits with no standard S/4HANA Utilities equivalent, each requiring redesign, testing, and regulatory rate approval before go-live. Full Greenfield in those territories would have extended program duration to 38 months and introduced customer billing disruption risk that the utility's regulatory commission relationship could not absorb. Brownfield-only, conversely, would have preserved precisely the IS-U custom code complexity that the assessment identified as the primary driver of long-term SAP operations cost deferring, rather than resolving, the transformation value case.

The combination approach was analytically validated as the optimal balance: Greenfield for the enterprise core (Finance, Group Reporting, Asset Management / PM-EAM, Work Order Management, Procurement, and HR), with brownfield system conversion for three regional subsidiary instances, including the two large-territory IS-U instances. A committed IS-U optimization program scoped, budgeted, and staffed as a defined Phase 2 was established as a condition of the combination strategy adoption, ensuring that the IS-U custom code complexity carried forward by brownfield conversion in the subsidiaries would be addressed within a structured 24-month post-go-live window.

7. Large-Scale Implementation Use Case: Vertically Integrated Electric Utility

7.1. Organizational Context and Pre-Migration Landscape

The following use case documents a large-scale SAP S/4HANA transformation program delivered for a vertically integrated electric utility operating regulated transmission and distribution service territories across four U.S. states, with merchant generation assets including thermal, hydroelectric, and wind generation, serving approximately 3.2 million retail customers and managing approximately $28 billion in regulated asset base (RAB). Annual revenue of $7.4 billion and 14,200 employees span regulated utility operations, merchant generation, and energy services subsidiaries.

The pre-transformation SAP landscape comprised four ECC 6.0 EHP7 production instances: a primary enterprise core instance (Finance, Procurement, HR) and three regional utility instances carrying IS-U billing and customer service for distinct service territories. The IS-U estate across the three regional instances encompassed 6,200 IS-U-specific custom ABAP objects including 47 custom rate determination exits, 23 FI-CA posting routines, and 31 meter reading interface adaptors serving three different AMI platforms. The PM/EAM estate comprised 340 equipment hierarchies covering transmission substations, distribution feeders, generation units, and renewable assets, with 8,400 functional locations and 2.1 million equipment records. Point-to-point interfaces numbered 280, spanning SCADA/EMS, AMI platforms (three distinct vendors), Customer Information System (CIS), and Geographic Information System (GIS) integrations.

A 14-week industry consulting-led transformation architecture assessment classified the custom code estate as follows: 2,800 objects recommended for retirement (functionality replaced by S/4HANA standard or no longer operationally required); 1,900 objects recommended for migration to BTP side-by-side extensions under the clean core extensibility model; 3,700 objects (predominantly IS-U rate logic and FI-CA customizations in the regional instances) designated for brownfield carry-forward with committed Phase 2 optimization.

7.2. Program Structure and Migration Design

The program was structured in two sequential waves with a parallel Phase 2 IS-U optimization stream:

- Wave 1 (24 months): Greenfield implementation of the enterprise core S/4HANA instance covering Finance (FI/CO, Group Reporting), Procurement (MM/SRM), Human Capital Management, and critically the enterprise-wide Plant Maintenance / Enterprise Asset Management transformation covering all generation, transmission, and distribution asset classes. The enterprise core instance was deployed on AWS GovCloud (US-East) under the utility's existing AWS enterprise agreement, maintaining full NERC-CIP compliance architecture under utility governance.
- Wave 2 (16 months, commencing Month 18 of Wave 1): Brownfield system conversion of the three regional IS-U instances to S/4HANA, with integration to the Wave 1 enterprise core. IS-U billing and customer service functionality was retained through conversion; FI-CA document structures and custom rate logic were carried forward under the change impact assessment approach.
- Phase 2 IS-U Optimization (18 months, commencing 3 months post-Wave 2 go-live): Structured program to retire or migrate to BTP the 3,700 IS-U custom objects carried forward by brownfield conversion, achieving clean core attainment in the regional instances and enabling adoption of S/4HANA Utilities' native AMI integration framework.

Peak program team comprised 380 resources: 195 industry consulting, 140 utility client staff, and 45 SAP specialists including IS-U architects, PM/EAM subject matter experts, and NERC-CIP compliance consultants. Program governance operated under SAP Activate methodology with 2-week sprint cycles, monthly Architecture Review Board (ARB) gates, and quarterly NERC-CIP compliance checkpoints aligned to the utility's existing regulatory audit calendar.

7.3. Utility-Specific Execution: EAM Transformation

The PM/EAM transformation covering 2.1 million equipment records across generation, transmission, distribution, and renewable asset classes was the most technically complex workstream in the enterprise core greenfield program. Three utility-specific design challenges required dedicated architectural resolution:

1. Linear Asset Management for Transmission and Distribution: SAP's linear asset management (LAM) capabilities in S/4HANA enabled re-architecture of the utility's transmission line and distribution feeder asset hierarchy from the ECC functional location model to a segment-based linear object model enabling spatial attribute management, GIS integration alignment, and regulatory maintenance documentation at the segment level rather than the functional location level. The migration of 8,400 functional locations and associated work order history to the new LAM structure required a dedicated 16-week data migration and cleansing workstream.
2. Generation Asset Compliance Maintenance: NERC reliability standard maintenance requirements (FAC, MOD, PRC standards) mandate documented preventive maintenance programs for bulk electric system generation assets. The greenfield implementation designed NERC-compliant maintenance plans natively in S/4HANA PM, replacing the ECC custom development that had previously generated NERC maintenance compliance reports. Integration with the utility's outage management system (OMS) was re-architected on SAP Integration Suite API flows, eliminating three legacy point-to-point interfaces.
3. Predictive Maintenance Foundation: The greenfield EAM implementation established the data architecture equipment master harmonization, measurement document standardization, and IoT integration design through SAP Asset Performance Management on BTP required to enable predictive maintenance for substation transformer assets in Phase 2. While predictive maintenance was not in Wave 1 scope, the architectural foundation (clean equipment master, standardized measurement points, APM connectivity) was built into the greenfield design to avoid a costly post-go-live re-architecture.

7.4. IS-U Migration: Brownfield Execution and Billing Continuity

The brownfield conversion of the three regional IS-U instances was executed sequentially across Wave 2, with a minimum 90-day stabilization window between each regional go-live. Billing continuity was the non-negotiable program constraint: under the utility's state regulatory commission service agreements and FERC requirements, any customer billing interruption exceeding 72 hours would trigger regulatory reporting obligations and potential service quality penalty proceedings. The IS-U brownfield execution employed a parallel billing run validation approach: for 60 days prior to each regional go-live, the S/4HANA Utilities conversion instance executed parallel billing cycles against the same meter reading inputs as the production ECC instance, with automated reconciliation confirming billing output parity to within 0.01% tolerance. This parallel validation approach requiring dedicated infrastructure investment but eliminating billing accuracy risk at go-live was developed as a utility-specific addition to the standard SAP Activate methodology based on the regulatory consequences of billing errors in a rate-regulated environment. Three IS-U go-live events were executed with zero customer billing interruption and billing accuracy maintained at 99.97% or higher across all three regional instances through the 90-day post-go-live stabilization periods. The FI-CA document migration encompassing 14 years of billing history for regulatory retention compliance was executed using SAP's Migration Cockpit with utility-specific validation rules ensuring open item continuity and dunning history integrity.

7.5. NERC-CIP Compliance Architecture

The NERC-CIP compliance architecture for the S/4HANA environment was designed in parallel with the greenfield implementation, with the utility's Reliability Compliance function embedded in the program governance structure from program inception. Key architectural decisions included:

- Network segmentation: The S/4HANA enterprise core instance was deployed in an Electronic Security Perimeter (ESP) compliant network segment within the AWS GovCloud tenancy, with documented access control architecture satisfying CIP-005 (Electronic Security Perimeters) and CIP-007 (Systems Security Management) requirements.
- Change management compliance: SAP Activate's sprint-based change management process was mapped to the utility's CIP-010 (Configuration Change Management) procedures, establishing an integrated change authorization workflow that satisfied both SAP implementation velocity requirements and NERC-CIP documentation obligations simultaneously eliminating the dual-process overhead that had previously characterized ECC change management.
- Audit trail integrity: S/4HANA's Universal Journal architecture and document-level audit trail were validated against CIP-011 (Information Protection) requirements for electronic access control documentation, with the utility's Compliance function confirming that S/4HANA's native audit capabilities satisfied NERC audit evidence requirements without requiring supplementary custom logging.
- Third-party access governance: The customer-managed deployment model maintained the utility's existing CIP-004 (Personnel and Training) framework for third-party access governance, with program consulting personnel managed under the utility's established Electronic Access Management program rather than introducing a new vendor category.

7.6. Integration Re-Architecture

The 280-interface integration landscape spanning SCADA/EMS, three AMI platforms, Customer Information System, GIS, and OMS was re-architected on SAP Integration Suite deployed on BTP, replacing all point-to-point interfaces with API-based

integration flows. The SCADA/EMS integration received specific architectural attention: real-time equipment status feeds from the EMS to SAP PM used to trigger condition-based work orders for transmission assets were re-implemented as event-driven API integrations with sub-60-second latency, a material improvement over the batch-based ECC interfaces that had introduced 4-to-6-hour equipment status lag in maintenance scheduling. AMI platform integration was re-architected to consolidate three legacy meter data management interfaces (serving three different AMI vendors' proprietary protocols) into a standardized SAP Meter Data Management (MDM) integration layer on Integration Suite, providing a single metering data API surface for S/4HANA Utilities billing and demand response management. This consolidation retired 31 custom ABAP interface objects and reduced meter reading error rates from 1.4% to 0.18%.

7.7. Outcomes and Performance Metrics

At the 12-month stabilization checkpoint following Wave 2 go-live, the following outcomes were measured:

- Custom code estate: 8,400 total objects at program commencement reduced to 3,276 objects across the consolidated S/4HANA landscape at Wave 2 go-live a 61% reduction. Of the 5,124 objects retired or transitioned: 2,800 retired (functionality replaced by S/4HANA standard); 1,900 migrated to BTP side-by-side extensions; 3,700 carried forward by brownfield conversion in IS-U regional instances for Phase 2 optimization.
- Asset maintenance scheduling efficiency: Average work order cycle time from maintenance plan trigger to work order completion and cost settlement reduced by 42%, driven by the linear asset management re-architecture, SCADA/EMS real-time integration, and S/4HANA PM's native mobile work execution capability through SAP Fiori.
- Financial close cycle: Monthly financial close reduced from 9 business days to 3 business days, driven by Universal Journal elimination of FI-CO reconciliation and automated intercompany settlement across generation, transmission, and distribution cost centers previously requiring manual reconciliation.
- Meter reading accuracy: Consolidated AMI integration reduced meter reading error rate from 1.4% to 0.18%, reducing manual meter reading exception handling by approximately 22,000 annual labor hours.
- Integration landscape: 280 point-to-point interfaces consolidated to 174 governed API flows on SAP Integration Suite a 38% reduction in integration objects, with full API governance, versioning, and monitoring capability.
- 5-year TCO projection: $16.8 million projected annual savings by Year 4 against $44 million program baseline, driven by single-instance core economics, IS-U custom code retirement (Phase 2), and integration maintenance cost reduction.
- NERC-CIP compliance: Zero NERC-CIP violations identified in post-go-live compliance audit; integrated CIP-010 change management workflow reduced compliance documentation labor by 35%.
- Billing continuity: Zero customer billing interruptions across all three regional IS-U go-live events; billing accuracy 99.97% or higher through 90-day stabilization periods.

Table 3: Use Case Summary Large-Scale S/4HANA Combination Migration: Vertically Integrated Electric Utility

Parameter	Program Details	Outcome / Metric
Organization profile	Vertically integrated electric utility; 4-state regulated T&D; merchant generation; 3.2M customers; $7.4B revenue; 14,200 employees	—
Pre-migration SAP landscape	4 ECC 6.0 EHP7 instances; 8,400 IS-U/PM custom objects; 280 point-to-point integrations; 3 AMI platforms	—
Migration strategy	Greenfield enterprise core (Finance, PM/EAM, Procurement, HR); Brownfield conversion for 3 regional IS-U instances	Clean core attained in enterprise core; IS-U Phase 2 optimization in progress
Deployment model	Customer-managed S/4HANA on AWS GovCloud (US-East); existing enterprise agreement leveraged; NERC-CIP ESP compliance maintained	Zero NERC-CIP violations in post-go-live audit
Program duration	Wave 1 (greenfield core): 24 months; Wave 2 (IS-U brownfield): 16 months; Phase 2 IS-U optimization: 18 months (in progress)	On schedule across Wave 1 and Wave 2; ±3 weeks variance
Peak team	380 resources: 195 consulting, 140 client, 45 SAP (IS-U, PM/EAM, NERC-CIP specialists)	—
Custom code disposition	8,400 total: 2,800 retired; 1,900 to BTP extensions; 3,700 brownfield carry-forward (Phase 2 target)	61% reduction at Wave 2 go-live (3,276 objects remaining)
EAM transformation	Linear asset management re-architecture; 8,400 functional locations; 2.1M equipment records; SCADA/EMS real-time integration	42% improvement in work order cycle time
IS-U billing continuity	Parallel billing run validation (60 days pre-go-live); sequential regional go-lives with 90-day stabilization windows	Zero billing interruptions; 99.97%+ billing accuracy

Integration re-architecture	280 point-to-point interfaces to 174 API flows on SAP Integration Suite / BTP; AMI consolidation to single MDM layer	38% integration object reduction; meter error rate 1.4% → 0.18%
Financial close	Universal Journal elimination of FI-CO reconciliation; automated intercompany settlement	9 business days → 3 business days
5-year TCO projection	Baseline: $44M annual SAP operations; Year 4 post-stabilization target	$16.8M projected annual savings by Year 4

Note: *Phase 2 IS-U optimization (18-month program) in progress at time of publication; Phase 2 outcomes will be reported in a subsequent paper.*

8. Integrated Decision Framework for Electric Utility S/4hana Programs

8.1. Strategy Selection Logic

The following decision logic synthesizes the assessment criteria and use case evidence into a structured framework for electric utility S/4HANA strategy selection:

- IS-U complexity threshold: IS-U custom code volume and complexity is the primary greenfield/brownfield differentiator: utilities with IS-U custom object counts exceeding 3,000 and more than 30% classified as high-complexity (custom rate exits, FI-CA posting routines) should evaluate combination or phased approaches rather than unitary Greenfield, due to billing continuity risk. Custom object counts below 1,500 with low complexity distribution favor Greenfield IS-U implementation.
- NERC-CIP obligation: Electric utilities subject to NERC-CIP bulk electric system cyber asset obligations should default to customer-managed S/4HANA deployment. RISE with SAP's managed infrastructure model introduces compliance governance complexity that regulated utilities with established NERC-CIP programs will find operationally burdensome. Non-BES utility subsidiaries or commercial energy operations are suitable RISE candidates.
- EAM strategic value: EAM transformation delivers higher value through Greenfield implementation. PM/EAM Greenfield enables linear asset management adoption, predictive maintenance foundation architecture, and SCADA/EMS real-time integration design that brownfield conversion cannot achieve without major post-conversion remediation. Even where IS-U considerations favor brownfield, EAM scope should be evaluated for Greenfield treatment within a combination strategy.
- Billing continuity: Customer billing continuity for regulated utilities is a non-negotiable constraint that must be explicitly designed into migration strategy selection. Parallel billing run validation (60 days minimum), sequential regional go-lives, and 90-day stabilization windows between IS-U go-live events are practitioner-validated design patterns for managing billing risk in regulated utility contexts.
- Phase 2 IS-U commitment: Committed Phase 2 IS-U optimization must be a condition of brownfield adoption in the combination strategy, not an aspirational future program. Organizations treating IS-U custom code simplification as optional post-go-live work will perpetuate the billing engine complexity that drives long-term SAP operations cost in the regulated utility sector.

8.2. The Integrated Decision Matrix

Table 4: Integrated Decision Matrix: Migration Strategy × Commercial Model Electric Utility Context

Decision Factor	Greenfield + Customer-Managed	Combination + Customer-Managed	Brownfield + Customer-Managed	Any Strategy + RISE
IS-U transformation depth	★★★★★	★★★★☆	★★☆☆☆	Strategy-dependent
NERC-CIP compliance fit	High	High	High	Requires enhanced governance
Billing continuity risk	High	Medium (managed)	Low-Medium	Strategy-dependent
EAM modernization ceiling	★★★★★	★★★★☆	★★☆☆☆	Strategy-dependent
5-year TCO	Lowest (if IS-U greenfield achievable)	Low-Moderate	Higher (IS-U debt)	Moderate (infrastructure savings; custom code risk)
Best-fit scenario	Low IS-U complexity; AMI greenfield; strategic clean core mandate	Complex IS-U + strong EAM transformation objective; heterogeneous landscape	Stable IS-U; compressed timeline; NERC-CIP constraints	Non-BES subsidiaries; commercial energy retailers; lightly regulated utility operations

9. Practitioner Lessons

Six practitioner lessons of broad applicability to electric utility S/4HANA programs emerged from this implementation:

1. IS-U readiness assessment precedes strategy selection: IS-U custom code assessment must be the first analytical workstream. The complexity distribution of IS-U custom code particularly the count of custom rate exits, FI-CA posting routines, and meter reading interface adaptors is the primary determinant of feasible migration strategy combinations. Organizations that compress this analysis systematically underestimate brownfield IS-U migration risk and overestimate Greenfield IS-U feasibility within commercial program timelines.
2. Parallel billing run validation is non-negotiable: Parallel billing run validation is a utility-specific addition to standard SAP Activate methodology that eliminates the most material go-live risk in regulated utility IS-U migrations. The 60-day parallel run investment significant in infrastructure and resource cost was recovered in reduced post-go-live exception handling within the first billing cycle.
3. EAM Greenfield investment delivers outsized returns: EAM linear asset management transformation delivers disproportionate value relative to its program investment in electric utilities. The transmission and distribution asset re-architecture on LAM representing approximately 15% of total program investment drove 42% of the work order cycle time improvement and established the architectural foundation for predictive maintenance adoption that the ECC linear asset model could not have supported.
4. NERC-CIP compliance is a program governance function, not a workstream: NERC-CIP compliance architecture must be embedded in program governance from inception, not managed as a compliance checkpoint at go-live. Embedding the Reliability Compliance function in the Architecture Review Board with standing authority to reject design decisions that would compromise the ESP architecture or CIP-010 change management framework prevented 14 design decisions that would have created post-go-live compliance remediation obligations.
5. AMI integration consolidation is a high-return investment: AMI integration consolidation delivers billing accuracy improvement that compounds over the IS-U program lifecycle. The reduction in meter reading error rates from 1.4% to 0.18% eliminated approximately 22,000 annual labor hours of exception handling a benefit that scales with customer count and AMI penetration in a way that ECC's fragmented AMI interface architecture could not have achieved.
6. Phase 2 IS-U commitment is a condition of combination strategy adoption: Phase 2 IS-U optimization must be funded, staffed, and governed at program inception. The organizations that fail to deliver on IS-U custom code simplification post-brownfield-conversion are those that treated Phase 2 as aspirational rather than contractual at the point of combination strategy adoption. The IS-U custom code estate is the primary driver of long-term SAP operations cost in the regulated utility sector; its optimization is not optional for organizations that have adopted the combination strategy.

9.1. Discussion

The use case evidence converges on a finding with specific implications for electric utility enterprises facing the 2027 migration horizon: the combination migration strategy greenfield for the enterprise core and EAM, brownfield for IS-U regional instances, represents the analytically optimal balance of transformation depth, billing continuity risk management, and program timeline feasibility for large vertically integrated utilities with complex IS-U configurations. The customer-managed S/4HANA deployment model's advantages for NERC-CIP-regulated utilities are not merely theoretical. The practical difficulty of managing SAP infrastructure personnel within an Electronic Security Perimeter framework under RISE's managed infrastructure model would introduce compliance overhead that the operational benefits of RISE's managed Basis function do not sufficiently offset. For the utility sector specifically, the existing hyperscaler enterprise agreements that most large utilities have established frequently on AWS GovCloud or Azure Government platforms provide infrastructure management economics comparable to RISE without the NERC-CIP compliance governance complexity.

The EAM transformation evidence, particularly the linear asset management re-architecture and SCADA/EMS real-time integration improvement, demonstrates that the value of S/4HANA in the electric utility sector extends well beyond financial consolidation and is concentrated in the asset management and grid operations integration capabilities that ECC's architecture could not efficiently support. Utilities that treat S/4HANA migration as a financial system modernization program will systematically under-invest in EAM transformation scope and forfeit the most material operational efficiency returns the platform enables. The energy transition context cannot be separated from the S/4HANA migration decision. Electric utilities that delay S/4HANA transformation beyond 2025 will enter the 2027 deadline period, simultaneously managing ECC maintenance obligations, escalating grid modernization demands, and the beginning of AMI data volume management challenges that ECC architectures are structurally incapable of handling at scale. The combination strategy documented in this paper demonstrates that even the most complex utility landscapes, including IS-U regional complexity, NERC-CIP compliance obligations, and 24/7 operational continuity requirements, can be navigated within a structured, phased program architecture.

9.2. Limitations and Future Research

This analysis is based on a single large vertically integrated U.S. electric utility, limiting generalizability to other utility profiles: municipal utilities, rural electric cooperatives, and international utility organizations with different regulatory frameworks will encounter different IS-U configuration environments and compliance obligation structures. The 5-year TCO projection is based on 12-month post-Wave-2 measurements and program baseline estimates; longitudinal validation at Years 3

and 5 is required to confirm financial projections, particularly regarding Phase 2 IS-U optimization cost and benefit realization. Phase 2 IS-U optimization outcomes the 18-month program targeting retirement or BTP migration of the 3,700 custom objects carried forward by brownfield conversion were not complete at time of publication. A follow-on paper will document Phase 2 outcomes, with particular focus on custom rate exit migration to BTP, AMI integration evolution toward SAP Energy Data Management, and the predictive maintenance program outcomes from the Asset Performance Management foundation established in Wave 1. Future research directions include: longitudinal TCO comparison across utility migration strategy combinations; IS-U to S/4HANA Utilities migration complexity frameworks calibrated to rate structure diversity and AMI penetration levels; NERC-CIP compliance architecture patterns for S/4HANA customer-managed versus RISE deployments; and the integration architecture implications of DER management system and Virtual Power Plant (VPP) integration with S/4HANA Utilities in the 2025–2030 grid modernization context.

9.3. Conclusion

The SAP S/4HANA transformation decision for electric power and grid utilities is simultaneously more complex and more consequential than for most enterprise sectors. The IS-U migration challenge, NERC-CIP compliance obligations, 24/7 billing continuity requirements, and the deep integration between ERP and operational technology environments create a transformation context that standard ERP migration frameworks inadequately address.This paper has demonstrated through a large-scale implementation use case that these challenges are navigable. The combination migration strategy greenfield for enterprise core and EAM, brownfield for IS-U regional instances, with a committed Phase 2 IS-U optimization program, provides a structured path to S/4HANA transformation that manages billing continuity risk without sacrificing the EAM modernization and financial architecture transformation that constitute the primary value drivers for electric utilities. Customer-managed S/4HANA deployment on AWS GovCloud maintained NERC-CIP compliance sovereignty without the compliance governance overhead that RISE with SAP's managed infrastructure model would have introduced. A 61% reduction in the custom ABAP estate, 42% improvement in asset maintenance scheduling efficiency, zero customer billing interruptions across three regional IS-U go-lives, and $16.8 million projected annual savings by Year 4 provide quantitative evidence that the combination strategy delivers its value proposition. The electric utility enterprises that will be best positioned for the 2027 deadline and for the grid modernization decade beyond it are those that treat S/4HANA migration as the transformation program it actually is: an architectural investment in the data foundation, operational integration, and clean core platform that grid modernization, energy transition, and regulatory compliance will demand through 2035 and beyond. The platform's capabilities are real, and in the electric utility sector's specific context, its EAM, IS-U, and integration architecture innovations are directly aligned with the operational imperatives that define competitive and regulatory success. The value, as always, is governed into existence.

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