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Leading Utility Practices for Integrated System Planning

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CEC Demand Analysis Working Group Meeting

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Current research on integrated system planning

- Utilities are beginning to move toward integrated system planning (ISP) to develop affordable, reliable, and robust investment plans.
- Scope: Conduct a technical review of ISP practices to date, identifying commonalities and differences with respect to planning across the bulk power and distribution systems
  - Load forecasting
  - Modeling approaches
  - Designing scenarios and sensitivities
  - Reliability planning
  - Co-optimizing investments
- Meet with subject-matter experts and utilities
  - Identify current and future challenges
  - Opportunities for utilities and regulators to advance ISP



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Traditional power system planning

Owned, operated and served by Utility XYZ



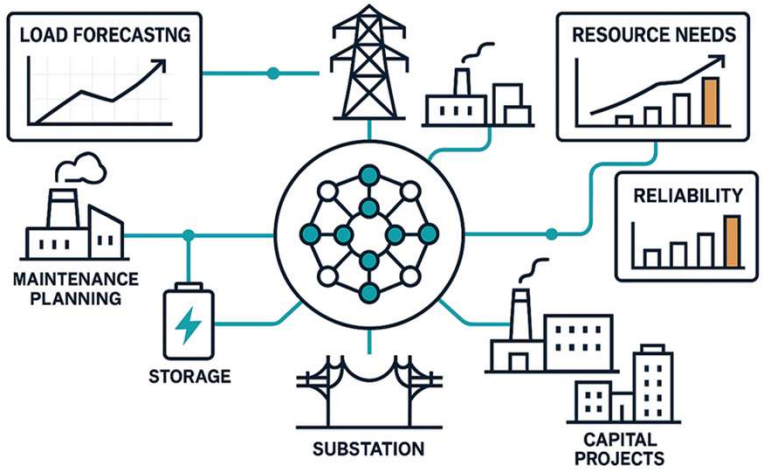
One-way planning for one-way power flow controlled by one company

<u>Planning Goals</u>
Reliability
Affordability

Resource Planning → Transmission Planning → Distribution Planning → Customer Programs

Factors driving the need for a more holistic approach

- Increasing system complexity
  - Resource mix evolution
  - Rapid load growth
  - Adoption of customer-sited resources at the grid edge
  - Aggressive energy goals in some jurisdictions
- Significant uncertainty and risks
  - Extreme weather, forecast uncertainty, price shocks, policy shifts, technology disruptions
- Demand for greater transparency
  - Regulators, stakeholders and customers want more information

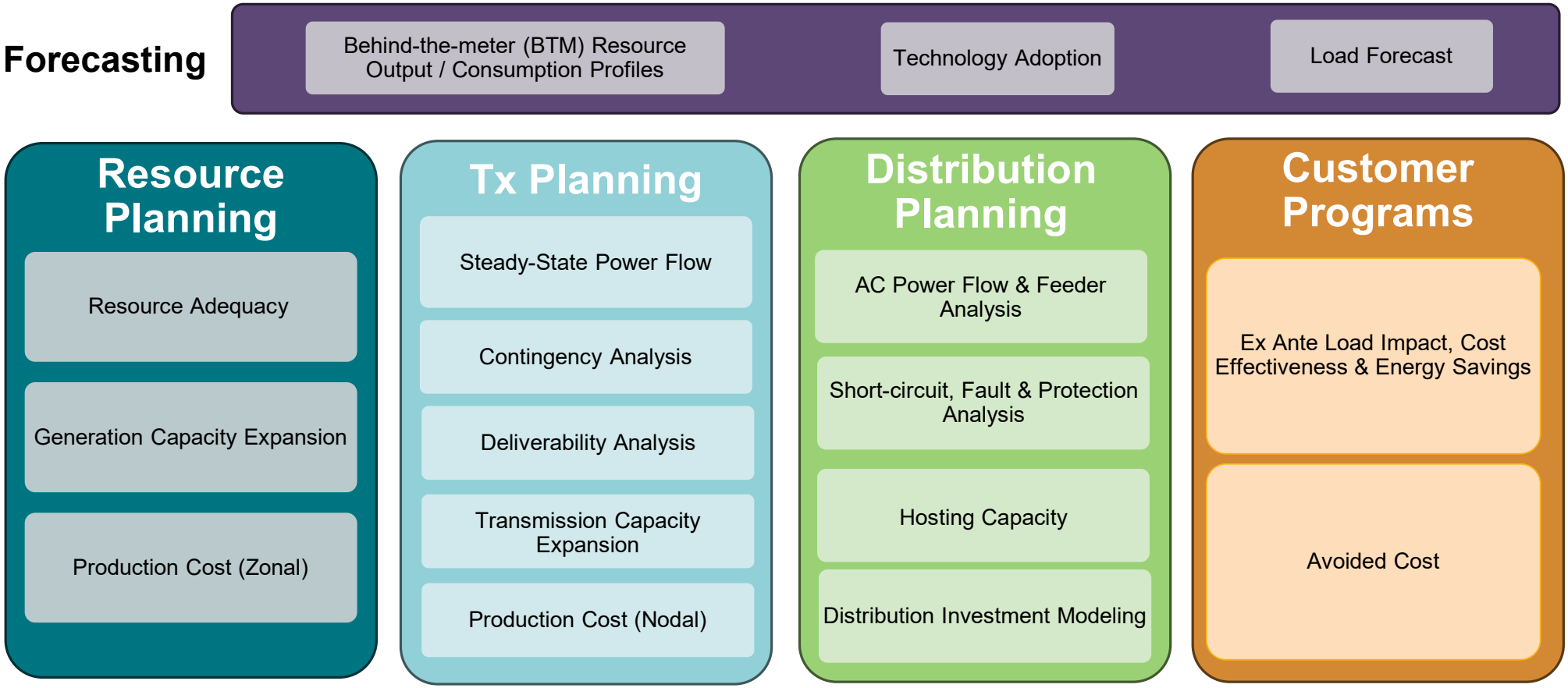


INTEGRATED SYSTEM PLANNING

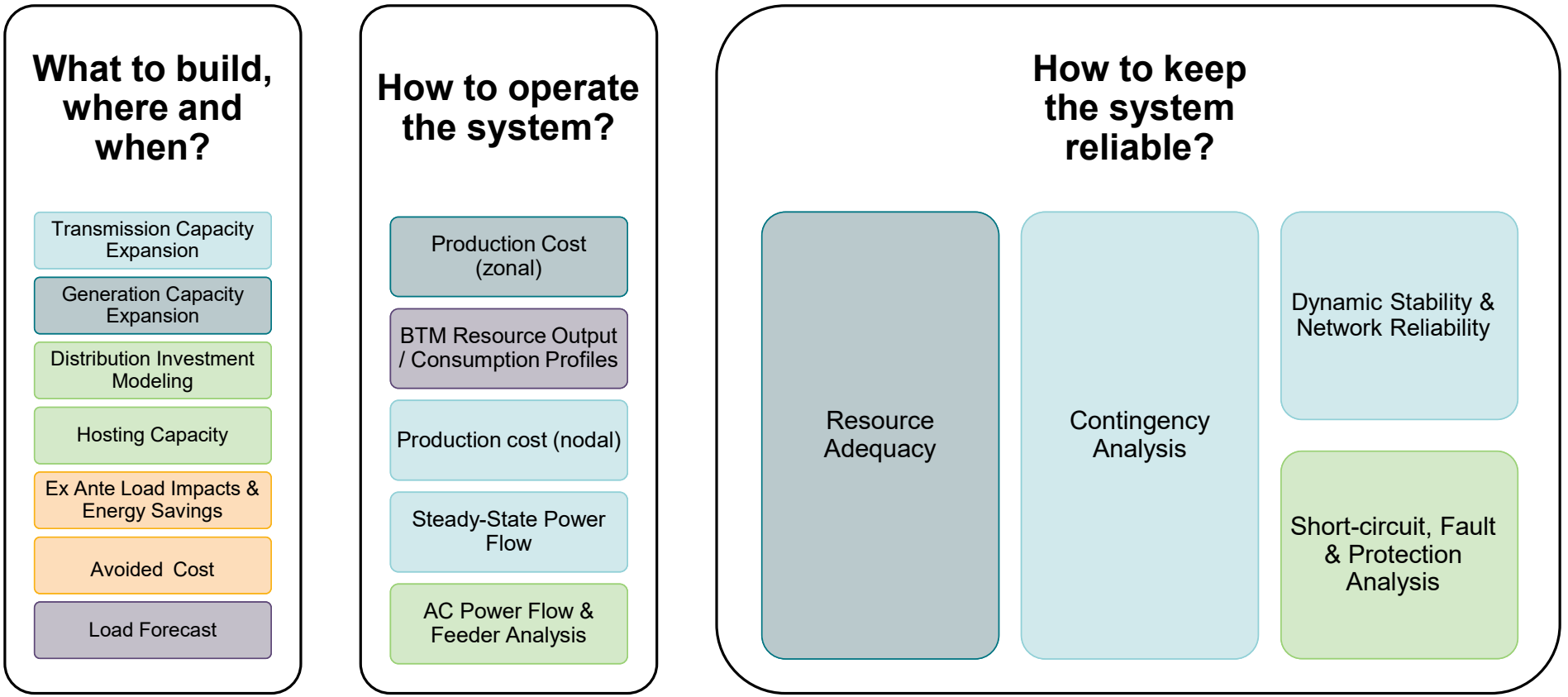


"ISP is is a pioneering effort to integrate generation, transmission, distribution, and customer/DER planning in a single holistic process."
- E3

Planning models



Utility decision-making applications



Distinguishing technical features of ISP

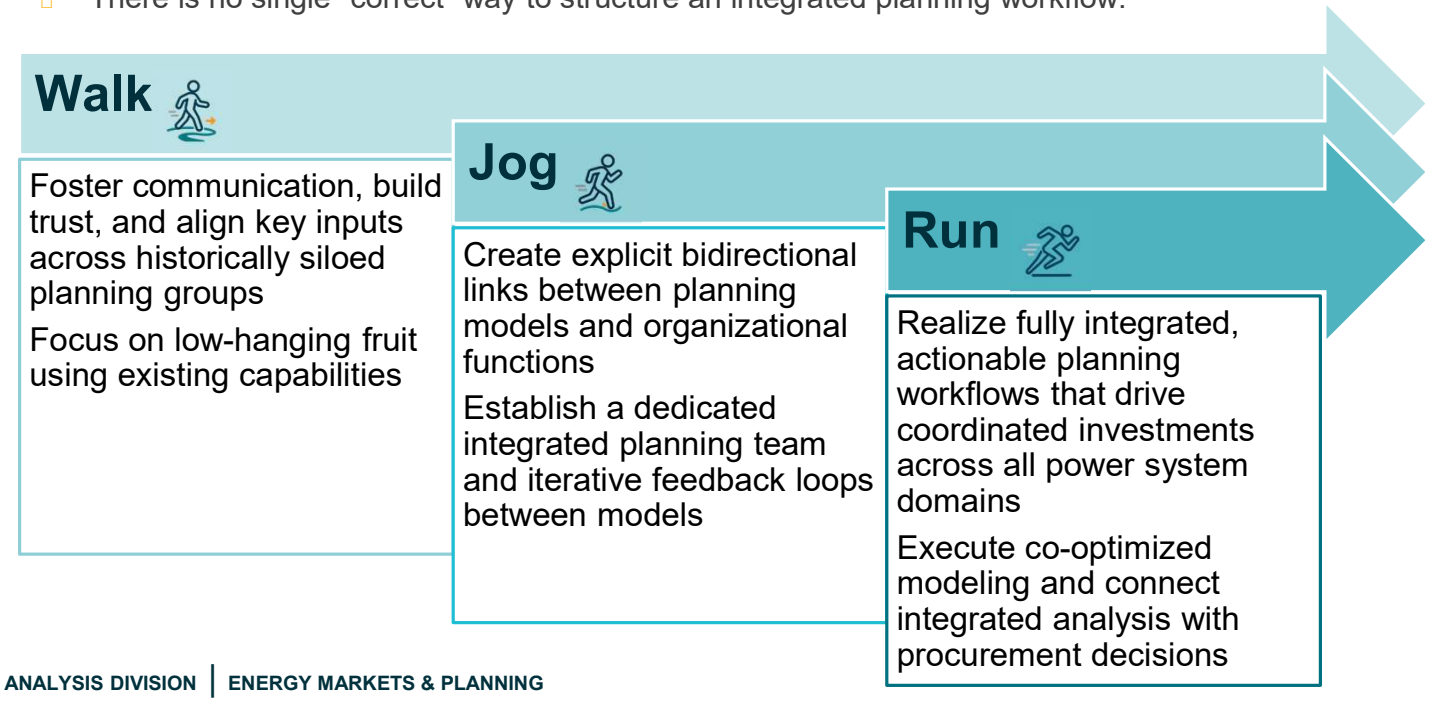
Planning Element	Traditional Approach	ISP Approach
Direction of planning flow	Serial with little-to-no feedback	Closed, iterative feedback loops
Interaction of planning domains (Generation, Transmission, Distribution, Customers)	Separate with minimal interaction and individually optimized plans	Closely coordinated with significant co-optimization
Data integrity	Unaligned data inputs, disconnected load forecasts and potentially inconsistent definitions	Standardized datasets, unified load forecasts and common definitions
Scenario approach	Narrow ranges that are separate for each domain	Common multi-dimensional scenarios provide wide range of possible futures across domains
Solutions considered	Siloed investment options capturing only the benefits in each silo and relying on avoided cost studies for cross-domain valuation	Cross-domain options capturing stacked benefits across Generation/Transmission/Distribution
Organizational & software architecture	Isolated teams with rigid departmental boundaries using specialized tools requiring heavy manual data reconciliation	Cross-functional teams leveraging integrated modeling platforms and shared data schema

“Walk, jog, run”

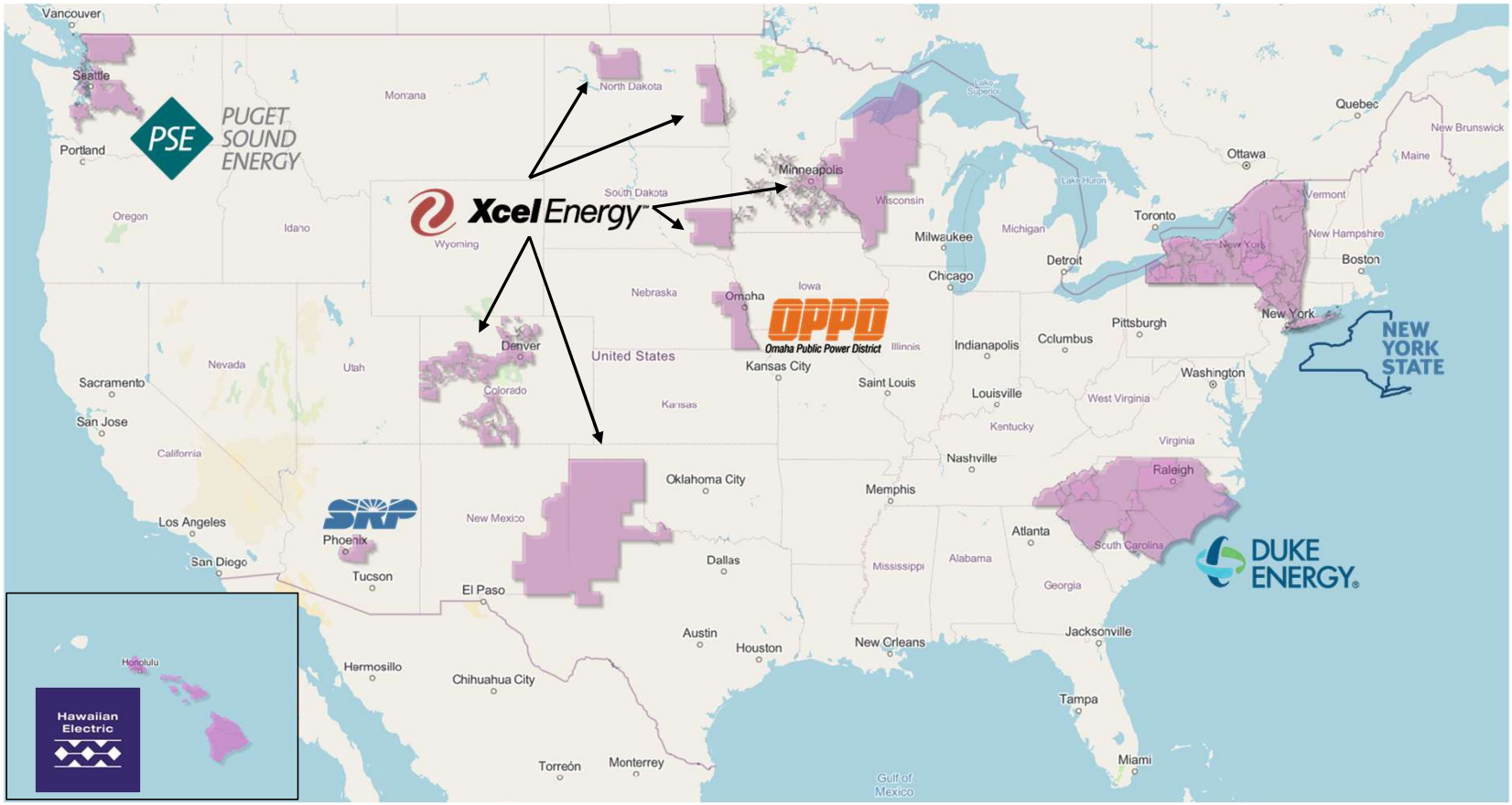
“*The desired level of planning integration across generation, transmission, distribution, and customer loads and resources may vary based on the specific needs and organization of the utility, system operator, or other system structures.*”

- Energy Systems Integration Group (ESIG) Integrated Planning Guidebook (2025)

- Literature identifies a practical roadmap to help system planners transition from legacy processes to an integrated approach over multiple planning cycles
  - Immediately jumping to significant co-optimization in an end-to-end framework is technically and organizationally intractable
  - There is no single “correct” way to structure an integrated planning workflow.



Leading utilities pursuing an integrated planning approach



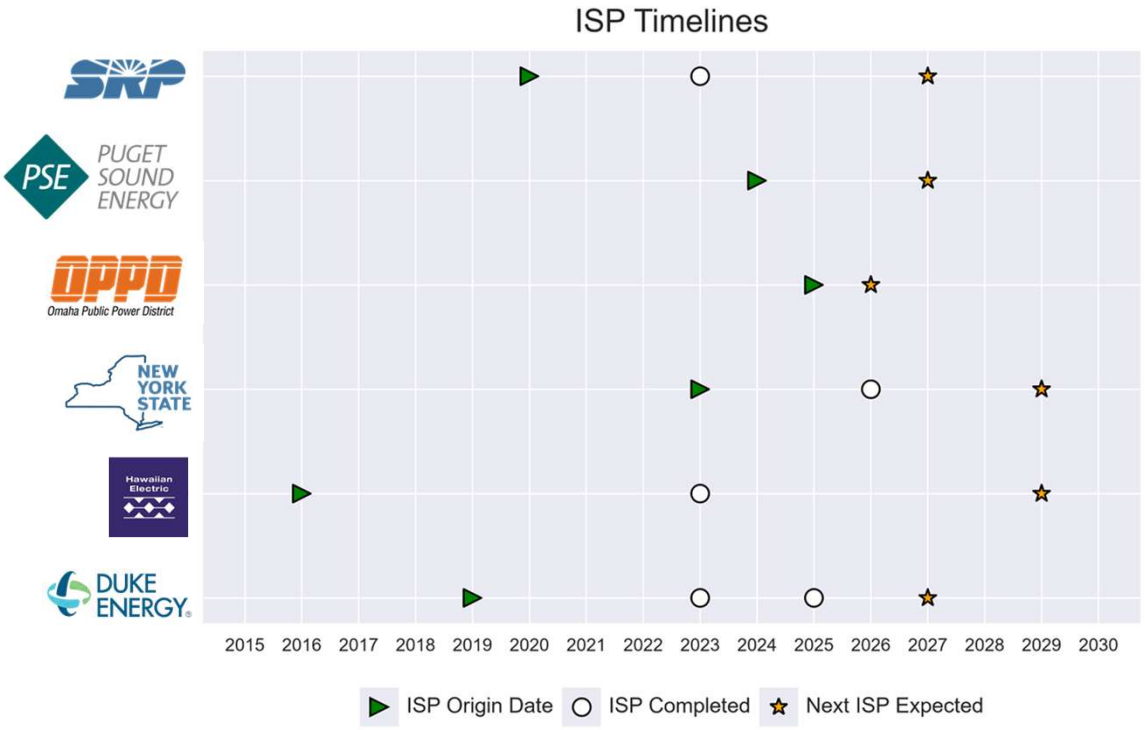
Map created at www.arcgis.com using data from EIA-861

Context for ISPs varies

	Organizational Structure and Planning Context
SRP	• Vertically integrated public power utility outside an RTO/ISO market* committed to corporate goals set by elected board
PSE Puget Sound Energy	• Vertically integrated IOU outside RTO/ISO market* with 100% clean energy mandate • ISP required by state commission and includes the gas system
OPPD Omaha Public Power District	• Vertically integrated public power utility in an RTO/ISO market (SPP) committed to corporate goals set by elected board
New York State	• State-led process coordinating multiple utilities, grid operator (NYISO) and research agency (NYSERDA) in an ISO with a capacity market
Hawaiian Electric	• Vertically integrated IOU with 100% renewable energy mandate • Isolated island grid topology without import/export capability
Duke Energy	• Vertically integrated IOU with service territories in multiple states (IN, OH, KY, NC, SC, FL) • Pursuing ISP in subset of service territories outside RTO/ISO markets (NC, SC)
Xcel Energy	• Vertically-integrated IOU with service territories in multiple states (MN, WI, ND, SD, CO, NM, TX) • Enterprise-level ISP effort across multiple RTOs/ISOs (MISO, SPP) and outside RTO/ISO markets

**Puget Sound Energy and SRP currently participate in CAISO's Energy Imbalance Market and have announced intent to join Southwest Power Pool's Markets+ (day-ahead + real-time markets)*

Still early days for the early adopters



Note: Xcel does not produce dedicated ISP reports and instead uses an integrated planning business unit to incorporate ISP approaches into required regulatory filings across its various service territories.

- Seminal reports and literature have emerged within the last 5 years
  - Electric Power Research Institute (EPRI)
  - Energy & Environmental Economics (E3)
  - Energy Systems Integration Group (ESIG)
  - Institute of Electrical and Electronic Engineers (IEEE)
- Some utilities are working on their first ISP, while the “most experienced” utilities are in their second planning cycle

How are utilities putting ISP into practice? (Preliminary findings)



- Most common planning seams addressed
  - Generation <> Transmission
  - Distribution <> Grid Edge Resources
- Leading utilities are still in the “walk” or “jog” stage
  - Alignment of planning scenarios, data inputs and model assumptions is universal
  - Consistent forecasts incorporating impacts of customer programs and grid-edge resources at fine spatial and temporal granularity are key
  - Some utilities have made progress introducing feedback loops between models
  - Co-optimization across planning domains is rare
- Challenges so far
  - Organizational inertia
  - Data consistency
  - In-house modeling expertise
  - Zonal-to-nodal mapping

Ongoing Activities

- Continued analysis of current utility practices
  - Which planning seams are receiving significant attention from utilities?
  - How are data and models being integrated across traditional silos?
- Discussions with subject-matter experts and utilities
  - ISP progress and successes thus far
  - Challenges
  - Technical needs on the horizon that have not yet been solved
- Targeting report publication in Spring 2027



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