INL Sovereign AI Energy Campus Blueprint

Primary Site: Idaho National Laboratory (INL)

Planning-Only Concept
Structured as an Energy-Integrated Test Environment on DOE-Managed Lands, Aligned with the March 2025 “AI Infrastructure on DOE Lands” Request for Information [DOE RFI, Mar 2025]

Executive Summary

This document presents a planning-grade blueprint for an INL Sovereign AI Energy Campus. It describes how a small, phased, energy-integrated AI campus could conceptually exist within the Idaho National Laboratory site, using INL’s large DOE-managed land base, nuclear energy heritage, and regional transmission context solely as planning inputs, as described in the RFI and its INL appendix [DOE RFI, Mar 2025].

The blueprint defines architecture templates, proxy modeling constructs, governance assumptions, and readiness criteria that DOE can use to evaluate whether and how INL might host sovereign AI infrastructure in the future. All content is strictly conceptual, unclassified, and based on proxy modeling. No operational control of reactors, grid assets, or other facilities is proposed or implied. No procurement, deployment, or vendor selection is contemplated.

Problem Statement and Opportunity

The RFI identifies Idaho National Laboratory as a prominent DOE site with extensive land holdings, a legacy in nuclear energy research and integrated energy systems, and connections to regional transmission infrastructure [DOE RFI, Mar 2025]. INL is described as the nation’s nuclear energy research laboratory with a history of building and testing advanced technologies, including multiple nuclear reactors, and as a leader in integrated energy systems and national and homeland security [DOE RFI, Mar 2025].

The problem is that DOE lacks a site-specific, disciplined concept for how AI infrastructure could be introduced at INL in a way that respects existing missions, environmental conditions, and regional energy context. The RFI notes INL’s suitability in broad terms but does not define an AI campus construct that:

- Defines how AI workloads might conceptually interact with integrated energy systems in planning models.

- Addresses the constraints of INL's extensive yet mixed-characterization lands and environmental conditions.
- Sets out phased, reversible growth paths that can be adapted as mission needs and site information evolve.

The opportunity is to create an INL-specific sovereign AI energy campus blueprint that:

- Uses INL's nuclear and integrated energy heritage purely as context for modeling and planning.
- Treats the site as an energy-linked test environment where AI workloads and conceptual energy resources interact in simulation, not in operations.
- Provides DOE with a conservative, risk-aware planning framework to compare INL with other candidate sites in the RFI.

Scope and Non-Scope

The scope of this blueprint includes defining a planning-only AI campus concept at INL and its relationship to INL's broader energy research landscape, as described in the RFI. The document defines architecture templates, proxy modeling structures, governance concepts, and readiness criteria that DOE can use for potential future internal decisions [DOE RFI, Mar 2025].

Within scope are conceptual definitions of AI campus footprints, their proxy interactions with abstract energy supply and integrated energy systems, environmental and land constraints at a qualitative level, and a phased and reversible growth logic. The blueprint focuses on unclassified planning, simulation, and analysis only.

Explicitly out of scope are any operational, control, or implementation aspects. There is no suggestion of real-time control of reactors, nuclear facilities, or grid elements. No specific reactors, plant types, or operational configurations are described beyond what the RFI provides as general context. No procurement, contracting, or vendor selection is addressed. No new numerical values for capacities, power outputs, transmission ratings, water volumes, workforce counts, or budgets are introduced beyond those stated in the RFI. Where such details do not appear in the RFI, they are explicitly treated as "Not specified in the RFI" [DOE RFI, Mar 2025].

RFI Alignment Narrative (Categories 1–10)

The blueprint is constructed to align with the RFI's structure and intent and to use only INL-specific information that appears in the RFI and its INL appendix [DOE RFI, Mar 2025].

- **Category 1 (Interest in Solicitation)**: The document expresses structured interest in INL as a candidate AI site, emphasizing its large DOE-managed land base, integrated energy systems work, and supportive regional context for advanced energy projects. It does not assume any future solicitation or selection [DOE RFI, Mar 2025].

- **Category 2 (Site Information and Data Center Design)**: The concept uses the INL appendix description that the site is extensive, that DOE owns substantial acreage within the larger INL area, and that these lands have mixed levels of characterization [DOE RFI, Mar 2025]. The blueprint treats AI campus design as modular, with small initial footprints and cautious expansion, without specifying exact footprints, cooling technologies, or building designs, which are not given in the RFI.

- **Category 3 (On-Site Energy Development)**: The blueprint recognizes that INL has a history with nuclear energy and integrated energy systems, and that DOE has previously conducted site characterization for new nuclear reactors at INL as part of the National Reactor Innovation Center [DOE RFI, Mar 2025]. It uses this only to justify conceptual energy-integrated planning, without assuming any particular reactor configuration or on-site energy project.

- **Category 4 (Off-Site Energy and Transmission Capacity)**: The document acknowledges that INL is connected to regional transmission lines, including multiple voltage levels depicted in the RFI appendix map, and that regional projects such as the Gateway West transmission project are in planning [DOE RFI, Mar 2025]. No line ratings, capacities, or interconnection details are introduced beyond what the RFI states.

- **Category 5 (Financial and Contractual Considerations)**: The blueprint notes that any AI campus at INL would involve DOE realty mechanisms such as ground leases or easements and that non-federal parties would bear costs and liabilities for infrastructure, as the RFI describes generally for all sites [DOE RFI, Mar 2025]. It does not propose financial terms or business models.

- **Category 6 (Benefits and Collaboration Opportunities)**: The concept outlines potential benefits such as enabling AI-assisted energy research, integrated energy studies, and national security analytics in a conceptual environment adjacent to INL's research activities. It references INL's leadership in integrated energy systems and nuclear energy research as a basis for such potential, without naming specific programs or partners beyond DOE [DOE RFI, Mar 2025].

- **Category 7 (Economic Opportunities and Considerations)**: The blueprint notes that INL is in a region described as supportive of nuclear and advanced technology projects and that the site could contribute to regional economic activity. Any detailed workforce or tax analysis is outside the RFI and is therefore not specified [DOE RFI, Mar 2025].

- **Category 8 (Environmental Documentation)**: The blueprint reflects the RFI's message that INL's lands have varying levels of characterization and that environmental data, flood information, hazards, and land use plans would be required for any specific project. It treats environmental factors as primary constraints for all campus templates [DOE RFI, Mar 2025].
- **Category 9 (Challenges and Additional Information)**: The concept notes that mixed characterization, potential hazards, and site access restrictions at INL introduce uncertainties that must be addressed through additional studies before any AI infrastructure could be considered [DOE RFI, Mar 2025].
- **Category 10 (Engagement Strategy with Communities and Tribes)**: The document acknowledges that DOE must communicate with Tribes, stakeholders, and local communities on proposed land uses at INL and that any AI campus concept would require early engagement, consistent with the RFI's statements [DOE RFI, Mar 2025].

Site Context (Strictly from RFI)

The RFI describes Idaho National Laboratory as the nation's nuclear energy research laboratory with a legacy of building and testing advanced technologies, including 52 nuclear reactors historically, with four in operation at the time of the RFI's description. It notes that INL is a leader in integrated energy systems and national and homeland security [DOE RFI, Mar 2025].

The site is characterized as an extensive area, with DOE owning a large subset of the overall INL lands. A map in the RFI appendix indicates DOE-owned lands and select areas for potential development with mixed levels of characterization, along with facility footprints and boundaries. The RFI notes that representing larger parcels provides flexibility for future land use planning, and that final areas for any development will be determined based on identified needs and further planning [DOE RFI, Mar 2025].

The RFI also illustrates regional transmission lines of different voltage levels in the vicinity of INL and mentions the Gateway West project as a transmission initiative expected to be in service at a future date [DOE RFI, Mar 2025]. The document does not specify exact transmission capacities, interconnection points, or available power for AI uses at INL.

Where specific details such as precise acreage of candidate parcels, current operating status of reactors, current available power for new loads, water resources, or detailed workforce information are not provided, they are treated as "Not specified in the RFI" [DOE RFI, Mar 2025].

Concept of Operations (CONOPS)

The INL Sovereign AI Energy Campus is conceived as an AI enclave that operates conceptually within the broader INL site while remaining fully separate from operational reactors and other mission facilities. It is characterized as an energy-integrated test environment focused on proxy modeling.

In this conceptual operation, AI clusters are located on DOE-managed lands indicated in the RFI as potential areas for development with mixed characterization. The AI campus is treated in models as a large but governed load that can be aligned with generic representations of energy resources and transmission. The campus' AI workloads are modeled as long-horizon, high-performance tasks that support research and national missions in a general, unclassified way, such as simulations, analytics, and method development.

Energy is represented abstractly as a combination of generic firm and variable supply, reflecting INL's role in nuclear and integrated energy systems but without associating AI loads with any specific reactor, plant, or operational asset. All interactions are simulated; no real-time control is assumed. Environmental and land constraints are applied conceptually to ensure that any modeled AI footprints fit within areas that could be considered for development in future planning.

Phased growth of the campus is represented as additional AI modules being added over time in models, subject to virtual checks on conceptual environmental, land use, and governance constraints. At no point does the CONOPS assume or require integration with classified activities, operational nuclear systems, or live grid assets.

Architecture Templates (I1 / I2 / I3)

The blueprint defines three architecture templates to structure planning at INL: I1, I2, and I3. These are conceptual patterns, not designs.

Template I1: Initial AI Energy Test Node

I1 is the smallest and most conservative template. It represents a single AI test node located in a carefully selected conceptual area on DOE-owned INL land that has sufficient characterization to consider future development in principle, as suggested by the RFI map [DOE RFI, Mar 2025]. The test node is intended solely as a planning construct to explore basic AI-and-energy interactions in proxy models.

Workloads in I1 are modeled as modest AI tasks such as method development and scenario analysis. Energy supply is represented as an abstract connection to generic firm and variable sources in the modeled regional grid, without assigning any specific generation or capacity. Environmental and land constraints are applied conservatively. I1 is designed to be fully reversible and to provide basic insights before any larger concept is considered.

Template I2: Distributed Energy-Integrated AI Nodes

I2 introduces multiple AI nodes distributed across different conceptual INL land areas, each within DOE-owned parcels depicted as potential development zones in the RFI map [DOE RFI, Mar 2025]. These nodes are modeled as separate AI load points with their own local constraints and energy connections, allowing analysis of distributed AI and energy interactions.

Each node in I2 can have a different workload mix, energy interaction profile, and environmental constraint set in models. The distributed nature allows study of how spreading AI loads across multiple locations could influence conceptual energy balancing and resilience in simulations. As in I1, energy resources remain generic abstractions, and all land characteristics beyond what is in the RFI are treated as "Not specified in the RFI."

Template I3: Long-Horizon Energy-Integrated Campus

I3 represents a long-term planning construct where the AI campus grows in phases from I1 or I2 configurations. Over successive phases, additional AI nodes are conceptually added, and their proxy energy interactions are evaluated against evolving assumptions about future integrated energy systems and grid conditions.

In I3, the AI campus remains fully conceptual and unclassified. Each phase is itself modeled as a combination of I1 and I2-like nodes, with new nodes only added at conceptual checkpoints after model-based assessments of environmental, land, and governance constraints. I3 emphasizes reversibility and requires that each expansion can be halted or scaled back without assuming prior commitments.

INL Design Principles

The blueprint adopts specific design principles for the INL Sovereign AI Energy Campus, grounded in the RFI.

- **Mission Protection**: All AI campus activities are conceptual and are assumed to be fully separated from operational nuclear reactors, security operations, and other sensitive INL missions. The AI enclave is treated as a distinct, non-operational planning construct.
- **Land Stewardship**: Only DOE-owned lands flagged in the RFI as potential areas for development with mixed characterization are considered in planning, and even then only at a conceptual level. Final site selection, if ever pursued, would require extensive additional analysis.
- **Energy Integration Through Abstraction**: INL's role in nuclear and integrated energy systems informs the modeling of generic energy supply and integrated energy test scenarios, but no direct coupling to actual reactors or plants is assumed.

- **Environmental Caution**: The blueprint assumes that environmental sensitivities and hazards described in the RFI, such as flood information or hazards in certain areas, would restrict where any AI campus could be considered in future planning [DOE RFI, Mar 2025].
- **Reversibility**: All expansions and architectural choices are designed to be reversible in planning models. No step in I1, I2, or I3 is presented as irreversible or as a commitment to physical development.
- **Unclassified Proxy Operation**: All use cases, data, and models remain unclassified and rely on synthetic or public datasets.

Unclassified Proxy Use-Case Menu

The blueprint recognizes that all use cases must be unclassified and based on proxy or public data. Representative conceptual use cases include:

- **Unclassified Energy Systems Modeling**: Where AI models are trained on synthetic or publicly available energy and grid datasets to explore general patterns without using actual INL or regional system data.
- **Materials and Reactor Physics Method Development**: Using public or synthetic physics datasets that mirror high-performance computing workloads but do not access sensitive or proprietary INL data. These tests would assess how AI methods might support complex simulations in principle.
- **Environmental and Climate Proxy Modeling**: Based on publicly available or synthetic data to explore how AI might assist in large-scale environmental analysis around sites like INL without connecting to operational monitoring systems.
- **Grid-Aware AI Scheduling**: Where synthetic grid time series and load profiles are used to test AI workload scheduling algorithms for load shaping, again without using real operational grid data.

Any additional use cases would follow the same principle: proxy or public data only, no direct access to operational INL systems or real-time grid controls.

Proxy Modeling Plan (Tool-Agnostic)

The proxy modeling plan for the INL Sovereign AI Energy Campus is tool-agnostic and uses only abstractions consistent with the RFI. AI workloads in I1, I2, and I3 are represented as time-varying demand profiles at conceptual nodes corresponding to each AI cluster.

Energy supply is modeled as a set of generic firm and variable sources connected through abstracted transmission paths that conceptually reflect the existence of multiple voltage-level lines shown in the RFI map and the Gateway West project mention [DOE RFI, Mar 2025]. No specific megawatt values or line ratings are used beyond what the RFI states, and all advanced energy technologies are represented generically.

Environmental and land constraints are encoded as exclusion and suitability zones based only on the RFI's qualitative descriptions of mixed characterization and hazards. For example, areas indicated as having flood concerns in the map would be treated as unsuitable for conceptual AI nodes, but no detailed flood depths or frequencies are assumed [DOE RFI, Mar 2025].

Scenarios include baseline operations where AI nodes run at nominal patterns; stress scenarios where generic energy availability profiles are constrained to test AI scheduling; and expansion scenarios where additional AI nodes in I3 are added to evaluate cumulative impacts. Outputs are qualitative or range-based and focus on relative comparisons rather than numerical forecasts.

Validation / Sensitivity / Robustness / Reversibility

Validation

Validation focuses first on internal consistency. Model inputs and assumptions are checked to ensure they are consistent with what the RFI states about INL's lands, energy context, and hazards [DOE RFI, Mar 2025]. Any site or energy detail not in the RFI is either omitted or labeled as "Not specified in the RFI."

Sensitivity

Sensitivity analysis varies key planning parameters within conservative ranges. These include the number and size of AI nodes in I2 and I3, the proportion of workloads modeled as flexible versus inflexible, and the degree of abstract energy constraint imposed in stress scenarios. The goal is to understand which assumptions most influence qualitative performance bands such as load accommodation and conceptual energy matching.

Robustness

Robustness is assessed by examining how each architecture template performs across a range of scenarios. I1 is expected to be robust in most conditions because of its small scope. I2's robustness depends on the ability to distribute AI loads across multiple conceptual sites without hitting land or hazard constraints. I3's robustness depends on how future phases interact with evolving assumptions about environment and energy.

Reversibility

Reversibility is embedded in all templates. I1 is inherently easy to scale back or abandon in planning. I2 allows removal of individual nodes. I3 includes conceptual decision points between phases where expansion can be paused or altered if new information suggests that constraints are tighter than expected. No step in the blueprint is assumed to bind DOE to a particular development path.

Governance, Security Zoning, and Data Handling

Governance

Governance for any AI campus at INL would operate within DOE's existing authorities and INL site governance. The RFI indicates that DOE would control realty agreements and land use terms, and that any AI infrastructure would have to be sited in coordination with existing site plans and missions [DOE RFI, Mar 2025]. This blueprint assumes that any further planning would be integrated with those processes.

Security Zoning

Security zoning is assumed as a planning constraint. The AI enclave is conceptualized as physically and logically separated from nuclear and security facilities. Access controls, network separation, and physical barriers are treated as necessary but are not specified in design terms. Classified workloads and special access environments are not included in this planning document.

Data Handling

Data handling is assumed to be unclassified and based on proxy or public datasets. Any future shift toward sensitive or mission-linked data would require separate, more detailed governance design, including data classification, access controls, and handling procedures. Those are beyond this blueprint's scope.

Collaboration Model

The collaboration model reflects INL's role and the broader DOE context described in the RFI. DOE retains strategic oversight of site selection and AI infrastructure planning [DOE RFI, Mar 2025]. INL provides scientific and technical input on integrated energy systems and nuclear energy research, as allowed by policy and within unclassified bounds.

Regional transmission entities would, in any further planning stage, be involved in providing planning-level information about interconnection possibilities and constraints, subject to their

own data sharing rules. Local communities and Tribes would be engaged as part of DOE's land use planning responsibilities for INL [DOE RFI, Mar 2025].

Research and academic partners may contribute methods for AI modeling of energy systems and environmental domains at a conceptual level. No specific institution, vendor, or consortium is assumed or named.

Deliverables Package

If DOE chooses to advance this concept into a fuller planning exercise, the deliverables would include:

- **Architecture Template Report**: Describing I1, I2, and I3 in detail, including their underlying assumptions, constraints, and conceptual roles.
- **Proxy Modeling and Scenario Report**: Documenting the modeling constructs, scenario definitions, and qualitative results for the different templates.
- **Governance and Zoning Note**: Outlining how potential AI footprints would align with INL's site governance, land use plans, and mission protection requirements.
- **Environmental and Land Constraints Brief**: Synthesizing what is known from the RFI and identifying needed additional data.
- **Readiness and Decision Framework**: To help DOE determine whether INL should move to more detailed studies or remain at the conceptual planning stage.

Timeline as Phases (No Calendar Dates)

The blueprint uses a phase-based framework without specific dates, consistent with the RFI's planning orientation [DOE RFI, Mar 2025].

- **Phase 0**: The emphasis is on concept refinement and initial modeling. Architecture templates are finalized, and first-pass proxy modeling and scenario analysis are completed, producing qualitative comparisons among I1, I2, and I3.
- **Phase 1**: Focuses on site and stakeholder refinement. INL site governance, environmental data, and land use plans are reviewed in more detail to align conceptual AI footprints with candidate areas, while early engagement plans for communities and Tribes are developed.

- **Phase 2**: A DOE decision phase. Based on the results of Phases 0 and 1, DOE decides whether further detailed environmental, engineering, and governance studies related to AI infrastructure at INL are warranted.
- **Phase 3**: If initiated, would involve pre-solicitation studies, including more detailed environmental analyses, hazard assessments, and transmission studies under DOE's existing processes. No procurement or deployment action is implied by this phase in the blueprint.

Risks, Assumptions, and Mitigations

Assumptions

The blueprint relies on several assumptions. It assumes that INL's DOE-owned lands include areas that could potentially host new infrastructure, as suggested by the RFI, but does not assume any specific parcel suitability [DOE RFI, Mar 2025]. It assumes that the regional context will remain supportive of nuclear and advanced technology projects, as described in the RFI, without assuming specific policies. It assumes that integrated energy system research at INL will remain a relevant context for AI energy modeling.

Key Risks

Key risks include uncertainties about land characterization, environmental hazards, and compatibility of any new infrastructure with INL's missions. There is also uncertainty about future energy system configurations and grid constraints in the region. Another risk is the possibility that stakeholder or community perspectives may limit or oppose certain land uses.

Mitigation Measures

Mitigation measures within this blueprint include keeping all architecture templates phased and reversible, using only proxy modeling rather than operational assumptions, and explicitly relying on further detailed studies and engagement before any real development is considered.

Success Metrics

Success metrics for this blueprint are qualitative and focus on planning completion rather than implementation. One metric is the production of internally consistent, RFI-aligned architecture templates and modeling constructs that can be used for cross-site comparison. Another metric is the identification and documentation of critical information gaps related to INL land, environment, and energy that would need to be addressed in any subsequent planning stage.

A further metric is the development of a clear readiness and decision framework that allows DOE to decide whether to advance INL in its AI infrastructure planning. Success is defined as a high-quality, conservative planning basis, not as movement toward deployment.

No-Fabrication Assurance

This INL Sovereign AI Energy Campus Blueprint is based exclusively on information contained in DOE's March 2025 "AI Infrastructure on DOE Lands" RFI and its Idaho National Laboratory appendix, together with the previously defined Project 24 concept and general DOE planning logic [DOE RFI, Mar 2025]. No new site-specific numbers for power, acreage, water, transmission ratings, workforce, budgets, or timelines have been introduced beyond what is explicitly stated in the RFI. Where information is not specified in the RFI, it is treated as "Not specified in the RFI" and handled qualitatively. All modeling and operational discussions are strictly proxy-based and conceptual. No operational control, grid actuation, reactor interfacing, facility control, procurement, or vendor selection is proposed or implied.

View Implementation Guide (Planning) (Manual link: https://ucdpforge.com/pdfs/NLIG/INL_AI_Energy_Impl_Guide.pdf)